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Concept of operation for Schiphol airport simulations

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Summary

With the continuing growth of air-traffic as well as the ever increasing level of urbanisation around most airports in Western Europe, the impact of aircraft noise and emissions on the quality of life for the surrounding communities has become a serious issue to be dealt with. Many European airports already face the conflicting problems of increasing their airport capacity to meet the amount of traffic, and the increasing pressure from the general public to reduce environmental impact, particularly noise and emissions, of the increased traffic volume. This has already resulted in specific local constraints to the operation of aircraft, not only around major airports such as Schiphol, Gatwick or Frankfurt, but also more regional airports are already experiencing the pressure to impose constraints to aircraft movements. Therefore, reduced nuisance to the community is a serious issue for the airline transport industry if the projected sustained growth is to be pursued. Of course all the efforts in the field of source noise reduction (quiet engine technology, quiet aircraft technology) have a significant effect on the noise impact around airports. It is expected that, by modifying and optimising approach and departure - procedures, a substantial reduction in the noise around airports can be achieved, while maintaining safety and efficiency.

In the Sourdine-II project, environmental friendly approach procedures are addressed. The project aims to support procedural improvements applicable to every airport facing these problems as well as to take into account improvements with more airport-specific characteristics. Therefore, a Generic and an Airport–specific part of these procedures are distinguished. The generic part shall be almost the same at all airports where the procedures will be applied. The specific part will be airport specific. The generic part describes the vertical and speed profile as well as how thrust and aircraft configuration will vary during the procedure. The specific part of the procedure describes the lateral information of the track. This track will be chosen in such a way that urbanised regions are avoided as much as possible and is therefore the airport specific route definition.

The Sourdine-II project will develop and evaluate the selected procedures. Evaluation will be performed by means of fast-time and real-time simulations combined with a safety assessment and a cost benefit analysis. The results of these simulations are aiming at providing a view on feasibility, applicability and acceptance. These results are expected to contribute to a future implementation of noise-friendly approach procedures and to bring them into operation.

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1 Introduction

1.1 Purpose

The purpose of the document is to describe the Sourdine II Operational Concept. It will be used as the basis for the Real Time Simulations (RTS) as well as the safety assessment of a selection of the Sourdine-II Noise Abatement Procedures (NAP). Also, it is intended that the finalisation of the Fast Time Simulation (FTS) of the Sourdine-II Noise Abatement Procedures applied for the Amsterdam Schiphol situation, will be based on the concept presented in this document.

1.2 Background

With the continuing growth of air-traffic as well as the ever increasing level of urbanisation around most airports in Western Europe, the impact of aircraft noise and emissions on the quality of life for the surrounding communities has become a serious issue to be dealt with. Many European airports already face the conflicting problems of increasing their airport capacity to meet the amount of traffic, and the increasing pressure from the general public to reduce environmental impact, particularly noise and emissions, of the increased traffic volume. This has already resulted in specific local constraints to the operation of aircraft, not only around major airports such as Schiphol, Gatwick or Frankfurt, but also more regional airports are already experiencing the pressure to impose constraints to aircraft movements. Therefore, reduced nuisance to the community is a serious issue for the airline transport industry if the projected sustained growth is to be pursued. Of course all the efforts in the field of source noise reduction (quiet engine technology, quiet aircraft technology) have a significant effect on the noise impact around airports. It is expected that, by modifying and optimising approach and departure procedures, a substantial reduction in the noise around airports can be achieved, while maintaining safety and efficiency.

1.3 Context

In the beginning of the Sourdine-II project, an inventory has been made of current and future technologies that can be applied for Noise Abatement Procedures [SII D1-1] for approach as well as departure. Also, the known NAPs and current operational practices are summarised [SII D1-1 and SII D3-1]. On the basis of these inventories, a large number of new NAPs are defined [SII D3-1]. For all these new NAPs, Single Event Simulations (SES) have been performed to assess the impact of the new procedures on the noise [SII D5-3]. Based on this assessment, a selection of the most promising of the newly defined NAPs has been made for further assessment of these procedures with respect to safety, emissions, capacity, cost/benefit, efficiency and user acceptance. Note that the considered assessments reported in D5-3 are assessments for **one single aircraft** at a time.

The document at present describes a concept of operation for a realistic (future) **air-traffic** situation and this deals in that respect with (among other things) the interaction between aircraft (pilots), by mutual interaction, and between aircraft and the ground (air-traffic controllers). It presents a possible concept of operation for the application of Noise Abatement Procedures at Airport Amsterdam Schiphol. The reference baseline concept is described in the document D3.1. The new concept is partly based on the principles used in the APPROVE project [APPROVE], and partly on innovative developments in the current project. As mentioned above, to assess the viability of this concept, it will be validated for noise, emissions, safety, cost/benefit, capacity and acceptability from a pilots and air traffic controllers perspective. The validation with respect to the acceptability will be done using the NLR ATC Research Simulator (NARSIM) and the NLR Generic Research Aircraft Cockpit Environment (GRACE). A detailed plan to perform these simulations will be presented in an internal NLR experiment plan. The simulations are part of the overall validation program in Sourdine-II. This program is executed along the lines of the Sourdine-II validation methodology [D2-1], which is based on the Master ATM European Validation Plan (MAEVA) methodology [MAEVA].

For information on the Sourdine-II project, the reader is referred to the Sourdine-II website: http://www.sourdine.org.

1.4 Document Structure

This document has the following structure:

- Chapter 1 introduces the current document.
- Chapter 2 presents the ATM problem that will be considered.
- Chapter 3 describes the operational procedure for the NAPs and expected benefits if the selected procedure(s) is (are) finally implemented at Schiphol airport.
- Chapter 4 provides an overview of the different tasks and responsibilities of ATC.
- Chapter 5 provides an overview of the different tasks and responsibilities of aircraft operation.
- Chapter 6 describes the air/ground communication procedures and clearances.
- Chapter 7 gives a concept analysis.
- Chapter 8 presents the technical systems and equipment.

1.5 Glossary

ACC	Area Control Centre
ACID	Aircraft Identifier
ACT	Acknowledgement
AGL	Above Ground Level
AMAN	Arrival Manager
AMSL	Above Mean Sea Level
AP	Auto Pilot
APP	Approach Control
APPROVE	Advanced airport aProach PROcedures including Validation and Elaboration
ARR	Arrival Control
AT	Auto Throttle
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Service
CAS	Calibrated Airspeed
CDA	Continuous Descent Approach
CF	Course to a Fix
COP	Co-ordination Point
CTA	Control Area
DAP	Downlink of Aircraft Parameters
DF	Direct to a Fix
DME	Distance Measuring Equipment
EAT	Expected Approach Time
EFL	Executive Flight Level
ELEV	Elevation
ESL	Entry Sequence List
ETA	Estimated Time of Arrival
ETO	Estimated Time Over

FA	Fix to an Altitude
FAF	Final Approach Fix
FAP	Final Approach Point
FAS	Final Approach Speed
FD	Flight Director
FIR	Flight Information Region
FL	Flight Level
FM	Fix to a Manual
FMS	Flight Management System
FPA	Flight Path Angle
FPM	Flight Path Monitoring
GPS	Global Positioning System
GRACE	Generic Research Aircraft Cockpit Environment
GS	Glide Slope
HAA	Height Above Airport
IAF	Initial Approach Fix
IAS	Indicated Airspeed
IF	Initial Fix
IRS	Inertial Reference System
JAA	Joint Aviation Authorities
KTS	Knots
L	Left
LAR	Lange Afstand Radar Long Range Radar
LIV	Landing Interval
LLR	Long Range Radar
LNAV	Lateral Navigation
LVNL	Luchtverkeersleiding Nederland ATC The Netherlands
MAEVA	Master ATM European Validation Plan
MAG	Magnetic
MAPt	Missed Approach Point
MCDU	Multi-function Control Display Unit
MONA	Monitoring Aid
NAP	Noise Abatement Procedure
NARSIM	NLR ATC Research Simulator
NLR	Nationaal Lucht- en Ruimtevaartlaboratorium National Aerospace Laboratory
NM	Nautical Mile
NTZ	No Transgression Zone
OEI	One Engine Inoperative
P-RNAV	Precision Area Navigation
PVD	Primary View Display
R	Right
RNAV	Area Navigation
RNP	Required Navigation Performance
R/T	Radio Telephony
RTA	Required Time of Arrival
RTS	Real Time Simulation
RWY	Runway
SES	Single Event Simulation
SID	Standard Instrument Departure
SOURDINE	Study of optimisation procedures for decreasing the impact of noise
SSR	Secondary Surveillance Radar

STAR	Standard Arrival Route
STATFOR	Statistical Forecast
STCA	Short Term Conflict Alert
TAR	Terminal Area Radar
TF	Track to Fix
TFL	Transfer Flight Level
TGL	Temporary Guidance Leaflet
THR	Threshold
TMA	Terminal Control Area
TOD	Top Of Descent
TOGA	Take-off / Go-around
TP	Trajectory Predictor
TTA	Target Time of Arrival
TTO	Target Times Over
TWR	Tower
VNAV	Vertical Navigation
VOR	Very High Frequency Omni-directional Range
WPT	Way point
Y	Yes

1.6 References

Short Reference	**Author / Organisation, Title, Edition, Date and Reference**
WwwS2	Website Sourdine-II: www.sourdine.org
AIP	Aeronautical Information Publication the Netherlands
DOC4444	Procedures for Air Navigation Services -Air Traffic Management, ICAO Doc-4444
DOC7030	Amendment to ICAO Doc. 7030, ICAO EUR Region Supplementary Procedures
S-II D1-1	SII Identification document, version 1.0, 03-03 2003, SICTA
S-II D2-1	SII Validation methodology report, version 1.0, 23-04 2003, Isdefe
S-II D3-1	SII Definition of new noise abatement procedures, version 1.0, 10-03 2003, INECO
S-II D5-3	SII Single event noise calculations, version 1.0, 23-06 2003, Airbus France
APPROVE	Application of RNAV Transition Routes in the Schiphol TMA, version 0.1, 13-06 2002, NLR
MAEVA	MAEVA Validation Guideline Handbook, version 2.0, 27-05 2003, Isdefe
STATFOR	EUROCONTROL Air Traffic Statistics and Forecasts Service (STATFOR): Forecast of Annual Number of IFR Flights (2003 - 2010), Volume 1 & 2

2 Scope of the concept

2.1 Current ATC system

Within the current European ATC system aircraft fly via fixed ATC routes towards the initial approach fixes (IAFs). These IAFs are located at the boundary of or inside the terminal area (TMA) boundary. Inside the TMA the air traffic controllers usually issue radar vectors to guide the aircraft towards the final approach. These instructions are used to comply with the minimum wake vortex separation criteria when building the sequence of arrival traffic.

The aircraft are most of the time vectored in the standard pattern of downwind, baseleg and final. Since controllers have to deal with the crossing of arrival and departure traffic, aircraft often have to descend relatively early to the ILS glide slope interception altitude when flying on downwind.

2.2 Problem description

The problem with the current ATC procedures is that aircraft fly at relatively low altitudes during the initial and intermediate approach segment and are vectored in a large area around the airport. Aircraft flying at those low altitudes on baseleg are often in a level flight. Combined with the required speed and the configuration of the aircraft this results in rather high thrust settings. All issues mentioned within this paragraph result in a substantial production of noise and emissions in the vicinity of the airport. To accommodate further growth under the stringent noise regulations that are in effect at most (major) airports, and to alleviate the nuisance to the surrounding communities, new technology and procedures will have to be developed.

2.3 Context

The Sourdine II project focuses on the year 2015. This means that the proposed noise abatement procedures could be implemented and the required technology should be available around this year.

Trends for new technology are improved navigation due to the introduction of precision area navigation (P-RNAV) with a required navigation performance (RNP) of 1.0 or even 0.3 NM.

Other foreseen technology trends are to perform part of the air-ground communication via datalink. Some airports already send Digital Automatic Terminal Information Service (D-ATIS) messages. These messages can contain besides the actual weather information also among others the ILS frequencies and the message that parallel independent runways are in use.

Mode S and ADS-B technology can achieve enhanced surveillance.

2.4 Solution objectives

Since all ATM problems require a multi-disciplinary approach, successful solutions should meet the following objectives:

Safety: Safety should never be comprised and therefore it is essential that the proposed SII concept maintains or improves at least the current safety level.

Efficiency: Since the Sourdine II project focuses on the year 2015, the concept should at least be able to deal with the required capacity for 2015.

Economy: A separate cost-benefit analysis (CBA) will investigate the economic aspects of the new SII procedures. The output of the cost-benefit analysis should be acceptable to the involved stake-holders.

Environmental: Airport growth should be possible within the current and future noise restrictions.

2.5 Solution

The high level solution for the problem described in this chapter is to reduce the spread of the aircraft flying within the TMA and try to prevent aircraft levelling off at low altitudes by introducing continuous descent approaches (CDAs).

2.6 Implementation

To allow a stepwise approach towards implementation, it is foreseen to introduce the required procedure initially during low density traffic, preferably at night. This allows both pilots and air traffic controllers to get used to the procedures.

If all required technology is available and the night trials are successful the procedures can be introduced over a longer time period and eventually all day.

3 Schiphol environment

3.1 Traffic flow, Airspace and Airport configuration

3.1.1 Traffic flow

The traffic flows to and from Schiphol are expected to increase the coming years. It is considered achievable to cope with the increased demand and to cater at least for part of the foreseen noise load problems by development and implementation of NAPs. Due to the timeframe and the acceptable scope of changes in airspace usage, it is chosen to investigate if these NAPs can be implemented within the present airspace organisation and airport configuration. In particular the current definitions of TMA entry points and holding areas are respected.

The ultimate goal of Sourdine-II is to determine the requirements, design NAP alternatives and to evaluate the NAP against several criteria for approach as well as departure for the year 2015. Based on Statistical Forecast (STATFOR) data [STATFOR] the total number of movements in the Flight Information Region (FIR) of the Netherlands in the year 2015 is estimated to be 625300 using an annual growth of 3.3%. The distribution of traffic over the three Initial Approach Fixes (IAF) is estimated to be unchanged over the years 2003 – 2015:

- 28% RIVER
- 28% SUGOL
- 44% ARTIP

3.1.2 Airspace

The Sourdine II noise abatement procedures are intended for use without significant changes in the present airspace structure (see figure 3.1). Therefore, the current ATC structure will be described.

3.1.3 Airport configuration

Amsterdam Airport Schiphol is a major airport with 5 main runways and 1 smaller runway, which can be used by up to medium size jet aircraft. The following runways are available (see also figure 3.2):

Runway	**Primary use**	**ILS equipped**	**Name**
18C/36C	36C: take-off 18C: landing	Runway 18C	Zwanenburgbaan
18L/36R	36R: landing 18L: take-off	Runway 36R	Aalsmeerbaan
06/24	06: landing 24: take-off	Runway 06	Kaagbaan
09/27	09: take-off 27: landing	Runway 27	Buitenveldertbaan
04/22	22: landing, short runway, only for aircraft up to medium size jets	Runway 22	Schiphol Oostbaan
18R/36L	18R: landing 36L: take-off	Runway 18R	Polderbaan

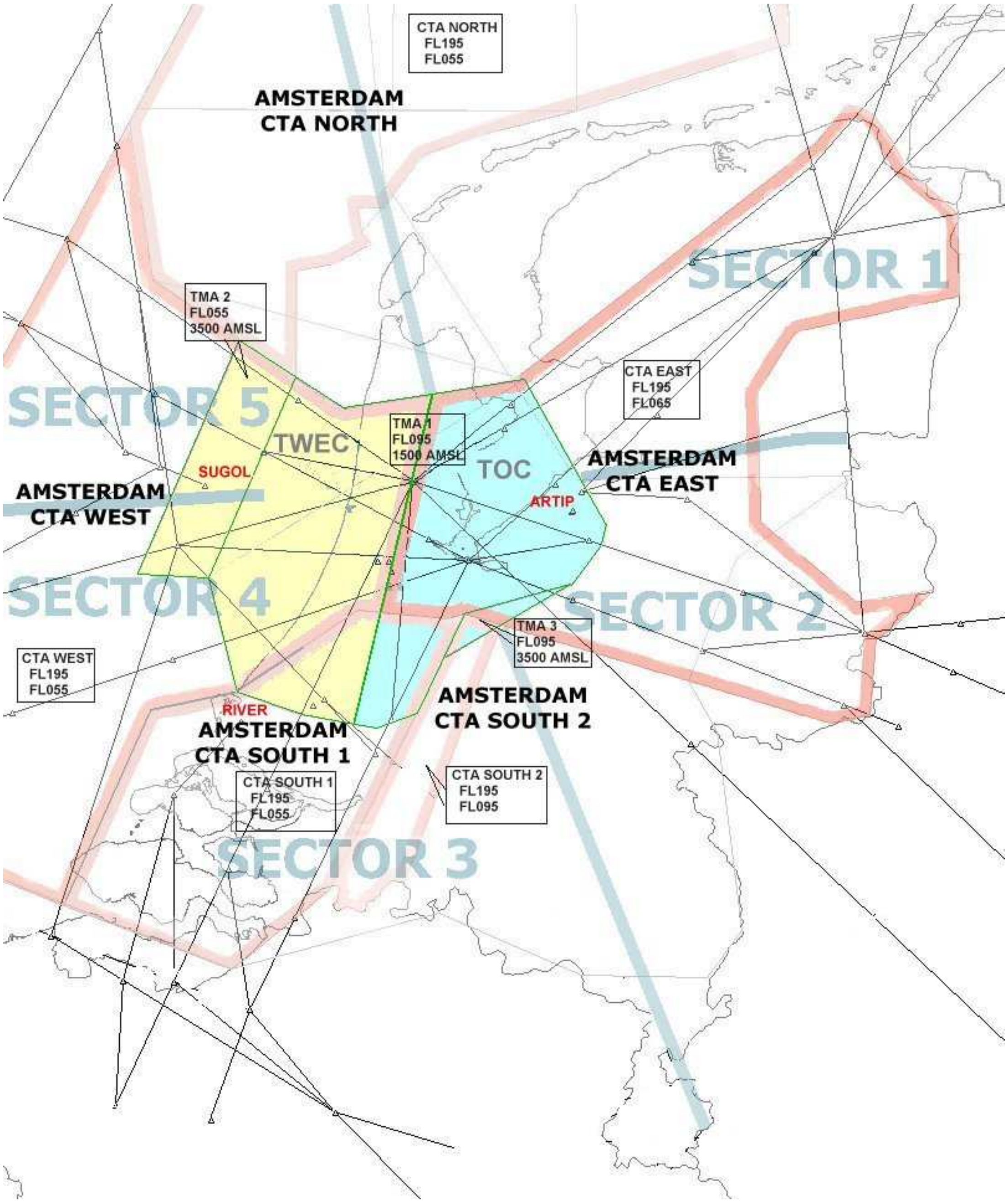


Figure 3.1: Overview of the 5 working areas over the CTA sectors

3.2 High level - Scenario definition

In the context of the objectives to be met by the Sourdine II project, and keeping in mind the primary objective to define generic procedures, it is considered sufficient to address only strictly relevant parts of approach procedures within the Dutch FIR.

In a research project like SOURDINE II, it is impossible to define the operational concept for a complete FIR. Some very high level selections are presented in this section. However, it should be noted that the concept of operation as defined in this document will form the basis of the (more detailed) definition of the experiment plan for the Real Time Simulation (RTS).

For the Sourdine-II project 2 modes of operation of the airport are considered (see figure 3.2), these modes cover approximately all operations, because they are combinations of different 2+1 runway configurations.

- Mode 1 (wind coming from the North): inbound runway 06 and 36R, outbound runway 36L and 36C.
- Mode 2 (wind coming from the South): inbound runway 18C and 18R, outbound runway 24 and 18L.

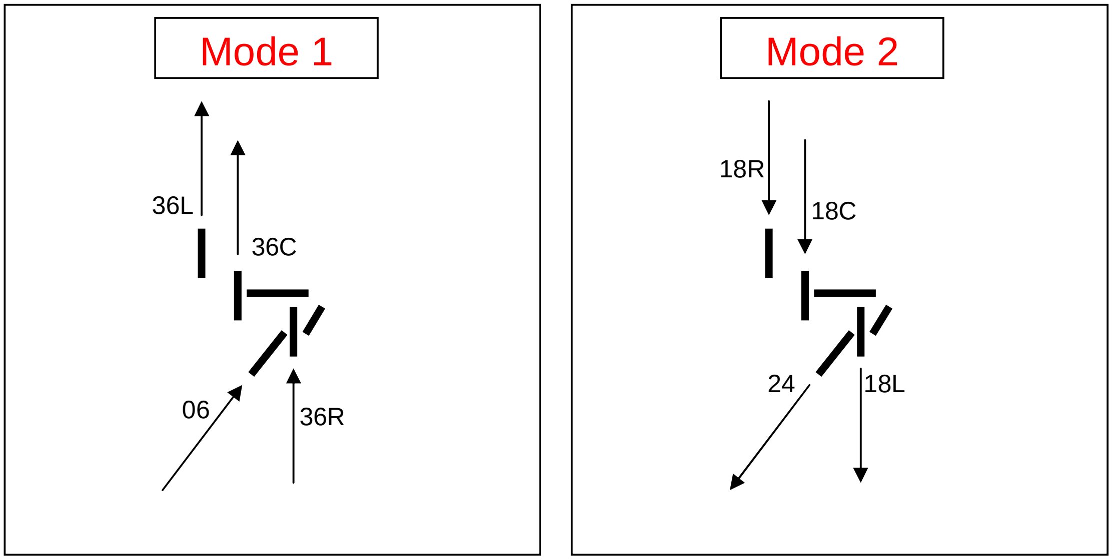


Figure 3.2: Mode 1 and Mode 2 runway configuration

For both of the operational modes, the following CTA/TMA sectors (see figure 3.1) will be involved:

- Schiphol TMA West
- Schiphol TMA East
- Amsterdam CTA East
- Amsterdam CTA South (1 and 2)
- Amsterdam CTA West
- Amsterdam CTA North

4 Description of Flight - Procedures

4.1 Generic part and Airport-specific part of the procedure

Airports need to increase their capacity to accommodate the continuing growth of air traffic. The objective of the Sourdine II noise abatement procedures is to reduce the environmental impact, particularly noise and emissions, of the increased traffic volume.

In Sourdine-II a Generic and an Airport–specific part of the arrival and departure procedure is distinguished. The generic part (see section 4.2) shall be almost the same at all airports where the procedures will be applied. The specific part will be airport specific.

The generic part describes the vertical and speed profile as well as how thrust and aircraft configuration will vary during the procedure.

The specific part of the procedure describes the lateral information of the track. This track will be chosen in such a way that urbanised regions are avoided as much as possible and is therefore the airport specific route definition. See section 4.3 for the Schiphol route definition.

4.2 General procedure description

4.2.1 Philosophy to define the generic part of the procedure

The general idea of a noise abatement arrival procedure is to combine a continuous descent profile with an effective low noise descent profile of the aircraft. Such an arrival procedure is defined by the vertical profile, the speed or thrust profile and the required aircraft configuration. Two of those three parameters can be prescribed and the third one will result from that. For example, if the aircraft configuration and the thrust profile is prescribed, the vertical profile will be variable and result from those two parameters.

With respect to generic noise abatement departure (climb-out) procedures, the procedure designers have limited room for noise reduction. In general, two extreme noise abatement procedures are possible. Either the noise impact close to the airport is optimised in a way that produces a large noise footprint area during further climb-out, or alternatively the noise is minimised further away, displacing the larger part of the noise footprint closer to the airport.

The following paragraphs will describe the SII proposed arrival (chapter 4.2.2) and departure (chapter 4.2.3) procedures (see also SII deliverable D3-1-1 and D3-1-2). These procedures have been selected following a number of workshops and brainstorm sessions with experts and stake-holders in taking into account the results from single event noise simulations of different variants of approach and departure procedures.

4.2.2 Approach procedures

Approach procedure I (baseline):

- Start at 8.000 or 7000ft with speed 220 KTS,
- From this altitude: descent at constant CAS down to 3000ft applying flight idle thrust, clean configuration, landing gear up
- Level off at 3000ft, flight idle, decelerate (to intermediate flap speed) and change configuration to intermediate flaps
- Intercept fixed 3 degree GS at 3000ft with flight idle, decelerate (to FAS) and change configuration to full flaps and landing gear down to be stabilised at 1000ft minimum

- After landing configuration is reached, thrust as required and descent with constant speed (to flare initiation height)

Approach procedure II (CDA with standard glide slope):

- Start at 8.000 or 7000ft with speed 220 KTS,
- At this altitude, level flight, flight idle, clean configuration, landing gear up
- Descent along a fixed 2 degree Flight Path Angle (FPA), decelerate (to FAS), change to full flaps and landing gear down to be stabilised at 3000ft minimum
- After landing configuration is reached, thrust as required and continue descent with constant speed down to 3000ft
- Intercept fixed 3 degree GS from 3000ft with thrust as required and descent with constant speed (to flare initiation height)

Approach procedure II-A (CDA with standard glide slope):

- Start at 8.000 or 7000ft with speed 220 KTS,
- At this altitude, level flight, flight idle, clean configuration, landing gear up
- Descent along a fixed 2 degree Flight Path Angle (FPA), decelerate (to intermediate flap speed), change configuration to intermediate flaps to be established at 3000 ft minimum to FAS),
- After intermediate flap configuration is reached, thrust as required and continue descent with constant speed down to 3000ft
- Intercept fixed 3 degree GS from 3000ft with flight idle, decelerate (to FAS) and change configuration to full flaps and landing gear down to be established at 1000ft minimum
- After landing configuration is reached, thrust as required and descent with constant speed (to flare initiation height)

Approach procedure III (CDA with increased glide slope):

- Start at 8.000 or 7000ft with speed 220 KTS,
- From this altitude, level flight, flight idle, clean configuration, landing gear up
- Descent along a fixed 2 degree Flight Path Angle (FPA), decelerate (to FAS), change to full flaps and landing gear down
- After landing configuration is reached, thrust as required and continue descent with constant speed down to 3000ft
- Intercept fixed 4 degree GS at 3000ft with thrust as required and descent with constant speed (to flare initiation height)

Approach procedure IV (CDA with variable path segment):

- Start at 8.000 or 7000ft with speed 220 KTS,
- From this altitude, level flight, flight idle, clean configuration, landing gear up
- Decelerate (to FAS), full flaps, landing gear down

- Descent along a variable path segment down to 2000ft with constant air speed, flight idle, full flaps, landing gear down
- Thrust as required, fixed 3 degree GS from 2000ft and descent with constant speed (to flare initiation height)

Approach procedure V (CDA with variable path segment):

- Start at 8.000 or 7000ft with speed 220 KTS,
- From this altitude, level flight, flight idle, clean configuration, landing gear up
- Decelerate (to intermediate flap speed), intermediate flaps, landing gear up
- Descent along a variable path segment down to 3000ft with constant air speed, flight idle, configuration intermediate flaps, landing gear up
- Flight idle, fixed 3 degree GS from 3000ft, decelerate (to FAS), change configuration to full flaps and landing gear down
- After landing configuration is reached, thrust as required and descent with constant speed (to flare initiation height)

4.2.3 Departure procedures

Departure procedure I (ICAO-A):

- Brake release and acceleration to rotation speed,
- Rotation and lift-off,
- Retraction of undercarriage,
- Climb out at a speed of V2 + 10-20 kts IAS,
- Reduce thrust from take-off to climb setting at 1500ft,
- Clean up configuration at 3000ft,
- Acceleration to 250 kts IAS and climb to 10000ft,

Remark: The speed limitation of 250kts is recommended by ICAO in lower airspace below 10.000ft.

Departure procedure I-A (ICAO-A with extended duration of climb thrust):

- Brake release and acceleration to rotation speed,
- Rotation and lift-off,
- Retraction of undercarriage,
- Climb out at a speed of V2 + 10-20 KTS IAS,
- Reduce thrust from take-off to climb setting at 1500ft,
- Clean up configuration at 5000ft,
- Acceleration to 250 KTS IAS and climb to 10000ft,

Departure procedure II (Sourdine optimised close-in):

- Brake release and acceleration to rotation speed,
- Rotation and lift-off,
- Retraction of undercarriage,
- Climb out at a speed of V2 + 10 KTS IAS,
- Reduce thrust from take-off to minimum thrust for 1.7% one engine inoperative (OEI) climb gradient at 1000ft, maintain V2 + 10 KTS IAS,
- Gradual increase thrust (to 93% N1) at 5000 ft and maintain V2 + 10 KTS IAS,
- At 7500 ft acceleration to 250 KTS IAS and clean up configuration,
- Climb to 10000ft.

Departure procedure III (Sourdine optimised distant):

- Brake release and acceleration to rotation speed,
- Rotation and lift-off,
- Retraction of undercarriage,
- Climb out at a speed of V2 + 10 KTS IAS,
- Acceleration to Vzf and retracting flaps/slats to configuration 1
- Reduce thrust from take-off to minimum thrust for 1.7% one engine inoperative (OEI) climb gradient at 1000ft, clean up configuration and maintain V2 + 10 KTS IAS,
- Increase thrust (to 93.5% N1)at 5000 ft and acceleration to 250 KTS IAS,
- Increase thrust to Max Climb at 9000 ft and maintain 250 KTS IAS,
- Climb to 10000ft.

4.3 Schiphol–specific part of the procedure

The lateral tracks for the Schiphol approach procedures are described in this chapter. There are specific paths for both Mode 1 (wind coming from the North, inbound runway 06 and 36R, outbound runway 36L and 36C) and Mode 2 (wind coming from the South, inbound runway 18C and 18R, outbound runway 24 and 18L) operations (see also section 3.2).

The procedures described here are variations following the most dominant approach procedures, applicable at present for the selected runway configurations at Schiphol. The original procedures are described in the AIP.

4.3.1 Mode 1

During Mode 1 the following RNAV transitions and approaches are available:

- RIVER 1A TRANSITION (TO RWY 06)
- SUGOL 1A TRANSITION (TO RWY 06)
- MONUT 1 APPROACH (TO RWY 36R)
- SOKSI APPROACH (TO RWY 06)

RNAV transitions, approaches and SIDs during mode 1:

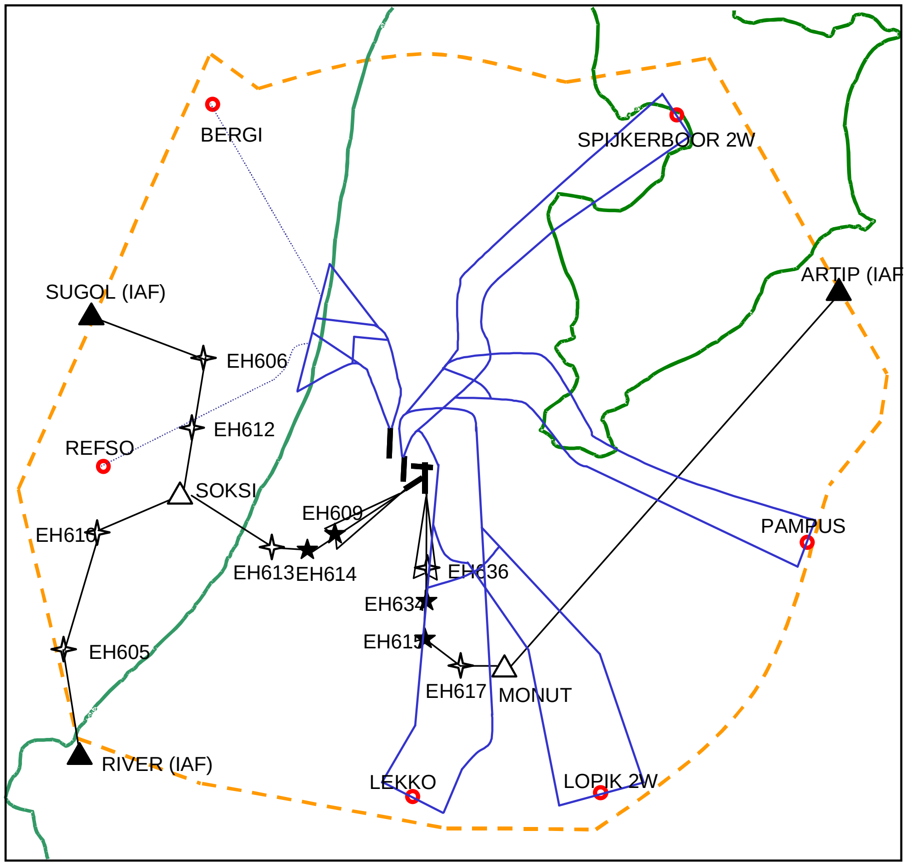


Figure 4.1: RNAV transitions, approaches and SIDs during Mode 1

During Mode 1 the following SIDs are available:

- LEKKO 2W (RWY 36C)
- LOPIK 2W (RWY 36C)
- PAMPUS 2W (RWY 36C)
- SPIJKERBOOR 2W (RWY 36C)
- BERGI 1V (RWY 36L)
- REFSO 1V (RWY 36L)

4.3.2 Mode 2

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)
- NIRSI APPROACH (TO RWY 18R)

RNAV transitions, approaches and SIDs during mode 2:

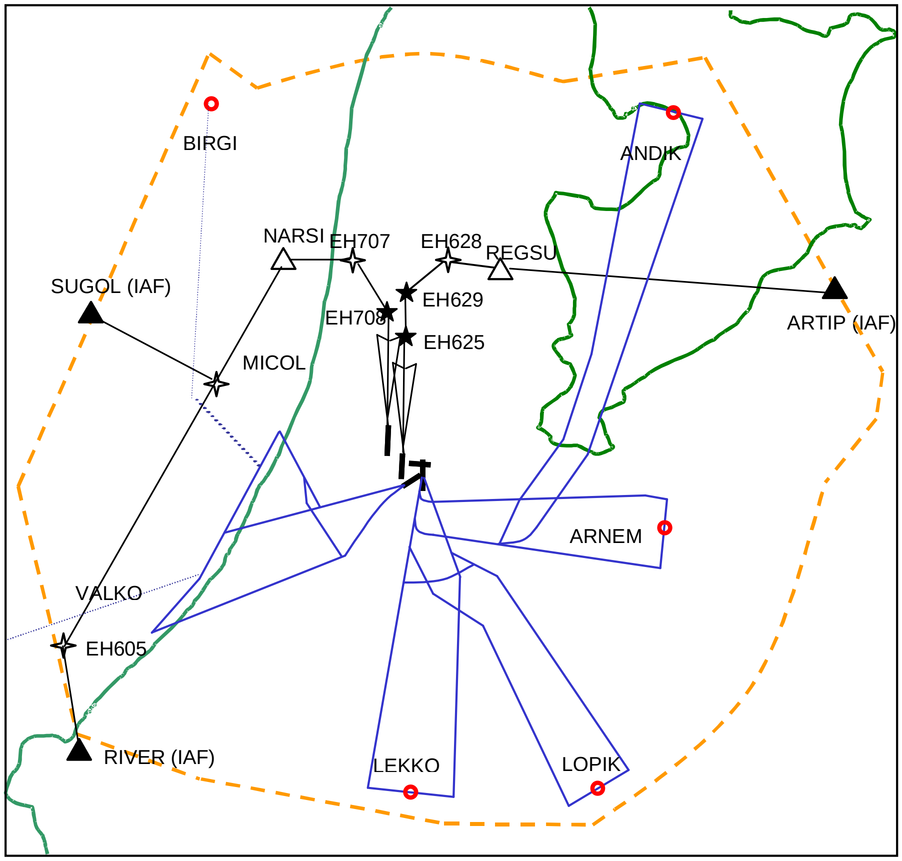


Figure 4.2: RNAV transitions, approaches and SIDs during Mode 2

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)

4.4 Selection of flight procedures

For the Operational concept description it was decided to start with an approach procedure with a fixed vertical path (approach procedure II and III). Since no increased glide slope procedures (like in approach procedure III) are foreseen in 2015, due to operational restrictions within the certification basis of the auto-land system, approach procedure II was chosen (see chapter 5.2).

Since approach procedure IV is the most beneficial from a noise perspective, the operational concept for this procedure is described in chapter 5.3.

There is not a lot of difference from an operational point-of-view in the departure procedures. Probably the procedure where the aircraft have the highest rate of climb (departure procedure I and I-A) are of most interest due to the possible intervention with inbound traffic. Therefore only the standard ICAO-A procedure is taken into account when describing the SII operational concept.

Mode 2 is chosen as the default mode of operation because of the added complexity of parallel approaches. The merging point EH606 is slightly displaced and now called MICOL. This was necessary because traffic from RIVER starts their CDA at FL80 instead of FL70. Therefore traffic between SUGOL and RIVER is always vertically separated at the merging point. Traffic will start their descend along the CDA vertical path after this merging point. Points NIRSI, EH607 and EH608 are also slightly displaced and now called NARSI, EH707 and EH708 respectively. This was necessary to comply with the PANS-OPS requirements for parallel approaches.

To increase the predictability of the aircraft behaviour several speed constraints (or speed windows) were applied both for arrival procedure II and procedure IV. For the RNAV procedures during the mode 2 runway configuration, this results in the procedures shown in figure 4.3 and 4.4.

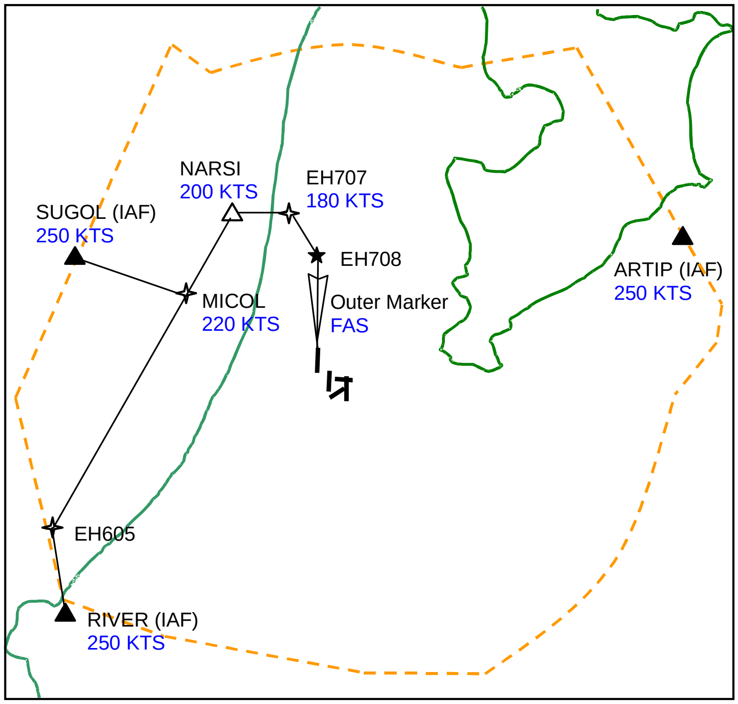


Figure 4.3: *Arrival procedure II with speed constraints in mode 2*

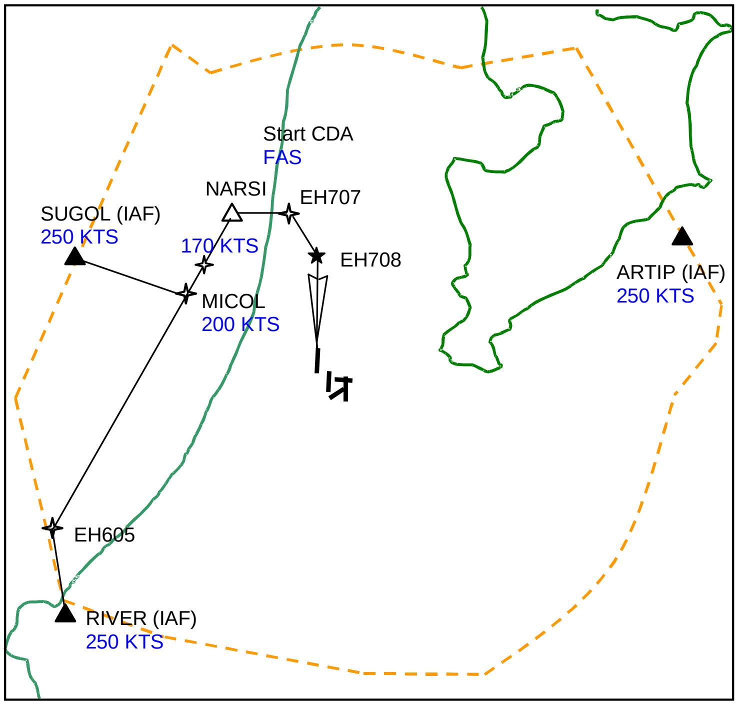


Figure 4.4: Arrival procedure IV with speed constraints in mode 2

5 Tasks and responsibilities for ATC

In the definition of the concept described in document at present, it is attempted to stay as close as possible to existing ATC procedures. The existing ATC procedures for Schiphol are very well described in the AIP Netherlands [AIP]. As a reference, section 5.1 gives a quick overview of the current ATC organisation. The organisation mentioned here is still applicable for the SII procedures. In sections 5.2 and 5.3 the selected Sourdine-II procedures are presented. Where section 5.2 describes the situation with a continuous descent approach using a fixed vertical path and section 5.3 describes the situation with a continuous descent approach using a variable vertical path.

The descriptions of tasks and responsibilities are limited to describing the handling of traffic arriving via SUGOL and RIVER. This was done because traffic handling over the different metering fixes is sufficiently similar to limit the description to one case only. Moreover, the limitation is justified because of the added complexity of merging two traffic streams coming from these IAFs. This allows to start with a baseline scenario using only traffic from RIVER and in a later stage adding SUGOL traffic and introduce the merging problem. The procedures in general will also be applicable for traffic coming from ARTIP.

5.1 Overview of the current ATC organisation

The present-day ATC organisation applies arrival procedure I and departure procedure I (ICAO-A) (see section 4.2.2 and 4.2.3).

After transfer from an adjacent ATC centre, an aircraft, **arriving** at Schiphol is currently handled by the following control positions:

1. ACC (area control)
    - Executive controller
    - Planner controller
    - Stack controller
2. APP (approach control)
    - Approach Planner (APLN)
    - Feeder/Departure Controller (FDR/DCO)
    - Arrival controller (ARR)
3. TWR (tower control)

Inbound traffic is usually transferred from ACC Executive controller to FDR/DCO at or before the IAFs RIVER, ARTIP and SUGOL. Minimum flight level is then FL70 and maximum speed 250 KTS IAS. FDR/DCO will use radar instructions to vector the aircraft to the downwind leg; ARR will guide the aircraft to the ILS of the runway in use. On final, the aircraft will contact TWR. The Approach Planner (APLN) function is often combined with the Approach Supervisor position. The APLN will decide among others on the active runway combination and the landing interval (LIV).

In some cases and only during night-time, fixed routes, so called transitions are used (see figure 4.1 and 4.2).

An aircraft **departing** from Schiphol will be transferred from TWR to FDR/DCO shortly after take-off. The standard maximum flight level is FL60 to prevent any conflict with inbound traffic entering at FL70. When the aircraft is clear of other traffic it will be cleared to climb to FL90 and transferred to ACC Executive controller. After that, the aircraft is transferred to an adjacent ATC centre.

5.2 Concept using CDA with fixed vertical path

Refer to procedures in Chapter 4

5.2.1 ACC procedures

Because the concept of operations is focussed at the Schiphol TMA, the ACC procedures are very close to the present working procedures. The Sourdine II approach procedures start at the TMA entry fixes ARTIP, RIVER and SUGOL, which are also the stack holding fixes.

The main change in operations is the clearance the ACC executive controller gives to the aircraft in order to clear them into the Schiphol TMA and the required accuracy of the sequence. The present working method is to clear aircraft direct to the SPL VOR/DME and to transfer the aircraft to the FDR/DCO controller for further instructions. Within the Sourdine II concept the ACC executive controller provides clearance to the aircraft from the TMA entry fixes by providing them the RNAV transition route.

For arrivals via RIVER, instead of issuing a "*After RIVER, proceed to SPL* ", the phraseology changes to *"After RIVER, proceed on RIVER 1B transition to NARSI"*. This implies a clearance to proceed with an approach procedure via the RNAV transition route until interception of the RNAV point NARSI. At or before reaching the IAF, the aircraft is transferred to the frequency of the FDR/DCO controller.

Another change in operations for the ACC controller will probably be the required accuracy to meet the time constraints on the IAF. Increased accuracy is required because of limited flexibility in the TMA to sequence the traffic in comparison with current day operations. Today ACC controllers are able to transfer aircraft at the IAF with an accuracy of 2 à 3 minutes (according to Dutch ACC controllers). Within the Sourdine II concept the required accuracy will probably be ± 1 minute. This 1 minute is a subjective value assessed by interviewing controllers. Without any additional tools this increased accuracy will have a negative impact on the sector capacity. This is due to the fact that controllers need more time per aircraft to reach this level of accuracy, so they can control less aircraft in their sector. The necessary tools that may prevent loss of capacity, are a stack list (an update of the current version of this list may be required) and the display of relative times (deviations from planned times) and sequence numbers in the aircraft label (see also chapter 7). These relative times are the difference between the EAT and the calculated time by the Trajectory Predictor (TP) in the ATC system or downlinked predicted time over the IAF by the aircraft. The ACC controller can use the relative time and the sequence numbers to build a traffic stream according to the scheduler planning.

The present concept of operation assumes a sufficiently ordered flow of inbound traffic entering the Schiphol TMA so that the aircraft may continue to follow the appropriate CDA. In the present situation, traffic passing the IAFs shows an accuracy of 2 à 3 minutes around the EAT times as provided in the arrival sequence by the scheduler. In order to better monitor and be able to sequence the traffic before the merging point of the two arrival transitions in the TMA without extensive vectoring, the accuracy of the traffic passing the IAFs should be improved. When practicable and with a lateral profile known by the pilot, individual aircraft can be delegated to achieve the given EAT over the IAF by making best use of the onboard FMS. In case this is not possible, the ACC controller will provide speed and heading instructions for achieving the desired sequence within the 5NM spacing at the TMA boundary.

Therefore, the initial set-up for this inbound planning is done by the ACC controller by means of the following clearances in the following order of preference:

- Delegating Required Times of Arrival (RTA) over the IAFs to the flight crews
- Speed instructions
- Heading instructions
- Flight level instructions

In order to achieve this set-up, if issued, a required EAT should be given by ATC as soon as practicable to the flight crews.

ACC tries to build a perfect sequence of all aircraft entering the TMA, however if the FDR/DCO has to compensate for 60 seconds deviation from the EAT there are at least two ways to achieve this:

Assuming an IAS of 250 KTS, the APP controller needs to extend or shorten the route by 4NM or increase or decrease the IAS by 25 KTS during 30NM.

5.2.2 APP procedures

5.2.2.1 Approach planning controller

The approach planning controller (APLN) is responsible for the chosen active runway combination, the landing interval and planning of the inbound traffic and is supported by an (advanced) Arrival Manager.

5.2.2.2 Feeder/departure controller

The feeder/departure controller (FDR/DCO) receives the inbound aircraft from the ACC executive controller. Inbound aircraft have already received a clearance from the ACC executive controller for the appropriate Sourdine II approach route (lateral RNAV route).

Lateral Control

Traffic from the ARTIP IAF always uses a dedicated runway. This runway is 36R during Mode 1 flying a MONUT 1 Approach or 18C during Mode 2 flying a REGSU 1 Approach. Approximately 44% of all arrival - traffic is flying via the ARTIP IAF.

Traffic from the RIVER IAF and the SUGOL IAF will use runway 06 during Mode 1 flying respectively a RIVER 1A Transition and a SUGOL 1A Transition. During Mode 2 both AIFs will use runway 18R. Traffic is then flying a RIVER 1B Transition or a SUGOL 1B Transition. Both IAFs will be passed by approximately 28% of all traffic. Just like ARTIP there is only one RNAV route between RIVER and the threshold of runway 06 and 18R. Because traffic from the RIVER and SUGOL IAF must be merged, there is some flexibility required in the RNAV route both from SUGOL and RIVER. This flexibility is obtained by providing shortcuts (via a Direct-To instruction) direct to NARSI between SUGOL and MICOL or between RIVER and EH605. Extensions of the RNAV routes are also optional. For example a “maintain heading” for aircraft coming from RIVER can be issued when the aircraft has not yet passed EH605. When the aircraft has passed EH605 the controller can issue a heading instruction to the west of the RNAV route (over sea). Once the controller estimates that enough separation has been gained he/she can issue a “direct EH605”, sending the aircraft back to it’s original routing.

An aircraft flying RNAV may be given a HDG by ATC. Switching between RNAV, temporary HDG and then back to RNAV again is not scope of the project.

The estimation of the separation can be supported by the usage of ghost plots. Aircraft coming from SUGOL will be displayed on the RIVER 1B transition with a ghost plot (see figure 5.1).

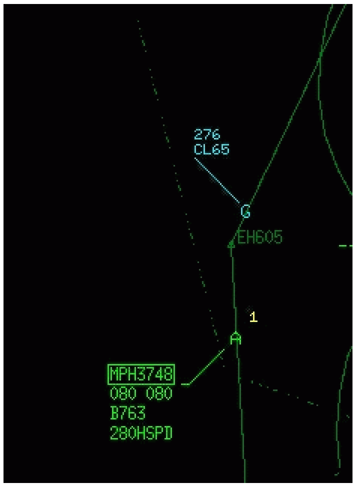


Figure 5.1: Ghost plot

Since lateral prediction is very important for on-board calculation of the CDA path, it is probably required to inform the crew about the RNAV transition, including a possible required shortcut or extension, well in advance (e.g., five minutes before entering the TMA). It needs to be investigated (during the prototyping) whether the controller can still give a direct NARSI after the aircraft has passed the SUGOL IAF. If the aircraft can still calculate the distance to the threshold (or the ILS intercept point), it will be able to calculate when to start the CDA and fly this procedure. The point to start the CDA depends on the type of the procedure.

The arriving traffic is transferred to the ARR controller when the inbound traffic flows are merged and separated from the departing traffic.

Vertical profile and Speed Control

Aircraft will follow altitude instructions given by the approach controller, especially for the first part of the transition. Aircraft are entering the TMA at an altitude between FL70-100 for SUGOL and FL80-100 for RIVER and must be at a flight level, fixed and cleared by ATC before reaching the merging point. Once the aircraft is cleared by the controller to start the CDA, it will initiate the descent shortly after passing the merging point (point MICOL in figure 5.2). Due to the fixed vertical profile of procedures II and III (see chapter 4.2.1), the controller knows the location of the aircraft's Top of Descent (TOD).

To increase the predictability of the aircraft behaviour several speed constraints (or speed windows) were applied both for arrival procedure II and procedure IV. For the RNAV procedures during the mode 2 runway configuration, this results in the procedures shown in figure 4.3 and 4.4.

5.2.2.3 Arrival controller

For the landing runway combinations of 18C-18R and 36R-06 there will be two Arrival Controllers (ARR), each responsible for one landing runway. Inbound traffic from the TMA entry fixes RIVER and

SUGOL will be planned by the Arrival Manager for runway 18R (Mode 2) or 06 (Mode 1), traffic from ARTIP will be assigned for runway 18C (Mode 2) or 36R (Mode 1). The Arrival controller receives the arriving traffic from the approach controller when it is on the downwind leg of the RNAV transition route. This means during Mode 1 for traffic coming from RIVER and SUGOL that the arrival controller will receive the traffic between SOKSI and EH613 and for traffic from ARTIP between MONUT and EH617 (see figure 4.1). During Mode 2 traffic will be transferred to the arrival controller between MICOL and NARSI when coming from RIVER and SUGOL and for traffic from ARTIP around REGSU (see figure 4.2).

When being cleared for the Sourdine II approach by the ACC executive controller before the IAF, the aircraft is cleared to follow the RNAV route until ILS interception. The ARR controller is responsible for the final sequencing in order to optimise the sequence.

Figure 5.2: NARSIM controller display

5.2.3 TWR procedures

This Sourdine II concept will have no effect on present operational procedures for the TWR controller.

5.3 Concept using CDA with variable vertical path

Refer to procedures in Chapter 4

The most important difference between this concept and the concept using the CDA with a fixed vertical path is the fact that the TOD and the flight path angle can be different for different aircraft. Aircraft will also have to reduce their speed earlier in comparison with the other concept (200 KTS at MICOL and 170 KTS at NARSI instead of 220 KTS at MICOL and 200 KTS at NARSI). This is because aircraft will start their CDA with variable vertical path with FAS instead of the 220 KTS when flying a CDA with a fixed vertical path.

5.3.1 ACC procedures

The ACC procedures are identical to those described in chapter 5.2.1 for the concept using CDA with fixed vertical path.

5.3.2 APP procedures

5.3.2.1 Approach planning controller

The approach planning controller (APLN) is still responsible for the chosen active runway combination, the landing interval and planning of the inbound traffic and is supported by an (advanced) Arrival Manager.

5.3.2.2 Feeder/departure controller

The feeder/departure controller (FDR/DCO) receives the inbound aircraft from the ACC executive controller. Inbound aircraft have already received a clearance from the ACC executive controller for the appropriate Sourdine II approach route (lateral RNAV route).

Lateral Control

Lateral control for the FDR/DCO is mainly identical to that described in chapter 5.2.2.2 for the concept using CDA with fixed vertical path. The arriving traffic is transferred to the ARR controller when the inbound traffic flows are merged and separated from the departing traffic.

Vertical profile and Speed Control

Aircraft will follow altitude instructions given by the approach controller, especially for the first part of the transition. Aircraft are entering the TMA at an altitude between FL70-100 for SUGOL and FL80-100 for RIVER and must be at a flight level, fixed and cleared by ATC before reaching the merging point. At this merging point the aircraft must be reduced to 200 KTS. Further along the path, at the point NARSI, the aircraft must be reduced to 170 KTS. Between this point NARSI and the point EH707 the aircraft starts its descent in full configuration with the required final approach speed (FAS).

5.3.2.3 Arrival controller

When being cleared for the Sourdine II approach by the ACC executive controller before the IAF, the aircraft is cleared to follow the RNAV route until ILS interception. The ARR controller is responsible for the final sequencing in order to optimise the sequence. Since the aircraft is flying in landing configuration with its FAS along the entire CDA, there is not a lot of manoeuvrability for both the controller as well as the pilot during this part of the arrival.

5.3.3 TWR procedures

This Sourdine II concept will have no effect on present operational procedures for the TWR controller.

6 Tasks and responsibilities for aircraft operation

6.1 Synopsis

Before approaching the top-of-descent from cruise altitude, which may be reached before the Amsterdam FIR boundary, aircraft inbound to Schiphol normally have received latest arrival information via the latest ATIS broadcast for Schiphol. This informs the crew with the following data: meteorological conditions, runways in use for landing, transition routing, possible holdings and other relevant information. With this information the crew can prepare the approach and complete the flight plan programmed in the FMS with the relevant arrival and transition route as stored in the onboard database. Upon entering the Amsterdam FIR, aircraft inbound to Schiphol will be cleared to follow one of the standard arrival routes or receive additional radar vectors towards the Initial Approach Fixes around the Schiphol TMA boundary (ARTIP, RIVER, SUGOL). While under control of Amsterdam Radar, these IAFs are the initial clearance limit. Before being transferred to the subsequent approach controller, the aircraft are normally cleared for the appropriate RNAV transition route. Only in case of delays, the aircraft are instructed to join the holding at ARTIP, RIVER or SUGOL.

Lateral navigation is typically performed based on LNAV (NAV) guidance provided by the FMS. In the vertical plane, the aircraft will be flown according to the altitude and speed instructions provided by ATC. With respect to the flight mode, altitude changes are usually performed in altitude select mode, i.e. idle thrust (i.e. constant idle thrust) with speed select mode on (“speed-on-elevator”). During horizontal segments the flight modes are altitude hold ("altitude-on-elevator") and speed select ("speed-on-throttle") Alternatively, the vertical profile may be flown by means of VNAV (PROF) mode, however, provided that ATC allows the crew to plan their descent and speed profile. Selection of VNAV mode, where speed and altitude control is performed by the FMS according to altitude / speed constraints in the navigation database, is a decision of the flight crew, depending on the type of ATC instructions and the anticipated freedom to plan the own vertical profile.

In this respect, the crew usually anticipates to be cleared to a final altitude between FL100 and FL70 with a maximum speed of 250 KTS IAS at the TMA boundary, as indicated on the published arrival and approach charts for Schiphol, unless ATC allows or instructs otherwise. These restrictions are also coded in the FMS navigation database and are thus taken into account by the VNAV planning algorithms.

After the crew has received clearance to proceed on the RNAV transition, the aircraft will follow the transition routing as published on the approach chart. All RNAV waypoints will be usually "fly-by" waypoints, unless otherwise coded. Since the published routing is RNAV, the horizontal guidance mode for flight director or autopilot remains LNAV mode. Speed reductions are made according to ATC or charted publications.

The approach instructions by ATC will be such that the final vertical profile of the approach procedure can be intercepted and flown safely. In case of a continuous descent profile, this should be performed in VNAV mode. The aircraft now follows the CDA profile in both LNAV and VNAV mode until the ILS localizer and glide slope are intercepted. Once established on the ILS, the crew will report so and the APP/ARR controller will transfer the aircraft to TWR for final instructions and landing clearance.

6.2 Overview of crew tasks

- PRE-FLIGHT PLANNING:

  It is assumed that the operator will use sufficiently equipped aircraft for the flight, in particular during line operations. However the crew should still verify the operational status of each individual aircraft, which may have a lower operational status than nominal due to certain inoperative equipement.

- DESCENT, ARRIVAL, APPROACH
  - Crew confirm that navigation database is current
  - Crew select STAR, approach and intended landing runway (order of selection depends on aircraft equipage)
  - Crew check active flightplan by comparing charts, SID or other applicable documents with the map display and the MCDU. This includes:
    - confirmation of the correct waypoint sequence
    - plausibility check of the track angles and waypoint distances
    - confirm altitude or speed constraints
    - identification of waypoints that may be designated as fly-by or fly-over
  - Crew focus on any P-RNAV segments that are to be flown below Minimum Safe Altitude (MSA)
  - Modification of waypoint sequence is to be included in the flight plan. Waypoints are to be selected from the procedure stored in the navigation database. Manual entry of waypoints is not permitted.
  - Crew check that the RNAV system is available. For RNAV systems without GNSS updating, a plausibility check is required during the descent phase before reaching the IAF.
  - Crew monitor the track keeping ability of the aircraft

- INTERCEPTING ILS
  - LNAV (NAV) is not used to intercept the ILS localiser

    Due to aircraft certification and/or company policy it may not be allowed to intercept the localiser when flying in LNAV mode. In this case the crew will disengage LNAV and select an intercept heading (in HDG mode) prior to arming the approach (APPR) mode. When the ILS localiser signal is captured, the aircraft's navigation system automatically switches from HDG to LOC mode;

  - LNAV (PROF) is used to intercept the ILS localiser

    Aircraft may allow engagement of LNAV until localiser intercept. Aircraft intercept the ILS localiser by continuing the RNAV route in LNAV mode and crew arms the approach (APPR) as well. When the ILS localiser signal is captured, the aircraft's navigation system automatically switches from LNAV to LOC mode.

7 Air/ground communication procedures and clearances

The voice communication procedures between aircraft and ATC should comply to present R/T standards as provided by ICAO Doc-4444 [DOC4444]. Some specific R/T phraseology is required for the clearance for RNAV transition routes and will be published in an Amendment to ICAO Doc. 7030, ICAO EUR Region Supplementary Procedures [DOC7030]

Example flight from REDFA:

In general, the crew is already informed on the current weather situation and runways in use at Schiphol, through the arrival information. When entering the Amsterdam FIR, the aircraft will be issued an initial RNAV route clearance after contacting Amsterdam ACC with the following contents. For instance traffic entering the Amsterdam FIR at HELEN will be cleared to RIVER initially:

ACC "Aircraft callsign, HELEN arrival"

In the cases that holdings are unavoidable, the aircraft is also provided with an expected approach time (EAT):

ACC "Aircraft callsign, Expected Approach Time is TT"

Alternatively, when applicable, a required time of arrival can be issued

ACC "Aircraft callsign, Required Time of Arrival for RIVER is TT"

Further on the aircraft will be given level and speed instructions along the route, e.g.:

ACC "Aircraft callsign, descend to FL70, reduce speed 250KTS"

When approaching the initial approach fix, the aircraft will be transferred to the FDR/DCO controller with a clearance like:

ACC "Aircraft callsign, after RIVER, proceed on RIVER 1B transition to NARSI"

ACC "Aircraft callsign, contact Schiphol approach on 121.2 (West) / 119.05 (East)"

This implies NARSI (instead of presently SPL) as the clearance limit for transfer from ACC to the APP controller. After correct read back, the transfer of control will be made.

The approach controller will monitor the traffic and decide when the aircraft can start its CDA procedure and descent at own discretion:

FDR "Aircraft callsign, after passing MICOL, continue on RIVER 1B transition to NARSI and prepare for CDA ILS 18R"

The approach controller may also provide shortcut routes for which the additional intermediate waypoints have been created. Operational practice should indicate the suitability of these waypoints and also in combination of flying CDA approaches:

FDR "Aircraft callsign, proceed direct to NARSI and prepare for CDA ILS 18R"

If parallel runways are in use, then the pilot is informed with a clearance like:

FDR *“Aircraft callsign, independent parallel approaches in force, ILS frequency is 110.1”*

Once the traffic has been sequenced onto the downwind leg between MICOL and NARSI, the aircraft will be transferred to the arrival controller:

FDR "Aircraft callsign, contact arrival on 118.4 (West) / 131.150 (East)”

The arrival controller will perform final sequencing and give the approach clearance when the aircraft is approaching NIRSI. In case of no traffic conflicts, the arrival controller will give a clearance, which will include a sentence like:

ARR "Aircraft callsign, cleared ILS approach runway 18R"

In other cases the arrival controller may provide further instructions for closer sequencing onto the final approach with standard day-to-day phraseology.

When the aircraft can not (or no longer) comply with the P-RNAV requirement while initiating the transition route or while flying the transition route, the crew will use the R/T phraseology *“Unable Precision RNAV” or “NEGATIVE Precision RNAV”.*

8 Concept analysis

This chapter analyses the concept. It describes among others some non-nominal cases, the influence of wind and some possible solutions for ATM problems.

8.1 Non-nominal aircraft behaviour

Non-nominal aircraft behaviour will almost always disrupt the already established flow of aircraft. Controllers will probably need to intervene. The following are possible situations:

1. The aircraft misses its top-of-descent (TOD). If the deviation is not too large (e.g. up to 2 NM) it might be possible to expedite the descent, resulting in a CDA with a steeper descent during the initial segment. For cases where the deviation is large see points 2 and 3.

2. At the start of the CDA, the aircraft's speed is too high. If the deviation is not too high, the aircraft could remain level and decelerate. Once it has reached the desired speed, it can start descending in a similar manner as mentioned in case 1. Again if the deviation is too high, see cases 2 and 3 for possible ATC intervention.

3. The deviation of the aircraft cannot be compensated in such a manner that the CDA can be completed. The aircraft can be "removed" from the established flow and inserted somewhere else, where there is space to add an extra aircraft,

4. The deviation of the aircraft cannot be compensated in such a manner that the CDA can be completed. The aircraft is allowed to continue its inbound flight, but a smooth correction of the deviation will have probably a knock-on effect on a number of aircraft in the vicinity of this non-nominal flight, which effect is less desirable and should be avoided. These aircraft will probably need to be vectored to the runway, making a CDA very unlikely. The CDA procedure allows therefore to quit the procedure at any moment and to merge later on, after a descent and leveling off maneuver, similar to a present-day approach procedure. Some spare capacity will be kept available in order to be able to perform such procedurally corrective operations.

8.2 Influence of wind

Wind will have a profound effect on an aircraft's 4-D flight path. For an individual aircraft conducting a CDA, this is not much of a problem. It is in the planned arrival sequence where the wind can cause problems. If the effect of wind has not properly been incorporated into the planning, the probability that aircraft will violate separation minima is likely to increase. The "average" wind information will be used with the trajectory prediction and thereby in the sequence planning. However, the wind fluctuation or deviations from this "average wind" cause the deviation from the planning and need to be dealt with.

If the winds are not too strong, i.e. less than 25 knots, it is expected that some speed instructions can make up for the disturbance. If winds are stronger, it might become a non-nominal situation where more intervention is needed.

8.3 Guaranteeing sequencing

From a controller point of view

Currently, it is completely up to the executive controller, having the flight under control, to decide on the preferable arrival sequence. Once the aircraft enters the TMA, it is up to the FDR/DCO to determine the aircraft's positioning in his/her sequence. Any arrival sequence calculated by the AMAN system might be ignored. This method works because the controller can direct the aircraft where ever he/she deems fit, thus enabling him/her to increase or decrease the length of the arrival path as necessary. This will no longer be possible while conducting CDA procedures. Once the aircraft has started its CDA, the path can no longer be changed (unless absolutely necessary for safety reasons). As the controller can no longer issue heading and/or level instructions, he/she will need to ensure that aircraft stick to the predicted path and times. Speed instructions can be issued to compensate for minor deviations, for example if the aircraft, arriving via RIVER, is a minute early it can be instructed to decrease its speed by about 25 knots during the stretch between RIVER and the merging point (MICOL) to compensate.

The consequence will be that the sequencing will have to rely heavier on medium-term and long-term prediction and that the role of preparing the sequencing in ACC airspace will become more demanding. This has effects on its turn on requirements on co-ordination support, on automated tools and on the user-friendliness of supportive HMI in order to allow the controller to perform his/her tasks appropriately.

From a pilot point of view

No changes of responsibilities have been foreseen in this concept. Therefore, sequencing is not up to the pilot. The pilot follows the instructions given to him/her by ATC.

8.4 Guaranteeing separation

From a controller point of view

As mentioned in the previous Section (Guaranteeing sequencing) a large part of the sequencing of inbound traffic should be performed outside the TMA. If the planned/estimated times, generated by the AMAN system, are sufficiently accurate, and if the controller is enabled to monitor time deviations in a sufficiently sensitive manner, separation can be performed on the basis of time, in stead of distance. This is to be preferred because time-based separation will be more accurate in reaching full and effective use of available capacity, while time-based separation assurance can be more sensitive and smooth in its operations also. The reason is that time-based separation can be based on a critically well-defined constant, while distance-based separation is dependent on current speeds of each individual flight.

While aircraft descend their TAS decreases resulting in aircraft gaining on each other, as one descends before the other. To compensate for this it would be beneficial if the planning system uses the minimum separation criteria in its planning process. The idea being that the times it generates over the IAF (EATs) would result in lateral separation values larger than the minimum required, but such that aircraft will not violate the separation criteria during the descent and are able to cross the runway threshold at minimum required separation.

From a pilot point of view

No changes of responsibilities have been foreseen in this concept. Therefore, maintaining separation is not up to the pilot. The pilot follows the instructions given to him/her by ATC.

8.5 Influence of ASAS in the TMA

ASAS in the TMA would facilitate solving the aspects mentioned in the sections (above). However, the algorithm needed to apply ASAS in TMA while conducting CDAs is very complex. The development of this algorithm is not within S2’s scope.

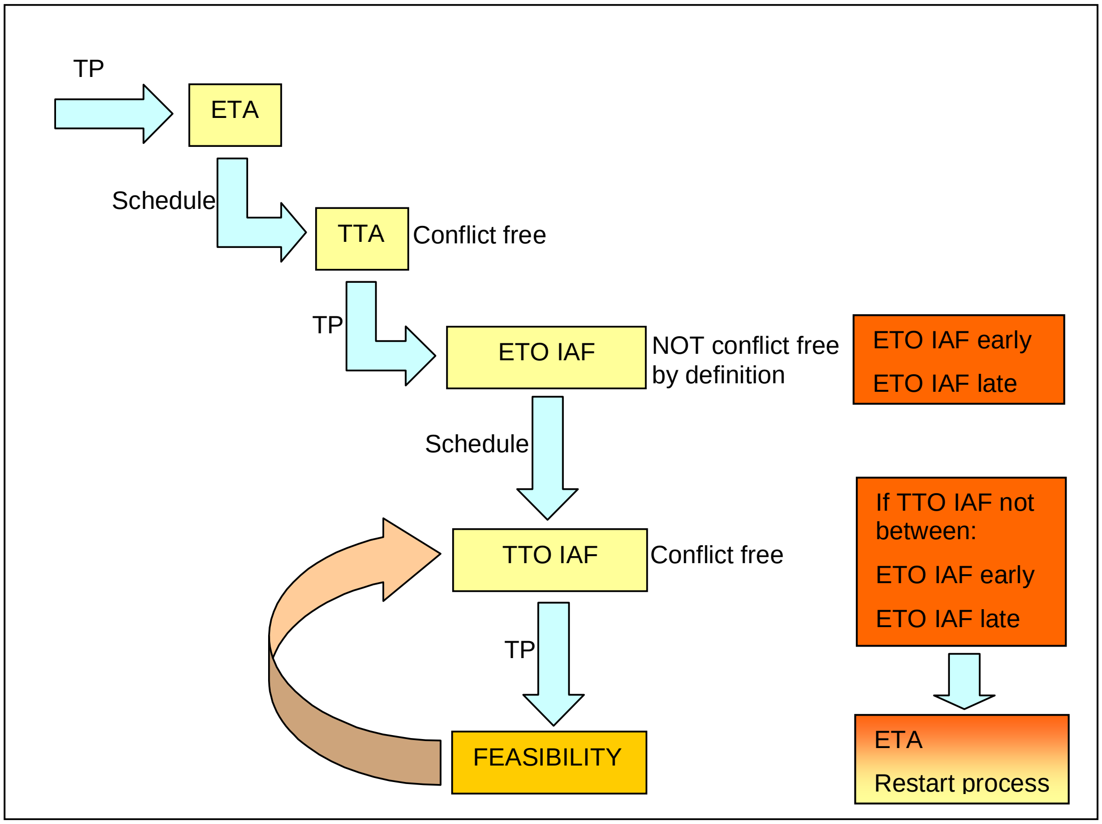
9 ATC support tools and aircraft equipment

This chapter will provide a brief overview of the support tools on the ground and the aircraft equipment.

9.1 ATC support tools

9.1.1 Arrival manager

When the system acknowledgement (ACT) is received by ATC (approximately 12 minutes before the aircraft reaches the FIR boundary), the Trajectory Predictor (TP) calculates estimated times over (ETOs) the Initial Approach Fix (IAF) and the runway threshold (then called Estimated Time of Arrival, ETA). To refine the trajectory information the TP can use the Downlink of Aircraft Parameters (DAP) information of the aircraft. An Arrival Manager (AMAN) consists of a TP and a scheduler. The scheduler uses the ETAs to build a sequence (planning) and defines the Target Times of Arrival (TTAs). From this TTA Trajectory synthesis is used to calculate ETOs for the IAF (the LVNL calls this the Expected Approach Time, EAT). These ETOs for the IAF are not conflict free by definition. Therefore the scheduler functionality is needed to sequence the aircraft on the IAF and define Target Times Over for the IAF (TTOs IAF). These TTO IAF values will be checked against their feasibility using information derived from the TP.

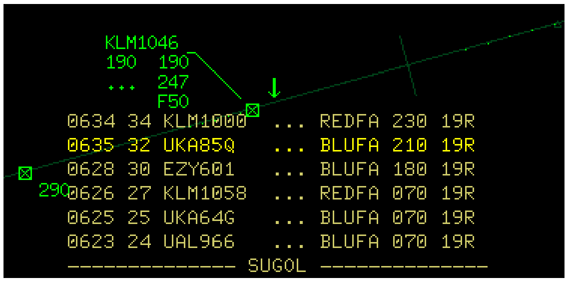


igure 9.1: AMAN sequence diagram

9.1.2 Stack list and entry sequence list

The ACC tactical controller uses the stack list (see figure 9.2) to see the ETAs of the traffic in the sector. This stack list displays the following information:

- ETO for the IAF
- EAT if the flight is planned, or
    - ... if the flight is not planned
    - DD if the flight is diverted (but not to EHAM)
    - HH if the flight is in the holding
- ACID (aircraft/flight identification)
- TFL (target flight level)
- (FIR) Entry Co-ordination Point (COP)
- EFL (executive/cleared flight level)
- Landing runway, if flight is planned

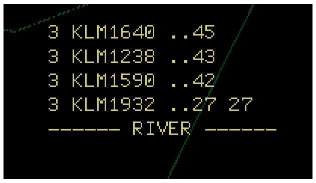


```
0634 34 KLM1000  ... REDFA 230 19R
0635 32 UKA85Q   ... BLUFA 210 19R
0628 30 EZY601   ... BLUFA 180 19R
0626 27 KLM1058  ... REDFA 070 19R
0625 25 UKA64G   ... BLUFA 070 19R
0623 24 UAL966   ... BLUFA 070 19R
-------------- SUGOL --------------
```

Figure 9.2: Stack list

A similar window, now called Entry Sequence List (ESL, see figure 9.3) is used by the APP controller to get an indication where, when and which flight is entering the TMA. This Entry sequence list displays the following information:

- ACC sector number
- ACID
- EAT if the flight is planned, or ETO if the flight is not planned
- Landing runway, if this is not the main landing runway



```
3 KLM1640 ..45
3 KLM1238 ..43
3 KLM1590 ..42
3 KLM1932 ..27 27
------ RIVER ------
```

Figure 9.3: Entry sequence list

9.1.3 Flight position monitoring

It needs to be investigated whether it is helpful for the controller to have a Flight Position Monitoring tool (FPM) or Monitoring Aid (MONA) to assist the controller in monitoring track deviations for arrival traffic and if there are specific strong requirements to support Arrival Management and in particular CDAs.

9.1.4 Short term conflict alert (STCA)

To serve as a safety net the APP and ARR controllers will have a Short Term Conflict Alert (STCA) working within the TMA. This will be the same functionality as used by the ACC controllers, with only a difference in the minimum lateral separation (3NM instead of 5NM). STCA uses radar data from an ARTAS tracker communicated by RADNET and is based on multi-tracking synthesised tracks.

9.1.5 Ghosting functionality

Ghosting functionality enables the projection of an aircraft label on another route. This functionality assists the controller in the merging of traffic.

For the Schiphol situation the ghosting functionality is used as follows:

To facilitate the merging of traffic flows at EH606, a ghosting tool will be used. As the approach controller has the option to deviate traffic arriving via RIVER, these aircraft will be classified as the slave aircraft. The aircraft arriving via SUGOL are classified as the master aircraft and their position will be projected on the RIVER transition.

9.1.6 Display options

As an additional sequencing aid, the controller can display a line between aircraft plots on the Plan View Display (PVD). This line will make the order in which aircraft have been sequenced clearer to the approach controller. This is particularly helpful when aircraft have deviated from the RNAV route. To maintain a complete picture it is important that the ghost plots on the RIVER route are also presented in this sequence line. Also, the moment for starting the CDA (starting at FL70) can be displayed on the controller’s PVD (see blue circle in figure 5.1). The radar labels for the ACC as well as the APP and ARR controllers will change slightly. For the ACC controllers the label will now also contain a sequence number from the Arrival Manager (AMAN) and the time difference from the calculated Expected Approach Time (EAT).

9.2 Aircraft technical equipment

All aircraft are assumed to be equipped with P-RNAV capability and hold an operational approval for P-RNAV operations in accordance with JAA TGL-10 in order to be able to fly the RNAV arrival routes. Mixed aircraft navigational capabilities are not scope of the project.

9.2.1 Navigation

Precision RNAV (P-RNAV) requires aircraft conformance to a lateral track-keeping accuracy of ±1NM for at least 95% of the flight time, together with significantly enhanced functionality on board the aircraft. Compliance with JAA TGL-10 is required and implies amongst others that:

- the RNAV system automatically reverts from DME/DME (Distance Measuring Equipment) to updated Inertial Reference System (IRS) with positive course guidance, when only two DME stations are received;
- the navigation database containing the procedures can be automatically loaded into the RNAV system;

- the RNAV system has turn anticipation capability;
- creation of new waypoints by manual entry into the RNAV system by the flight crew is not permitted;
- prior to the arrival phase, the flight crew should verify that the correct terminal procedure has been loaded. The active flight plan should be checked by comparing the charts with the map display (if applicable) and the MCDU (Multi-function Control Display Unit). This includes confirmation of the waypoint sequence, reasonableness of track angles and distances, any altitude or speed constraints, and, where possible, which waypoints are fly-by and which are fly-over.

P-RNAV operations are based upon the use of RNAV equipment that automatically determines the aircraft position in the horizontal plane using inputs from the following types of positioning sensor:

a. DME/DME;

b. VOR/DME where it is identified as meeting the requirements of the procedure;

c. GPS with or without ground-based (GBAS) or space-based (SBAS) augmentations;

d. IRS with automatic updating from radio based navigation equipment.

Ad c) Contrary to TGL-10, it is assumed in the safety assessment that the RNAV transition routes are not to be flown with stand-alone GPS equipment only. Given the timeframe of 2015, it can be expected that the aviation community is in the middle of the transitioning phase involving different positioning systems, e.g.:

- 2004: SBAS (requires specific SBAS receiver)
- 2008: GBAS (requires specific GBAS receiver)
- 2008: GALILEO (requires specific receiver) and possible combined use of GPS and GALILEO.
- 2010: modernisation of US GPS space-based infrastructure through the provision of additional civil frequencies and improved clocks.

With respect to the availability of a number of augmentations to existing positioning systems as well as new positioning systems, the following assumptions are made in this project:

- GPS is to be read as unaugmented GPS. This means basic GPS signal-in-space of US Department of Defense (DoD). No modernisation of US GPS is taken into account.
- It is assumed that no separate GBAS/SBAS/GALILEO-based procedures are published.

Ad d) In the event of unavailability or loss of radio sensor derived automatic position updating, it is permissible to use, for a short period of time, data from an IRS as the only means of positioning [TGL10]. The period of time depends amongst others on the IRS configuration and drift rate.

Most multi-sensor FMS will use the following hierarchy [FMSACC] in order to derive the best position estimate:

1. IRS/GPS;
2. IRS/DME;
3. IRS/DME/VOR for a co-located VOR/DME;
4. IRS/LOC/DME for localizer updates;
5. IRS.

9.2.2 Altitude control and guidance

Many RNAV systems also have the capability of providing vertical navigation (VNAV or PROF). VNAV presents to the pilot computed vertical guidance referenced to a specified vertical path angle (VPA). The computer-resolved vertical guidance may be based on barometric altitude (baro-VNAV) or geometric altitude (e.g. from the GNSS – geometric VNAV) and is either specified as a vertical path angle from to a waypoint or as a geometric path between two waypoints.

Vertical guidance may be provided by distance versus prescribed altitude constraints, or by baro-VNAV, but it is not prescribed, i.e., the flight crew may also compare their actual altitude to altitude constraints at waypoints in the approach procedure.

9.2.3 Mode of flight

The RNAV transition route is flown with the guidance system connected to the Flight Management System (LNAV mode). Aircraft control will be either manual with flight director or automatic.

9.2.4 Transponder

Given the airspace classification A of the Schiphol TMA, all aircraft in the Schiphol TMA are required to carry a switched-on SSR transponder.

9.2.5 Communication

Communication will be provided by conventional VHF radiotelephony as laid down in ICAO Doc-4444 [DOC4444]. Some specific R/T phraseology is required for the clearance for RNAV transition routes and is to be published in an Amendment to ICAO Doc. 7030, ICAO EUR Region Supplementary Procedures [DOC7030]. In case of the remote probability of communication failure, a dedicated procedure may need to be developed. However, this is not within the scope of the present developments.

As part of the implementation aspects and foreseen introduction of datalink communication, it needs to be decided later whether a part of the communication will be performed via datalink.

9.2.6 Surveillance

- Aircraft

  From 1 January 2003 and in accordance with ICAO Annex 6.18.1-2 all turbine-engined aeroplanes of a maximum certificated take-off mass in excess of 15,000 kg or authorized to carry more than 30 passengers, require TCAS II collision avoidance known as ACAS II, Change 7.

  From 1 January 2005, all fixed-wing turbine aircraft in excess of 5700 kg MTOW or authorized to carry more than 19 passengers, require TCAS II collision avoidance known as ACAS II, Change 7.

- ATC

  ATC units ACC/APP/TWR do not have a monitoring facility to check the GPS signal-in-space.

  During parallel approach operations ATC APP need to monitor the No Transgression Zone (NTZ) The NTZ is a fictitious area shown on the radar display that is located between the two runways and is not be entered by any aircraft during parallel approach operations. It is assumed that the ATCo can also switch off the NTZ overlay.

The usage of a Precision Approach Radar (PAR) for Precision Radar Monitoring (PRM) is not foreseen before 2010.

Two Airport Surveillance and Detection Equipment (ASDE) are available.

Appendix A: RNAV transitions and departures

During Mode 1 the following SIDs are available:

- LEKKO 2W (RWY 36C)
- LOPIK 2W (RWY 36C)
- PAMPUS 2W (RWY 36C)
- SPIJKERBOOR 2W (RWY 36C)
- BERGI 1V (RWY 36L)
- REFSO 1V (RWY 36L)

Table 3.1: Description of the SIDs during Mode 1

Designator	**Route**		**After departure**	
	Lateral	**Vertical**	**Contact**	**Climb to maintain**
LEKKO 2W	THR 36C / EH007 / EH004 (MAX 220 KT IAS) / EH036 / EH072 / LEKKO	LEKKO at FL 060	Passing 2000 ft AMSL: 119.050 MHz	FL 060
LOPIK 2W	THR 36C / EH007 / EH004 (MAX 220 KT IAS) / EH036 / EH033 / LOPIK	LOPIK at FL 060	Passing 2000 ft AMSL: 119.050 MHz	FL 060
PAMPUS 2W	THR 36C / EH045 / EH081 / EH082 / PAM VOR	PAM VOR at FL 060	Passing 2000 ft AMSL: 119.050 MHz	FL 060
SPIJKER-BOOR 2W	THR 36C / EH045 / EH044 / SPY VOR / ANDIK	ANDIK at FL 060	Passing 2000 ft AMSL: 121.200 MHz	FL 060
BERGI 1V	THR 36L / EH084 / EH089 / EH092 / BERGI	BERGI at FL 060	Passing 2000 ft AMSL: 121.200 MHz	FL 060
REFSO 1V	THR 36L / EH084 / EH089 / EH090 / EH091 / VOLLA / REFSO	VOLLA at FL 060	Passing 2000 ft AMSL: 121.200 MHz	FL 060

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)

Table 3.2: Description of the SIDs during Mode 2

Designator	**Route**		**After departure**	
	Lateral	**Vertical**	**Contact**	**Climb to maintain**
ANDIK 2E	THR 18L / EH037 (MAX 220 KT IAS) / EH024 / PAM VOR / ANDIK	ANDIK at FL 060	Passing 2000 ft AMSL: 119.050 MHz	FL 060
ARNEM 2E	THR 18L / EH037 (MAX 220 KT IAS) / IVLUT / ARNEM	ARNEM at FL 060	Passing 2000 ft AMSL: 119.050 MHz	FL 060
LEKKO 2E	THR 18L / At 500 ft AMSL turn left / EH037 / LEKKO	LEKKO at FL 060	Passing 2000 ft AMSL: 119.050 MHz	FL 060
LOPIK 2E	THR 18L / At 500 ft AMSL turn left / EH029 / EH050 / LOPIK	LOPIK at FL 060	Passing 2000 ft AMSL: 119.050 MHz	FL 060
BERGI 1S	THR 24 / EH001 / EH051 / EH009 / EH 028 / BERGI	BERGI at FL 060	Passing 2000 ft AMSL: 121.200 MHz	FL 060
VALKO 1S	THR 24 / EH001 / EH051 / EH009 / VALKO	VALKO at FL 060	Passing 2000 ft AMSL: 121.200 MHz	FL 060

During Mode 1 the following RNAV transitions and approaches are available:

- RIVER 1A TRANSITION (TO RWY 06)
- SUGOL 1A TRANSITION (TO RWY 06)
- MONUT 1 APPROACH (TO RWY 36R)
- SOKSI APPROACH (TO RWY 06)

Note that for the following description of the RNAV approach procedures the altitude and speed constraints only count for the default RNAV procedures. The SII procedures can result in other altitude and speed constraints.

Table 3.3: Description of the STARs during Mode 1

RIVER 1A TRANSITION RWY 06

Design.	WPT	Function	Path term.	Fly over	Turn	Altitude (ft AMSL)	Speed (KT IAS)	Track (MAG)/ Distance (NM) to next WPT
En route								
RIVER	RIVER	IAF	IF			+FL070		358°/ 9.2
	EH605		TF		R			026°/ 9.2
	EH610		TF		R			071°/ 5.6
	SOKSI		IF		R	+4000	220	116°/ 4.0
	EH613		TF		L			093°/ 2.4
	EH614	IF	TF		L	+2900	190-210	059°/ 3.0
	EH609	FAF	TF			2000		059°/ 2.3
	Additional information final approach and initial missed approach non-precision procedure							
	EH616		TF			1275		059°/ 3.9
	THR 06	MAPt	TF	Y		ELEV –11.9		059°
		Initial missed approach	FM			2000		

SUGOL 1A TRANSITION RWY 06

Design.	WPT	Function	Path term.	Fly over	Turn	Altitude (ft AMSL)	Speed (KT IAS)	Track (MAG)/ Distance (NM) to next WPT
En route								
SUGOL	SUGOL	IAF	IF			+FL070		113°/ 16.6
	EH606		TF		R			186°/ 11.2
	SOKSI		IF		L	+4000	220	116°/ 4.0
	EH613		TF		L			093°/ 2.4
	EH614	IF	TF		L	+2900	190-210	059°/ 3.0
	EH609	FAF	TF			2000		059°/ 2.3
	Additional information final approach and initial missed approach non-precision procedure							
	EH616		TF			1275		059°/ 3.9
	THR 06	MAPt	TF	Y		ELEV –11.9		059°
		Initial missed approach	FM			2000		

MONUT 1 APPROACH RWY 36R

Design.	WPT	Function	Path term.	Fly over	Turn	Altitude (ft AMSL)	Speed (KT IAS)	Track (MAG)/ Distance (NM) to next WPT
En route								
MONUT	MONUT		IF			+3000		274°/ 3.0
	EH617		TF		R			319°/ 2.0
	EH615		TF		R			004°/ 2.0
	EH634	FAF	TF			3000		004°/ 5.5
	Additional information final approach and initial missed approach non-precision procedure							
	EH635		TF			1260		004°/ 3.8
	THR 36R	MAPt	TF	Y		ELEV –11.5		004°/ 5.0
	EH637	Initial missed approach	TF	Y		1500		004°
			FM			2000		

RNAV transitions and approaches during mode 2:

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)
- NIRSI APPROACH (TO RWY 18R)

Table 3.4: Description of the STARs during Mode 2

RIVER 1B TRANSITION RWY 18R

Design.	WPT	Function	Path term.	Fly over	Turn	Altitude (ft AMSL)	Speed (KT IAS)	Track (MAG)/ Distance (NM) to next WPT
En route								
RIVER	RIVER	IAF	IF			+FL070		358°/ 9.2
	EH605		TF		R			026°/ 34.3
	NIRSI		TF		R	+4000	220	091°/ 4.9
	EH607		TF		R			133°/ 4.0
	EH608	IF	TF		R	+3400	190-210	184°/ 4.6
	EH621	FAF	TF			2000		184°/ 2.2
	Additional information final approach and initial missed approach non-precision procedure							
	EH622		TF			1310		184°/ 4.0
	THR 18R	MAPt	TF	Y		ELEV –13.1		184°
		Initial missed approach	FA			500		
	EH624		DF	Y	R	2000		
			FM			200		280°

SUGOL 1B TRANSITION RWY 18R

Design.	WPT	Function	Path term.	Fly over	Turn	Altitude (ft AMSL)	Speed (KT IAS)	Track (MAG)/ Distance (NM) to next WPT
En route								
SUGOL	SUGOL	IAF	IF			+FL070		113°/ 16.6
	EH606		TF		L			026°/ 10.7
	NIRSI		TF		R	+4000	220	091°/ 4.9
	EH607		TF		R			133°/ 4.0
	EH608	IF	TF		R	+3400	190-210	184°/ 4.6
	EH621	FAF	TF			2000		184°/ 2.2
	Additional information final approach and initial missed approach non-precision procedure							
	EH622		TF			1310		184°/ 4.0
	THR 18R	MAPt	TF	Y		ELEV –13.1		184°
		Initial missed approach	FA			500		
	EH624		DF	Y	R	2000		
			FM			200		280°

REGSU 1 APPROACH RWY 18C

Design.	WPT	Function	Path term.	Fly over	Turn	Altitude (ft AMSL)	Speed (KT IAS)	Track (MAG)/ Distance (NM) to next WPT
En route								
REGSU	REGSU		IF			+3000		278°/ 3.0
	EH628		TF		L			229°/ 4.0
	EH629		TF		L			184°/ 2.0
	EH625	FAF	TF			3000		184°/ 5.3
	Additional information final approach and initial missed approach non-precision procedure							
	EH626		TF			1310		184°/ 4.0
	THR 18C	MAPt	TF	Y		ELEV –12.6		184°/ 5.2
	EH638	Initial missed approach	TF	Y		1500		184°
			FM			2000		

Appendix B: Waypoints

Designator	Latitude	Longitude
THR06	52°17’21”N	004°44’14”E
SOKSI	52°14’15”N	004°21’52”E
EH605	52°03’59”N	004°06’58”E
EH606	52°25’21”N	004°23’16”E
EH609	52°14’04”N	004°35’45”E
EH610	52°12’19”N	004°13’18”E
EH611	52°19’53”N	004°40’58”E
EH612	52°19’41”N	004°22’33”E
EH613	52°12’33”N	004°27’45”E
EH614	52°12’28”N	004°31’35”E
EH616	52°15’17”N	004°38’53”E

Designator	Latitude	Longitude
THR18C	52°19’53”N	004°44’24”E
REGSU	52°33’29”N	004°55’13”E
EH625	52°29’10”N	004°45’15”E
EH626	52°23’53”N	004°44’45”E
EH628	52°33’49”N	004°50’20”E
EH629	52°31’09”N	004°45’26”E
EH630	52°26’02”N	004°44’58”E
EH638	52°14’40”N	004°43’55”E

Designator	Latitude	Longitude
THR18R	52°21’37”N	004°42’42”E
NIRSI	52°35’02”N	004°30’48”E
EH605	52°03’59”N	004°06’58”E
EH606	52°25’21”N	004°23’16”E
EH607	52°35’02”N	004°38’49”E
EH608	52°32’22”N	004°43’41”E
EH621	52°27’46”N	004°43’16”E
EH622	52°25’36”N	004°43’04”E
EH624	52°21’10”N	004°32’55”E

Designator	Latitude	Longitude
THR36R	52°17’27”N	004°46’38”E
MONUT	52°04’31”N	004°52’37”E
EH615	52°06’11”N	004°45’36”E
EH617	52°04’42”N	004°47’46”E
EH634	52°08’11”N	004°45’47”E
EH635	52°13’37”N	004°46’17”E
EH636	52°11’18”N	004°46’04”E
EH637	52°22’24”N	004°47’06”E

Designator	Latitude	Longitude
THR18L	52°19’17”N	004°46’49”E
EH024	52°15’11”N	004°58’50”E
EH029	52°11’16”N	004°49’14”E
EH037	52°15’33”N	004°46’28”E
EH050	52°09’19”N	004°55’05”E

Designator	Latitude	Longitude
THR24	52°18’16”N	004°46’39”E
EH001	52°16’31”N	004°42’04”E
EH009	52°13’25”N	004°33’16”E
EH028	52°21’28”N	004°25’16”E
EH051	52°14’38”N	004°39’04”E

Designator	Latitude	Longitude
THR36C	52°18’06”N	004°44’14”E
EH004	52°21’59”N	004°50’08”E
EH007	52°22’09”N	004°44’37”E
EH033	52°05’51”N	005°03’17”E
EH036	52°15’25”N	004°50’52”E
EH044	52°26’06”N	004°51’49”E
EH045	52°21’27”N	004°44’33”E
EH081	52°25’25”N	004°50’44”E
EH082	52°25’27”N	004°59’20”E

Designator	Latitude	Longitude
THR36L	52°19’43”N	004°42’32”E
EH084	52°23’43”N	004°42’55”E
EH089	52°27’03”N	004°41’04”E
EH090	52°28’02”N	004°32’04”E
EH091	52°25’22”N	004°29’20”E
EH092	52°30’04”N	004°35’32”E

Appendix C: Flight procedures

PROCEDURE BP1L

Procedure BP1L (see Figure B.1) describes a typical CAT I coupled approach (no Auto-Land) with a 3.0 degrees Glide Slope intercept altitude at 3000 ft HAA. Auto-Pilot, Flight Director and ATS are used. LNAV (NAV) and VNAV (PROF) may be used.

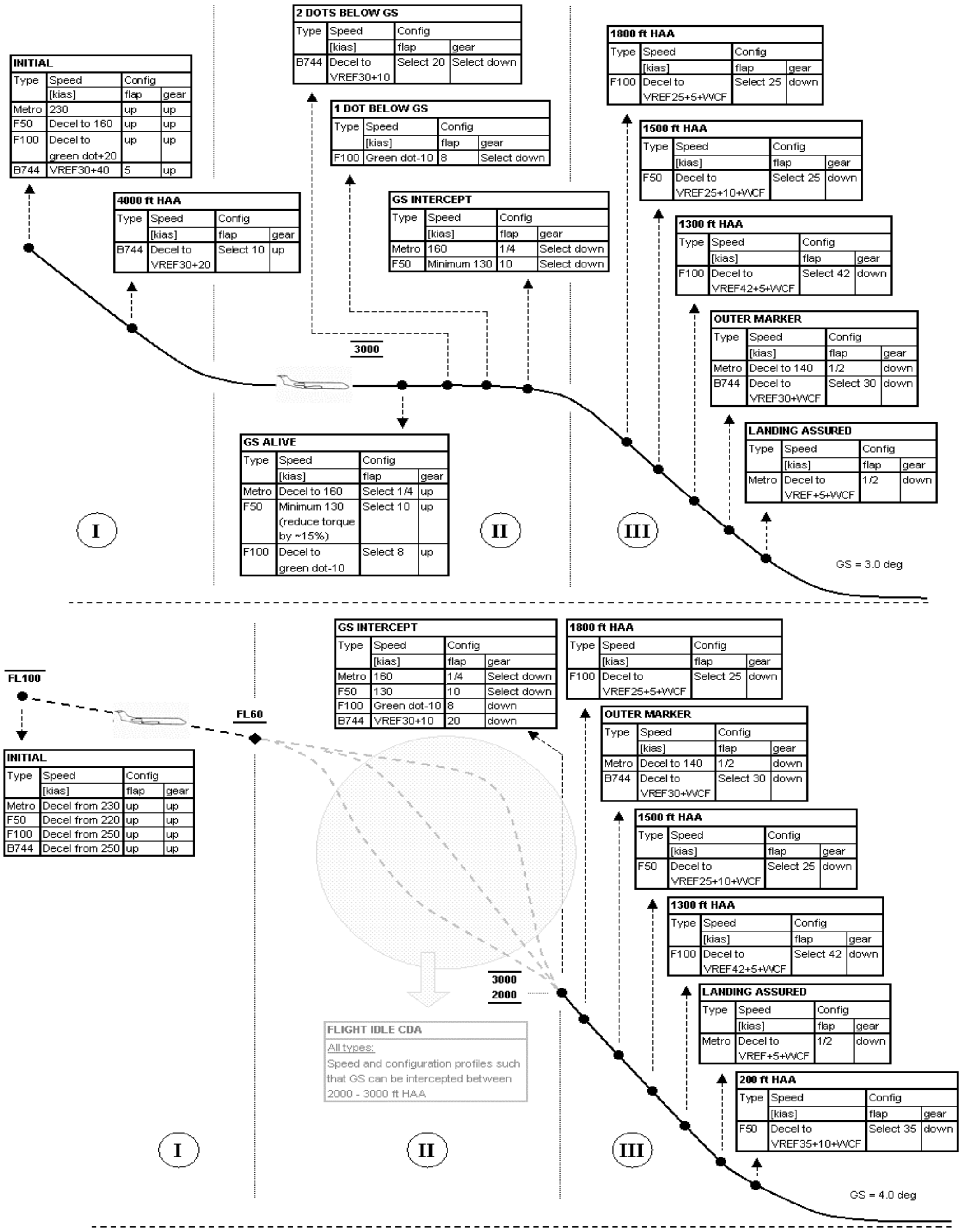
Procedure BP1L		
SECTION I		
Thrust:	As required	
Airspeed:	Decelerating	
Flight path angle:	~ – 3 °	
Flaps/Slats:	As required	
Gear:	Up	
TRANSITION SECTION I – II		
Altitude:	3000 ft	
Distance to threshold:	15 NM	
SECTION II		
Thrust:	Thrust for level flight	
Airspeed:	Decelerating, as required	
Flight path angle:	Level flight	
Flaps/Slats:	As required	
Gear:	Up	
TRANSITION SECTION II – III (FAP)		
Altitude:	3000 ft HAA	
Distance to threshold:	10 NM	
SECTION III		
Thrust:	As required	
Airspeed:	Initially: After approx. 1000ft HAA:	Approx. 180 kts Final approach speed
Flight path angle:	– 3.0 °	
Flaps/Slats:	Initially: After approx. 1000ft HAA:	Intermediate setting One of the landing settings
Gear:	Initially: After approx. 1500ft HAA:	Up Down
At DA(H): If visual references are insufficient initiate GA, otherwise disconnect AP, switch off FD and perform manual landing.		
FLARE / LANDING		
Flare initiation altitude:	35 – 50 ft AGL	
Thrust:	Retard	
Flight path angle:	Increasing from -3 degrees to 0 degrees (or runway slope)	
At touchdown:	Select reverse thrust and apply brakes as required	

PROCEDURE PP1L

Procedure PP1L (see Figure B.1 for a rough impression) describes one of the newly proposed NAP approach procedures. This approach consists of two parts: A flight-idle CDA initial approach with a final ILS CAT I coupled approach (no Auto-Land) with a Glide Slope of 4 degrees or more. Auto-Pilot, Flight Director and ATS are used. LNAV (NAV) and VNAV (PROF) are used.

Procedure PP1L	
SECTION I	
Thrust:	As required
Airspeed:	Decelerating
Flight path angle:	Shallow (~ – 2 °)
Flaps/Slats:	As required
Gear:	Up
TRANSITION I – II	
Altitude:	>= FL60
Distance to threshold:	Depends on a/c performance in section II
SECTION II	
Thrust:	Flight idle
Airspeed:	Constant / ‘speed on elevator’ (value depends on section III intercept perimeters for particular aircraft)*
Flight path angle:	Variable / result of windspeed, idle thrust, anti-icing configuration and chosen speed for particular configuration*
Flaps/Slats:	As required full down or second last setting*
Gear:	Down*
TRANSITION II – III (FAP)	
Altitude:	Between 2000 – 3000 ft HAA
Distance:	4.5 – 6.9 NM
SECTION III	
Thrust:	As required / result of final approach speed and flight path angle for particular configuration
Airspeed:	Final approach speed
Flight path angle:	– 4.0 °
Flaps/Slats:	Full down
Gear:	Down
At DA(H): If visual references are insufficient initiate GA, otherwise disconnect AP, switch off FD and perform manual landing.	
FLARE / LANDING	
Flare initiation altitude:	35 – 50 ft AGL
Thrust:	Retard
Flight path angle:	Increasing from -4 degrees to 0 degrees
At touchdown:	Select reverse thrust and apply brakes as required
Assumption: *As far as allowed within SOPs, speedbrakes / inflight spoilers may be used as required*	

**) Schedules as required (such that GS can be intercepted between 2000 – 3000 ft HAA)*



INITIAL

Type	Speed	Config	
	[kias]	flap	gear
Metro	230	up	up
F50	Decel to 160	up	up
F100	Decel to green dot+20	up	up
B744	VREF30+40	5	up

4000 ft HAA

Type	Speed	Config	
	[kias]	flap	gear
B744	Decel to VREF30+20	Select 10	up

2 DOTS BELOW GS

Type	Speed	Config	
	[kias]	flap	gear
B744	Decel to VREF30+10	Select 20	Select down

1 DOT BELOW GS

Type	Speed	Config	
	[kias]	flap	gear
F100	Green dot-10	8	Select down

GS INTERCEPT

Type	Speed	Config	
	[kias]	flap	gear
Metro	160	1/4	Select down
F50	Minimum 130	10	Select down

GS ALIVE

Type	Speed	Config	
	[kias]	flap	gear
Metro	Decel to 160	Select 1/4	up
F50	Minimum 130 (reduce torque by ~15%)	Select 10	up
F100	Decel to green dot-10	Select 8	up

1800 ft HAA

Type	Speed	Config	
	[kias]	flap	gear
F100	Decel to VREF25+5+WCF	Select 25	down

1500 ft HAA

Type	Speed	Config	
	[kias]	flap	gear
F50	Decel to VREF25+10+WCF	Select 25	down

1300 ft HAA

Type	Speed	Config	
	[kias]	flap	gear
F100	Decel to VREF42+5+WCF	Select 42	down

OUTER MARKER

Type	Speed	Config	
	[kias]	flap	gear
Metro	Decel to 140	1/2	down
B744	Decel to VREF30+WCF	Select 30	down

LANDING ASSURED

Type	Speed	Config	
	[kias]	flap	gear
Metro	Decel to VREF+5+WCF	1/2	down

INITIAL

Type	Speed	Config	
	[kias]	flap	gear
Metro	Decel from 230	up	up
F50	Decel from 220	up	up
F100	Decel from 250	up	up
B744	Decel from 250	up	up

GS INTERCEPT

Type	Speed	Config	
	[kias]	flap	gear
Metro	160	1/4	Select down
F50	130	10	Select down
F100	Green dot-10	8	down
B744	VREF30+10	20	down

FLIGHT IDLE CDA

All types:

Speed and configuration profiles such that GS can be intercepted between 2000 - 3000 ft HAA

1800 ft HAA

Type	Speed	Config	
	[kias]	flap	gear
F100	Decel to VREF25+5+WCF	Select 25	down

OUTER MARKER

Type	Speed	Config	
	[kias]	flap	gear
Metro	Decel to 140	1/2	down
B744	Decel to VREF30+WCF	Select 30	down

1500 ft HAA

Type	Speed	Config	
	[kias]	flap	gear
F50	Decel to VREF25+10+WCF	Select 25	down

1300 ft HAA

Type	Speed	Config	
	[kias]	flap	gear
F100	Decel to VREF42+5+WCF	Select 42	down

LANDING ASSURED

Type	Speed	Config	
	[kias]	flap	gear
Metro	Decel to VREF+5+WCF	1/2	down

200 ft HAA

Type	Speed	Config	
	[kias]	flap	gear
F50	Decel to VREF35+10+WCF	Select 35	down

Figure B.1: Typical baseline ILS approach (top) and proposed NAP approach (bottom)