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FOR THE SAFETY OF AIR NAVIGATION



**EUROCONTROL EXPERIMENTAL CENTRE**

**GERMANY 98 REAL-TIME SIMULATION**

**EEC Report No. 336**

Project SIM-S-EA (S21)

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<b>Abstract:</b>  This report describes a EUROCONTROL Real-Time simulation study which was design to verify the results of the F16/EAM04 Airspace Model Simulation as a part of the Optimisation Plan of the German Airspace Structure overall project.						

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### SUMMARY

The Germany 98 Real-Time simulation took place at the EUROCONTROL Experimental Centre between 28<sup>th</sup> September and 23<sup>rd</sup> October 1998. Eighty-nine DFS (Deutsche Flugsicherung GmbH) controllers, 8 Swiss controllers from Zurich, 5 Brussels controllers from CANAC and 9 Maastricht controllers from EUROCONTROL participated in 50 simulation exercises.

This simulation was designed to verify the ATS route structure and sectorisation of the F16/EAM04 Fast-Time Simulation (EEC Task – F16, EEC Note N° 1/98) in the western, southern and north-western German Airspace. The simulated airspace included the interface area with Maastricht, Brussels and Zurich airspace.

The results are based on the controllers' subjective opinions expressed during the simulation and the analysis of system recordings during simulation exercises. The results indicate that the new airspace concept was well received by most of the controllers. It was also highlighted that there were still many outstanding problems and further studies would be required in certain areas of the airspace before the implementation of the new route structure and sectorisation.

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**REFERENCES**

1. F16/EAM04 Airspace Model Simulation - EEC Task – F16, EEC Note N° 1/98
2. German AIP
3. Facility Specification Part 1,2 and 3 – EEC Internal Documents
4. Germany 98 Controller Information – EEC Document

## ABBREVIATIONS

<b>Abbreviation</b>	<b>De-Code</b>
<b>ACC</b>	<b>A</b> rea <b>C</b> ontrol or <b>A</b> rea <b>C</b> ontrol <b>C</b> entre
<b>APP</b>	<b>A</b> pproach <b>C</b> ontrol
<b>ARN</b>	<b>A</b> TS <b>R</b> oute <b>N</b> etwork
<b>ATC</b>	<b>A</b> ir <b>T</b> raffic <b>C</b> ontrol
<b>ATM</b>	<b>A</b> ir <b>T</b> raffic <b>M</b> anagement
<b>ATS</b>	<b>A</b> ir <b>T</b> raffic <b>S</b> ervices
<b>BRNAV</b>	<b>B</b> asic <b>A</b> rea <b>N</b> avigation
<b>CANAC</b>	<b>C</b> omputer- <b>A</b> ssisted <b>N</b> ational <b>A</b> TC <b>C</b> enter - Belgium
<b>CVSM</b>	<b>C</b> onventional <b>V</b> ertical <b>S</b> eparation <b>M</b> inima
<b>CWP</b>	<b>C</b> ontroller <b>W</b> orking <b>P</b> osition
<b>DFS</b>	<b>D</b> eutsche <b>F</b> lugsicherung GmbH (DFS) - Germany
<b>EAM</b>	<b>E</b> UROCONTROL <b>A</b> irspace <b>M</b> odel
<b>EATCHIP</b>	<b>E</b> uropean <b>A</b> TC <b>H</b> armonisation and <b>I</b> ntegration <b>P</b> rogramme
<b>EEC</b>	<b>E</b> UROCONTROL <b>E</b> xperimental <b>C</b> entre
<b>EXC</b>	<b>E</b> xecutive <b>C</b> ontroller
<b>FIR</b>	<b>F</b> light <b>I</b> nformation <b>R</b> egion
<b>FLOS</b>	<b>F</b> light <b>L</b> evel <b>O</b> rientation <b>S</b> cheme
<b>F16/EAM04</b>	EEC Task Number of Germany Fast-Time Simulation
<b>HMI</b>	<b>H</b> uman <b>M</b> achine <b>I</b> nterface
<b>ISA</b>	<b>I</b> ntermediate <b>S</b> elf <b>A</b> ssessment
<b>MASPS</b>	<b>M</b> inimum <b>A</b> ircraft <b>S</b> ystems <b>P</b> erformance <b>S</b> pecification
<b>N/A</b>	<b>N</b> ot <b>A</b> pplicable
<b>OAT</b>	<b>O</b> perational <b>A</b> ir <b>T</b> raffic
<b>ODS</b>	<b>O</b> perator <b>D</b> isplay <b>S</b> ystem
<b>OPS</b>	ATM <b>O</b> perational & <b>S</b> imulation <b>E</b> xpertise
<b>ORG</b>	<b>O</b> rganisation
<b>RFL</b>	<b>R</b> equested <b>F</b> light <b>L</b> evel
<b>RVSM</b>	<b>R</b> educed <b>V</b> ertical <b>S</b> eparation <b>M</b> inima
<b>S-EA</b>	Germany 98 EATCHIP Task Code
<b>SID</b>	<b>S</b> tandard <b>I</b> nstrument <b>D</b> eparture
<b>STAR</b>	<b>S</b> tandard <b>I</b> nstrument <b>D</b> eparture <b>R</b> oute
<b>STCA</b>	<b>S</b> hort <b>T</b> erm <b>C</b> onflict <b>A</b> lert
<b>TMA</b>	<b>T</b> erminal <b>M</b> anoeuvring <b>A</b> rea
<b>TRA</b>	<b>T</b> emporary <b>R</b> eserved <b>A</b> rea
<b>UAC</b>	<b>U</b> pper <b>A</b> rea <b>C</b> ontrol <b>C</b> entre
<b>UIR</b>	<b>U</b> pper <b>I</b> nformation <b>R</b> egion
<b>VFR</b>	<b>V</b> isual <b>F</b> light <b>R</b> ules

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### 1. INTRODUCTION

The Germany 98 Real-Time simulation took place at the EUROCONTROL Experimental Centre between September 28th to October 23rd, 1998 and was an EEC project designed to meet the joint requirements of the German Administration (DFS: Deutsche Flugsicherung GmbH).

Germany is in the process of undertaking the Optimisation Plan of the German Airspace Structure. The main elements of this programme are the implementation of the EATCHIP (European Air Traffic and Harmonisation and Implementation Program) ATS Route Network (ARN) Development V3, with the related new Airspace Structure and Sectorisation. This plan also takes into account the military requirements. This new airspace structure was used during the Germany 98 Real-Time Simulation. Single Alternate RVSM (Reduced Vertical Separation Minimum) FLOS (Flight Level Orientation Scheme) and BRNAV (Basic Area Navigation) were also used.

Various fast-time and Real-Time simulations have taken place in Germany. Some of the results of these simulations have already been implemented.

The F16/EAM04 EUROCONTROL Airspace Model Simulation of German Airspace was conducted in three phases from 1995 to 1997. This fast-time simulation studied the various re-sectorisation plans combined with the proposed EATCHIP compatible route network.

The Germany 98 Real-Time Simulation had originally an objective to verify the ATS route structure and sectorisation resulting from the F16 fast-time simulation, and incorporate any additional changes in the planned simulated airspace.

This report presents the results and conclusions of the Germany 98 Real-Time Simulation.



**Figure 1: General view of the Germany 98 Operations Room**

## 2. OBJECTIVES

### GENERAL OBJECTIVES

The overall simulation objective was to confirm the ATS route structure and sectorisation found in the F16/EAM04 Fast-Time Simulation in the western, southern and north-western German Airspace. The simulated airspace included the interface area with Maastricht, Brussels and Zurich airspace.

### SPECIFIC OBJECTIVES

1. Verify and evaluate the planned:

- New ATS route structure aligned with the major European traffic streams
- Congruent lower and upper route network
- New airport departure and arrival links segregated from overflying routes
- New sectorisation plan in compliance with optimum profiles
- New sector division flight levels
- Upper sectors for Karlsruhe and Maastricht.

2. Study the traffic flow in the interface area between:

- Different German ACC and UAC sectors
- Frankfurt TMA and ACC sectors (ORG 4),
- Stuttgart TMA and ACC sectors (ORG 1),
- Maastricht and German Airspace (ORG 4),
- Zürich and German Airspace (ORG 1),
- Brussels and German Airspace (ORG 2).

3. Implement and test recommended airspace changes by the controllers.

4. Assess the impact of BRNAV and RVSM.

This objective was not analysed by organisations. The general feedback of the controllers on this subject can be found in heading 8.5.

### EEC INTERNAL OBJECTIVE

Confirm the trends of F16/EAM04 Fast-Time simulation.

Many changes were implemented in the simulated airspace during the preparation and simulation phases of the Real-Time simulation. Due to these changes the comparison of the results of the two simulations is not feasible.

### **3. SIMULATION CONDUCT**

#### **3.1. SECTOR TYPES**

The simulation area was divided into "Measured sectors" and "Feed sectors".

##### **3.1.1. Measured Sectors**

Measured sectors except Frankfurt Approach, were manned by two controllers: Executive (EXC) and Planning (PLC) controllers. Frankfurt TMA was manned by three Executive controllers (see ORG 4).

Measured sectors were associated with two Controller Working Positions (CWP).

A description of sector organisation is provided in 3.3 below.

The Operation Room layout for each organisation can be found at Annex B.

##### **3.1.2. Feed Sectors**

The primary feed task was to provide a realistic interface with the measured sectors, and to carry out pilot orders such as climb, descent, heading and frequency change using the Hybrid position (*Hybrid – a combined pilot/controller position*).

Each feed sector was manned by one controller.

A description of feed sector organisation is provided in 3.3 below.

#### **3.2. AIRSPACE**

The simulated measured airspace included the western, southern and north-western German Airspace and the interface area with Maastricht, Belgian and Swiss airspace. Feed sectors were created outside of the measured area, to deliver and receive traffic to /from the measured sectors.

#### **3.3. ORGANISATIONS**

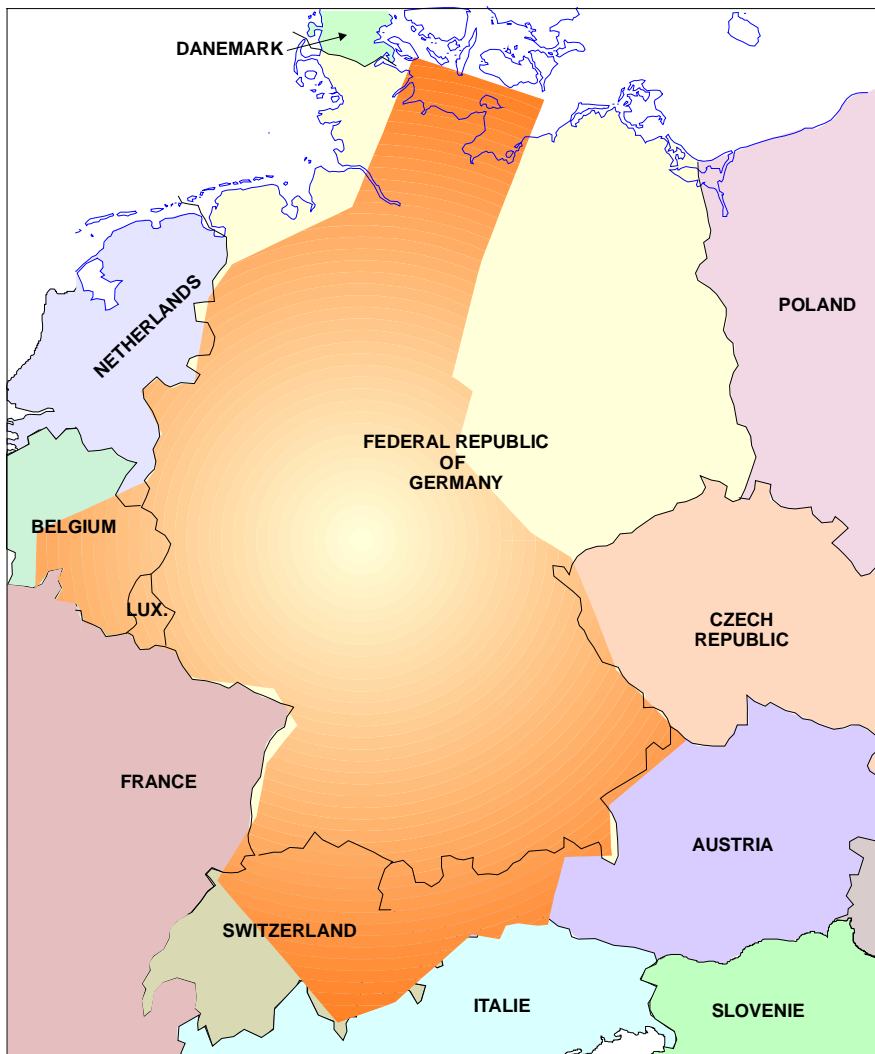
Due to the size of the simulated airspace and capacity of the Brétigny Real-Time simulator the airspace was broken down into 4 parts. Each part, which referred to one Organisation, was simulated for one week.

The following **measured sectors** were simulated:

**Organisation 1** (1st week)

BODENSEE (BODEN)	FRANKFURT ACC
BADEN (BADEN)	FRANKFURT ACC
STUTTGART (STUGA)	STUTTGART APP
KARLSRUHE (KARL)	KARLSRUHE ACC
KARLSRUHE H (KARLH)	KARLSRUHE ACC
WALDA (WLD)	MÜNCHEN ACC
KEMPTEN H (KPTH)	MÜNCHEN ACC
MÜNCHEN (MUN)	MÜNCHEN ACC
ALPEN (ALPEN)	MÜNCHEN ACC
ZURICH E (LSE)	ZÜRICH ACC
ZURICH W (LSW)	ZÜRICHACC
ZURICH H (LSU)	ZÜRICH ACC

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**Figure 2: Simulated measured area (orange colour)**

### Organisations 2 (2nd week)

EIFEL 1 (EIF1)	FRANKURT / DÜSSELDORF ACC
EIFEL 2 (EIF2)	FRANKURT / DÜSSELDORF ACC
SAAR (SAAR)	FRANKFURT ACC
TAUNUS (TAUN)	FRANKFURT ACC
ALFAS (ALFAS)	FRANKFURT ACC
MOSEL (MOSEL)	KARLSRUHE UAC
MOSEL H (MOSLH)	KARLSRUHE ACC
HANAU (HANAU)	KARLSRUHE ACC
HANAU H (HANUH)	KARLSRUHE ACC
LÜDENSCHIED (LUDEN)	DÜSSELDORF ACC
EAST H (EH)	BRUSSELS ACC
SOUTH H (SH)	BRUSSELS ACC

### Organisations 3 (3rd week)

DINKELSBÜHL (DINKL)	FRANKFURT ACC
BAYREUTH (BAYER)	FRANKFURT ACC
ODENWALD (ODEN)	FRANKFURT ACC
SPESSART (SPESS)	FRANKFURT ACC
FRANKEN (FRANK)	KARLSRUHE UAC
FRANKEN H (FRANH)	KARLSRUHE UAC
GRAFENWÖHR (GRAFE)	KARLSRUHE UAC
GRAFENWÖHR H (GRAFH)	KARLSRUHE UAC
ALLLESBERG (ALB)	MÜNCHEN ACC
RODING (RDG)	MÜNCHEN ACC
DONAU (DON)	MÜNCHEN ACC
DONAU H (DONH)	MÜNCHEN ACC

### Organisations 4 (4th week)

RHOEN (RHOEN)	FRANKFURT ACC
GEDERN (GEDER)	FRANKFURT ACC
EIFEL 1 (EIF1)	FRANKURT / DÜSSELDORF ACC
EIFEL 2 (EIF2)	FRANKURT / DÜSSELDORF ACC
EMIL (EMIL)	FRANKFURT ACC
FRANKFURT ARRIVAL (FRAPE)	FRANKFURT APP
FRANKFURT ARRIVAL (FRAPW)	FRANKFURT APP
FRANKFURT FEEDER (DIR)	FRANKFURT APP
WARBURG (WARBU)	KARLSRUHE UAC
GRAFENWÖHR (GRAFE)	KARLSRUHE UAC
GRAFENWÖHR H (GRAFH)	KARLSRUHE UAC
LÜBECK (LUBBE)	MAASTRICHT UAC
OSNABRÜCK (OSNA)	MAASTRICHT UAC

#### 3.3.1. Surrounding Airspace

Up to six feed sectors were created around the measured sectors:

Org 1: North, North-East, South-East, East, South-West, Frankfurt TMA

Org 2: North, East, South, West, Frankfurt TMA

Org 3: North, East, South, West, Frankfurt TMA  
Org 4: North, East, Lower, Middle, Frankfurt Departure

### 3.3.2. Danger and Restricted Areas

The following Danger and Restricted areas were simulated:

ED-R 33 (Unterlöss)  
ED-R 34 (Meppen)  
ED-R 95 (Ohrdruf)  
ED-R 97 (Schwarzenborn)  
ED-R 112 (Senne)  
ED-R 113 (Vogelsang)  
ED-R 116 (Baumholder)  
ED-R 117 (Alsenborn)  
ED-R 130 (Münsingen)  
ED-R 132 (Heuberg)  
ED-R 134 (Widflecken)  
ED-R 136 (Grafenwöhr)  
ED-R 137 (Hohenfels)  
ED-R 138 (Siegenburg)  
ED-R 140 (Treuchtlingen)  
ED-R 141 (Altendstadt)  
ED-R 142 (Reiteralpe)

TRA EIFEL  
TRA LAUTER  
TRA LAUTER EXTENDED  
TRA 207A  
TRA 207B  
TRA 307  
TRA 302

### 3.4. TRAFFIC

The traffic samples were based upon 2 sets (3 hours morning and 3 hours afternoon) of traffic recordings from 12 September 1997. These traffic samples were then adjusted to the new airspace by a group of controllers from each administration using the EEC preparation tools. Two morning and two afternoon traffic samples were created representing the traffic flow in these periods. Each simulation exercise lasted for a period 1 hour 20 minutes, 60 minutes of which was measured for analysis.

The traffic samples were converted to include RVSM flight levels. Half of the traffic samples in ORG 1 and ORG 3 reflected CVSM flight levels. ORG 2 and ORG 4 were fully RVSM.

The DFS also provided the military traffic samples. These traffic samples were simply integrated into the civil traffic samples.

Our experience is that simulated traffic is slightly more predictable than live traffic therefore 10% extra traffic was added to compensate for this "simulator effect".

The basic traffic levels were similar to those used in the fast-time simulation. During the simulation exercises the controllers requested more traffic with greater complexity to thoroughly test the new airspace. More traffic was added on a daily basis as the controllers requested. These changes also reflected the traffic situation in the airspace on different days other than the 12 of September 1997. The table below shows the traffic increase by organisations (final traffic level/basic traffic level):

Organisation	Basic traffic (A/C per hour)	Final traffic (A/C per hour)	% of increase
Org1	192	264	38
Org2	189	260	38
Org3	189	246	30
Org4	226	338	50

### 3.4.1. Traffic Sample Analysis

Sector capacity measurement was not the subject of this simulation. The analysis of the traffic samples below shows the load that the traffic samples represented for the measured sectors:

**Notes:**

Explanation of table header:

Flow: number of A/C on frequency during the measured hour

Peak: peak number of A/C on frequency

Mean value for all exercise: All measured exercises

Mean value for peak exercise: The measured exercises with the highest level of traffic which were run during the last days of each week.

Special measurements for MOSEL, SPESS and BAYER sectors:

Due to the major changes in these sectors in the middle of Organisation 2 and 3 separate statistics were made for them.

#### Org1

SECTOR	All exercises		Peak exercises	
	Flow Mean value	Peak Mean value	Flow Mean value for	Peak Mean value
ALPEN	41	10	52	12
BADEN	56	11	70	13
BODEN	50	13	60	13
KARL	38	10	47	13
KARLH	21	7	20	6
KPTH	35	8	44	10
LSE	48	12	62	12
LSU	58	15	67	16
LSW	56	14	46	11
MUN	33	7	37	7
STUGA	40	12	52	14
WLD	43	10	55	12

**Org2**

## MOSEL Sectors

SECTOR	All exercises		Peak exercises	
	Flow	Peak	Flow	Peak
	Mean value	Mean value	Mean value for	Mean value
MOSEL	50	12	N/A	N/A
MOSELH	36	10	N/A	N/A
MOSELN	60	13	60	13
MOSELS	27	7	27	7

## OTHERS Sectors

SECTOR	All exercises		Peak exercises	
	Flow	Peak	Flow	Peak
	Mean value	Mean value	Mean value for	Mean value
ALFAS	45	10	46	11
EH	39	8	40	8
EIF1	43	7	44	7
EIF2	49	11	50	11
HANAU	41	10	41	10
HANUH	32	8	32	9
LUDEN	42	10	43	11
SAAR	57	10	57	10
SH	56	12	56	12
TAUN	37	8	38	9

**Org3**

## BAYER and SPESSART Sectors

SECTOR	All exercises		Peak exercises	
	Flow	Peak	Flow	Peak
	Mean value	Mean value	Mean value for	Mean value
BAYER	54	12	N/A	N/A
SPESS	16	6	N/A	N/A
BAYER(new)	49	10	49	10
SPESS(new)	38	8	35	7

OTHER Sectors

SECTOR	All exercises		Peak exercises	
	Flow	Peak	Flow	Peak
	Mean value	Mean value	Mean value for	Mean value
ALB	35	9	44	13
DINKL	57	11	61	12
DON	34	8	32	7
DONH	35	10	36	11
FRANH	36	10	37	9
FRANK	36	8	36	8
GRAFE	35	8	40	9
GRAFH	38	12	40	12
ODEN	51	11	51	10
RDG	32	8	34	9

*Org4*

SECTOR	All exercises		Peak exercises	
	Flow	Peak	Flow	Peak
	Mean value	Mean value	Mean value for	Mean value
DIR	42	9	48	10
EIF1	52	12	52	12
EIF2	39	9	42	12
EMIL	47	12	46	11
FRAPE	46	10	51	11
FRAPW	25	7	27	7
GEDER	40	9	36	7
GRAFE	34	10	34	9
GRAFH	34	9	39	10
LUBBE	39	11	38	11
OSNA	56	18	54	17
RHOEN	39	9	35	8
WARBU	43	11	42	12

**3.5. PROGRAM OF EXERCISES**

The typical daily program was the following:

<b>0900 to 1030</b>	<b>First exercise</b>
1030 to 1100	Coffee break
<b>1115 to 1245</b>	<b>Second exercise</b>
1230 to 1345	Lunch
<b>1345 to 1515</b>	<b>Third exercise</b>
1515 to 1530	Coffee break
1530 to 1700	Debrief

Each week's program started with training exercises followed by measured exercises. Discussions, briefings and debriefings were fitted in as required.

The table below shows the total exercises simulated:

Organisation	Training exercise	Measured exercise
Org 1	3	10
Org 2	3	11
Org 3	4	9
Org 4	4	9

### 3.6. SIMULATED ATC SYSTEM

The simulation system represented a common platform for the ATC units involved in the simulation. The system employed the following main facilities:

- Controller Working Position (CWP)
- Colour radar display
- Mouse input device
- Touch Input Device (TID)
- Telecom panel
- Paper strips

Note: The full technical specification can be found in Facility Specification Part 3 (see References).

#### 3.6.1. Operations Room Configuration

The operation room was configured with 29 Controller Working Positions as follows (also see Annex B):

Org 1:	24 measured positions (12 sectors)	5 feed positions
Org 2:	24 measured positions (12 sectors)	5 feed positions
Org 3:	24 measured positions (12 sectors)	5 feed positions
Org 4:	23 measured positions (11 sectors)	6 feed positions

#### 3.6.2. ATC Procedures and Controller Tasks

The ATC procedures used during the simulation were in accordance with current Letters of Agreement and Operational Instructions. Some new procedures were adopted during the exercises.

The Single Alternate RVSM FLOS was used in the RVSM exercises.



**Figure 3: Controller Working Position (CWP)**

### 3.7. ANALYSIS

The simulation results contained in this report were compiled from questionnaire responses, the notes taken at simulation debriefings and the observation of the project team.

The Instantaneous Self-Assessment (ISA) method was used to assess the 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 Low, Low, Fair, High or Very High. The definitions of these ratings are the follows:

Very Low: The controller has little or nothing to do.

Low: The controller has more time than is necessary to complete the tasks. The time passes slowly.

Fair: The controller has enough work to keep him/her simulated. All tasks are under control.

High: The controller is working “at the limit”. Certain non-essential tasks are postponed. Time passes quickly.

Very high: The controller is overloaded. Some tasks are not completed. The controller feels he/she is not in control.

The objective data were taken from exercise recordings made during each measured exercise.

### 3.7.1. Questionnaire about ATC sector control problems

During the Germany '98 simulation a new questionnaire methodology was introduced. In addition to the “standard” post organisation and post simulation questionnaires a new type of questionnaire was distributed to the controllers.

Because no two air traffic control sectors are identical, and the flows of traffic in sectors vary, the primary aim was to gain a better understanding of individual sector ATC problems that can be associated with:

- controller working methods
- sector shape, size or restrictions
- ATC procedures
- radar and communications equipment
- separation standards

and/ or other elements that affect the way a controller provides air traffic services.

#### **Methodology**

To establish a common baseline using subjective data based on individual controller opinion, and to limit the effects of extreme or irregular influences or occurrences, the structure of data collection and validation was as follows:

##### **1. To establish the baseline**

A sector questionnaire pack contained a list of common ATC problems. The controllers were asked to use this list to identify the major problem in their sector. Once selected, this problem became the baseline used to measure the effect of the changes simulated.

##### **2. To confirm the baseline**

The controllers were asked to respond to the sector questionnaires as follows:

- Complete the questionnaires as a group.
- Reach agreement on the main problem in the sector.
- Limit their selection to identify extremely severe or severe problems.

**N.B. To simplify our analysis, the controllers were asked to select one problem only. It was recognized that ATC problems involve multiple causes and influences. In cases where controllers could not agree, or felt that there was more than one extremely severe or severe problem, they were provided with a second pack.**

**3. To validate the selected problem**

The controllers were given a list of elements and asked to identify which single element was the greatest cause of, or had the greatest influence upon the problem in the sector.

**4. To correlate the problem and its element**

The controllers were asked to estimate the extent of the influence of the element upon the problem on a sliding scale. (Almost entirely, greatly, fifty percent, slightly, hardly)

**5. To assess the effect of the simulated changes on the sector problems**

Reference was made to the original problems and the controllers were asked to re-assess:

- What was the major sector problem in the simulated exercise?
- Was it the same problem that they previously identified?
- Was the problem still as severe?
- What was the main element that contributed to the problem?

**6. Find any new problems that were not in the sector before the change.**

If any of the above had changed, the controllers were asked to use the common problem list and element list to show:

- What new ATC problem occurs in the sector;
- The severity of this problem;
- Or what new element is now the cause of the problem;
- The influence of the element causing the problem.

**Objective of questionnaire**

The aim of this questionnaire was to find:

1. the problems that exist in the current situation,
2. the problems that were solved or reduced by the changes simulated,
3. what new problems appeared, if any,
4. and what problems remain, if any.

This interim report only shows the results pertaining to sector problems that the controllers classified as **EXTREMELY SEVERE**. Other major sector control problems classed as **SEVERE** and **MODERATE** will be included in a separate document.

**The fact that some sector's problems are not listed in this report should not be taken as an indication that ATC control problems do not exist in these sectors.**

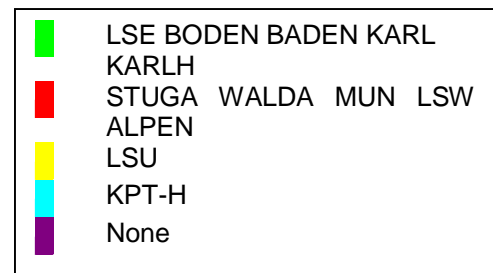
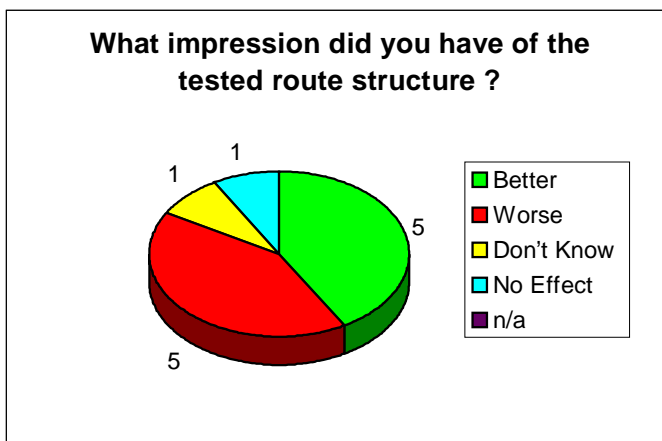
4. RESULTS - ORGANISATION 1

4.1. OBJECTIVE 1 (ORG 1)

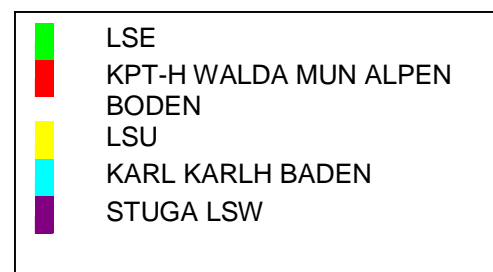
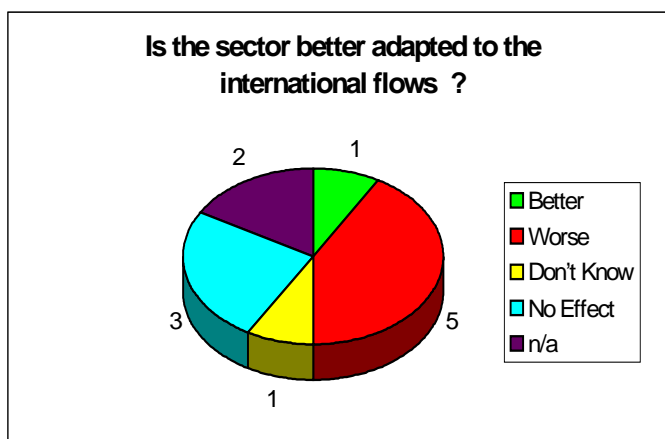
Verify and evaluate the planned:

- **New ATS route structure aligned with the major European traffic streams**
- **Congruent lower and upper route network**
- **New airport departure and arrival links, which are segregated from overflying routes**
- **New sectorisation plan in compliance with optimum profiles**
- **New sector division flight levels**

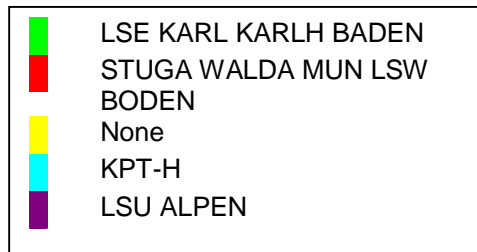
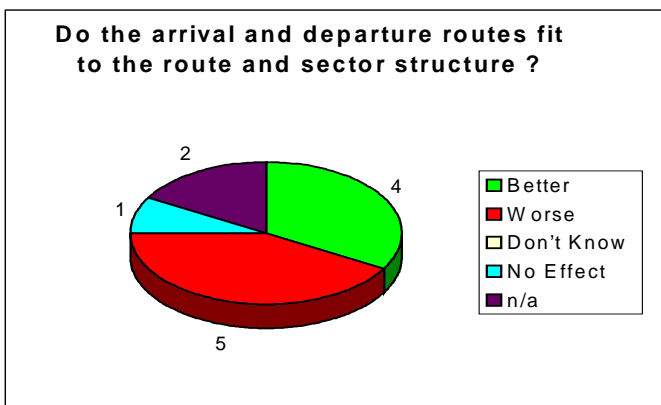
Q: What impression did you have of the tested route structure?



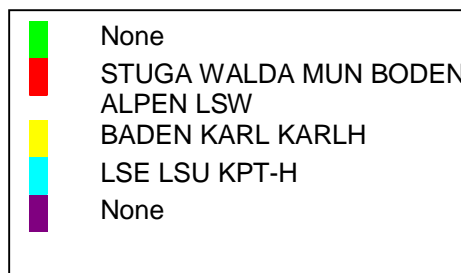
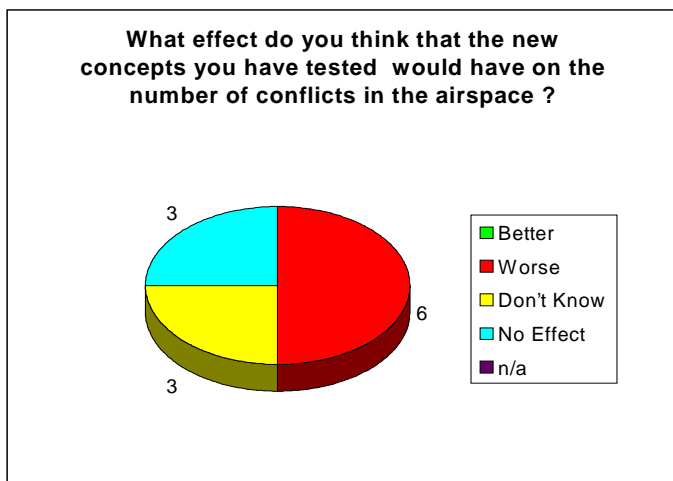
Q: Is the sector better adapted to the international flows (think about the problem solution possibilities in the sectors)?



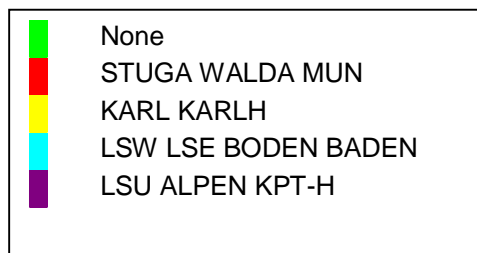
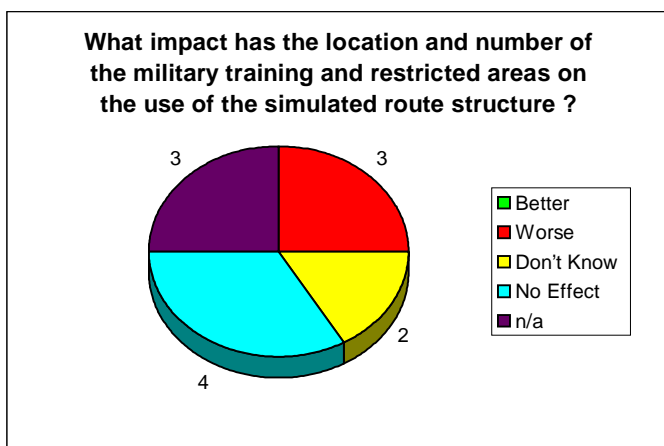
Q: Do the arrival and departure routes fit to the route and sector structure?



Q: What effect do you think that the new concepts you have tested would have on the number of conflicts in the airspace?



Q: What impact has the location and number of the military training and restricted areas on the use of the simulated route structure? Were the international flows and the connections to and from the major aerodromes taken into account?



Remark: TRA 207/307 was simulated during the 3<sup>rd</sup> week of the simulation (ORG 3).

Q: Do you have any suggestions regarding the requirements of military traffic?

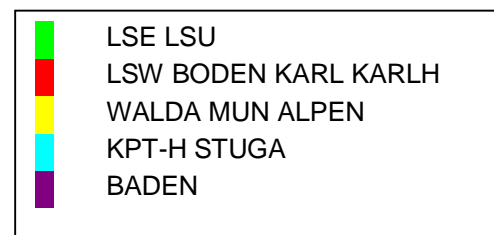
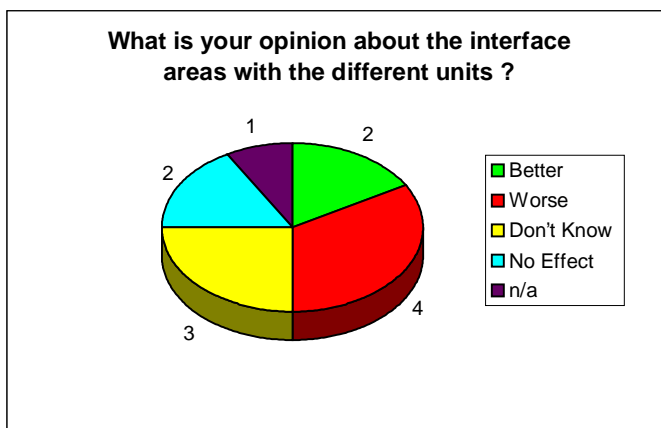
The military areas are causing big problems in the implementation of the new routes in the Munich area. The military units should be moved from ETSI (Munich ACC).

#### 4.2. RESULTS - OBJECTIVE 2 (ORG1)

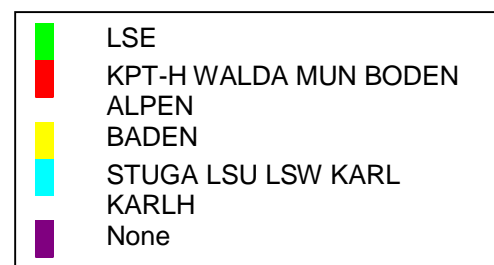
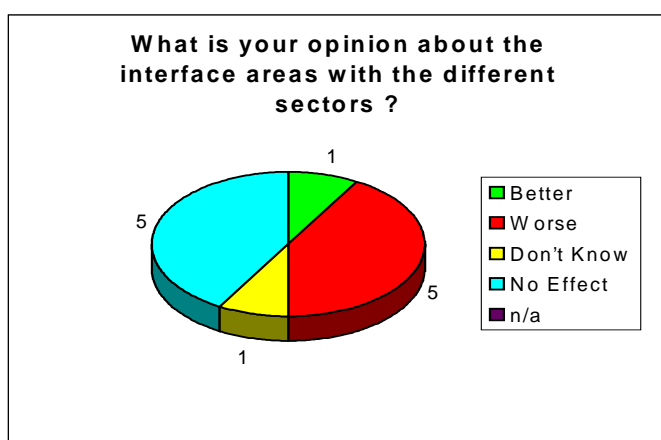
*Study the traffic flow in the interface area between:*

- *Different German ACC and UAC sectors,*
- *Stuttgart TMA and ACC sectors,*
- *Zürich and German Airspace.*

Q: What is your opinion about the interface areas with the different units?



Q: What is your opinion about the interface areas with the different sectors?



### 4.3. RESULTS - OBJECTIVE 3 (ORG1)

**Implement and test recommended airspace changes by the controllers.**

1. Stuttgart departure traffic was re-routed from SUL-ANTON to LOKMI-ANTON.

This change made the situation better for the en-route sectors and worse for Stuttgart APP.

2. Zurich arrival traffic was re-routed from WEKAR-BADEN-EKRON to WEKAR-KARLS-LOKMI-SAFFA and from TGO-HEUSE-SAFFA to TGO-SUL-SAFFA.

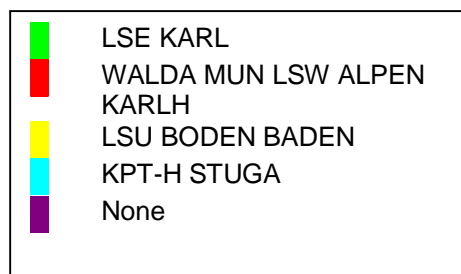
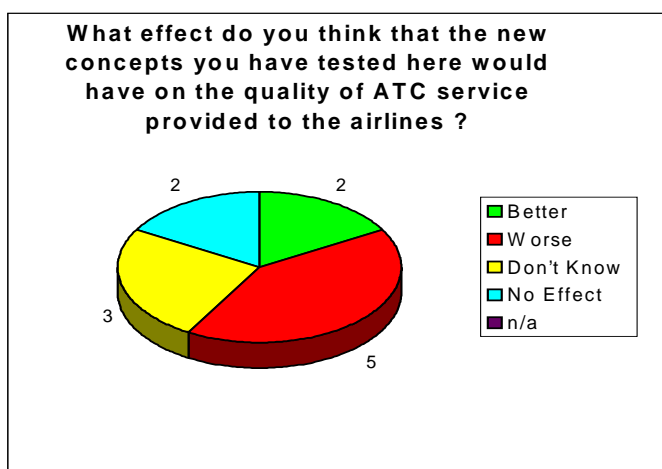
These changes improved the situation for Zurich, Karlsruhe and Stuttgart but were worse for Frankfurt ACC.

Note:

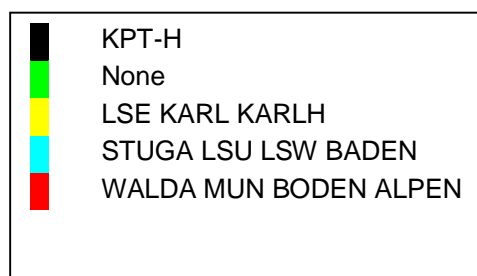
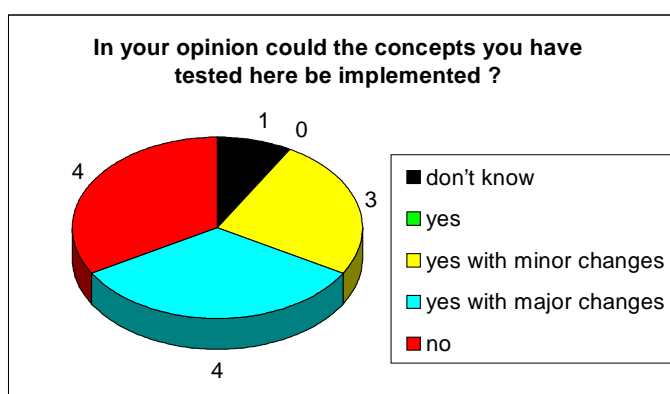
It was not clearly identified in the questionnaires why it was worse or better for the sectors concerned.

### 4.4. QUESTIONNAIRE GENERAL RESPONSES (ORG1)

Q: What effect do you think that the new concepts you have tested here would have on the quality of ATC service provided to the airlines?



Q: In your opinion could the concepts you have tested here be implemented?



Remark: KARL and KARLH commented that moderate changes were required.

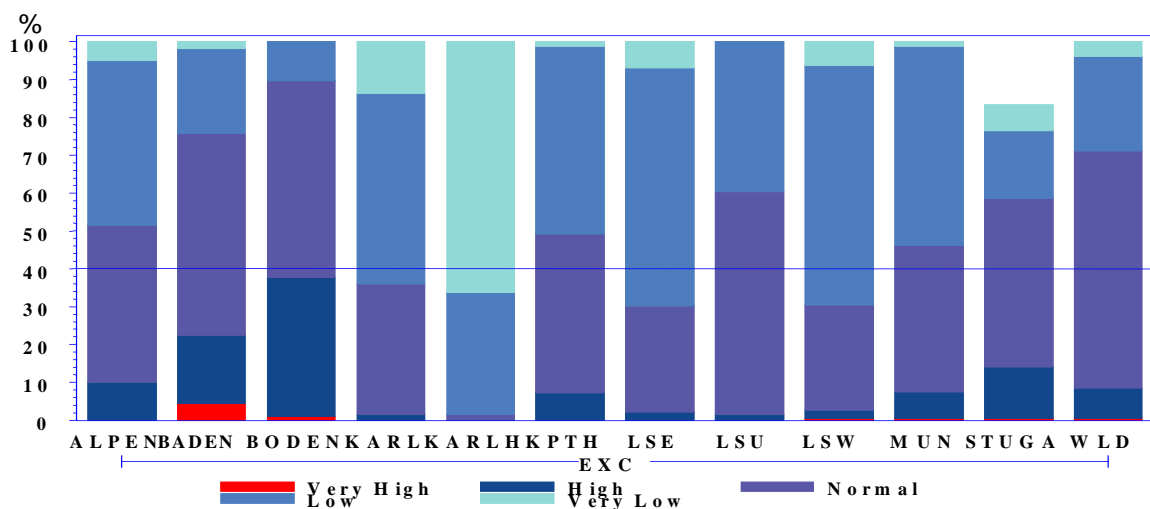
#### 4.5. WORKLOAD (ORG1)

ISA results below show the executive controllers' (EXC) mean workload for all exercises of Organisation 1.

Remark:

The Planning controller's workload is not shown. The PLC workload was not representative because of major differences from the live environment. The PLC had no assistant and strip handling was a major contributor to the workload.

#### Estimated Workload



**Figure 4: Distribution of Mean ISA ratings of all exercises by EXC positions – Org 1**

The ISA values indicated high workload in the BADEN and BODEN sectors. The same observation reported in the debriefings. The workload in KARLH sector was light.

#### 4.6. ATC SECTOR PROBLEMS (ORG 1)

In Org 1, controllers identified the following ATC problems as EXTREMELY SEVERE in the current sectors and airspace structure;

- A. Traffic bunching
- B. R/T loading
- C. High Co-ordination workload
- D. Sequencing problems
- E. Several traffic flows converging at a single point
- F. Single crossing point
- G. Complex mix of arrivals, departures and flights in cruise
- H. Monitoring flights in sector that are controlled by another sector

- I.** Manoeuvring and vectoring problems
- J.** Aircraft profile problems (too high, fast, low or slow when transferred)
- K.** Complex mix of high and low performance aircraft on same SID or STAR
- L.** Late transfer of communications from previous sector/centre
- M.** Multiple crossing points in sector

**Note:** The summary table can be found in Annex C.

**A. TRAFFIC BUNCHING**

The sectors where this problem is extremely severe and the associated causes are;

- Kempten                      Sector shape
- Alpen                         High traffic levels
- Stuttgart                     No FLAS/flow control
- München                     Military airspace restrictions
- Boden                        Route structure

The status in situation in ORG 1 and effects;

- **Kempten**                      **Sector too small / FL 330 overloaded / Military areas**  
*Status*                              *No change to problem or original element and additional contributory factors.*
- **Alpen**                         **High traffic levels**  
*Status*                              *No change to problem. Sector dimensions vertically extended, but split unsatisfactory.*
- **Stuttgart**                     **No FLAS/flow control**  
*Status*                              *No change to problem or element.*
- **München**                     **Military airspace restrictions**  
*Status*                              *No change to problem or element.*
- **Boden**                        **Route structure**  
*Status*                              *No change to problem or element.*

**B. R/T LOADING**

The sectors where this problem is extremely severe and the associated causes are;

- Alpen                         High traffic levels  
The status in situation in ORG 1 and effects;

- **Alpen**                         **High traffic levels**  
*Status*                              *Problem increased due to higher traffic levels simulated.*

### C. HIGH CO-ORDINATION WORKLOAD

The sectors where this problem is extremely severe and the associated causes are:

- Stuttgart                      Current ATC procedure  
The status in situation in ORG 1 and effects:
- **Stuttgart**                      **High traffic levels**  
Status                              *Not addressed as concerned adjacent units were not included in this simulation.*

### D. SEQUENCING PROBLEMS

The sectors where this problem is extremely severe and the associated causes are:

- Walda                              Military area

The status in situation in ORG 1 and effects:

- **Walda**                              **Military area**  
Status                              No change. Certain TRA's interfere with arriving and departing traffic to/from EDDS, EDDM, EDMA and EDDH. Insufficient vectoring for Military traffic ETSN/ETSI entering or leaving TRA. Similar problem for sector MUN with TRA 209/309 causes traffic bunching.

### E. SEVERAL TRAFFIC FLOWS CONVERGING AT A SINGLE POINT

The sectors where this problem is extremely severe and the associated causes are:

- München                              Route structure
- Karl/Karl High                      Route structure
- Baden                                      Route structure

The status in situation in ORG 1 and effects:

- **München**                              **Route structure**  
Status                              No change to problem or element.
- **Karl/Karl High**                      **Route structure**  
Status                              No change to problem or element.
- **Baden**                                      **Route structure**  
Status                              Problem remains but severity reduced to Moderate and element contribution to 50%.

### F. SINGLE CROSSING POINT

The sectors where this problem is extremely severe and the associated causes are:

- Karl/Karl High                      Route structure
- Baden                                      Route structure

The status in situation in ORG 1 and effects:

- **Karl/Karl High**                      **Route structure**  
Status                              Significant reduction in severity from extremely severe to slight. =
- **Baden**                                      **Route structure**  
Status                              Marked reduction in severity from extremely severe to 50%.

#### G. COMPLEX MIX OF ARRIVALS, DEPARTURES AND FLIGHTS IN CRUISE

The sectors where this problem is extremely severe and the associated causes are:

- Karl/Karl High      Route structure
- Zurich W            Sector size

The status in situation in ORG 1 and effects:

- **Karl/Karl High**      **Route structure**  
Status                    Problem resolved due to new route structure.
- **Zurich W**            **Sector size**  
Status                    No change to problem or element. Sector too small to apply route changes.

#### H. MONITORING FLIGHTS IN SECTOR THAT ARE CONTROLLED BY ANOTHER SECTOR

The sectors where this problem is extremely severe and the associated causes are:

- Baden                Aircraft flight profiles restricted to avoid other sectors
- Boden                Aircraft flight profiles restricted to avoid other sectors

The status in situation in ORG 1 and effects:

- **Baden**                **Aircraft flight profiles restricted to avoid other sectors**  
Status                    *No change to problem or element*
- **Boden**                **Aircraft flight profiles restricted to avoid other sectors**  
Status                    *Problem resolved due to unrestricted flight profiles.*

#### I. MANOEUVRING AND VECTORING PROBLEMS

The sectors where this problem is extremely severe and the associated causes are:

- Baden                Sector lateral dimensions restricted due to TRA west of main departure route

*The status in situation in ORG 1 and effects;*

- **Baden**                **Sector lateral dimensions restricted due to TRA west of main departure route**  
Status                    *Problem remains, but severity reduced from extremely severe to moderate.*

#### J. AIRCRAFT PROFILE PROBLEMS (TOO HIGH, FAST, LOW OR SLOW WHEN TRANSFERRED)

The sectors where this problem is extremely severe and the associated causes are;

- Boden                Interface with next sector/centre

*The status in situation in ORG 1 and effects*

- **Boden**                **Interface with next sector/centre**  
Status                    *Problem remains, but severity reduced from extremely severe to Moderate.*

**K. COMPLEX MIX OF HIGH AND LOW PERFORMANCE AIRCRAFT ON SAME SID OR STAR**

The sectors where this problem is extremely severe and the associated causes are;

- Zurich E                      Route structure

*The status in situation in ORG 1 and effects*

- **Zurich E**                      **Route structure**  
*Status*                              *No change to problem or element*

**L. LATE TRANSFER OF COMMUNICATIONS FROM PREVIOUS SECTOR/CENTRE**

The sectors where this problem is extremely severe and the associated causes are;

- Zurich H                      No commonality of procedures with adjacent centres

*The status in situation in ORG 1 and effects*

- **Zurich H**                      **No commonality of procedures with adjacent centres**  
*Status*                              *No change to problem or element*

**M. MULTIPLE CROSSING POINTS IN SECTOR**

The sectors where this problem is extremely severe and the associated causes are;

- Zurich E                      Route structure

*The status in situation in ORG 1 and effects*

- **Zurich E**                      **Route structure**  
*Status*                              *Reduction in severity to moderate.*

5. RESULTS - ORGANISATION 2

5.1. OBJECTIVE 1 (ORG2)

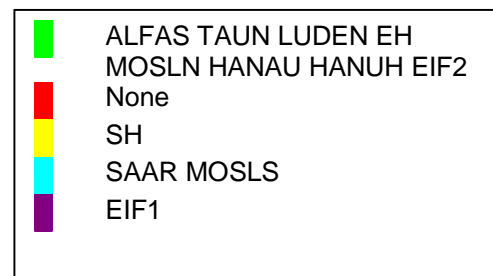
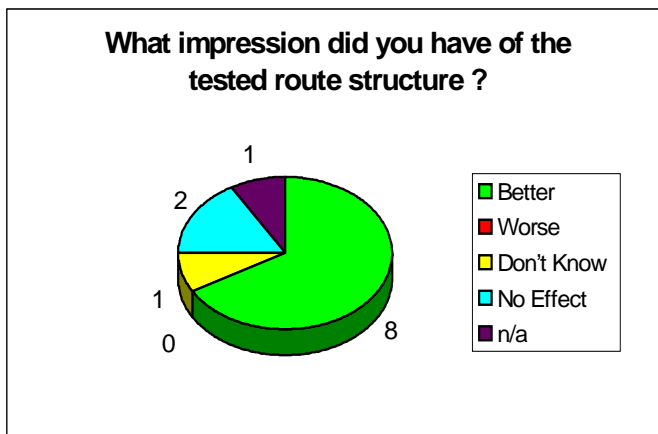
Verify and evaluate the planned:

- **New ATS route structure aligned with the major European traffic streams**
- **Congruent lower and upper route network**
- **New airport departure and arrival links, which are segregated from overflying routes**
- **New sectorisation plan in compliance with optimum profiles**
- **New sector division flight levels**

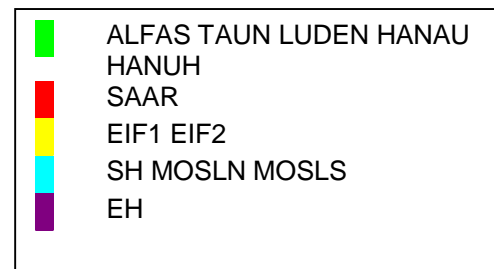
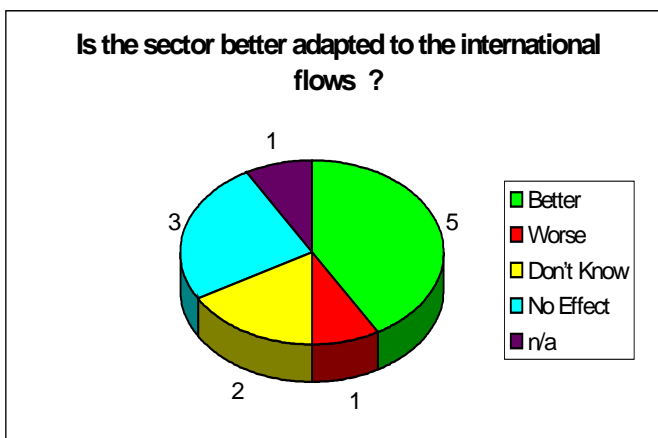
Remark:

MOSEL and MOSLH sectors changed to MOSEL NORTH and MOSEL SOUTH sectors. The new names (MOSLN and MOSLS) are used in this chapter.

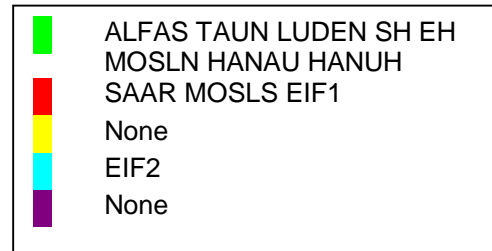
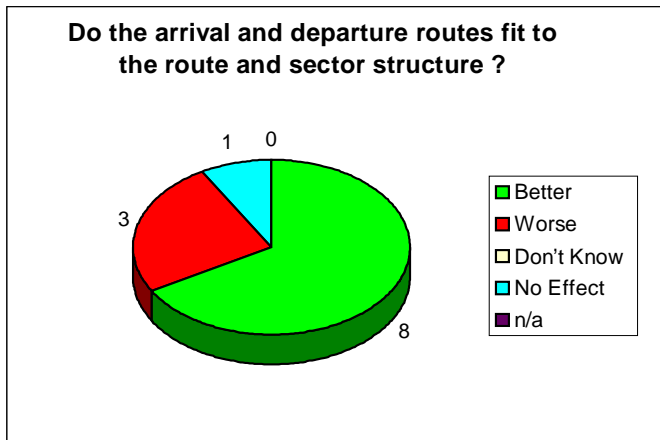
Q: What impression did you have of the tested route structure?



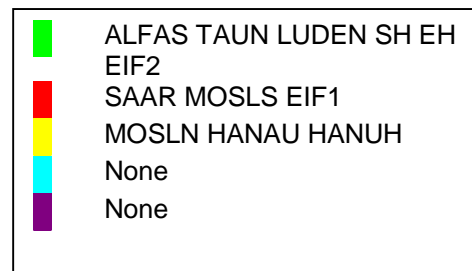
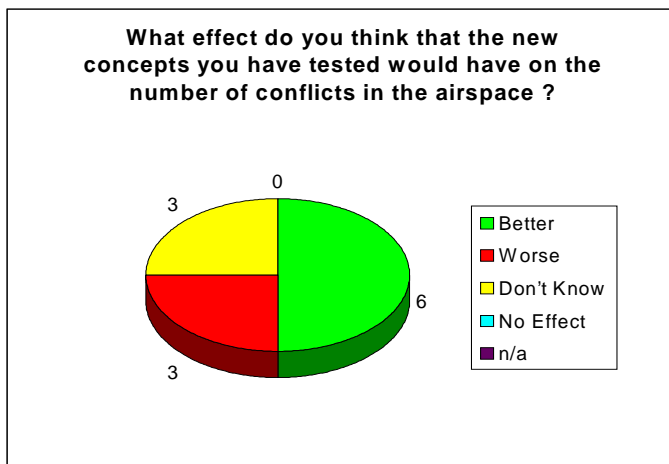
Q: Is the sector better adapted to the international flows (think about the problem solution possibilities in the sectors)?



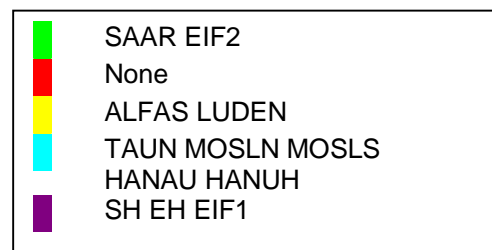
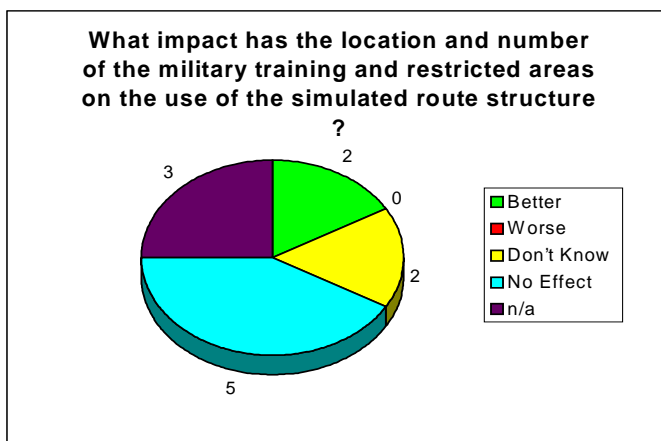
Q: Do the arrival and departure routes fit to the route and sector structure?



Q: What effect do you think that the new concepts you have tested would have on the number of conflicts in the airspace?



Q: What impact has the location and number of the military training and restricted areas on the use of the simulated route structure? Were the international flows and the connections to and from the major aerodromes taken into account?



Q: Do you have any suggestions regarding the requirements of military traffic?

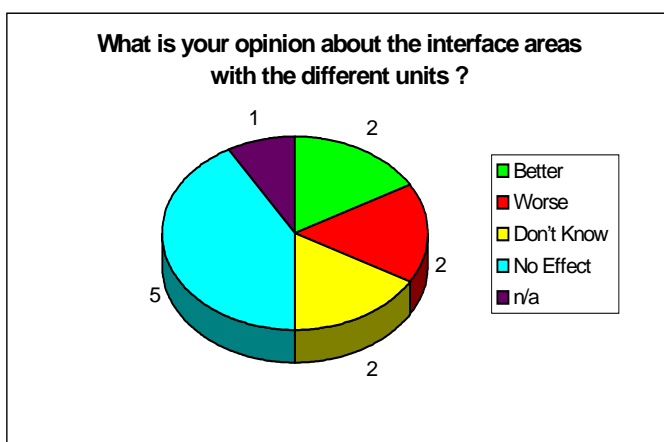
The controllers had no recommendations.

5.2. RESULTS - OBJECTIVE 2 (ORG 2)

Study the traffic flow in the interface area between:

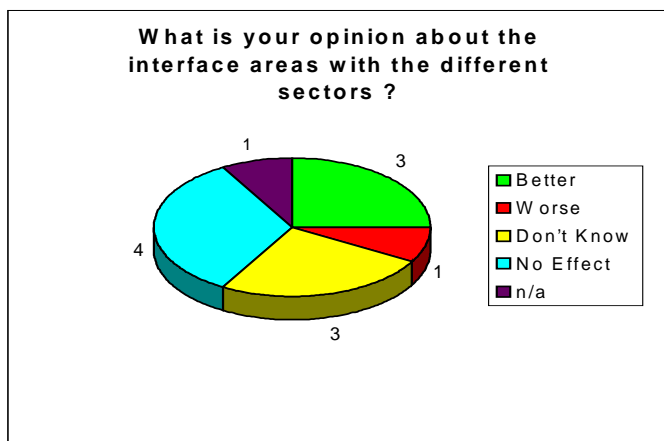
- Different German ACC and UAC sectors
- Frankfurt TMA and ACC sectors
- Brussels and German Airspace.

Q: What is your opinion about the interface areas with the different units?



- ALFAS MOSLN
- SAAR EIF1
- SH EH
- LUDEN MOSLS HANAU
- HANUH EIF2
- TAUN

Q: What is your opinion about the interface areas with the different sectors?



- MOSLN HANAU HANUH
- MOSLS
- TAUN EH EIF1
- ALFAS SAAR LUDEN EIF2
- SH

**5.3. RESULTS - OBJECTIVE 3 (ORG 2)**

***Implement and test recommended airspace changes by the controllers.***

1. Direct route from SPY and SPI to GOARS for Frankfurt arrivals was used when the military area was deactivated.

The controllers reported this made the situation better than when the routes avoided the active military area.

2. MOSEL sectors had a new configuration where they were geographically split to SOUTH and NORTH above F290.

The controllers preferred this solution to the vertical split in the sector. They also recommended that the new two sectors with one top sector above F335 would be the best solution for MOSEL.

3. Brussels: A new division line was created (between SH and EH from a point north abeam ETIEN and the points south abeam SPI-BULUX-REMBA) which gave more airspace to EH.

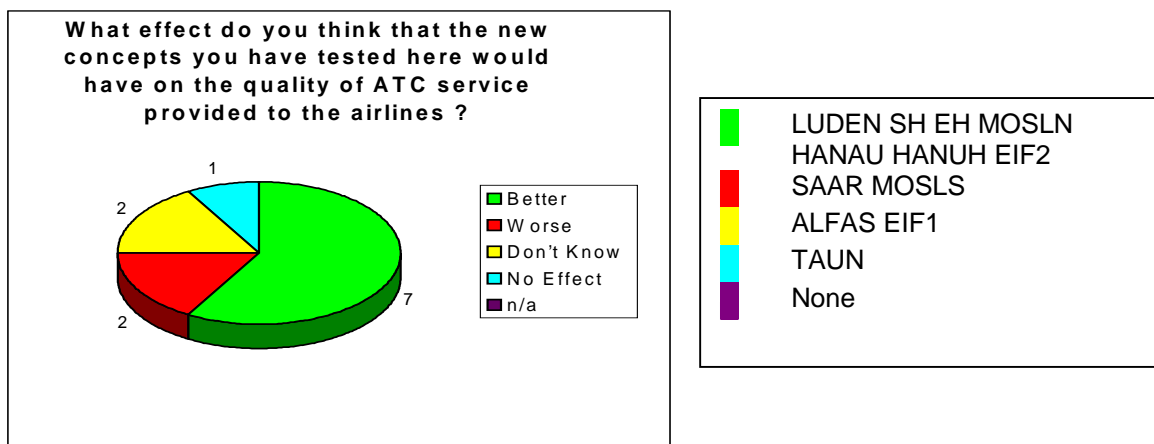
The Brussels controllers preferred this configuration. Better traffic and workload distribution between the two sectors was achieved.

4. SAAR was divided into two sectors due to high traffic level. A division line running from west to east and crossing OSNEL was created and the south part of the sector was added to the feed sector.

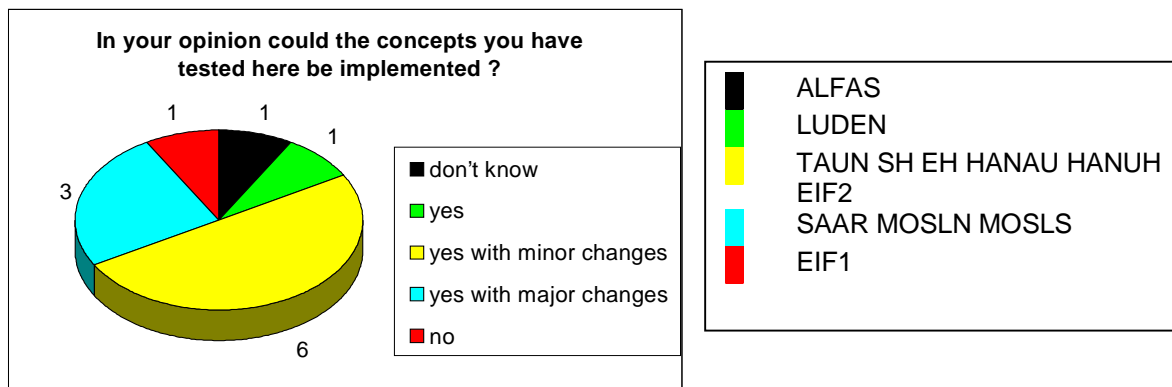
The observation was that this split generally improved the situation but increased the co-ordination work. Vertical split was suggested in the debriefing but has not been tested.

**5.4. QUESTIONNAIRE GENERAL RESPONSES (ORG 2)**

- Q: What effect do you think that the new concepts you have tested here would have on the quality of ATC service provided to the airlines?



Q: In your opinion could the concepts you have tested here be implemented?



Remark: EIF2 commented that moderate changes were required.

### 5.5. WORKLOAD (ORG 2)

ISA results below show the executive controllers' (EXC) mean workload for all exercises of Organisation 2.

Remark 1:

The PLC workload was not representative because the major differences from the live environment. The PLC had no assistant and strip handling was a major impact to his/her workload.

Remark 2:

MOSEL and MOSLH sectors changed to MOSEL NORTH and MOSEL SOUTH sectors after three days.

The distribution of workload without MOSEL sectors:

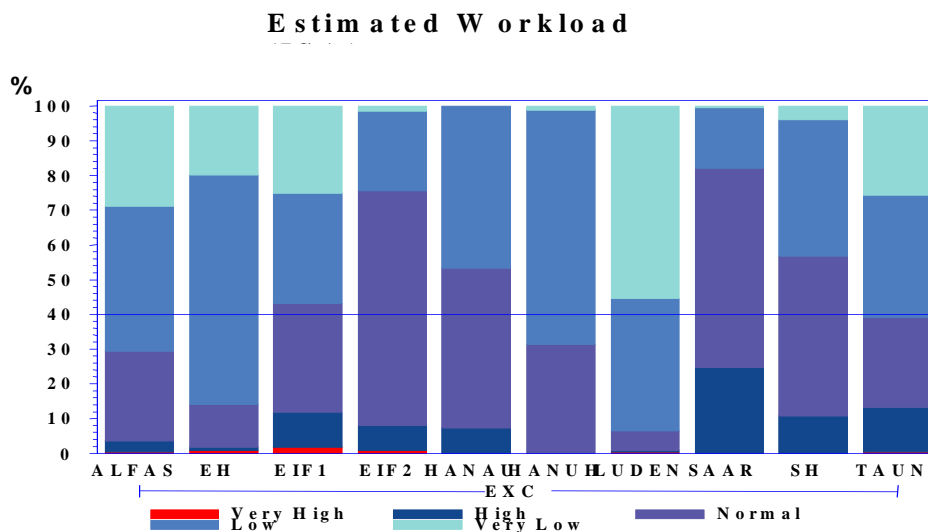
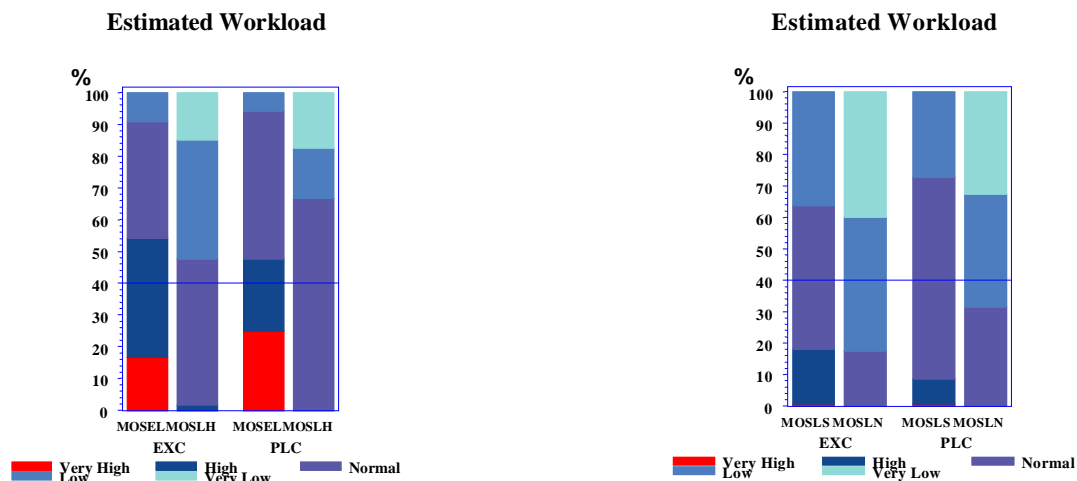


Figure 5: Distribution of Mean ISA ratings of all exercises by EXC positions – Org 2

The ISA values indicated very excessive workload in the SAAR sector. The controllers recommended a vertical split in this sector due to the very high workload and the different traffic demands at low and high vertical levels in the sector. The workload in LUDEN sector was light.

Although the traffic level was much higher for the new configuration of MOSEL sectors (MOSEL North and South), the workload showed lower values for the new configuration with MOSEL North and South than for the original MOSEL and MOSEL H sectors (see **Figure 6** below).



**Figure 6: Workload in MOSEL sectors**

## 5.6. ATC SECTOR PROBLEMS (ORG 2)

In Org 2 the current ATC control problems assessed by the controllers as EXTREMELY SEVERE were:

- A.** Traffic bunching
- B.** R/T loading
- C.** High co-ordination workload
- D.** Sequencing problems
- E.** Several traffic flows converging at a single point
- F.** Single crossing point for multiple routes
- G.** Complex mix of arrivals, departures and flights in cruise
- H.** Manoeuvring and vectoring problems
- I.** Multiple crossing points in sector
- J.** Airspace restrictions

**Note:** The summary table can be found in Annex C.

#### A. TRAFFIC BUNCHING

The sectors where this problem is Extremely Severe and the associated causes are:

- Eifel 1                   Route structure
- Eifel 2                   Sector shape
- Hanau/Hanau H   No FLAS/flow control

The status in situation in ORG 2 and effects;

- **Eifel 1                   Route structure**  
Status                   No change to problem but contributory element is now sector shape (no change to influence)
- **Eifel 2                   Sector shape**  
Status                   No change to problem, but contributory element now route structure, (influence slightly less)
- **Hanau/Hanau H   Flow control ineffective**  
Status                   No change to problem

#### B. R/T LOADING

The sectors where this problem is Extremely Severe and the associated causes are:

- Eifel 2                   High traffic density /Sector lateral dimensions
- Alfas                   Route structure
- Taunus                  ATC procedure

The status in situation in ORG 2 and effects

- **Eifel 2                   Sector lateral dimensions – high traffic density**  
Status                   No change
- **Alfas                   Route structure**  
Status                   Problem remains but severity reduced to Moderate
- **Taunus                  ATC procedure**  
Status                   Problem resolved

#### C. HIGH CO-ORDINATION WORKLOAD

The sectors where this problem is Extremely Severe and the associated causes are:

- Eifel 1                   ATC procedure

The status in situation in ORG 2 and effects

- **Eifel 1                   ATC procedure**  
Status                   No change

#### D. SEQUENCING PROBLEMS

- Eifel 2                   Sector lateral dimensions

The status in situation in ORG 2 and effects

- **Eifel 2                   Sector lateral dimensions**  
Status                   Problem resolved

**E. SEVERAL TRAFFIC FLOWS CONVERGING AT A SINGLE POINT**

The sectors where this problem is Extremely Severe and the associated causes are:

- Hanau/Hanau H           Route structure

The status in situation in ORG 2 and effects

- **Hanau/Hanau H**           **Route structure**  
Status                           Original problem resolved, but problem is now multiple crossing points in sector

**F. SINGLE CROSSING POINT FOR MULTIPLE ROUTES**

The sectors where this problem is Extremely Severe and the associated causes are:

- Hanau/Hanau H           Route structure
- Eifel 1                   Route structure
- Taunus                   Route structure

The status in situation in ORG 2 and effects

- **Hanau/Hanau H**           **Route structure**  
Status                           Original problem resolved, but problem is now multiple crossing points in sector

- **Eifel 1**                   **Route structure**  
Status                           No change to problem but contributory factor now sector shape

- **Taunus**                   **Route structure**  
Status                           Problem resolved

**G. COMPLEX MIX OF ARRIVALS, DEPARTURES AND FLIGHTS IN CRUISE**

The sectors where this problem is Extremely Severe and the associated causes are:

- Saar                      Current ATC procedure

The status in situation in ORG 2 and effects;

- **Saar**                      **Current ATC procedure**  
Status                           Problem resolved due to route structure

**H. MANOEUVERING AND VECTORING PROBLEMS**

The sectors where this problem is Extremely Severe and the associated causes are:

- Eifel 1                   Route structure
- Eifel 2                   Sector lateral dimensions

The status in situation in ORG 2 and effects;

- **Eifel 1**                   **Route structure**  
Status                           No change to problem or severity
- **Eifel 2**                   **Sector lateral dimensions**  
Status                           Problem remains but severity reduced to Moderate

**I. MULTIPLE CROSSING POINTS IN SECTOR**

The sectors where this problem is Extremely Severe and the associated causes are:

- Eifel 1                      Sector lateral dimensions

The status in situation in ORG 2 and effects;

- **Eifel 1**                      **Sector lateral dimensions**

Status                      Problem remains but contributory factor is now sector shape

**J. AIRSPACE RESTRICTIONS**

The sectors where this problem is Extremely Severe and the associated causes are:

- Saar                      Military or other restricted area

The status in situation in ORG 2 and effects;

- **Saar**                      **Military or other restricted area**

Status                      Problem remains but severity reduced to Moderate

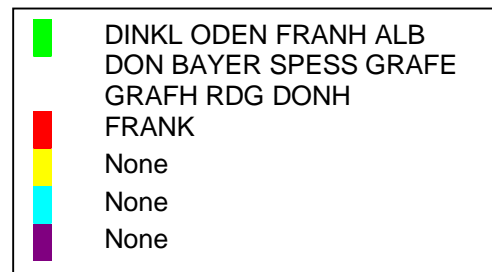
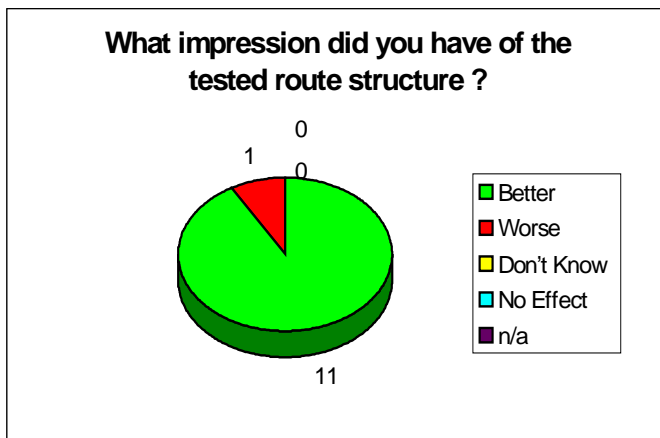
6. RESULTS - ORGANISATION 3

6.1. OBJECTIVE 1 (ORG 3)

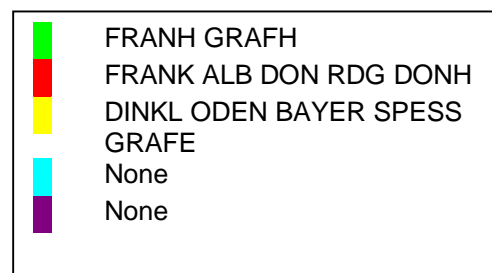
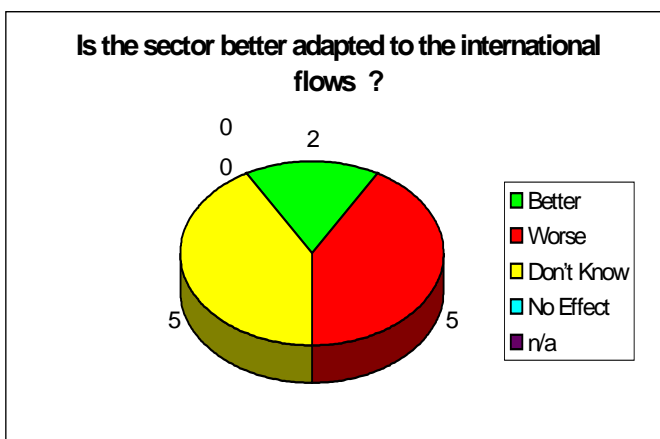
Verify and evaluate the planned:

- **New ATS route structure aligned with the major European traffic streams**
- **Congruent lower and upper route network**
- **New airport departure and arrival links, which are segregated from overflying routes**
- **New sectorisation plan in compliance with optimum profiles**
- **New sector division flight levels**

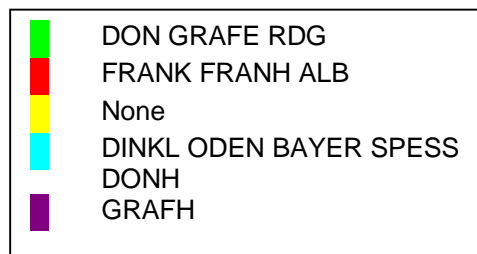
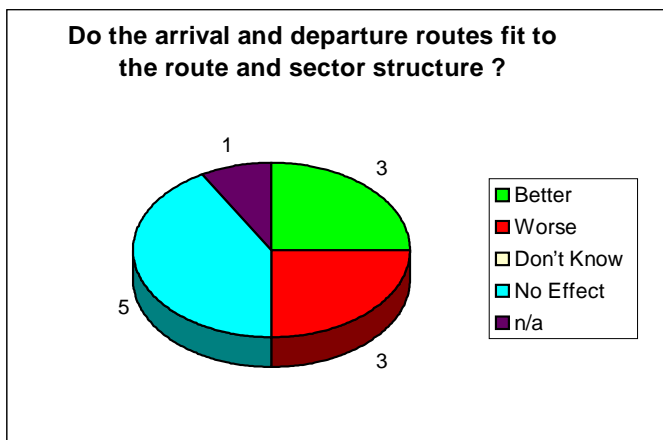
Q: What impression did you have of the tested route structure?



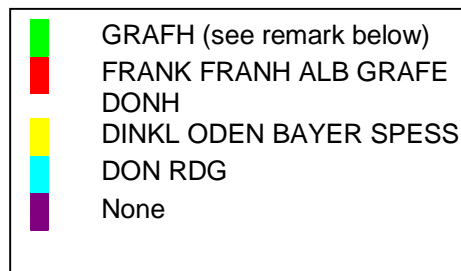
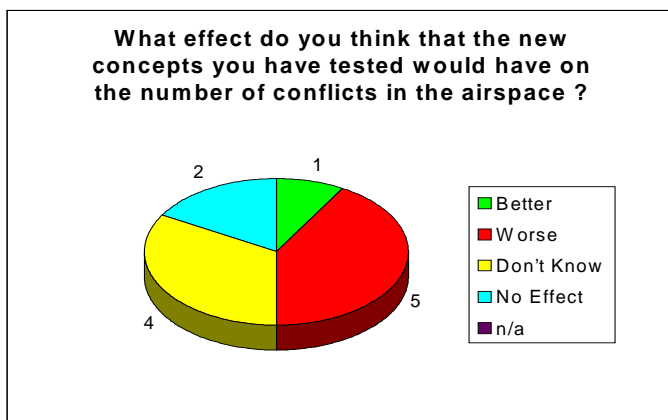
Q: Is the sector better adapted to the international flows (think about the problem solution possibilities in the sectors)?



Q: Do the arrival and departure routes fit to the route and sector structure?

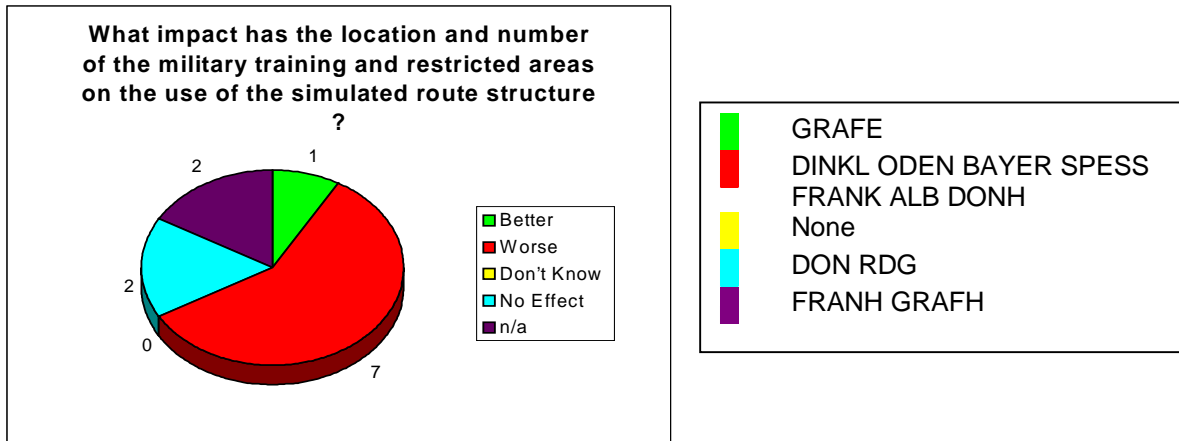


Q: What effect do you think that the new concepts you have tested would have on the number of conflicts in the airspace?



Remark:  
The GRAFH controllers answered that it was “better” with RVSM (see above) and “worse” with CVSM.

Q: What impact has the location and number of the military training and restricted areas on the use of the simulated route structure? Where the international flows and the connections to and from the major aerodromes taken into account?



Q: Do you have any suggestions regarding the requirements of military traffic?

The controllers recommended that:

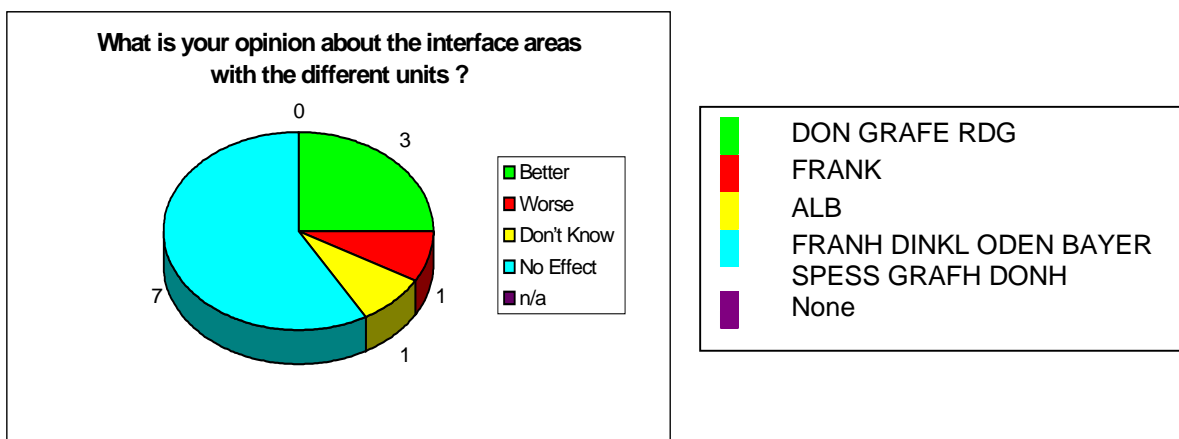
TRA207/307 should be reallocated because the use of UL608A for optimum routing.  
 TRA209/309 should be reallocated or closed because this area is too close to the Munich and Frankfurt arrival routes.  
 Generally the military traffic should either use the TRAs or operate as GAT using the ATS route structure out of the TRAs.

## 6.2. RESULTS - OBJECTIVE 2 (ORG 3)

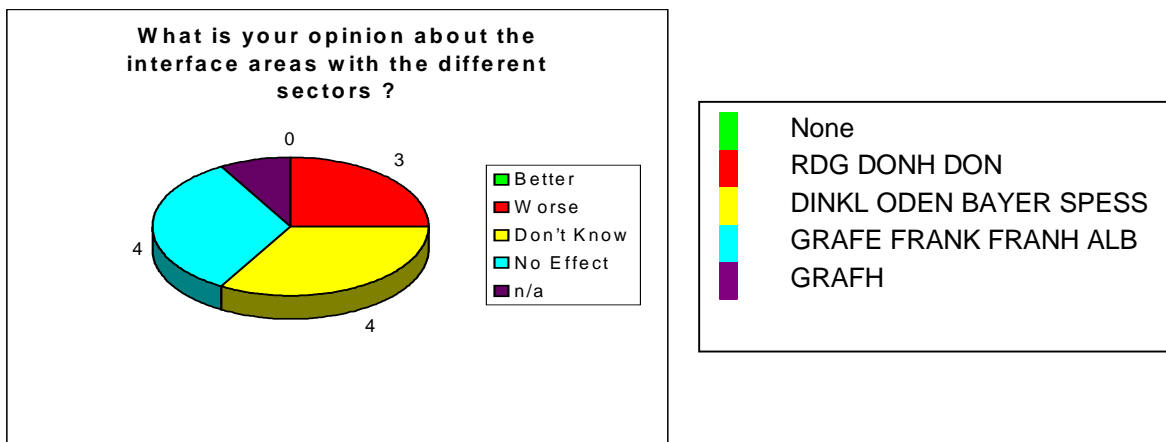
*Study the traffic flow in the interface area between:*

- **Different German ACC and UAC sectors;**
- **Frankfurt TMA and ACC sectors.**

Q: What is your opinion about the interface areas with the different units?



Q: What is your opinion about the interface areas with the different sectors?



### 6.3. RESULTS - OBJECTIVE 3 (ORG 3)

***Implement and test recommended airspace changes by the controllers.***

1. TRA 207/307 was activated for one run and the traffic used UL608 instead of UL608A to avoid the restricted area. (This was planned prior to the simulation to test the impact of the military area.)

The controllers reported that this made the situation worse.

2. SPESS and BAYER sectors had a new configuration where the western part of BAYER sector over SPESS sector between F205-295 was attached to the SPESS sector.

The controllers preferred this solution to the original version however the large amount of inbound traffic to Frankfurt in SPESS sector caused problems.

3. A so called SPESS "CORIDOR" was created between ALB and SPESS sectors where the north part of DINKL sector around VDF7 arrival route was delegated to the SPESS sector. Two versions of this corridor were tried with upper limit F205 and F295.

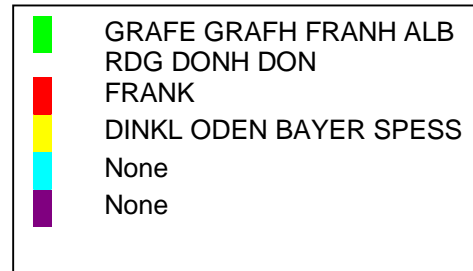
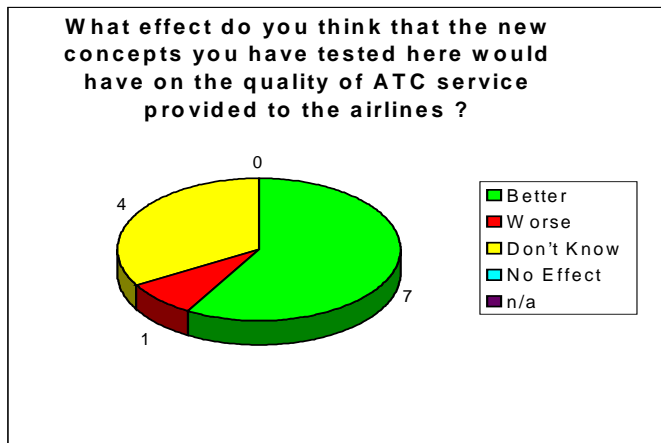
The Munich controllers (ALB sector) preferred the corridor with F295 split. The Frankfurt controllers pointed out that none of the versions were workable due to the crossing traffic and there was not enough airspace for en-route holding in case of heavy inbound traffic. The enlarged radar scale had also a negative impact.

4. GRAFE lower limit F275

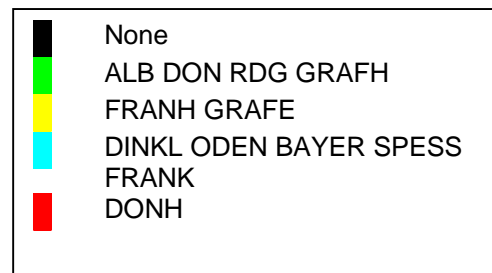
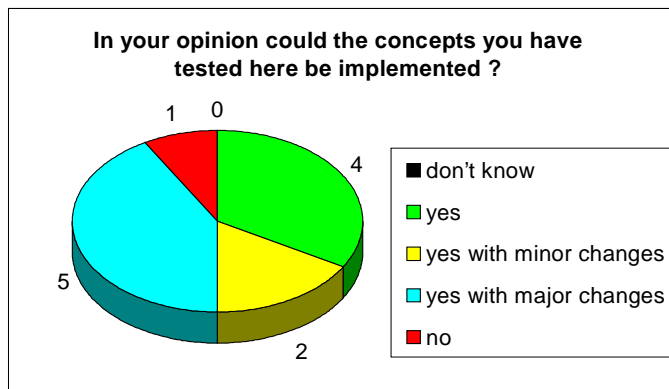
The situation was found to be worse than the situation with the lower limit F295 by all sectors concerned expect BAYER.

**6.4. QUESTIONNAIRE GENERAL RESPONSES (ORG 3)**

Q: What effect do you think that the new concepts you have tested here would have on the quality of ATC service provided to the airlines?



Q: In your opinion could the concepts you have tested here be implemented?



**6.5. WORKLOAD (ORG 3)**

ISA results below show the executive controllers' (EXC) mean workload for all exercises of Organisation 3.

Remark 1:

The PLC workload was not representative because the major differences from the live environment. The PLC had no assistant and strip handling was a major impact to his/her workload.

Remark 2:

SPESS and BAYER sectors shapes were changed after four measured exercises.

The distribution of workload without BAYER and SPESS sectors:

### Estimated Workload

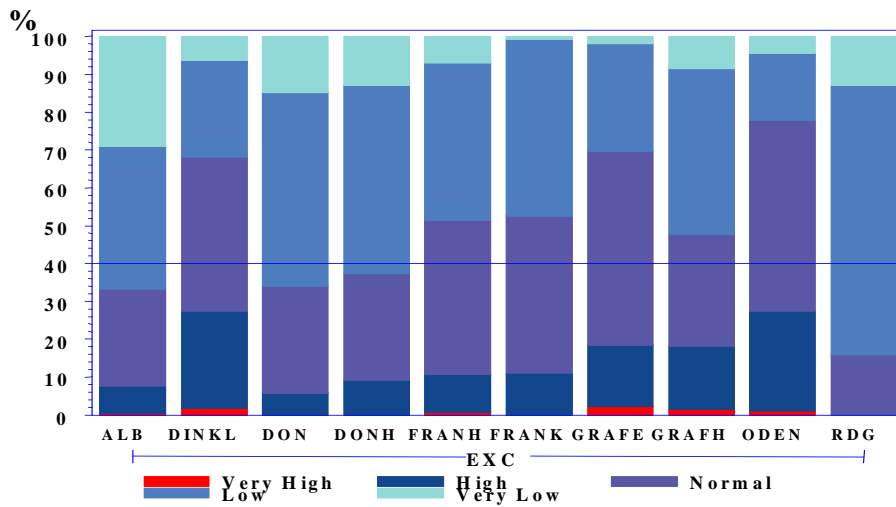


Figure 7: Distribution of Mean ISA ratings of all exercises by EXC positions – Org 3

The ISA values indicated one of the highest workload in the DINKL sector. The controllers suggested that vertical division level of the sector should be tested in other simulation.

Although the traffic level was much higher for the new configuration of BAYER and SPESS sectors but the workload of the EXC positions showed lower values for the new configuration (see Figure 6 below on the right).

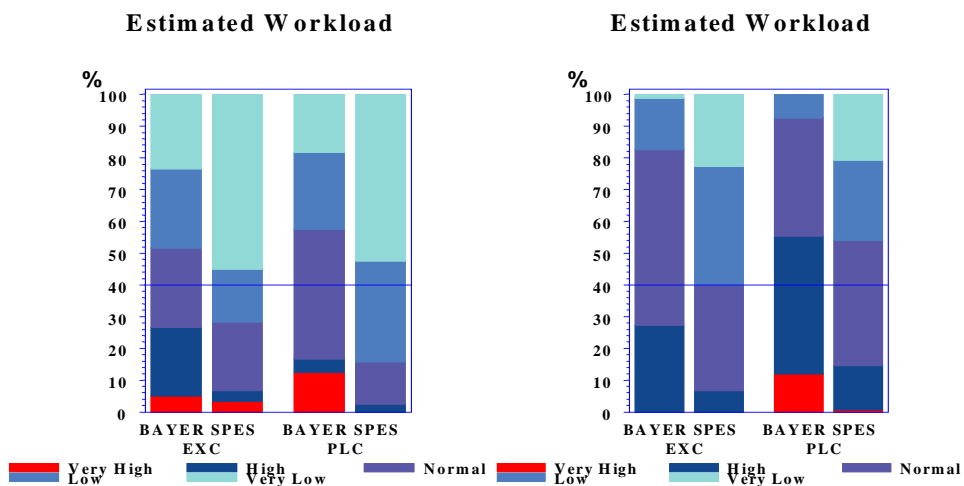


Figure 8: Workload in BAYER and SPESS sectors

## 6.6. ATC SECTOR PROBLEMS (ORG 3)

In Org 3 the current ATC control problems assessed by the controllers as EXTREMELY SEVERE were:

- A. Traffic bunching
- B. R/T loading
- C. High co-ordination workload
- D. Several traffic flows converging at a single point
- E. Complex mix of arrivals, departures and flights in cruise
- F. Complex mix of arrivals and departures
- G. Manoeuvring and vectoring problems
- H. Multiple crossing points in sector
- I. Late transfer of communications from previous sector/centre
- J. Several traffic flows converging at the same point

**Note:** The summary table can be found in Annex C.

### A. TRAFFIC BUNCHING

The sectors where this problem is Extremely Severe and the associated causes are:

- Frank                      Flow control insufficient
- Grafe                      Route structure
- Bayer                      Separation standards/route structure and sector lateral  
Dimensions
- Dinkl                      Flow control
- Franh                      Route structure
- Oden                      Aircraft profile restricted

The status in situation in ORG 3 and effects

- **Frank**                      **Flow control insufficient**  
Status                      No change to problem but severity reduced to Moderate
- **Grafe**                      **Route structure**  
Status                      Problem resolved. New problem is controlling flights within limits of  
another sector.
- **Bayer**                      **Separation standards/route structure and sector lateral  
Dimensions**  
Status                      No change to problem but the severity reduced to Moderate
- **Dinkl**                      **Flow control insufficient**  
Status                      No change to problem or severity
- **Franh**                      **Route structure**  
Status                      No change to problem. Insufficient flight levels available in CVSM  
and no agreed level for descent for arrival traffic.
- **Oden**                      **Aircraft profile restricted**  
Status                      No change to problem or severity

**B. R/T LOADING**

The sectors where this problem is Extremely Severe and the associated causes are:

- Dinkl High traffic density
- Oden High traffic density

The status in situation in ORG 3 and effects

- **Dinkl** **High traffic density**  
Status New problem is traffic sequencing caused by inconsistent ATC practices
- **Oden** **High traffic density**  
Status No change to problem or severity

**C. HIGH CO-ORDINATION WORKLOAD**

The sectors where this problem is Extremely Severe and the associated causes are:

- Frank Interface with next centre

The status in situation in ORG 3 and effects

- **Frank** **Interface with next centre**  
Status No change to problem or severity but element is no current ATC procedure

**D. SEVERAL TRAFFIC FLOWS CONVERGING AT A SINGLE POINT**

- Grafh Route structure
- Dinkl Route structure

The status in situation in ORG 3 and effects

- **Grafh** **Route structure**  
Status Problem severity classed as Severe and main element now interface with next sector/centre
- **Dinkl** **Route structure**  
Status No change to problem or severity

**E. COMPLEX MIX OF ARRIVALS, DEPARTURES AND FLIGHTS IN CRUISE**

The sectors where this problem is Extremely Severe and the associated causes are:

- Dinkl Route structure
- Oden Aircraft profiles restricted
- Grafe Route structure

**NOTE: In the current structure, Donau/Donau H does not experience problems involving complex mixed traffic i.e. arrivals, departures and flight in cruise. In organisation 3, controllers expressed great concern at this new development and classed the problem as extremely severe.**

The status in situation in ORG 3 and effects

- **Dinkl** **Route structure**  
Status No change to problem or severity

- **Oden**  
Status                      **Aircraft profiles restricted**  
Original problem severity slightly reduced to Severe, and influence of restricted flight profiles defined as greatest influence
- **Grafe**  
Status                      **Route structure**  
No longer the Extremely Severe problem in sector. Problem is now limited number of flight levels available for use, classed as Severe.

#### F. COMPLEX MIX OF ARRIVALS AND DEPARTURES

The sectors where this problem is Extremely Severe and the associated causes are:

- Frank                      Current ATC procedure
- Dinkl                      Route structure

**NOTE: In the current structure, Donau/Donau H does not experience problems involving complex mixed traffic i.e. arrivals, departures. In organisation 3, controllers expressed great concern at this new development and classed the problem as extremely severe.**

The status in situation in ORG 3 and effects

- **Frank**  
Status                      **Current ATC procedure**  
The problem now is several traffic flows converging at the same point, and this is made more complex by a limited amount of available flight levels
- **Dinkl**  
Status                      **Route structure**  
Original problem no longer the main concern. Problem now is complex mix of high and low performance aircraft on the same SID/STAR. Severity is Moderate and contributory element is inconsistent ATC practises

#### G. MANOEUVRING AND VECTORING PROBLEMS

The sectors where this problem is Extremely Severe and the associated causes are:

- Frank                      Current ATC procedure

The status in situation in ORG 3 and effects

- **Frank**  
Status                      **Current ATC procedure**  
No change to problem but severity now classed as Severe, and main element is the route structure

#### H. MULTIPLE CROSSING POINTS IN SECTOR

The sectors where this problem is Extremely Severe and the associated causes are:

- Frank                      Route structure
- Franh                      Route structure
- Oden                      Route structure
- Bayer                      Route structure

The status in situation in ORG 3 and effects

- **Frank**                      **Route structure**  
Status                      Original problem remains, and severity classed as Severe
  
- **Franh**                      **Route structure**  
Status                      Original problem increased as new structure has created more crossing points in the sector.
  
- **Oden**                      **Route structure**  
Status                      Original problem increased as new structure has created more crossing points in the sector
  
- **Bayer**                      **Route structure**  
Status                      Problem remains but severity classed as Severe - Moderate

**I. LATE TRANSFER OF COMMUNICATIONS FROM PREVIOUS SECTOR**

The sectors where this problem is Extremely Severe and the associated causes are:

- Oden                      Adjacent sector/centre

The status in situation in ORG 3 and effects

- **Oden**                      **Adjacent sector/centre**  
Status                      Problem remains but severity reduced to Moderate

**J. SEVERAL TRAFFIC FLOWS CONVERGING AT THE SAME POINT**

The sectors where this problem is Extremely Severe and the associated causes are:

- Oden                      Adjacent sector/centre

The status in situation in ORG 3 and effects

- **Oden**                      **Adjacent sector/centre**  
Status                      Problem remains but severity reduced to Moderate

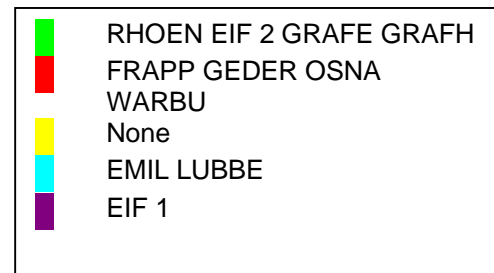
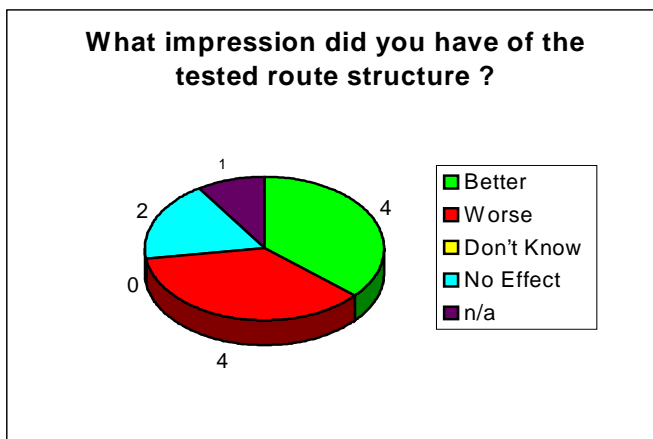
**7. RESULTS - ORGANISATION 4**

**7.1. OBJECTIVE 1 (ORG 4)**

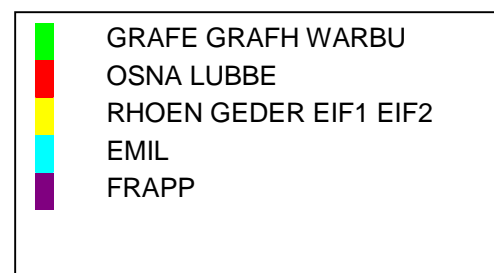
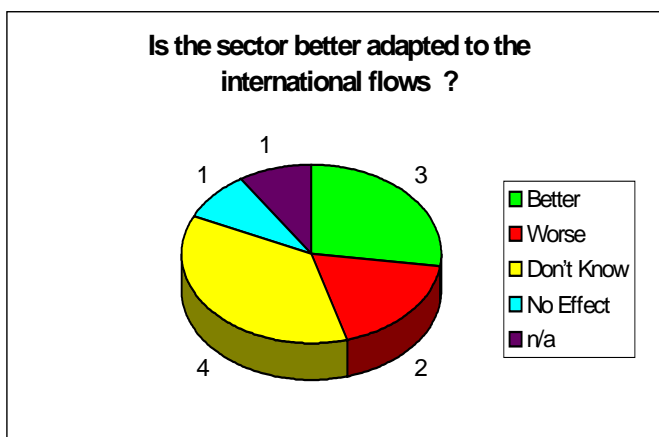
*Verify and evaluate the planned:*

- ***New ATS route structure aligned with the major European traffic streams***
- ***Congruent lower and upper route network***
- ***New airport departure and arrival links, which are segregated from overflying routes***
- ***New sectorisation plan in compliance with optimum profiles***
- ***New sector division flight levels***
- ***Upper sectors for Karlsruhe and Maastricht.***

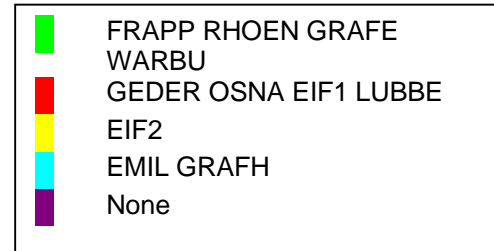
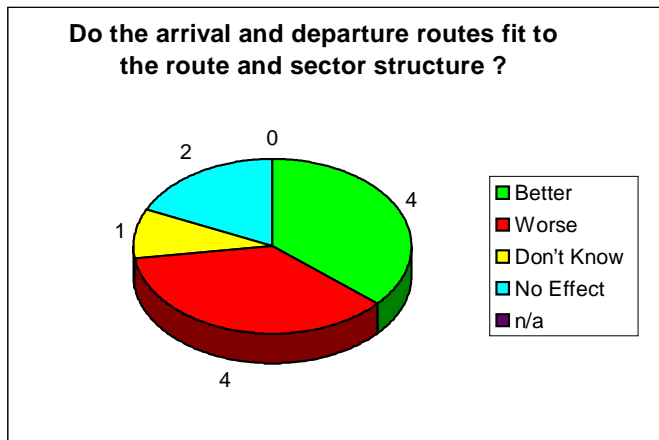
Q: What impression did you have of the tested route structure?



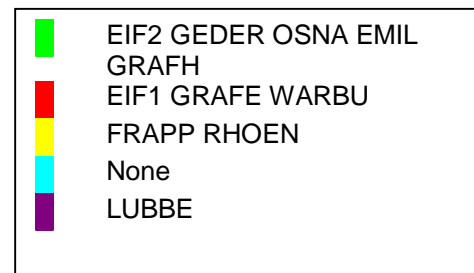
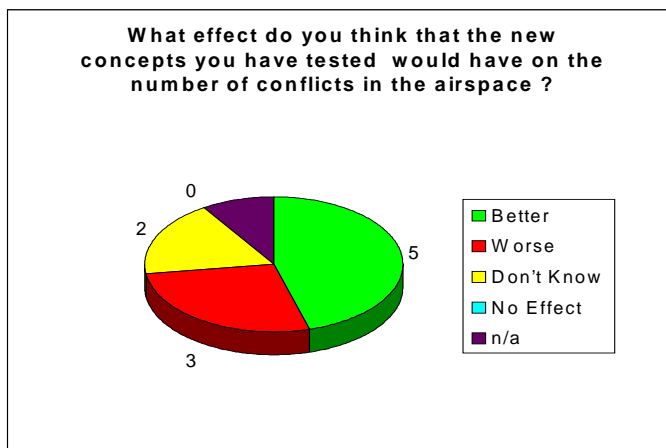
Q: Is the sector better adapted to the international flows (think about the problem solution possibilities in the sectors)?



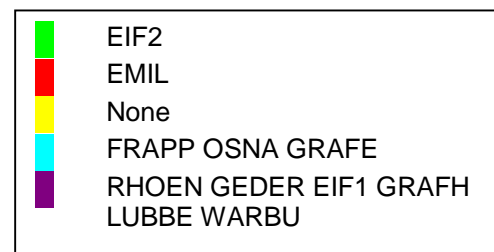
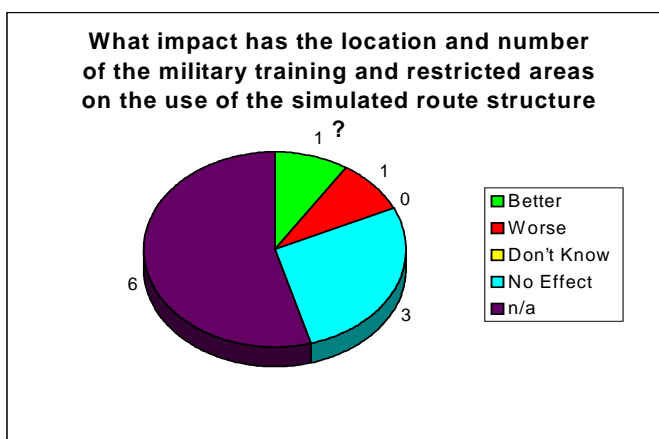
Q: Do the arrival and departure routes fit to the route and sector structure?



Q: What effect do you think that the new concepts you have tested would have on the number of conflicts in the airspace?



Q: What impact has the location and number of the military training and restricted areas on the use of the simulated route structure? Were the international flows and the connections to and from the major aerodromes taken into account?



Q: Do you have any suggestions regarding the requirements of military traffic?

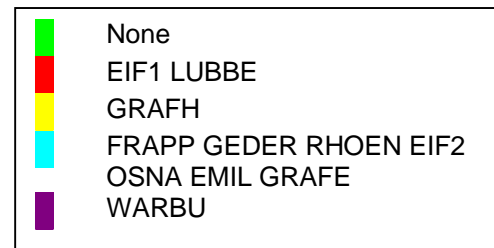
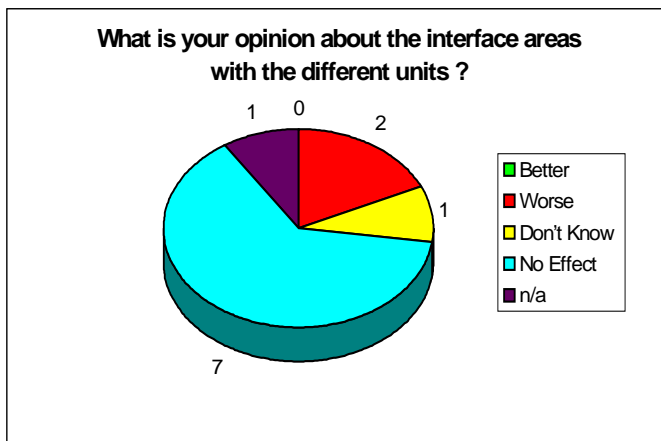
No recommendation was made.

7.2. RESULTS - OBJECTIVE 2 (ORG 4)

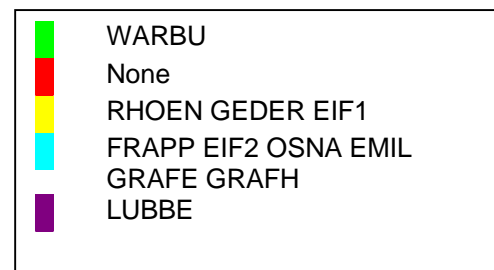
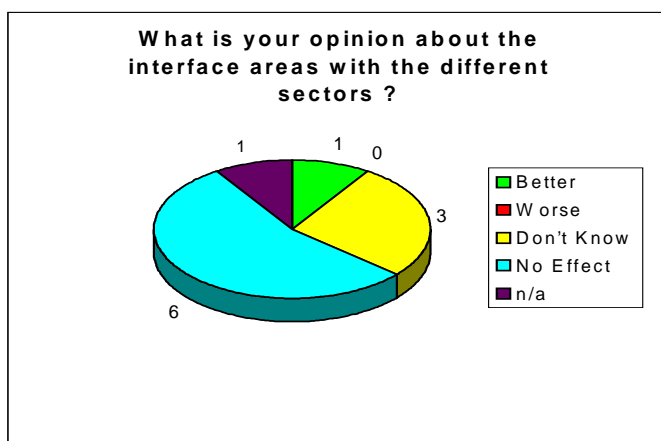
*Study the traffic flow in the interface area between:*

- *Different German ACC and UAC sectors,*
- *Frankfurt TMA and ACC sectors,*
- *Maastricht and German Airspace.*

Q: What is your opinion about the interface areas with the different units?



Q: What is your opinion about the interface areas with the different sectors?



**7.3. RESULTS - OBJECTIVE 3 (ORG 4)**

***Implement and test recommended airspace changes by the controllers.***

1. EIF 1 extended to north-west

This did not change the situation.

2. The upper limit of LUBE sector was changed from FL335 to FL460.

The controllers reported that this made the situation better than the original version.

3. The upper limit of OSNA sector was changed from FL335 to FL460.

The controllers reported that this made the situation better than the original version.

4. Frankfurt departure route YDF5 was re-routed from TAUER-SITKA-SORGA to SITKA-SALZU-A21 and Frankfurt arrival was re-routed to MAG-DP1-LARUM-FRAFU-GEDNO.

The sectors concerned considered this an improvement.

5. EDDL inbounds were re-routed from SULUS-SWEIN (UL604) to SULUS-KISSI then parallel vector with UL604 (new definition for VDL7:SWEIN ABKIS LULI).

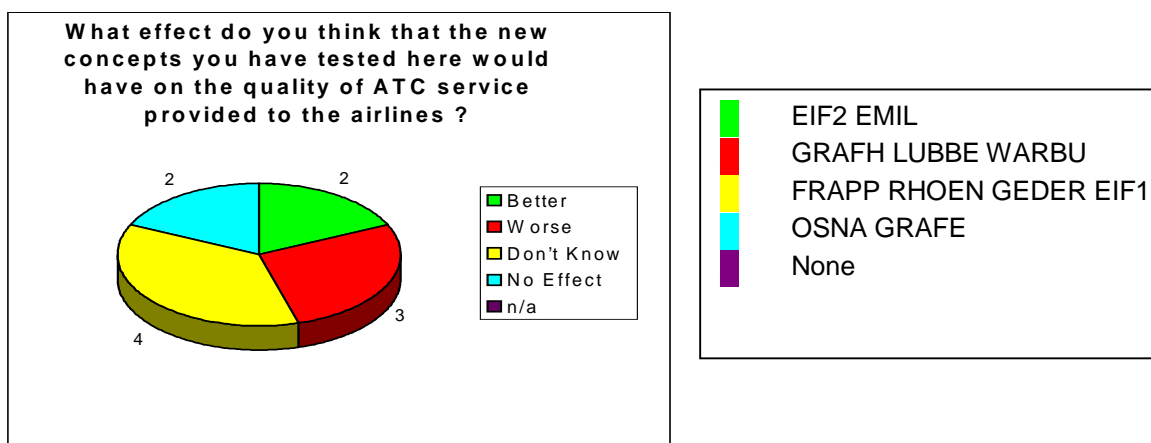
The parallel routing of overflight and inbound traffic made the situation easier than the original version. The controllers tried another version to separate the inbound traffic from the overflights where the overflight traffic was rerouted from UL604 to UL602 via ELLI-SALZI-HMM. The second version was preferable.

6. The geographical boundary of the WARBU sector was extended to the south-west.

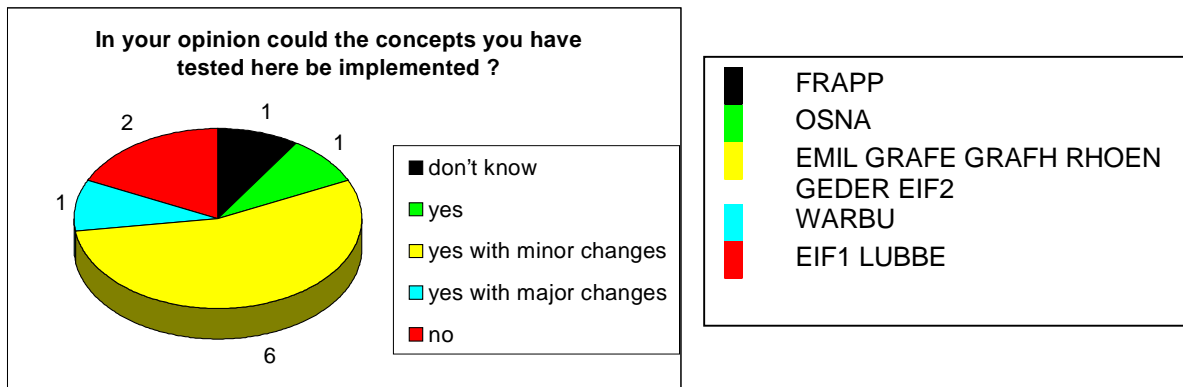
The general opinion was that this change was very positive. The new sector shape increased the airspace enabling a bigger vectoring area around SITKA conflict zone.

**7.4. QUESTIONNAIRE GENERAL RESPONSES (ORG 4)**

Q: What effect do you think that the new concepts you have tested here would have on the quality of ATC service provided to the airlines?



Q: In your opinion could the concepts you have tested here be implemented?



Remark: RHOEN, GEDER and EIF2 commented that moderate changes were required.

### 7.5. WORKLOAD (ORG4)

ISA results below show the executive controllers' (EXC) mean workload for all exercises and the peak exercises of Organisation 4.

Remark:

The Planning controller's workload is not shown. The PLC workload was not representative because the major differences from the real-life work. The PLC had no assistant and strip handling was a major impact to the workload.

### Estimated Workload

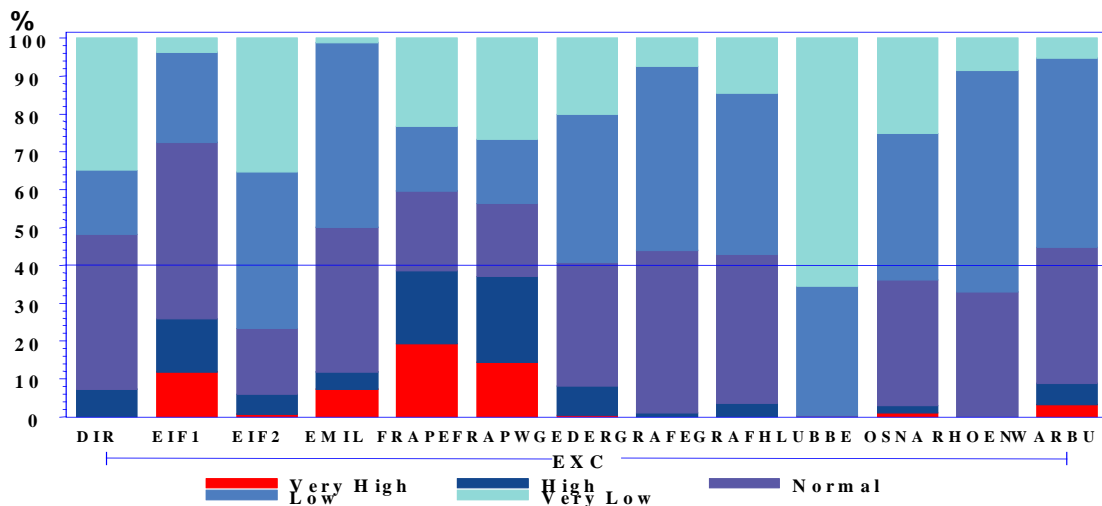


Figure 9: Distribution of Mean ISA ratings of all exercises by EXC positions – Org 4

### Estimated Workload

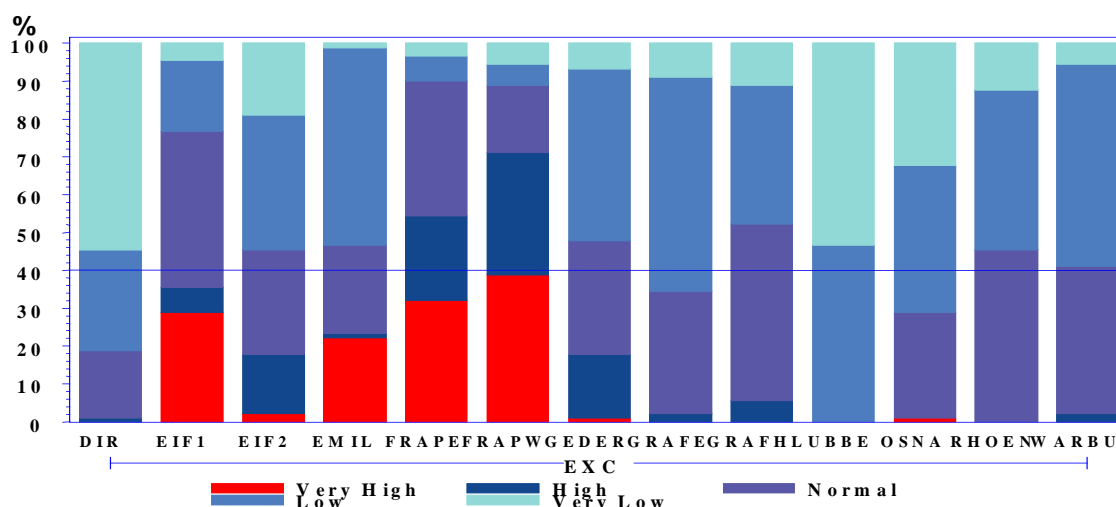


Figure 10: Distribution of Mean ISA ratings of peak exercises by EXC positions–Org 4

The ISA values show very high workload in the Frankfurt TMA East and West positions. During the peak, where the traffic level was higher than the real-life flow the workload became too high. A high percentage of “Very High” was also observed in the EMIL and EIF1 sectors. This level of workload is unmanageable.

#### 7.6. ATC SECTOR PROBLEMS (ORG 4)

In Org 4 the current ATC control problems assessed by the controllers as EXTREMELY SEVERE were:

Notes:

No results for sectors Eifel 1, and Eifel 2 are included in this chapter. Comments made by the controllers for Org 2 remain valid in Org 4.

Similarly, no results for sector Grafe are included as the results and comments made by the controllers in Org 3 remain valid in Org 4.

- A. Traffic bunching
- B. R/T loading
- C. High co-ordination workload
- D. Several traffic flows converging at a single point
- E. Multiple crossing points in sector

**Note:** The summary table can be found in Annex C.

#### A. TRAFFIC BUNCHING

The sectors where this problem is Extremely Severe and the associated causes are:

- Geder                      No flow restrictions and holding pattern

The status in situation in ORG 4 and effects

- **Geder**                      **No flow restrictions and holding pattern**
- Status                      No change to problem or element

## B. R/T LOADING

The sectors where this problem is Extremely Severe and the associated causes are:

- Frapp Traffic density
- Geder Holding pattern

The status in situation in ORG 4 and effects

- **Frapp** Traffic density
- Status No change

- **Geder** Holding pattern
- Status Problem remains Extremely Severe, but additional contributory elements are the sector lateral dimensions and the route structure



Figure 11: Screen Image of part of the Frankfurt TMA showing high traffic density

## C. HIGH CO-ORDINATION WORKLOAD

The sectors where this problem is Extremely Severe and the associated causes are:

- Osna Military or other restricted area

The status in situation in ORG 4 and effects;

- **Osna** Military or other restricted area
- Status There was no military participation in this simulation. This problem should be addressed in the future

## D. SEVERAL TRAFFIC FLOWS CONVERGING AT A SINGLE POINT

- Warbu Route structure

The status in situation in ORG 4 and effects;

- **Warbu** Route structure
- Status The Extremely Severe problem in this sector now is multiple crossing points and the main contributory element is the route structure

## E. MULTIPLE CROSSING POINTS IN SECTOR

The sectors where this problem is Extremely Severe and the associated causes are:

- Rhoen Flight not on planned route

The status in situation in ORG 4 and effects

- **Rhoen**  
Status

**Flight not on planned route**

No change to problem, but severity classed as Severe and contributory element now route structure

## 8. CONCLUSIONS AND RECOMMENDATIONS

The Germany 98 Real-Time simulation successfully achieved its objectives, providing much useful information that will assist in the introduction of the new airspace into operational service.

### 8.1. GENERAL RESULTS

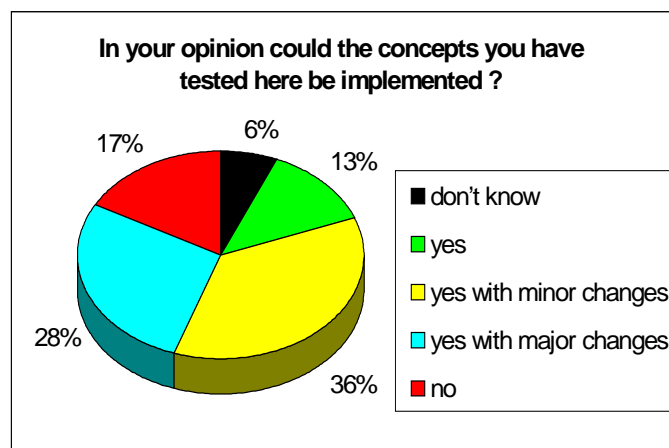
The simulation had important merits providing a large and varied data source. A large number of controllers from different centres participated in the simulation and its preparation. The project provided the opportunity to them and their managers to verify the planned new airspace, to have discussions, and implement and test new ideas within in certain limits. This process provided an evolutionary development in line with the operational needs.

The majority of the controllers (77% in favour and 17% against) accepted the new concept. Most of them (64%) remarked that the new airspace still needed further changes.

A large portion of the controllers (38% in favour and 23% against) commented that the airlines would benefit from the new airspace.

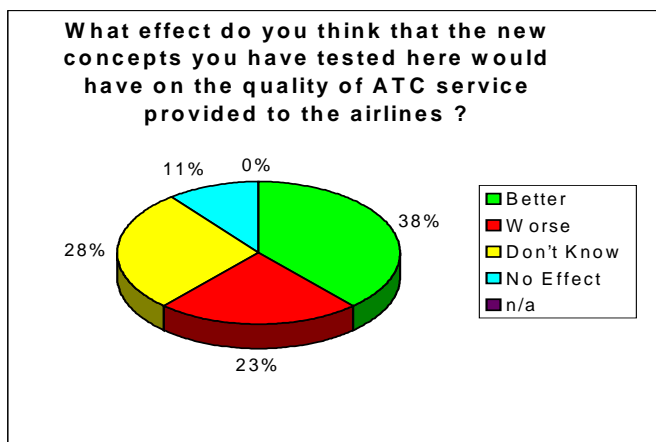
Note: The pie chart below shows the summary of the controllers' responses for the four organisations:

Q: In your opinion could the concepts you have tested here be implemented?



Remark: KARL, KARLH, RHOEN, GEDER, EIF2 sectors commented that moderate changes were required.

Q: What effect do you think that the new concepts you have tested here would have on the quality of ATC service provided to the airlines?



## 8.2. RESULTS - OBJECTIVE 1

*Verify and evaluate the planned:*

- ***New ATS route structure aligned with the major European traffic streams***
- ***Congruent lower and upper route network***
- ***New airport departure and arrival links, which are segregated from overflying routes***
- ***New sectorisation plan in compliance with optimum profiles***
- ***New sector division flight levels***
- ***Upper sectors for Karlsruhe and Maastricht.***

The new route structure was favoured by the majority of the controllers (60% in favour and 21% against). More problems were observed with the arrival and departure links than with the other routes but the concept received positive feedback (41% in favour and 32% against).

A serious problem occurred when the Frankfurt lower sectors applied en-route holdings outside the Frankfurt TMA. It proved difficult to accommodate the holding aircraft outside from the arrival and departure routes in the small sectors.

There was no clear indication whether the simulated sectors were better fit to the international flows than the current sectors (23% better and 27% worse).

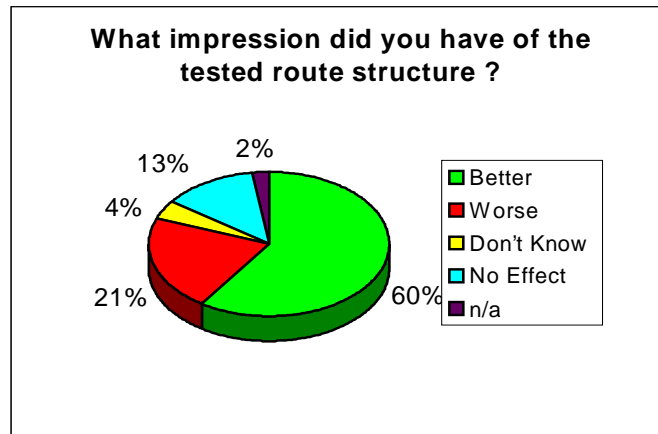
The controllers stated that the implementation of the new airspace created more conflicts as a consequence of the use of BRNAV. The airspace was used more effectively than in the current live situation with a more complex route structure and this resulted in more conflict points instead of fewer main conflict points. However this also meant that more space for conflict resolution was available.

The vertical split of the sectors was standardised, the lower sectors up to FL 295 except Munich lower sectors with FL275 or FL285 upper limit, the upper airspace sectors split at FL335. This configuration was endorsed for most of the sectors. This vertical structure will be well suited to the free route concept.

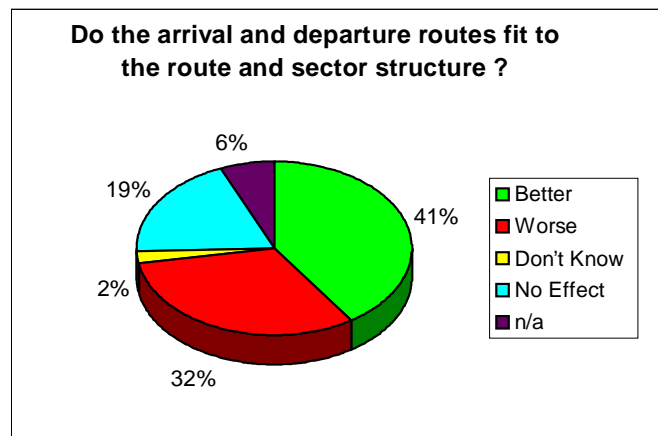
The controllers pointed out that there were more problems with the military areas in the new airspace than in the current situation. The military areas should also be revised to fit the new structure.

Note: The pie charts below show the summary of the controllers' responses for the four organisations:

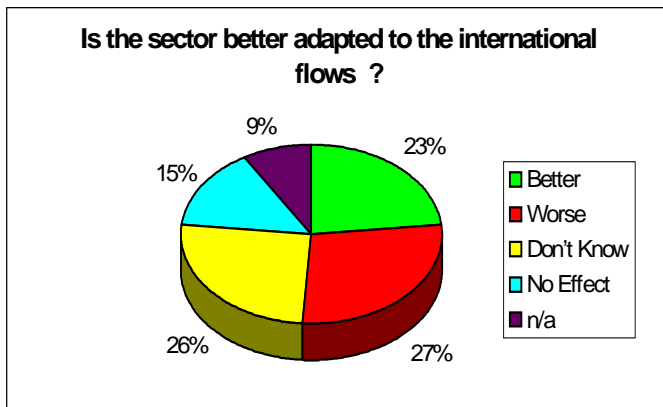
Q: What impression did you have of the tested route structure?



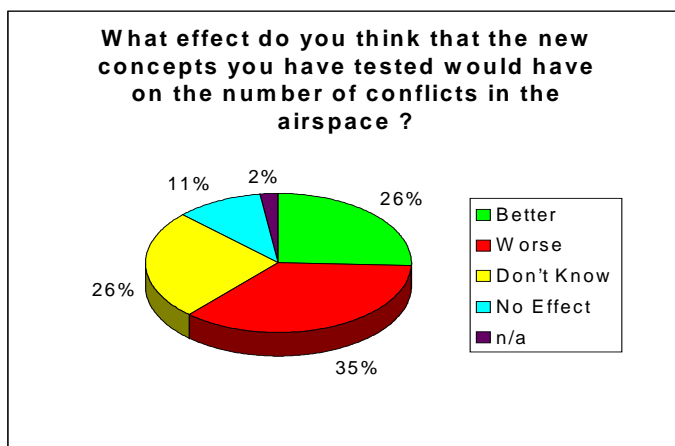
Q: Do the arrival and departure routes fit to the route and sector structure?



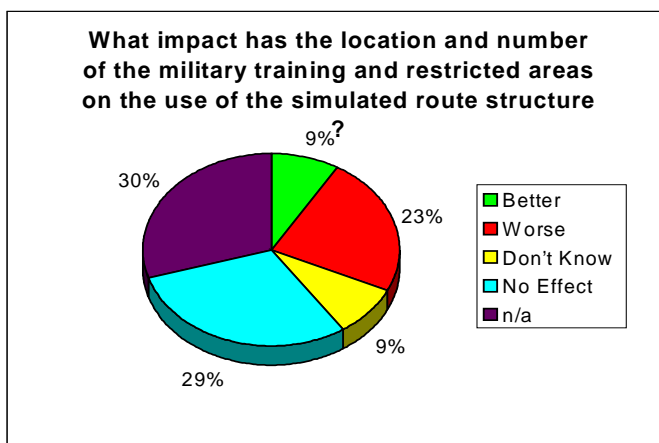
Q: Is the sector better adapted to the international flows (think about the problem solution possibilities in the sectors)?



Q: What effect do you think that the new concepts you have tested would have on the number of conflicts in the airspace?



Q: What impact has the location and number of the military training and restricted areas on the use of the simulated route structure? Where the international flows and the connections to and from the major aerodromes taken into account?



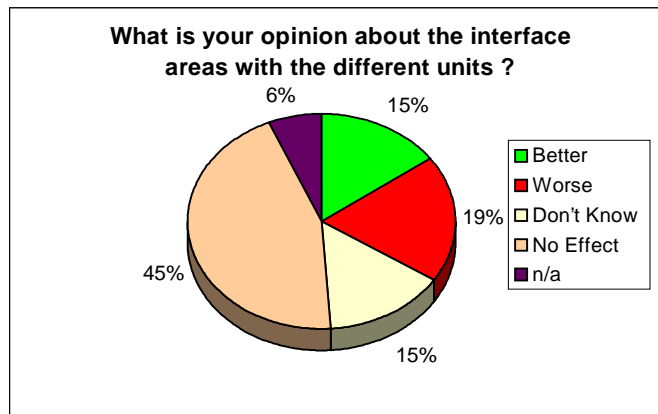
8.3. RESULTS - OBJECTIVE 2

*Study the traffic flow in the interface area between:*

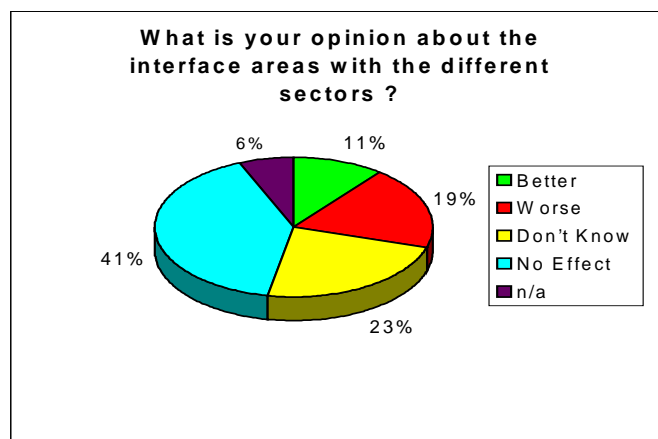
- *Different German ACC and UAC sectors,*
- *Frankfurt TMA and ACC sectors,*
- *Stuttgart TMA and ACC sectors (ORG 1),*
- *Maastricht and German Airspace (ORG 4),*
- *Zürich and German Airspace (ORG 1),*
- *Brussels and German Airspace (ORG 2).*

The general opinion was that the situation with the interface areas between the sectors and ATC units became slightly worse. It should also be emphasised that approximately two thirds of the sectors reported “No effect” or “Don’t know”.

Q: What is your opinion about the interface areas with the different units?



Q: What is your opinion about the interface areas with the different sectors?



#### 8.4. RESULTS - OBJECTIVE 3

##### ***Implement and test recommended airspace changes by the controllers.***

Most of the sector shapes were revised throughout the preparation, testing and simulation periods. This report refers only to the changes implemented during the simulation.

Most of the sector changes were preferred by the controllers as:

- Delegated airspace from Zurich West to East,
- MOSEL sectors,
- Brussels EH and SH,
- SPESS and BAYER,
- WARBU,
- OSNA,
- LUBE.

The revised SAAR and EIF 1 sectors were not ideal either and further changes are required.

The lower limit FL275 of GRAFE sector was found to be worse and was changed back to FL295.

Many routes were successfully revised during the whole project.

#### 8.5. RESULTS - OBJECTIVE 4

##### ***Use of BRNAV and RVSM***

The controllers said that the use of BRNAV and RVSM was a great benefit. These procedures allowed the more effective use of airspace horizontally and vertically above flight level 290.

Karlsruhe UAC stated that the new route structure could work only with RVSM.

#### 8.6. EEC INTERNAL OBJECTIVE

##### ***Confirm the trends of F16/EAM04 Fast-Time simulation.***

Many changes were implemented in the simulated airspace during the preparation and simulation phases of the Real-Time simulation (also see 8.4). Due to these changes the comparison of the results of the two simulations was not feasible.

## 8.7. RECOMMENDATION

The following recommendations are made:

Further studies are required for certain areas of the airspace before the implementation of the new route structure and sectorisation.

The results of the simulation could be partly implemented in the areas where major problems were not identified.

The RVSM should be implemented as soon as practicable.

The military areas should be revised in line with whole new airspace concept taking into account the military interest.

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## Traduction en langue française du Résumé, de l'Introduction, des Objectifs, des Conclusions et Recommandations

### RÉSUMÉ

La simulation en temps réel Allemagne 98 s'est déroulée au Centre Expérimental d'EUROCONTROL du 28 septembre au 23 octobre 1998. 89 contrôleurs de la DFS (Deutsche Flugsicherung GmbH), 8 contrôleurs suisses du Centre de Zurich, 5 contrôleurs du CANAC à Bruxelles et 9 contrôleurs du Centre EUROCONTROL de Maastricht ont participé à 50 exercices de simulation.

Cette simulation visait à valider la structure de routes ATS et la sectorisation dans l'espace aérien ouest, sud et nord-ouest de l'Allemagne, telles qu'elles résultent de la simulation en temps accéléré F16/EAMO4 (Tâche CEE - F16, note CEE n° 1/98). L'espace aérien simulé incluait les zones d'interface avec les espaces aériens contrôlés par les Centres de Maastricht, Bruxelles et Zurich.

Les résultats tiennent compte des avis subjectifs exprimés par les contrôleurs pendant la simulation ainsi que de l'analyse des enregistrements du système pendant les exercices de simulation. Il en ressort que le nouveau concept d'espace aérien a été bien accueilli par la plupart des contrôleurs, mais que de nombreux problèmes se posent encore et que des études complémentaires seront nécessaires pour certaines parties de l'espace aérien, préalablement à la mise en oeuvre de la nouvelle structure de route et de la nouvelle sectorisation.

## 1. INTRODUCTION

La simulation en temps réel Allemagne 98 a été réalisée au Centre Expérimental d'EUROCONTROL, du 28 septembre au 3 octobre 1998. Ce projet CEE visait à répondre aux exigences conjointes de l'Administration allemande (DFS : Deutsche Flugsicherung GmbH).

L'Allemagne s'attache actuellement à la réalisation du Plan d'optimisation de la structure de l'espace aérien allemand. Ce Plan, qui tient également compte des exigences militaires, consiste essentiellement à mettre en oeuvre la version 3 du Réseau de routes ATS (ARN) d'EATCHIP (Programme européen d'harmonisation et d'intégration du contrôle de la circulation aérienne) ainsi que la nouvelle structure de l'espace aérien et la nouvelle sectorisation associées audit réseau. La simulation en temps réel Allemagne 98 est fondée sur cette nouvelle structure de l'espace aérien ainsi que sur l'utilisation du RVSM alterné niveau par niveau (Minimum réduit de séparation verticale), du FLOS (Système d'orientation des niveaux de vol) et de la BRNAV (Navigation de surface).

Plusieurs simulations en temps accéléré et en temps réel ont eu lieu en Allemagne, et les résultats obtenus sont déjà partiellement mis en oeuvre.

EUROCONTROL a réalisé la simulation en temps accéléré de l'espace aérien allemand F16/EAM04 en trois phases, de 1995 à 1997. Cette simulation visait à étudier les différents plans de resectorisation au regard des propositions de réseaux de routes conformes aux spécifications EATCHIP.

La simulation en temps réel Allemagne 98 avait pour objectif initial de valider la structure de routes ATS et la sectorisation issues de la simulation en temps accéléré F16, et d'apporter toute modification supplémentaire requise dans l'espace aérien simulé prévu.

On trouvera dans le présent rapport les résultats et les conclusions de la simulation en temps réel Allemagne 98.

## 2. OBJECTIFS

### OBJECTIFS GENERAUX

La simulation avait pour objectif global de valider la structure de routes ATS et la sectorisation dans l'espace aérien ouest, sud et nord-ouest de l'Allemagne, telles qu'elles résultent de la simulation en temps accéléré F16/EAM04. L'espace aérien simulé incluait les zones d'interface avec les espaces aériens contrôlés par les centres de Maastricht, Bruxelles et Zurich.

### OBJECTIFS SPECIFIQUES

1. Valider et évaluer :
  - la nouvelle structure de routes ATS alignée sur les grands courants de trafic européens;
  - les réseaux de routes correspondants dans les espaces aériens inférieur et supérieur;
  - les nouvelles routes d'arrivée et de départ des aéroports, distinctes des routes de survol;
  - le nouveau plan de sectorisation conforme aux profils optimums;
  - les nouveaux niveaux de vol de démarcation dans les secteurs;
  - les secteurs supérieurs de Karlsruhe et de Maastricht.
  
2. Etudier les courants de trafic dans les zones d'interface situées entre:
  - les différents secteurs CCR et UAC allemands;
  - la TMA et les secteurs CCR de Francfort (ORG 4);
  - la TMA et les secteurs CCR de Stuttgart (ORG 1);
  - l'espace aérien contrôlé par Maastricht et l'espace aérien allemand (ORG 4);
  - l'espace aérien contrôlé par Zurich et l'espace aérien allemand (ORG 1);
  - l'espace aérien contrôlé par Bruxelles et l'espace aérien allemand (ORG 2).
  
3. Mettre en oeuvre et tester les modifications relatives à l'espace aérien recommandées par les contrôleurs.
  
4. Evaluer les incidences de la BRNAV et du RVSM.

Cet objectif n'a pas été analysé par organisations. On trouvera les commentaires généraux des contrôleurs à ce sujet dans le chapitre RESULTATS - OBJECTIF N° 4.

### **OBJECTIF INTERNE DU CEE**

Valider les tendances se dégageant de la simulation en temps accéléré F16/EAM04.

L'espace aérien simulé ayant fait l'objet de nombreuses modifications pendant les phases de préparation et de simulation de la simulation en temps réel, la comparaison des résultats des deux simulations n'est pas possible.

### 3. CONCLUSIONS ET RECOMMANDATIONS

La simulation en temps réel Allemagne 98 a atteint ses objectifs, puisqu'elle a apporté quantité d'informations utiles qui faciliteront la mise en service opérationnel du nouvel espace aérien.

#### RESULTATS GENERAUX

La simulation s'est révélée très utile, car elle a fourni des données nombreuses et variées. Un grand nombre de contrôleurs issus de différents centres y ont participé, ainsi qu'aux travaux préparatoires. Le projet leur a permis, ainsi qu'à leurs managers, de valider le nouvel espace aérien prévu, d'échanger leurs vues ainsi que de mettre en oeuvre et de tester de nouvelles idées, dans des limites données. Ce processus a favorisé un avancement évolutif des travaux en fonction des besoins opérationnels.

Une majorité de contrôleurs se sont déclarés favorables au nouveau concept (77 % pour, 17 % contre) ; la plupart d'entre eux (64 %) ont indiqué que des modifications supplémentaires devraient encore être apportées au nouvel espace aérien.

De nombreux contrôleurs (38 % pour, 23 % contre) ont fait observer que les compagnies aériennes tireraient avantage du nouvel espace aérien.

#### RESULTATS - OBJECTIF 1

**Vérifier et évaluer les projets suivants :**

- **la nouvelle structure de routes ATS alignée sur les grands courants de trafic européens;**
- **les réseaux de routes correspondants dans les espaces aériens inférieur et supérieur;**
- **les nouvelles routes d'arrivée et de départ, distinctes des routes de survol;**
- **le nouveau plan de sectorisation conforme aux profils optimums;**
- **les nouveaux niveaux de vol de démarcation dans les secteurs;**
- **les secteurs supérieurs de Karlsruhe et de Maastricht.**

Une majorité de contrôleurs est favorable à la nouvelle structure de routes (60 % pour, 21 % contre). Les routes d'arrivée et de départ semblent créer plus de problèmes que les autres routes, mais le concept a été accueilli favorablement (41 % pour, 32 % contre).

Un sérieux problème s'est posé lorsque les secteurs inférieurs de Francfort ont demandé des attentes en vol en dehors de la TMA de Francfort. Il s'est révélé difficile d'accueillir des aéronefs en attente hors des routes d'arrivée et de départ dans les petits secteurs.

Il ne ressort pas clairement des réponses que les secteurs simulés soient mieux adaptés aux courants internationaux que les secteurs actuels (23 % pour, 27 % contre).

Selon les contrôleurs, la mise en oeuvre du nouvel espace aérien crée davantage de conflits du fait de l'utilisation de la BRNAV. L'espace aérien est exploité de manière plus efficace qu'actuellement, mais la structure de routes, plus complexe, loin de réduire les points de conflits, les augmente ; les contrôleurs disposent toutefois de plus d'espace pour les résoudre.

La séparation verticale des secteurs était standardisée : la limite verticale des secteurs inférieurs était fixée au FL 295, sauf dans les secteurs inférieurs de Munich, où elle était fixée au FL 275 ou FL 285 et dans les secteurs de l'espace aérien supérieur, où elle était fixée au FL 335. Cette configuration, qui a été approuvée pour la plupart des secteurs, sera bien adaptée au concept d'espace aérien à itinéraire libre.

Selon les contrôleurs, les zones militaires poseront davantage de problèmes dans la nouvelle structure qu'actuellement; il conviendrait donc de les adapter également à cette dernière.

## RESULTATS - OBJECTIF 2

*Etudier les courants de trafic dans les zones d'interface entre :*

- *les différents secteurs CCR et UAC allemands;*
- *la TMA et les secteurs CCR de Francfort;*
- *la TMA et les secteurs CCR de Stuttgart (ORG 1);*
- *l'espace aérien contrôlé par Maastricht et l'espace aérien allemand (ORG4);*
- *l'espace aérien contrôlé par Zurich et l'espace aérien allemand (ORG1);*
- *l'espace aérien contrôlé par Bruxelles et l'espace aérien allemand (ORG2).*

De l'avis général, la situation dans les zones d'interface entre les secteurs et les centres ATC s'est légèrement dégradée. On notera également que deux tiers des secteurs environ ont répondu "Aucune incidence" ou "Sans opinion".

## RESULTATS - OBJECTIF 3

*Mettre en oeuvre et tester les modifications de l'espace aérien recommandées par les contrôleurs.*

La configuration de la plupart des secteurs a été modifiée pendant les travaux de préparation, d'essai et de simulation. Le présent rapport ne rend compte que des changements mis en oeuvre pendant la simulation.

La plupart de ces modifications de secteur ont été jugées préférables par les contrôleurs, comme:

- la délégation d'espace aérien de Zurich West à Zurich East ;
- les secteurs MOSEL,
- Bruxelles EH et SH,
- SPESS et BAYER
- WARBU,
- OSNA,
- LUBE.

Les nouveaux secteurs SAAR et EIF 1, n'étant pas non plus jugés satisfaisants, devront faire l'objet de modifications supplémentaires.

La limite inférieure du secteur GRAFE (FL 275), jugée moins bonne, a été rétablie au FL 295.

De nombreuses routes ont été modifiées, avec succès, pendant les différentes phases du projet.

## RESULTATS - OBJECTIF 4

### *Utilisation de la BRNAV et du RVSM.*

Les contrôleurs ont déclaré que l'utilisation de la BRNAV et du RVSM présentait des avantages considérables, car elle permettait une exploitation plus efficace de l'espace aérien, tant horizontalement que verticalement, au-dessus du FL 290.

Selon l'UAC de Karlsruhe, la nouvelle structure de routes ne peut fonctionner qu'en association avec le RVSM.

## OBJECTIF INTERNE DU CEE

### *Valider les tendances se dégageant de la simulation en temps accéléré F16/EAM04.*

L'espace aérien simulé ayant fait l'objet de nombreuses modifications pendant les phases de préparation et de simulation de la simulation en temps réel, la comparaison des résultats des deux simulations n'est pas possible (cf. aussi RESULTATS - OBJECTIFS 3).

## RECOMMANDATION

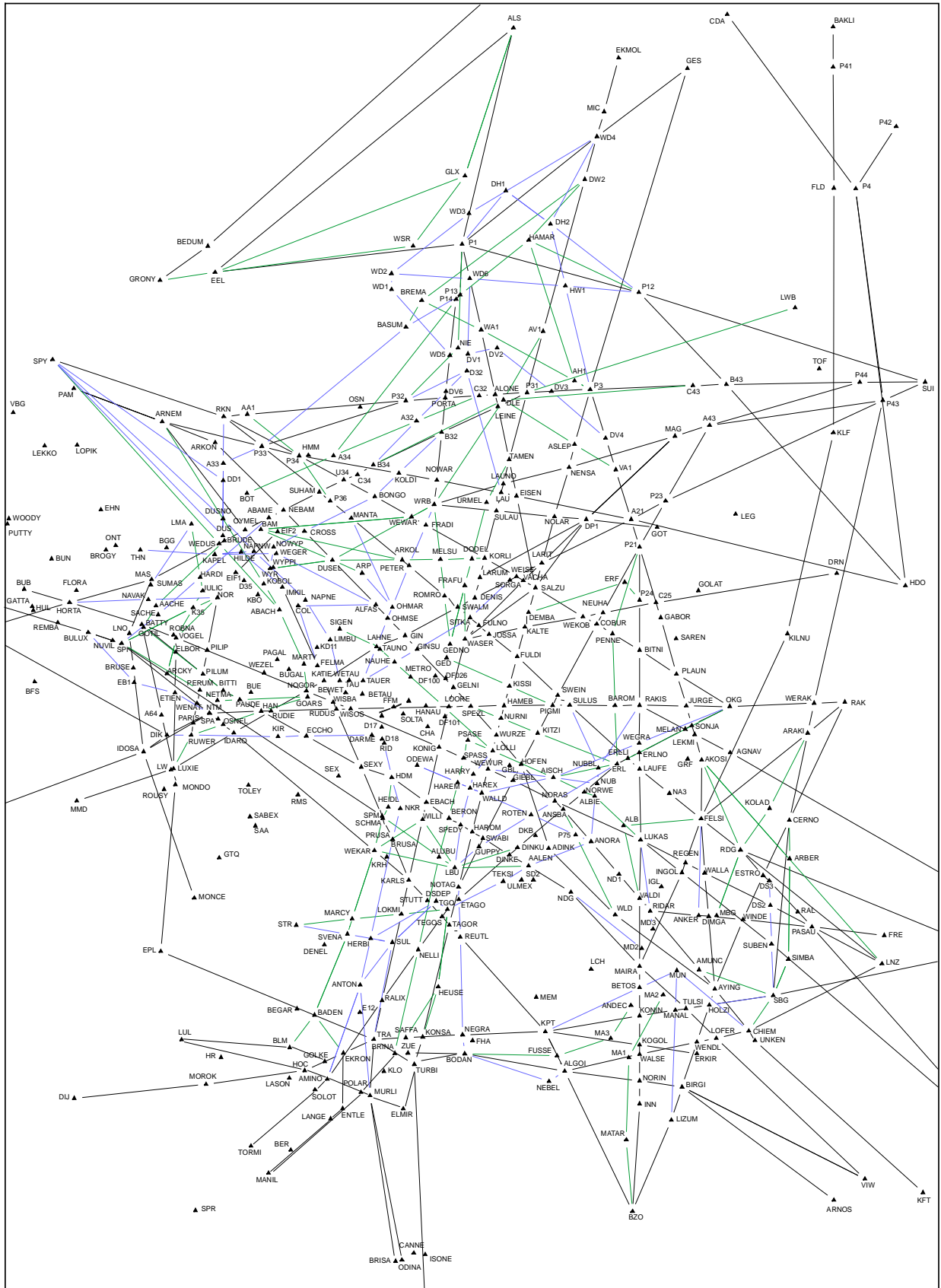
Il est recommandé de :

- réaliser des études complémentaires pour certaines régions de l'espace aérien avant d'y mettre en oeuvre la nouvelle structure de routes et la nouvelle sectorisation;
- mettre en oeuvre partiellement les résultats de la simulation dans les régions où aucun problème majeur n'a été relevé;
- mettre en oeuvre le RVSM dès que possible;
- revoir les limites des zones militaires compte tenu du nouveau concept d'espace aérien et des intérêts militaires.

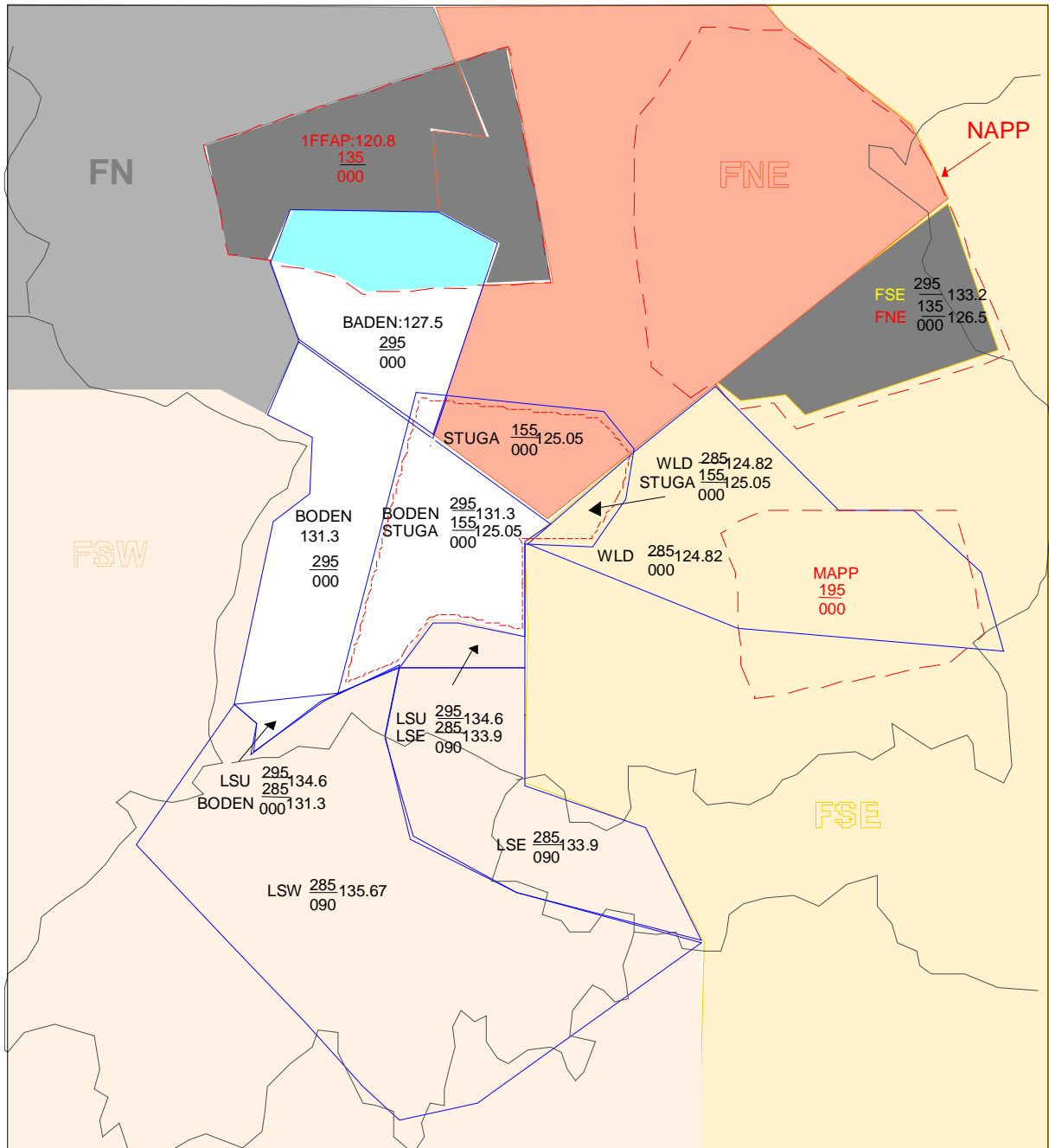
## **Annex A: Maps**



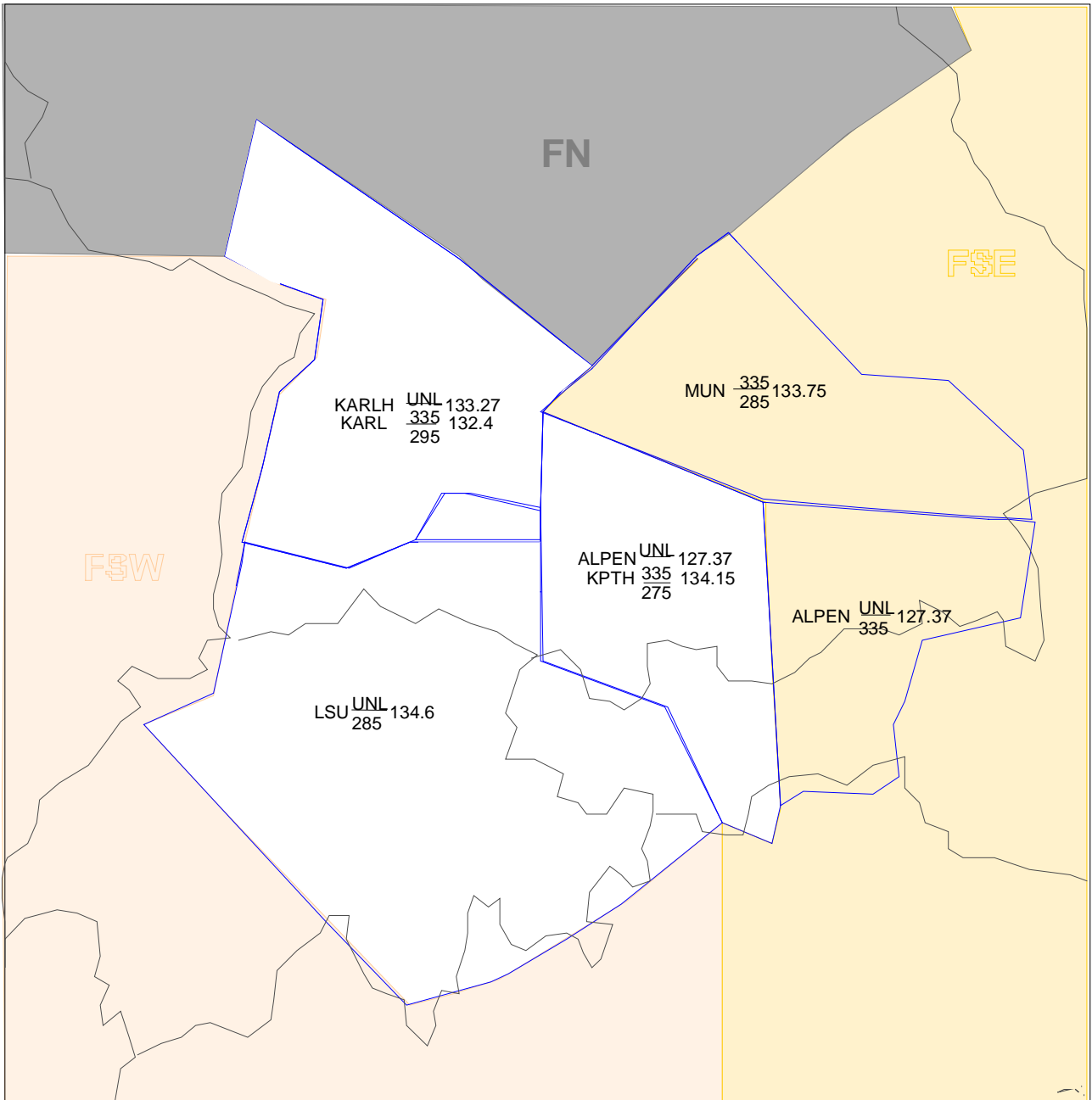
# SIMULATED ROUTE STRUCTURE



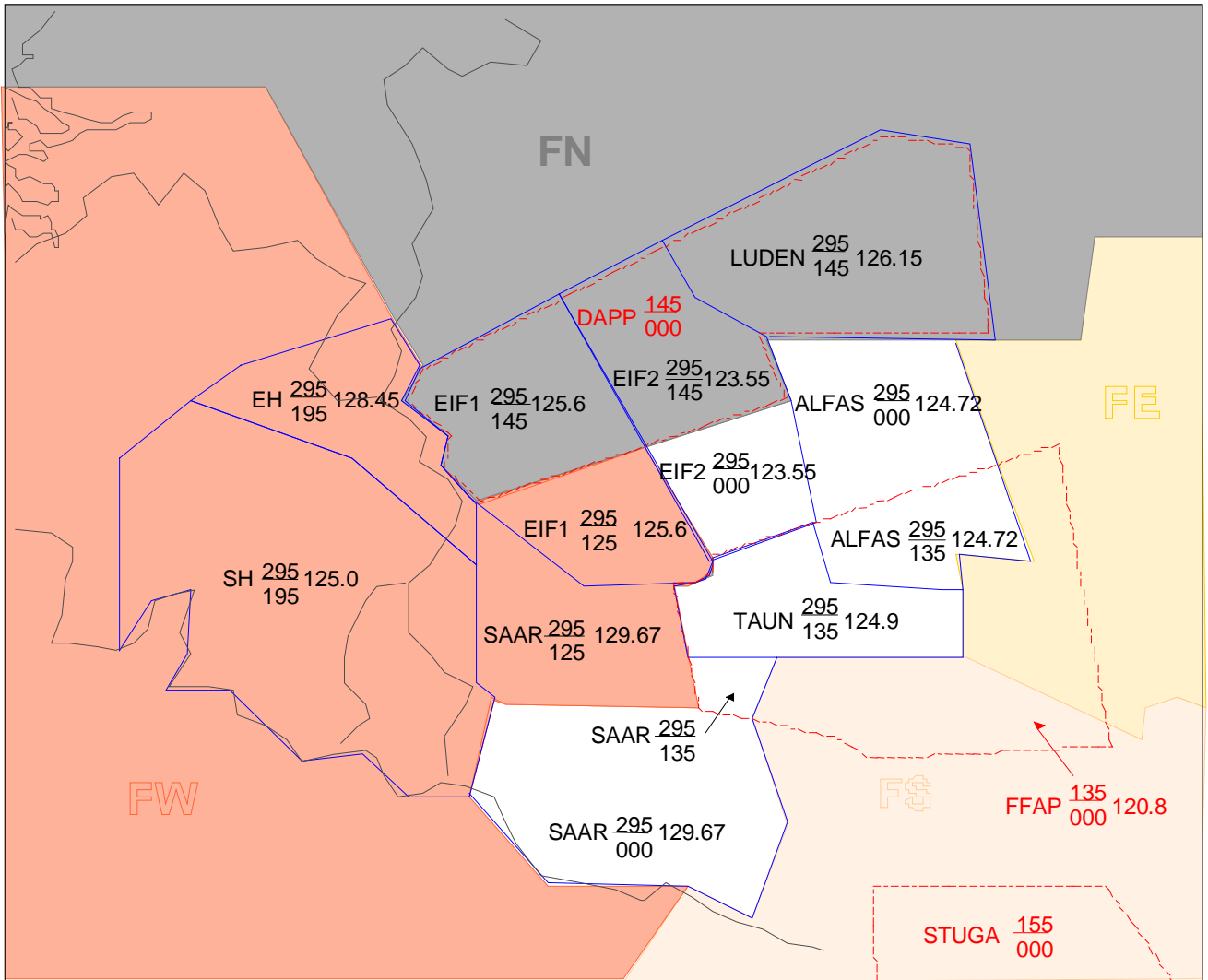
GERMANY 98 - ORG 1 - FL295 BELOW



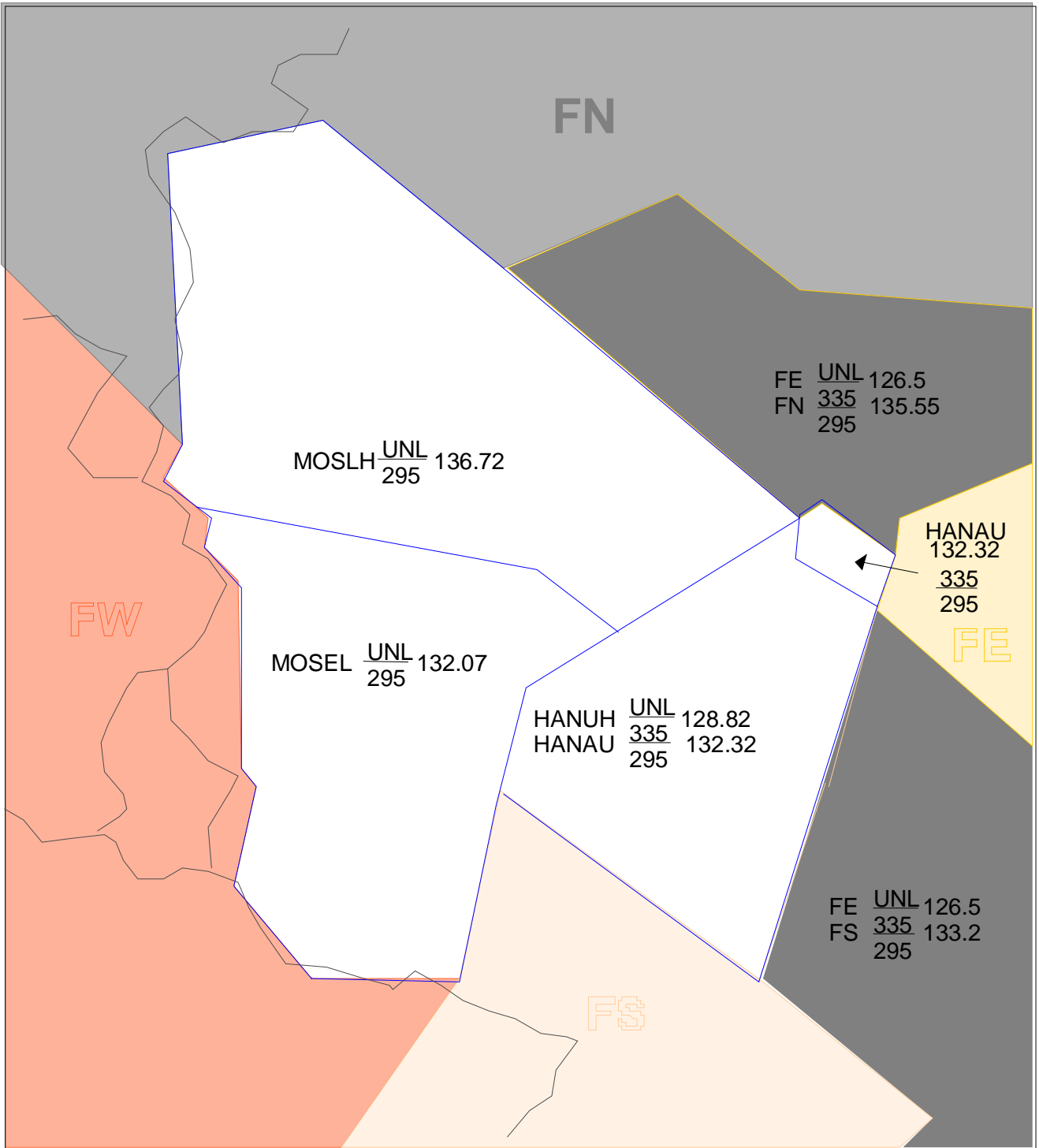
GERMANY 98 - ORG 1 - FL295 ABOVE



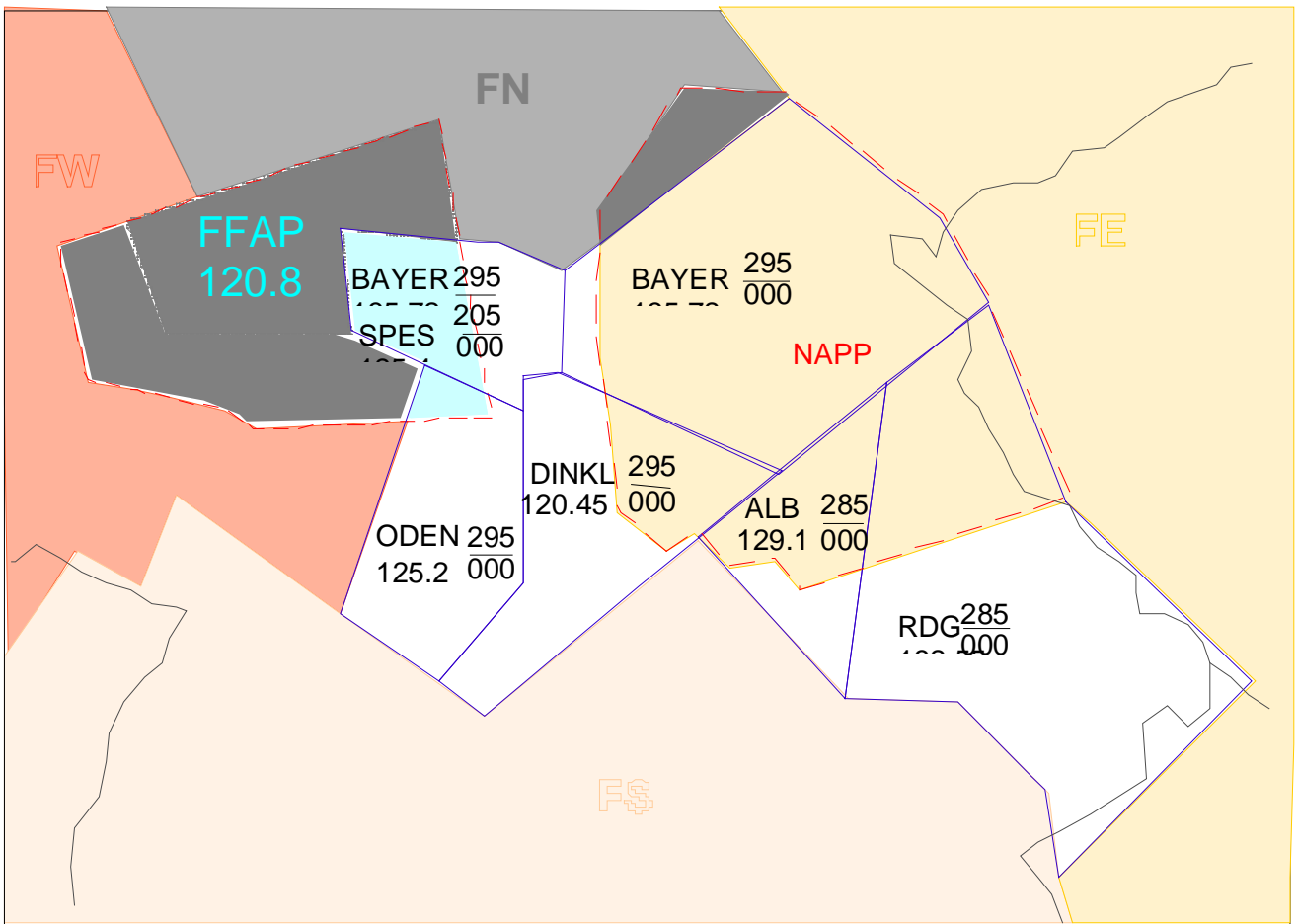
# GERMANY 98 - ORG 2 - FL295 BELOW



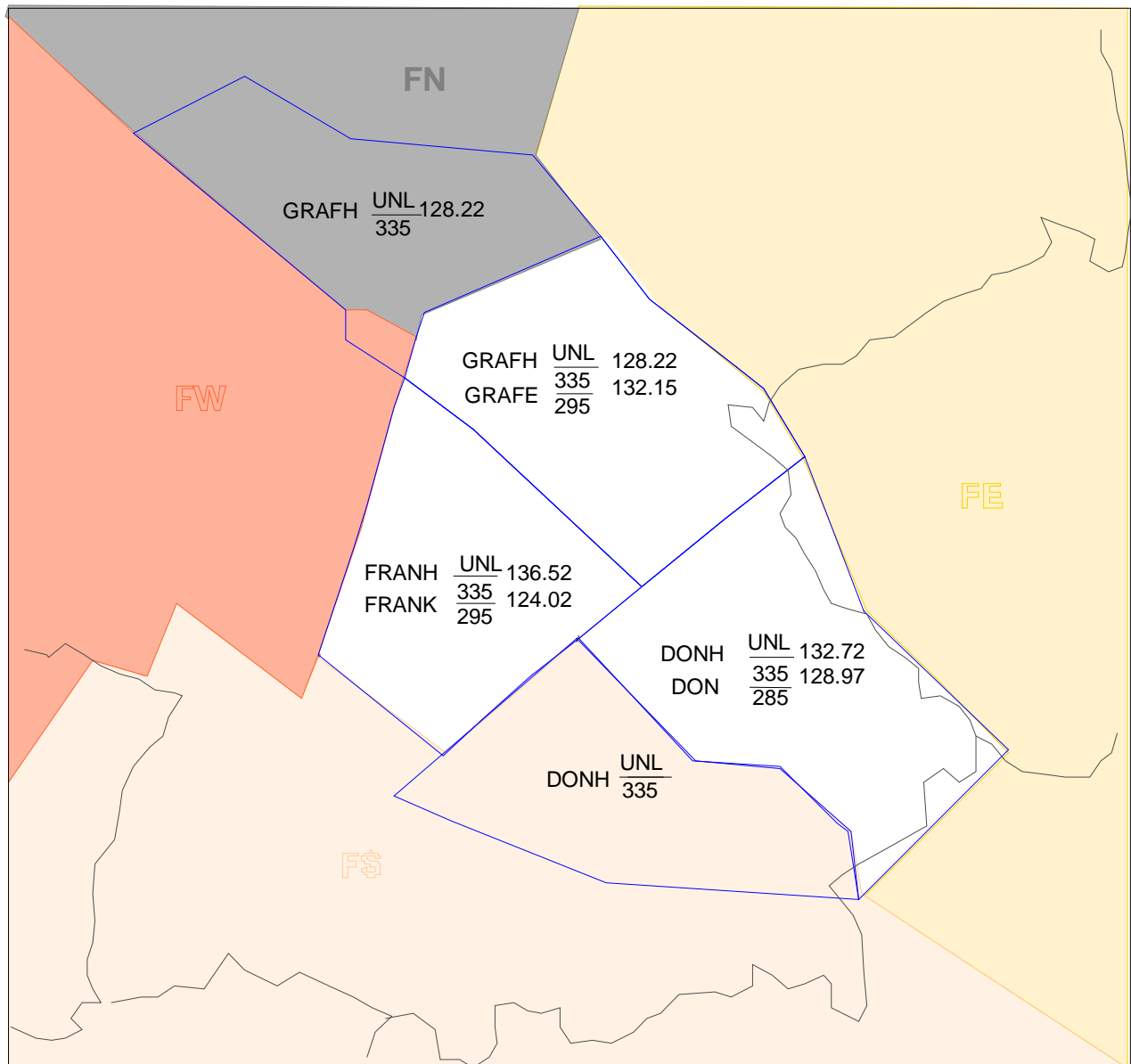
GERMANY 98 - ORG 2 - FL295 ABOVE



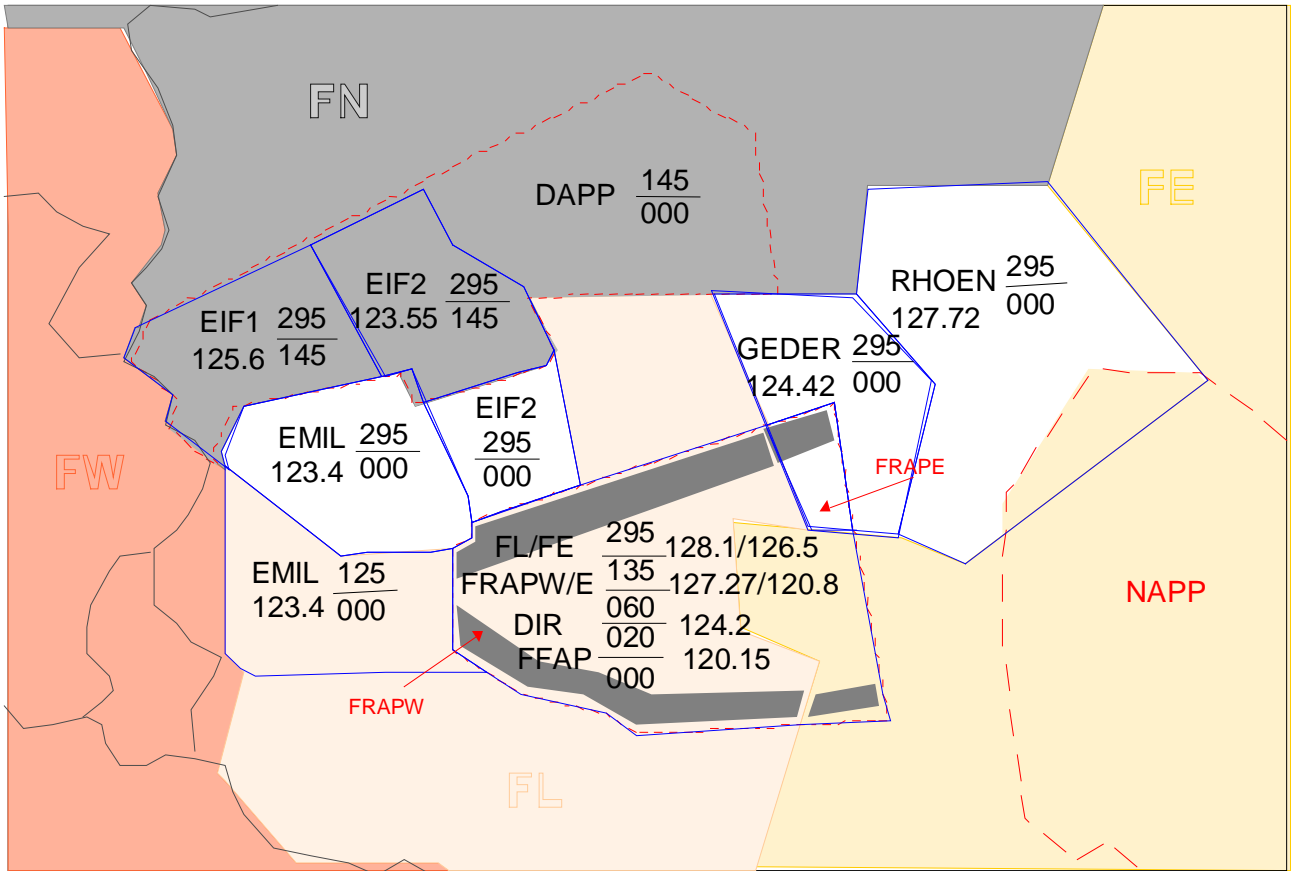
GERMANY 98 - ORG 3 - FL295 BELOW



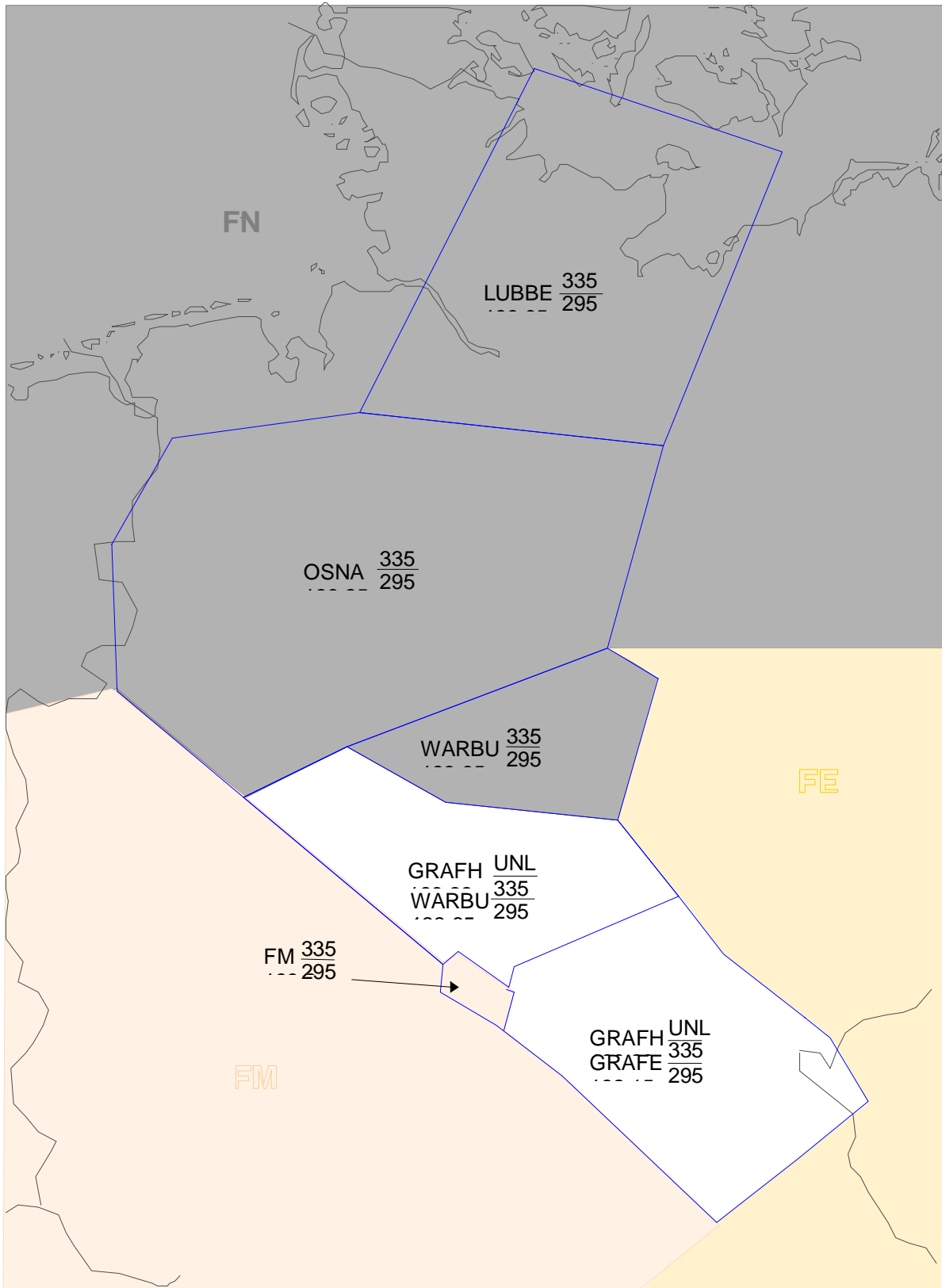
# GERMANY 98 - ORG 3 - FL295 ABOVE



GERMANY 98 - ORG 4 - FL295 BELOW



GERMANY 98 - ORG 4 - FL295 ABOVE

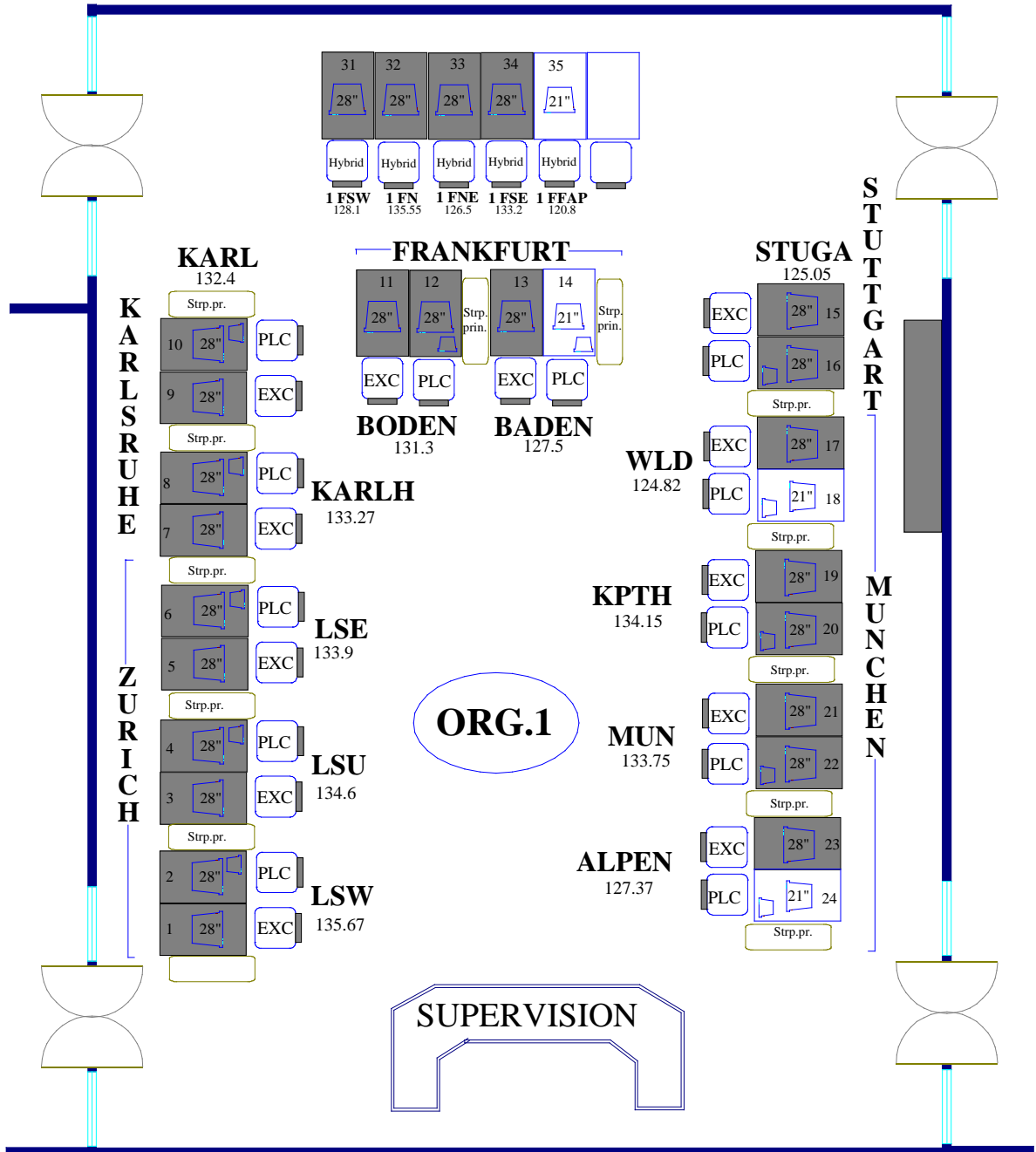




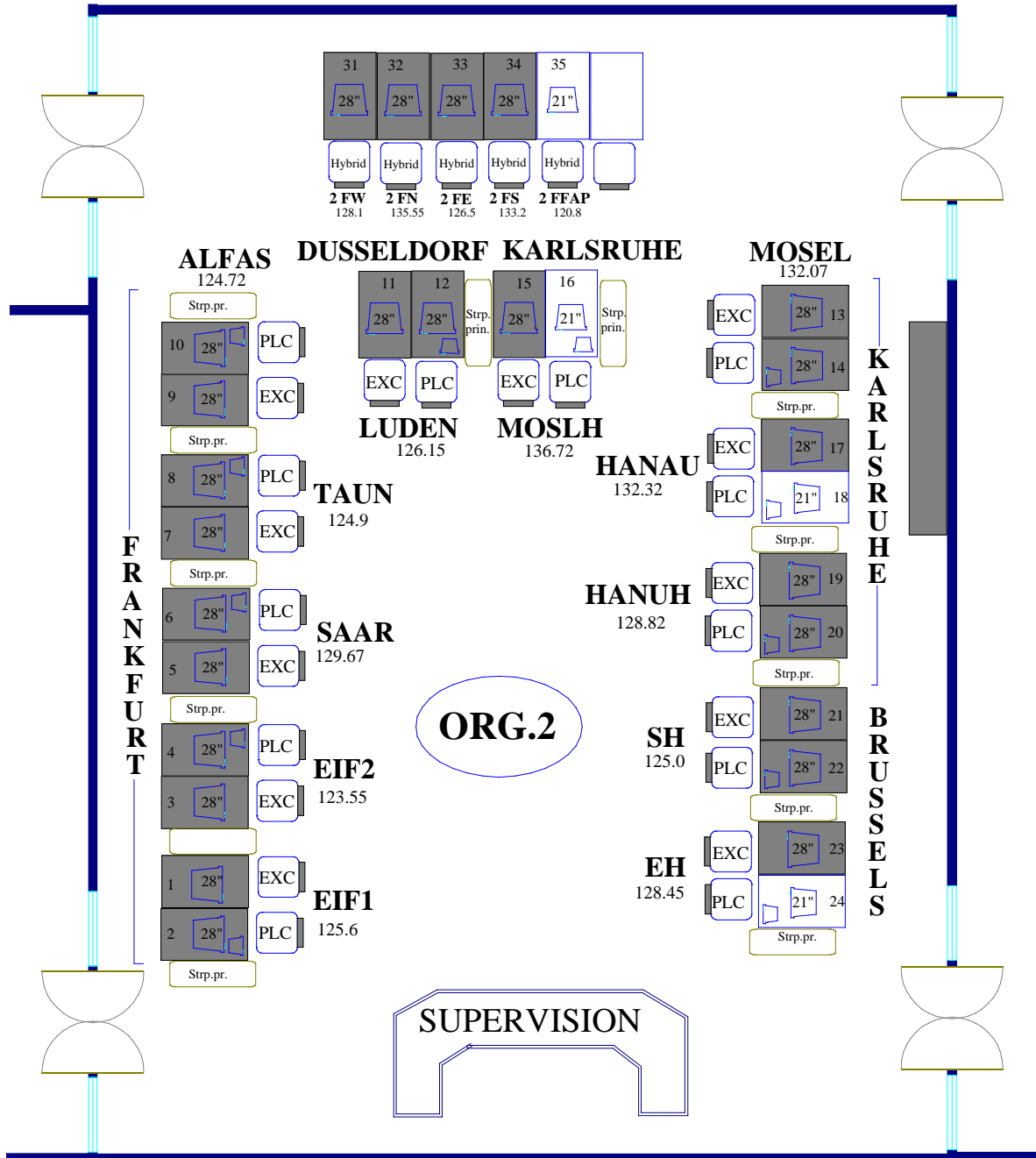
## **Annex B: Room Layout**



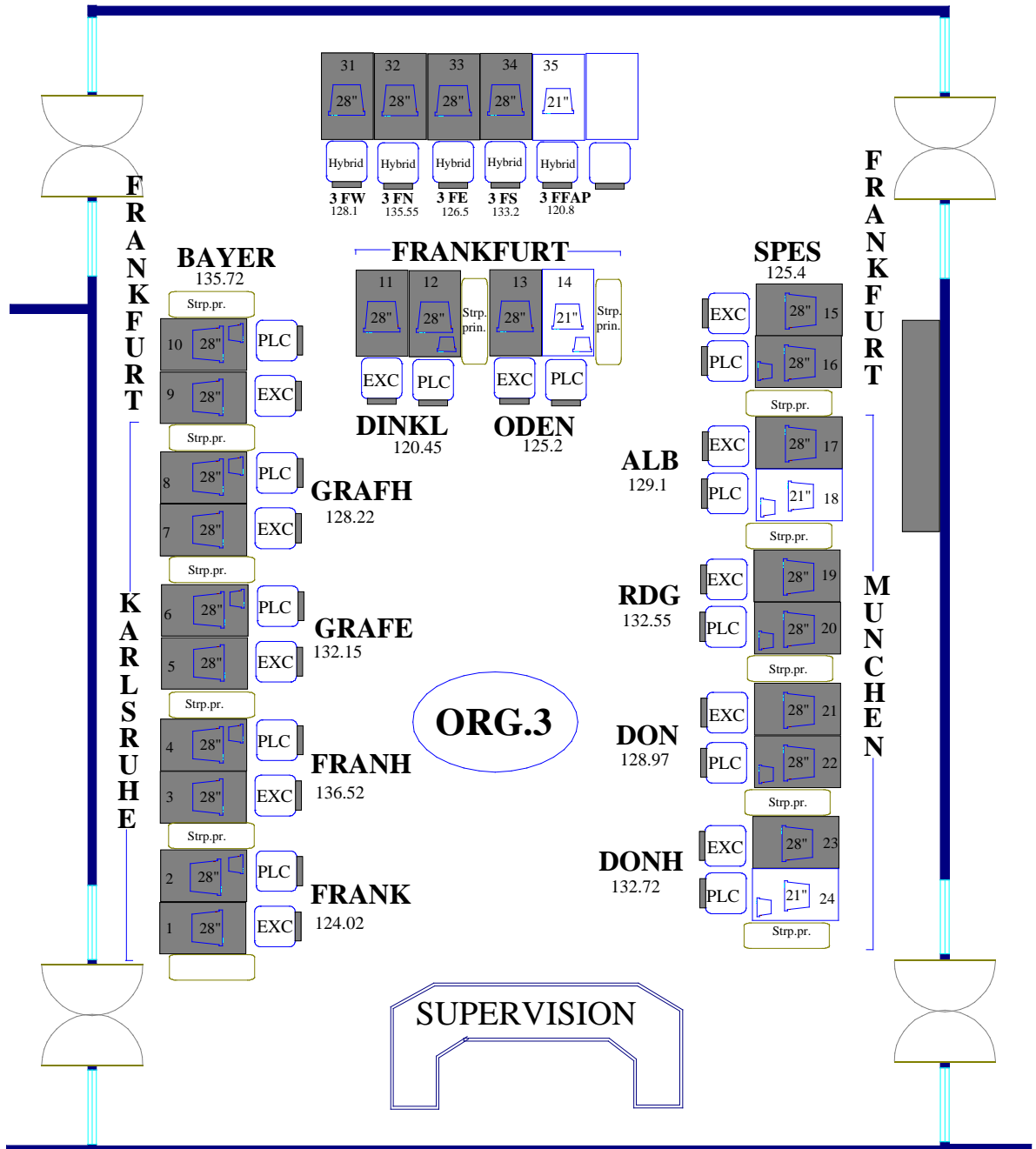
# OPERATIONS ROOM – ORGANISATION 1



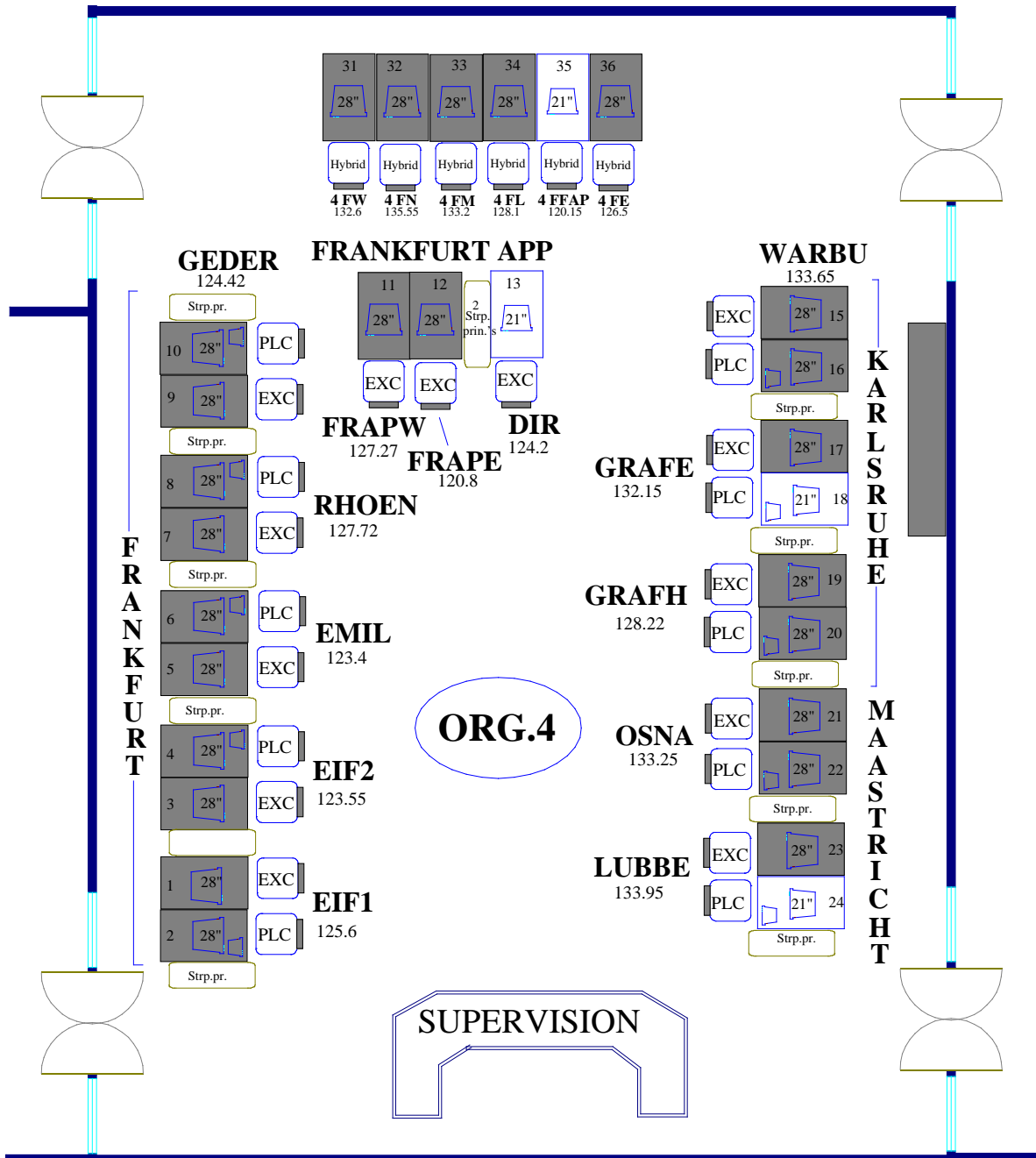
# OPERATIONS ROOM – ORGANISATION 2



# OPERATIONS ROOM – ORGANISATION 3



# OPERATIONS ROOM – ORGANISATION 4



## **Annex C: ATC Sectors Problem Table**



## IMPACT OF ORGANISATIONS ON CURRENT ATC SECTOR PROBLEMS - CONTROLLER DEFINED

### Note:

The tables on the following pages only show the results pertaining to sector problems that the controllers classified as **EXTREMELY SEVERE**. Other major sector control problems classed as **SEVERE** and **MODERATE** will be included in a separate document, which will be published by 31/07/99.

### LEGEND:



Extremely severe



Severity increased



Severity decreased



New problem



Problem resolved







No change

ORG 1											
Sectors Problems	BODEN	BADEN	STUGA	KARL/H	WLD	KPTH	MUN	ALPEN	LSE	LSU	LSW
A											
B											
C											
D											
E											
F											
G											
H											
I											
J											
K											
L											
M											

ORG 2						
SECTORS PROBLEMS	EIFEL 1	EIFEL 2	SAAR	TAUNUS	ALFAS	HANAU/HANUH
A						
B						
C						
D						
E						
F						
G						
H						
I						NEW
J						

ORG 3							
SECTORS PROBLEMS	DINKL	BAYER	ODEN	FRANK	FRANH	GRAFE	GRAFH
A							
B							
C							
D							
E							
F							
G							
H							
I							
J							

ORG 4					
SECTORS PROBLEMS	GEDER	FRAPE	OSNA	WARBU	RHOEN
A					
B					
C					
D				NEW	
E					