Appendix A

ATC RVSM SIMULATIONS IN THE CAR/SAM REGIONS

I. Objectives of the continental ATC RVSM simulation in Brazil

1. The objectives of the continental RVSM simulation in Brazil were as follows:

a) Assess the impact of RVSM implementation in the Brazilian continental airspace, based on a comparison of the parameters obtained from the simulation of the proposed scenarios;

b) Propose actions and make recommendations for the implementation of RVSM in the Brazilian continental airspace;

c) Provide information that will expedite RVSM implementation in the CAR/SAM Regions;

d) Propose guidelines for the development of ATC training programmes; and

e) Assess the need to conduct additional ATC RVSM simulations.

2. Real-time (radar) simulation

2.1 Parameters

In order to assess the impact of applying the RVSM concept in Brazilian continental airspace, three scenarios were developed and simulated in real time. In each scenario, parameters had to be collected for use as additional aid in the analytical process, based on data collation.

The following parameters were selected to assess the effects of RVSM implementation on the work load of air traffic controllers:

2.1.1 Ground/air/ground communications

Ground/air/ground communications are one of the main factors affecting the work load of air traffic controllers. The longer ground/air/ground communications are used, less time will be available for other typical ATC activities and the greater the work load of the controller. More complex scenarios, such as sectors responsible for aircraft climb and descent control or for accommodating non-RVSM aircraft, tend to demand a more significant amount of this type of communications. The measurement of the time used for ground/air/ground communications is one of the factors that will permit to draw conclusions as to the consequences of RVSM implementation on controller work load. The number of ground/air/ground communications and the total time used for said communications was measured for each aircraft in specified time intervals, and the data were collected systematically. A comparison of the times used for ground/air/ground communications in the various scenarios will provide information that will help to identify the best way to implement RVSM.

2.1.2 Ground/ground communications

Like for ground/air/ground communications, traffic coordination communications between adjacent ATS units and among sectors of a single ATC unit tend to increase in more complex ATC scenarios. The number of ground/ground communications and the total time used for said communications were measured at specified time intervals, and the data were collected systematically. A comparison of total times used for ground/ground communications in the various scenarios will also provide information about the consequences of RVSM implementation and, especially, its impact on controller work load.

2.1.3 Observable tasks of air traffic controllers

For purposes of the continental ATC RVSM simulation in Brazil, observable tasks were considered to be those activities performed by air traffic controllers in the effective control position during the provision of air traffic services. These tasks are basically the following: ground/air communications, keyboard activities, coordination with the assistant, and filling the flight progress strips. As in the case of the aforementioned parameters, there is a trend to use more time in the performance of observable tasks in a highly complex environment, thus reducing the time for ATC traffic planning and "recovery", which hinders the capability of controlling simultaneous aircraft and the ATC capacity of control sectors. A comparison betweeen the times used by air traffic controllers in the performance of observable tasks in the various scenarios will permit an analysis of the effects of RVSM implementation in the Brazilian airspace.

2.1.4 Incidents occurred

Normally, a highly complex operational environment is more favourable for the occurrence of air traffic incidents. For purposes of the Brazilian continental ATC RVSM simulation, an air traffic incident was considered to be the condition in which aircraft proximity was smaller to the minimum established by current standards. Air traffic incidents occurring in each scenario were identified and accounted for. A comparison between the number of incidents occurred in Scenario 1 (baseline) and other scenarios provided information about the trend for traffic incident occurrence in an RVSM environment.

2.1.5 Unfulfilled flight level requests

RVSM implementation is expected to improve the use of optimum flight levels. Accordingly, the data collected on unfulfilled flight level requests in the various scenarios were of vital importance, and the difference between the requested and cleared flight levels for each aircraft whose request was not fulfilled was identified. This parameter led to the identification of the best option from the users perspective. Aircraft not granted the requested flight level were classified as aircraft granted a flight level other than that requested during any of the flight phases.

2.2 Simulation tools

The X-4000 system, used at the Belem, Brasilia, Manaus and Porto Velho area control centres, was used as a simulation tool. It is an exact reproduction of the system used in the aforementioned Brazilian ACCs.

2.3 Scenarios

Taking into account the aspects to be submitted to an objective and/or subjective analysis based on the selected parameters, three scenarios were defined:

a) Non-RVSM (baseline);

b) RVSM applied in an exclusive airspace, between FL 290 and FL 410; and

c) RVSM applied in a non-exclusive airspace, between FL 290 and FL 410, allowing for non-RVSM aircraft operations in RVSM airspace.

2.3.1 Non-RVSM (baseline) scenario

In this scenario, normal non-RVSM traffic conditions were simulated, which served to obtain values for collation with other simulation conditions foreseen in the other scenarios.

2.3.2 RVSM applied in an exclusive airspace between FL 290 and FL 410

For this scenario, the following simulation aspects were considered:

a) All non-RVSM aircraft flew below FL290 or above FL410, except for State aircraft, and humanitarian, maintenance and ferry flights.

b) Taking into account that the Cruise Level Table to be applied in the CAR/SAM Regions after RVSM implementation will reflect the opposite direction of the Cruise Level Tables for the EUR/SAM corridor, consideration was given to the possibility of having, at some point, aircraft flying the same flight level in opposite directions in the proximity of the current RVSM transition area of the Recife ACC.

c) The need to provide a 2000-ft vertical separation minimum between non-RVSM aircraft and other aircraft (RVSM or non-RVSM), whenever other type of (lateral or longitudinal) separation was not guaranteed.

2.3.3 RVSM applied in a non-exclusive RVSM airspace between FL 290 and FL 410, allowing for the operation of non-RVSM aircraft in RVSM airspace

In this scenario, RVSM was applied between FL 290 and FL 410, allowing for the operation of non-RVSM aircraft, depending on existing traffic conditions and ATC judgment. The following aspects were considered for the simulation:

a) The need to provide a 2000-ft vertical separation minimum between non-RVSM aircraft and other aircraft (RVSM or non-RVSM), whenever other types of (lateral or longitudinal) separation were not guaranteed.

b) Regarding the EUR/SAM corridor, the possibility remains that, at some point in time, aircraft will be flying the same flight level in opposite directions in the proximity of the current RVSM transition area of the Recife ACC.

2.4 Simulation area

In view of the characteristics and availability of ATC operational positions in the simulator and the established parameters, the simulation scenarios developed included high traffic density areas (the regions of Sao Paulo and Rio de Janeiro in the Brasilia FIR, and control sectors 3 and 4 of the Curitiba FIR) and areas of high complexity for RVSM application (Sectors 1 to 6 of the Recife FIR, given the operational characteristics in the EUR/SAM corridor).

The simulation area was sized and distributed among available simulator operational positions as follows:

Operational position	Control sector	FIR
1	1 y 2	Recife
2	3 y 4	Recife
3	5 y 6	Recife
4	Rio region	Brasilia
5	Sao Paulo region	Brasilia
6	3 y 4	Curitiba

2.5 Operational aspects

2.5.1 Coordination

In order to accommodate non-RVSM aircraft, the sector responsible for the effective control of the aircraft made coordinations with the adjacent sector in advance, in order to ensure the continuing flight of non-RVSM aircraft, at least in two control sectors. Where it was not possible to secure the flight level to accommodate the aircraft in the adjacent sector, the pilot was notified and made the decision whether or not to enter the RVSM airspace, depending on possible flight restrictions.

2.5.2 Phraseology

Use was made of the phraseology contained in ICAO Doc. 4444, PANS-ATM, Air Traffic Management, and in the Brazilian National Documentation, in Portuguese and English. The specific RVSM phraseology contained in the Draft ATC RVSM Training Guidance Manual for the CAR/SAM Regions, Version 0.2, was also used.

2.5.3 Procedures for total suspension of RVSM operations

In the event of a total suspension of RVSM operations in a given portion of airspace due to more than moderate or severe turbulence, the following Cruise Level Table was applied:

MAGNETIC HEADING	
000º to 179º	*180º to 360º*
	FL 300
FL 330	
	FL 360
FL 390	

This table was prepared based on the following criteria:

a) Elimination of the Cruise Level Table used prior to RVSM implementation, since controllers would no longer be familiar with its use and aeronautical charts and automated flight plan systems would already have been modified for RVSM application.

b) Use of a Table of Cruising Levels that will avoid the presence of aircraft at the same flight level in opposite directions. This could occur if a 2000-ft separation were applied without taking into account the direction of flights.

As may be noted, the Cruise Level Table was developed for a 3000-ft separation, which only provides two FL in each direction. However, taking into account that suspensions rarely occur, traffic flow control measures could be adopted to ensure that the flight levels used are sufficient for traffic during total suspension of RVSM operations.

During the simulation, traffic was gradually accommodated according to the new Cruise Level Table, and traffic flow control measures were taken, based on the availability of only two flight levels in each direction.

2.5.4 Procedures to accommodate non-RVSM aircraft

To accommodate non-RVSM aircraft flights in scenarios 2 (State aircraft, humanitarian, maintenance and ferry flight) and 3, the following specific procedures were developed:

a) blockage of adjacent flight levels above and below the cleared flight level of non-RVSM aircraft, maintaining the aircraft in said cleared flight level, air traffic conditions permitting;

b) diverting non-RVSM aircraft 2000 ft (two-way routes) or 1000 ft (one-way routes) above or below the cleared flight level, depending whether the conflicting traffic is in the flight level immediately below or above, respectively, the non-RVSM aircraft;

c) diverting non-RVSM aircraft 4000 ft (two-way routes) or 3000 ft (one-way routes) below the cleared level, if there is conflicting traffic in the levels above or below the non-RVSM aircraft; and

d) removing the non-RVSM aircraft from RVSM airspace.

In order to accommodate non-RVSM aircraft, two flight levels were posted in the strips for said aircraft: one below FL 290, to be used in case the non-RVSM aircraft could not be accommodated, and the other at or above FL 290, to be used in the event the non-RVSM aircraft could be accommodated.

During the simulation, the air traffic controller accommodated the non-RVSM aircraft, ensuring 2000-ft vertical separation or horizontal (longitudinal or lateral) separation. Preference was given to RVSM aircraft over non-RVSM aircraft for flight level clearance. Preference was given to non-RVSM aircraft only when it entailed an operational advantage for the ATC, as established in the CAR/SAM RVSM Operational Concept (CONOPS RVSM).

2.5.5 Procedures in the event of failure of existing airborne systems

In the event of failure of aircraft altimetry or height-keeping systems, the air traffic controller adopted the same procedures used for accommodating non-RVSM aircraft, trying, wherever possible, to keep the aircraft within RVSM airspace. The case of failure of airborne systems in an aircraft is similar to accommodating non-RVSM aircraft.

2.5.6 Procedures for the EUR/SAM corridor RVSM transition area – Cruise Level Table

Based on the application of the reverse Cruise Level Table in the EUR/SAM corridor, the following procedures were adopted for scenarios 2 and 3:

a) Aircraft entering the EUR/SAM corridor and/or continental airspace will climb 1000 ft, if there is no traffic conflict, verifying only that the corresponding Cruise Level Table is complied with.

b) Aircraft flying from Europe to South America or *vice versa* will climb 1000 ft, depending on traffic conditions. Once the essential traffic has been surpassed, the aircraft to which the corresponding Cruise Level Table was not applied will climb.

c) Aircraft flying from Europe to South America will climb 1000 ft, and aircraft flying from South America to Europe will descend 1000 ft.

d) If traffic conditions prevent the application of the procedures described in a), b) and c) above, use radar vectors so that each aircraft will fly 5NM to the right of the route.

2.6 Requirement specifications for the ATC RVSM simulation

2.6.1 Composition and duration

Simulations were developed based on information obtained from a real data base. Of a total of 181 aircraft, 43 were non-RVSM (6 humanitarian flights, 10 State aircraft and 1 ferry flight). The time interval between 18:00 and 22:00 UTC was selected. Events were condensed in a total of three hours.

2.6.2 Simulation details by scenario

The traffic volume used in the simulation for the non-RVSM (baseline) scenario was taken from the operational reality of each ATC unit/region/sector, with conditions that forced controllers to apply, between FL 290 and FL 410, processes which involved FPL clearances, new flight level clearances, traffic sequencing for terminal control areas or for STARs, and to foresee/resolve traffic conflict conditions using an approach mainly based on route crossings, taking into account that all the conditions present in this simulation were also present in subsequent simulations in which RVSM was applied.

In the area of the Recife ACC, the simulation included the following conditions:

a) Conflicting traffic in ATS route crossings, mainly over the Fortaleza, Mossoró, Salvador and Recife VORs;

b) FPL clearances, with situations in which the requested FL could not be granted;

c) International FPL clearances departing from Fortaleza, Recife and Salvador and headed for Europe, with holding time on ground due to non-availability of flight levels;

d) Traffic sequencing for the main TMAs in the area; and

e) Handover of traffic with conflicting flight levels to/from the Brasilia ACC.

In the Brasilia ACC area, the simulation included the following conditions:

a) Conflicting traffic in ATS route crossings, mainly over the Confins and Campinas VORs, and at the crossings of ATS routes with route UG741;

b) FPL clearances, with situations in which the requested flight level could not be granted;

c) International FPL clearances departing from Guarulhos, Galeao and Confins, headed for Europe or the United States, with holding time on ground due to non-availability of flight levels;

d) Traffic sequencing for STARs at the main aerodromes in the area; and

e) Handover of traffic with conflicting flight levels to/from the Curitiba and Recife ACCs.

In the Curitiba ACC area, the simulation included the following conditions:

a) Conflicting traffic in ATS route crossings, mainly over the Sorocaba, Curitiba and Navegantes VORs;

b) FPL clearances, with situations in which the requested flight level could not be granted;

c) International FPL clearances departing from Curitiba, Guarulhos and Porto Alegre, and headed for Europe or the United States, with holding time on ground due to non-availability of flight levels;

d) Traffic sequencing for STARs at the main aerodromes in the area; and

e) Handover of traffic with conflicting flight levels to /from the Brasilia ACC.

The simulation exercise for the scenario in which RVSM is applied in an exclusive airspace contained all the conditions of exercise 1, with the same traffic volume and data extracted from the operational reality of each ATC unit/region/sector, and conditions which forced the controller to apply the RVSM concept between FL 290 and FL 410, under conditions involving FPL clearances, new flight level clearances, traffic sequencing for terminal control areas or STARs, and to foresee/resolve traffic conflict situations, using an approach mainly based on route crossings, in order to measure the impact of RVSM implementation.

In the area of the Recife ACC, this exercise included all the conditions of exercise 1, in addition to the following:

a) Traffic crossings between RVSM and non-RVSM aircraft (State aircraft, humanitarian, maintenance and ferry flights), under conditions that forced the controller to provide vertical separation of, at least, 2000 ft;

b) Non-RVSM traffic requesting RVSM FL clearance;

c) Northbound RVSM traffic on FL310, FL350, FL390 and FL410 in conflict with southbound traffic on the same levels, in the RVSM transition area in the proximity of the EUR-SAM corridor; and

d) Take-offs from Salvador headed for Recife, Fortaleza and Europe, requesting flight levels FL310, FL350, FL390 and FL410.

In the area of the Brasilia and Curitiba ACCs, simulation conditions were the same as for exercise 1, in addition to the following:

a) Traffic crossings between RVSM and non-RVSM aircraft (State aircraft, humanitarian, maintenance and ferry flights) under conditions that forced the controller to provide a vertical separation of, at least, 2000-ft; and

b) Non-RVSM aircraft requesting RVSM FL clearance.

The third ATC simulation exercise considered a scenario in which the RVSM concept was applied, without restrictions for entry by non-RVSM aircraft between FL 290 and FL 410. The conditions for this exercise were identical to those for exercise 1, with situations that forced the controller to apply the RVSM concept under conditions involving FPL clearances, new flight level clearances, traffic sequencing for terminal control areas or STARs, and foresee/resolve traffic conflicts, using an approach mainly based on route crossings, while accommodating non-RVSM aircraft, with the separations required between these and RVSM aircraft, in order to measure and evaluate the impact of the tactical application of the RVSM concept.

In the area of the Recife, Brasilia and Curitiba ACCs, simulation conditions were the same as for exercise 2, but also included the crossing of RVSM and non-RVSM aircraft, under conditions which forced the controller to provide a vertical separation of, at least, 2000 ft, and their accommodation between FL 290 and FL 410.

2.6.3 Controller work load

During simulation planning, the following distribution of controller work load was noted:

a) During the first fifteen minutes (0’-15’), the work load was low (4 ACFT controlled per grouped sectors or region, in average); this time was used to get the controller acquainted with the simulation;

b) Between fifteen and thirty minutes (15’-30’), there was a gradual increase of traffic, reaching 10 ACFT controlled per grouped sectors or region;

c) Between thirty and sixty minutes (30’- 01h), the traffic volume average remained the same (10 ACFT controlled per grouped sectors or region);

d) Between sixty and one hundred minutes (01h – 01:40h), there was a "peak hour" (an average of 12 ACFT controlled per grouped sectors or region);

e) Between one hundred and one hundred and fifty minutes (01:40h – 02:30h), traffic volume returned to average (10 ACFT controlled per grouped sectors or region); and

f) Between one hundred and fifty and one hundred and eighty minutes a (02:30h – 03:00h), the traffic volume average was maintained (10 ACFT controlled per grouped sectors or region).

2.6.4 Conduction of the exercises

The conduction of the exercises required a team of 46 air traffic controllers from the Brasilia, Curitiba and Recife ACCs, in the period from 1 to 18 September, at the simulators of the Flight Protection Institute, located in Sao José dos Campos. Simulation exercises involved five or six repetitions of each scenario, allowing for the collection of data for analysis.

3. Simulation results

The results of the Brazilian ATC simulation were obtained in different ways: by sector, by scenario, by status of RVSM approval of aircraft, etc., with a view to identifying all the factors which might have an impact on RVSM implementation in Brazilian airspace.

Collation of parameters by sector provided significant information for reaching conclusions on each of the Brazilian FIRs. These results were obtained from the average number of valid exercises. For valid exercises, the average and trend of collected data were considered, trying to give more consistency to the sample for subsequent analysis. This method allowed for the elimination of atypical results of the sample, due by contingencies such as: data collection failures, below or above average air traffic controller performance, the natural familiarisation process during the initial exercises, etc. Thus, the analysis covered the three exercises that obtained the most representative results, except for the "unfulfilled flight level requests" parameter, which was included in 5 exercises; and the "air traffic incidents" parameters and the questionnaire, which were included in all of the exercises. The results by sector are shown in the **Attachment** to this document.

Tables 1, 2 and 3, below, show the general results, by scenario, in which the results obtained by sector have been added and compared between scenarios:

General results by scenario - absolute values								
SCENARIO	Ground/air/ground communications				Ground/ground communications			
	N	D	NM	DM	N	D	NM	DM
1	572.33	8.351.33	2.84	41.41	81.67	1.852.00	0.96	21.87
2	537.67	7.050.67	2.67	34.96	71.00	1.589.00	0.82	18.42
3	490.33	6.284.00	2.50	32.06	61.33	1.524.00	0.70	17.52
	Legend: N – Number of ground/air/ground communications D – Total duration of ground/air/ground communications, in seconds NM – Average number of communications per aircraft DM – Average duration of communications per aircraft, in seconds				Legend: N – Number of ground/ground communications D – Total duration of ground/ground communications NM – Average number of communications per aircraft DM – Average duration of communications per aircraft			

General results by scenario - absolute values						
SCENARIO	Observable tasks			Unfulfilled flight level requests (total)		
	D	NA	DM	N	D	DM
1	13.739.33	202.67	67.79	8.60	17.753.44	2.064.35
2	10.306.50	197.50	52.18	40.00	125.612.00	3.140.30
3	10.117.33	196.67	51.44	3.60	2.500.00	694.44
	Legend: D – Total duration of observable tasks, in seconds. NA – Number of aircraft DM – Average duration of observable tasks, in seconds			Legend: N – Number of aircraft not granted preferred flight levels D – Total difference between requested and cleared levels, in feet DM – Average difference between requested and cleared levels, in feet.		

Table 1 – Absolute values of parameters

General results by scenario – comparative values Comparison between scenarios 2 and 3 and the baseline (scenario 1)								
Scenario	Ground/air/ground communications				Ground/ground communications			
	%N	%D	%NM	%DM	%N	%D	%NM	%DM
2	- 6%	- 16%	- 6%	- 16%	- 13%	- 14%	- 15%	- 16%
3	- 14%	- 25%	- 12%	- 23%	- 25%	- 18 %	- 27%	- 20%
	Legend: %N – Percent variation of the number of ground/air/ground communications between scenarios 2 and 3 and the baseline (scenario 1). %D – Percent variation of the duration of ground/air/ground communications between scenarios 2 and 3 and the baseline (scenario 1). %NM – Percent variation of the average number of ground/air/ground communications per aircraft between scenarios 2 and 3 and the baseline (scenario 1). %DM – Percent variation of the average duration of ground/air/ground communications per aircraft between scenarios 2 and 3 and the baseline (scenario 1).				Legend: %N – Percent variation of the number of ground/ground communications between scenarios 2 and 3 and the baseline (scenario 1). %D – Percent variation of the duration of ground/ground communications between scenarios 2 and 3 and the baseline (scenario 1). %NM – Percent variation of the average number of ground/ground communications per aircraft between scenarios 2 and 3 and the baseline (scenario 1). %DM – Percent variation of the average duration of ground/ground communications per aircraft between scenarios 2 and 3 and the baseline (scenario 1).			

General results by scenario – comparative values Comparison between scenarios 2 and 3 and the baseline (scenario 1)						
Scenario	Observable tasks			Unfulfilled flight level requests (total)		
	%D	%NA	%DM	%N	%D	%DM
2	- 25%	- 3%	- 23%	+365%	+ 608%	+52%
3	- 26%	- 3%	- 24%	-58%	- 86%	- 66%
	Legend %D – Percent variation of the duration of observable tasks between scenarios 2 and 3 and the baseline (scenario 1). %NA – Percent variation of the number of aircraft between scenarios 2 and 3 and the baseline (scenario 1). %DM – Percent variation of the average duration of observable tasks per aircraft between scenarios 2 and 3 and the baseline (scenario 1).			Legend %N – Percent variation of the number of aircraft not granted preferred flight levels between scenarios 2 and 3 and the baseline (scenario 1). %D – Percent variation of the total difference between cleared and requested levele between scenarios 2 and 3 and the baseline (scenario 1). %DM – Percent variation of the average difference between cleared and requested flight levels between scenarios 2 and 3 and the baseline (scenario 1).		

Table 2 – Comparative parameter values (scenarios 2 and 3, in relation to scenario 1)

General results by scenario – comparative values Comparison between scenarios 2 and 3								
Scenario	Ground/air/ground communications				Ground/ground communications			
	%N	%D	%NM	%DM	%N	%D	%NM	%DM
3	- 9%	- 11%	- 6%	- 8%	-14%	- 4%	- 14%	- 5%
	Legend %N – Percent variation of the number of ground/air/ground communications between scenarios 2 and 3. %D – Percent variation of the duration of ground/air/ground communications between scenarios 2 and 3. %NM – Percent variation of the average number of ground/air/ground communications per aircraft between scenarios 2 and 3. %DM – Percent variation of the average duration of ground/air/ground communications per aircraft between scenarios 2 and 3.				Legend %N – Percent variation of the number of ground/ground communications between scenarios 2 and 3 %D – Percent variation of the duration of ground/ground communications between scenarios 2 and 3. %NM – Percent variation of the average number of ground/ground communications per aircraft between scenarios 2 and 3. %DM – Percent variation of the average duration of ground/ground communications per aircraft between scenarios 2 and 3.			

General results by scenario – comparative results Comparison between scenarios 2 and 3						
Scenario	Observable tasks			Unfulfilled flight level requests (total)		
	%D	%NA	%DM	%N	%D	%DM
3	- 2%	0%	- 1%	- 91%	- 98%	- 78%
	Legend %D - Percent variation of the duration of observable tasks between scenarios 2 and 3. %NA – Percent variation of the number of aircraft between scenarios 2 and 3. %DM – Percent variation of the average duration of observable tasks per aircraft between scenarios 2 and 3.			Legend %N – Percent variation of the number of aircraft not granted their preferred flight levels between scenarios 2 and 3. %D – Percent variation of the total difference between the cleared and requested levels between scenarios 2 and 3. %DM – Percent variation of the average difference between cleared and requested levels between scenarios 2 and 3.		

Table 3 – Comparative parameter values (scenario 3 in relation to scenario 2)

3.1 Ground/air/ground communications

According to simulation results, there was a reduction of ground/air/ground communications between scenarios 1 and 2 and between scenarios 1 and 3, as shown in table 2. Obviously, this also represents a reduction of communications between scenarios 2 and 3, as shown in table 3. It may also be concluded that scenario 3, which accommodated non-RVSM aircraft, had the lowest ground/air/ground communications load, showing the feasibility of implementing procedures to authorise the entry of non-RVSM aircraft in RVSM airspace in a low/medium traffic density scenario, according to simulation assumptions.

3.2 Ground/ground communications

As in the case of ground/air/ground communications, and based on simulation results, there was also a reduction of ground/ground communications between scenarios 1 and 2 and between scenarios 1 and 3, as shown in table 2. Obviously, this also represents a reduction of communications between scenarios 2 and 3, as shown in table 3. It may also be concluded that scenario 3, which accommodated non-RVSM aircraft, had the lowest ground/ground communications load, showing the feasibility of implementing procedures to authorise the entry of non-RVSM aircraft in RVSM airspace in a low/medium traffic density scenario, according to simulation assumptions.

3.3 Observable controller tasks

As in the case of ground/air/ground and ground/ground communications, simulation results also show that there was a reduction in the time used for observable controller tasks between scenarios 1 and 2 and between scenarios 1 and 3, as shown in table 2. Obviously, this also implies a reduction, albeit not significant, of communications between scenarios 2 and 3, as shown in table 3. Considering that the Observable Tasks parameter includes ground/air communications and that there was a significant reduction in the ground/air/ground communications parameter between scenarios 2 and 3, it may be concluded that the other tasks of the controller increased, mainly coordination with the assistant in scenario 3. It may also be concluded that scenario 3, which accommodated non-RVSM aircraft, had the least time devoted to observable tasks, showing the feasibility of implementing procedures to authorise the entry of non-RVSM aircraft in RVSM airspace in a low/medium traffic density scenario, according to simulation assumptions.

3.4 Air traffic incidents

During the ATC RVSM simulation, two air traffic incidents occurred. One occurred while running scenario 1 (baseline), but was not considered for analysis of results since it was not caused by RVSM implementation. The other one occurred while running scenario 3, and was caused by an oversight of the status of a non-RVSM aircraft by the air traffic controller. This generated a violation of the separation foreseen for the sector (10 NM), where an RVSM aircraft flew at about 7 NM from a non-RVSM aircraft, with a 1000-ft vertical separation. The main contributing factor for the occurrence of this incident was that the ATC simulation system was not adjusted for RVSM implementation.

3.5 Unfulfilled flight level requests

According to simulation results, there was an increase in the number of aircraft granted their preferred flight levels between scenarios 1 and 2 and a reduction between scenarios 1 and 3, as shown in table 2. There was also a significant reduction in the number of aircraft that were not granted their preferred flight levels between scenarios 2 and 3. Thus, it may be concluded that, from the users point of view, which include non-RVSM and RVSM aircraft, scenario 3 allows for more aircraft to be granted their preferred flight levels, with the least difference between requested and cleared levels. It is important to stress that this analysis was made by comparing the number of requested and cleared levels in each scenario, and that scenario 2 used the levels requested in scenario 1 (baseline), taking into account the need to reflect the level of satisfaction of airspace users who, obviously, in the case of non-RVSM aircraft (scenario 2), would not like to fly below FL 290, and had to request a FL outside RVSM airspace.

3.6 Questionnaire

Another tool used for the subjective evaluation of the ATC RVSM simulation was a questionnaire developed with a view to obtaining the opinion of air traffic controllers and supplementing the analysis of objective parameters. This made it possible to collate the information obtained from objective parameters with the subjective opinion of air traffic controllers, thus contributing to the validation of the data obtained.

The main questions were the following:

Compared to scenario 1 (baseline), scenario 2 may be considered:

	Scenario 1		Scenario 2		Scenario 3	
	Nº	%	Nº	percent	Nº	%
a) much more complex	Not applicable		1	1%	Not applicable	
b) a little more complex			59	82%		
c) equivalent			9	13%		
d) a little less complex			2	3%		
e) much less complex			1	1%		

The accommodation of State aircraft and humanitarian and ferry flights in scenario 2 may be considered:

	Scenario 1		Scenario 2		Scenario 3	
	Nº	%	Nº	percent	Nº	%
a) non feasible	Not applicable		0	0%	Not applicable	
b) very complex			0	0%		
c) little complex			52	72%		
d) like a normal operation			20	28%		

Total suspension of RVSM operations may be considered:

	Scenario 2		Scenario 3		Total	
	Nº	percent	Nº	percent	Nº	percent
a) non feasible	0	0%	0	0%	0	0%
b) very complex	8	22%	3	6%	11	81%
c) little complex	25	69%	44	90%	69	13%
d) like a normal operation	3	8%	2	4%	5	6%

The task of accommodating an aircraft that has lost its RVSM status may be considered:

	Scenario 2		Scenario 3		Total	
	Nº	percent	Nº	percent	Nº	percent
a) easy	11	31%	20	45%	31	39%
b) average	25	69%	24	53%	49	60%
c) difficult	0	0%	1	2%	1	1%

Compared to scenario 1 (baseline), scenario 3 may be considered:						
	Scenario 1		Scenario 2		Scenario 3	
	Nº	%	Nº	%	Nº	percent
a) much more complex	Not applicable		Not applicable		1	2%
b) a little more complex					49	81%
c) equivalent					5	8%
d) a little less complex					4	7%
e) much less complex					1	2%

Compared to scenario 2, scenario 3 may be considered:						
	Scenario 1		Scenario 2		Scenario 3	
	Nº	%	Nº	%	Nº	percent
a) much more complex	Not applicable		Not applicable		0	0%
b) a little more complex					42	70%
c) equivalent					13	22%
d) a little less complex					5	8%
e) much less complex					0	0%

The number of non-RVSM aircraft you consider advisable to accommodate at the same time within RVSM airspace in the sector under your control is:						
	Scenario 1		Scenario 2		Scenario 3	
	Nº	%	Nº	%	Nº	percent
a) 0	Not applicable		Not applicable		0	0%
b) 1					4	8%
c) 2					0	0%
d) 3					21	35%
e) more than 3					34	57%

ATTACHMENT to ATC RVSM Simulations in Brazil

GROUND/AIR/GROUND COMMUNICATIONS

Presentation of results by scenario/control sector absolute values

Scenario	BS02					CW01				
	N	D	NA	NM	DM	N	D	NA	NM	DM
1	202.33	2.682.67	62.67	3.23	42.81	145.00	2.025.00	56.00	2.59	36.16
2	180.67	2.244.67	64.33	2.81	34.89	149.67	1.903.00	57.67	2.60	33.00
3	163.33	1.769.33	64.67	2.53	27.36	135.00	1.968.67	53.33	2.53	36.91

Presentation of results by scenario/control sector absolute values

Scenario	RE01					RE02				
	N	D	NA	NM	DM	N	D	NA	NM	DM
1	126.00	2.183.33	39.00	3.23	55.98	99.00	1.460.33	44.00	2.25	33.19
2	115.00	1.720.67	36.33	3.17	47.36	92.33	1.182.33	43.33	2.13	27.28
3	102.00	1.424.33	35.33	2.89	40.31	90.00	1.121.67	42.67	2.11	26.29

Legend:
N – Number of ground/air/ground communications
D – Total duration of ground/air/ground communications, in seconds
NA – Average number of aircraft
NM – Average number of communications per aircraft
DM – Average duration of communications per aircraft, in seconds

Presentation of results by scenario/control sector – comparative values
Comparison between scenarios 2 and 3 and the baseline (scenario 1)

Scenario	BS02				CW01				RE01				RE02			
	%N	%D	%NM	%DM	%N	%D	%NM	%DM	%N	%D	%NM	%DM	%N	%D	%NM	%DM
2	- 11%	- 16%	- 13%	- 18%	+ 3%	- 6%	0%	- 9%	- 9%	- 21%	- 2%	- 15%	- 7%	- 19%	- 5%	- 18%
3	- 19%	- 34%	- 22%	- 36%	- 7%	- 3%	- 2%	+ 2%	- 19%	- 35%	- 11%	- 28%	- 9%	- 23%	- 6%	- 21%

Presentation of general results by scenario - comparative values Comparison between scenarios 2 and 3																
Scenario	**BS02**				**CW01**				**RE01**				**RE02**			
	%N	**%D**	**%NM**	**%DM**	**%N**	**%D**	**%NM**	**%DM**	**%N**	**%D**	**%NM**	**%DM**	**%N**	**%D**	**%NM**	**%DM**
3	-10%	- 21%	- 10%	- 22%	- 10%	- 3%	- 2%	+ 12%	- 11%	- 17%	- 9%	- 15%	- 3%	- 5%	- 1%	- 4%
	Legend %N – Percent variation between scenarios of the number of ground/air/ground communications. %D – Percent variation between scenarios of the duration of ground/air/ground communications. %NM – Percent variation between scenarios of the average number of ground/air/ground communications per aircraft. %DM – Percent variation between scenarios of the average duration of ground/air/ground communications per aircraft.															

Ground/ground communications

Presentation of results by scenario/control sector absolute values										
Scenario	BS01					RE03				
	N	D	NA	NM	DM	N	D	NA	NM	DM
1	43.00	1.077.67	44.00	0.98	24.49	38.67	774.33	40.67	0.95	19.04
2	38.25	889.75	44.25	0.86	20.11	32.75	699.25	42.00	0.78	16.65
3	33.00	841.67	45.00	0.73	18.70	28.33	682.33	42.00	0.67	16.25
	Legend: N – Number of ground/ground communications D – Total duration of ground/ground communications, in seconds NM – Average number of communications per aircraft DM – Average duration of communications per aircraft, in seconds									

Presentation of results by scenario/control sector – comparative values Comparison between scenarios 2 and 3 and the baseline (scenario 1)								
Scenario	BS01				RE03			
	%N	%D	%NM	%DM	%N	%D	%NM	%DM
2	- 11%	- 17%	- 12%	- 18%	- 15%	- 10%	- 18%	- 13%
3	- 23%	- 22%	- 25%	- 24%	- 27%	- 12%	- 29%	- 15%

Presentation of general results by scenario - comparative values Comparison between scenarios 2 and 3								
Scenario	BS01				RE03			
	%N	%D	%NM	%DM	%N	%D	%NM	%DM
3	- 14%	- 5%	- 15%	- 7%	- 13%	- 2%	- 13%	- 2%
	Legend %N – Percent variation between scenarios of the number of ground/ground communications. %D – Percent variation between scenarios of the duration of ground/ground communications. %NM – Percent variation between scenarios of the average number of ground/ground communications. %DM – Percent variation between scenarios of the average duration of ground/ground communications per aircraft.							

Observable controller tasks

Presentation of results by scenario/control sector absolute values												
Scenario	BS02			CW01			RE01			RE02		
	D	NA	DM	D	NA	DM	D	NA	DM	D	NA	DM
1	2.735.67	64.00	42.74	3.238.33	55.67	58.17	4.040.67	39.00	103.61	3.724.67	44.00	84.65
2	2.018.75	65.50	30.82	2.609.00	53.25	49.00	2.892.50	36.25	79.79	2.786.25	42.50	65.56
3	1.871.67	64.67	28.94	2.428.33	53.33	45.53	3.057.00	35.33	86.52	2.760.33	43.33	63.70
	Legend: D – Total duration of observable tasks, in seconds. NA – Number of aircraft DM – Average duration of observable tasks, in seconds											

Presentation of results by scenario/control sector – comparative values Comparison between scenarios 2 and 3 and the baseline (scenario 1)								
Scenario	BS02		CW01		RE01		RE02	
	%D	%DM	%D	%DM	%D	%DM	%D	%DM
2	- 26%	- 28%	- 19%	- 16%	- 28%	-.23%	-.25%	- 22%
3	- 32%	- 32%	- 25%	- 22%	- 24%	- 16%	- 26%	- 24%
Presentation of general results by scenario - comparative values Comparison between scenarios 2 and 3								
Scenario	BS02		CW01		RE01		RE02	
	%D	%DM	%D	%DM	%D	%DM	%D	%DM
3	- 7%	- 6%	- 7%	- 7%	+ 6%	+ 8%	- 1%	- 3%
	Legend %D – Percent variation between scenarios of the duration of observable tasks %NA – Percent variation between scenarios of the number of aircraft %DM – Percent variation between scenarios of the average duration of observable tasks per aircraft							

Unfulfilled flight level requests

Presentation of results by scenario/control sector
Absolute values

Scenario	STATUS	REF	BS 01			BS 02			CW 01		
			N	D	DM	N	D	DM	N	D	DM
1	RVSM	FPV	-	-	-	0.60	1.200.00	2.000.00	0.60	1.600.00	2.666.67
1	Ñ RVSM	FPV	-	-	-	0.60	680.00	1.133.33	0.40	1.600.00	4.000.00
TOTAL			-	-	-	1.20	1.880.00	1.566.67	1.00	3.200.00	3.200.00
2	RVSM	FPV	-	-	-	0.40	80.00	200.00	1.20	440.00	366.67
2	Ñ RVSM	BASELINE	6.20	17.200.00	2.774.19	9.60	28.200.00	2.937.50	6.20	19.200.00	3.096.77
TOTAL			6.20	17.200.00	2.774.19	10.00	28.280.00	2.828.00	7.40	19.640.00	2.654.05
3	RVSM	FPV	-	-	-	-	-	-	1.20	420.00	350.00
3	Ñ RVSM	FPV C/ACOM	-	-	-	-	-	-	0.40	140.00	350.00
3	Ñ RVSM C/ACOM	FPV C/ACOM	-	-	-	-	-	-	0.40	140.00	350.00
TOTAL			-	-	-	-	-	-	2.00	700.00	350.00

Presentation of results by scenario/control sector
Absolute values

Scenario	STATUS	REF	RE 01			RE 02			RE 03		
			N	D	DM	N	D	DM	N	D	DM
1	RVSM	FPV	0.40	280.00	700.00	3.60	8.125.00	2.256.94	1.80	3.128.44	1.738.02
1	Ñ RVSM	FPV	0.40	340.00	850.00	0.20	800.00	4.000.00	-	-	-
TOTAL			0.80	620.00	775.00	3.80	8.925.00	2.348.68	1.80	3.128.44	1.738.02
2	RVSM	FPV	0.40	120.00	300.00	2.00	1.738.00	869.00	1.80	1.616.80	898.22
2	Ñ RVSM	BASELINE	4.00	23.400.00	5.850.00	3.40	11.600.00	3.411.76	4.80	22.017.20	4.586.92
TOTAL			4.40	23.520.00	5.345.45	5.40	13.338.00	2.470.00	6.60	23.634.00	3.580.91
3	RVSM	FPV	-	-	-	-	-	-	-	-	-
3	Ñ RVSM	FPV C/ACOM	0.40	680.00	1.700.00	0.40	220.00	550.00	-	-	-
3	Ñ RVSM C/ACOM	FPV C/ACOM	0.40	680.00	1.700.00	0.40	220.00	550.00	-	-	-
TOTAL			0.80	1.360.00	1.700.00	0.80	440.00	550.00	-	-	-

Unfulfilled flight level requests

Presentation of results by scenario/control sector – comparative values
Comparison between scenarios 2 and 3 and the baseline (scenario 1)

Scenario	BS01			BS02			CW01		
	%N	%D	%DM	%N	%D	%DM	%N	%D	%DM
2	-	-	-	7.33	14.04	0.81	6.40	5.14	(0.17)
3	-	-	-	(1.00)	(1.00)	(1.00)	1.00	(0.78)	(0.89)

Presentation of results by scenario/control sectors – comparative values
Comparison between scenarios 2 and 3 and the baseline (scenario 1)

Scenario	RE01			RE02			RE03		
	%N	%D	%DM	%N	%D	%DM	%N	%D	%DM
2	4.50	36.94	5.90	0.42	0.49	0.05	2.67	6.55	1.06
3	-	1.19	1.19	(0.79)	(0.95)	(0.77)	(1.00)	(1.00)	(1.00)

Presentation of general results by scenario - comparative values
Comparison between scenarios 2 and 3

Scenario	BS01			BS02			CW01		
	%N	%D	%DM	%N	%D	%DM	%N	%D	%DM
3	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(0.73)	(0.96)	(0.87)

Presentation of general results by scenario – comparative values
Comparison between scenarios 2 and 3

Scenario	RE01			RE02			RE03		
	%N	%D	%DM	%N	%D	%DM	%N	%D	%DM
3	(0.82)	(0.94)	(0.68)	(0.85)	(0.97)	(0.78)	(1.00)	(1.00)	(1.00)

Legend
%N – Percent variation between scenarios of the number of aircraft not granted their preferred levels.
%D – Percent variation between scenarios of the total difference between cleared and requested levels.
%DM – Percent variation between scenarios of the average difference between cleared and requested levels.

II. RVSM ATC Simulations in the Chile Unified ACC

1. Introduction

1.1 In accomplishing the RVSM ATC National Training programme and, also, accomplishing regional agreements in this respect, the RVSM ATC simulation was carried out between 7 and 25 April 2003, with the collaboration of designated Air Traffic Control Instructors, to Air Traffic Controllers working in sectors 1 – 2 and 4 assigned to area control sectors, from the 8 sectors that form the Unified Area Control Center. The details of the results are shown hereunder.

2. Objective

a) Determine the feasibility of Air Traffic Control Services to accommodate civil and State non-RVSM approved aircraft in the domestic RVSM airspace, between FL 290 and FL 410 inclusive, in the Control sectors responsibility of the Unified Area Control Center.

b) Identify situations and possible conflict points that may affect air operations safety in regarding traffic flows in relation to:

- Current traffic
- Foreseen traffic
- Controllers workload

c) Identify delicate or possible conflict situations.

3. Participation

3.1. ATC RVSM simulation considered a theoretic presentation on RVSM regulatory aspects and simulation objectives, every Controller qualified in the three (3) control sectors participated.

4. Simulation

4.1 General

The ATC simulation was developed within the following guidelines:

a) Area Control Service was provided by the use of the Radar, creating real scenarios of the airspace responsibility of the sectors;

b) Use of the current traffic volumes, identifying "peak" hours according to the air movement compiled in December 2002, increased in 20%;

c) In the first exercise of each sector, a greater number of non-approved aircraft was considered in respect of RVSM approved and, in the second exercise, a similar RVSM non-approved and approved aircraft percentage;

d) Routes and traffic flows with preference flight direction currently used for aircraft routing;

e) Use of RVSM flight levels according to the track established in the Rules of the Air (DAR 02 – ANNEX 2);

f) Application of the longitudinal separation:

1) Among aircraft with the <u>same track and same FL</u>:

- *Distance-based:*
  - Radar Environment: 20 NM, similar performance, same MNT or less
- *Time-based:*
  - Procedural Control (Non-Radar): 5 minutes adjusted by MNT.

2) Among aircraft with the <u>same track and different FL:</u>

- *Distance-based:*
  - Radar Environment: 10 miles
- *Time-based:*
  - Procedural Control (Non-Radar): 3 minutes

5. **Evaluation**

5.1 From the evaluation of the participant ATCs, it is unanimously concluded that it is possible to accommodate non-RVSM approved traffic, and that airspace efficiency is increased applying RVSM. However, the opinion in respect of the workload reflects that flexibility in non-RVSM approved traffic treatment impacts in different ways in the ATCs working in the different control sectors due to:

a) The structure and of some routes and specially the converging routes;

b) The experience level of the ATC of the sectors in which control is mainly Procedural Control (Non-Radar)-based;

c) Change in the way of using flight levels FL310, FL350 and FL390;

d) RVSM phraseology;

e) RVSM contingencies.

6. **Conclusion**

6.1 The RVSM ATC simulation carried out in sectors 1, 2 and 4 of the Unified Area Control Center (CCAU) let us conclude that it is possible to “accommodate" non-RVSM approved aircraft in the continental RVSM airspace. However, this operational flexibility increases the controllers workload and the indefinite application of this exception or the increment of users with non-RVSM approved aircraft may, also, decrease airspace capacity, specially in bi-directional routes, where vertical separation needs to be increased when aircraft with different approval status operate in opposite tracks.

6.2 Therefore, it is necessary to adopt measures so that non-RVSM approved aircraft operation do not have a negative impact, but may decrease the actual ATC workload levels. Among these measures, in general, the following are suggested:

a) Radar Service availability;

b) Modification of the visualization automated systems, updating them for RVSM scenarios;

c) Operational planning;

d) Initial longitudinal separation;

e) Flight Level tactical use;
f) Establishment of advanced navigation routes systems (RNAV/RNP/GNSS) laterally separated, specially in those areas with no radar coverage;}

g) Review the application of the Required Navigation Performance 5 (RNP 5) or more exactly, in current and future ATS routes of the RVSM airspace;

h) Air Traffic Management.

6.3 Air Traffic Management basic initiatives will be developed as a measure to reduce Controllers workload.

III. RVSM ATC Simulations in Colombia

1. Introduction

1.1 In order to analyse the behaviour of peak hour traffic in Colombian airspace, as well as the behaviour of air traffic control in different RVSM scenarios, simulations were carried out during the first half of September 2003, with the participation of controllers from the Bogota and Barranquilla ACCs.

2. Analysis

2.1 RVSM simulations were carried out for 120 hours, both under normal conditions as well as under bad weather, with upper winds, communication failures, lack of radar coverage, aircraft in distress, and with very precise objectives, namely:

a. determine the restrictions for non-RVSM aircraft
b. identify applicable RVSM procedures, such as traffic re-routing and contingency procedures
c. determine the convenience of using offset procedures
d. determine the need to modify airspaces
e. identify the necessary work aids, such as level tables, charts, etc.
f. decide upon the modification of existing letters of agreement
g. decide upon the modification of the rated capacity of the sector
h. assess the impact of RVSM in levels below FL290 in an exclusive environment
i. assess the possibility of applying combined horizontal/vertical separation for tactical operations in Colombian airspace
j. assess the need and advisability of properly timing the take-off of non-RVSM aircraft in order to facilitate tactical control.

3. Results and suggested action

3.1 After conducting the corresponding simulations, it was concluded that:

a. Under normal weather conditions, there are no traffic problems and airspace capacity increases.

b. Under bad weather conditions, it is necessary to divert aircraft from the route and provide radar control services to ensure separation.

c. Changing the level of overflying aircraft complicates the work of controllers and might have a negative impact on the target level of safety (TLS). It is suggested that letters of agreement be adjusted to avoid changing levels of overflying aircraft.

d. In the event of contingencies, excellent systems of coordination with adjacent FIRs are required; it would be dangerous otherwise. In case of diversion due to bad weather and contingencies, excellent communications and radar coverage ensure compliance with the target levels of safety.

e. Under current conditions, additional restrictions for non-RVSM aircraft are not required.

f. Use of the OFF SET procedure in a radar environment provides an additional safety margin in the event of loss of RVSM capabilities and turbulence.

g. With the implementation of RVSM, it would be advisable to modify the sectorisation of the Bogota UTA to a vertical one, eliminating the existing horizontal sectorisation. This would allow for a better distribution of the work load and eliminate congestion in the frequency. A technical solution for the coverage issue (modification of the extended VHF range) is required.

h. It is suggested that the existing letters of agreement be modified to reflect specific RVSM requirements.

i. Control sectors increase their rated capacity.

j. In an exclusive environment, RVSM implementation in levels below FL290 would cause losses to airlines and congestion in levels 280, 270 and 260 inclusive.

k. The application of a combined horizontal/vertical separation for tactical operations in Colombian airspace would facilitate the work of controllers.

l. Timing of take-off operations of non-RVSM aircraft facilitates tactical control and increases the target level of safety (TLS).

IV. ATC-RVSM Simulation in Guyana

1. Introduction

1.1 The ATC working group concluded that States carry out and continue to carry out ATC simulations for the implementation of RVSM. (AP/ATM/5/26).

1.2 The ATC-RVSM simulation carried out by Mexico was used as guidance to prepare and conduct RVSM simulation in Guyana.

2. Objective

2. The objective of the first simulation was to introduce the operational concept of RVSM to ATCOs and to identify potential problems that they may encounter.

3. Participants

3.1 All ACC controllers and supervisors participated the ATC RVSM simulation.

4. Scenarios

4.1 Scenarios were developed from operational day's traffic transiting Georgetown's FIR from FL290 to FL410 inclusive. The peak periods, ATS routes, frequently used flight levels etc. were filtered into the simulation.

5. Summary of observations and results

5.1 Identification of RVSM approved aircraft on flight progress strips.

5.1.1 It was found that although flight plans may have the letter "W" in box 10 of flight plan forms, there need to be a similar method of identifying RVSM approved aircraft on flight progress strips. Every strip associated with an RVSM approved aircraft must be marked with such symbol.

6. Use of flight levels

6.1 Each ATCO was given a graphic of the flight level allocation table, with particular emphasis on the change from the conventional westbound levels being eastbound in RVSM scenario. As a result it was noted that there was caution in assigning flight levels to aircraft.

6.2 A chart depicting the flight level allocation scheme will be displayed in the simulator and the ACC for quick reference.

7. Vertical separation of 1000 ft

7.1 Vertical separation of 1000ft was applied with little difficulty, however when a non-RVSM approved aircraft was included there were occasions when 2000ft separation was not assured throughout the airspace.

8. Coordination

8.1 Coordination also suffered at times when aircraft could not maintain RVSM. Letters of Agreement between states should include all elements of information to be coordinated, agreement for assignment of flight level no in correlation to track, etc.

9. Transition areas

9.1 Transition areas were not included in exercises as a result of conclusion AP/ATM/5/31.

10. Suspension of RVSM

10.1 The suspension of RVSM increased the workload and anxiety level of the ATCOs. The nominal 2000ft separation required proved to be quite a task in some cases. In other cases longitudinal separation or lateral separation negated the 2000ft separation requirement.

11. Conclusion

11.1 The objectives of this first RVSM simulation were met. Guyana will programme simulation continuously as procedures are developed and fine-tuned. ATCOs will have to familiarise themselves more with operational RVSM procedures and other related information. Seminars, newsletters, Memos, etc, will be programmed and disseminated to staff.

V. Instruction and Training Programme of ATCOS in Paraguay

1. INTRODUCTION:

1.1 In order to follow up the schedule of activities and tasks to be carried out in the RVSM Implementation environment in the CAR/SAM Regions, an information course was prepared and implemented addressed to Air Traffic Controllers, who will be directly affected by RVSM Implementation in Paraguay. The main objective was to provide basic information to the personnel involved in order to become aware and to have an optimum level desired, of the kindness and benefits of the implementation, as well as of the exigencies in the environment involved.

1.2 We have the intention to follow up the information, instruction and training programme of the Asuncion ACC ATCOS, which has benefited, in its first stage, 98% of the ATCOS involved, obtaining interesting results and stating situations to be detailed.

2. DEVELOPMENT

2.1 Basically, the contents of the introduction course to an RVSM environment, with the basic concepts and conditions, has raised interesting concerns in the Air Traffic Controllers and, at the same time, they stated situations from the operational point of view.

2.2 First, we have noticed a relevant aspect, which is the interest of having aircraft above FL 290 with only 1.000 ft. separation and the reliability and safety this represents for the applications of separations.

2.3 It was also pointed out, with relative uncertainty, the benefits of its application, considering the situation of allowing non-homogenous aircraft in the RVSM airspace.

2.4 In summary, the remarks made have greatly contributed with the personnel in charge of the implementations from the instruction point of view, as a laboratory simulation programme has been developed and the level II course addressed to disperse any doubt and making the first necessary modifications regarding the mentioned aspects.

2.5 In order to have a more clear vision of the instruction and training situation, attached herewith is the foreseen schedule of activities.

ACTIVITIES	DATE	STATUS
RVSM COURSE	JULY /2003	COMPLETE
SIMULATION VOL I	OCTOBER / 2003	TENTATIVE
RVSM COURSE	OCTUBER / 2003	TENTATIVE
SIMULATION VOL II	JANUARY / 2004	TENTATIVE

3. RVSM IMPLEMENTATION PROGRAMME LOGO

3.1 Our objective is to present to the Representatives of the different States, the Logo designed, based in the one used by the RVSM CAR/SAM Implementation Project.

3.2 This logo will be used in every programme and activity addressed to RVSM implementation in Paraguay.

3.3 The above mentioned Logo is as follows:

VI. RVSM operational requirements for Mexico ATC Automated Systems

1. Introduction

1.1 RVSM implementation in ICAO NAM, CAR and SAM Regions requires an anticipated and detailed planning of the different actions to be carried out, to achieve its objectives, highlighting among these the necessary changes in ATC automation, which will efficiently support the Air Traffic Controllers' work.

2. Flight Plan Forms

2.1 In order to reduce human errors during the transmission of flight plans through AFTN towards the ATC automated system, it has been considered a new version of the flight plan forms, installed in ATS units.

2.2 The computer programme will not accept flight plans with levels between FL 290 and FL 410 if a letter W does not appear in field 10 and/or the legend STS/NON RVSM (non-RVSM aircraft) in field 18 of the ICAO flight plan form.

3. Flight Plans Processing

3.1 The necessary modifications are planned to be made to the ATC automated system, so that flight plans that might erroneously arrive are not processed and sent to the window of rejected messages.

3.2 The specifications for the ATC automated system, shall enable the ATCO to ascend/descend within RVSM airspace, to non-RVSM aircraft (STS/NONRVSM) or those not approved that upon judgment of the ATCO, might be authorized in a determined moment.

4. ATS automated messages

4.1 The installation of an automated modification message (CHG) is foreseen, because it is useful for users and controllers that must notify a change to RVSM status in aircraft.

4.2 It is convenient to analyze the operational needs of ATS automated messages to attend a future CNS/ATM environment, as well as the message exchange among adjacent FIRs.

5. Radar display

5.1 In order that the ATCO may apply 2000 ft separation at every moment to non-RVSM approved aircraft, it is necessary that the position symbol and corresponding aircraft label non-RVSM approved appear in a color (yellow) showing that it is different from other RVSM approved aircraft, as of a level that could be FL 290 or any other level below the aforementioned.

5.2 An altitude filter, for example, at FL200 (lower limit from Mexico upper airspace) would enable to observe with enough time in advance the movement of non-RVSM approved aircraft that could request entrance to non-exclusive RVSM airspace.

6. **Flight Progress stripes**

6.1 It is foreseen that in field 8 of printed stripes (corresponding to flight level or any other field), the abbreviation STSNONRVSM or NONRVSM be written down, to indicate the non-radar and radar controller that the aircraft is non-RVSM approved.

6.2 In case of electronic stripes of RCP (radar control position), it is convenient to observe in the same color of non-RVSM air traffic in screen. The field should be any one that the controller visualizes easily.

7. **Conflict alert**

7.1 The conflict alert (SCTA) should respond to the eventual reduction of the separation in cases of 1000 ft and 2000 ft within RVSM airspace, in the following cases:

- **RVSM vs. RVSM (1000 ft)**
- **RVSM vs. STS/NONVRVSM (2000 ft); and**
- **RVSM vs. NONRVSM (2000 ft).**

7.2 Likewise, the visual alert Mode C is recommended, when it does not comply with the parameter of 200 ft as maximum reference to the authorized aircraft flight level.

8. **Change of RVSM status during the flight**

8.1 Controllers must have the facility to manually change the RVSM status of the aircraft in flight, due to possible failures or contingencies that might arise (RVSM to NON-RVSM). Also, the presentation of in-flight plans (AFIL) and its creation by the controller must be taken into consideration.

8.2 The suppression of letter W in field 10 may cause an automatic process to modify the color of the symbol of position and label. Additionally, the controller could write down in field 18 any additional information related to the aircraft status, as the entering of AFIL flight plans presented by the pilot.

9. **FPL or CPL messages**

9.1 The exchange of information of field 18, ATC adjacent units, facilitates the coordination of the updated RVSM status of the aircraft.

9.2 CPL messages transmitted to the adjacent ACC from which the logic message acknowledging receipt (LAM message) may only be modified through oral coordination between controllers.

10. **Modifications to radar simulator**

10.1 It is recommendable that the changes related with the automated ATC system, be also applied to radar simulator with enough time in advance. This will permit more real simulations of RVSM environment foreseen and to the training of ATC personnel in a time close to the implementation.

11. **Other aspects**

11.1 It is convenient to study the modification of the ICAO Repetitive Flight Plan form (RPL), to include specifically and permanently a similar field to field 10 of the individual flight plan form (FPL), given the importance to know in a formal and anticipated manner by the ATC, the data of COM/NAV/SSR Mode and RVSM capacity. Currently, the use of field Q of the repetitive flight plan does not show in practice the stability of the necessary flight information for the ATC.

VII. Cost of ATC Modifications in Chile

1. Introduction

1.1 The Directorate General of Civil Aviation of Chile (DGAC), in view of RVSM implementation, determined to make the modifications and updating of the EUROCAT 1000 Visual System of the Air Traffic Services located in the Area Control Centers along the country.

1.2 The updating consists in the installation of an RVSM software patch in the visual system that will enable Air Traffic Controllers, among other aspects, to maintain permanent information of the approval status of every aircraft operating not only in RVSM airspace, but also in the surroundings. Another characteristic to be included in the visualization system is related with the handling of the information of the flight plans for the automatic updating of the electronic flight progress strips.

1.3 The updating of the EUROCAT 1000 System also considers the installation of the Medium Term Conflict Detection system (MTCD) that along with the Small Term Conflict Detection system (STCD), actually in use, will contribute to maintain and increase the national RVSM airspace safety levels.

1.4 The approximate cost of this updating is around US$700,000 and is estimated to be in service the first semester of 2004.