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SPATA 2000
REAL-TIME SIMULATION

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Abstract:

This report describes a EUROCONTROL real-time simulation study of the Athens TMA with a single airport using parallel RWYs in SPATA, conducted on behalf of HCAA Greece. The study aimed to assist HCAA in testing the new operational procedures and finding operational problems in the TMA generated by opening SPATA airport. The simulation included feed positions simulating civil and military Towers, using a special interface to make it as realistic as possible. a study was also made in Athens TMA of RNAV STAR procedures for one of the RWYs. Automatic Safety Monitoring Tool was used to make Safety Analysis during the simulation. The study was designed based on results of a SIMMOD model based simulation. The simulation formed part of the COSIBA project and this report includes only results of the Spata Real-Time Simulation. Traffic samples representing forecast levels for 2001-2004 + Olympic Games were simulated.

SUMMARY

The Government of Greece has decided to build a new airport in Athens to increase the capacity of air transportation and to be fully prepared for the Olympic Games in 2004.

The new Athens International Airport called "Eleftherios Venizelos" located in the area of Spata Attica commenced operation in March 2001.

HCAA asked EUROCONTROL to test new TMA procedures for "Eleftherios Venizelos" airport, to develop and test new SIDs and STARs and to ascertain any potential problems by carrying out real-time and fast time simulations.

In this context, Spata 2000 Real-Time Simulation took place at the EUROCONTROL Experimental Centre between 2nd of May and 26th of May 2000. During the simulation controllers participated in 53 simulation exercises in a total of 73 simulation hours.

The simulation evaluated the best operation mode for the parallel RWYs (segregated mod and parallel independent mode), procedures to be used and a set of SIDs and STARs for all RWYs.

Military flights from/to Elefsis Airport were included in the simulation to see the impact of this traffic on the overall TMA traffic.

Operational TMA positions have been assessed and some of them have been redesign during the simulation.

TMA sectors shapes have been designed and developed during the simulation.

Losses of separation and incidents have been monitored during the simulation using ASMT (Automated Safety Monitoring Tool).

The impact of the VFR traffic in the tower position and in the whole TMA have been studied using a special HMI for the Tower Feed positions.

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Thanks also to the ASMT team, who were working for the first time in a real-time simulation environment and provided very good support to the simulation.

Finally, thanks to the Greek controllers who participated in the simulations. They all displayed a high level of professionalism and enthusiasm and it is their input that provided the results to be found in this report.

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REFERENCES

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[2] Real-Time Simulation of Greek Airspace EEC Report No. 279, April 1995.

[3] SIMMOD STUDY of Athinai TMA and the New Eleftherios Venizelos International Airport (Spata), EEC Note No. 01/2000, February 2000.

[4] Spata 2000 Real-Time Simulation Controller Handbook, 04 April 2000.

[5] Spata 2000 Real-Time Simulation Pilot Handbook, 04 April 2000.

[6] Spata 2000 Facility Specification Part 1&2 Operational and Analysis, 03 April 2000.

[7] Spata 2000 Facility Specification Part 3 Technical, 24 May 2000.

[8] Romania 99 Real-Time Simulation EEC Report No. 346, May 2000.

[9] Operational Use of ASMT for the Real-Time Simulations, Spata 2000 Experience, June 2000.

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[11] Spata 2000 Real-Time Simulation - Analysis of the Participating Controllers Responses to Questionnaires.

ABBREVIATIONS

Abbreviation	De-Code
ACC	**A**rea **C**ontrol **C**entre
AFL	**A**ctual **F**light **L**evel
AMN	EUROCONTROL **A**irspace **M**anagement and **N**avigation **D**ivision
ANT	**A**irspace and **N**avigation **T**eam
APP	**App**roach **C**ontrol
APW	**A**rea **P**roximity **W**arning
ARN	**A**TS **R**outes and associated **N**avigation means plan
ARR	**Arr**ival **F**lights
ARRE	**Arr**ival **E**ast Position
ARRW	**Arr**ival **W**est Position
ASMT	**A**utomatic **S**afety **M**onitoring **T**ool
ATC	**A**ir **T**raffic **C**ontrol
ATS	**A**ir **T**raffic **S**ervice
B-RNAV	**B**asic **A**rea **N**avigation
CFL	**C**leared **F**light **L**evel
COOR	**Co**-**or**dinator Position
COSIBA	**Co**mmon **Si**mulation for the **Ba**lkans
CWP	**C**ontroller **W**orking **P**osition
DEP	**Dep**arting Flights
DFL	**D**ynamic **F**light **L**eg
DIR	**Dir**ector Position
EATCHIP	**E**uropean **H**armonisation and **I**ntegration **P**rogramme
ECAC	**E**uropean **C**ivil **A**viation **C**onference
EEC	**E**UROCONTROL **E**xperimental **C**entre
EFL	**E**ntry **F**light **L**evel
EONS	**E**UROCONTROL **O**pe**N** and generic graphic **S**ystem
ETL	**E**xtended **T**rack **L**abel
ETO	**E**stimated **T**ime **O**ver
EUR-ANP	**Eur**opean **A**ir **N**avigation **P**lan
EXC	**Ex**ecutive **C**ontroller
FDA	**F**light **D**ata **A**rrival
FDD	**F**light **d**ata **D**eparture
FDP	**F**light Plan **D**ata **P**rocessing
FIR	**F**light **I**nformation **R**egion
FRQ	**Freq**uency
FUA	**F**lexible **U**se of **A**irspace
GAT	**G**eneral **A**ir **T**raffic
GE	**G**reece **E**ast Feed Sector
GN	**G**reece **N**orth Feed Sector
GND	**Gr**ou**nd**
GW	**G**reece **W**est Feed Sector
HCAA	**H**ellenic **C**ivil **A**viation **A**uthority
HMI	**H**uman **M**achine **I**nterface

Abbreviation	De-Code
IFR	**I**nstrument **F**light **R**ules
ILS	**I**nstrument **L**anding **S**ystem
IMC	**I**nstrumental **M**eteorological **C**onditions
ISA	**I**nstantaneous **S**elf **A**ssessment
LGAV	ICAO Abbreviation for Athens Airport
LGEL	ICAO Abbreviation for Elefsis Airport
L-NAV	**L**ateral **Nav**igation
MCS	**M**ulti-**C**ockpit **S**imulator
MSAW	**M**inimum **S**ector **A**ltitude **W**arning
MTCD	**M**edium **T**erm **C**onflict **D**etection
MUDPIE	A **M**ulti-**U**ser **D**ata **P**rocessing **I**nteractive **E**nvironment for Simulations Tool
OAT	**O**perational **A**ir **T**raffic
OCL	**O**bstacles **C**lear **L**imit
ODS	**O**perational **D**isplay **S**ystem
OLDI	**O**n-**l**ine **D**ata **I**nterchange
PALLAS	Actual ATM Operational System in Greece
PLC	**Pl**anning **C**ontroller
RDEP	**R**adar **De**parture **P**osition
RDEPE	**R**adar **De**parture **E**ast **P**osition
RDEPW	**R**adar **De**parture **W**est **P**osition
RDP	**R**adar **D**ata **P**rocessing
RNAV	A**r**ea **Nav**igation
RTF	**R**adio **T**elephony
RWY	**R**un**wy**ay
SEL	**Se**ctor **L**ist
SFL	**S**upplementary **F**light **L**evel
SID	**S**tandard **I**nstrument **D**eparture
SIMMOD	**Mod**el Based (Fast Time) Simulation Tool
SLW	**S**elected **L**abel **W**indow
SSR	**S**econdary **S**urveillance **R**adar
STAR	**St**andard **A**rrival **R**oute
STCA	**S**hort **T**erm **C**onflict **A**lert
StS	**S**upport **t**o **S**tates (EUROCONTROL)
SYSCO	**Sys**tem Assisted **Co**-ordination
TE	**T**ower **E**ast Feed Sector
TID	**T**ouch **I**nput **D**evice
TMA	**T**erminal **M**anoeuvring **A**rea
TRA	**T**raffic **R**estricted **A**reas
TSA	**T**emporary **S**egregated **A**rea
TW	**T**ower **W**est Feed Sector
TWR	Aerodrome Control
UIR	**U**pper Flight **I**nformation **R**egion
VFR	**V**isual **F**light **R**ules
VMC	**V**isual **M**eteorological **C**onditions
XFL	E**x**it **F**light **L**evel

1. INTRODUCTION

The Spata 2000 real-time simulation took place at the EUROCONTROL Experimental Centre between May 2nd and May 26th 2000. This simulation was designed to meet the requirements of the Hellenic Civil Aviation Authority (HCAA).

This report contains the results of the Spata 2000 simulation.

HCAA asked EUROCONTROL to test new procedures for "Eleftherios Venizelos" airport in the TMA, to develop and test new SIDs and STARs and to ascertain and resolve any potential problems by carrying out Spata 2000 real-time simulation.

Problems arising from the new location have been identified during the simulation and solutions have been evaluated.

A safety assessment has been made using the Automatic Safety Monitoring Tool (ASMT).

Figure 1: SPATA 2000 simulation at EEC

2. OBJECTIVES

2.1. General Objectives

1) To assess the planned ATC operations and their impact on the capacity and the efficiency in the approach area of responsibility, within the PALLAS ATC System environment.
2) To assess the controller responsibilities and workload.

2.2. Specific Objectives

1) To evaluate alternative departure and arrival procedures within the TMA.
2) To evaluate the new SIDs and STARs.
3) To identify potential operational problems in the new approach area.
4) To evaluate working with one and two final arrival sectors.
5) To determine optimum traffic management and procedures for the final approaches.
6) To compare mixed RWY operations, with segregated runway operations, for arrival and departure using parallel runways.
7) Evaluate the effect of military traffic on certain approach operations.
8) Evaluate the use of the Holding Stacks within the TMA and formulate solutions in the event that holding problems are identified[1].
9) Evaluate the effect of VFR traffic in the final arrival sectors.
10) Evaluate the impact of the KOTRONI restricted area for arrival and departing traffic from Spata.
11) Evaluate RNAV procedures for RWY21L.

[1] The aim of this objective is to find the maximum and the average time of delay.

3. SIMULATION CONDUCT

3.1. AIRSPACE

The simulated airspace included the entire Athens TMA and parts of the Athens Upper Airspace.

The simulated airspace was divided into either “Measured” positions or “Feed” sectors. Measured positions represented the study airspace of the simulation and were simulated as realistically as possible. Feed sectors provided a realistic interface with the surrounding airspace without representing in full the actual sectorisation.

3.1.1. Feed Positions

There were three types of feed sectors: En-route feed sectors ; Athens Tower feed sectors ; and Elefsis airport feed sector.

The en-route feed sectors were divided in three: GN, GE and GW, to share the workload equally. There was no connection with actual sectorisation.

Athens Tower feed sectors (TW and TE) had a special Human Machine Interface (HMI), which allowed them to land and depart aircraft in a very realistic way. Their role was to depart and land traffic, to give information to the VFR traffic, to co-ordinate between the landings and takes-off and to accommodate the VFR traffic together with IFR traffic on the two parallel runways.

Elefsis airport feed sector (TWR) was created to generate co-ordination for the measured sectors, concerning departures and arrivals to LGEL and to depart manually all flights from LGEL (Elefsis).

3.1.2. Measured Positions

Initially there were seven or eight measured positions, depending on organisation), planned for the simulation: DIR2, DIR3, FDD, RDEP, COOR, ARRE, ARRW and FDA.

Details of the airspace originally planned is contained in the Facility Specification Part 1 & 2 (Ref. 6 Spata 2000 Facility Specification Part 1&2 Operational and Analysis, 03 April 2000).

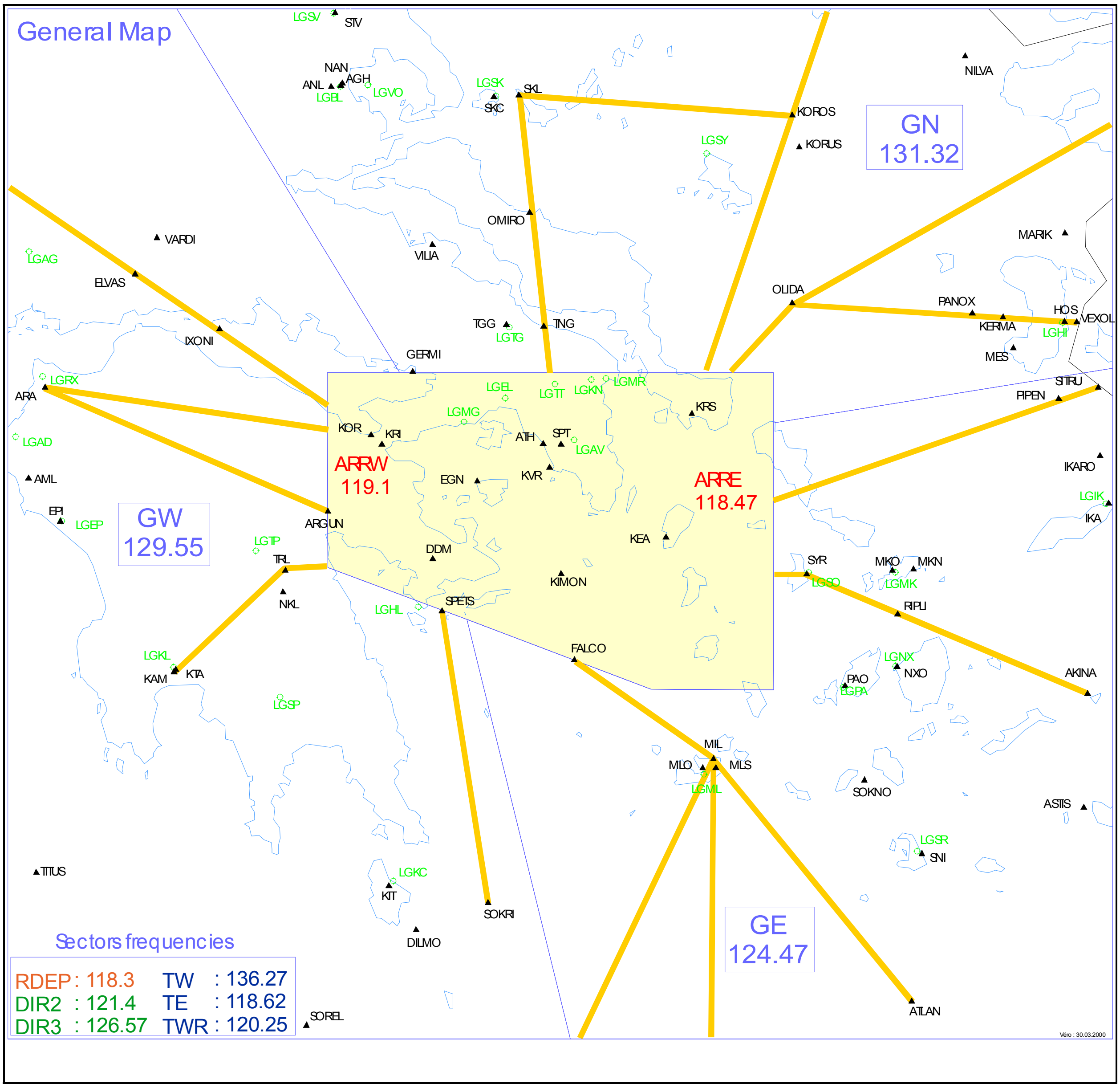


Figure 2: General map of simulated airspace

After the testing period and after simulating ORG A and D at 2001 traffic level, it was discovered that a single radar departure (RDEP) was not able to cope with the simulated amount of traffic and COOR was inadequately loaded. Consequently the airspace and control position were modified:

- RDEP was transformed in RDEPE (Radar Departure LOWER Position).
- COOR was transformed in RDEPW (Radar Departure UPPER Position).
- The vertical airspace division managed by these two positions was tested during the simulation at both FL 70 and FL110.

During the simulation it was discovered that the Executive Positions (EXC), sharing the same airspace and using different frequencies increased the workload of all positions and some losses of separation occurred.

Various sector volumes were tested during the simulation in different organisations.

The following description of the airspace was used for both RWY orientations:

ARRW/ARRE	GND	to FL245
DIR2/DIR3	GND	to FL060
RDEPE	GND	to FL105
RDEPW	FL105	to FL245 the light-blue "corridors"

The blue circles shown in Figure 3 and Figure 4 indicate a common area shared between RDEPW and ARRW/ARRE and all traffic followed these agreed levels:

- KRS DEP 130FL,
  ARR 140FL.
- KEA DEP 150FL,
  ARR 160FL.
- ELF DEP 140FL,
  ARR 150FL.
- KOR DEP 220FL,
  ARR 230FL.

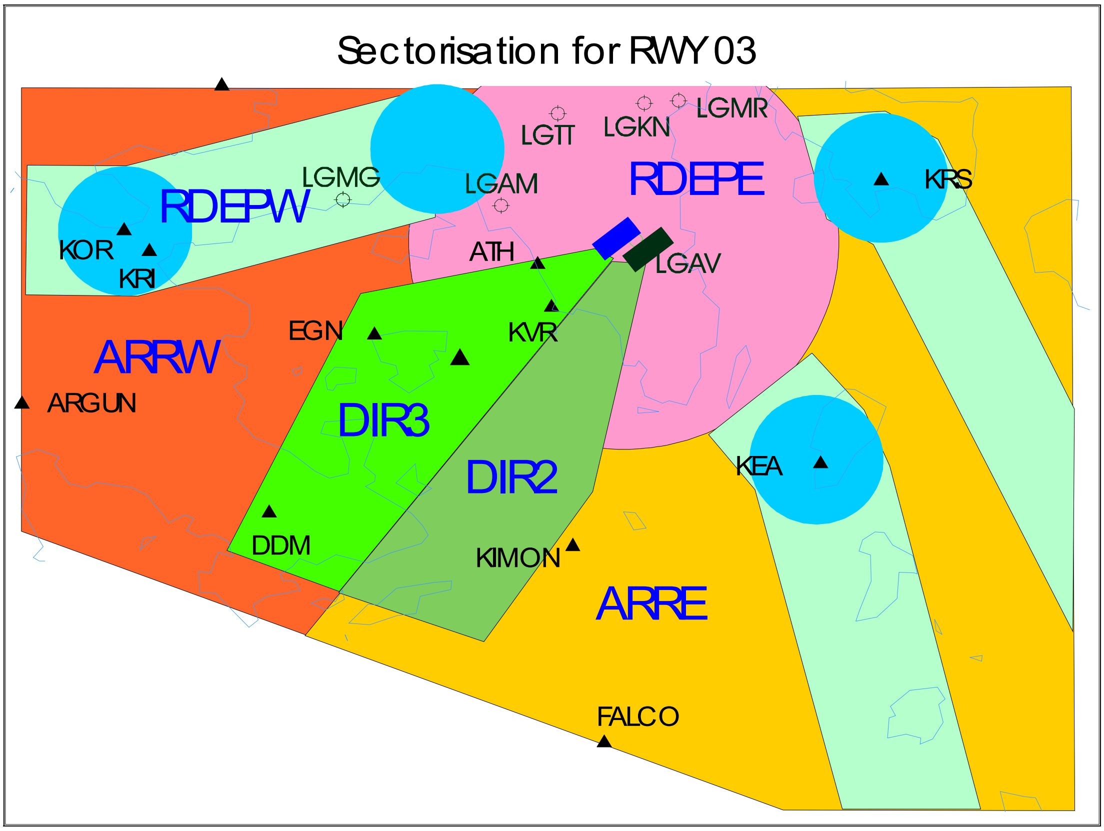


Figure 3: Sectors ABC

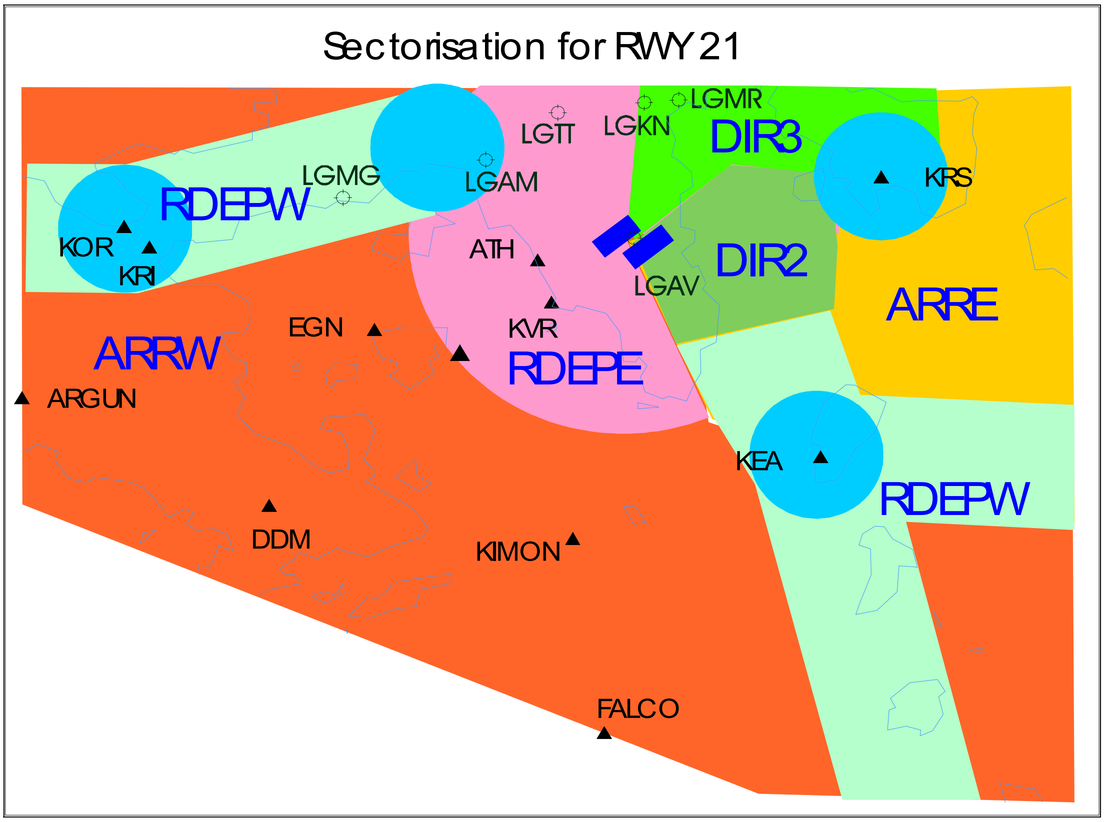


Figure 4: Sectors DEFG

3.1.3. Danger and Restricted Areas

Military Temporary Restricted Areas (TRAs) were specified. KOTRONY restricted area and DEKELIA/TATOI restricted areas were not active during the simulation, but they were considered for statistic analysis.

3.1.4. Vectoring Area

The HCAA defined vectoring area (minimum safety altitude map) was available as a selectable map to all controllers.

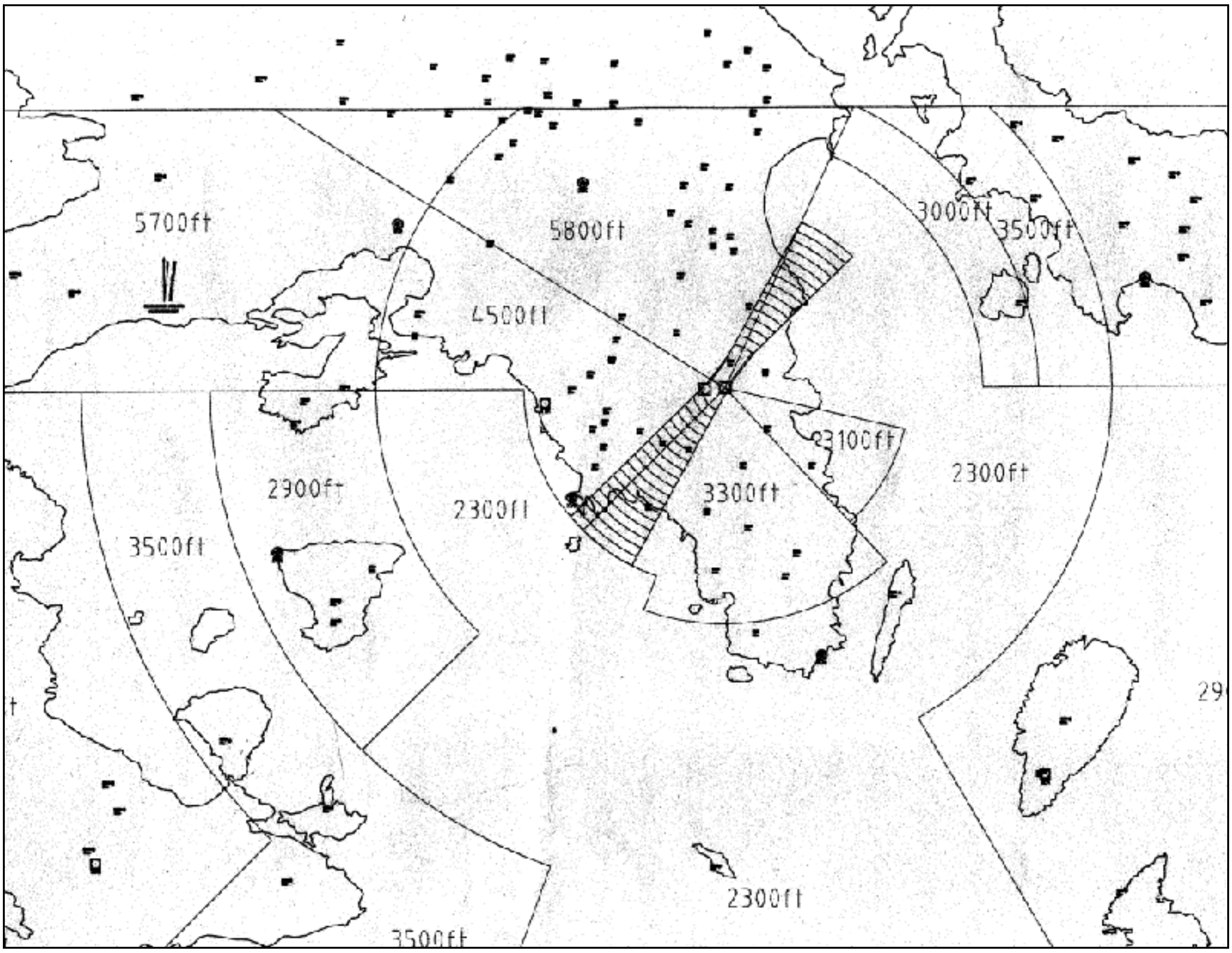


Figure 5: Vectoring area

3.2. TRAFFIC

The traffic samples were based on 24hr traffic recordings from 1st August 1997, increased by the HCAA to 2001 traffic level. The same traffic sample had been used for a SIMMOD Fast Time Simulation: SIMMOD Study of Athinai TMA and the New Eleftherios Venizelos International Airport (Spata) EEC note no. 1/2000, Project SIM-F-E1.

From this sample, EEC and client experts took two peak periods of 2hr 30min one from the morning and another one from the afternoon, considered as representative samples to meet the simulation objectives.

Thereafter they were refined and adjusted to 1hr 30min in order to fit the real-time simulation schedule.

Finally, the two 2001, 1hr 30min traffic samples were proportionally increased by approximately 30% so as to reach the expected year 2004 + Olympic Games traffic levels.

The simulated traffic arriving and departing to/from LGEL (Elefsis) was taken from the eight hours traffic on 1st of August 1997 increased by 25% to reach 2001 traffic level. This special increase was made to assist in the detection of potential problems in the area.

3.2.1. Training Samples

Some training traffic samples were used to cater for initial training (equipment familiarisation, system debugging, and acceptance test), during the acceptance test week. These were developed from the basic samples of 2001 but reduced by 30% so as not to overload the controllers during the familiarisation and training phase.

3.2.2. Traffic Sample Analysis

The analysis of the traffic samples is described in Annex A.

3.3. ORGANISATION

To achieve the simulation objectives, seven organisations were foreseen.

The basic elements of the simulated organisations are described below.

3.3.1. Organisation A

Segregated mode operation, RWY 03L Arrivals/ RWY 03R Departures.

3.3.2. Organisation B

Parallel Independent Arrivals and Departures RWY 03 with a single Radar Director.

3.3.3. Organisation C

Parallel Independent Arrivals and Departures RWY 03 with Two Radar Directors.

3.3.4. Organisation D

Segregated mod operation, RWY 21L Arrivals / RWY 21R Departures.

3.3.5. Organisation E

Parallel Independent Arrivals and Departures RWY 21 with a single Radar Director.

3.3.6. Organisation F

Parallel Independent Arrivals and Departures RWY 21 with two Radar Directors.

3.3.7. Organisation G

Parallel Independent Arrivals and Departures RWY 21 with Two Radar Directors Using RNAV Arrival for RWY 21L.

3.4. PROGRAM EXERCISES

Three simulation exercises were conducted each day, with a main debriefing period scheduled after the final exercise of the day.
Exercises were of 1hr 10mins duration that started with an initial traffic charge which gradually grew during the first 10mins after which the next 1hr was conducted at the appropriate traffic level.

The tables below show the programs of exercises that were eventually completed.

Table 1: Spata 2000 exercise program

Spata 2000 Exercise Program			
Week	**Org**	**No of Exercises**	**Traffic Level**
1	A	4	2001
	B	2	
	B	1	2004
	D	4	2001
	E	1	
2	A	2	2004
	B	2	2001
	C	4	
	E	3	
	F	4	
3	A	2	2004
	B	3	
	C	2	
	D	1	
	E	4	
	F	3	
4	C	2	2004
	D	1	
	F	3	
	G	4	
		Total 52	Representing 73 hours of simulation time.

The staffing of positions followed a strict rotation which took into account controller's qualifications and which ensured that each controller experienced each variation of organisation from as many different control positions as possible.

3.5. SIMULATED ATC SYSTEM

The simulated ATC System used for Spata 2000 represented the PALLAS system, which is already in use in Athens, simplified for the simulation.

Details of the simulated system are contained in the Facility Specification Part 3 Technical (Ref. 7 Spata 2000 Facility Specification Part 3 Technical, 24 May 2000).

3.5.1. Operations Room Configuration

The operations room was configured as required for the various organisations of the simulation (see Annex **A**).

The original configuration of the operations room was with 7, or 8, (depending of the organisation) measured CWPs as follows:

DIR2	1 Executive Position (1 CWP)
DIR3	1 Executive Position (1 CWP)
FDD	1 Planning Position (1 CWP)
RDEPE	1 Executive Position (1 CWP)
COOR	1 Planning Position (1 CWP)
ARRE	1 Executive Position (1 CWP)
ARRW	1 Executive Position (1 CWP)
FDA	1 Planning Position (1 CWP)

The Measured Controller Working Position consisted of:

- 28 in square colour display, used to provide a multi-window working environment for Executive positions.
- 21 in square colour display used to provide a multi-window working environment for Planning positions.
- Main CPU Processor and display driver.
- 3 button mouse.
- Keyboard.
- A simulation telecommunication system with headset, handsets, footswitch, and panel-mounted push to talk facility.
- A strip printer for some positions.

The measured positions were comprised of identical CWPs configured as either Executive (EXC) or Planning (PLC) positions. Each CWP provided access to the same facilities ; controllers had the capability to determine display preferences depending on the control task.

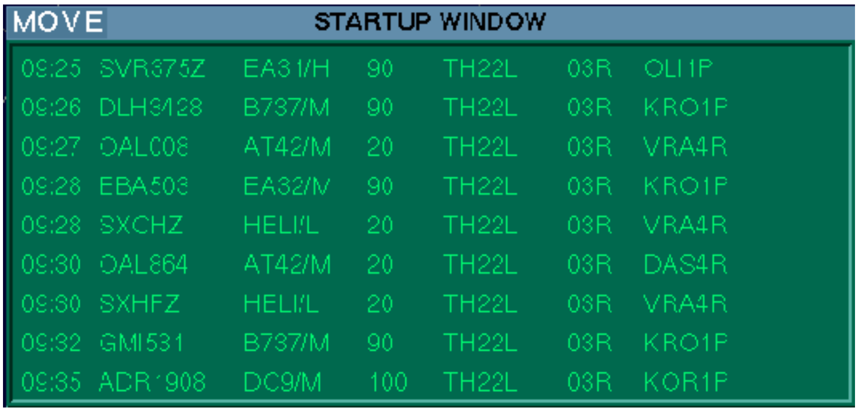
Each CWP included a subjective workload panel (Instantaneous Self-Assessment – ISA) used by the controller for periodic input throughout the measured exercise.

En-route Feed Sectors were provided with the same CWP as the Executive measured positions.

TWR/TW/TE were provided with a specific interface known as the “hybrid feed sector”. This incorporated a piloting function which interpreted controller inputs as pilot inputs allowing the sector to operate autonomously for all departures without the need for a dedicated pilot operator, and a pilot position for arriving traffic.

Some of these positions were specially designed to simulate tower operations. In real life towers visually control aircraft, for the simulation we created a HMI which allowed the tower controllers to:

- Initiate the “Start Up”.

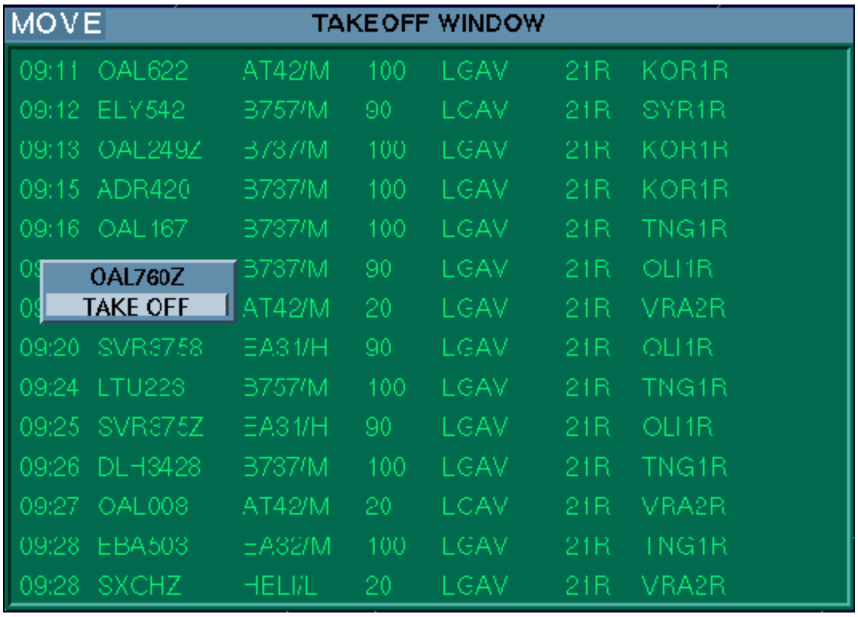


MOVE — STARTUP WINDOW

09:25	SVR375Z	EA31/H	90	TH22L	03R	OLI1P
09:26	DLH3428	B737/M	90	TH22L	03R	KRO1P
09:27	OAL008	AT42/M	20	TH22L	03R	VRA4R
09:28	EBA503	EA32/M	90	TH22L	03R	KRO1P
09:28	SXCHZ	HELI/L	20	TH22L	03R	VRA4R
09:30	OAL864	AT42/M	20	TH22L	03R	DAS4R
09:30	SXHFZ	HELI/L	20	TH22L	03R	VRA4R
09:32	GMI531	B737/M	90	TH22L	03R	KRO1P
09:35	ADR1908	DC9/M	100	TH22L	03R	KOR1P

Figure 6: Start up window

- Change the “Start Up” time.
- Change Runway.
- Change SID.
- Line up and take off traffic.



MOVE — TAKEOFF WINDOW

09:11	OAL622	AT42/M	100	LGAV	21R	KOR1R
09:12	ELY542	B757/M	90	LGAV	21R	SYR1R
09:13	OAL2492	B737/M	100	LGAV	21R	KOR1R
09:15	ADR420	B737/M	100	LGAV	21R	KOR1R
09:16	OAL167	B737/M	100	LGAV	21R	TNG1R
09	OAL760Z	B737/M	90	LGAV	21R	OLI1R
09	TAKE OFF	AT42/M	20	LGAV	21R	VRA2R
09:20	SVR3758	EA31/H	90	LGAV	21R	OLI1R
09:24	LTU223	B757/M	100	LGAV	21R	TNG1R
09:25	SVR375Z	EA31/H	90	LGAV	21R	OLI1R
09:26	DLH3428	B737/M	100	LGAV	21R	TNG1R
09:27	OAL008	AT42/M	20	LGAV	21R	VRA2R
09:28	EBA503	EA32/M	100	LGAV	21R	TNG1R
09:28	SXCHZ	HELI/L	20	LGAV	21R	VRA2R

Figure 7: Take of window

- See the rolling phase on the RWY (RWY occupancy).

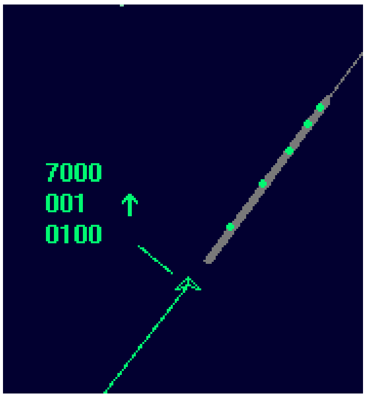


Figure 8: Rolling phase

- Control arriving IFR traffic.
- Control arriving VFR traffic.
- Issue holding and "go around" clearances and instructions.
- Monitor traffic near the airport and to modify speed on the final approach.

During the simulation, because of the need to open two departure positions, the operations room configuration was changed slightly. RDEP was replaced by RDEPE (Radar Departure Lower), COOR was replaced by RDEPW (Radar Departure Upper) and FDD (Flight Data Departure) was placed between the two Departure positions (see ANNEX A).

3.5.2. ATC Procedures and Controller Tasks

Details of the controller tasks and procedures are contained in the Spata 2000 Controller Handbook (Ref. 4 Spata 2000 Real-time Simulation Controller Handbook, 04 April 2000).

3.6. SAFETY ASSESSMENT

3.6.1. Automated Safety Monitoring Tool (ASMT)

To have a quick look at losses of separation and to understand why they were happening, ASMT was used. Data was available about 10 minutes after an exercise was finished.

The aims of using the ASMT were:

1) To have a fast graphical feedback of separation infringements.
2) To have the basis of discussing with the controllers after each exercise why separation infringements occurred.
3) To accustom the Greek controllers to the ASMT.
4) To accustom the ASMT team to the operational environment of a real-time simulation.

3.6.2. MUDPIE

MUDPIE is “A ***M***ulti - ***U***ser ***P***rocessing ***I***nteractive ***E***nvironment for ***S***imulations”.

This tool was used for most of the analysis of the Spata 2000 Simulation. This tool also provided a set of graphics and tables in relation to losses of separation.

3.7. METHODOLOGY

The simulation results contained in this report were compiled from the notes taken at simulation de-briefing sessions, questionnaire responses and the observations of the project team.

Simulator recordings of controller inputs, pilot inputs and aircraft flight paths were analysed to provide further supporting evidence for the results.

The Instantaneous Self-Assessment (ISA) method was used to assess controller workload. Participants were asked to respond to a prompt every 2 minutes by pressing a button appropriate to their perceived workload at the time ; Very High, High, Fair, Low or Very Low.

Figure 9: SPATA 2000 simulation at EEC

4. RESULTS - OBJECTIVE 1

To evaluate alternative departure and arrival procedures within the TMA.

4.1. INTRODUCTION

4.1.1. The Split of RDEP

During the testing week and the first week of simulation it was observed that **RDEP** position could not cope with the 2001 traffic level. One exercise was tested with the 2004+Olympics traffic level ORG. B. RDEP controller was overloaded 100% of the time and FDD was loaded 80% of the time and the other 20% of the time he had a high workload. Figure 14 shows the distribution of traffic in RDEP and Figure 15 traffic origin and next sector.

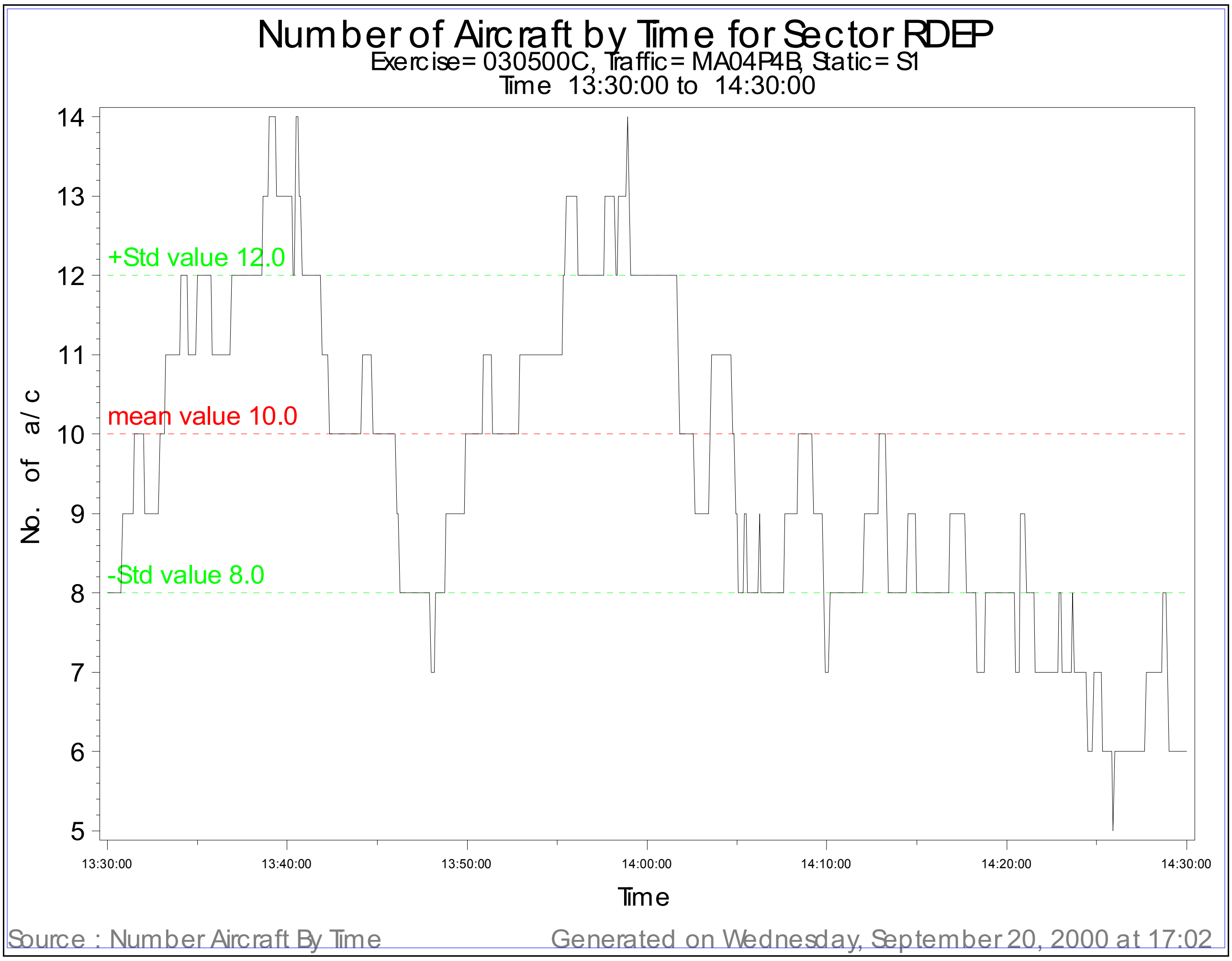


Figure 10: Number of aircraft in RDEP

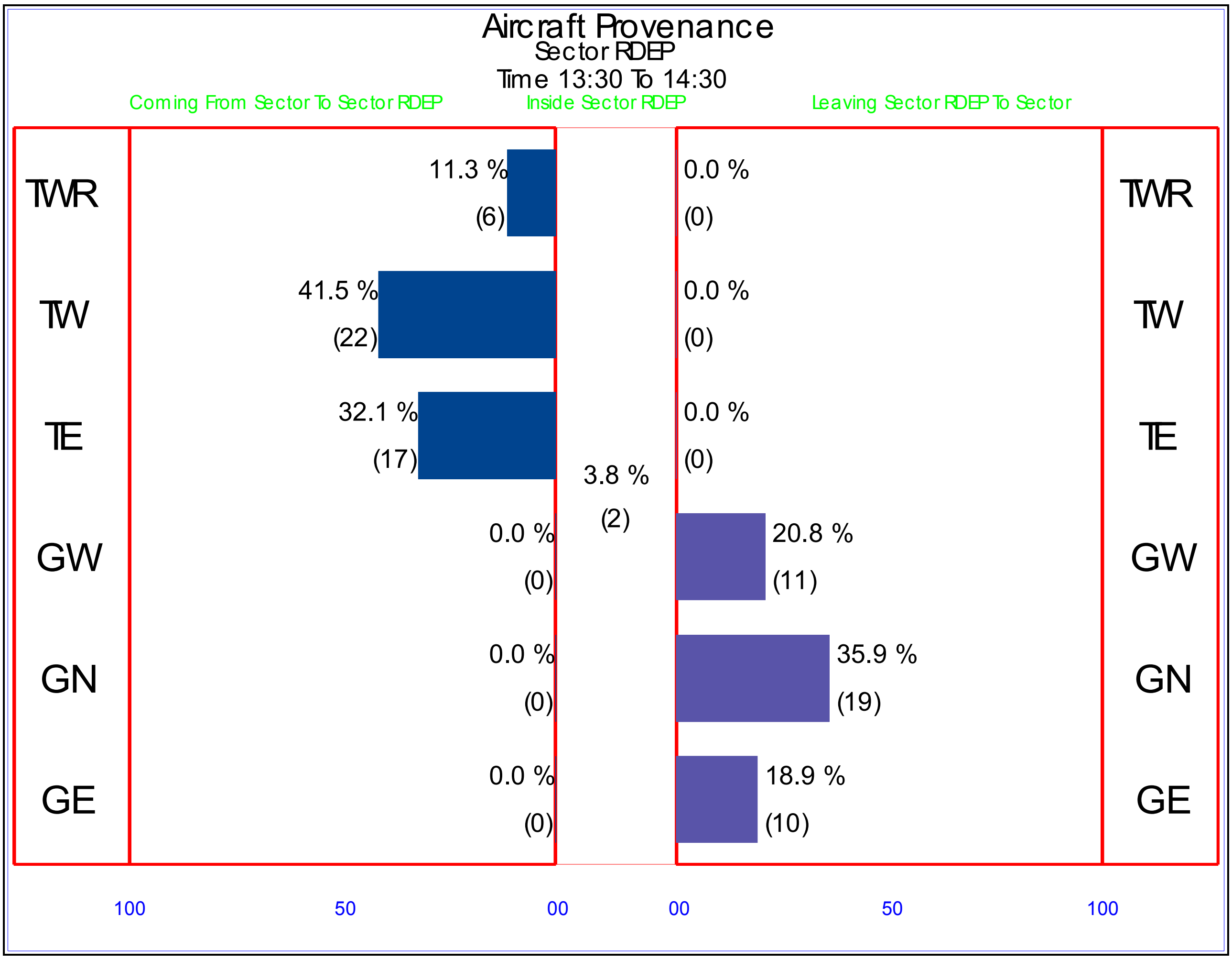


Figure 11: Aircraft provenance RDEP 2004

The general philosophy of organising the positions (sectors) was to divide all airspace in two giving a set of arriving and departing positions for one RWY and another set of arriving and departing positions for the other RWY.

The simulated operational agreement between RDEP and the two Towers (TE/TW) was that the Towers could depart aircraft at the maximum capacity of the two RWYs.

In this way RDEP position, especially when simulating parallel independent operation mode, was fed with traffic coming from the two RWYs.

The RDEP controller, during the 2004 + Olympics traffic level, was totally overloaded. The radar map was set at an extended range because of the huge area of responsibility. The controllers found it impossible to read the radar label on the screen because they were overlapped, especially immediately after departure when radar tracks are very close and thus it was not possible to control traffic in this area.

The FDD controller, during the 2004 + Olympics traffic level, was totally overloaded.

As a result of the facts described above, two Radar Departure Sectors were designed:

RDEPE (Radar Departure LOWER), was created from RDEP position, in charge of the departures from the ground up to FL100.

RDEPW (Radar Departure Upper), created from COOR position, in charge of departures from FL 100 to FL 245.

FDD and FDA took the responsibilities and tasks of COOR position.

After splitting the RDEP sector in 2 (RDEPE and RDEPW), the workload of each departure sectors was manageable.

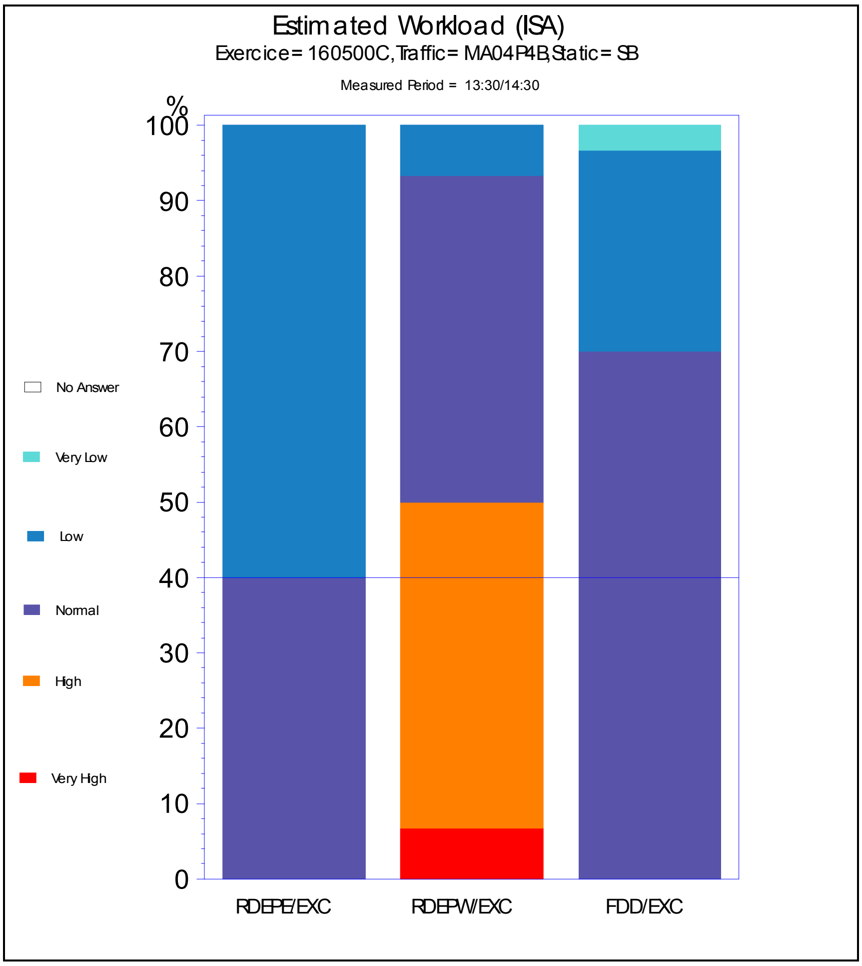


Figure 12: Workload of two departure sectors

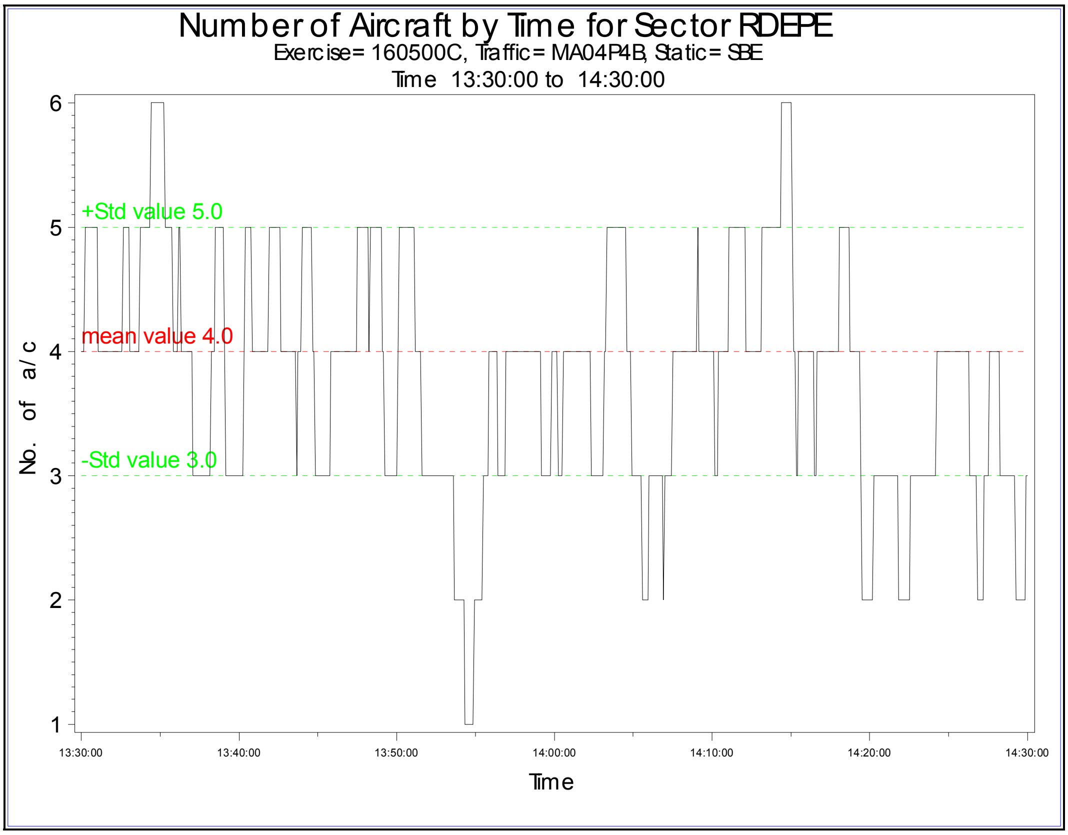


Figure 13: Number of aircraft in RDEPE

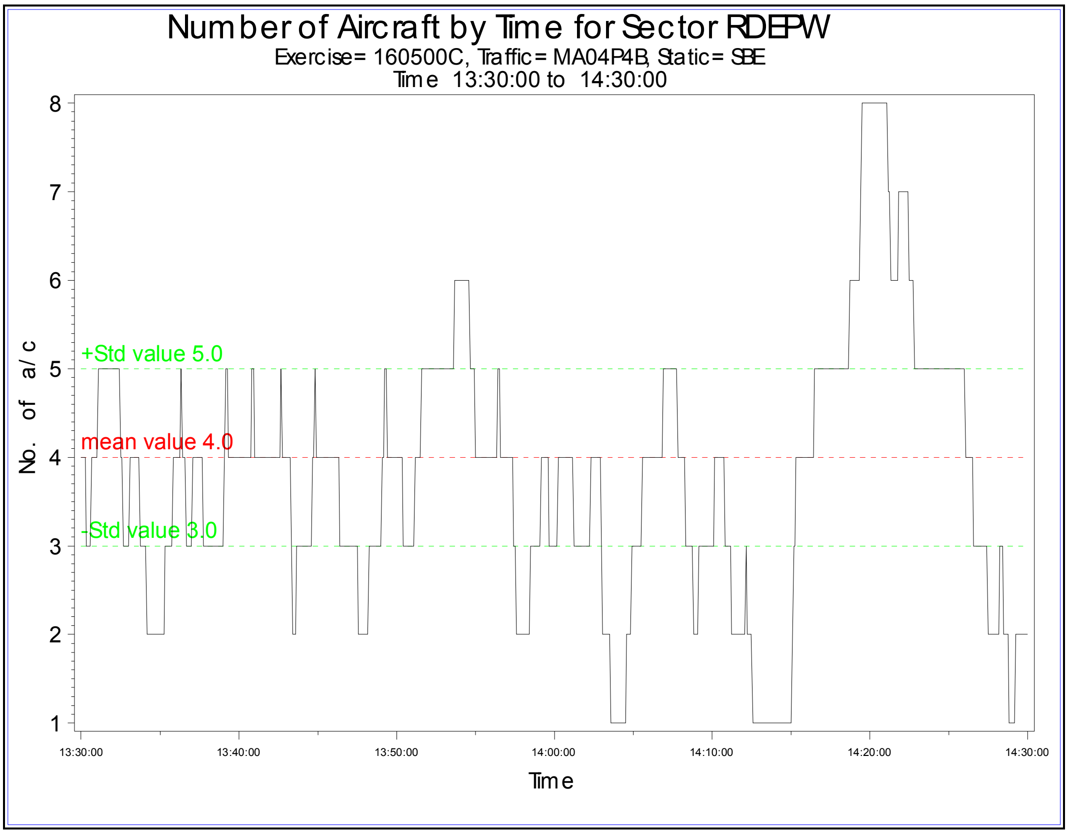


Figure 14: Number of aircraft in RDEPW

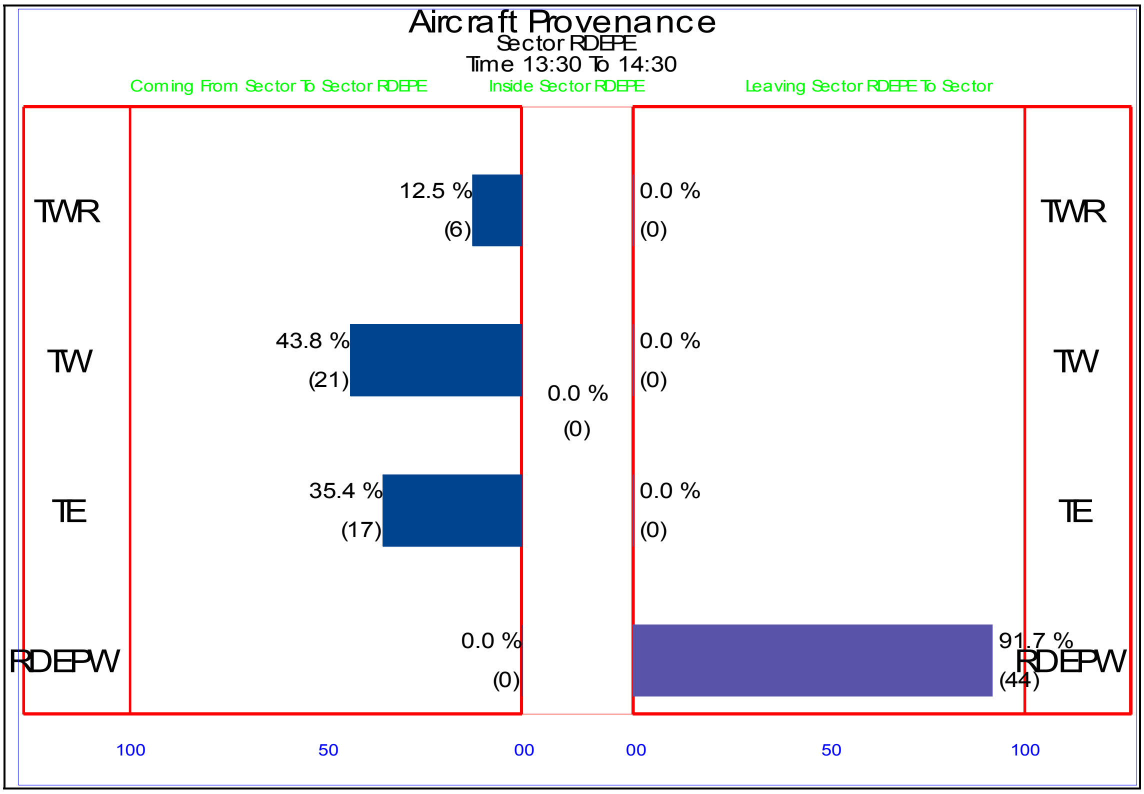


Figure 15: Aircraft provenance RDEPE 2004

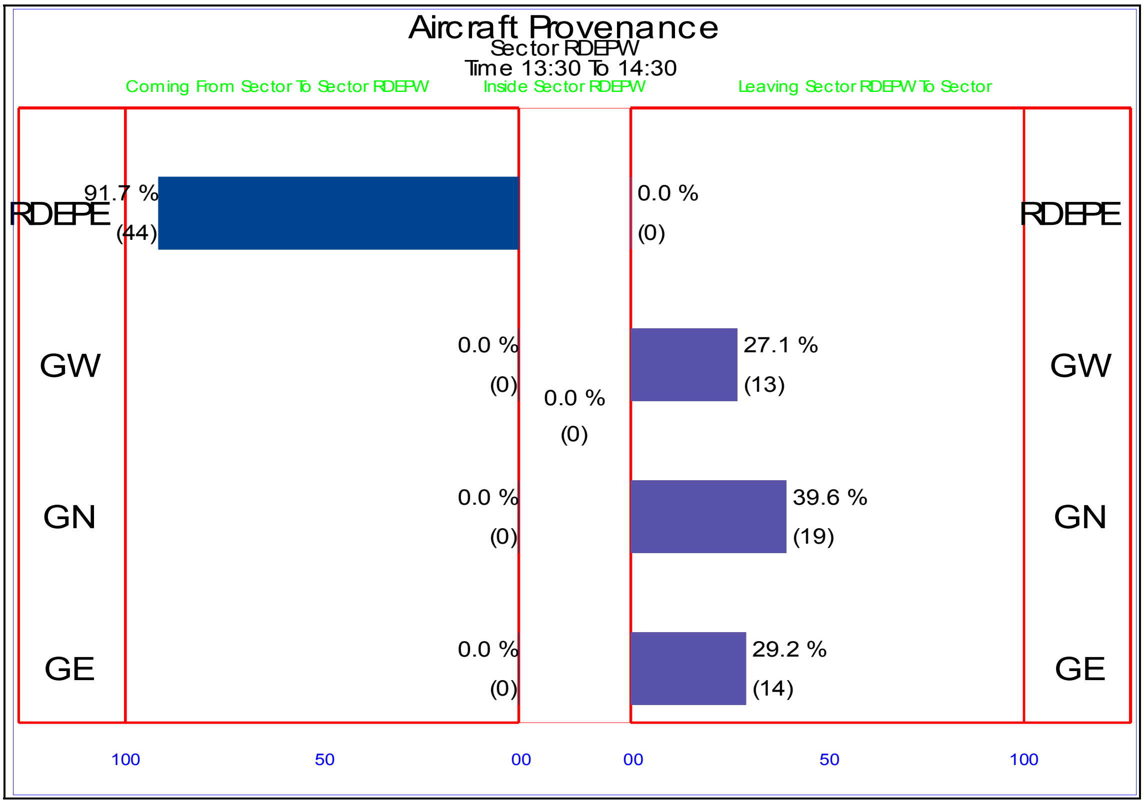


Figure 16: Aircraft provenance RDEPW 2004

4.1.2. Creation of Sectors With Defined Sector Volumes

All organisations were run with 2001 traffic samples, using the initial planned positions. ARRE, ARRW, RDEPE and RDEPW positions were all the time overloaded because controllers had to control their assumed traffic and monitor the not concerned traffic, controlled by the other positions, inside the same airspace.

In some cases the situation ended up as in the following example:

RWY in use 21, segregated mod (RWY21L for Arrivals, RWY 21R for Departures).

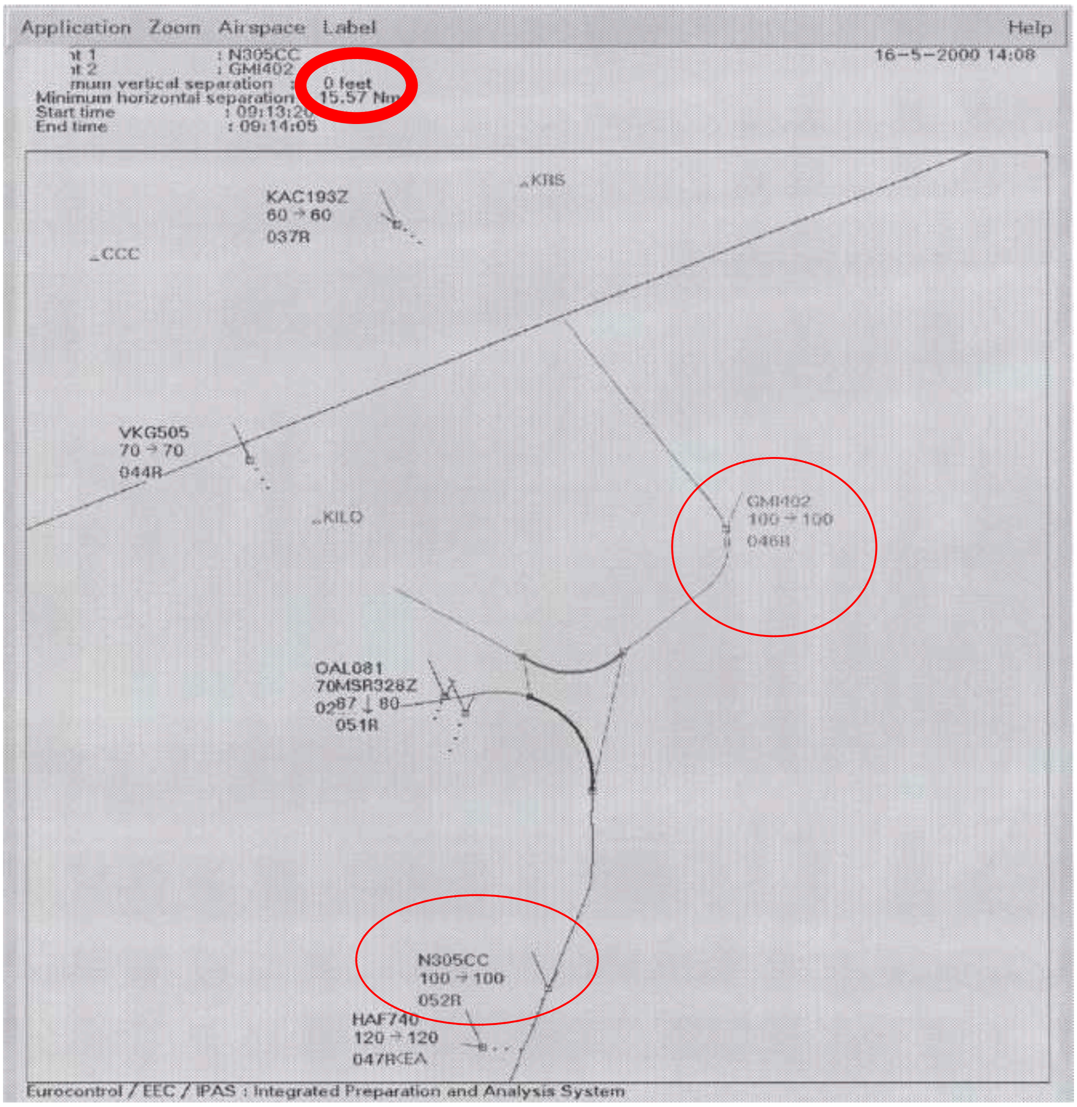


Figure 17: ASMT1

GMI402 was an arrival flight to LGAV (Spata), controlled by ARRE position on FRQ 118.47.

N305CC was another arrival to LGAV, controlled by ARRW position on FRQ 119.1.

Both flights were cleared to maintain the same FL, they were supposed to turn to the west, descent and land on the same RWY. Traffic level 2004 + Olympic Games.

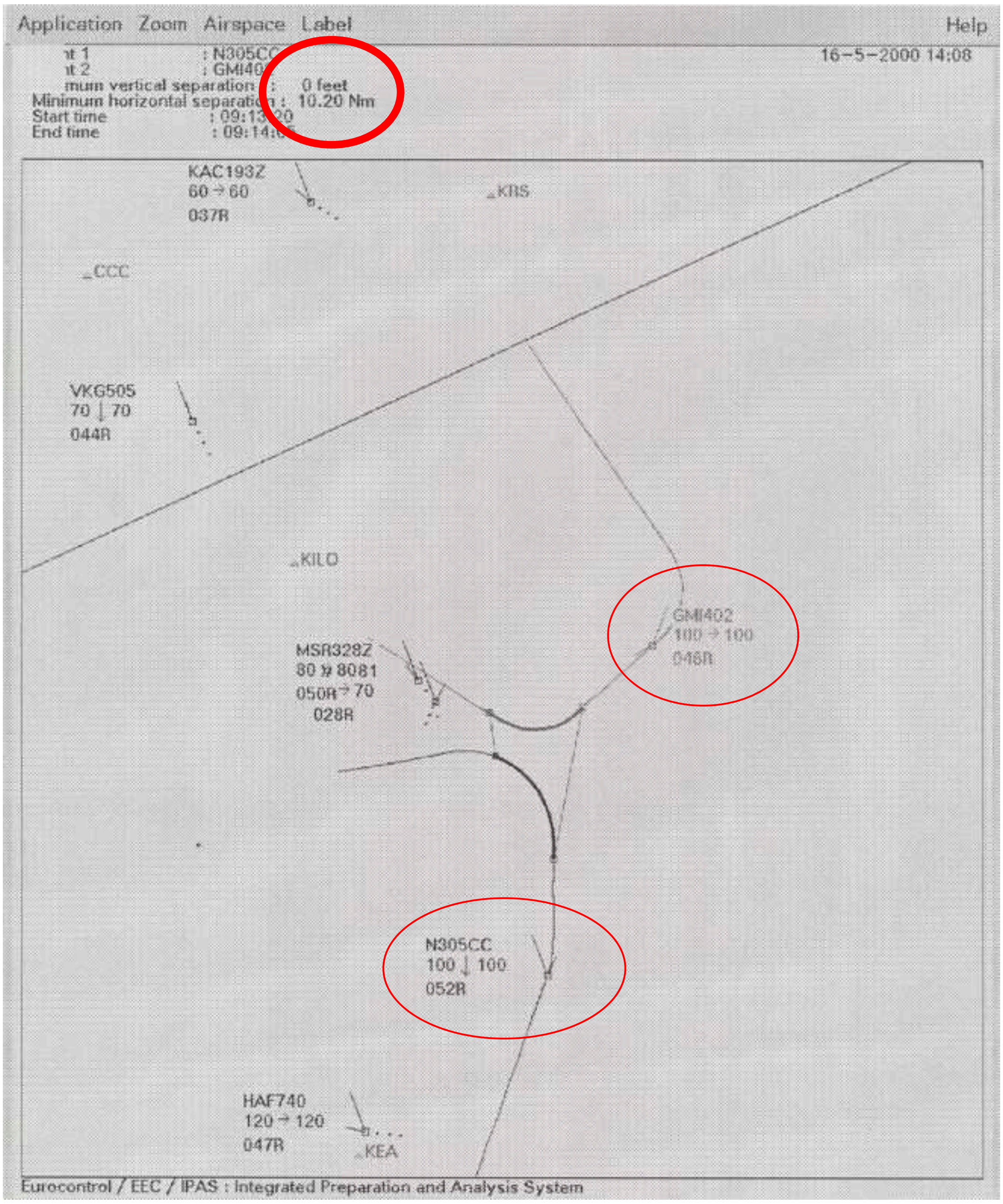


Figure 18: ASMT2

At 10NM opposite track, ARRW finally observed that flights were about to loose separation and decided to descend N305CC to FL90. No co-ordination was made with ARRE.

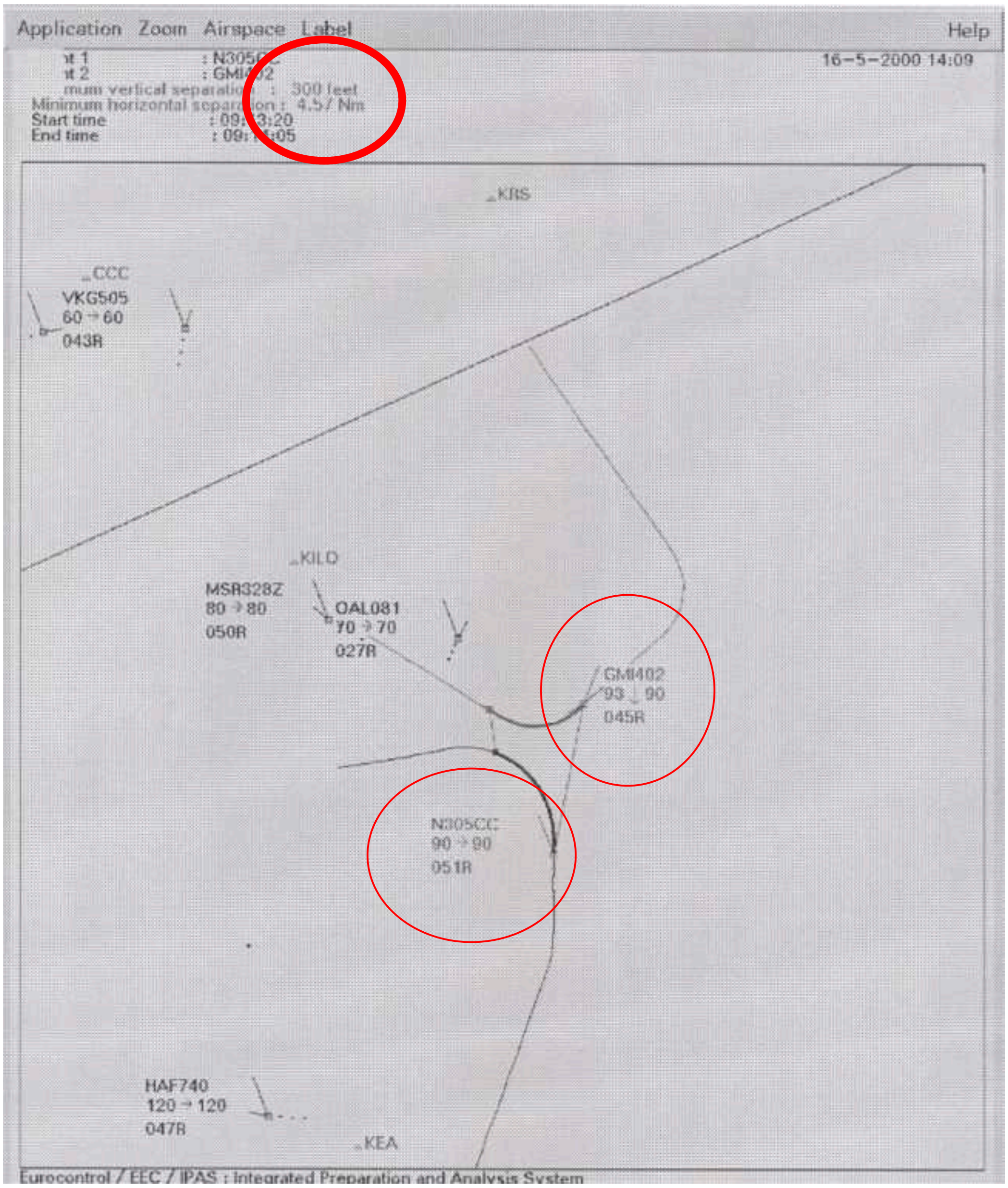


Figure 19: ASMT3

At the same time, ARRE also recognised the conflict and decided to descend his flight GMI402 to FL90 again without any co-ordination with ARRW.

After a few seconds seeing that the other flight (N305CC) was descending at the same FL, ARRE tried another measure and turned his flight (GMI402) to the right, without co-ordinating anything with ARRW.

Meanwhile ARRW observed that the other position (ARRE) descended his flight as well and decided to turn left N305CC to avoid a collision.

At that moment, there were 4.5NM between the two flights from 5NM required.

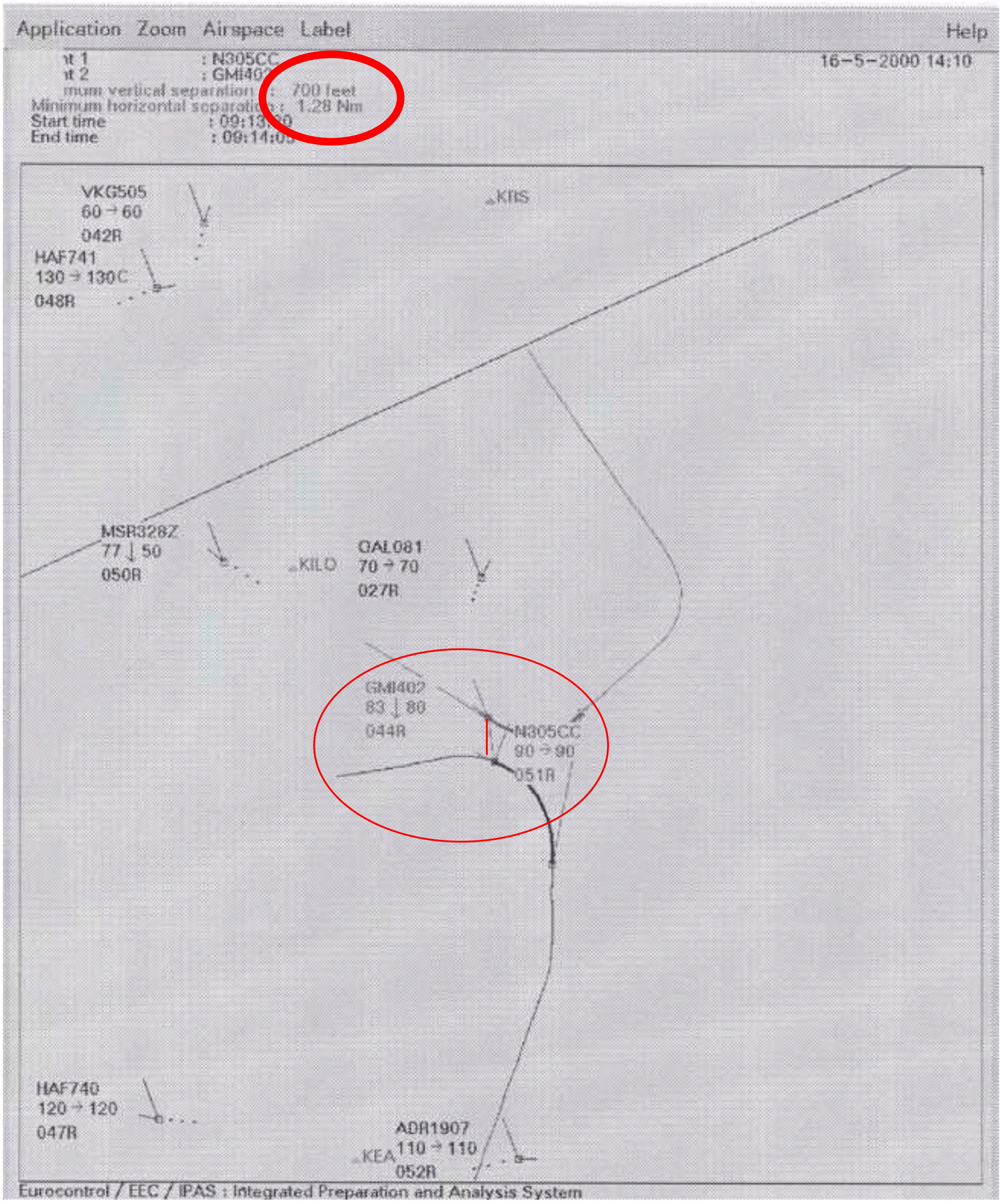


Figure 20: ASMT4

Finally, only 1.2NM separated the two flights. The required separation is 5NM.

The main cause of this incident was that both positions ARRE and ARRW were using the same airspace and there were no co-ordination procedures between them.

The main contributor to this dangerous situation was the control by multiple controllers in shared airspace without defined co-ordination procedures. To correct this, control responsibility was restricted to a defined volume of airspace and co-ordination procedures were established (see Figure 3: Sectors ABC and Figure 4: Sectors DEFG).

4.2. ORGANISATION A

Segregated mode operation, RWY 03 L Arrivals/ RWY 03 R Departures with a Single Radar Director.

A difficulty was found in co-ordination between ARRE/ARRW and DIR2.

There were two operational procedures tested:

- DIR2 was assuming traffic he believed he can accommodate and ARRE/ARRW were transferring the traffic to the Director,
- ARRE/ARRW co-ordinated the traffic between them, organised the sequence and than offers the traffic to DIR2.

In both cases, the average workload was high:

DIR2	:	10% very high, 39% high
ARRW	:	10% very high, 32% high
ARRE	:	2% very high, 24% high

Defined sectors were requested by the controllers because of the above problem. The implementation of defined volumes did not significantly improve the workload distribution.

DIR2 was forced to transfer traffic to the TE/TW 10/12NM from touch down because he had to concentrate on the vectoring phase for intercepting the ILS.

DIR2 had to operate with a large displayed range to monitor aircraft that were going to enter from the two arrival sectors.

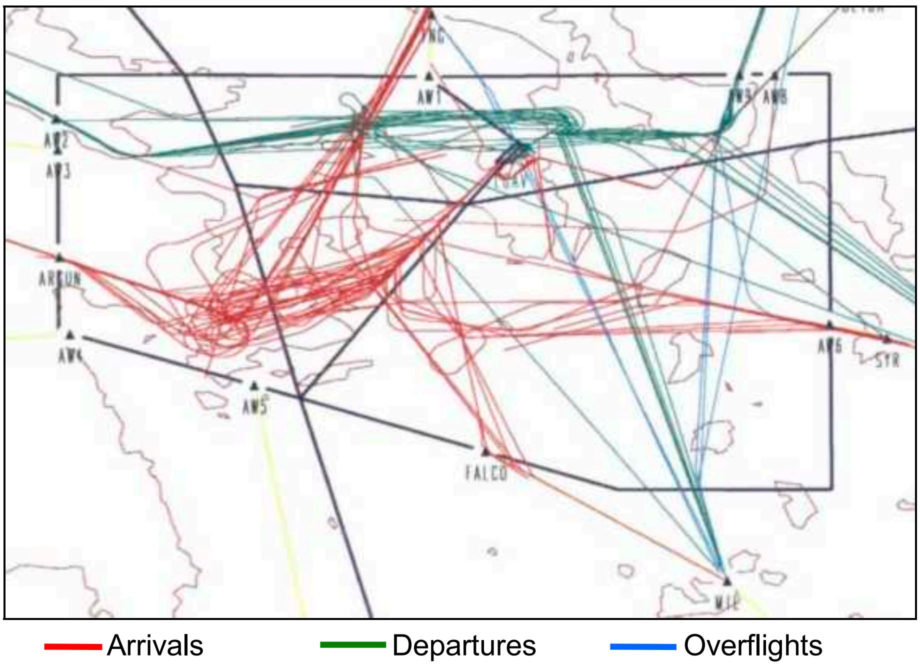


Figure 21: Flights in one exercise from ORG A

4.2.1. RDEPW

(Radar Departure Upper) was overloaded several times, sometimes the controller “lost the picture”. When operating in the segregated mode the split between RDEPE (Radar Departure Lower) and RDEPW (Radar Departure Upper) should be FL 110/120.

RDEPW was transformed from COOR (Co-ordinator) and for the simulation it had no access to the electronic strips. In the real PALLAS system it should be properly configured.

4.3. ORGANISATION B

Parallel Independent Arrivals and Departures RWY 03 with a single Radar Director.

The same problem with co-ordination as in ORG A occurred between ARRE, ARRW and DIR2.

4.4. ORGANISATION C

Parallel Independent Arrivals and Departures RWY 03 with Two Radar Directors.

This was the controller preferred organisation for RWY03.

However a significant amount of co-ordination was needed for traffic to/from LGEL.

Military traffic (arr. /dep. LGEL) was transferred from one arrival sector to the other.

The problem of co-ordination faced in ORG A and B between ARRE, ARRW and DIR2 was solved in ORG C. ARRE co-ordinated only with DIR2 and ARRW co-ordinated only with DIR3. All traffic coming from the East was controlled by ARRE DIR2 and landed on RWY 03R, all traffic coming from the West was controlled by ARRW DIR3 and landed on RWY 03L.

There was a problem when the arrivals coming from one direction (to land on a specified RWY) are denser than the arrivals coming from the other. The two Directors should be able to have the flexibility to change the RWY according to the traffic density. Three issues emerged from this:

- When is the last moment a pilot flying in VMC or IMC can change the RWY?
- Special co-ordination procedures are needed between DIR2 and DIR3,
- Special co-ordination procedures with TE/TW are needed.

There are two different co-ordination procedures for arrivals and departures with the Tower:

- Tower is taking off traffic regardless of RWY – TMA exit point allocation, considering only the traffic expedition on the airport, without a prior co-ordination with the departure sector RDEPE. This procedure creates a high workload for the departure sectors, especially for the RDEPW (Upper Departure Sector) Arrival sequence is organised by the two directors without prior co-ordination with the towers. This procedure might create disturbances for the airport operators and for departure taxing traffic.
- Tower is taking off traffic only from the planned RWY correlated with the TMA exit point, or changes the RWY after prior co-ordination with the departure sectors. This procedure has an impact in the expedition of the departing traffic from the airport. DIR2 and DIR3 can change the planned RWY correlated with the TMA entry point, only after a prior co-ordination with the booth towers. This procedure has an impact in the two director’s workload.

4.5. ORGANISATION D

Segregated mod operation, RWY 21 L Arrivals / RWY 21 R Departures with a single Radar Director.

After running the 2001 traffic sample:

4.5.1. DIR2

Was heavy loaded all the time. It was very difficult to accommodate arrivals on RWY 21L because of the high minimum altitude. The role of the "DIRECTOR" in general was not clearly defined, controllers didn't know how to operate it:

- to make the landing sequencing before turning aircraft on final,
- to maintain the 3NM separation on final, after the sequence was made by arrival sectors.

Clear procedures have to be developed.

4.5.2. ARRE/ARRW

This organisation was run without sector volumes. No clear procedure was developed for the two sectors, controllers faced the same problem as DIR2.

Co-ordination between the two arrival sequences was very difficult. The main constraint was the restricted TMA airspace in the NE. A small extension of the TMA to the NE would be a considerable help. With such an extension would enable the final approach to start about 20NM from touch down. There were two proposals for entry levels depending on the philosophy applied for the arrivals:

1) KOROS FL70,
   SYR FL60,
   KIMON FL50.

2) KOROS FL60,
   SYR FL70,
   KIMON FL90.

There were also two proposals for arriving procedures (which traffic should be controlled by which sector <position>):

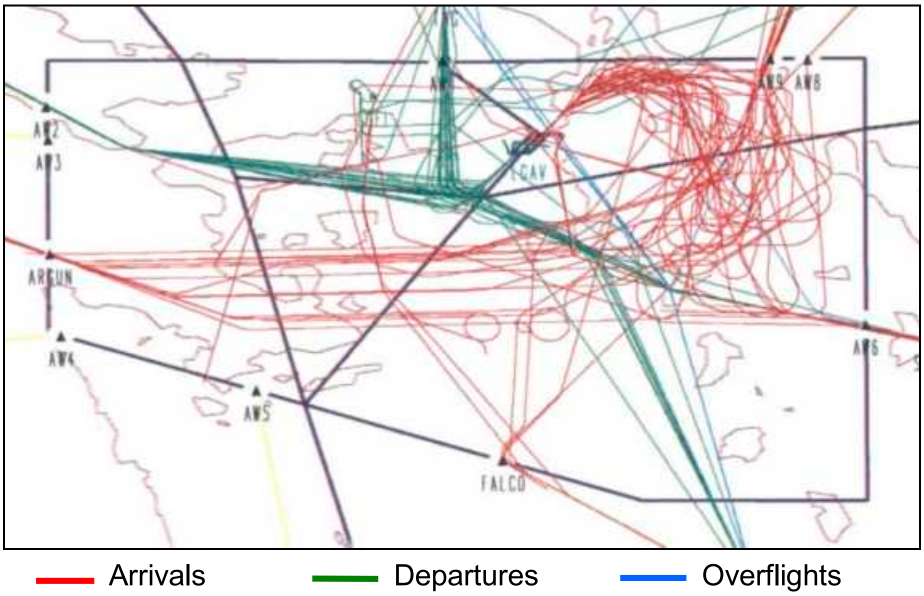


Figure 22: Flights in one exercise from ORG D

Proposal 1:

1) ARRW should control traffic from:
   KOR – ARGUN – KIMON and transfer to DIR2
2) ARRE should control traffic from:
   FALCO – SYR – KOROS and transfer to DIR2
3) DIR2 should select traffic from both sectors to make the sequencing for final approach.

Proposal 2:

ARRW should transfer all traffic to ARRE. Creation of two different volumes needed for ARRE and ARRW.

Because of the example presented in chapter 4.1.2 of these document, the creation of different volumes should be mandatory.

After running the 2004 traffic sample, controllers decided to cancel the organisation because in high traffic it was impossible to co-ordinate between the two arrival sectors ARRW and ARRE. Both sectors were overloaded and controllers continuously “lost the picture”.

4.6. ORGANISATION E

Parallel Independent Arrivals and Departures RWY 21 with a single Radar Director

4.6.1. DIR2 –

Space for vectoring on final approach is limited.

Aircraft were arriving high on finals because of the minimum altitude (vectoring area) which is too high. Before turning on "final approach", they have to maintain 4000ft and after the final turn they have 4000ft over the outer marker.

Controllers believed this to be **very dangerous** when working with parallel arrivals on RWYs 21 because of the minimum altitude which is too high and the TMA lateral limits in the NE.

General opinion for DIR2 was that the **segregated mode was less dangerous** but the amount of traffic, which can be accommodated, is lower.

SOLUTION for parallel arrivals RWY21 –

Participants considered that the only way to use parallel arrivals on RWYs 21 is to have more space to the north (in the Tanagra area of responsibility), at least 5NM. In this way, aircraft can align on final 20NM from touch down.

4.6.2. ARRE –

It was found impossible for the traffic coming from the North (OLIDA – KOROS) to use a defined STAR because they arrive too high and the only way to descent them is radar vectoring. To enable descent of this traffic, vectoring procedures should be developed.

More space from NE and N of the TMA needed because of:

- Descending traffic.
- Vectoring.

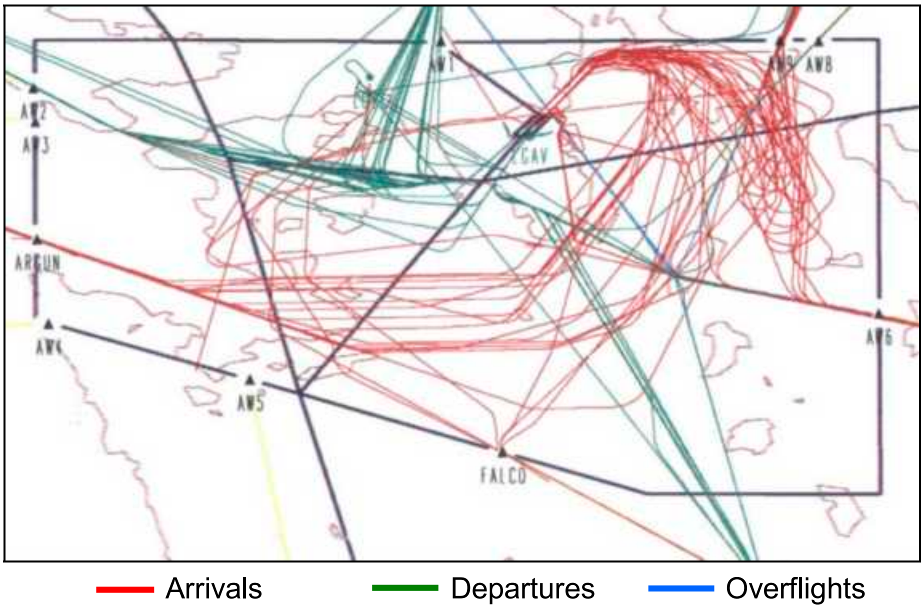


Figure 23: Flights in one exercise from ORG E

4.6.3. RDEPW –

Workload is too high because the airspace of the TMA is too big. Despite the fact that the distance from the LGAV RWYs to the northern border of the TMA is too small and the arriving traffic on RWY 21 has no room to turn on final, the TMA is too big to the south and west and the RDEP controller can hardly control the departing traffic in the whole area.

Difficulty in controlling, monitoring and vectoring arriving traffic to LGEL.

4.6.4. RDEPE –

RDEPE experience high workloads when the tower (TE/TW) departed traffic without any co-ordination. On these occasions RDEPE had to handle parallel simultaneous departures proceeding to the same exit point. If traffic is to depart without co-ordination between Tower and departing sectors, different independent SIDs for each RWY are needed. Alternatively the tower should not depart simultaneous flights with the same destination (exit point), without prior co-ordination with RDEPE.

Controllers agreed that RDEPE should control traffic from GND until FL100.

4.7. ORGANISATION F

Parallel Independent Arrivals and Departures RWY 21 with Two Radar Directors

4.7.1. Two Directors –

Participating controllers found using two directors was less dangerous than a single director. Controllers felt less loaded and they could handle the traffic easier.

The difficulty to handle the traffic was, because TMA is too short in the northern part and the vectoring area is too high around the airport.

More space from the north of the TMA (Tanagra area) is needed.

4.7.2. DIR2 –

It is difficult to handle but easier than DIR3.

4.7.3. DIR3 –

Some aircraft entered 5000ft minimum altitude area flying 3000ft because they were avoiding traffic landing on RWY 21R.

Participating controllers found it dangerous and very difficult to handle because of 180° turn on short final.

The speed of the aircraft turning on final should be very slow, about 170kts.

4.7.4. ARRE –

Workload of the sector was high but under control.

Sector management was found easier than with a single director because co-ordination with ARRW was not needed.

4.7.5. RDEPW–

It was a difficult procedure to keep traffic for a long time at low altitude to allow arriving traffic to descent.

4.7.6. RDEPE–

When aircraft departed simultaneous from both RWYs, going to the same destination, they lost their required separation immediately after departure.

When aircraft departed simultaneous from both RWYs, in crossing directions they also lost the required separation immediately after departure.

An approved procedure for tower (TE/TW) id required when using parallel RWYs (see problem from Chapter 4.6.4.).

4.8. ORGANISATION G

Parallel Independent Arrivals and Departures RWY 21 with Two Radar Directors Using RNAV Arrival for RWY 21L.

4.8.1. DIR2 -

With RNAV this was found very easy to handle (because the final turn was made automatically by the pilots).

4.8.2. RDEPE -

Controllers knew all the time exactly what the arrival sectors were going to do because all aircraft were flying the same route. There was no need for specific co-ordination with the arrival sectors.

4.8.3. ARRW -

It was difficult to monitor and control the entire sector because it is too big. Corridors (sector volumes) (Figure 3, Figure 4) were used but workload was still very high because the TMA is too big.

4.8.4. ARRE -

Participating controllers found it difficult to handle. A lot of vectoring was needed because traffic landing on RWY 21L was to low at the entry points of the TMA and the traffic landing on RWY 21R was too high.

Area is to small to descent the traffic.

Participating controllers find it very useful and they would like to see it implemented.

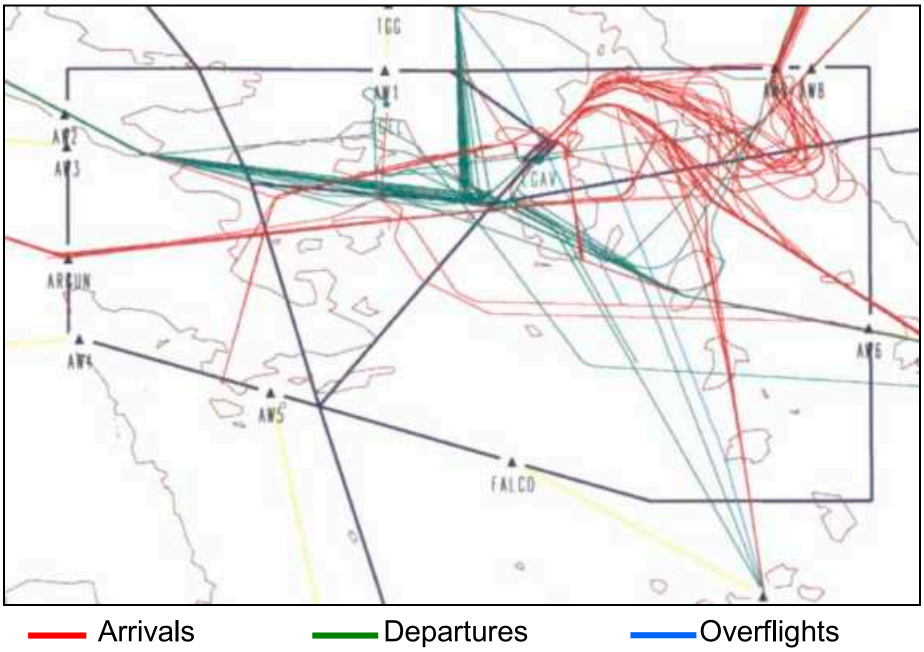


Figure 24: Flights in one exercise from ORG G

4.9. CONCLUSIONS

1) The departure sector (RDEP) should be split in two vertical sectors:
   - A lower departure sector from ground to FL 115.
   - A upper departure sector from FL 115 to FL 155.
2) Dedicated sectors with defined volumes should be created instead of having positions sharing the same airspace.
3) For the RWY direction 03, the best organisation was ORG C.
4) For the RWY direction 21, none of the organisations simulated were acceptable:
   - ORG. D – DIR2 and arrival sectors were experienced unacceptable workloads,
   - ORG. E - DIR2 and the arrival sectors couldn't safely accommodate the traffic because of the minimum altitude restrictions near by the airport and because there is not enough space for the final approach in the TMA (at least 5NM of additional airspace is needed in the north to enable aircraft to turn onto final at 20NM from touch down).
   - ORG. F – With the simulated dimensions of the TMA DIR3 couldn't safely handle the traffic because of an 180° turn onto final and the impossibility to vector traffic to maintain the 3NM separation on final (parallel arriving traffic on the right and high minimum altitude on the left).
   - The dimensions of ARRE are too small.
   - The dimensions of ARRW are too big and controllers cannot monitor the whole area.
   - ORG. G – Was the best organisation but there are no agreed RNAV arrival procedures.

5. RESULTS - OBJECTIVE 2

To evaluate the new SIDs and STARs

5.1. GENERAL

The definition of the first part of all SIDs (from take-off until the beginning of the first turn) should be revised. The beginning of the first turn should be defined in distance and altitude from a navigation aid. In the way they were defined for the simulation ("After take-off, climb on RWY heading until reaching xxx altitude, then turn right…"), aircraft with different rates of climb lost separation shortly after take-off.

When using parallel simultaneous departures, SIDs ending at the same point should be separated all the time, with at least 3NM between them. When this is not possible, special procedures should be developed.

Controllers should be trained to use as much as possible the SIDs and the STARs, for better expediency and accommodation of the traffic in the approach area.

All the graphics below represent the usage of each SID or STAR along the measured hour. With other words figures are representing an average number of aircraft of the same exercise, using the studied SID or STAR.

5.2. SIDs

Table 2: Usage of SIDs

SID	Usage of SIDs in the measured hour for the run traffic samples													
	ORG A		ORG B		ORG C		ORG D		ORG E		ORG F		ORG G	
	M	A	M	A	M	A	M	A	M	A	M	A	M	A
KRO1N			**15**	13	14	13								
OLI1N			4	2	4	1								
SYR1N			3	4	3	4								
SER1N			1	1	0	0								
DDM1N			0	0	0	0								
KOR1N	0	1	2	2	0	4								
TNG1N			0	0	0	0								
KRO1P	14	12			3									
OLI1P	3	2												
SYR1P	3	5		1		2								
SER1P	2	5	1	5	2	5								
DDM1P	0	0	0	0	0	0								
KOR1P	12	10	13	11	13	11								
TNG1P	0	0	0	0	0	0								
RIP1P	0	0	0	0	0	0								
KRO1Q									0	2	0	2	0	1
OLI1Q									3	0	4	0	3	0
DDM1Q									0	0	0	0	0	0
KOR1Q									3	2	2	4	3	0
TNG1Q									6	1	5	2	3	3
SER1Q									1	3	2	5	2	6
SYR1Q									2	4	3	4	3	4
KRO1R							0	0	0	0	0	0	0	0
OLI1R							3	2	2		3			
DDM1R							0	0	0	0	0	0	0	0
KOR1R							10	10	8	11	12	11	11	13
TNG1R							12	12	10	11	11	12	16	13
SYR1R							2	5						
SER1R							1	5		1				

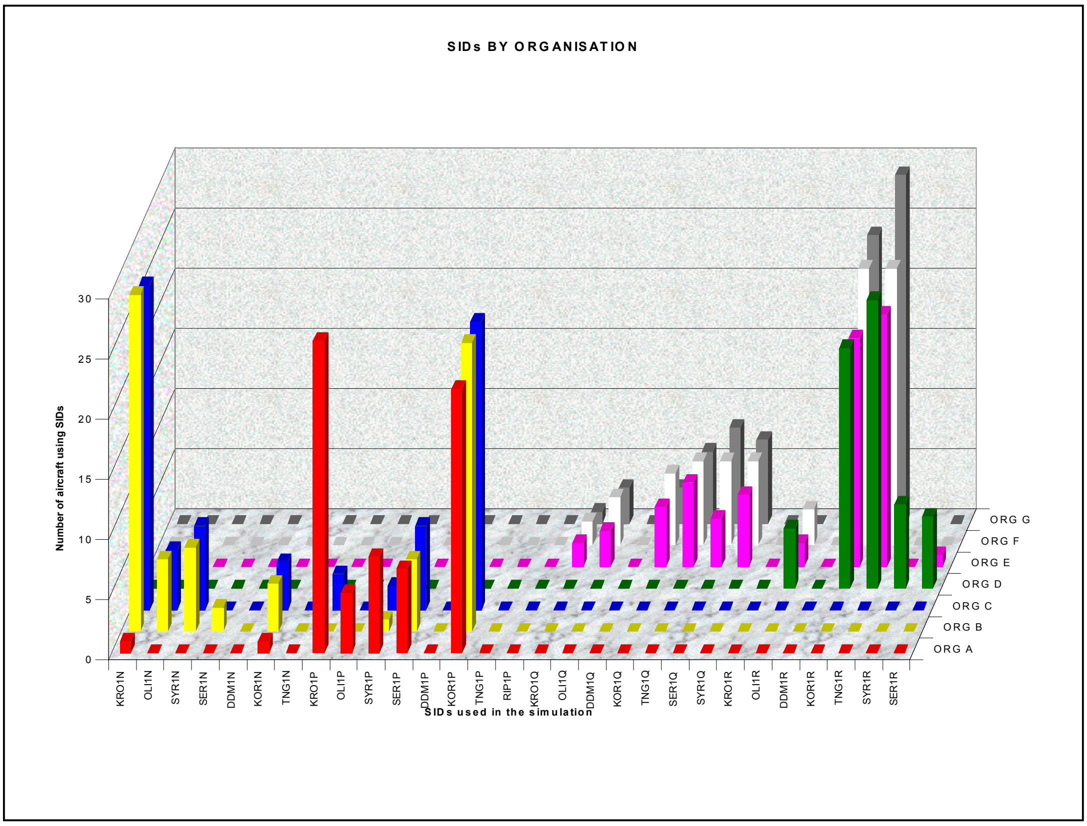


Figure 25: Use of SIDs by organisation

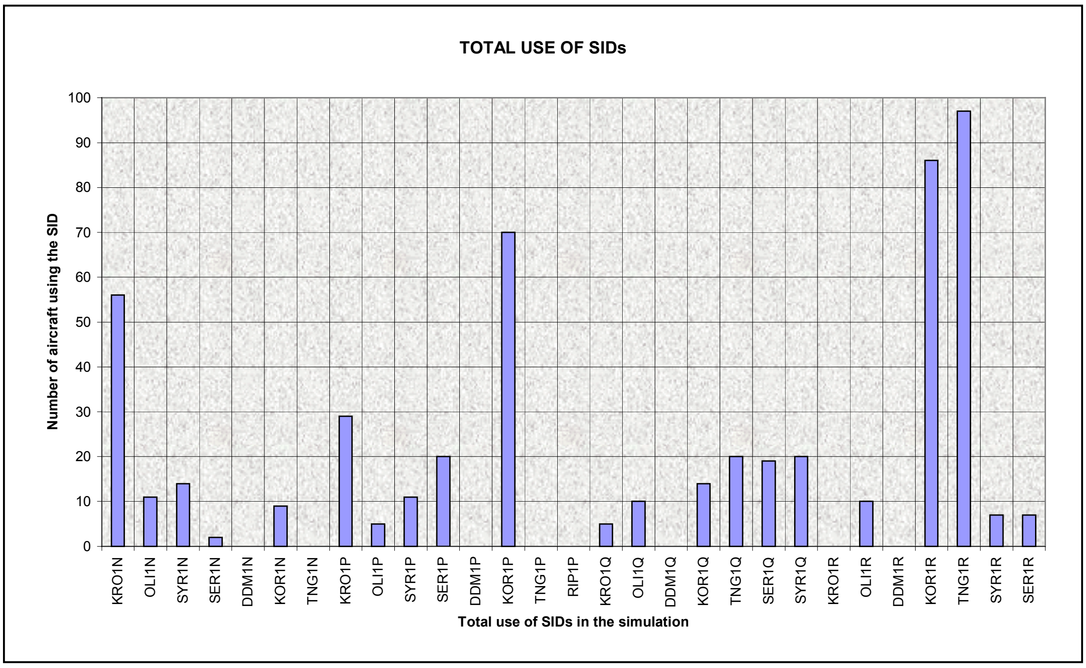


Figure 26: Total use of SIDs

This graphic represents the total usage of SIDs during the all simulation, regardless of Organisation.

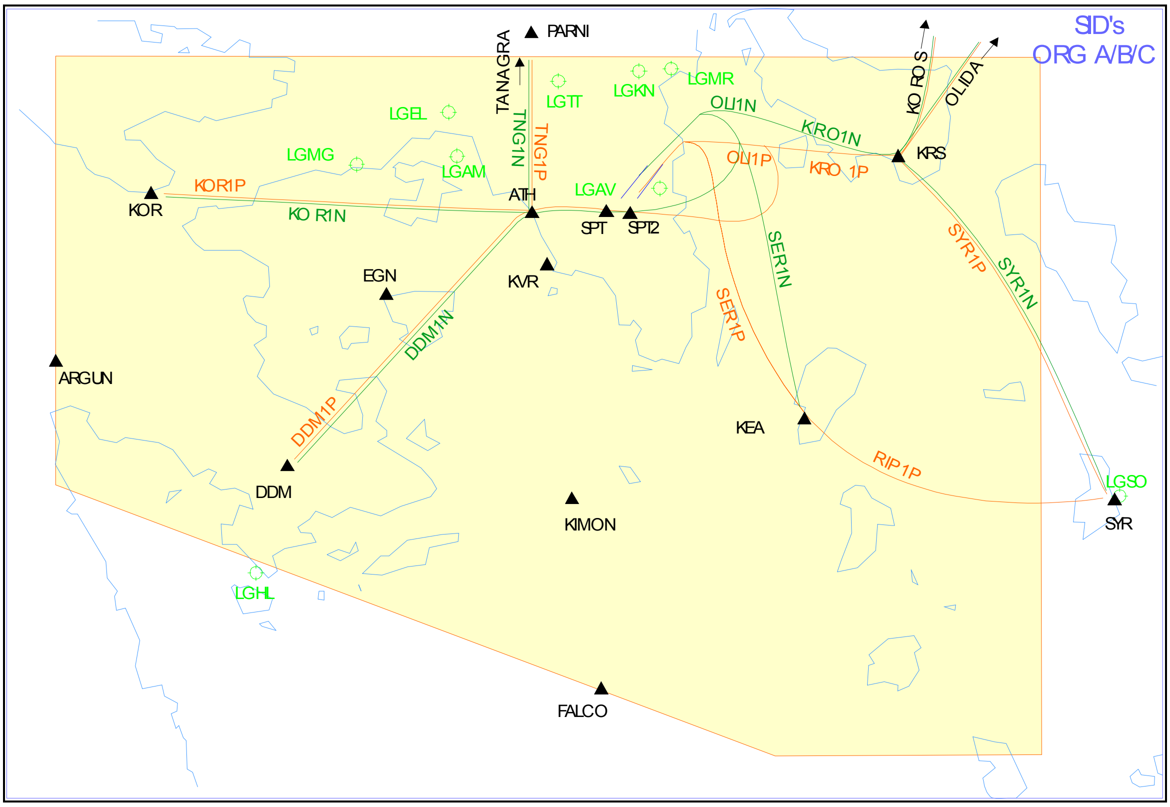


Figure 27: SID ORG A/B/C

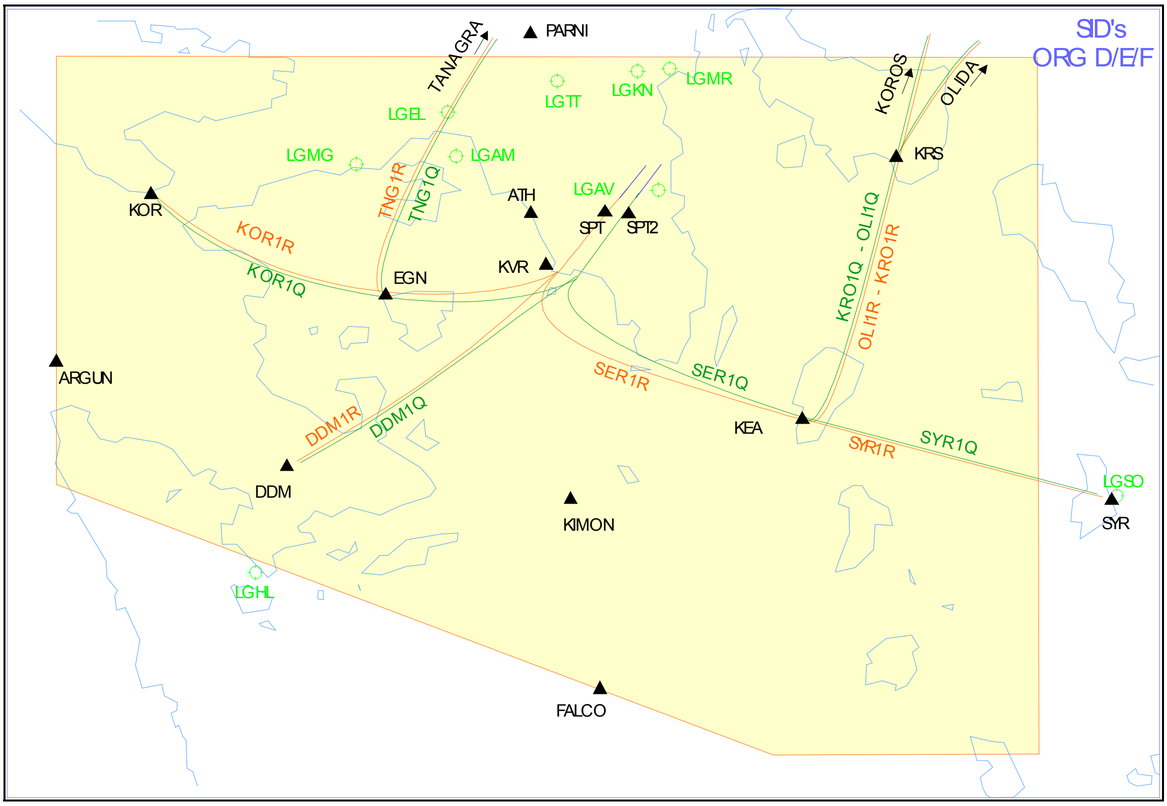


Figure 28: SID ORG D/E/F

5.2.1. KRO1P

Is too short. When there are several departures one after the other, there is no possibility to establish the correct separation, this has to be made by ACC sectors.

Military departures from LGEL inbound to KRS conflict with flights on this SID.

5.2.2. SER1P

The original SID was tested crossing TNG1P, KOR1P and DDM1P after the first turn. See Figure 25: Use of SIDs by organisation. Because of this, all departures on this SID lost the required separation after the first turn between TNG, KOR and DDM.

During the simulation, this SID (TNG1P, KOR1P and DDM1P) was redesigned to have the first turn at the same time and place.

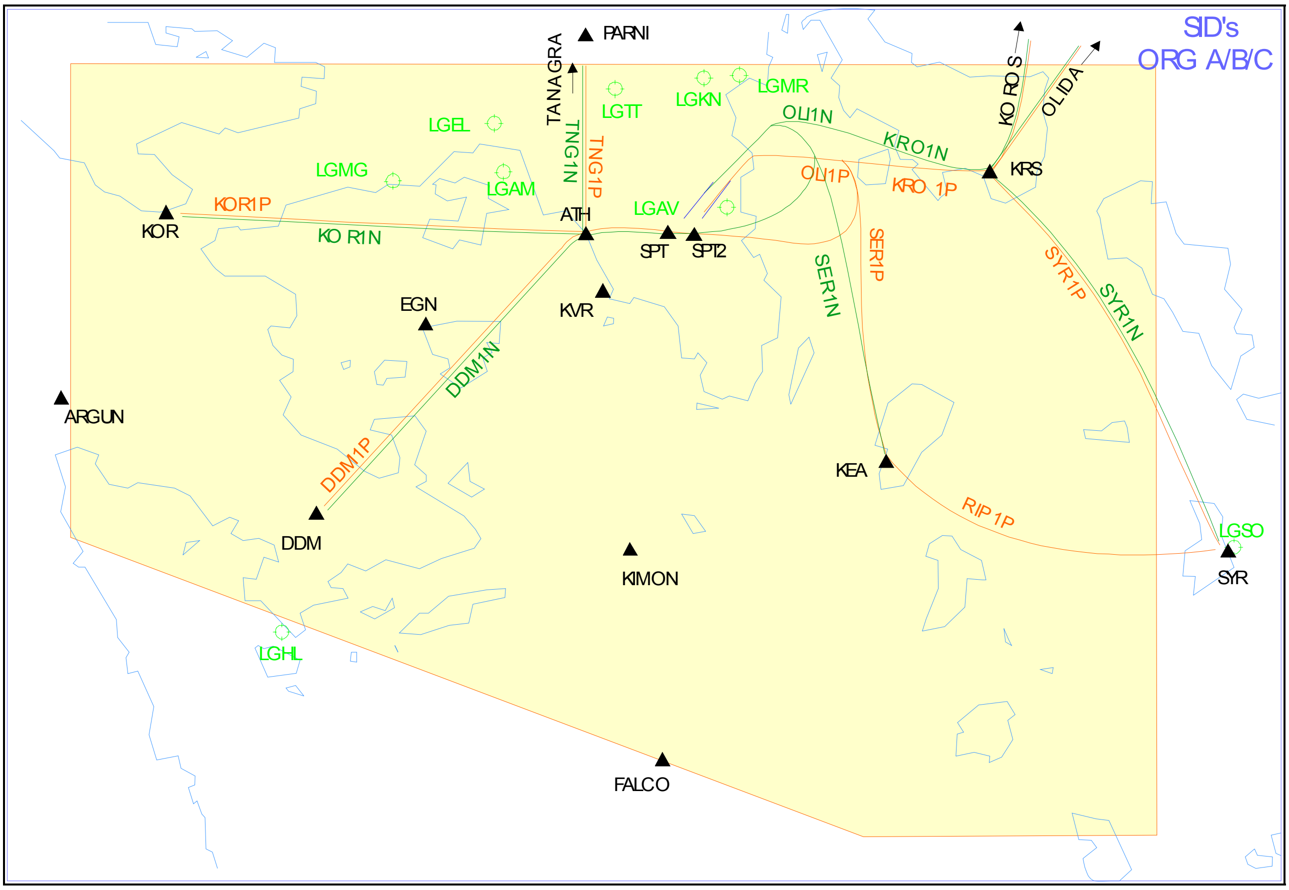


Figure 29: Sid ORG A-B-C with SER1P modified

5.2.3. KOR1N

This SID should be designed after departure to turn left to KOR. This procedure makes arrivals from Tanagra easier to descent. For RDEPE this procedure reduced the workload because labels are not overlapping and controller can better understand the air situation.

To properly design this SID (with left turn) more space from the North needed.

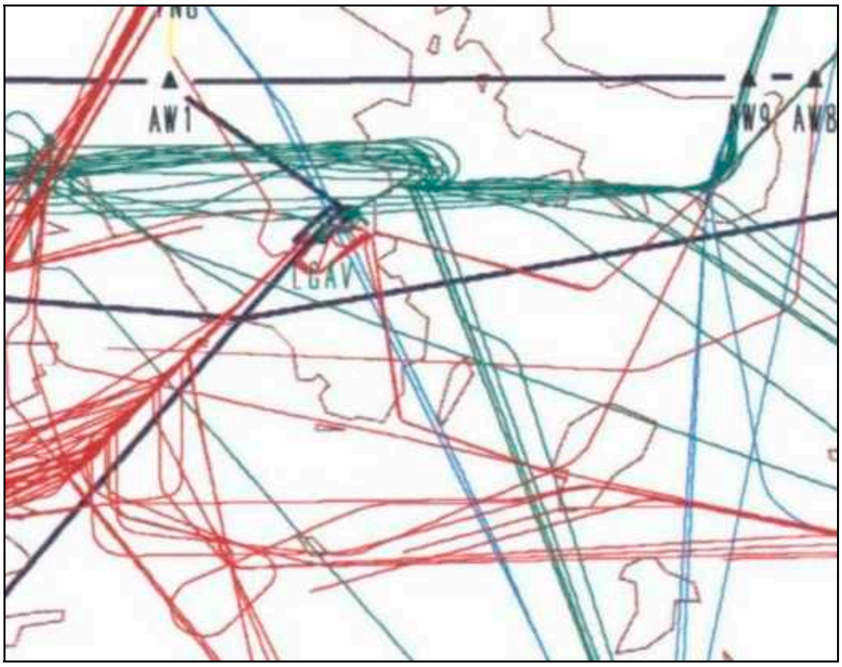


Figure 30: Traces of flights from one exercise ORG A

This is a trace of all flights flown in one exercise of Organisation A.

5.2.4. OLI1R

This SID should be redesigned to turn right after departure to KRS. This procedure will give more space for the arrivals from OLIDA and KOROS.

5.2.5. TNG1R

SID should climb to FL 220.

5.3. STARs

Table 3: Usage of STARs

STAR	Usage of STARs in the measured hour for the run traffic samples													
	ORG A		ORG B		ORG C		ORG D		ORG E		ORG F		ORG G	
	M	A	M	A	M	A	M	A	M	A	M	A	M	A
KRS1K	4	1												
SYR1K	7	3	1											
FAL1K	4	4	1											
SOK1D	0	0	0	0	0	0								
ARG1D	5	9	5	9	5	11								
KOR1E	0	0	0	0	0	0								
TNG1E	7	9	8	9	8	10								
KRS3K			5	1	5	1								
SYR3K			0	3	7	4								
FAL3K			5	4	6	4								
SOK3D			0	0	0	0								
ARG3D			0	3	0	0								
KOR3E			0	0	0	0								
TNG3E			1	1	0	0								
TNG2K							0	0	0	0	0	0		
KRO2K							7	8		1	9	10		
OLI2K							4	1						
SYR2K							6	3	2	1	3	1		
FAL2K							4	3	4	4	5	3		
SOK2K														
ARG2K							3	7	4	8	5	8		
KOR2K							0	0	0	0	0	0		
TNG4K									0	0	0	0	2	0
KRO4K									7	9	7	8	9	11
OLI4K									5	1	5	1	5	1
SYR4K								2	5	3	6	3		
FAL4K									0	0	1	2		
SOK4K									0	0	0	0		
ARG4K									0	1	1	2		
KOR4K									0	1	0	0		
SYR2R													8	3
FAL2R													6	4
SOK2R														
ARG2R													5	11
KOR2 R														

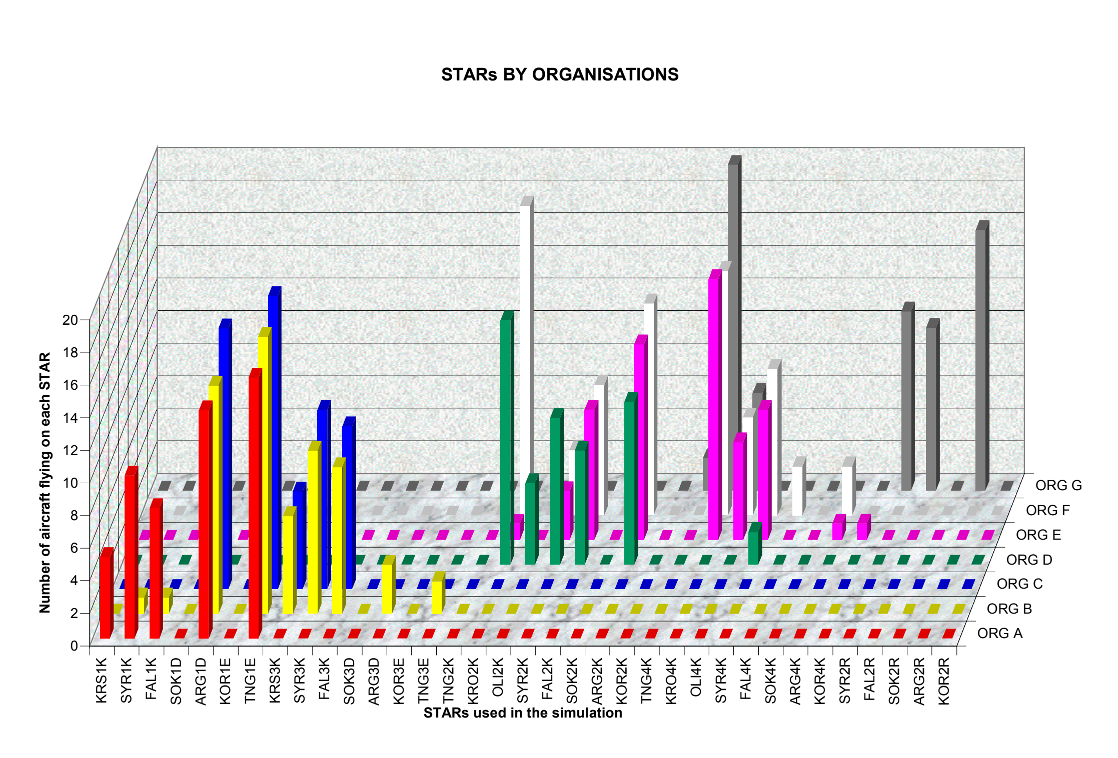


Figure 31: STARs by organisations

This graphic represents the usage of all STARs by Organisation

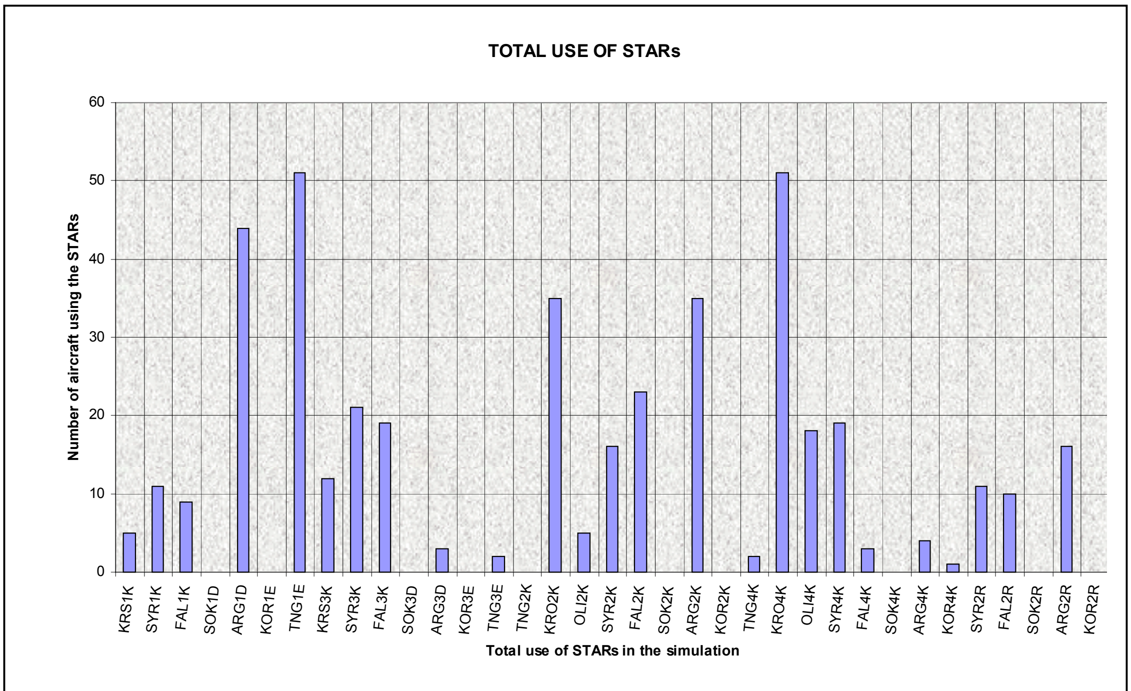


Figure 32: Total use of STARs

This graphic represents the total usage of STARs during the all simulation, regardless of Organisation.

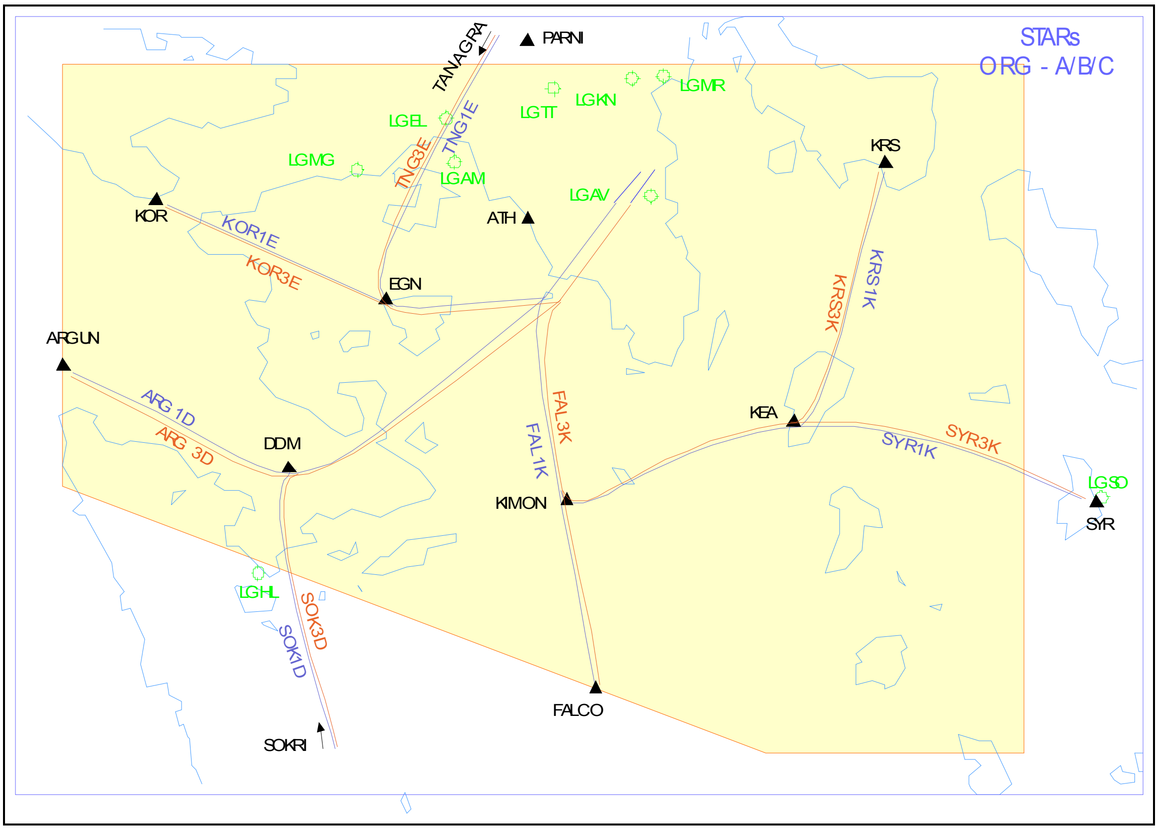


Figure 33: STARs for ORG A/B/C

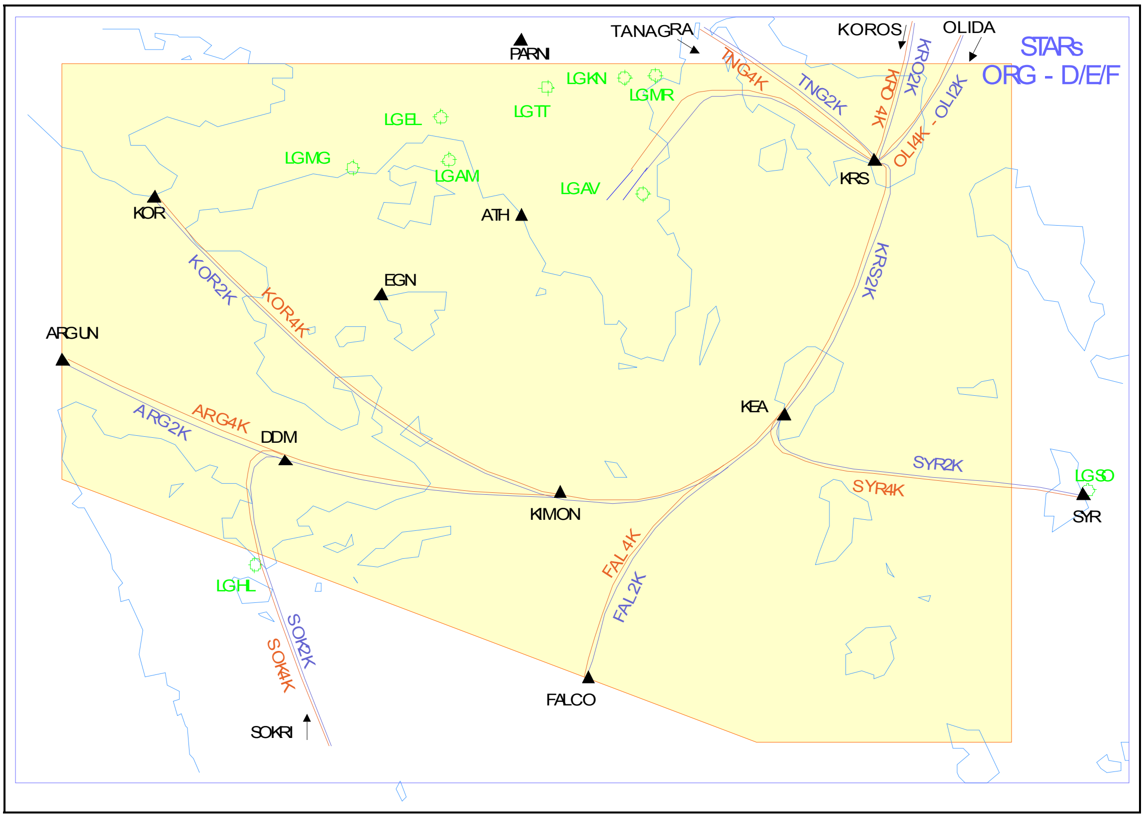


Figure 34: STARs for ORG D/E/F

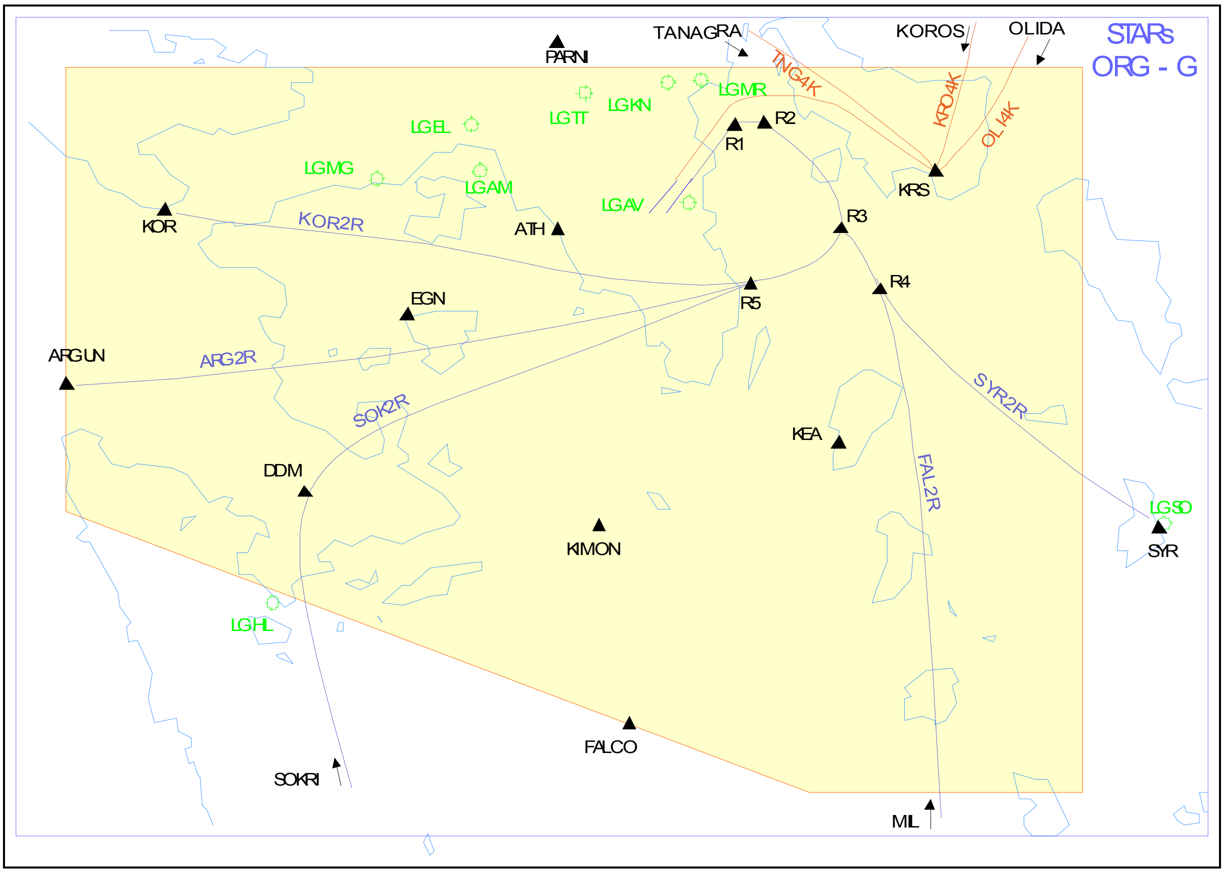


Figure 35: STARs for ORG G

5.3.1. KRO2K

The start FL is very high. Aeroplanes cannot use it because they cannot descend sufficiently quickly in such a short distance.

To accommodate the arrivals, controllers vectored all flights to the south until east of KEA for descent than vector them back to the north to KRS.

5.3.2. OLI2K

The start FL is very high. Aeroplanes cannot use it because they cannot descend sufficiently quickly in such a short distance.

To accommodate the arrivals, controllers vectored all flights to the south until east of KEA for descent then vectored them back to the north to KRS.

5.3.3. SYR2K

Participating controllers requested this STAR to be FL 160 over KEA.

5.3.4. KRO4K

The start FL is very high. Aeroplanes cannot use it because they cannot descend sufficiently quickly in such a short distance.

To accommodate the arrivals, controllers were vectored all flights to the south until east of KEA for descent than vector them back to the north to KRS.

5.3.5. OLI4K

Start FL is very high. Aeroplanes cannot use it because they cannot descend sufficiently quickly in such a short distance.

To accommodate the arrivals, controllers were vectored all flights to the south until east of KEA for descent then vectored them back to the north to KRS.

5.3.6. FAL2R

STAR was designed only for the simulation use.

5.3.7. ARG2R

STAR was designed only for the simulation use.

6. RESULTS - OBJECTIVE 3

To identify potential operational problems in the new approach area.

6.1. GENERALITIES

During the peak hours in parallel runway mode all departures go to the same exit points.

Using the tested SIDs, parallel rwys cannot be used without radar vectoring for departures.

ARRW sector is too big and difficult to be monitored by a single controller.

ARRE sector is too small, no space for vectoring and holding is available.

When RWY 21 is in use, all STARs from TANAGRA, KOROS and OLIDA arrive at a very high level requiring vectoring to the south until east of KEA before being turned back to KRS.

During the simulation the following principle was used:

- For departures, TE/TW assigned the RWY according to their needs,
- For arrivals, DIR(s) changed the RWY according to their own needs with no co-ordination with the Tower concerned.

This procedure created a high workload for the departure sectors because flights, which should fly south, were taking off from the northern RWY and vice-versa.

TE/TW should allocate the departure RWY in accordance with the TMA exit point and co-ordinate any change with RDEPE.

TMA entry levels are too high and exit levels are too low. There should be the possibility to split the TMA at FL 185 and delegate to the ACC the airspace between FL 185 and FL 245.

With the simulated shape of the TMA, only low traffic can be accommodated for the RWYs 21.

Traffic to/from SKL should not follow the same route for arrivals and departures. Both arrival sectors and ACC sectors were overloaded.

In segregated mode for RWY 03 a dedicated extra position needed for each arrival sectors because of holdings.

6.2. ORGANISATION A

Segregated mod operation, RWY 03 L Arrivals/ RWY 03 R Departures with a Single Radar Director.

There was difficulty in co-ordination between ARRW, ARRE and DIR2.

1) In one exercise (MA01S3A – 04.05.2000) DIR2 chose which traffic to assume.
2) In another exercise (MM01S3A - 04.05.2000) ARRW/ARRE co-ordinated between themselves and then proposed the traffic to DIR2.

See chapter 4.2 which is the explanation of Organisation A for the objective 1.

Generally this Organisation was found **unacceptable** because of the reduction in runway capacity and high workload of all sectors.

6.3. ORGANISATION B

Parallel Independent Arrivals and Departures RWY 03 with a single Radar Director.

The FDD was not correctly situated in the OPS room, it should be in between RDEPE and RDEPW. RDEPW needed more help and because of the position of FDD it was not possible to support him.

RDEPW was overloaded because he has to control a big area. Creating volumes of airspace might improve the situation.

The FDA position in the OPS room should be in between ARRE and ARRW.

DIR2 cannot monitor traffic until touch down. Controllers have to concentrate on vectoring to intercept the ILS. Workload was generally high.

GENERAL –

Arrivals shall be descended to FL160and departures climbed to FL150 via KRS by ACC.

Participating controllers found this an acceptable organisation.

6.4. ORGANISATION C

Parallel Independent Arrivals and Departures RWY 03 with Two Radar Directors.

This was the controller preferred organisation for RWY 03.

Encountered problems are described in para 4.4.

6.5. ORGANISATION D

Segregated mode operation, RWY 21 L Arrivals / RWY 21 R Departures with a single Radar Director.

The workload for DIR2 was high. It was difficult to accommodate traffic due to "vectoring area" (OCL on the right of RWY 21R). Because of the terrain traffic have to stay very high until the final approach and during the final approach was no possibility to divert left or right (aircraft have to turn and descent in a narrow canal. Once in the canal they can not get out.)

The role of the DIRECTOR was not clearly defined, controllers didn’t know how to:

- manage the landing sequencing before turning on final,
- maintain the 3NM separation on final after the sequence was made by the arrival sectors.

The ACC feed sectors considered it unrealistic that traffic used the route KRS – KOROS. All traffic should depart and arrive via TNG.

ARRE/ARRW – During periods of high traffic it became impossible to co-ordinate between the two sectors. Both sectors became overloaded and “lost the picture”.

There were some grave losses of separation (less than 1NM) with aircraft flying in the two different sectors because of the impossibility to monitor the traffic.

This organisation was cancelled.

For more details see chapter 4.5, Organisation D in Objective 1.

7. RESULTS - OBJECTIVE 4

To evaluate working with one and two final arrival sectors.

All participants considered working with two radar directors (final arrival sectors) for both RWY directions was the best solution.

When a single director is used:

- Co-ordination between ARRW, ARRE and DIR2 is difficult, especially when RWY 21 is used in the parallel independent mode.
- It is not possible to monitor traffic until touch down. Controllers have to concentrate on radar vectoring to intercept the ILS. Transfer to the Tower was made too early 10/12NM from touch down.
- Workload of the single director is very high.

When two directors are used:

- Co-ordination between directors and arrival sectors is much easier because one director coordinates with a single arrival sector.
- Directors can observe traffic until the RWY touch down.
- Controller workload was reduced to a manageable and efficient level.

8. RESULTS - OBJECTIVE 5

To determine optimum traffic management and procedures for the final approaches.

Generally

When RWY 03 was in use, there were no particular problems, irrespective whether one or two directors were working.

When RWY 21 was in use:

- The “vectoring area” (the simulated minimum altitude map cap 3.1.4) was too high. A more precise and detailed minimum altitude map will reduce considerably the risk and the controllers workload.
- Aircraft were coming to high on final because of vectoring area. Before turning on final, they have to maintain 4000ft and after the final turn, they have 4000ft over the outer marker.
- There is insufficient space for an efficient method of approach control in the North East part of the TMA. In ORG. F when the two runways were used in a parallel independent mode, because of the space limitation and the vectoring area, several times, radar separation was lost. DIR3 was found to be very dangerous to handle because of the vectoring area, precise turn of 1800 on the short final and traffic landing on the right-hand. The speed of the aircraft turning on final should be very slow, about 170kts.

A clear standard procedure should be developed when transferring the responsibility from the arrival sectors to the director(s). During the simulation, DIRs were "forced assume"[1] traffic they believed it can be accommodated, without any telephone co-ordination, than arrival sectors transfer the assumed traffic to DIR.

Because of big area DIR had to monitor, controllers were forced to transfer traffic to TW/TE very soon 10/12NM from touch down, because he has to concentrate to the vectoring phase to intercept the ILS.

When using parallel independent runways, a clear procedure should be developed about how the runway can be changed. When is the last moment when RWY can be changed, should be find out. A proper co-ordination shall be made before Director(s) is/are changing the runway.

The roll of the DIRECTOR was not clearly defined, controllers didn’t know how to operate it:

- To make the landing sequencing before turning on final,
- To maintain the 3NM separation on final after the sequence was made by arrivals sectors.

DIR2 in ORG G find RNAV very easy to handle.(because the final turn was made automatically by the pilots). No vector has been used. All traffic has been accommodated with RNAV.

[1] The ASS key can be pressed once the track has been designated.
The function is authorised on any coupled radar track or flight plan track provided that the corresponding flight plan is not yet controlled by the position.
If the flight plan was previously controlled by another position, the flight plan becomes not controlled by that position and the flight plan information (label, strips) turn to the “Non controlled track” colour.

9. RESULTS - OBJECTIVE 6

To compare mixed RWY operations, with segregated runway operations, for arrival and departure using parallel runways.

After all exercises were run, 100% of controllers said that mixed RWY operation is better than the segregated RWY operation.

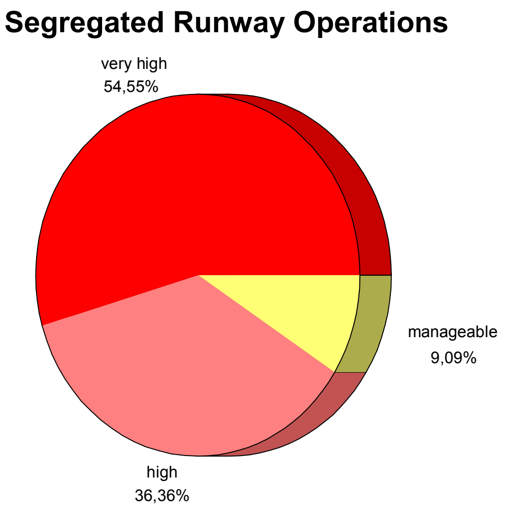


Figure 36: Segregated RWY op.

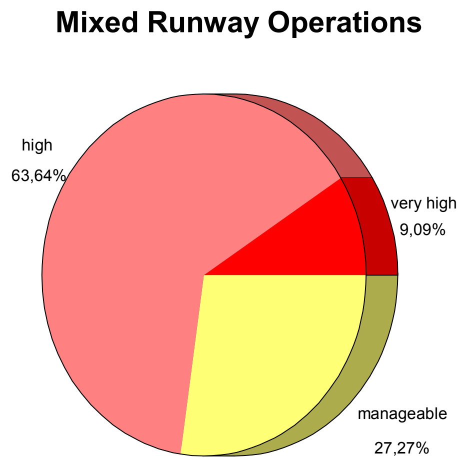


Figure 37: Mixed RWY

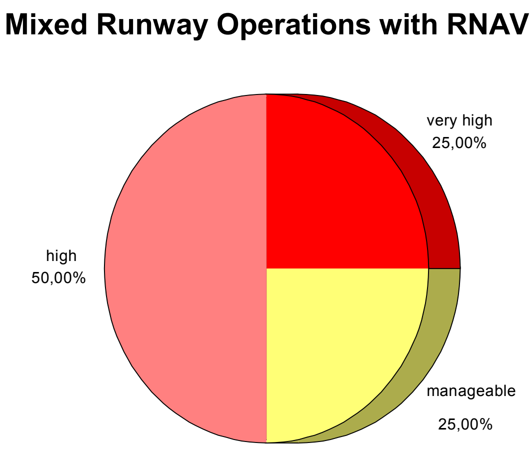


Figure 38: Mixt RWY op. With RNAV

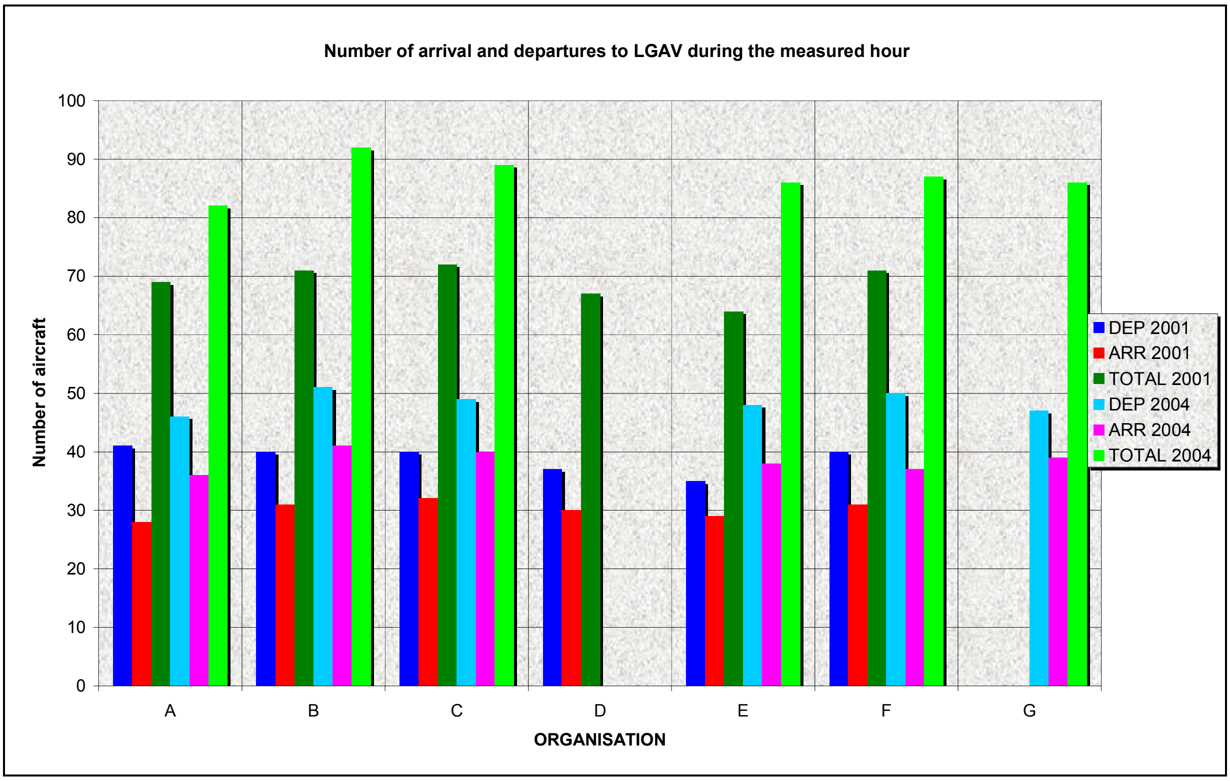


Figure 39: ARR and DEP to/from LGAV

Despite the general opinion of the controllers, several problems occurred for RWY 21 with 2004 traffic level. For this traffic level, it was impossible to accommodate the traffic because of several reasons:

- In segregated mod all sectors were overloaded because of RWY capacity.
- In parallel mode with a single director, arrival sectors were overloaded because of co-ordination.
- In parallel mode with two directors, final vectoring was not safe because of a very small area and because of the vectoring area, which is to high.
- Standard arrival flight levels were too high and standard departure flight levels were too low.
- All sectors are overloaded.

RDEPE/W considered that segregated mode is better for departures but arrivals can not accommodate too much traffic because of the limitation of a single RWY.

ARRE couldn't maintain 5NM separation between aircraft because of traffic vectored from the N, which had to lose altitude.

ARRW sector is too big. Impossibility to monitor the all traffic.

DIR 3 considered that the corridor for the final approach is to narrow.

DIR 2 had less space than the other DIR.

The conclusion for the RWY 21 was that segregated mod is safer. Parallel independent mode is too difficult and too dangerous.

10. RESULTS - OBJECTIVE 7

Evaluate the effect of military traffic on certain approach operations

During the simulation, when RWY 03 was used, departures from LGEL to KRS were conflicting with departures from LGAV to KRS.

TWR (LGEL TWR for the simulation) considered that arrivals to LGEL were difficult to handle with the tested “vectoring area”. LGEL was not taken into account when vectoring area was designed.

RDEPE (**low**), when RWY 03 was used, had problem with the overlapping labels. Radar picture could not be zoomed more because of LGEL airport.

ARRE, when RWY 03 was used, had to perform a lot of co-ordination for traffic destination LGEL. All this traffic was transferred from ARRE sector to ARRW sector than to the LGEL TWR.

RDEPW (**high**), when RWY 21 was used, had an increased workload because of traffic departing from LGEL.

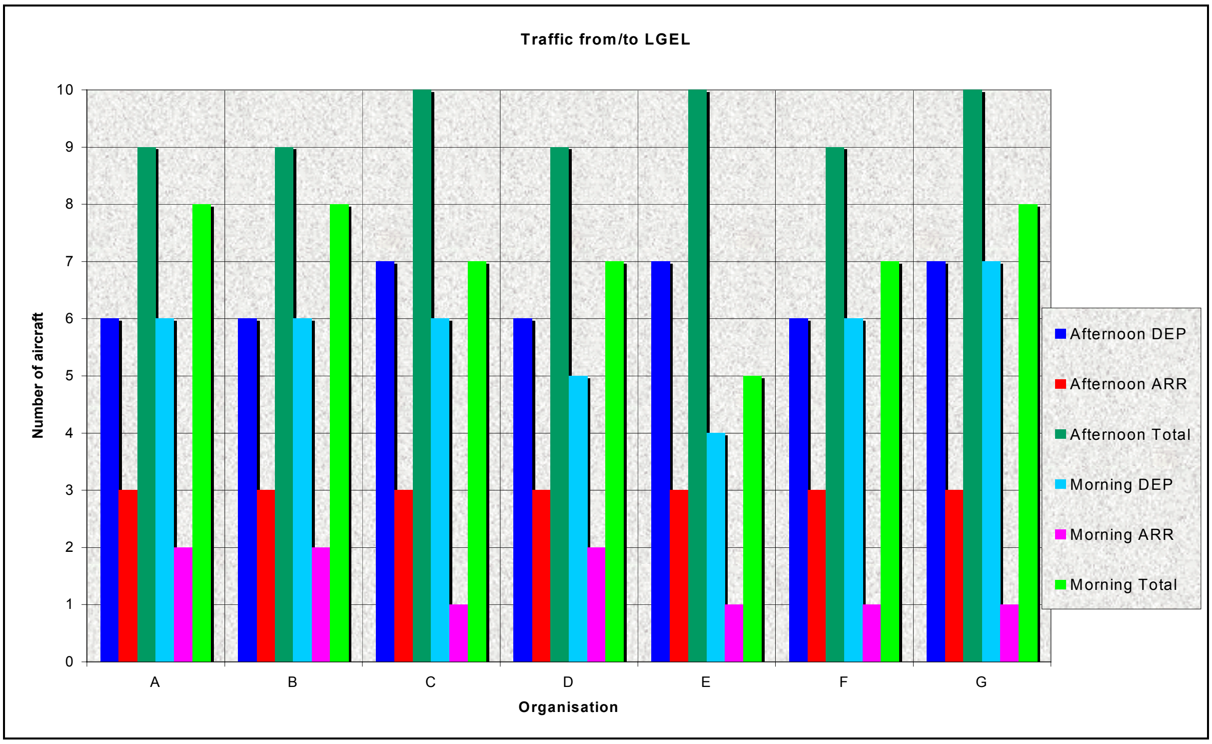


Figure 40: Traffic from/to LGEL

LGEL airport had a big impact in the overall context, being an important factor in increasing the workload of arrival and departure sectors.

New SID and STARs for LGEL should be created, apart of the crowded points used by traffic of LGAV.

11. RESULTS - OBJECTIVE 8

Evaluate the use of the Holding Stacks within the TMA and formulate solutions in the event that holding problems are identified

A set of five holding stacks was used during simulation.

In the beginning of the simulation, controllers were trying to use holding stacks but at the end, they quit using them. The reason for this was the wrong placement of each holding which instead of helping, increases the workload very high.

When RWY 21 is in use KRS Stack is too close to the RWY and too close to the northern limit of the TMA and it is the point where several STARS are joining for the final approach. More than this, departures are crossing the same point.

When RWY 21 is in use KEA Stack had more or less the same problem, arrivals are crossing departures in that point.

A better Stack for RWY 21 might be KIMON but this point is too far away from the routes coming from TANAGRA, KOROS and OLIDA.

With the simulated shape of the TMA, for RWY 21 is no space where proper Holding Stacks can be placed ; there is a small area between the RWYs and the eastern lateral limit of the TMA.

When RWY 03 is in use, KRS and KEA have the same problems as for the RWY21 STARs are crossed by SIDs in that points.

Controllers believed that no holding stack can be used in high traffic because this increases the workload of the executive controller. They preferred to give long vectors than opening a holding stack.

Two assistants (Flight Data), one for each arrival sector, needed especially when holding stacks are opened.

A clear procedure to use holding stacks should be developed and a defined position needed when a holding stack is open.

During the simulation a number of flights were delayed in holding and vectoring procedures:

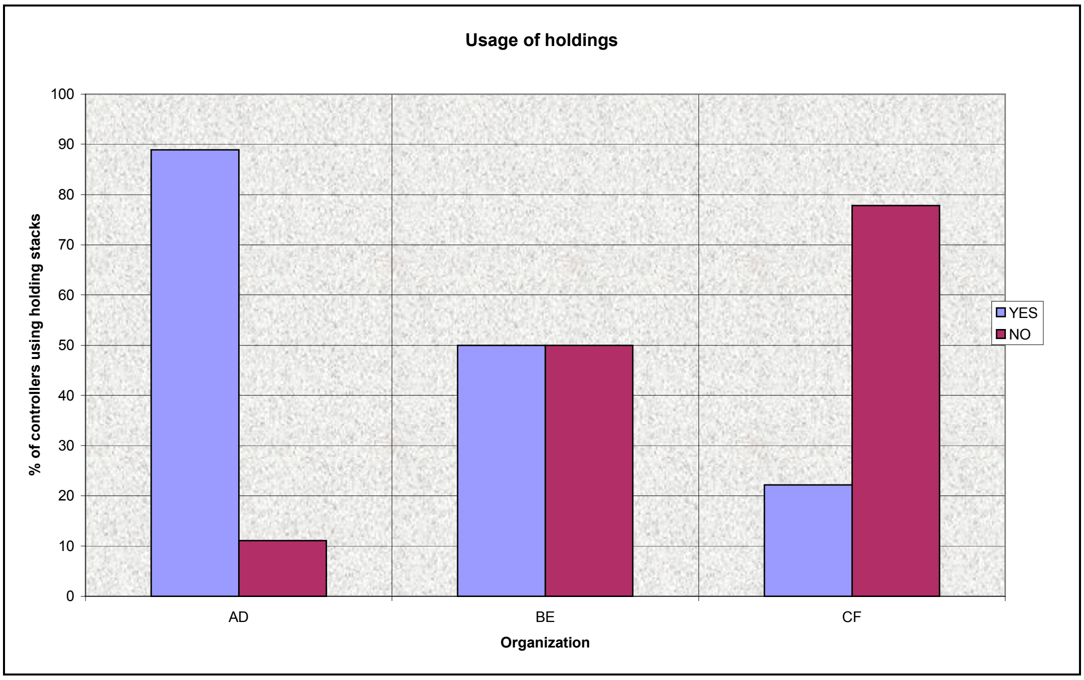


Figure 41: Usage of holdings

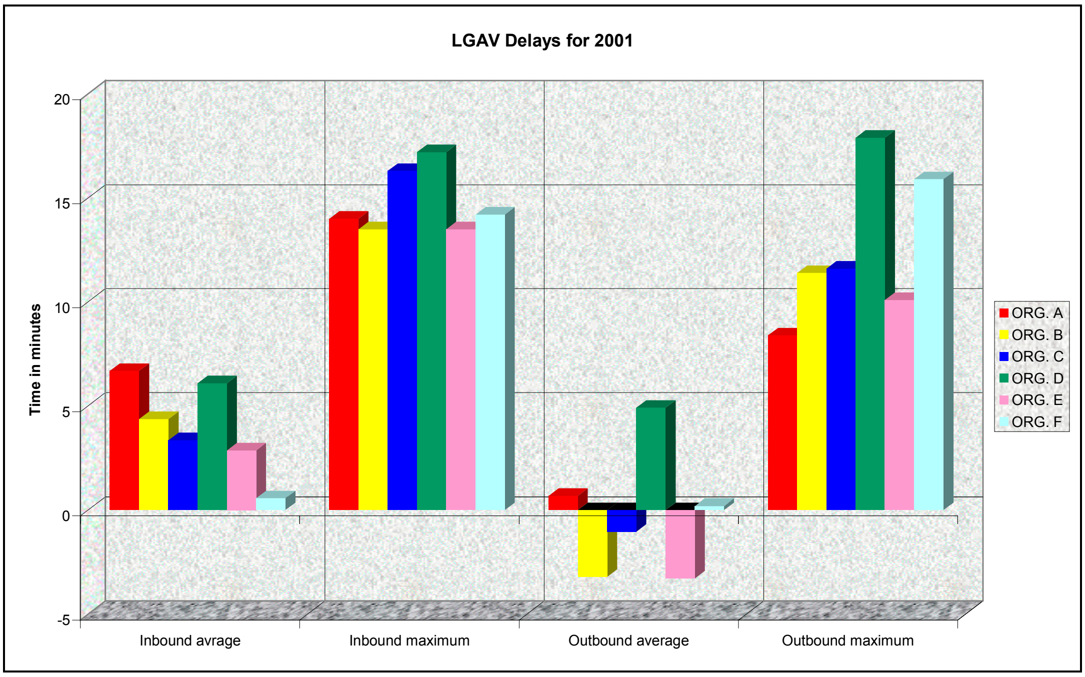


Figure 42: LGAV delays for year 2001

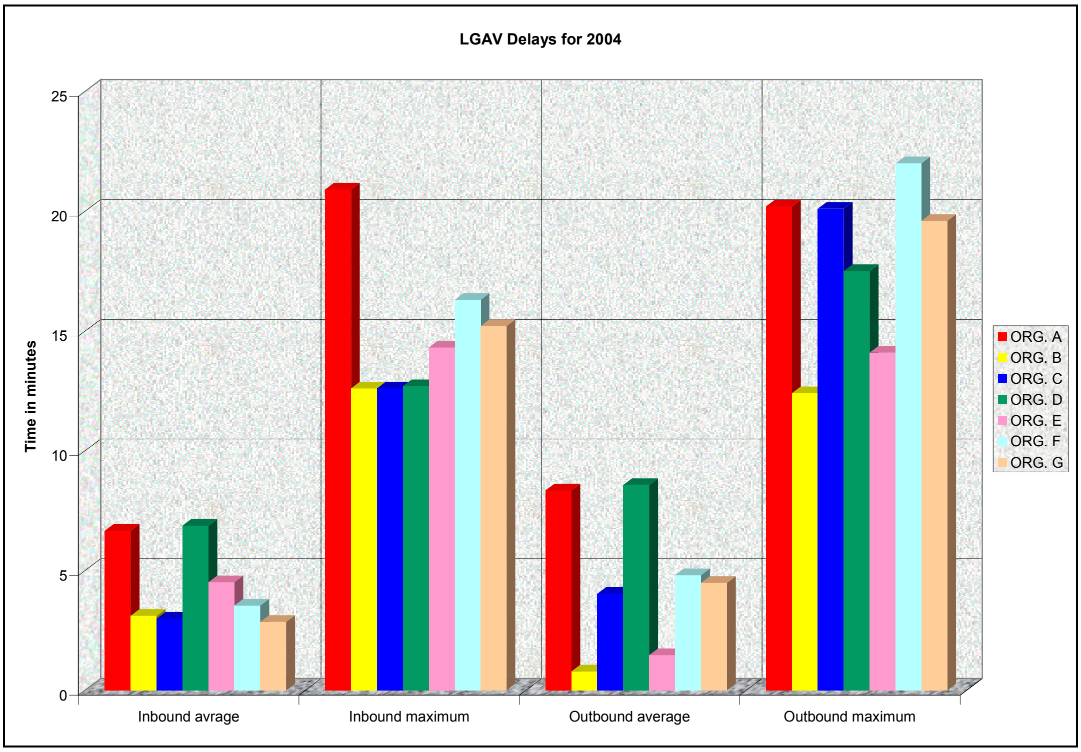


Figure 43: LGAV delays for year 2004

12. RESULTS - OBJECTIVE 9

Evaluate the effect of VFR traffic in the final arrival sectors

When using the RWYs in the segregated mod with 2001 traffic level, VFR arrivals were holding, some times more than 30 min. To avoid holding they were landed on the departure RWY. This was the single way VFR traffic could be accommodated but IFR departures were delayed because RWY was blocked by VFR arrivals.

When using the RWYs in the segregated mod with 2004 traffic level, to land VFR traffic was not possible because of big amount of IFR traffic landing. In attempt to land VFR they were delayed until the end of the exercise.

When using the RWYs in the parallel mode, especially with 2004 traffic level, VFR traffic was very difficult to be accommodated.

Because of the airspace classification, no separation was provided by the air traffic control between IFR traffic and VFR traffic. Several times, VFR traffic was very close of IFR traffic less than 1NM.

VFR holding points were found too far from the airport. When was a gap between two IFR arrivals a VFR traffic was cleared to leave the holding point and come for landing. Because the way was too long some other new IFR were coming and they were forced to go back to the holding point.

13. RESULTS - OBJECTIVE 10

Evaluate the impact of the KOTRONI restricted area for arrival and departing traffic from Spata.

Table 4: Aircraft overflying KOTRONI restricted area

Level	Year 2001		Year 2004	
ORG	Nb of Aircraft	Time	Nb of Aircraft	Time
A	27,25	1,49	33,5	1,54
B	25,50	2,17	32,75	2,23
C	24,00	2,14	27,00	2,19
D	26,50	3,61	34,50	3,42
E	29,00	3,87	35,33	3,80
F	30,20	3,99	35,83	3,65
G			34,25	3,49

14. RESULTS - OBJECTIVE 11

Evaluate RNAV procedures for RWY21L

RNAV procedure was generally like by the controllers.

DIR2 find RNAV procedures very easy to handle (because the final turn was made automatically by the pilots), no need for vectoring.

For the TE, it was difficult to depart traffic and accommodate VFR because arrivals were very closed one to the others.

RDEPE find this procedure very easy because controller knew all the time exactly what arrival sectors were going to do because everybody was flying the same route.

ARRW had problems because of the departing traffic was going at the same exit/entry points as the RNAV arrivals.

ARRE find RNAV flights difficult to handle. A lot of vectoring was needed because traffic landing on RWY 21L was to low. Area used by this sector is too small and there is no room for vectoring and holding. This remark is common for all organisations where RWY 21 is used.

Controllers find it a ”Nice game” and they would like to see it properly developed and implemented.

15. CONCLUSIONS AND RECOMMENDATIONS

15.1. CONCLUSIONS

15.1.1. General

The simulation RDEP position, should be split in two:

- RDEP Low - from GND to FL 100
- RDEP Upper - from FL 100 to FL 245

The existing COOR position can provide the basis for RDEP Upper. COOR tasks can be delegated to FDD and FDA positions.

FDD position should be positioned in the operations room, preferably between the two departure positions (RDEP Low and RDEP Upper), or near RDEP Upper position who needs the assistance of a planner.

FDA position should be positioned between the two arrival positions (ARRE and ARRW).

Dedicated sectors should be created inside the TMA. Operational procedures and Letters of Agreement should be developed for each of these new TMA sectors.

RDEP Upper should have its own airspace (like the simulated "corridors") with clear operating procedures. During the simulation two sectorisation options were developed depending on the runway direction.

Procedures for the intersection areas where arriving traffic cross the departing traffic should be developed.

15.1.2. Workload

When RWY 21 is in use:

- The ARRW sector is overloaded because the sector is too large.
- The ARRE sector is overloaded because the sector has insufficient space to manage the traffic.
- In the configuration with a single Radar Director for final approach, ARRW and ARRE sectors are overloaded because of an excessive amount of co-ordination.

RDEPW (Upper) sector is continuously overloaded because of the large monitoring area.

The ARRW and ARRE sectors in segregated mode with 2004 traffic level are overloaded because of the excessive number of holds and vectoring required to accommodate the arriving traffic.

When using parallel departures the RDEPE (Low) sector is overloaded because simultaneous departures go to the same TMA exit point.

15.1.3. SIDs

Initially separated aircraft on the same SID lost separation after the first turn due to inadequate SID design.

SER1P and RIP1P SIDs conflict with KOR1P immediately after take off.

When runway 03 is in use the departing traffic towards KOR and TNG should take off from the runway 03L (Left) and turn left. This procedure enables early descent for arriving traffic from TNG.

15.1.4. STARs

The simulated STARs for the RWY 21 are not suitable for independent parallel runway operations.

Start flight levels for the simulated STARs were too high for KOR, OLI and TNG when RWY 21 in use.

15.1.5. Operational Problems

It was not possible to find a viable solution to accommodate the traffic of the year 2004 level on runway 21 because:

- in segregated mode all sectors are overloaded because of reduced runway capacity,
- in parallel independent mode with a single radar director arrivals sectors (ARRW and ARRE) were overloaded because of excessive co-ordination,
- in parallel independent mode with two radar directors final vectoring was not considered by the participating controllers as being safe because of a restricted vectoring area constrained by high ground.
- Clear runway allocation procedures in accordance with the exit point were missing. These should be developed taking into account LoAs (Letters of Agreement) between RDEPE (Low) and TWR.

The simulated entry flight levels in the TMA were too high and exit flight levels were to low. The possibility to split the TMA at FL 185 and delegate to the ACC the airspace between FL 185 and FL 245 should be considered.

There is an inappropriate division of airspace in the TMA (too much in the west and too little in the North and north-eastern).

Traffic to/from SKL should not follow the same route for arrivals and departures. Both arrival sectors and ACC sectors were overloaded.

In segregated mode for runway 03 a dedicated "flight data" position (an additional position) is needed for each arrival sector to accommodate holding.

15.1.6. Holding Stacks

The simulated KRS holding stack was not usable because it was too close the final approach for runway 21.

Generally, the positions of the simulated holding stacks were too close to the airport and they were placed exactly at the points where arrival traffic crosses departure traffic.

Clear procedure to use holding stacks should be developed.

15.1.7. Military Traffic From LGEL

The simulated military traffic from LGEL (Elefsis) airport had a big impact on the overall context. This traffic was an important factor in increasing the workload of all arrival and departure sectors.

New SID and STARs for LGEL should be created away from the congested points used by traffic of LGAV.

15.1.8. VFR Traffic

Arriving and departing VFR traffic was accommodated on the departure RWY when segregated mode was used.

VFR traffic was difficult to accommodate in parallel mode.

On several occasions departing and arriving VFR traffic came within 1nm of IFR traffic.

VFR holding points were found to be located too far from the airport.

15.1.9. RNAV Arrivals for RWY 21L

Simulated RNAV arrival procedures were liked by the participating controllers.

Using this RNAV arrival procedure, workload of the DIR 2 sector was low.

The ARRW sector had problems because the departing traffic used the same exit/entry points.

15.2. RECOMMENDATIONS

Clear procedures of co-ordination between **ARRIVAL** sectors and **DIRECTORS** should be developed.

Vectoring areas with appropriate minimum altitude in regard to terrain should be created.

TMA sectors with defined volumes should be created with appropriate LOAs to replace shared controller operation in the same airspace.

Clear procedures runway allocation for departures should be created.

Clear procedures to change the runway for arrivals should be created.

Some SIDs and STARs should be redesigned,

Holding stacks should be redesigned to separate them from the main intersecting points of arriving and departing traffic,

For the runways 03L/R parallel independent mode can be used unrestricted only if SID to KOR is designed from 03L with a left turn after take-off.

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TRADUCTION EN LANGUE FRANCAISE

RESUME

Le gouvernement grec a décidé de construire à Athènes un nouvel aéroport qui permette d'augmenter la capacité du transport aérien, notamment en prévision des jeux olympiques de 2004.

Le nouvel aéroport international d'Athènes, baptisé "Eleftherios Venizelos" et situé dans la région de Spata Attica, a été mis en service en mars 2001.

Les autorités grecques de l'aviation civile ont demandé à EUROCONTROL de tester de nouvelles procédures pour la TMA dudit aéroport, de développer et de tester de nouvelles SID et STAR et de mettre en lumière tout problème éventuel au moyen de simulations en temps réel et de simulations mathématiques.La simulation en temps réel Spata 2000 s'est déroulée au Centre expérimental d'EUROCONTROL du 2 au 26 mai 2000.¨Pendant cette période, les contrôleurs ont participé à 53 exercices de simulation qui ont duré, au total, 73 heures.

La simulation visait à déterminer le meilleur mode de gestion des pistes parallèles (pistes spécialisées et pistes indépendantes), les procédures à appliquer ainsi qu'un ensemble de SID et STAR pour toutes les pistes.

La simulation s'intéressait également aux vols militaires à destination et en provenance de l'aéroport d'Elefsis, afin d'en évaluer les incidences sur l'ensemble du trafic dans la TMA.

Les positions de contrôle TMA opérationnelles ont été évaluées, et certaines d'entre elles ont été réorganisées pendant la simulation.

Les formes des secteurs TMA ont été conçues et développées pendant la simulation.

Les pertes de séparation et les incidents ont été surveillés à l'aide de l'ASMT (instrument automatisé de contrôle de la sécurité).

L'incidence du trafic VFR sur la tour et dans l'ensemble de la TMA a été étudiée au moyen d'une HMI conçue spécialement pour les positions qui alimentent la tour.

1. INTRODUCTION

La simulation en temps réel Spata 2000, réalisée à la demande des autorités grecques de l'aviation civile (HCAA), s'est déroulée au Centre expérimental d'EUROCONTROL du 2 au 26 mai 2000.

Le présent rapport en expose les résultats.

La HCAA a demandé à EUROCONTROL de tester de nouvelles procédures dans la TMA de l'aéroport "Elefherios Venizelos", de développer et de tester de nouvelles SID et STAR et de mettre en lumière tout problème potentiel.

La simulation Spata 2000 a permis de cerner les problèmes liés à l'implantation du nouvel aéroport et d'évaluer des solutions.

Une évaluation des pertes de Séparation radar a été évalué à l'aide de l'outil ASMT (Automatic Safety Monitoring Tool).

2. OBJECTIFS

2.1. OBJECTIFS GENERAUX

1) Évaluer les opérations ATC planifiées et leur incidence sur la capacité et l'efficacité dans la zone d'approche, dans l'environnement du système ATC PALLAS.
2) Évaluer la charge de travail et les responsabilités des contrôleurs.

2.1.1 Objectifs Spécifiques

1) Évaluer d'autres procédures de départ et d'arrivée au sein de la TMA.
2) Évaluer les nouvelles SID et STAR.
3) Cerner les problèmes d'exploitation potentiels liés à la nouvelle zone d'approche.
4) Évaluer les modalités de travail avec un ou deux secteurs d'arrivée.
5) Déterminer les modalités optimales de gestion du trafic et les meilleures procédures d'approche finale.
6) Comparer la gestion des arrivées et des départs sur pistes parallèles, selon que celles-ci sont gérées en mode spécialisé ou mixte.
7) Évaluer les incidences du trafic militaire sur certaines opérations d'approche.
8) Évaluer l'utilisation des piles d'attente au sein de la TMA et proposer des solutions en cas de problèmes liés à ces attentes[1].
9) Évaluer l'incidence du trafic VFR dans les secteurs d'arrivée finale.
10) Évaluer l'incidence de la zone réservée de KOTRONI sur les vols qui décollent de Spata ou qui y arrivent.
11) Évaluer les procédures RNAV pour la RWY21L.

[1] L'objectif est de déterminer la durée maximale et la durée moyenne des retards.

3. CONCLUSIONS ET RECOMMANDATIONS

3.1. CONCLUSIONS

3.1.1 Généralités

Il conviendrait de dédoubler comme suit la position RDEP utilisée dans la simulation :

- RDEP inférieure : - du sol à FL 100
- RDEP supérieure : - du FL 100 au FL 245

La position COOR actuelle pourrait former la base de la RDEP supérieure, ses tâches étant alors déléguées aux positions FDD et FDA.

La position FDD devrait se situer dans la salle d'exploitation, de préférence entre les deux positions de départ (RDEP inférieure et RDEP supérieure), ou près de la position RDEP supérieure, qui a besoin de l'assistance d'un organique.

La position FDA devrait se situer entre les deux positions d'arrivée (ARRE et ARRW).

Il conviendrait de créer des secteurs spécialisés au sein de la TMA. Des procédures d'exploitation et des lettres d'accord devraient être arrêtées pour chacun de ces nouveaux secteurs TMA.

La position RDEP supérieure devrait avoir son propre espace aérien (comme les "corridors" simulés), assorti de procédures d'exploitation claires. Pendant la simulation, deux formules de sectorisation ont été développées en fonction de l'orientation des pistes.

Il conviendrait d'élaborer des procédures propres aux zones d'intersection où les vols à l'arrivée croisent les vols au départ.

3.1.2 Charge de Travail

Lorsque la RWY21 est en service :

- le secteur ARRW est surchargé, en raison de ses dimensions trop importantes,
- le secteur ARRE est surchargé car l'espace disponible est insuffisant pour gérer le trafic,
- dans la configuration où l'approche finale se fait avec un seul directeur radar, les secteurs ARRW et ARRE sont surchargés par excès de coordination.

Le secteur RDEPW (supérieur) est continuellement surchargé en raison de ses dimensions trop importantes.

Les secteurs ARRW et ARRE sont surchargés lorsqu'ils fonctionnent en mode réservé avec les niveaux de trafic prévus pour 2004, en raison de l'importance des attentes et du guidage nécessaires pour prendre en charge les vols à l'arrivée.

Lorsque les départs se font en parallèle, le secteur RDEPE (inférieur) est surchargé, car des vols décollant simultanément se dirigent vers le même point de sortie de la TMA.

3.1.3 SID

Des aéronefs suivant la même SID ont perdu leur séparation initiale dès le premier virage comme suite à une mauvaise conception de la SID.

Les SID SER1P et RIP1P entrent en conflit avec la KOR1P immédiatement après le décollage.

Lorsque la piste 03 est en service, il faudrait que les vols en direction de KOR et TNG décollent de la piste 03L (gauche) et virent à gauche ; les vols en provenance de TNG pourraient ainsi entamer leur descente plus tôt.

3.1.4 STAR

Les STAR simulées pour la RWY 21 ne conviennent pas en cas de gestion de pistes parallèles indépendantes.

Les niveaux de vol au début des STAR simulées étaient trop élevés pour KOR, OLI et TNG lorsque la RWY 21 est en service.

3.1.5 Problèmes Opérationnels

Il n'est pas possible de prendre en charge le trafic prévu pour 2004 sur la piste 21 pour les raisons ci-après :

- en cas de gestion de pistes spécialisées, tous les secteurs sont surchargés en raison de la réduction de la capacité des pistes,
- en cas de gestion de pistes indépendantes parallèles, avec un seul directeur radar, les secteurs d'arrivée (ARRW et ARRE) sont surchargés en raison d'un excès de coordination,
- en cas de gestion de pistes indépendantes parallèles, avec deux directeurs radar, les contrôleurs ont estimé que le guidage final n'étaient pas sûr du fait que la zone de guidage était limitée par l'élévation du relief.
- Il n'existe pas de procédure claire d'attribution des pistes en fonction du point de sortie ; il serait opportun d'instaurer de telles procédures compte dûment tenu des lettres d'accord entre le secteur RDEPE (inférieur) et la tour.

Les points d'entrée dans la TMA simulés étaient trop élevés et les points de sortie trop bas. Il y aurait lieu d'envisager une scission de la TMA au FL 185 et de déléguer au CCR l'espace compris entre le FL 185 et le FL 245.

La répartition de l'espace aérien au sein de la TMA n'est pas satisfaisante (trop à l'ouest et pas assez au nord et au nord-est).

Les vols en provenance et à destination de SKL ne devraient pas suivre la même route. Les deux secteurs d'arrivée et les secteurs CCR étaient surchargés.

Lorsque la piste 03 fait l'objet d'une gestion spécialisée, chaque secteur d'arrivée a besoin d'une position "donnée de vols" spécialisée (position supplémentaire) pour prendre en charge les attentes.

3.1.6 Piles d'Attente

La pile d'attente KRS ne convenait pas en raison de sa proximité avec la trajectoire d'approche finale de la piste 21.

D'une manière générale, les piles d'attente simulées étaient trop proches de l'aéroport et se situaient exactement aux points d'intersection des vols à l'arrivée et des vols au départ.

Il conviendrait de définir des procédures claires d'utilisation des piles d'attente.

3.1.7 Trafic Militaire en Provenance de LGEL

Le trafic militaire simulé en provenance de LGEL (Elefsis) a une forte incidence sur le contexte général, car il augmente de manière considérable la charge de travail de l'ensemble des secteurs de départ et d'arrivée.

Il serait opportun de créer pour LGEL de nouvelles SID et STAR éloignées des points, très encombrés, de passage du trafic de LGAV.

3.1.8 Trafic VFR

En cas de gestion de pistes spécialisées, les vols VFR à l'arrivée et au départ ont été pris en charge sur la piste "départ".

La prise en charge du trafic VFR s'est révélée difficile en cas de gestion parallèle.

A plusieurs reprises, des vols VFR au départ et à l'arrivée se sont retrouvés à moins d'un mille nautique du trafic IFR.

Les points d'attente VFR ont été jugés trop éloignés de l'aéroport.

3.1.9 Arrivées RNAV pour RWY21L

Les contrôleurs ont apprécié les procédures d'arrivée RNAV simulées, qui diminuent la charge de travail du secteur DIR 2.

Le secteur ARRW a connu des problèmes liés au fait que les vols à l'arrivée et au départ utilisent les mêmes points d'entrée / de sortie.

3.2. RECOMMANDATIONS

Il serait opportun de définir des procédures claires de coordination entre les secteurs ARRIVÉES et les DIRECTEURS.

Il conviendrait de créer des zones de guidage dont les altitudes minimales tiennent dûment compte du relief.

Il conviendrait de créer des secteurs TMA avec des volumes définis et d'établir des lettres d'accord appropriées afin d'éliminer l'exploitation partagée du même espace aérien.

Il conviendrait d'instaurer des procédures claires d'attribution des pistes de décollage.

Il conviendrait d'instaurer des procédures claires d'attribution des pistes d'atterrissage.

Il y aurait lieu de revoir certaines SID et STAR.

Il y aurait lieu de déplacer les piles d'attente loin des grands points d'intersection des vols à l'arrivée et des vols au départ.

Les pistes 03L/R ne peuvent être utilisées en mode indépendant parallèle que si la SID à destination de KOR part de la 03L et vire à gauche après le décollage.

ANNEX

ANNEX A: FLOORPLANS

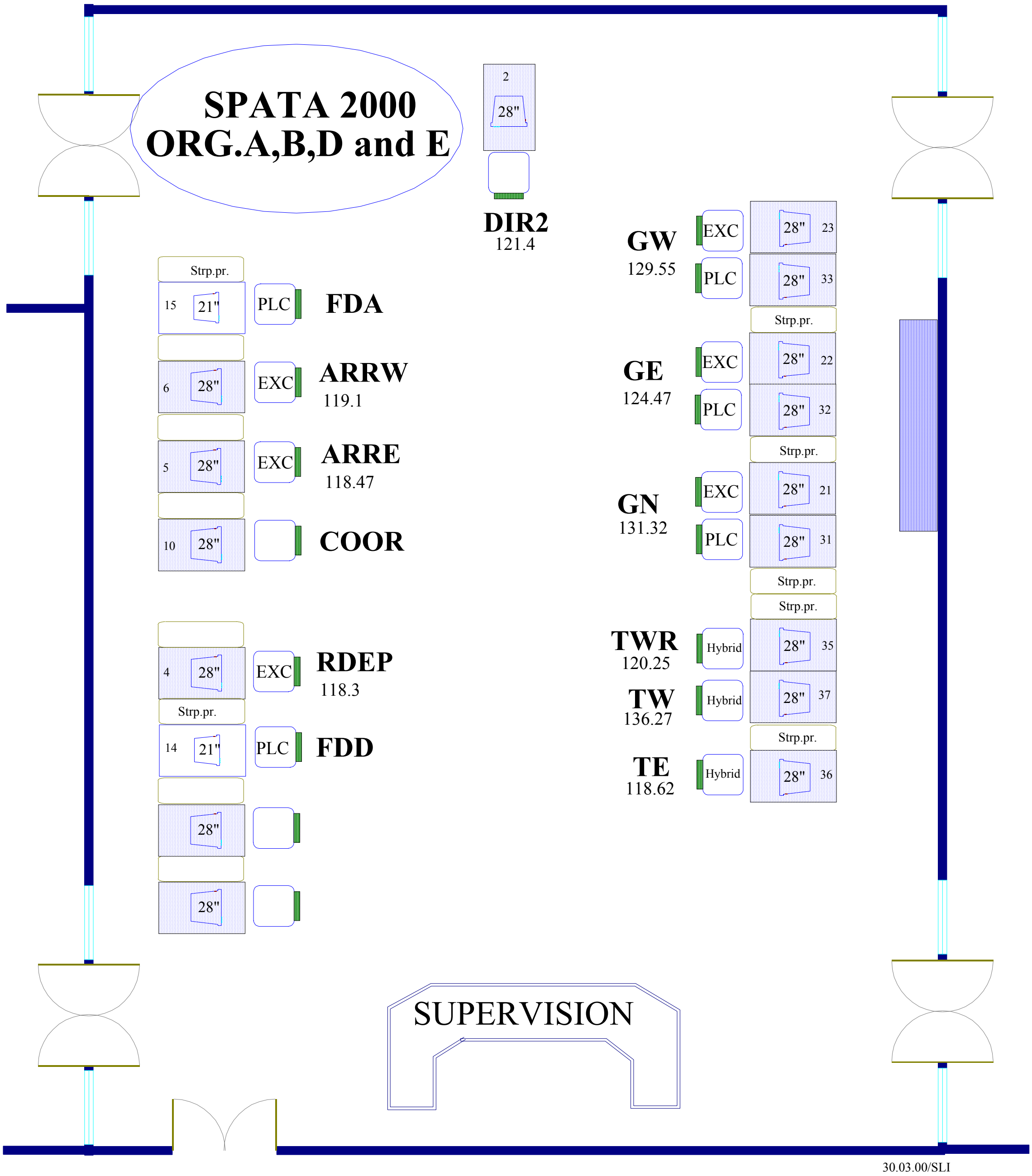

Figure A.1: Floorplan Org ABDE

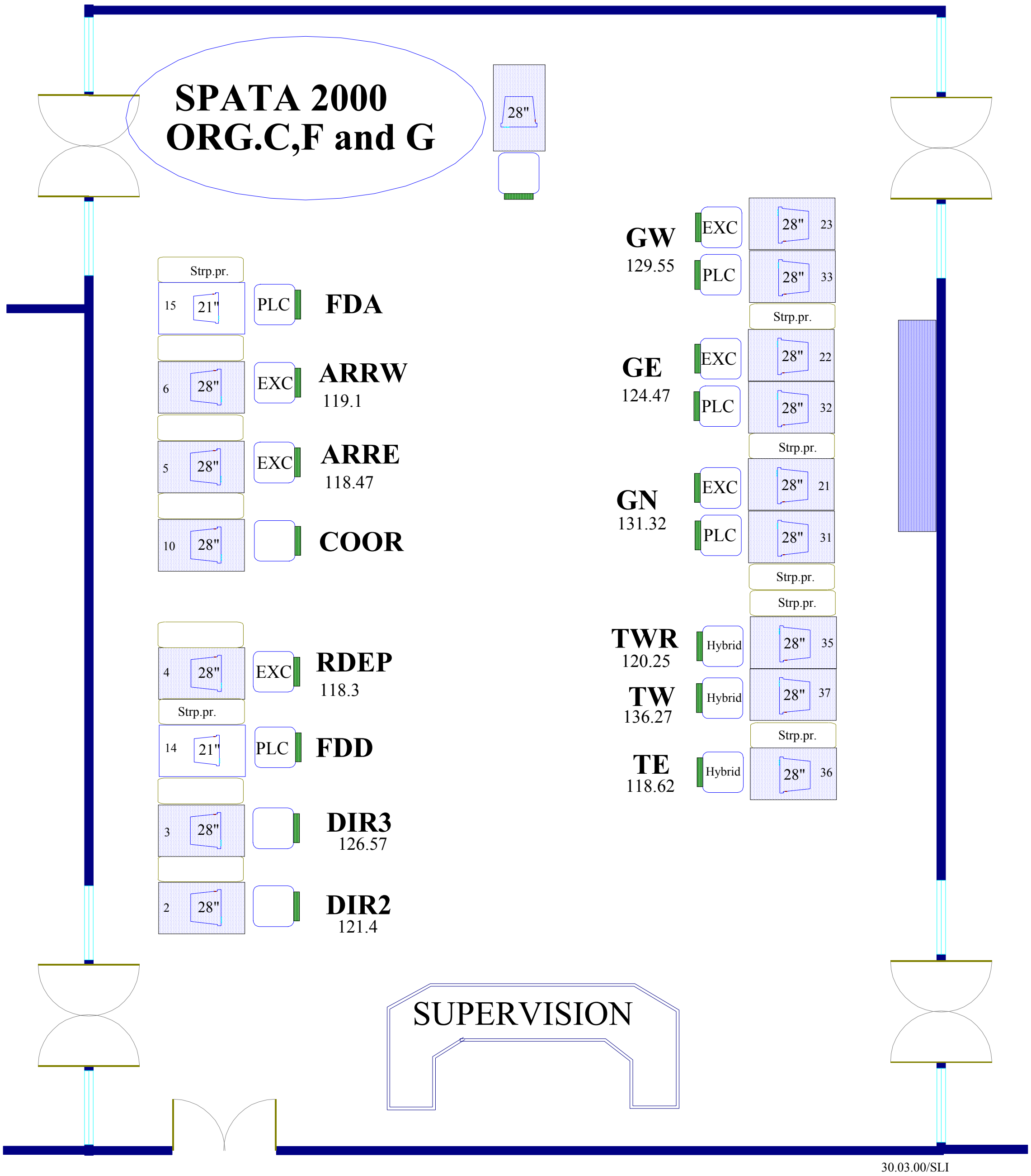

Figure A.2: Floorplan Org CFG

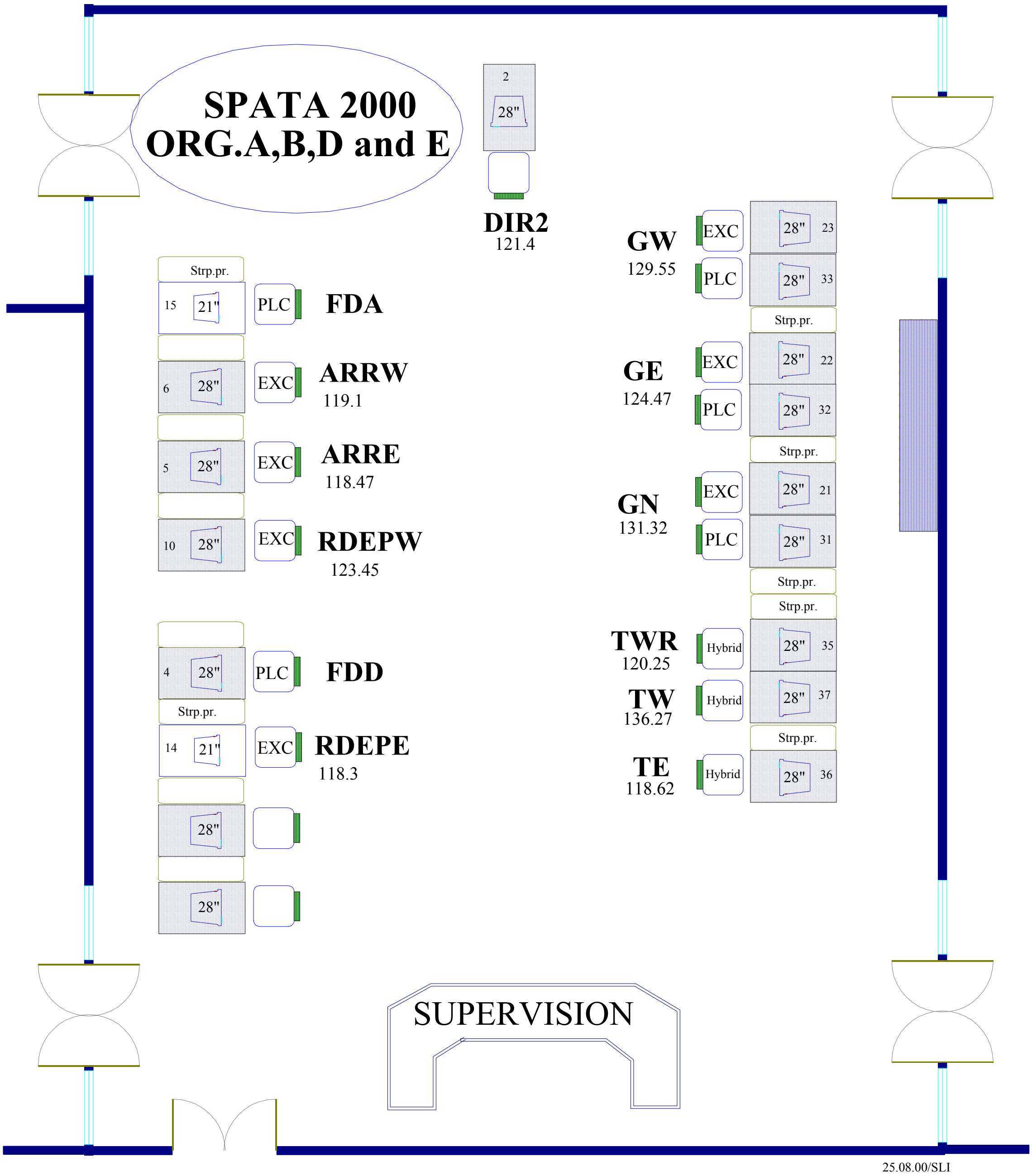

Figure A.3: New Floorplan ABDE

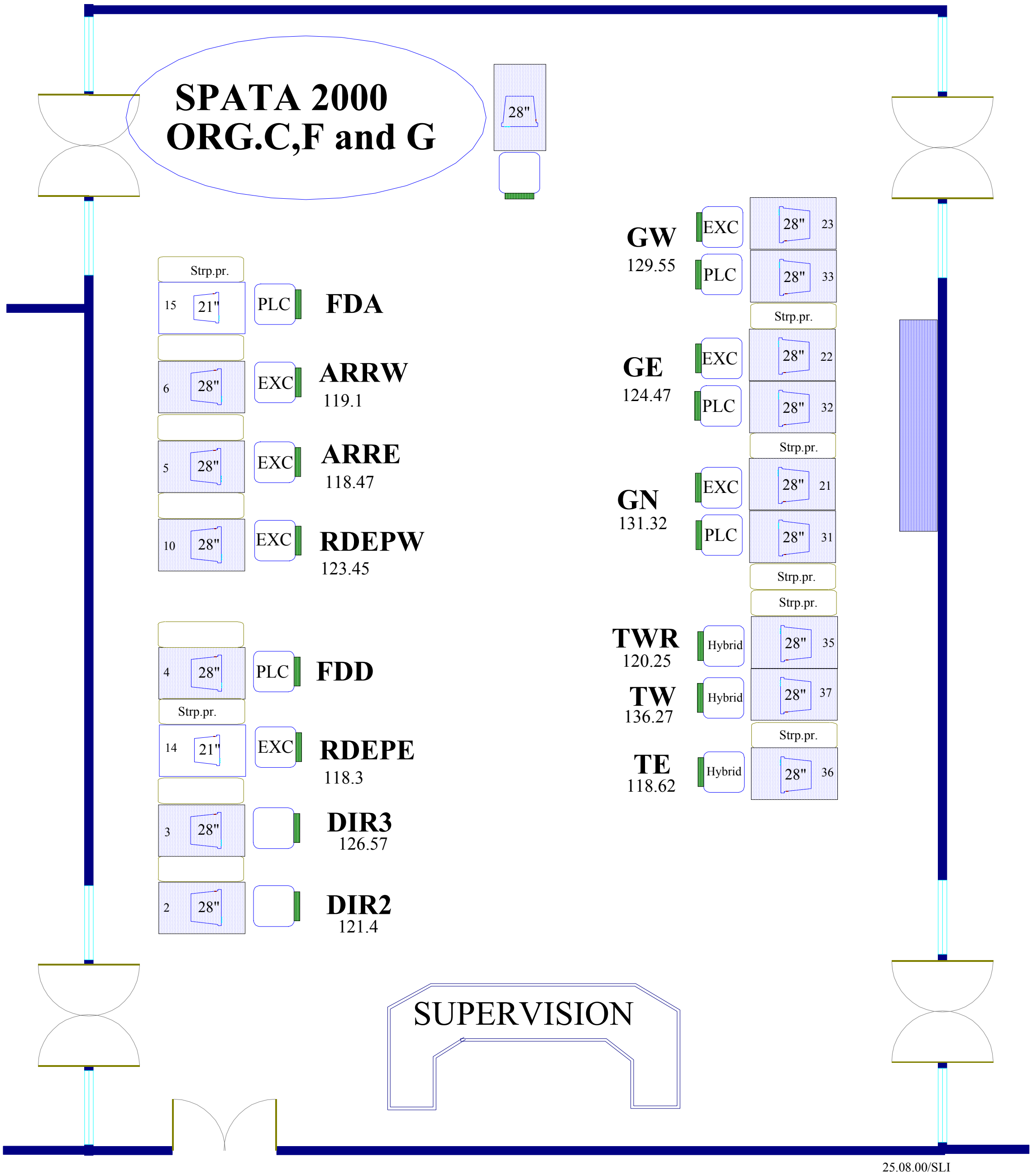

Figure A.4: New Floorplan CFG