FIRST MEETING OF SAT/14/TASK FORCE
SAT14/TF1

(Sal, Cape Verde, 10-12 June 2009)

Agenda Item 5 Improvement of the airspace structure in the EUR/SAM Corridor

"DOUBLE UNIDIRECTIONALITY" POST-IMPLEMENTATION COLLISION RISK ASSESSMENT (EUR/SAM CORRIDOR)

(Presented by SATMA)

SUMMARY

This WP presents the DOUBLE UNIDIRECTIONALITY post-implementation Safety Assessment results applying a collision risk model to available data

INTRODUCTION/BACKGROUND

SATMA was committed by SAT group to conduct the studies and required Assessments to ensure a Safety application of RVSM-and RNP10 in EUR/SAM Corridor. As result of these actions the EUR/SAM corridor became an RVSM-RNP10 area in January 2002 .

After a compromise period , it become mandatory to perform and present an **RVSM RNP-10 Post-implementation Analysis** about the situation in the EUR/SAM Corridor in order to ensure that critical parameters stay between safe figures and that required Target Level of Safety keeps bellow allowed figures. This report was presented and approved on SAT13 with the following conclusion recommended by WP13 (SATMA):

SAT/13 Meeting is invited to take into consideration the results shown in the "EUR/SAM Risk Assessment" study, which suggest that current operations in the Corridor after the implementation of RVSM and RNP are safe until the year 2015.

Nevertheless, the SAT/13 is also invited to recognise the lack of real data on deviations occurred in the Corridor available for the study, specially as regards Large Height Deviation (LHD). Conservative assumptions have been made in the study to overcome the lack of real data. The SAT/13 is invited to recommend the Service Providers to collect larger data samples of real deviations in order to refine the results of the safety assessment.

1. Review of Conclusions from New Airspace Structure Study Group

1.1 The meeting recognized that the implementation of RNP10 and RVSM in the recent past years marked an important step forward that now enables more capacity and efficiency of operations, with an improved flight level allocation and optimal speeds that meet users' needs. The important increase in traffic demand and forecasts provided by different agencies show, in the most pessimistic scenario, an average annual growth of 4% until 2015.

1.2 In view of the increase in traffic demand, the meeting analyzed the study presented by Spain based on fast-time simulations and showing comparative air traffic data in 2005 and 2015, detailing traffic per airway, workload on ATC and number of Nautical Miles flown out of optimum Flight Level. The complete study presented during the meeting will be posted to the ICAO Offices (Dakar and Lima) websites: http://www.icao.int/wacaf/ and http://www.lima.icao.int/.

1.3 Taking the above into account, the meeting analyzed a strategy for the short, medium and long-term implementation of a new airspace structure in the EUR/SAM Corridor, with the objective of improving safety, capacity and efficiency of operations and meeting aircraft operators' needs.

1.4 It was also recalled that the work programme of the IAS/SG included the mandate to develop a short-term plan using the current separation standards based on RNP10, including the implementation of new ATS routes. The meeting reviewed different options of implementing a new ATS route network, including a preliminary safety assessment for each option, taking into account the traffic increase foreseen in the EUR/SAM Corridor until 2015.

1.5 In view of the above, the meeting analyzed four proposals for a new ATS structure in the EUR/SAM Corridor based on RNP10 functionalities and complemented with a preliminary safety assessment based on the Reich Collision Risk Model.

1.6 Two of the options were based on the implementation of additional ATS routes, while the two others were based on unidirectional ATS routes, thus maintaining the current network. Several parameters were used in the study (Dstribution of the air traffic per hour and per airway; Number of aircraft penalized with non optimum flight level;Total NM flown at not optimum flight level,...).

1.7 With this simulation te number of aircraft penalized with non optimal flight level increaseda 60%, the number of nautical miles flown at non optimal flight level increased a 55%, and the percentage of workload in the ATC Units increased a 50%

1.8 Taking into account these parameters, the meeting concluded that the EUR/SAM Corridor structure should be modified in the short term to provide appropriate ATC services and

that the situation foreseen for 2015 would not acceptable. The four proposals analyzed were the following:

1.8.1 *Proposal 1:* *8 ATS routes (4 additional routes from present situation)*

1.8.2 *Proposal 2:* *6 ATS routes (2 additional routes form present situation)*

1.8.3 *Proposal 3:* *ATS Route UN 741 as unidirectional*

1.8.4 Proposal 4: ATS Routes UN 741 and UN 866 as unidirectional

1.9 The meeting discussed at length the four proposals presented as well as other options for the short and mid term that were presented during the debate, and was of the opinion that at this stage the best option would be the **implementation of a unidirectional flight level allocation scheme on routes UN 741 and UN 866. Proposal 4**

1.10 The meeting also agreed that to implement the new structure in the EUR/SAM Corridor, it would be necessary that the concerning States provide the Regional Monitoring Agency with the statistical data on traffic above Fl 290 that flew outside Canaries FIR during the period from January to November 2005.

1.11 **Conclusion SAT 13/TF/1/21: Implementation of UN741 and UN866 as unidirectional routes. :** a) That the concerned SAT member States implement routes UN741 and UN866 as unidirectional routes on the AIRAC date of 5th July 2007; and

1.12 **Conclusion SAT 13/TF/1/22: Operational Procedures for the implementation day of the double unidirectional routes UN741 and UN866 :** That the transitional procedure at attachment to this report shall be adopted by all concerned ACCs for implementation with Spain as coordinator of all the activities during the transition.

2. DISCUSSION

This report presented resume the post-implementation collision risk assessment made for the EUR/SAM Corridor in order to analyse safety after the change in the routing structure, which took place 5th July 2007 (routes UN-741 and UN-866, previously bidirectional, became unidirectional).

It assesses the lateral and vertical collision risk in the Corridor, where RNP10 and RVSM are implemented, with data of traffic between FL290 and FL410 collected during the first year of operation, from 10th July 2007 to 10th July 2008.

The existing route network is composed of four nearly parallel north-south routes situated within the Canaries UIR, SAL Oceanic UIR/UTA, Dakar Oceanic UIR and Recife FIR.

The denomination of the routes is, from west to east, UN-741, UN-866, UN-873 and UN-857, and their magnetic direction varies around 45º for northbound traffic and 225º for southbound traffic.

Minimum lateral separation between routes is 110NM for routes UN-741/UN-866, 90NM for routes UN-866/UN-873 and 50NM for routes UN-873/UN-857.

Routes UN-741 and UN-866 are unidirectional, with traffic in odd and even flight levels, (Southbound traffic on route UN-741 and Northbound traffic on route UN-866).On the other hand, routes UN-873 and UN-857 are bidirectional. The flight level allocation scheme in these last two routes is the following:

- Southbound flight levels: FL300, FL320, FL340, FL360, FL380 and FL400.
- Northbound flight levels: FL290, FL310, FL330, FL350, FL370, FL390 and FL410.

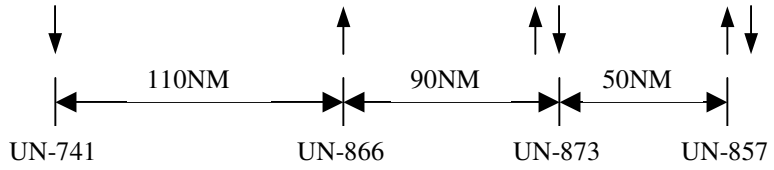

Figure 1
Route network

41 crossing trajectories (real crossings or changes between routes) have been identified in the Canaries UIR, 33 in SAL UIR, 9 in Dakar UIR and 4 in Recife UIR. From these, the trajectories with more than 50 aircraft per year to be considered in this study. Analysing these trajectories, only 0.87% of the traffic is not being considered in the Canaries UIR, 1.32% in SAL, 0.18% in Dakar and 0.08% in Recife. Therefore, this hypothesis seems reasonable

This study does not consider the reduction of the collision risk that would be obtained with the use of ADS.

Besides data from Palestra, only a traffic sample from SAL (01/11/07-31/01/08 and 01/04/08-10/07/08) and a traffic sample from Atlantic-Recife (01/09/2007-30/06/08) were also available for this assessment.

Therefore, in this study only data from those months for which there is traffic information from both UIRs, SAL and Recife, has been used, combining the data in order to get a complete sample and extrapolating to other UIRs when necessary.

The most common aircraft types, the number of flights per type and the proportion of these types over the total of flights detected during the time period considered between FL290 and FL410 have been analysed. The overall average traffic is 91.9 flights per day with a standard deviation of 12.05 flights per day.

For the studied scenario, lateral and vertical collision risks are assessed. This assessment is made in six different locations along the Corridor, covering the four UIRs. The locations are:

- Canaries: boundary between the Canaries UIR and the SAL OCEANIC UIR
- SAL1: Route UR-976/UA-602
- SAL2: Boundary between SAL OCEANIC UIR and DAKAR OCEANIC UIR
- DAKAR1: Route UL-435
- DAKAR2: Boundary between DAKAR OCEANIC UIR and ATLANTIC FIR
- RECIFE: Route UL-375/UL-695

LATERAL COLLISION RISK

Once all the parameters of are obtained, it is possible to calculate the lateral collision risk for the current scenario. This value must not exceed the maximum allowed, for which the system is considered to be safe. This threshold, denominated TLS (Target Level of Safety), has been set to $TLS = 5\times10^{-9}$. It means that 5×10^{-9} accidents per flight hour are accepted.

Lateral collision risk values obtained

In the current system, with RNP10, two routes unidirectional and two routes bidirectional, the collision risk values obtained until 2018 in the different locations are the ones shown in the following sections.

Locations	Lateral Collision Risk 2008	Lateral Collision Risk 2018
Canaries	$2.1289*10^{-9}$	$4.5961*10^{-9}$
SAL 1	$2.0055*10^{-9}$	$4.3296*10^{-9}$
SAL 2	$2.4510*10^{-9}$	$5.2915*10^{-9}$
Dakar 1	$1.9075*10^{-9}$	$4.1182*10^{-9}$
Dakar 2	$1.6749*10^{-9}$	$3.6160*10^{-9}$
ATL - Recife	$1.7024*10^{-9}$	$3.6752*10^{-9}$

Considerations on the results

Parallel routes

Lateral collision risk is below the $TLS = 5\times10^{-9}$ with the current traffic flow and it is estimated that, considering 8% as the annual traffic growth rate, it will continue to be laterally safe until 2017. According to these results, the TLS would be exceeded in 2018. Nevertheless, it must be taken into account that conservative assumptions have been made.

Comparing these results with those obtained for the pre-implementation safety assessment, it can be seen that the new values are higher. This is due to the traffic growth in the Corridor (higher than expected) and the different distribution of traffic on the flight levels of unidirectional routes. It has also been confirmed that the results are similar in all the locations analysed.

TECHNICAL VERTICAL COLLISION RISK

The technical vertical collision risk values obtained until 2018 in the different locations are the ones summarized in the following sections.

Locations	Technical Vertical Collision Risk 2008	Technical Vertical Collision Risk 2018
Canaries	$0.2725*10^{-9}$	$0.5883*10^{-9}$
SAL 1	$0.1337*10^{-9}$	$0.2887*10^{-9}$
SAL 2	$0.1488*10^{-9}$	$0.3212*10^{-9}$
Dakar 1	$0.1822*10^{-9}$	$0.3935*10^{-9}$
Dakar 2	$0.1776*10^{-9}$	$0.3835*10^{-9}$
ATL - Recife	$0.1633*10^{-9}$	$0.3527*10^{-9}$

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Considerations on the results

Parallel and crossing routes

It can be seen that the estimates of the technical vertical risk are below the technical TLS even in 2018, being similar the values obtained in all the locations.

Comparing these results with those obtained for the pre-implementation safety assessment, , it can be seen that the new values are higher. This is due to the traffic growth in the Corridor (higher than expected), the different distribution of traffic on the flight levels of unidirectional routes and the use of a much more conservative value for the probability of lateral overlap, $P_y(0)$.

TOTAL VERTICAL COLLISION RISK

The total vertical risk is the sum of the technical risk and the risks due to large height deviations involving whole numbers of flight levels (both climbing/descending aircraft and level flight aircraft) and the risk due to large height deviations not involving whole numbers of flight levels. As it has been said, it is assumed that the same type of collision risk model applies to the different risk components, being only different the probability of vertical overlap, $P_z(S_z)$, and the average relative vertical speed used in each case

Therefore, the only term to be calculated is the risk due to aircraft levelling off at a wrong level. To do this, it is necessary to know the time spent at the incorrect flight level. As it can be seen , this information is only provided by Recife, and some hypothesis would be required to estimate it in the case of SAL and Dakar. For this reason, collision risk has been calculated first in Recife.

The vertical risk due to large height deviations in Atlantic-Recife UIR would be 1.0535×10^{-6} and its contribution to the risk in the whole Corridor would be 2.252×10^{-7}. These results are much higher than the TLS

Nevertheless, it is important to remark that all the deviations received were due to a coordination error, and they are not related to RVSM operations. If these coordination errors were not taken into account, the total vertical risk would comply with the TLS, since it would be equal to the technical vertical risk.

It must also be taken into account that, despite these large values for total vertical risk, the deviation reports received indicated that there was not any traffic in conflict

The same problem, the collision risk being higher than the TLS if coordination errors are taken into account, has also been identified in other Regions, such as CAR/SAM or Asia/Pacific. In any case, as the problem is clearly identified, the use of adequate corrective actions **(See WP_AA)** to reduce coordination errors in the Corridor will reduce the risk

Annex presentation

Both Annex and Safety Assessment will be published in SATMA website www.satmasat.com

ACTION BY THE MEETING

The SAT14/TF1 Meeting is invited to approve the results of DOUBLE UNIDIRECTIONALITY post-implementation safety assessment presented by SATMA with results applying a collision risk model to available data :

a) **Lateral and Vertical technical collision risk are and below the TLS in all UIRs**

b) Following other RMAs criteria (Operational coordination errors may not imply a RVSM Deviation so they have not been taken into account), the total vertical risk comply with the TLS.

c) In order to subsane detected operational coordination errors, proper corrective actions should be implemented