



EUROPEAN COMMUNITY
COMPETITIVE AND SUSTAINABLE
GROWTH PROGRAMME



SOURDINE II

D6-2

Prototyping results flight simulator

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

Sourdine II Consortium:

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

Document Change Log

| Release | Author | Affected Sections / Comments | Document Nature | Date |
|---------|--------|------------------------------|-----------------|----------|
| 0.1 | NLR | All, Creation | Confidential | 11/10/04 |
| 0.2 | NLR | Update title | Confidential | 10/11/04 |
| 0.3 | NLR | Update after review partners | Confidential | 07/03/05 |
| 1.0 | NLR | Final version | Public | 17/05/05 |
| 2.0 | NLR | Inclusion of EC approval | Public | Sept '05 |

Document Distribution

| Partner | Distribution list |
|---------------------------------|--|
| AENA | Pablo Sánchez Escalonilla Alfredo Gomez de Segura |
| Airbus France | Michel van Boven |
| Eurocontrol Experimental Centre | Peter Hullah Laurent Cavadini |
| Ineco | Peter Lubrani |
| Isdefe | Marcos Esteban Medina |
| NLR | Ruud Den Boer Collin Beers |
| SICTA | Mariacarmela Supino |

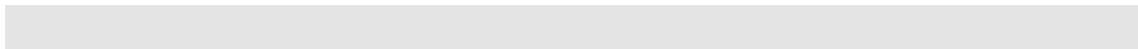
Review and Approval of the Document

| Organisation Responsible for Review | Reference of comment documents | Date |
|---------------------------------------|---------------------------------------|----------|
| AENA | E-mail | 25/01/05 |
| SICTA | E-mail | 23/02/05 |
| Organisation Responsible for Approval | Name of person approving the document | Date |
| Project Manager | Ruud den Boer | June '05 |
| Work Package Leader | Collin Beers | June '05 |
| EC Official | Morten Jensen | June '05 |

| Document Information | |
|-------------------------|---|
| Document title | Prototyping results flight simulator |
| Version | V2.0 |
| Date | 03-01-2006 |
| Classification | Public |
| Work package | WP6.1 |
| Document identification | SII_D6-2_Flight_simulator_prototype_results_v10.doc |

| Contributing Partners | Authors |
|-----------------------|---|
| NLR | H. Huisman, huisman@nlr.nl N. de Gelder, degelder@nlr.nl M. Roerdink, mroerdin@nlr.nl |

| Contact Information |
|--|
| National Aerospace Laboratory, NLR |
| Attn. Mr. C.S. Beers |
| Anthony Fokkerweg 2 |
| 1059 CM Amsterdam |
| The Netherlands |
| Tel.: +31-20-5113173 |
| Fax: +31-20-5113210 |
| e-mail: csbeers@nlr.nl |



Summary

As part of work package 6 a prototyping evaluation has been conducted to gather pilot views on both the SourDine II procedures as well as the flight deck tools to support these procedures. Three pilots participated in the prototyping sessions for which a medium fidelity cockpit mock-up called APERO was used. One former test pilot, one technical pilot and an instruction pilot participated.

The results show that the acceptance of arrival procedure IV was very low and technical problems and risks were identified. Arrival procedure II was deemed feasible although questions were raised whether the noise benefit would be sufficient. The pilot support tools on the flight deck were only partly required, some elements could be removed without any problem.

Table of Contents

| | |
|--|----|
| Summary | 5 |
| 1 Introduction | 8 |
| 1.1 Purpose..... | 8 |
| 1.2 Background..... | 8 |
| 1.3 Document Structure | 8 |
| 1.4 Glossary..... | 9 |
| 1.5 Reference documents..... | 9 |
| 2 Objectives of the prototyping..... | 10 |
| 3 Prototype environment | 11 |
| 4 Prototype variables..... | 14 |
| 5 Results..... | 15 |
| 5.1 Introduction | 15 |
| 5.2 Procedures evaluated..... | 15 |
| 5.3 Arrival Procedure 2 (2 degrees descent path, without speed constraints)..... | 15 |
| 5.4 Arrival procedure 2 (2 degrees descent path, with speed constraints) | 16 |
| 5.5 Arrival procedure 4 (full landing configuration, idle descent from 7000ft) | 16 |
| 5.6 Arrival procedures 3 and 5..... | 17 |
| 5.7 Departure procedures..... | 17 |
| 5.8 General remarks | 18 |
| 5.9 Results versus the 7 objectives | 18 |
| 6 Conclusions | 20 |
| 7 Recommendations | 21 |
| Appendix A: Procedures | 22 |

Figures

Figure 1 Cockpit Mock-up Apero

Figure 2 Primary Flight Display with energy cue (left of the artificial horizon)

Figure 3 Navigation display with Sourdine specific elements

Figure A.1: RNAV transitions, approaches and SIDs during Mode 2

1 Introduction

1.1 Purpose

The general aim of the SII flight deck prototyping sessions for the airborne side was

- to present pilots with the new noise abatement procedures (NAPs) and the pilot tools,
- to collect pilot comments regarding the expected feasibility ("flyability") and acceptance of the proposed NAPs,
- to collect pilot comments regarding the usability and acceptance of the proposed pilot tools.

The collected comments and pilot views served as input for the definition of the evaluation in the full mission flight simulator GRACE. For these evaluations in GRACE, crews will be invited consisting of airlines whereas for the prototyping sessions as described in this document only single pilots were involved all being test pilots or technical pilots.

1.2 Background

The new air traffic management (ATM) concept, which the Sourdine II project intends to address, is to improve the impact of aircraft noise and emissions around most airports by the definition of new approach and departure procedures.

Before new procedures can be implemented, it needs to be demonstrated that they do indeed solve the ATM problem they were designed to solve in a satisfactory way. After this, an accepted implementation plan will be studied within the project to provide information and improve acceptance in Europe.

Sourdine II will use validation to ensure the quality and suitability of the new air navigation procedures that Sourdine II proposes to solve part of current problems in European ATM. Validation is the process which an ATM concept undergoes throughout its lifecycle in order to ensure that it addresses the ATM problem for which it was designed and that it achieves its stated aims.

Homogeneity of experiment results has been ensured through the elaboration of a validation plan and the set up of a suitable validation management structure. The validation plan is based on existing ATM validation frameworks (MAEVA) and emphasises exercises to build confidence in the airport approach and departure procedures developed within Sourdine II.

A programme of validation exercises has also been defined, using the most suitable validation techniques and sequencing for each lifecycle phase, to establish objectively the performance benefits that Sourdine II can deliver.

1.3 Document Structure

This document contains seven sections and two appendixes that includes additional information and specifications:

- Section 1 presents a brief introduction that includes the document purpose, the project background, the document structure, as well as the definition of the terms and the description of the referenced documents used in this document.
- Section 2 discusses the objectives of the prototyping sessions and the questions that need to be answered during these sessions.
- Section 3 describes the environment in which the prototyping sessions have been conducted.

- Section 4 describes the prototyping variables.
- Section 5 describes the results of the prototyping sessions.
- Section 6 contains the main conclusions derived from the prototyping sessions.
- Section 7 contains the main recommendations derived from the prototyping sessions.

Finally, the appendixes include the procedures used during the prototyping sessions and the changes made to NARSIM simulator during SOURDINE II

1.4 Glossary

| Term | Description |
|-------|---|
| APERO | Advanced Prototyping Environment |
| ATC | Air Traffic Control |
| CDU | Control and Display Unit |
| DCP | Display Control Panel |
| FMS | Flight Management System |
| GRACE | Generic Research Aircraft Cockpit Environment |
| HMI | Human-Machine Interface |
| ILS | Instrument Landing System |
| LNAV | Later Navigation |
| NAP | Noise Abatement Procedure |
| ND | Navigation Display |
| PFD | Primary Flight Display |
| RTS | Real Time Simulation |
| VNAV | Vertical Navigation |

1.5 Reference documents

| Short Reference | Description |
|-----------------|---|
| [TA] | SII Technical Annex. |
| [D2-1] | D2-1: Validation Methodology Report, version 0.9 |
| [D3-1-2] | Updated Definition of New Noise Abatement Procedures |
| [D3-2] | Requirements document for the pilot and controller tools |
| [D6-1] | D6-1: Prototyping results ATC simulator |
| [D6-6] | D6-6: Concept of operation for Schiphol airport simulations |

2 Objectives of the prototyping

The general aim of these sessions is to get pilot feedback on both the pilot tools as well as for the procedures. For these prototyping sessions the same objectives apply as for the RTS sessions are stated. However, in the RTS sessions objective measurements will be used to support the investigation of these objectives. The prototyping sessions as discussed in this report include only qualitative, subjective, pilot feedback. In order to let pilots be able to form an opinion about the pilot tools and the procedures, a cockpit mock-up, APERO, was used which included the Sourdine II specific pilot tools and the Sourdine procedures were pre-programmed in the FMS.

It was decided to limit the number of procedures during the prototyping sessions to a near term and a longer term procedure, leaving sufficient time for discussion with the pilots. As near term solution, procedure II was used and procedure IV was selected as the longer term solution. By evaluating procedure II and IV most important issues were thought to be covered I these prototyping sessions.

Objective 1: Evaluate the flyability of the proposed NAPs.

Objective 2: Evaluate whether the proposed Noise Abatement Procedures (NAPs) yield a reduction in the noise level as compared with current procedures.

Objective 3: Evaluate the impact of the NAPs on airline costs (“flight efficiency”).

Objective 4: Evaluate whether the proposed NAPs and pilot tools change the level of safety as compared with current procedures and tools.

Objective 5: Evaluate acceptance of the NAPs and pilot tools.

Objective 6: Evaluate the impact of the proposed NAPs and pilot tools on workload.

Objective 7: Evaluate the impact of the NAPs and pilot tools on situational awareness (“energy awareness”).

For all above mentioned objectives applies that pilot opinions and expectations will be collected during the prototyping sessions. More objective results will be collected during the flight simulator experiment which will be the follow up of these prototyping sessions.

3 Prototype environment



Figure 1 Cockpit Mock-up Apero

Flight Deck displays

In support of the Sourdine II procedures the following tools are added on the flight deck:

- Energy cue (PFD)
- Vertical navigation display (ND)
- Flap and gear deployment cues (ND)
- Required descent point (ND) (for either idle or 2 degrees descent)

Further modifications are assumed not to be required. The relevant procedure is assumed to be available in the navigation data base. Which is for the prototyping sessions the case.

As baseline Airbus A330 display layouts were used.

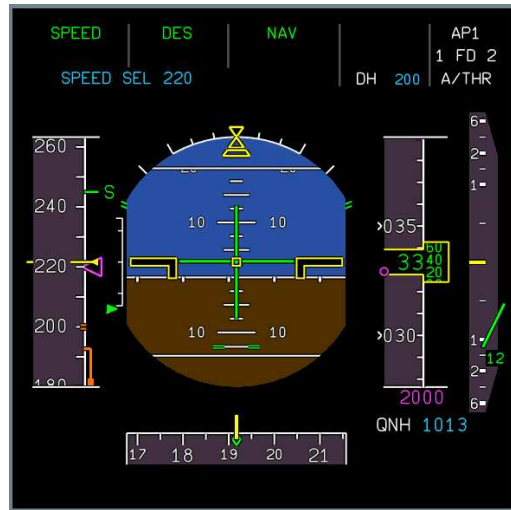


Figure 2 Primary Flight Display with energy cue (left of the artificial horizon)

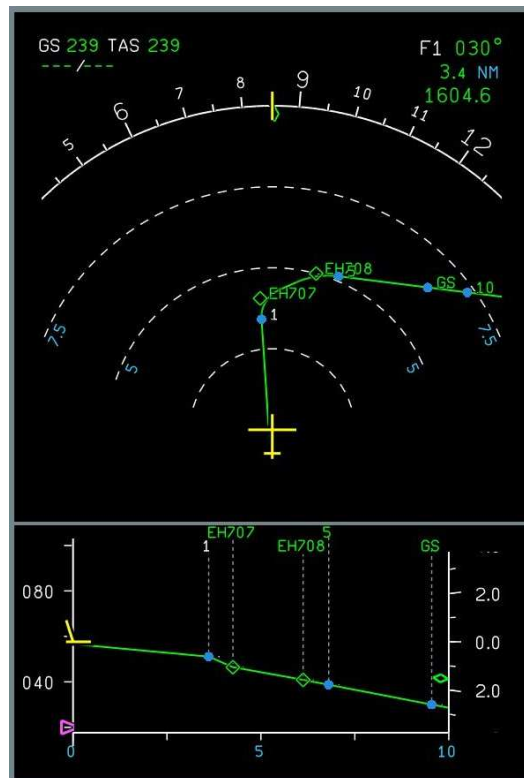


Figure 3 Navigation display with Sourdine specific elements

APER0 provides next to the primary flight display (PFD) and navigation display (ND) as presented above the following:

- Control and Display Unit (CDU) of the Flight Management System (FMS)

- Electronic Centralised Aircraft Monitor (ECAM) for amongst others engine indications
- Flight Control Unit (FCU) for auto pilot settings
- Display Control Panel (DCP) for (navigation) display settings
- Flap lever
- Gear lever
- Speed brakes lever



4 Prototype variables

During the evaluation noise abatement procedure II and IV were evaluated using the pilot tools as presented in chapter 2. For procedure II speed constraints were varied from none to relatively low speeds. Procedure I was assumed to be the standard operating procedure as currently used and since no measurements were taken, but only subjective feedback no added value was assumed. Procedure III and V were not part of the prototyping setup but were discussed based upon the procedure description of Sourdine II.

The take-off noise abatement departure procedures were discussed based upon the Sourdine descriptions.

5 Results

5.1 Introduction

Three pilots participated in the prototyping sessions, one former aircraft manufacturer test pilot, one technical pilot and one instruction pilot.

For all sessions applied that it started with level flight at 7000ft, assuming transition level to be passed already. The FMS was pre-programmed with the arrival route including the ILS for the expected runway. The speed was in all cases 250kts. Pilots were encouraged to think aloud and comment on each item, either flight deck implementation, NAP procedure, crew procedure etc.

During these sessions no simulator data was recorded since three pilots make only a small sample and the flights were used only to provoke discussion and get feedback in the sense of expert judgement rather than performance data.

In the next sections comments of the pilots are given without prioritization nor discussion concerning relevancy. Only qualitative results were captured due to the nature of the sessions.

5.2 Procedures evaluated

The prototyping sessions were conducted in a medium fidelity mock-up with the goal to collect comments and pilot views on the Sourdine II procedures and pilot tools. During these sessions pilots were asked to relate the Sourdine II procedure with the current day practice which they normally perform in their daily operation. Therefore procedure I has not been evaluated since it is not required to have a reference scenario when collecting only subjective feedback.

It was decided to limit the number of procedures during the prototyping sessions to a near term and a longer term procedure, leaving sufficient time for discussion with the pilots. As near term solution, procedure II was used and procedure IV was selected as the long term solution. This means that procedure III and V were not part of this evaluation. Procedure III was regarded as a longer term due to the fact that it includes a four degrees ILS path and procedure V was seen as the more conservative version of IV. By evaluating procedure II and IV the most important issues were covered.

Regarding the departure procedures no flights were performed, only discussions with the pilots were conducted in order to get their opinion.

5.3 Arrival Procedure 2 (2 degrees descent path, without speed constraints)

- Starting the sequence of speed reductions and configuration changes initially with 250kts leads to a high workload situation where many configuration changes need to be made in a very limited time span. It need to be emphasized that the FMS calculations were based upon idle thrust settings between the first speed reduction until final approach speed was reached.
- In case the aircraft remains too high, it is very difficult to correct for this altitude error later during the arrival and approach. The main reason for this is that the FMS deceleration/flap extension schedules are based on idle thrust from the first deceleration.
- Due to the fact that speed reductions are applied rather late, the risk exists that the localizer is intercepted with an unusual high speed. Auto pilot designs normally have a maximum speed to allow for an appropriate localizer capture.
- During the initial descent from 7000ft on the 2 degrees descent path, thrust is required, this has the following aspects:

- towards the first deceleration point thrust is required. The concern was that this would be fuel inefficient and hardly low noise. It should however be kept in mind that the assumption behind procedure II is that descending with 2 degrees produces less noise than level flight, which is currently applied, and therefore a noise benefit is achieved.
- making a turn, the aircraft is banking which leads to an increase in drag. In order to maintain the 2 degrees path and maintain speed, additional thrust is required. So making turns leads to thrust changes. It was questioned whether this would be acceptable with respect to the SourDine II goals on noise reduction and experienced noise nuisance by people on the ground.
- changing environmental conditions (e.g. wind profile, inversions, layers with icing) have an effect on flight path and thrust requirements. When controlling to a fixed descent path, flight path changes will result in pitch corrections and as a consequence speed variations. These speed variations lead to so-called hunting behaviour of the engines, which has, as explained in the previous bullet, a negative impact on the SourDine II goals.
- The thrust required to maintain the 2 degrees descending flight path with constant speed requires an engine thrust setting somewhat above idle. For some aircraft (or rather engine types) this is a thrust setting for which engines are not optimised. In addition in this thrust area a number of consumers (like bleed air) have their on/off switching threshold. Switching of, for example, bleed air is annoying for passengers due to variations in airconditioning flows (noise but also pressure changes) and has also a negative impact on noise on the ground.

It was suggested to calculate the flap deployment points using a thrust setting of idle + delta in order to create some time and path length between the flap deployment points leading to a reduced workload situation.

5.4 Arrival procedure 2 (2 degrees descent path, with speed constraints)

- Applying speed constraints leads to a speed reduction over the complete arrival. A lower speed requires (in the considered flight phase) on its turn earlier flap selection compared to the non speed constraints procedure. The effect is that the configuration changes are spread out over a longer period decreasing the workload of the crew.
- The use of speed constraints requires higher thrust settings in order to maintain the lower speed in combination with the 2 degrees descending path. The negative impact is extra noise but the advantage is that the sensitivity to unexpected (tail) wind decreases. So the energy management is easier compared to the non speed constraint procedure.

5.5 Arrival procedure 4 (full landing configuration, idle descent from 7000ft)

- All pilots agreed strongly that this procedure is highly unrealistic.
- From the moment of initiating the descent from 7000ft no control is available for the crew. The engines are on idle, all configuration changes have been made, so the only control available would be the spoilers (speed brakes). However in many aircraft the spoilers (speed brakes) are inhibited once landing configuration has been set.
- Once the glide slope has been intercepted the steep descent changes into a 3 degrees descent on the ILS. This requires a relatively high thrust setting at least higher than nowadays applied. In the conventional procedure, the landing configuration is selected once being stable on the glideslope (about 1500ft nominally). So this would result in more noise in the area the glide slope is intercepted.

- Aircraft were never designed to fly for such a long time in landing configuration. The extra load on the aircraft construction might lead to higher maintenance costs due to structure fatigue.
- The steep descent towards the glide slope intercept might trigger the ground proximity warning for possibly terrain in the surrounding of the airfield but possibly also for flat areas due to the high sink rates applied in order to maintain idle thrust. Especially in low visibility conditions, pilots are expected to cancel the approach and initiate a go-around.
- The steep descent will lead to an unusual aircraft attitude in combination with relatively high pressure changes. Both being uncomfortable for passengers.
- Although not relevant in this prototyping session, pilots questioned the controllability of the concept for ATC controllers.
- When encountering icing conditions, anti icing will be selected by the crew leading to higher thrust settings of the engine. This increase of thrust leads directly to an energy surplus which might result in either overshooting the glideslope or a late glide slope intercept.
- Autopilot control laws and logic were never designed, nor certified, for these conditions. Initiating the descent at 7000ft in landing configuration to a steep flight path angle might result in reaching the limits of control laws, possibly of the aircraft structure as well.
- Intercepting the glide slope from above might not be feasible for all aircraft. For example interference of the glide slope capture mode and VNAV mode might result in not capturing the glide slope at all.
- Flying at low speed (final approach speed) from 7000ft onwards might have a very negative impact on the capacity. Final approach speeds vary from aircraft to aircraft and within aircraft types it depends on the weight. The speed bracket available in landing configuration is very small. So spacing between aircraft must cater for these speed differences.

It was suggested to select an intermediate flap setting at 7000ft, initiate an idle descent towards the glide slope and continue the configuration changes to landing configuration on the glide slope. The advantage of it is that aircraft have a wider speed bracket available, so a stream of aircraft can be created. A higher speed can be maintained. Less noise is produced upon intercepting the glide slope since the high drag configuration has not been selected yet. The structure of the aircraft is less strained. There remains some control to the crew in the sense that the remaining flap selections and gear selection can be done earlier or postponed according to the energy state of the aircraft. The selection of the landing configuration may be postponed from typically 1500ft to 1000ft.

5.6 Arrival procedures 3 and 5

Arrival procedure 3 and 5 were not part of the prototyping session but were discussed with the participating pilots based on the Sourdine II specification. Regarding procedure 3 it was remarked that the increased glide slope angle is a matter of aircraft certification and therefore not a short term development. More in depth discussions have not found place.

Regarding procedure 5, the comments collected on procedure 4 are almost self explanatory. For procedure 4 it was suggested to postpone the selection of the landing configuration to the moment it is applied in current days operation. The initial (or intermediate) flap settings could be done earlier, on the 7000 ft for example. Subsequently discussing procedure 5 lead to the conclusion by the pilots that procedure 5 would be the more realistic alternative for procedure 4.

5.7 Departure procedures

The departure procedures were not simulated in APERO but only discussed based upon a paper description and explanation.

It was commented that the procedure II resembles exactly what Fokker Aircraft provided as option in their auto flight system in the Fokker 100 aircraft from the early 1990's.

The main comment was that there should be a limited number of departure procedures and the noise abatement departure should be used by pilots often and not by exception. Since the thrust cutback is rather drastic, the exposure of the procedure should be sufficient in order to let pilots operate it with confidence.

The issue was raised whether the noise abatement departures require full thrust take-offs instead of de-rated take-off thrust. Especially for the large aircraft the difference in these thrust levels are significant.

5.8 General remarks

- For each of these procedures it is important to have FMS guidance available for calculating the configuration change points, the 2 degrees descending path or the 7000ft continuous descent point. Many airlines have the instruction not to (re-)program the FMS below FL100. This would mean that the ATC instruction should be available rather early to avoid late (i.e. at low altitude) FMS programming activities by the crew.
- The energy cue was not rated as useful. It combines speed energy and altitude energy into one parameter. Pilots however are used to control these separately in the currently used procedures and the SourDine II procedures did require to change that.
- The vertical navigation display is useful, but not required.
- The configuration change points are clear.
- The speed profile applied by the FMS should be in line with pilots' expectations. (Background: procedure 2 without speed constraints and the FMS calculations based on idle were clearly not in line with pilots' expectations.

5.9 Results versus the 7 objectives

Objective 1: Evaluate the flyability of the proposed NAPs.

Regarding flyability, procedure II with speed constraints was regarded as flyable. Procedure IV was regarded as hardly operational feasible due to the fact that the crew has no control after leaving 7000ft.

Objective 2: Evaluate whether the proposed Noise Abatement Procedures (NAPs) yield a reduction in the noise level as compared with current procedures.

Doubts were raised whether the thrust fluctuations as part of procedure II (with speed constraints) would meet the required noise reduction. With respect to procedure IV it was questioned what the impact was of the relatively high thrust level maintaining the glide slope completely in landing configuration.

Objective 3: Evaluate the impact of the NAPs on airline costs ("flight efficiency").

Especially procedure IV was rated negatively in this respect in two ways:

- From 7000ft downwards final approach speed is flown leading to increase of flight time and reduction of runway capacity.
- Flying relatively long in landing configuration might lead to an increase of maintenance caused by structural fatigue.

Objective 4: Evaluate whether the proposed NAPs and pilot tools change the level of safety as compared with current procedures and tools.

The level of safety was questioned for procedure II without speed constraints and procedure IV. Procedure II without speed constraints require many crew actions in a very short time frame leading to possibly unacceptable workload levels. Procedure IV leads to high sink rates and intercepting the glide slope from above, both having a negative impact on safety.

Objective 5: Evaluate acceptance of the NAPs and pilot tools.

The tools provided to the pilots were more than required. The energy cue was seen as not useful, the vertical navigation display was seen as useful but not required. The flap deployment cues and gear down cue was seen as useful.

Objective 6: Evaluate the impact of the proposed NAPs and pilot tools on workload.

Procedure II without speed constraints was seen as raising workload to an unacceptable level. Procedure IV lead to high workload since hardly any controls were available for the crew to intervene during the descent from 7000ft. Procedure II with speed constraints was regarded as acceptable in the sense of workload.

Objective 7: Evaluate the impact of the NAPs and pilot tools on situational awareness (“energy awareness”).

Deviations from the FMS path in either altitude or speed gave sufficient awareness concerning the actual energy state. Predicting whether the glide slope intercept would succeed was more difficult. The energy cue did not help in that respect, the vertical navigation display did help in this awareness.

6 Conclusions

The 2 degrees descending flight path was regarded as flyable by the pilots, though the hunting behaviour of the engines to maintain the 2 degrees path was seen as a problem.

Speed constraints were seen as natural elements creating time for the crew in a high workload flight phase and a more controllable situation for ATC.

Only very limited pilot support tools were required on the navigation display. The vertical navigation display was useful but not required, the flap deployment cues for procedure II were required, the energy cue was neither useful nor required.

A complete idle descent in landing configuration was not seen as realistic.

Questions were raised about the actual noise reduction and runway capacity for both procedure II and IV.

7 Recommendations

Apply speed constraints, this has advantages for both aircrew as well as ATC.

Autopilot control laws might require more intelligence in order to avoid hunting behaviour of the engines following the 2 degrees descending path.

In order to maintain capacity high, a STAR might contain a path stretching area consisting of a set of waypoints. ATC can instruct each aircraft to take one of the 'exits'. This allows ATC to control the inbound stream and the crew to minimise FMS programming actions in a low altitude flight phase.

Avoid fully idle procedures since these are too sensitive for wind conditions.

Check whether engines can operate in low thrust regions and do not suffer from switching behaviour from power users like bleed air.

Appendix A: Procedures

During Mode 2 the following RNAV transitions and approaches are available:

- RIVER 1B TRANSITION (TO RWY 18R)
- SUGOL 1B TRANSITION (TO RWY 18R)
- REGSU 1 APPROACH (TO RWY 18C)

RNAV transitions, approaches and SIDs during mode 2:

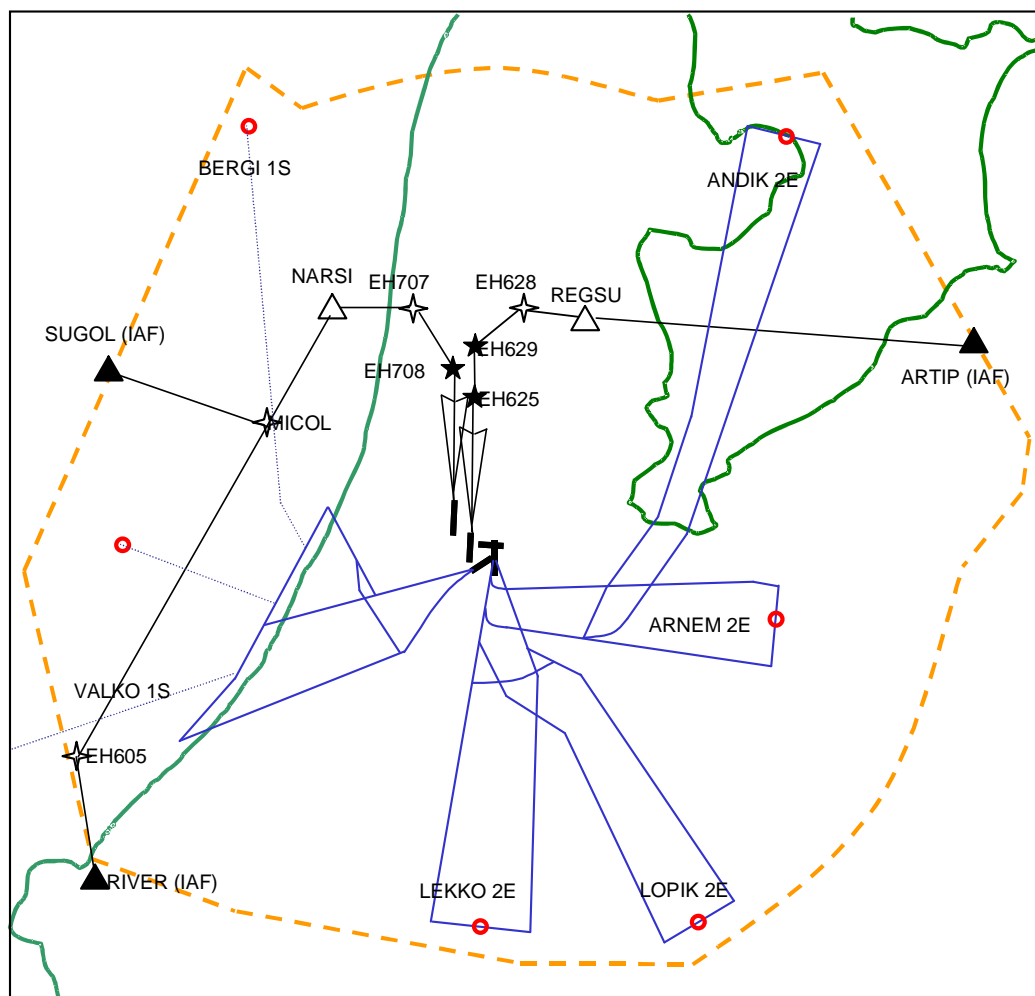


Figure A.1: RNAV transitions, approaches and SIDs during Mode 2

During Mode 2 the following SIDs are available:

- ANDIK 2E (RWY 18L)

- ARNEM 2E (RWY 18L)
- LEKKO 2E (RWY 18L)
- LOPIK 2E (RWY 18L)
- BERGI 1S (RWY 24)
- VALKO 1S (RWY 24)