International Civil Aviation Organization

MIDANPIRG/19 and RASG-MID/9 Meetings

(Riyadh, Saudi Arabia, 14-17 February 2022)

Agenda Item 3.3: Air Navigation Subjects of interest to RASG-MID including RVSM Operations and Monitoring

RVSM OPERATIONS AND MONITORING ACTIVITIES IN THE MID REGION

(Presented by the MIDRMA and Secretariat)

SUMMARY

This paper presents the latest developments related to RVSM operations and safety monitoring activities in the MID Region

Action by the meeting is at paragraph 3.

REFERENCES

- MIDANPIRG/18 and RASG-MID/8 Meetings Report (virtual, 15 - 22 February 2021).
- ATM SG/7 Report (Virtual Meeting, 15 – 18 November 2021).
- MIDRMA Board/17 (Virtual meeting, 18-19 January 2022).

1. INTRODUCTION

1.1 The meeting may wish to recall MIDANPIRG Conclusion 18/7:

MIDANPIRG CONCLUSION 18/7: MID RVSM SMR 2021

That,

*a) the FPL/traffic data for the period **1 – 31 July 2021** and LHD Reports for the period 1 January 2021 to 31 December 2021 be used for the development of the MID RVSM Safety Monitoring Report (SMR 2021);*

b) only the appropriate Traffic Data as per MIDRMA requirements shall be submitted; any corrupted traffic data will be rejected; and

c) the final version of the MID RVSM SMR 2021 be ready for presentation to and endorsement by MIDANPIRG/19

1.2 The MID RVSM SMR 2021 reflects the airspace safety review of the MID RVSM airspace conducted based on a one-month traffic data sample (TDS) collected for July 2021. The MID SMR 2021 also includes the monthly Large Height Deviation (LHD) reports for the same reporting period submitted by MIDRMA member States through the LHD online reporting system.

1.3 The meeting may wish to recall that the MIDRMA has currently several tools to improve the monitoring of RVSM implementation such as:

- MID Collision Risk Assessment Software (MID RAS);
- Large Height Deviation (LHD) Online Reporting Tool;
- Online Auto Minimum Monitoring Tool; and
- Airspace Collision Risk Hot-spot Analysis software

1.4 The meeting may wish to recall that the MIDRMA Board/11 (Cairo, 27 – 29 September 2011) approved the development/purchase of the MID Risk Analysis Software (MID RAS) which is currently used by the MIDRMA to develop the annual MID RVSM Safety Monitoring Reports (SMRs).

1.5 The meeting may wish to note that the current software features require further improvements to facilitate the calculation of all RVSM risk parameters, and to help MIDRMA Member States to overcome problems and errors frequently found in the submitted Traffic Data Samples (TDS), and to avoid excessive time consuming and efforts by the MID RMA to ensure the correctness of thousands of traffic data records.

2. DISCUSSION

2.1 The meeting may wish to note, that the ATM SG/7 (Virtual, 15 - 18 November 2021) reviewed the initial results of the MID RVSM Safety Monitoring Report 2021.

2.2 Additionally, the MIDRMA Board/17 meeting reviewed the final version of the MID RVSM SMR 2021 at **Appendix A**.

2.3 Based on the above, the MIDRMA Board/17 agreed to the following Draft Conclusion:

DRAFT CONCLUSION 17/1: MID RVSM SMR 2021

*That, the MID RVSM Safety Monitoring Report (SMR) 2021 at **Appendix A**, be presented to the MIDANPIRG/19 meeting for endorsement.*

2.4 The meeting noted the long standing RVSM Safety Protocol opened at Muscat/Mumbai FIR Boundaries and urged the concerned States to address it in coordination with the relevant Regional Offices and RMAs.

2.5 The meeting noted that Tripoli FIR was excluded from the SMR 2021 due to the non-provision of required data. Additionally the meeting noted with concern that Libya has not submitted the TDS for long period, and urged the Libyan CAA to provide the data to include Tripoli FIR in the upcoming SMRs.

2.6 The meeting noted with concern the increased number of LHD reports submitted by Sana'a ACC, and urged the concerned States to address it and to resolve the issue; in coordination with the relevant Regional Offices and RMAs.

2.7 The meeting may wish to noted that ICAO MID and APAC Regional Office is planning to organize a meeting between India and Oman, to address the issues on the Regional interface boundaries, between Muscat/Mumbai FIR.

2.8 The meeting may wish to note that ICAO MID and ESAF Regional Offices is planning to organize a series of meetings between Yemen and its adjacent FIRs to address the issue of the increased number of LHD Reports by Yemen. The first meeting was conducted (Virtual, 9 Feb 2022) with the participation of Ethiopia (Addis Ababa FIR) and the RMAs of both Regions.

2.9 The meeting may wish to note that the MIDRMA Board/17 agreed that for the Year 2022 the highest volumes of traffic will be observed, in addition to the Hajj season, during the FWC 2022 event, organized by Qatar (November and December 2022). Accordingly, the meeting agreed that it will be very beneficial to measure the RVSM TLS during the FWC 2022 event.

2.10 Based on the above, the meeting agreed on the following draft Conclusion:

DRAFT CONCLUSION 17/2: MID RVSM SMR 2022

That,

a) States are required to provide the FPL/traffic data for the period 1st June until 30th June 2022 and LHD data for the period 1 January to 31 December 2022 to the MIDRMA before 1 August 2022, for the development of the MID RVSM Safety Monitoring Report (SMR 2022);

b) Bahrain, Iran, Iraq, Kuwait, Oman, Saudi Arabia and UAE, are urged to provide the FPL/traffic data for the period 1 – 30 November and 1 – 31 December 2022 to the MIDRMA before 31 January 2023 for measuring the ICAO RVSM TLS (Technical and Overall) during the FWC 2022 event; the remaining States are strongly encouraged to provide the FPL/traffic to the MIDRMA for the same period (months of November and December 2022).

c) only the appropriate Flight Data form, available on the MIDRMA website (www.midrma.com), should be used for the provision of FPL/traffic data to the MIDRMA; and

d) the final version of the MID RVSM SMR 2022 be ready for presentation to and endorsement by the MIDANPIRG/20 meeting.

2.11 The meeting noted the areas of improvement of the MID RAS Software gathered by the MIDRMA Team through the extensive work on the software during the last 10 years; and the offer received from the MID RAS Developer to address these issues and improvements, with the total cost of USD 100,700.00, which is available within the MIDRMA budget.

2.12 Based on the above, the meeting agreed to the following Decision:

MIDRMA BOARD DECISION 17/2: BUSINESS CASE / COST-BENEFIT ANALYSIS FOR THE MIDRAS SOFTWARE UPGRADE

That, the MIDRMA develop a business case / cost-benefit analysis related to the upgrade of the MIDRAS, to be presented to the MIDANPIRG/19 meeting, to support the decision-making process on the subject.

2.13 The meeting may wish to note that the Business Case for the MID RAS Upgrade project, provided at **Appendix B** was shared with the MIDRMA Board members for comments. No comment was received.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) endorse the Draft Conclusions in para 2.3 and para. 2.9; and

b) review the Business Case, at **Appendix B**; and agree on the way forward.

MID RVSM SMR 2021

MID RVSM SAFETY MONITORING REPORT 2021 (SMR 2021)

Prepared by the Middle East Regional Monitoring Agency (MIDRMA)

SUMMARY

The aim of the MID RVSM Safety Monitoring Report 2021 is to provide airspace safety review of the MID RVSM airspace and to highlight by means of arguments and supporting evidence that the implementation of RVSM in the ICAO Middle East Region is acceptably safe.

1. INTRODUCTION:

1.1 Executive Summary

The MID RVSM Safety Monitoring Report is issued by the Middle East Regional Monitoring Agency (MIDRMA) for endorsement by the Middle East Air Navigation Planning and Implementation Regional Group (MIDANPIRG).

The report presents evidence that according to the data and methods used, all safety objectives set out in the MID RVSM Safety Policy in accordance with ICAO Doc 9574 (2nd Edition) continue to be met in operational services within the Middle East RVSM airspace with some reservation for Safety Objective 3 which is under continuous monitoring by MIDRMA.

To conclude on the current safety of RVSM operations, the three key safety objectives endorsed by MIDANPIRG have to be met:

Objective 1 The risk of collision in MID RVSM airspace due solely to technical height-keeping performance meets the ICAO target level of safety (TLS) of 2.5×10^{-9} fatal accidents per flight hour.

The value computed for technical height risk is estimated **3.509×10^{-12}** this meets RVSM Safety Objective 1.

Objective 2 The overall risk of collision due to all causes which includes the technical risk and all risk due to operational errors and in-flight contingencies in the MID RVSM airspace meets the ICAO overall TLS of **5×10^{-9}** fatal accidents per flight hour.

The value computed for the overall risk is estimated **4.073×10^{-10}** this meets RVSM Safety Objective 2.

Objective 3 Address any safety-related issues raised in the SMR by recommending improved procedures and practices; and propose safety level improvements to ensure that any identified serious or risk-bearing situations do not increase and, where possible, that they decrease. This should set the basis for a continuous assurance that the operation of RVSM will not adversely affect the risk of en-route mid-air collision over the years.

Middle East RVSM Airspace Estimated Annual Flying Hours = (**1,421,352**) Average Aircraft Speed = **444.35 kts**			
Risk Type	**Risk Estimation**	**ICAO TLS**	**Remarks**
Technical Risk	**3.509×10^{-12}**	**2.5×10^{-9}**	**Below ICAO TLS**
Overall Risk	**4.073×10^{-10}**	**5×10^{-9}**	**Below ICAO TLS**

Conclusions:

(i) The estimated risk of collision associated with aircraft height- keeping performance is **3.509×10^{-12}** and meets the ICAO TLS of **2.5×10^{-9}** fatal accidents per flight hour (RVSM Safety Objective1).

(ii) The estimated overall risk of collision due to all causes which includes the technical risk and all risk due to operational errors and in-flight contingencies is **4.073×10^{-10}** meets the ICAO overall TLS of **5×10^{-9}** fatal accidents per flight hour (RVSM Safety Objective 2)

(iii) Based on currently-available information (Except for Tripoli FIR), there is no evidence available to MIDRMA that the continued operations of RVSM adversely affects the overall vertical risk of collision other than the violation of Non-RVSM approved aircraft to the MID RVSM airspace which is under continuous monitoring and review by MIDRMA. (More details in 2.5)

1.2 Considerations on the Safety Objectives for MID RVSM SMRs

When considering the three safety objectives for RVSM, the following considerations should be borne in mind:

1. The assessment of risk against the TLS, both for technical and overall risk estimates, relies on height keeping performance data to assess the risk in the vertical plane and studies of traffic density to calculate the risk in the horizontal plane. There are numbers of assumptions that must be verified to satisfy the reliability of the risk assessment, the verification of these assumptions deals primarily with monitoring of aircraft performance issues.
2. The Aircraft performance is assessed by individual airframe and by monitoring group. A monitoring group consists of aircraft that are nominally of the same type with identical performance characteristics that are made technically RVSM compliant using a common compliance method. Monitoring group analysis is necessary to verify that the Minimum Aviation System Performance Standards (MASPS) for that group is valid. Aircraft that are made RVSM compliant on an individual basis are termed non-group.
3. RVSM Safety Objective 2, dealing with overall risk, takes into account the technical risk together with the risk from all other causes. In practice, this relates to the human influence and assessment of this parameter relies on adequate reporting of Large Height Deviation (LHD) Reports, and the correct interpretation of events for input to the CRM.
4. RVSM Safety Objective 3 requires the RMA to monitor long-term trends and to identify potential future safety issues, this compare the level of risk bearing incidents for the current reporting period. It also highlights if there are issues that should be carried forward as recommendations to be adopted for future reports.

2 Discussion

Scope:

The geographic scope of the MID RVSM Safety Monitoring Report covers the MID RVSM airspace, which comprises the following FIRs/UIRs:

Amman	Bahrain	Beirut	Baghdad	Cairo	Damascus	Emirates
Jeddah	Kuwait	Khartoum	Muscat	Sana'a	Tehran	Tripoli*

T-1: FIRs/UIRs of the Middle East RVSM Airspace

***Note: Tripoli FIR excluded from the RVSM safety analysis due to lack of data.**

The Data Sampling periods covered by SMR 2020 are as displayed in the below table

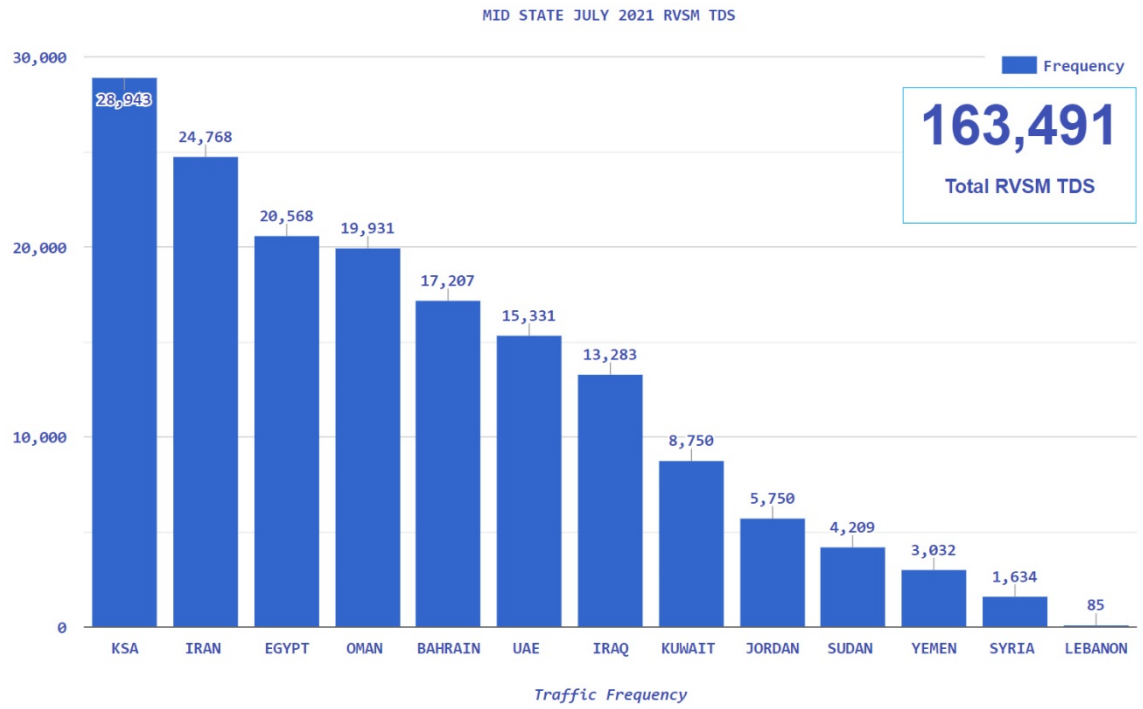
Report Elements	Time Period
Traffic Data Sample	01/07/2021 - 31/07/2021
Operational & Technical Errors	01/01/2021 - 31/12/2021

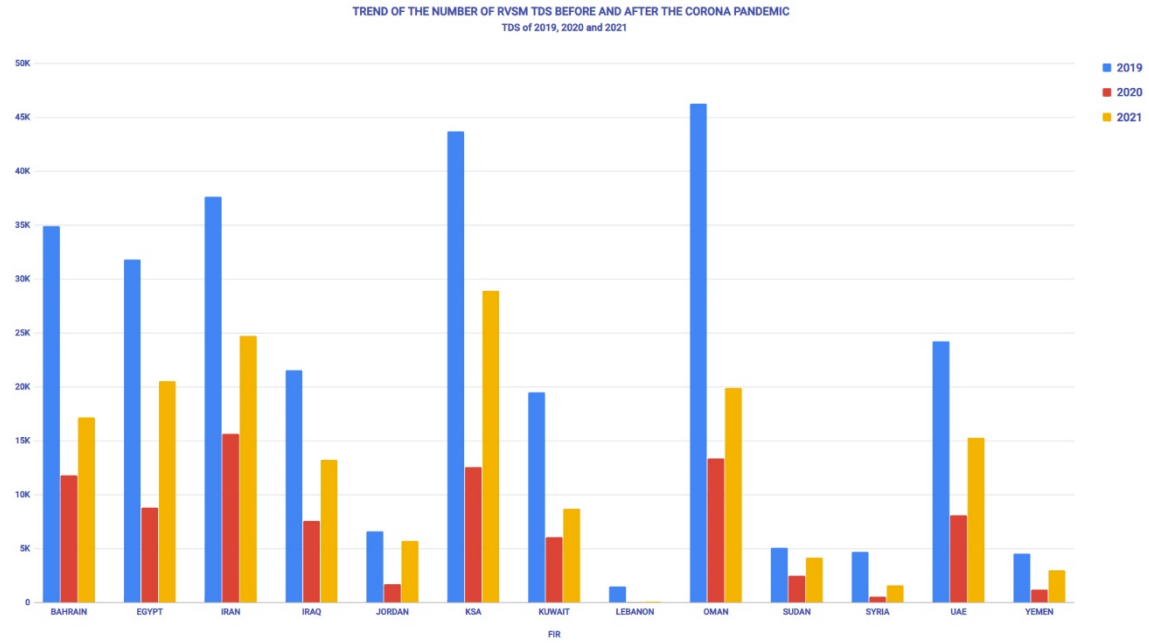
2.1 The descriptions of the traffic data collected from each MIDRMA Member State are depicted in table below:

MID States	**No. of Flights**	**Received Dates**	**Status**
Bahrain FIR	17207	12/08/2021	Accepted
Cairo FIR	20568	26/08/2021	Accepted
Amman FIR	5750	28/08/2021	Accepted
Muscat FIR	19931	17/08/2021	Accepted
Tehran FIR	24768	12/09/2021	Accepted
Khartoum FIR	4209	30/08/2021	Accepted
Emirates FIR	15331	22/08/2021	Accepted
Damascus FIR	1634	12/09/2021	Accepted
Sana'a FIR	3032	23/08/2021	Accepted
Baghdad FIR	13283	25/08/2021	Accepted
Kuwait FIR	8750	01/08/2021	Accepted
Jeddah FIR	28943	19/08/2021	Accepted
Beirut FIR	85	04/09/2021	Accepted
Tripoli FIR	-	-	No Data Submitted
Total	**163491**		

Table 1: Details of the MID States RVSM Traffic Data Sample (TDS) for July 2021.
Note: MIDRMA still faces number of errors/mistakes in the delivered TDS data from many States.

2.2 The description of the traffic data processed for each MIDRMA member state by the MID Risk Analysis Software (MIDRAS) is depicted in the graph below, a total of **163,491** flights were processed for the 13 FIRs, these flights were evaluated and processed very carefully to ensure accurate results according to the data submitted.



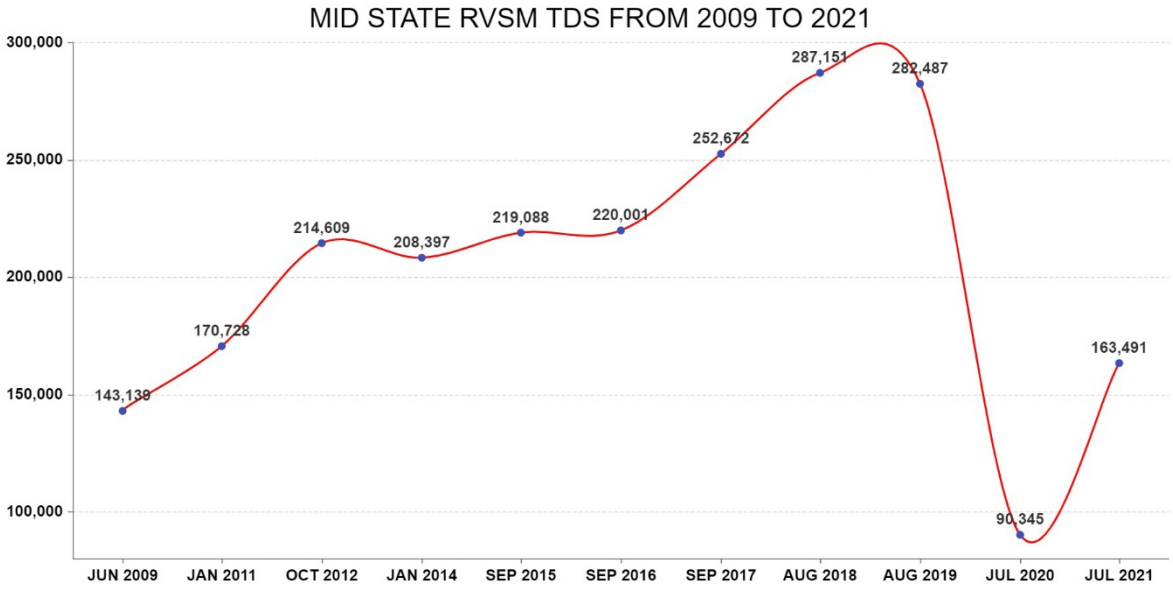


2.3 The COVID-19 pandemic has had a major impact on the airline industry across the world due to travel restrictions and reduced demand among travelers. The significant decrease in passenger demand is starting to improve compared to 2020 while this SMR TDS has reached 58% of what was recorded for TDS 2019 (before the pandemic).

#	MID FIRs	No of TDS July 2020	No of TDS July 2021	TDS Difference 2020 vs 2021	% of TDS Difference 2020 vs 2021
1	**Bahrain FIR**	11844	17207	5363	↑ **45.28 %**

2	**Cairo FIR**	8838	20568	11730	↑ **132.72 %**
3	**Amman FIR**	1752	5750	3998	↑ **228.2 %**
4	**Muscat FIR**	13404	19931	6527	↑ **48.69 %**
5	**Tehran FIR**	15689	24768	9079	↑ **57.87 %**
6	**Khartoum FIR**	2526	4209	1683	↑ **66.63 %**
7	**Emirates FIR**	8137	15331	7194	↑ **88.41 %**
8	**Damascus FIR**	582	1634	1052	↑ **180.76 %**
9	**Sana'a FIR**	1233	3032	1799	↑ **145.9 %**
10	**Jeddah FIR**	12605	28943	16338	↑ **129.62 %**
11	**Beirut FIR**	28	85	57	↑ **203.57 %**
12	**Baghdad FIR**	7602	13283	5681	↑ **74.73 %**
13	**Kuwait FIR**	6105	8750	2645	↑ **43.33 %**
14	**Tripoli FIR**	NO TDS	NO TDS	-	-
	Total	**90,345**	**163,491**	**73,146**	↑ **80.96%**

Comparison Table of MIDRMA Member States TDS for Years 2020 and 2021



2.4 Compiling and correcting the traffic data and then analysing it require a lot of efforts and follow up with the focal points to ensure the highest quality results obtained are reliable to study the impact of RVSM implementation within the ICAO Middle East Region, the MIDRMA decided to arrange for an upgrade to the MIDRAS to overcome problems with the errors in the received TDS from some member states, the upgrade will include other necessary features which will facilitate calculating all RVSM risk parameters and shall save a lot of time to avoid rejecting the TDS due to a lot of errors which usually delay the production of the SMR.

#	Reporting Points	FIRs	Frequency
1	**TASMI**	BAGHDAD / KUWAIT	4951
2	**RATVO**	BAGHDAD / ANKARA	4857

3	**SIDAD**	BAGHDAD / KUWAIT	4823
4	**DAVUS**	BAHRAIN / KUWAIT	4500
5	**NINVA**	BAGHDAD / ANKARA	4133
6	**ULINA**	CAIRO / AMMAN	4041
7	**KITOT**	CAIRO / JEDDAH	3634
8	**ULADA**	BAHRAIN / JEDDAH	3541
9	**LONOS**	BAHRAIN / KUWAIT	3156
10	**DEESA**	AMMAN / JEDDAH	3004
11	**RASKI**	MUSCAT / MUMBAI	2848
12	**GABKO**	TEHRAN / EMIRATES	2661
13	**ALPOB**	BAHRAIN / EMIRATES	2542
14	**RASDA**	CAIRO / NICOSIA	2477
15	**NUBAR**	CAIRO / KHARTOUM	2363
16	**TUMAK**	BAHRAIN / EMIRATES	2339
17	**DAROR**	BAHRAIN / JEDDAH	2305
18	**NARMI**	BAHRAIN / JEDDAH	2290
19	**PASAM**	CAIRO / JEDDAH	2249
20	**BONAM**	TEHRAN / ANAKRA	2221

TDS 2021 Top 20 Busiest FIR Entry / Exit Points in the ICAO MID RVSM Airspace

2.5 For the Seventh consecutive Safety Monitoring Reports, Tripoli FIR excluded temporary from the RVSM safety analysis due to lack of TDS and LHD reports, taking into consideration the MIDRMA never done any risk analysis for Tripoli FIR RVSM airspace since Libya joint the MIDRMA, this issue require the MIDRMA board and MIDANPIRG to decide what action should be taken if RVSM operations resume within the Tripoli FIR in the future

2.6 **The Collision Risk Model (CRM)**

2.6.4 The risk of collision to be modelled is that due to the loss of vertical separation between aircraft flying between FL290 and FL410 in a given portion of an airspace. One collision between two aircraft is counted as the occurrence of two accidents. The risk of collision depends both on the total number and types of aircraft flying in the system and the system characteristics.

2.6.2 The CRM provides an estimate of the number of accidents within an airspace system that might occur per aircraft flight hour due to aircraft collisions resulting from the loss of vertical separation in an RVSM environment analysis, is expressed in terms of quantifiable parameters. In the vertical dimension the CRM can be broken down in order to separately model a single route on which aircraft are flying in the same or opposite directions at adjacent flight levels, pairs of crossing routes and combinations of individual and intersecting routes, this model is applied equivalently to vertical, lateral and longitudinal separation.

2.6.3 Three parameters used within the CRM:

a. The Vertical Overlap Probability, denoted as Pz(1 000).

b. The Lateral Overlap Probability, denoted as Py(0).

c. The aircraft Passing Frequency are the most important quantities in determining the vertical collision risk. Of these, the vertical overlap probability is also an important parameter to calculate.

2.7 Technical Height Keeping Performance Risk Assessment

RVSM Safety Objective 1

The risk of collision in MID RVSM airspace due solely to technical height-keeping performance meets the ICAO target level of safety (TLS) of **2.5×10^{-9}** fatal accidents per flight hour.

Direct evidence of compliance with TLS for Technical Height-Keeping Error

The result shows the risk of collision due to technical height-keeping performance is estimated to be **3.509×10^{-12}** fatal accidents per flight hour, which is less than the ICAO TLS **2.5×10^{-9}**.

MID RVSM SMRs Technical Risk Values				
Year 2006	**Year 2008**	**Year 2010**	**Year 2011**	**Year 2012/13**
2.17×10^{-14}	1.93×10^{-13}	3.96×10^{-15}	5.08×10^{-14}	6.37×10^{-12}
Year 2014	**Year 2015**	**Year 2016**	**Year 2017**	**Year 2018**
3.18×10^{-12}	3.056×10^{-10}	6.347×10^{-11}	4.966×10^{-11}	1.562×10^{-11}
Year 2019	**Year 2020**	**Year 2021**		
2.012×10^{-13}	9.185×10^{-13}	3.509×10^{-12}		

According to the technical risk values as shown in the above table the TLS values still, meet the ICAO TLS.

2.7.1 Supporting evidence of compliance with TLS for technical height-keeping performance

To demonstrate that the result is reliable, it is necessary to demonstrate that the following assumptions are true:

a. The estimated value of the frequency of horizontal overlap, used in the computations of vertical-collision risk, is valid;

b. Pz(1000) – the probability of vertical overlap due to technical height-keeping performance, between aircraft flying 1000 ft. separation in MID RVSM airspace is estimated **5.207×10^{-10}** valid and is less than the ICAO requirement of **1.7×10^{-8}**.

c. The monitoring target for the MID RVSM height-monitoring programme is an on-going process.

d. The input data used by the CRM is valid.

e. An adequate process is in place to investigate and correct problems in aircraft technical height-keeping performance.

2.7.2 Calculating the Probability of Lateral Overlap (P_y (0))

The probability of lateral overlap $P_y(0)$ is the probability of two aircraft being in lateral overlap which are nominally flying on (adjacent flight levels of) the same route. The calculation of the Py (0) for the SMR 2021 has the following to consider:

a. The MIDRMA continued to calculate the probability of lateral overlap $\boldsymbol{P_y(0)}$ for all the MID RVSM airspace as per the ICAO methodology developed for this purpose and derived by the MID Risk Analysis Software (MIDRAS).
b. The MIDRMA calculated the probability of lateral overlap $\boldsymbol{P_y(0)}$ for each MIDRMA Member State and found all the results are valid :

1- Bahrain FIR:
Passing Frequency (n_equiv): 6.43304E-003
Probability of Lateral Overlap (Py(0)): 0.16441.

2- Cairo FIR:
Passing Frequency (n_equiv): 2.38668E-001
Probability of Lateral Overlap (Py(0)): 0.15226.

3- Baghdad FIR
Passing Frequency (n_equiv): 2.95343E-002
Probability of Lateral Overlap (Py(0)): 0.1658.

4- Tehran FIR
Passing Frequency (n_equiv): 4.18680E-002
Probability of Lateral Overlap (Py(0)): 0.14065.

5- Amman FIR
Passing Frequency (n_equiv): 4.13924E-002
Probability of Lateral Overlap (Py(0)): 0.13698

6- Kuwait FIR
Passing Frequency (n_equiv): 3.87258E-003
Probability of Lateral Overlap (Py(0)): 0.1716

7- Beirut FIR
Passing Frequency (n_equiv): Not enough traffic to measure
Probability of Lateral Overlap (Py(0)): 0.097463

8- Muscat FIR
Passing Frequency (n_equiv): 1.93820E-001
Probability of Lateral Overlap (Py(0)): 0.16611

9- Jeddah FIR
Passing Frequency (n_equiv): 2.13603E-002
Probability of Lateral Overlap (Py(0)): 0.14626

10- Khartoum FIR
Passing Frequency (n_equiv): 5.63241E-002
Probability of Lateral Overlap (Py(0)): 0.17548

11- Damascus FIR
Passing Frequency (n_equiv): 2.82413E-001
Probability of Lateral Overlap (Py(0)): 0.12441

12- Emirates FIR
Passing Frequency (n_equiv): 3.61452E-003
Probability of Lateral Overlap (Py(0)): 0.16116

13- Sana'a FIR
Passing Frequency (n_equiv): 2.39246E-001
Probability of Lateral Overlap (Py(0)): 0.17121

c. Overall, the results are considered to be valid.

2.7.3 Pz(1000) Compliance

The Pz(1000) is the probability that two aircraft at adjacent RVSM flight levels will lose vertical separation due to technical height keeping errors. The value of the probability of vertical overlap Pz(1000), based on the actual observed ASE and typical AAD data is estimated to be of **5.207×10^{-10}**

This value meets the Global System Performance Specification that the probability that two aircraft will lose procedural vertical separation of 1000ft should be no greater than **1.7×10^{-8}**.

The MIDRMA continues to issue the minimum monitoring requirements (MMRs) through the automated MMR software which is programmed to address the MIDRMA member states with their updated requirements according to the latest RVSM approvals received, the MMR table valid for December 2021 is available in **Appendix B**.

Note: All member states are required to check and comply with their MMR through the MIDRMA website (www.midrma.com).

2.7.1 **Conclusions on Technical Vertical Collision Risk:**

a. The current computed vertical-collision risk due to technical height-keeping performance meets the ICAO TLS.

b. The probability of vertical-overlap estimate, Pz(1000), satisfies the global system performance specification.

c. Most monitoring groups are complying with ICAO TVE component requirements (also known as technical height-keeping group requirements).

2.7.2 **Recommendations for Safety Objective 1:**

a. The MIDRMA shall continue to review the content and structure of its aircraft monitoring groups (on going task).

b. The MIDRMA will continue to keep the methods of calculating the technical CRM parameters and the risk due to technical height keeping errors under review and explore more options to enhance the MID Risk Analysis Software (MIDRAS),

Note: new project has started to include more features in the MIDRAS (will be presented to the MIDRMA Board meeting for approval.

c. The MIDRMA shall carry out continuous height monitoring survey and investigation concerning aircraft flying within the MID RVSM airspace by collecting the TDS from member states offered to submit their RVSM TDS on a monthly basis.

d. More MIDRMA Member states other than Bahrain, Iraq and UAE are encouraged to send their monthly RVSM traffic data to explore more possible violations to the MID RVSM airspace.

2.8 Assessment of overall risk due to all causes against the TLS of 5 x 10^{-9} fatal accidents per flight hour

RVSM Safety Objective 2

The overall risk of collision due to all causes which includes the technical risk and all risk due to operational errors and in-flight contingencies in the MID RVSM airspace meets the ICAO overall TLS of **5 x 10^{-9}** fatal accidents per flight hour.

The value computed for the overall risk is estimated **4.073 x 10^{-10}** this meets RVSM Safety Objective 2.

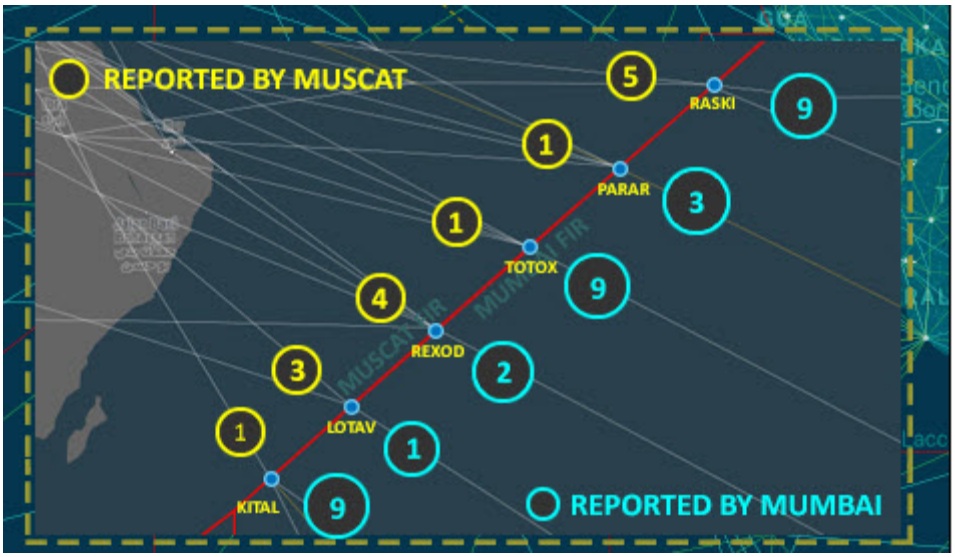
Overall Risk Values				
Year 2006	**Year 2008**	**Year 2010**	**Year 2011**	**Year 2012/13**
Not calculated	4.19 x 10^{-13}	6.92 x 10^{-12}	1.04 x 10^{-11}	3.63 x 10^{-11}
Year 2014	**Year 2015**	**Year 2016**	**Year 2017**	**Year 2018**
4.91 x 10^{-11}	7.351 x 10^{-10}	5.691 x 10^{-10}	4.518 x 10^{-11}	9.845 x 10^{-11}
Year 2019	**Year 2020**	**Year 2021**		
8.345 x 10^{-10}	5.206 x 10^{-10}	4.73 x 10^{-10}		

2.8.1 The vertical risk estimation due to atypical errors has been demonstrated to be the major contributor in the overall vertical-risk estimation for the MID RVSM airspace, In the previous SMRs the processed data were severely influenced by either NIL reporting of Large Height Deviations (LHDs) and very few reports of categories A, B, C, D, J and K as without enough data (especially from FIRs with high volume of traffic) will not reflect confidence with the final results.

2.8.2 The MIDRMA continues to monitor the LHD reports at the eastern FIR boundary of Muscat FIR filed by Mumbai, the MIDRMA indicated in SMR 2017 the level of LHD reports filed by Muscat and Mumbai ATCUs related to each other at their transfer of control points reached to a dangerous level and started to effect the ICAO TLS of RVSM implementation in the MID and APAC regions, therefore the MIDRMA requested from MIDRMA Board/15 meeting (Muscat – Oman 29 – 31 January 2018) to open a Safety Protocol for the purpose of resolving this issue as soon as possible.

2.8.3 Although, the traffic level reduced at the common FIR boundary points for Muscat and Mumbai, the MIDRMA can't see much improvement for SMR 2021 as the safety concern still exist and more works required from both ATCUs to close this safety protocol such as the implementation of OLDI/AIDC which is still ambiguous at this stage and required follow up from MIDANPIRG.

Note: A Safety Protocol is a critical safety issue effecting the implementation of RVSM operations which require the concerned authority an immediate action to rectify/resolve the problem in a certain period of time under the supervision of MIDRMA and ICAO MID Office.

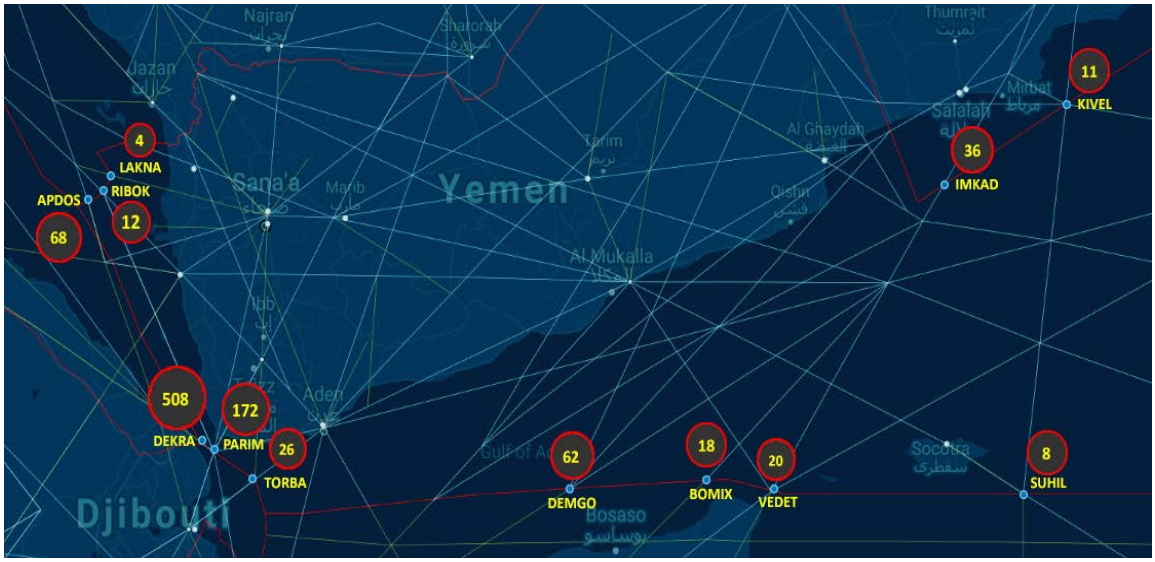


2.8.4 The Safety Protocol is under continuous review by MIDRMA and MAAR and the LHD reports filed by all concerned ATC Units are investigated and evaluated through the MIDRMA online LHD system and further update will be addressed to the next MIDRMA Board meeting.

2.8.5 The problem of the increased number of LHD reports submitted by Sana'a ACC related to some its neighboring ATCUs began to appear more than three years ago and did not improve even with the decrease in the number of air traffic in 2020 and 2021 due to the outbreak of the Corona pandemic, the MIDRMA is addressing this issue to the MIDRMA Board/17 to take all necessary measures to resolve this problem.

2.8.6 Through the evaluation review for the LHD reports valid for SMRs 2017, 2018, 2019 and 2020 the MIDRMA noticed very few Member States are investigating the reported LHDs related to their FIRs and reply with their outcomes/corrective actions. The meeting may wish to note that the Online LHD System has the feature to allow all Member States to forward their reports directly to the concerned focal points responsible to receive the LHD reports and allow them to reply with their outcomes in the same report which will be archived for future analysis.

2.8.7 The MIDRMA pointed out during the last Board meeting the issue of lack of response to the received LHD reports using the feature of direct response to the reporting unit to ensure that all responses are archived and referenced when needed. Unfortunately, the extreme majority of the Member States are not using this feature and don't bother to investigate and reply to the received LHD reports.



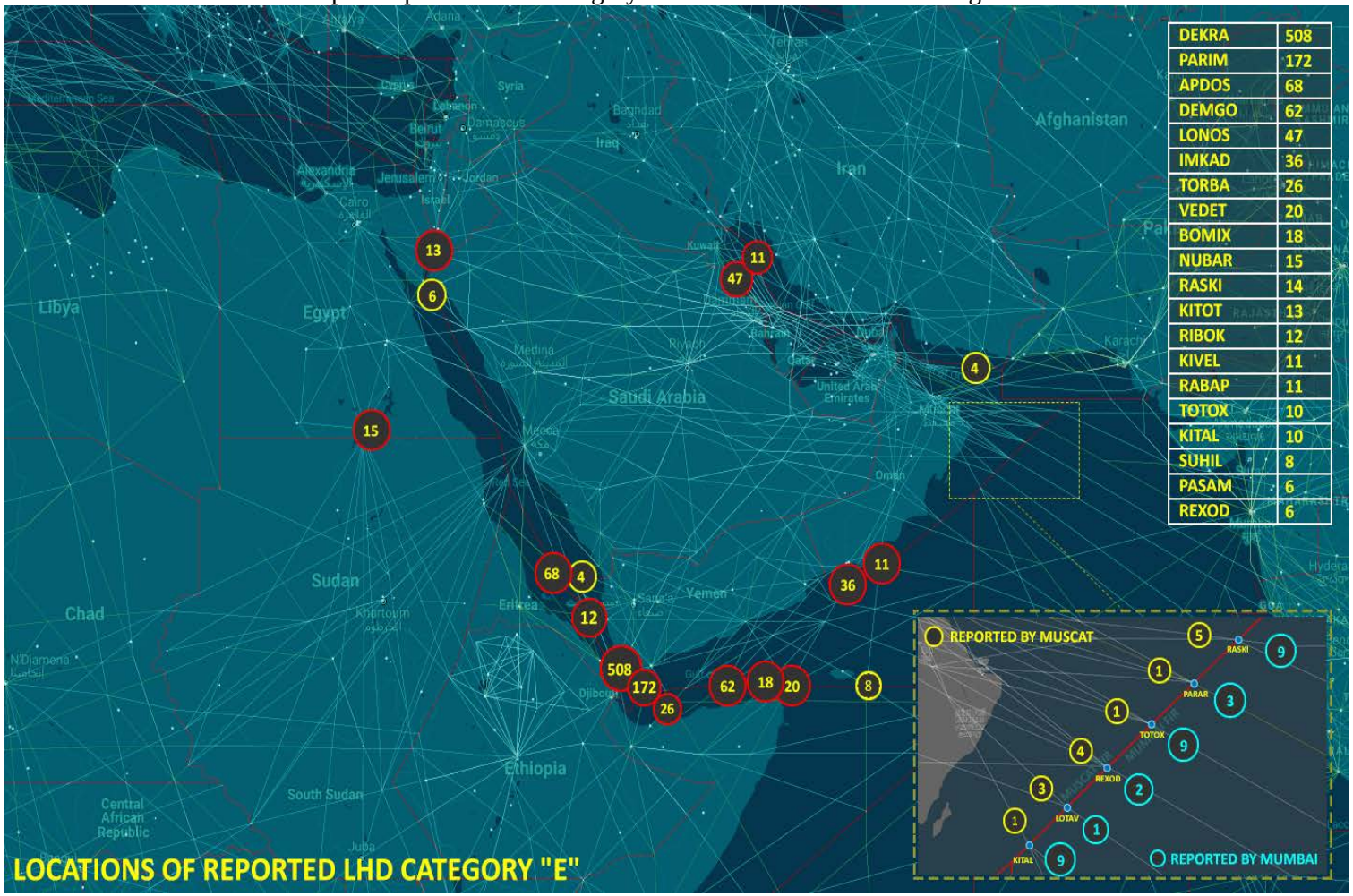
2.8.8 The Table below presents a summary of operational risk associated with Large Height Deviation (LHD) reports by LHD categories, these reports used to calculate the overall vertical collision risk for the MID RVSM airspace.

LHD Cat. Code	Large Height Deviation (LHD) Category	No. of LHDs	LHD Duration (Sec.)
A	Flight crew fails to climb or descend the aircraft as cleared	**6**	**95**
B	Flight crew climbing or descending without ATC clearance	-	-
C	Incorrect operation or interpretation of airborne equipment	-	-
D	ATC system loop error	-	-
E	ATC transfer of control coordination errors due to human factors	**42**	**990**
F	ATC transfer of control coordination errors due to technical issues	**1**	**15**
G	Aircraft contingency leading to sudden inability to maintain level	-	-
H	Airborne equip. failure and unintentional or undetected FL change	**2**	**25**
I	Turbulence or other weather related cause		
J	TCAS resolution advisory and flight crew correctly responds	**1**	**5**
K	TCAS resolution advisory and flight crew incorrectly responds	-	-
L	An aircraft being provided with RVSM separation is not RVSM approved	**1**	**20**
M	Other	-	-
	Total	**53**	**1150**

Summary of Operational Risk associated with Large Height Deviation Reports

MID RVSM SMR 2021

2.8.9 The picture below reflects the locations of the top 20 reported LHDs category E in the ICAO Middle East Region.



2.8.10 **Effects of Future Traffic Growth**

For the second year, the Coronavirus outbreak and the relevant precautionary measures to limit its spreading are having clear impacts on human mobility at global scale. This provoked a reduction of domestic and international volumes of air passenger traffic worldwide, such effects are currently being observed in the Middle East region. This has clear implications for the aviation industry as well as indirect consequences to several sectors (e.g. tourism) and the economy at large as well as the society.

The MIDRMA continuously monitoring the traffic growth from the RVSM traffic data received on a monthly basis from Bahrain, Iraq and UAE and found the traffic growth compared with July 2020 has increased by 25% - 30% . These range from a quick and complete recovery to less optimistic scenarios of a slower or even incomplete recovery, and will depend on the duration and severity of the lockdown and the spread of this virus in the MIDRMA member states.

The effect of future traffic growth on the vertical collision risk can be evaluated on the assumption of a linear relationship between traffic growth and frequency of horizontal overlap, which will directly affect the two components of the risk: the risk due to technical height-keeping performance and due to atypical operational errors.

With the current uncertainty over traffic growth this issue will be revisited when the Middle East economic conditions return to more normal growth.

2.8.11 **Conclusions on the overall vertical risk:**

a. The overall risk of collision due to all causes which includes the technical risk and all risk due to operational errors and in-flight contingencies in the MID RVSM airspace, estimated from the operational and technical vertical risks calculated with LHD reports from most of the member states, the computed result for this SMR is considered to be representative for the MID RVSM airspace.

b. The effect of future traffic growth on the vertical collision risk can be evaluated on the assumption of a linear relationship between traffic growth and frequency of horizontal overlap, which will directly affect the two components of the risk: the risk due to technical height-keeping performance and due to atypical operational errors. It is very clear the MID region is suffering sever reduction in the traffic growth which is keeping the estimation of overall risk in safe side.

2.8.12 **Recommendations Applicable to Safety Objective 2:**

a. The MIDRMA shall continue to encourage States to provide Large Height Deviation Reports (LHD) of all categories and not only related to handover issues.

b. Due to the failure of replying related LHD reports by some member states, the MIDRMA will upgrade the LHD online reporting system to alert states who failed to respond with the need to investigate and report their outcomes in the system itself as soon as possible.

c. The MIDRMA, in coordination with concerned States, assure that incidents and violations which have direct impact on the implementation of RVSM within the MID Region are reported in continuous basis through the MIDRMA LHD online reporting system in due time for operational safety assessment analysis.

2.9 **ASSESSMENT OF SAFETY-RELATED ISSUES RAISED IN THIS REPORT**

RVSM Safety Objective 3

Address any safety-related issues raised in the SMR by recommending improved procedures and practices; and propose safety level improvements to ensure that any identified serious or risk-bearing

situations do not increase and, where possible, that they decrease. This should set the basis for a continuous assurance that the operation of RVSM will not adversely affect the risk of en-route mid-air collision over the years.

a. The MIDRMA improved its monitoring capabilities by conducting trial ADSB Height Keeping Performance for some RVSM approved aircraft registered by MIDRMA member states.

b. The MIDRMA started to build its database for the RVSM approved aircraft registered by MIDRMA member states which are capable of ADSB out to conduct height monitoring using AHMS (ADSB Height Monitoring System)

c. The MIDRMA started to address Performance-Based Communication and Surveillance (PBCS) approvals request from member states issuing PBCS approvals and forward reports received from other regions related none compliant of PBCS requirements.

d. The MIDRMA will address the Hot Spots of each MID FIR generated by the (MIDRAS) Software (for information only).

e. Current risk-bearing situations have been identified by using the MIDRAS and the MID Visualization and Simulation of Air Traffic and action will be taken to ensure resolving all violations to RVSM airspace by non-approved aircraft.

f. The MIDRMA continued to carry out scrutiny checks for aircraft filling W in their flight plans for all aircraft flying within the ICAO Middle East RVSM airspace and address all violating aircraft to the concerned authorities.

g. The MIDRMA arranged for an upgrade project to enhance the MIDRAS which will improve and facilitate the calculation of all RVSM risk parameters.

-It is concluded that this Safety Objective is currently met.

Appendix A

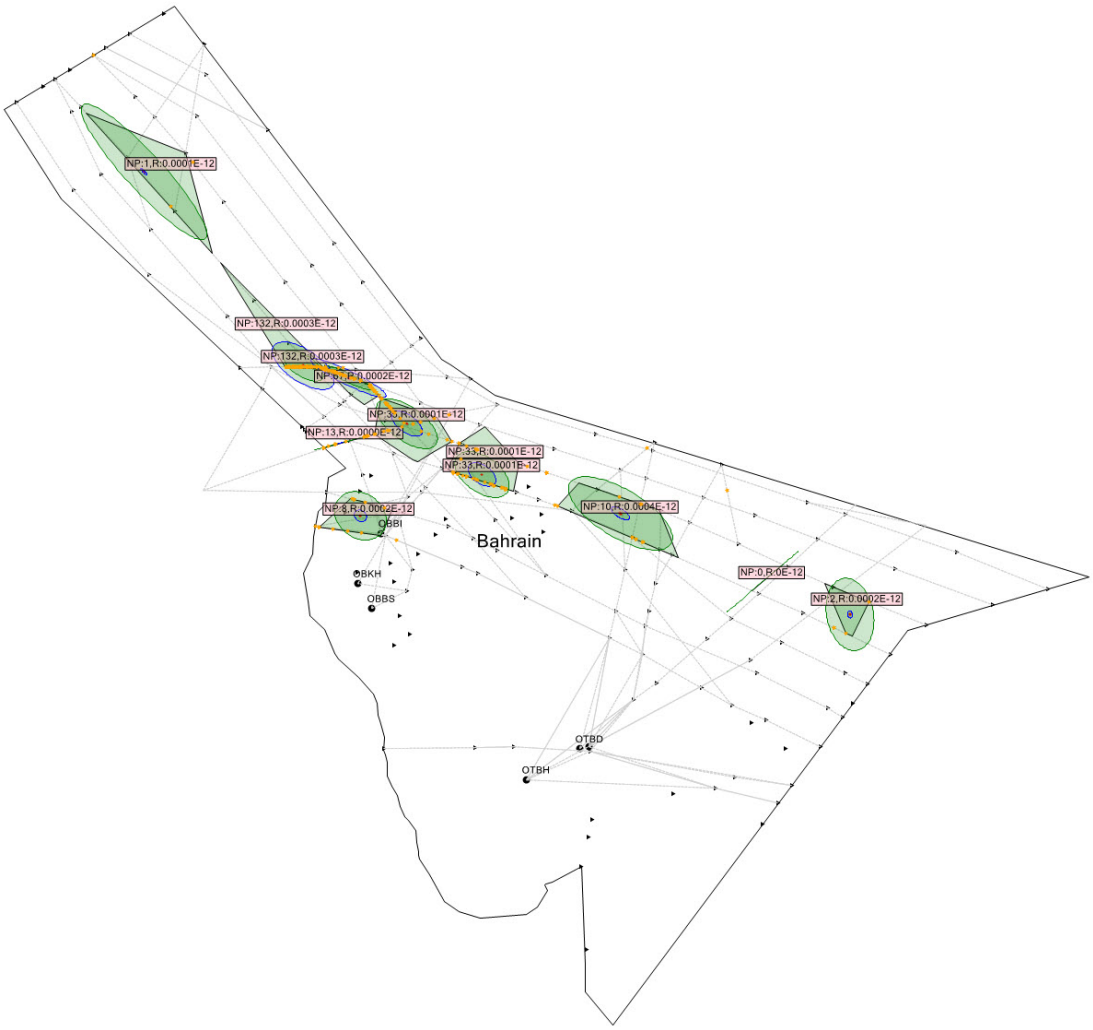
MID STATES RVSM AIRCRAFT MINIMUM MONITORING REQUIREMENTS

Valid as of 31st December 2021

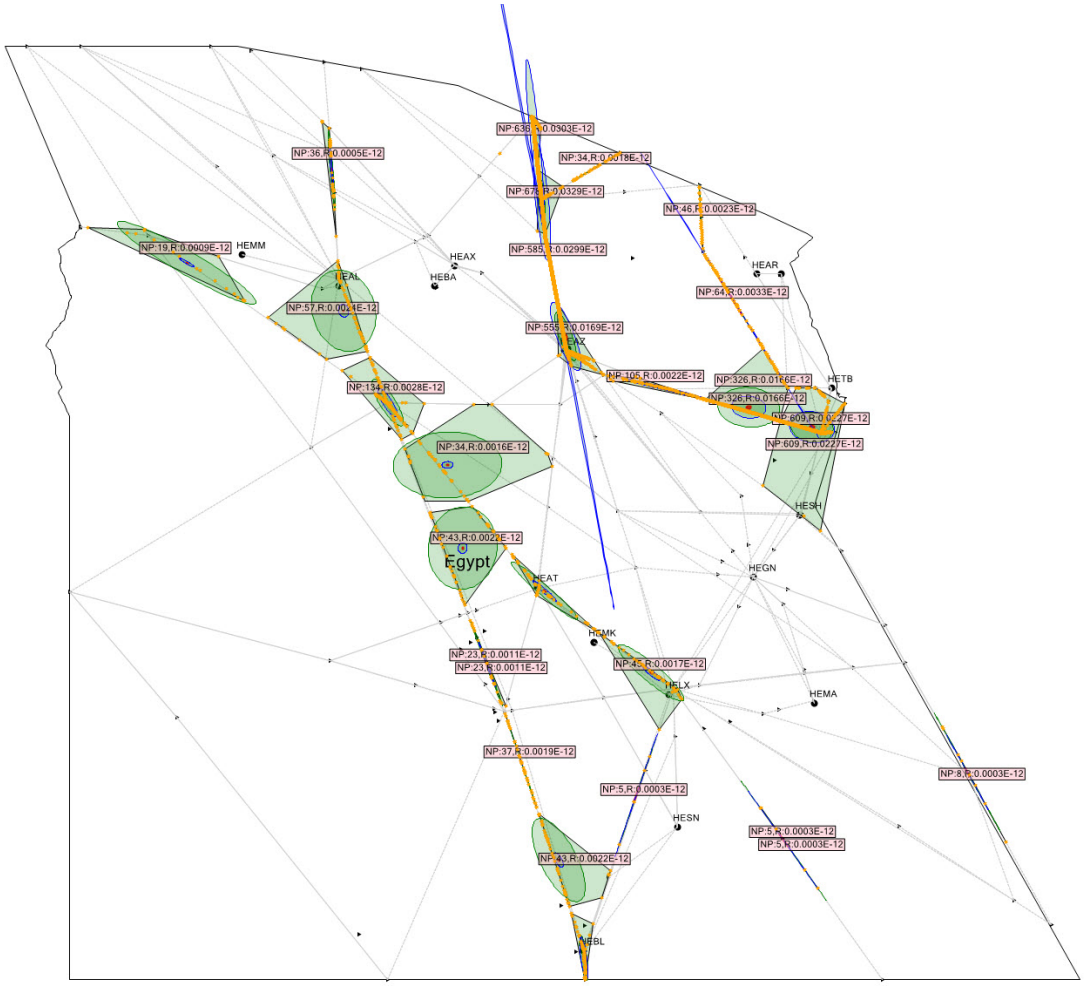
MID STATES	RVSM APPROVED A/C	HAVE RESULTS OR COVERED	NOT COVERED	NOT COVERED IN %	A/C MMR
Bahrain	60	60	0	0%	**0**
Egypt	156	113	43	28%	**27**
Iran	249	138	111	45%	**36**
Iraq	43	43	0	0%	**0**
Jordan	44	40	4	9%	**4**
KSA	259	257	2	0.8%	**2**
Kuwait	70	64	6	9%	**5**
Lebanon	32	32	0	0%	**0**
Libya	31	9	22	71%	**15**
Oman	72	63	9	13%	**3**
Qatar	276	276	0	0%	**0**
Sudan	10	10	0	0%	**0**
Syria	15	0	15	100%	**9**
UAE	584	529	55	9%	**24**
Yemen	5	0	5	100%	**5**
TOTAL	**1906**	**1635**	**271**	**14.22%**	**130**

Appendix B

MIDRMA Member States Hot Spots Generated from July 2021 TDS
(For information ONLY)



Bahrain FIR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Egypt
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HEAT
HTMK
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HELX
HEMA
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NP:8,R:0.0003E-12
NP:5,R:0.0003E-12
HESN
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HEBL

Cairo FIR


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ORKK
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ORBI
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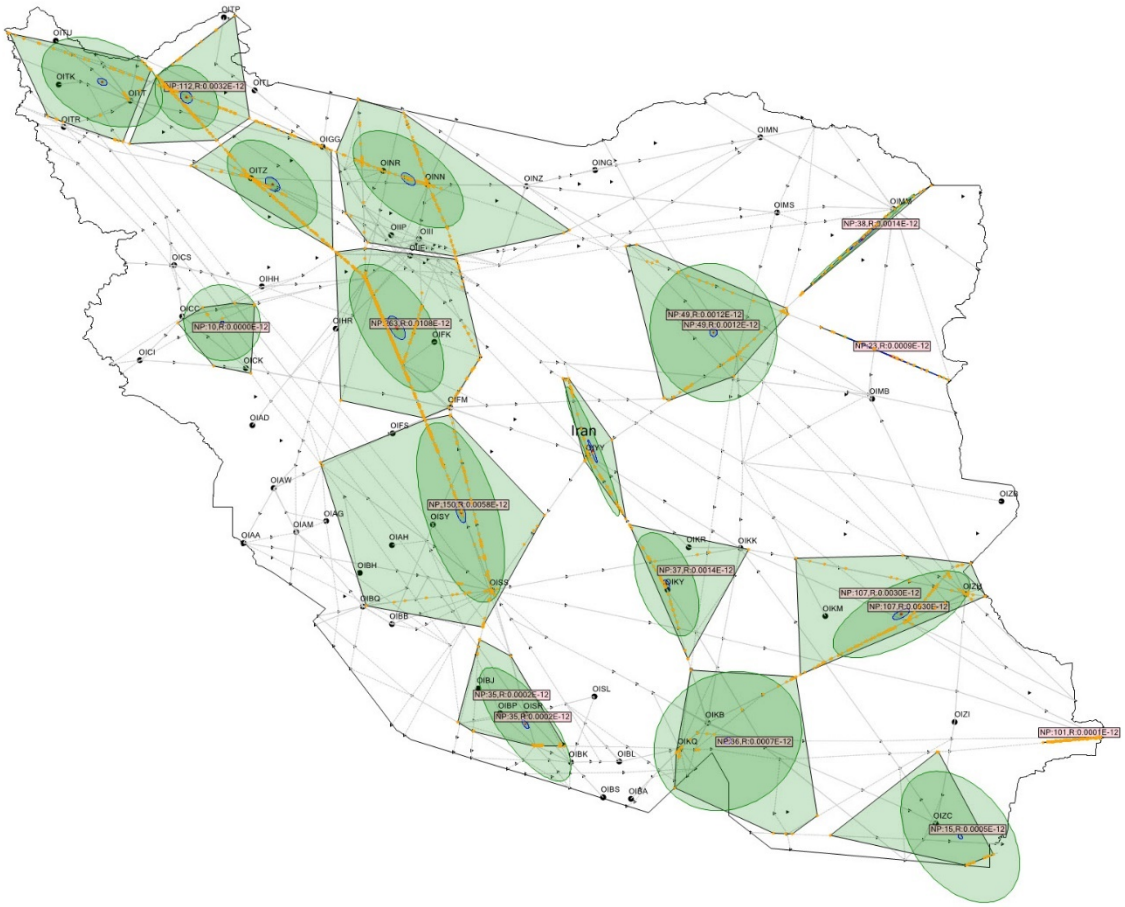
BAGHDAD FIR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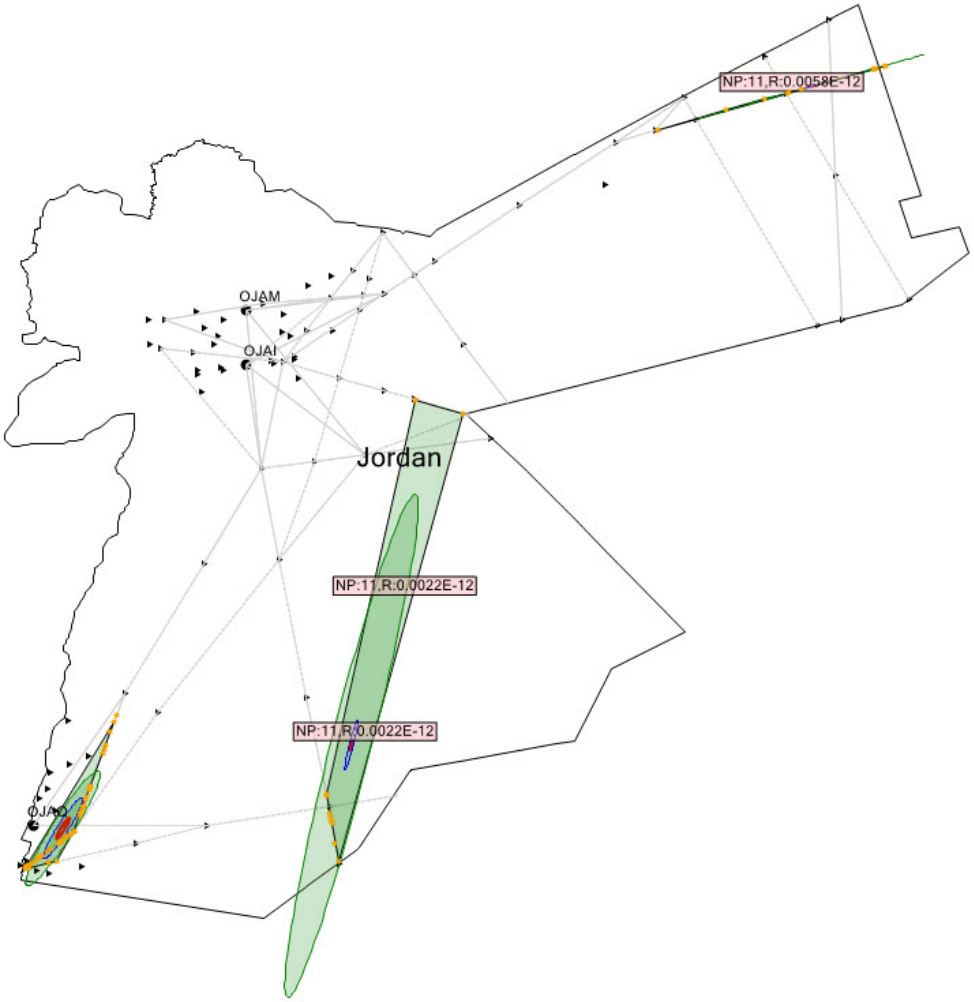
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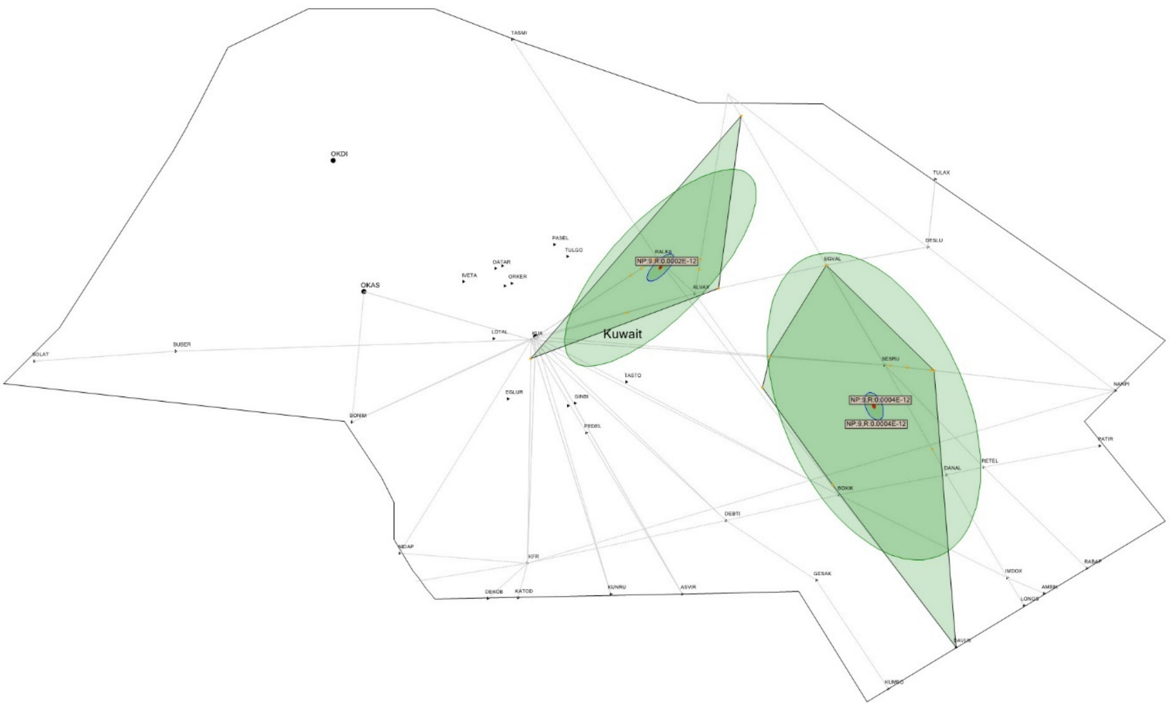
OJAC

AMMAN FIR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PASEL
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DATAR
IVETA
ORKER
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Kuwait
LOTAL
SUBER
SOLAT
BONIM
EGLUR
GINBI
PEDEL
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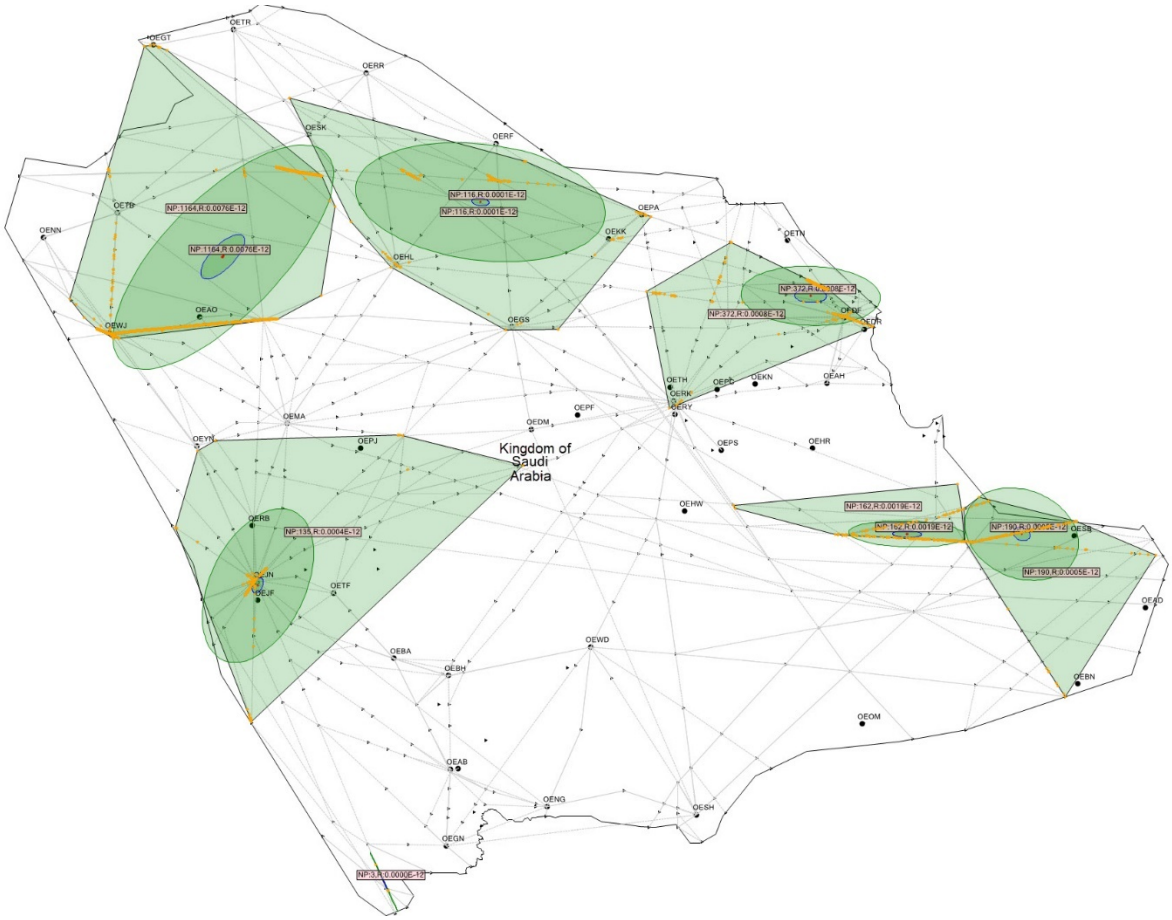
SAVUS
KUMBO

KUWAIT FIR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JEDDAH FIR


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OOMS
OOFD
OOGB
Oman
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OOMK
OOMX
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NP:195,R:0.0005E-12
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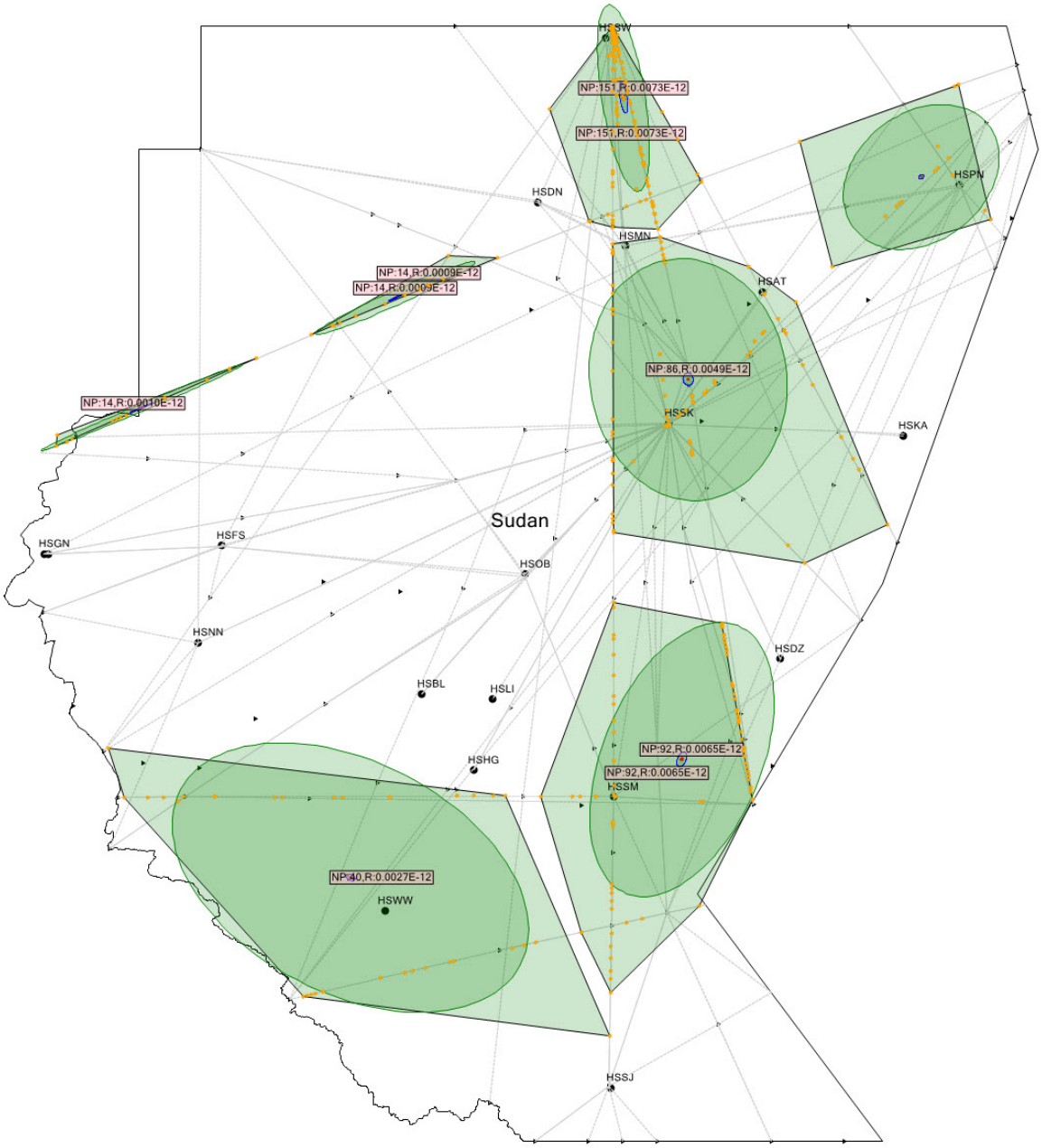
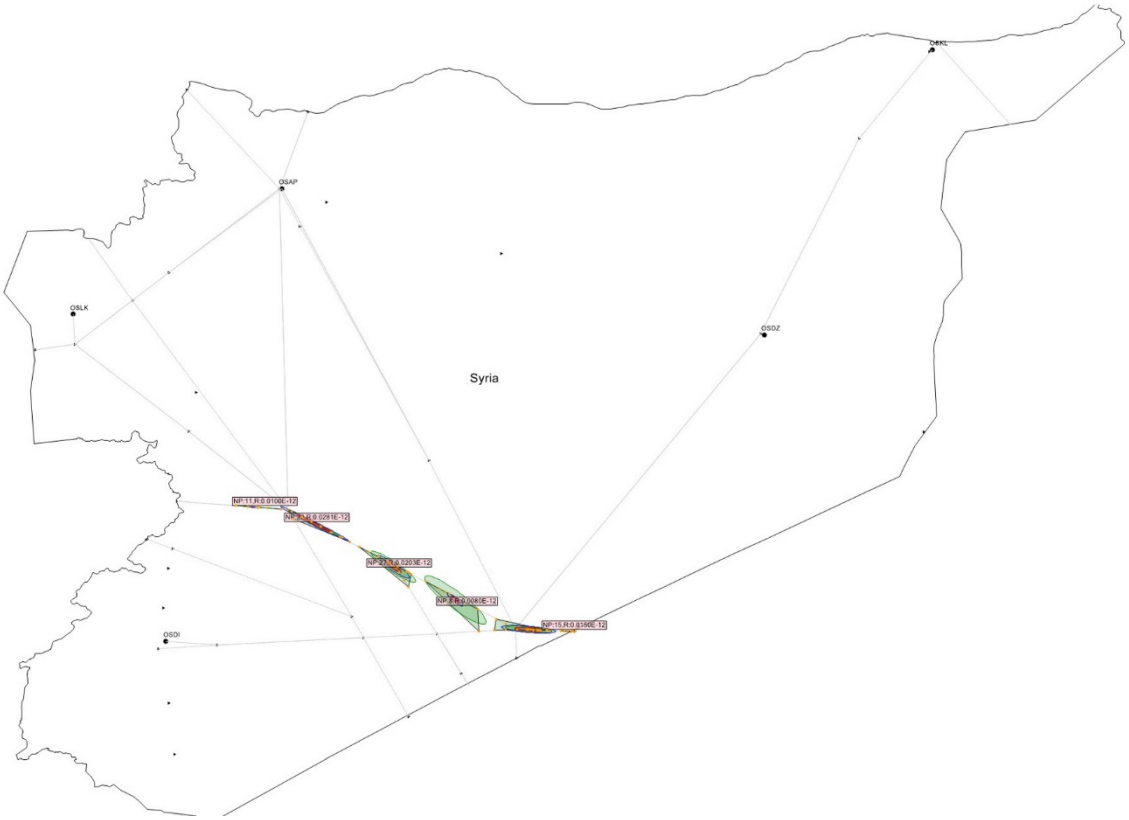
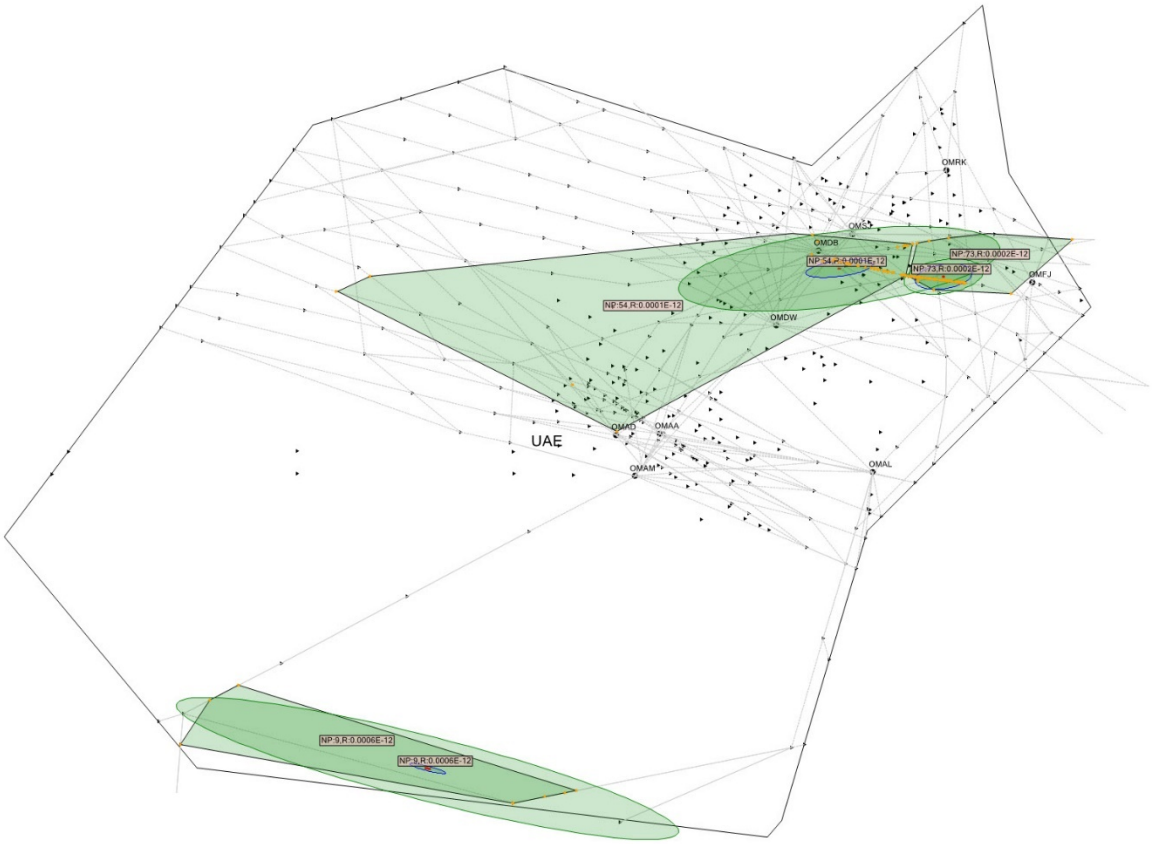
MUSCAT FIR



KHARTOUM FIR



DAMASCUS FIR



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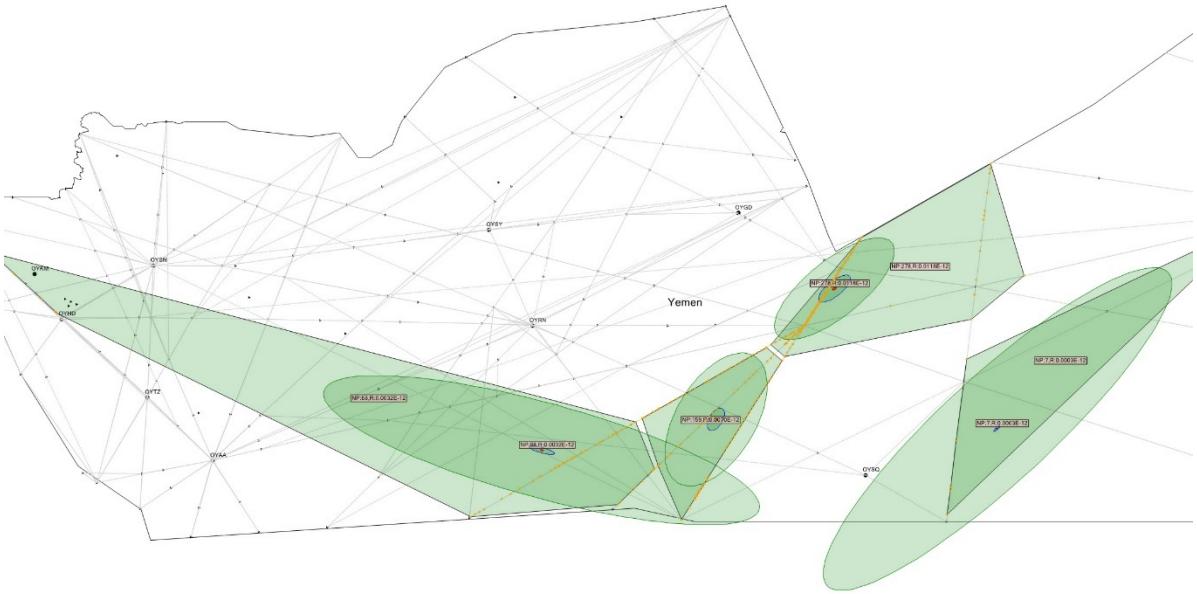

SANA’A FIR

- END -

BUSINESS CASE FOR THE MIDRAS UPGRADE PROJECT

FAREED ALALAWI
Middle East Regional Monitoring Agency
January 2022
V1.0

CONTENTS

INTRODUCTION

MID RMA Tasks and responsibilities

Given the continued growth in air transportation, one of the key challenges faced by Air Navigation Service Providers (ANSPs) and airlines is: ow to increase airspace capacity without compromising aviation safety. New air traffic management (ATM) paradigms by ICAO aim for doubling the airspace capacity (2x) while increasing the safety by a factor of 10 by 2030. To achieve such ambitious targets, development of new operational concepts, safety measures and safety performance indicators in the air traffic system are not only expected but also necessary. Reduced Vertical Separation Minimum (RVSM) airspace which is ranging vertically from 29,000 feet (FL290) to 41,000 feet (FL410), reduces the vertical separation from 2000 feet to 1000 feet, adding 6 extra flight levels. To maintain the safety and integrity of airspace stringent procedures by ICAO are in place. To achieve these measures, MIDRMA has developed MIDRAS software for collision risk assessment of Middle East airspace. This software uses ICAO RGCSP Vertical Collision Risk Model for collision risk computation. The ICAO model is based on knowledge of the traffic flows along a given route structure. The software computes Collision Risk equation parameters; and processes flight data for each member State to compute Collision Risk. The MIDRAS software also provides an interactive interface for collision risk visualization, simulation, modelling of scenarios and Hot-Spot analysis.

The need for MIDRAS upgrade business-case

This study provides Member States and the MIDRMA Board the scope of work for the upgrade of MIDRAS, based on the identified needs, weaknesses and associated benefits and costs,. to support the decision making process.

Structure of the business-case

The business-case is developed in three Sections, as follows:

Section One: Current status and the need for the upgrade.

Section Two: MIDRAS Upgrade Project Costs and Benefits.

Section Three: The value of the Upgrade Project.

SECTION ONE:

History and status of the Current software/tool

The development and procurement of the current version of the MID Region Risk Analysis Software (MID RAS) was approved by the MIDRMA Board/11 (Cairo, 27 – 29 September 2011). Since then, the software has been used by the MIDRMA team to develop all the MID RVSM Safety Monitoring Reports (SMRs).

The MIDRAS software is a customized tool that integrates the ICAO standards and models for collision risk calculations and provides an interactive interface for collision risk analysis, scenario planning, Hot-Spot analysis and fast-time air traffic simulation. The functionality of the software is based on the methodologies adopted by the MIDRMA to calculate the RVSM Safety parameters for the development of the SMRs based on the Traffic Data Sample (TDS) provided by the MID States.

Additionally, the current version of the software uses the Aircraft performance criteria issued and updated by EuroControl; however, the EU has recently decided to not support this information any more, which leaves the MIDRAS with outdated aircraft performance data, and not including any new aircraft types. This obliged the MIDRMA team to add the required data manually along with other manual inputs required to present the mathematical results in geo-referenced graphs.

On the other hand, the MIDRMA receives the TDS from MID States on periodic basis, and it has been identified that the TDS has been continuously submitted with issues related to the accuracy and continuity of the traffic trajectory information, which represents the foundation of the development of the SMR. Therefore, a lot of extra efforts by the MIDRMA team is required to identify the issues and make necessary corrections in coordination with concerned States, which requires a lot of extra time.

Furthermore, frequent changes in the dynamics of the Regional and International traffic flows within the Region, different Airspace reconfiguration, increased congestion and variation on the demand, have been observed; therefore, the MIDRAS software needs significant upgrades to keep pace with these developments.

Note: the current software was subject to different minor updates, mainly related to periodic maintenance and compatibility issues with the other platforms (like for example newer MS. Windows versions, security updates, etc.).

The need for upgrade

Based on the above; the MIDRMA Team, despite the 10 years of extensive work on the current software version, has faced several issues that necessitates a lot of extra efforts and time to overcome, which led in several occasions to delays in the development of the SMR.

Based on the experience gained, the MIDRMA team identified the issues/weaknesses and required mitigation measures including the modifications/upgrades of the MIDRAS and associated benefits and costs, in coordination with the MIDRAS developer and his team. Accordingly, the developer

proposed an offer for the upgrade of the software that will support the MIDRMA team and increase efficiency.

Upgrade Project Framework (Scope of work)

The MIDRAS necessary upgrades that have been identified include the followings (Scope of Work):

1- New Hot-Spot Detection and Visualization model.
2- Congestion areas Analysis.
3- Updating aircraft types performance database.
4- Enhanced risk parameters calculations.
5- Autocorrect Member States Traffic Data Samples (TDS).
6- Enhanced Geographical presentation of the mathematical results.
7- Top of Decent analysis.
8- Airway Occupancy statistics and analysis.
9- Other necessary technical features requested by the MIDRMA to help tracing errors, crashed registry errors and guidance to spot exceeded TLS in any RVSM airspace in the Middle East Region.

Upgrade Project Goals and Objectives

The new features and upgrades listed above will enable the MIDRMA to conduct effective analysis of collision risk in the Region and gain new insights into emerging traffic dynamics; this will support the States and ANSPs in the Region to enhance the Airspace management measures.

Scope of Work and Work Packages (WP) and Deliverables

The Upgrade Project is planned to be divided into three Work Packages as follows:

Work Package 1: New Features in MIDRAS

This work package will develop the new features in MIDRAS software using Artificial Intelligence. This will include:

1. A new Hot-Spot Detection and Visualization model,
2. Top of Decent analysis,
3. Airway Occupancy statistics and analysis,
4. A new metrics for Congestion analysis.

5. A tool to develop Target Level of Safety Collision Risk Graph generation and display capabilities, along with video recorder built-in the MIDRAS AI software.

WP2: Upgrades to MIDRAS

This work package will upgrade some existing capabilities in MIDRAS software. Such upgrades will include:

1. Automated Flight input data correction.
2. Automated speed/distance errors fixes.
3. Extended interactive features in terms of Zoom and Pan.
4. Time control feature for MIDRAS air traffic simulation tool, which can help user to choose the simulation speed.

Such upgrades will allow MIDRAS users to speed up the data processing, and reduce the need for manual intervention for data entry, thanks to the AI algorithms/features. This will allow for better traffic flow analysis and greater understanding of collision risk at crossing points; and overall enhanced efficiency and accuracy.

WP3: Correction to MIDRAS

This work package will modify existing features due to changes in the business rules for dealing with RVSM flights entering and exiting at non-RVSM levels. The correction will also include revising data inputs files such as BADA file, related to aircraft performance criteria used in MIDRAS (outdated and requires manual interventions/corrections).

In addition, further to the numerous changes in Middle East airspace redesign/reconfiguration since the development of MIDRAS, there is a need to update the software and its databases to keep pace with these developments, including the improvement of the features/functionalities, which allow the users (MIDRMA) to do the necessary updates by themselves (without the need of the developer every time there are changes). Moreover, there is a need to improve the quality of the error messages generated during the process (to be more detailed and accurate, so that the exact issue could be identified and dealt with more easily, which will again save a lot of time and efforts by the MIDRMA team).

Upgrade Project Deliverable

The followings are the key deliverables of the project:

1. MIDRAS Software with New Hot-Spot identification and traffic congestion visualization model.
2. MIDRAS Software with updated Input/output files, Graph display and Error handling capabilities.
3. MIDRAS Software with new business rules for flight plan processing and data analytic features.

SECTION TWO:

MIDRAS Upgrade Project Costs and Benefits

The MIDRAS upgrade will, inter alia, enable the MIDRMA to shorten the duration of the SMR development period from 50 – 60 days to 10 days, and will significantly reduce contacts with Member States having problems with the submitted TDS. The upgrade will include also improved graphical display, which will enable all those requesting technical information/clarification to understand the results in a much easier manner.

Upgrade Project Direct Cost:

The direct cost is mentioned in the third section of the business-case, including all the upgrade works, consultation and training services. It is to be highlighted in this respect, the upgrade of the network connections will be carried out by Bahrain CAA with no financial cost.

Upgrade Project Indirect Cost

There is no anticipated further cost involved for this upgrade project; all hardware, utilities and manpower already used by MIDRMA in the current arrangement of MIDRAS will be sufficient to meet the new features in the MIDRAS upgrade.

Upgrade Project Intangible Cost

The foreseen intangible cost of this upgrade project is the time and efforts by the MIDRMA Team to follow up the progress of the upgrade working packages with the developer and the work required from their side related to training and validation of the new MIDRAS version.

Upgrade Project Competitive Cost

MIDRAS is a unique software developed to enhance the results of the ICAO Collision Risk Model specially tailored to the MID RMA functions. The Regional Monitoring Agency Coordination Group (RMACG) was apprised of the MIDRAS functionalities and impressed with its performance. The upgrade is a continuation of MIDRMA's success in calculating the ICAO RVSM TLS with high efficiency, and it can encourage other RMAs to follow the MIDRMA's footsteps.

SECTION THREE:

Total Value of the Upgrade Project

The total cost of the received offer for the upgrade project is USD 100,700.00 (One Hundred Thousand and Seven Hundred US Dollars) this amount will be supported from the net profit generated by the MIDRMA team from conducting RVSM height monitoring activities and will not burden the MIDRMA's budget.

Upgrade Project Timeline

The Work-packages for the upgrade project mentioned in the first section will start concurrently depending upon the architecture of the software and related activities in respective work packages. There can be significant overlaps in the work packages given the nature of the project, which may require the output of one work-package as input to others.

The expected duration of the project is Six months (after the signature of the contract).

SUMMARY

In summary, the MIDRAS is a custom-made analysis software/tool that has been used by the MIDRMA for the past 10 years. Based on the experience gained by the MIDRMA team, and to keep pace with developments and increase efficiency, an upgrade of the MIDRAS deemed to be necessary. The software developer provided an offer addressing all the identified issues and necessary enhancements. The revenue generated by the MIDRMA monitoring activities are largely covering the required costs for the upgrade. The upgraded version will enhance the deliverables of the MIDRMA according to its functions, and will reduce the time and efforts needed to develop the safety analyses and enhance the Airspace planning of the concerned States and ANSPs. Overall, the new MIDRAS version will contribute to an improved efficiency; and the cost-savings in terms of man power will cover in a relatively short period this investment; in addition to the benefits accrued from the new functionalities/features, including those using Artificial Intelligence (AI).

ATTACHMENTS

Attachment A: Proposed "Project Agreement MIDDLE EAST RISK ASSESSMENT SOFTWARE SYSTEM UPGRADE" by Dr. Sameer Alam.

- END -