



International Civil Aviation Organization

Middle East Regional Monitoring Agency Board

Twentieth Meeting (MIDRMA Board/20)

(Muscat, Oman, 10 – 11 November 2024)

Agenda Item 4: RVSM Monitoring and related Technical Issues

DOHA FIR PHASE 2 PRE-IMPLEMENTATION RVSM AIRSPACE ASSESSMENT

(Presented by the MIDRMA)

SUMMARY

This working paper outlines the progress made in implementing ICAO Council Decision C-DEC 225/10 in response to the MIDANPIRG/20 request for an RVSM risk analysis related to the establishment of the Doha FIR/SRR, with emphasis on the completion of Phase 1. As a part of Phase 2 pre-implementation RVSM assessment, the MIDRMA was tasked to carry out an RVSM safety assessment. The technical risk values for RVSM airspace have been calculated both prior and following the transfer of airspace from Bahrain and Qatar, with the results included herein. The evaluation of these results should be entrusted to an independent competent entity, for further comprehensive assessment and determination of any necessary actions for future steps or improvements.

Action by the meeting is in paragraph 3.

REFERENCES

- ICAO Council Decision C-DEC 225/10
- MIDANPIRG/20 Report
- MIDRMA Board/19 Report

1. INTRODUCTION

1.1 In response to MIDANPIRG Conclusion 20/16, which requests the Middle East Regional Monitoring Agency (MIDRMA) to conduct a safety monitoring assessment for the RVSM (Reduced Vertical Separation Minimum) within the airspace of Bahrain and Doha FIRs, the MIDRMA undertook the necessary assessment activities. This paper outlines the scope of the assessment, highlights key findings, and provides an overview of traffic bottlenecks, hotspots, and areas of congestion within the RVSM airspace of the two FIRs.

1.2 The details of the Safety Monitoring Report are included in **Appendix A** incorporated with the results for Bahrain FIR, before and after the establishment of Doha FIR on 23 March 2023 and for the results of the newly established Doha FIR.

2. DISCUSSION

Scope of Assessment

2.1 The RVSM safety monitoring assessment was limited to the RVSM airspace within Bahrain and Doha FIRs, focusing on air traffic operations and risks associated with reduced vertical separation. It is important to note that this assessment does not encompass overall risk evaluation for the safe implementation of RVSM in both FIRs due to the lack of operational error reports, specifically Large Height Deviation (LHD) data. As such, the assessment's conclusions are limited to the current technical risk factors observed in the RVSM airspace, without a comprehensive safety risk measurement.

Assessment Findings

2.2 The MIDRMA conducted the assessment in line with the methodologies typically applied to RVSM airspace monitoring. The key findings are summarized as follows:

- **Doha FIR:**

The assessment indicates that within the current Doha FIR boundaries, considering limited number of airways and low volume of traffic, no hotspots, bottlenecks, or areas of traffic congestion were observed. No significant RVSM issue was identified particularly across the three parallel airways managed by Doha ACC. As a result, the technical risk value for RVSM operations in Doha FIR is currently considered negligible.

- **Bahrain FIR:**

The assessment reflects the continued presence of bottlenecks and areas of traffic congestion that were identified prior to the establishment of Doha FIR. These traffic challenges have persisted despite the reallocation of airspace responsibilities. A significant factor is that a vast majority of movements within the RVSM airspace remain under the control of Bahrain ACC. Therefore, while Doha ACC has slightly alleviated traffic pressure, the technical and operational challenges within Bahrain FIR's RVSM airspace remain largely unchanged.

Limitations and Challenges

2.3 One critical challenge faced during this assessment was the lack of operational error reports, particularly LHD data. The absence of this data makes it impossible to carry out a comprehensive risk evaluation for RVSM safety in the Bahrain and Doha FIRs. The MIDRMA's current monitoring capabilities are restricted to technical risk factors without the ability to assess the overall safety risk levels. This gap in data hampers the ability to fully evaluate the effectiveness and safety of RVSM implementation in both FIRs.

Conclusion

2.4 While the assessment indicates that no significant RVSM issues exist within Doha FIR, Bahrain FIR continues to experience traffic congestion and operational bottlenecks. The MIDRMA has attached the results of this RVSM safety assessment for both FIRs for review by the Board.

Recommendations

2.5 Given the limitations of the assessment, the MIDRMA recommends the following:

- a. continued monitoring and data collection in Bahrain FIR, particularly in relation to operational error reports and LHDs, to enable a more thorough safety risk assessment in the future.
- b. ongoing evaluation of air traffic flow in Doha FIR to ensure the continued safe and efficient management of RVSM airspace.
- c. encourage both States to provide the TDS on a monthly basis for continue monitoring.

Note: This report is intended solely for the consideration of the ICAO Middle East Air Navigation Planning and Implementation Regional Group (MIDANPIRG) and should not be used for any other purpose without proper authorization.

3. ACTION BY THE MEETING

3.1 The meeting is invited to review and discuss the contents of this working paper and the risk assessment results for Bahrain and Doha FIRs RVSM airspace which will be forwarded to MIDANPIRG/21 for endorsement.



RVSM Safety Monitoring Report for Bahrain and Doha FIRs

RVSM Risk Analysis Report Within Bahrain and Doha FIRs

Prepared for: ICAO Middle East Air Navigation Planning and Implementation Regional Group
(MIDANPIRG)

Prepared by: Middle East Regional Monitoring Agency (MIDRMA)

Date: 01st October 2024

Executive Summary:

In response to MIDANPIRG Conclusion 20/16 regarding the implementation of C-DEC225 for the establishment of the Doha FIR, the MIDRMA coordinated with the ICAO Office, as well as Bahrain and Qatar ATMUs, to provide the necessary data for conducting the RVSM safety assessment for both FIRs, with the aim of identifying hotspots and areas of traffic congestion.

MIDANPIRG CONCLUSION 20/16: IMPLEMENTATION OF C-DEC225/10: ESTABLISHMENT OF DOHA FOR/SRR

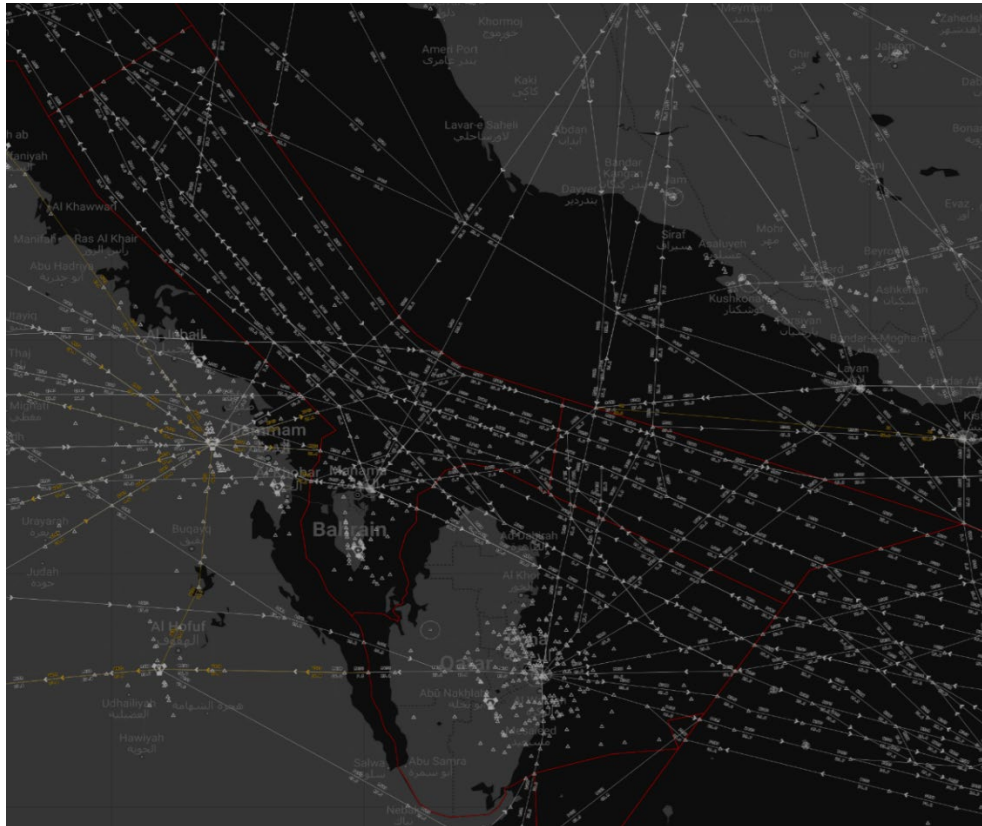
That,

- a) the ICAO MID Office to monitor the implementation of the C-DEC225/10 and facilitate coordination between the States concerned, as required.*
- b) States to carry out bilateral and multilateral coordination to finalize the operational and technical requirements, including the necessary letters of agreement.*
- c) MIDRMA to conduct a safety Monitoring assessment for the RVSM airspace within Bahrain and Doha FIRs, highlighting bottlenecks, hotspots and areas of traffic congestion.*
- d) Qatar to provide inputs for the development of the required proposal(s) for amendment to the MID ANP.*
- e) States and other Stakeholders to provide implementation feedback and comments to the MID Office on a quarterly basis for review by the ATM SG; and*
- f) the ATM SG to agree on necessary measures for the conduct of the technical study necessary to support the decision-making for the implementation of Phase 2 and develop a roadmap for the implementation of phase 2 to be presented to MIDANPIRG for endorsement.*

The RVSM risk analysis was first conducted for the Bahrain FIR prior to the h Implementation of Phase one of the Doha FIR. This allowed for a comparison of the impact of establishing the Doha FIR both before and after the airspace handover.

This report presents the findings of the risk analysis conducted to assess the risk of implementing the Reduced Vertical Separation Minimum (RVSM) within Bahrain and Doha Flight Information Regions (FIRs). The study focused exclusively on the RVSM airspace within these FIRs and utilized one month of Bahrain FIR RVSM TDS (February 2023) which is before the implementation of Phase one of Doha FIR and three months of RVSM TDS (December 2023, January, and February 2024), post implementation of the Doha FIR. The RVSM TDS were processed through the new version of the Middle East Regional Monitoring Agency Risk Analysis Software Artificial Intelligence (MIDRAS AI).

The analysis produced very limited results primarily due to the absence of key parameters necessary for a comprehensive assessment, notably the primary ICAO Target Level of Safety (TLS) for the Technical Risk and the Overall TLS for Doha FIR. Additionally, the lack of overall TLS for Bahrain FIR, attributed to the absence of Large Height Deviation (LHD) reports from both FIRs, further hindered the analysis. Therefore, it is recommended that the technical evaluation of the RVSM risk analysis be entrusted to an independent competent entity for further comprehensive assessment, taking into account the absence of LHD data when making decisions on further actions or improvements in RVSM airspace management.



Key Findings

a- Limited Results:

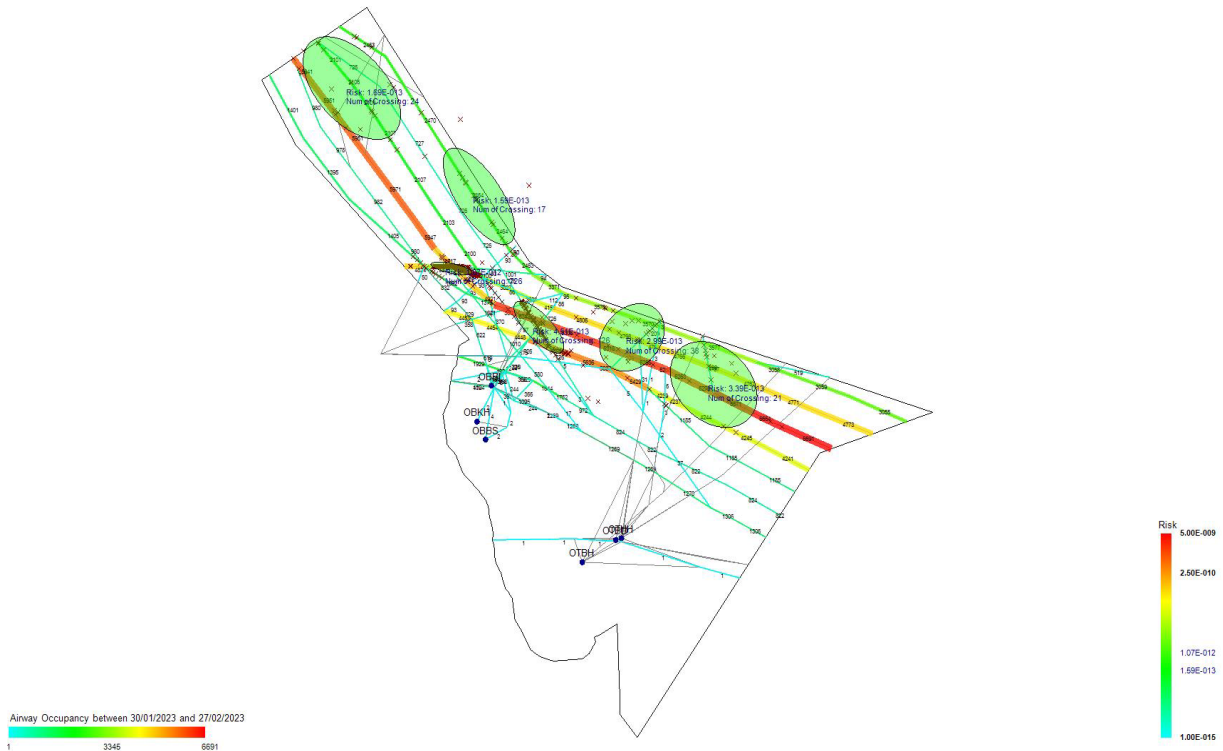
The analysis faced challenges due to inability to calculate the ICAO TLS for Operational risks for both FIRs , making it difficult to draw definitive conclusions, in addition it was not possible to calculate the ICAO Technical and Overall TLS values for Doha FIR.

b- Technical and Overall TLS for Doha FIR:

Within Doha FIR, the flow of RVSM traffic (see the map below) did not indicate any discernible risk, leading to the inability to calculate the Technical and the Overall risk values. This suggests a low likelihood of RVSM-related issues within Doha FIR airspace.

c- Overall TLS for Bahrain FIR:

The Overall TLS for Bahrain FIR could not be calculated due to the lack of Large Height Deviation Reports. Without this data, it is not possible to accurately assess the operational risk associated with RVSM implementation within Bahrain FIR, which leads to the Technical and Overall risk values being the same.



Bahrain FIR Hotspots and Airways Occupancy for February 2023

The RVSM risk analysis for the Bahrain FIR, prior to March 23, 2023, when control of the RVSM airspace within the current Doha FIR boundaries was transferred from the Bahrain CAA to the Qatar CAA presents a clear picture of airspace performance. As illustrated in the accompanying image, the identified hotspots and airway occupancy show minimal variation when compared to the post-handover RVSM risk analysis. This indicates that the technical risk profile remained largely consistent before and after the handover date.

Comparison of ICAO RVSM technical risk measured within Bahrain FIR before and after the establishment of Doha FIR:

FIR	RVSM TDS	RVSM Technical Risk	RVSM Pz 1000
Bahrain- Before 23rd March 2023	February 2023	2.488 × 10⁻¹²	1.267 × 10⁻⁹
Bahrain	December 2023	2.455 × 10⁻¹²	1.353 × 10⁻⁹
Bahrain	January 2024	3.063 × 10⁻¹²	1.252 × 10⁻⁹
Bahrain	February 2024	3.042 × 10⁻¹²	1.3 × 10⁻⁹

APPENDIX A

Results for Bahrain FIR, Feb 2023 RVSM TDS :

Relative Along Track Speed (ΔV): 15 kts
Relative Cross Track Speed (Δy): 20 kts
Relative Along Track Vertical Speed (Δz): 1.5 kts
Average Aircraft Diameter (λ_{xy}): 0.028768 NM 174.8 ft
Average Aircraft Wingspan (λ_y): 0.02676 NM 162.6 ft
Average Aircraft Height (λ_z): 0.0082688 NM 50.242 ft
Number of Flights involved: **30860**
Flying Time: **11,259 hours**
Flying Distance: **4,991,912 NM**
Average Speed: **468.89 kts**
Passing Frequency (n_{equiv}): **5.69131E-003**
Probability of Lateral Overlap ($P_y(0)$): **0.16799**

Technical Vertical Risk (N_{az}):

(*) Probability of Vertical Overlap (**$P_z(1000)$**): **1.2669E-09**

(*) **Technical Risk: 2.4877E-12**

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

(*) Probability of Vertical Overlap ($P_z_{nonwhl}(1000)$): 0

(*) TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{cl_d}(1000)$): 0

(*) TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{wl}(1000)$): 0

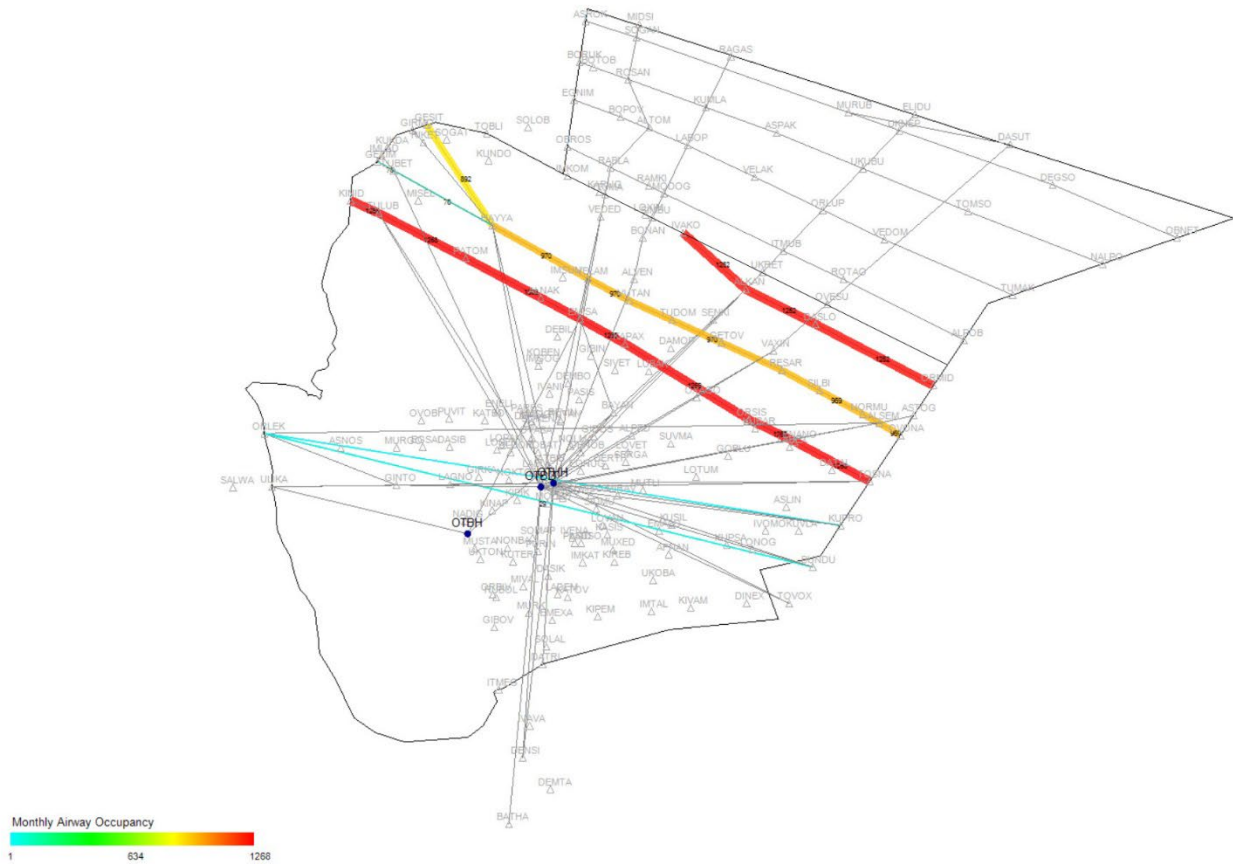
(*) TVR due to levelled off at a wrong flight level: 0

Bahrain FIR Overall Risk

Average Aircraft Diameter (λ_{xy}): 0.028768 NM 174.8 ft
Average Aircraft Wingspan (λ_y): 0.02676 NM 162.6 ft
Average Aircraft Height (λ_z): 0.0082688 NM 50.242 ft
Number of Flights involved: 30860
Flying Time: 11,259 hours
Flying Distance: 4,991,912 NM
Average Speed: 468.89 kts
Average Passing Frequency: 5.69131E-003

Technical Risk (N_{az}):

Overall Risk (N_{total}): 2.4877E-12



Doha FIR

Results for Doha FIR, Dec 2023 RVSM TDS :

Relative Along Track Speed (ΔV): **15 kts**
 Relative Cross Track Speed (Δy): **20 kts**
 Relative Along Track Vertical Speed (Δz): **1.5 kts**
 Average Aircraft Diameter (λ_{xy}): 0.024652 NM 149.79 ft
 Average Aircraft Wingspan (λ_y): 0.022047 NM 133.96 ft
 Average Aircraft Height (λ_z): 0.007148 NM 43.432 ft
 Number of Flights involved: **3915**
 Flying Time: **662 hours**
 Flying Distance: **261,842 NM**
 Average Speed: **404.63 kts**
 Passing Frequency (n_{equiv}): 0.00000E+000
 Probability of Lateral Overlap ($P_y(0)$): 0.13841

Technical Vertical Risk (N_{az}):

(***) Probability of Vertical Overlap ($P_z(1000)$): 2.0469E-10**

(***) Technical Risk: 0 (Not Calculated)**

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

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(* Probability of Vertical Overlap ($Pz_{nonwhl}(1000)$): 0

(* TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(* Probability of Vertical Overlap ($Pz_{cl_d}(1000)$): 0

(* TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

(* Probability of Vertical Overlap ($Pz_{wl}(1000)$): 0

(* TVR due to levelled off at a wrong flight level: 0

Doha FIR Overall Risk

Technical Risk (N_{az}):

(* Average Probability of Vertical Overlap (**$Pz(1000)$**): **2.0469E-10**

(*TVR due technical: 0

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

(*Probability of Vertical Overlap ($Pz_{nonwhl}(1000)$): 0

(*TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(*Probability of Vertical Overlap ($Pz_{cl_d}(1000)$): 0

(*TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

(*Probability of Vertical Overlap ($Pz_{wl}(1000)$): 0

(*TVR due to levelled off at a wrong flight level: 0

Doha FIR Overall Risk (N_{total}): 0 (Not Calculated)

Results for Doha FIR, Jan 2024 RVSM TDS :

Relative Along Track Speed (ΔV): 15 kts
Relative Cross Track Speed (Δy): 20 kts
Relative Along Track Vertical Speed (Δz): 1.5 kts
Average Aircraft Diameter (λ_{xy}): 0.02513 NM 152.7 ft
Average Aircraft Wingspan (λ_y): 0.022465 NM 136.5 ft
Average Aircraft Height (λ_z): 0.0072369 NM 43.972 ft
Number of Flights involved: **3901**
Flying Time: **654 hours**
Flying Distance: **275,864 NM**
Average Speed: **415.55 kts**
Passing Frequency (n_{equiv}): 0.00000E+000
Probability of Lateral Overlap ($P_y(0)$): 0.14103

Technical Vertical Risk (N_{az}):

(*) Probability of Vertical Overlap (**$P_z(1000)$**): **2.8217E-10**

(*) Technical Risk: 0 (Not Calculated)

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

(*) Probability of Vertical Overlap ($P_z_{nonwhl}(1000)$): 0

(*) TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{cl_d}(1000)$): 0

(*) TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{wl}(1000)$): 0

(*) TVR due to levelled off at a wrong flight level: 0

Doha FIR Overall Risk

Technical Risk (N_{az}):

(*) Average Probability of Vertical Overlap (**$P_z(1000)$**): **2.8217E-10**

(*)TVR due technical: 0

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

(*)Probability of Vertical Overlap ($P_z_{nonwhl}(1000)$): 0

(*)TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(*)Probability of Vertical Overlap ($P_z_{cl_d}(1000)$): 0

(*)TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

(*)Probability of Vertical Overlap ($P_z_{wl}(1000)$): 0

(*)TVR due to levelled off at a wrong flight level: 0

Doha FIR Overall Risk (N_{total}): 0 (Not Calculated)

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Results for Doha FIR, Feb 2024 RVSM TDS :

Relative Along Track Speed (ΔV): 15 kts
Relative Cross Track Speed (Δy): 20 kts
Relative Along Track Vertical Speed (Δz): 1.5 kts
Average Aircraft Diameter (λ_{xy}): 0.025195 NM 153.09 ft
Average Aircraft Wingspan (λ_y): 0.022461 NM 136.48 ft
Average Aircraft Height (λ_z): 0.0072439 NM 44.015 ft
Number of Flights involved: **3633**
Flying Time: **518 hours**
Flying Distance: **231,569 NM**
Average Speed: **406.74 kts**
Passing Frequency (n_{equiv}): 0.00000E+000
Probability of Lateral Overlap ($P_y(0)$): 0.14101

Technical Vertical Risk (N_{az}):

(*) Probability of Vertical Overlap (**$P_z(1000)$**): **2.9669E-10**

(*) **Technical Risk: 0 (Not Calculated)**

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

(*) Probability of Vertical Overlap ($P_z_{nonwhl}(1000)$): 0

(*) TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{cl_d}(1000)$): 0

(*) TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{wl}(1000)$): 0

(*) TVR due to levelled off at a wrong flight level: 0

Doha FIR Overall Risk

Technical Risk (N_{az}):

(*) Average Probability of Vertical Overlap (**$P_z(1000)$**): **2.9669E-10**

(*)TVR due technical: 0

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

(*)Probability of Vertical Overlap ($P_z_{nonwhl}(1000)$): 0

(*)TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(*)Probability of Vertical Overlap ($P_z_{cl_d}(1000)$): 0

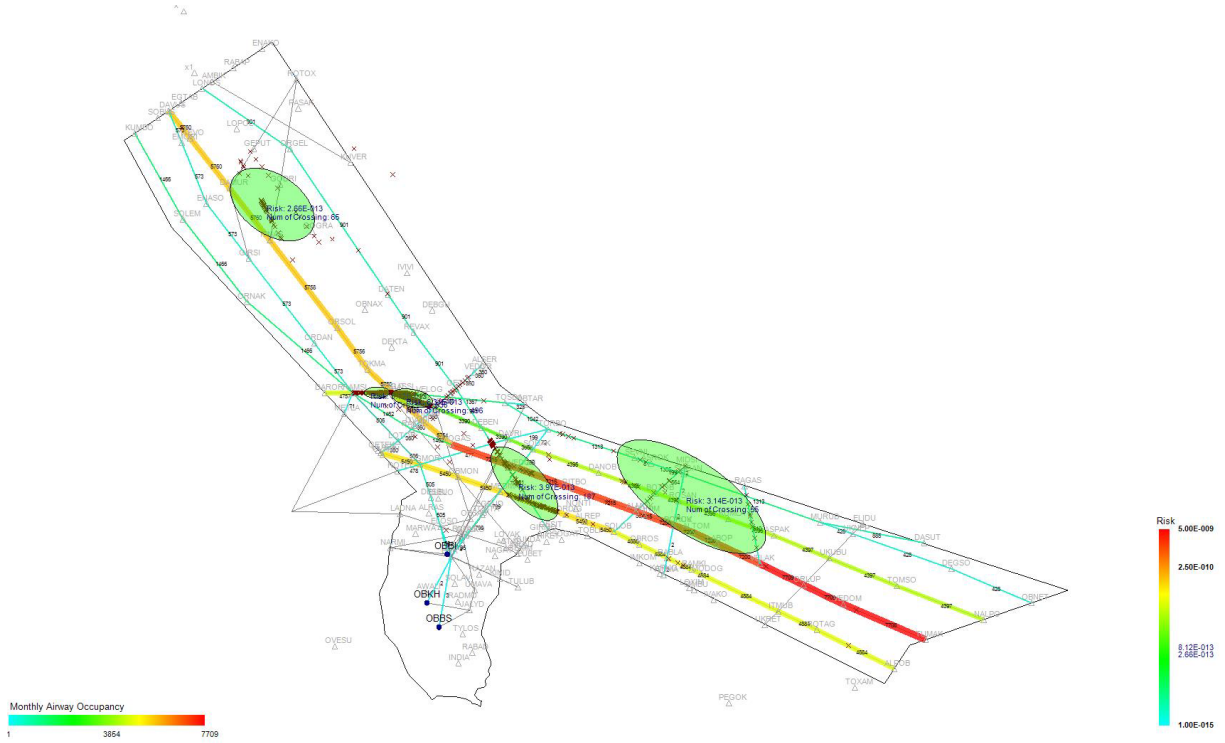
(*)TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

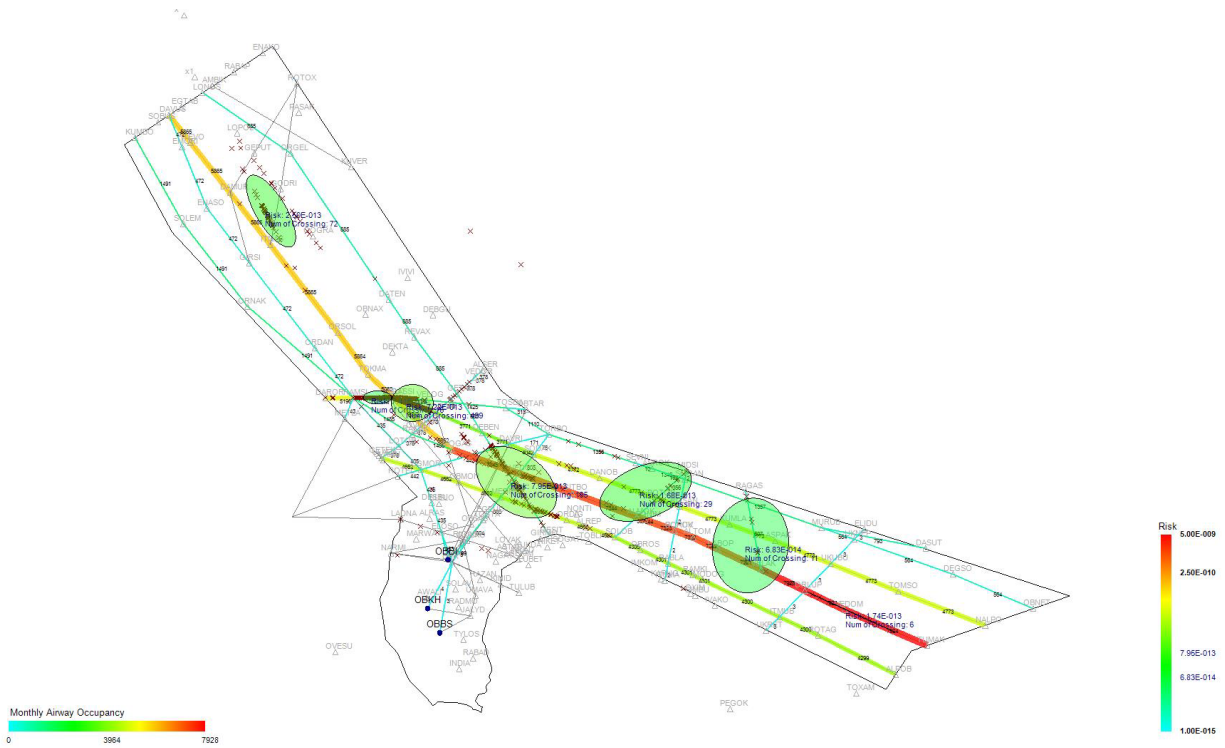
(*)Probability of Vertical Overlap ($P_z_{wl}(1000)$): 0

(*)TVR due to levelled off at a wrong flight level: 0

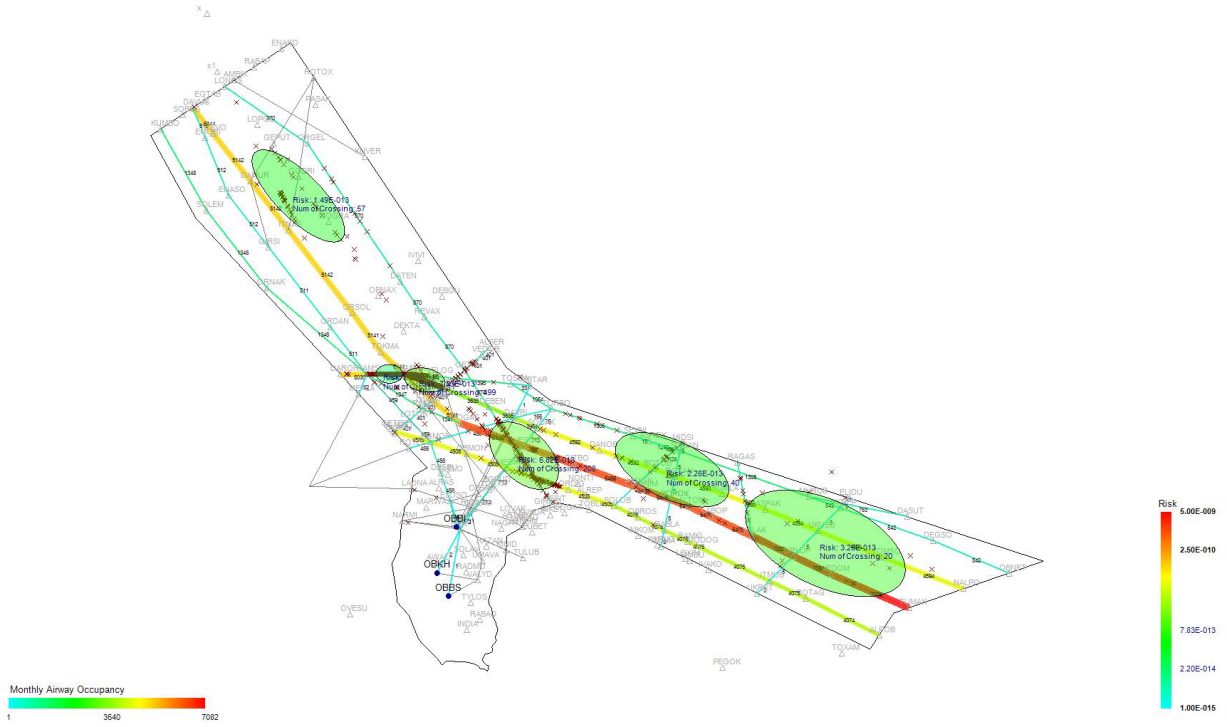
Doha FIR Overall Risk (N_{total}): 0 (Not Calculated)



Bahrain FIR Hotspots & AWY Occupancy for Dec 2023 RVSM TDS



Bahrain FIR Hotspots & AWY Occupancy for Jan 2024 RVSM TDS



Bahrain FIR Hotspots & AWY Occupancy for Feb 2024 RVSM TDS

Results for Bahrain FIR, Dec 2023 RVSM TDS :

Relative Along Track Speed (ΔV): 15 kts
Relative Cross Track Speed (Δy): 20 kts
Relative Along Track Vertical Speed (Δz): 1.5 kts
Average Aircraft Diameter (λ_{xy}): 0.028803 NM 175.01 ft
Average Aircraft Wingspan (λ_y): 0.026782 NM 162.73 ft
Average Aircraft Height (λ_z): 0.0082446 NM 50.095 ft
Number of Flights involved: **34523**
Flying Time: **12,307 hours**
Flying Distance: **5,543,594 NM**
Average Speed: **455.41 kts**
Passing Frequency (n_{equiv}): **5.23104E-003**
Probability of Lateral Overlap ($P_y(0)$): 0.16813

Technical Vertical Risk (N_{az}):

(*) Probability of Vertical Overlap (**$P_z(1000)$**): **1.3534E-09**

(*) **Technical Risk: 2.4467E-12 (Meets ICAO Technical TLS)**

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

(*) Probability of Vertical Overlap ($P_z_{nonwhl}(1000)$): 0

(*) TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{cl_d}(1000)$): 0

(*) TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{wl}(1000)$): 0

(*) TVR due to levelled off at a wrong flight level: 0

Bahrain FIR Overall Risk

Technical Risk (N_{az}):

(*) Average Probability of Vertical Overlap (**$P_z(1000)$**): **1.3534E-09**

(*) **TVR due technical: 2.4467E-12**

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

(*) Probability of Vertical Overlap ($P_z_{nonwhl}(1000)$): 0

(*) TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{cl_d}(1000)$): 0

(*) TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{wl}(1000)$): 0

(*) TVR due to levelled off at a wrong flight level: 0

Bahrain FIR Overall Risk (N_{total}): 2.4467E-12

Note: The calculated value coincides with the technical risk value, attributable to the absence of LHD reports within the RVSM airspace of Bahrain FIR for this month.

APPENDIX A

Results for Bahrain FIR, Jan 2024 RVSM TDS :

Relative Along Track Speed (ΔV): 15 kts
Relative Cross Track Speed (ΔY): 20 kts
Relative Along Track Vertical Speed (ΔZ): 1.5 kts
Average Aircraft Diameter (λ_{xy}): 0.028983 NM 176.11 ft)
Average Aircraft Wingspan (λ_y): 0.027061 NM 164.43 ft)
Average Aircraft Height (λ_z): 0.008308 NM 50.48 ft
Number of Flights involved: **34597**
Flying Time: **12,611 hours**
Flying Distance: **5,583,155 NM**
Average Speed: **455.22 kts**
Passing Frequency (n_{equiv}): **7.00804E-003**
Probability of Lateral Overlap ($P_y(0)$): 0.16988

Technical Vertical Risk (N_{az}):

(* Probability of Vertical Overlap (**$P_z(1000)$**): **1.2517E-09**

(* **Technical Risk: 3.0631E-12 (Meets ICAO Technical TLS)**

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

(* Probability of Vertical Overlap ($P_z_{nonwhl}(1000)$): 0

(* TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(* Probability of Vertical Overlap ($P_z_{cl/d}(1000)$): 0

(* TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

(* Probability of Vertical Overlap ($P_z_{wl}(1000)$): 0

(* TVR due to levelled off at a wrong flight level: 0

Bahrain FIR Overall Risk

Technical Risk (N_{az}):

(* Average Probability of Vertical Overlap (**$P_z(1000)$**): **1.2517E-09**

(* **TVR due technical: 3.0631E-12**

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

(* Probability of Vertical Overlap ($P_z_{nonwhl}(1000)$): 0

(* TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(* Probability of Vertical Overlap ($P_z_{cl/d}(1000)$): 0

(* TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

(* Probability of Vertical Overlap ($P_z_{wl}(1000)$): 0

(* TVR due to levelled off at a wrong flight level: 0

Bahrain FIR Overall Risk (N_{total}): 3.0631E-12

Note: The calculated value coincides with the technical risk value, attributable to the absence of LHD reports within the RVSM airspace of Bahrain FIR for this month.

Results for Bahrain FIR, Feb 2024 RVSM TDS :

Relative Along Track Speed (ΔV): 15 kts
Relative Cross Track Speed (Δy): 20 kts
Relative Along Track Vertical Speed (Δz): 1.5 kts
Average Aircraft Diameter (λ_{xy}): 0.028791 NM 174.94 ft
Average Aircraft Wingspan (λ_y): 0.026883 NM 163.35 ft
Average Aircraft Height (λ_z): 0.0082672 NM 50.232 ft
Number of Flights involved: **32092**
Flying Time: **11,625 hours**
Flying Distance: **5,143,231 NM**
Average Speed: **454.89 kts**
Passing Frequency (n_{equiv}): **6.74594E-003**
Probability of Lateral Overlap ($P_y(0)$): 0.16877

Technical Vertical Risk (N_{az}):

(*) Probability of Vertical Overlap ($P_z(1000)$): 1.3E-09

(*) **Technical Risk: 3.0422E-12**

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

(*) Probability of Vertical Overlap ($P_z_{nonwhl}(1000)$): 0

(*) TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{cl_d}(1000)$): 0

(*) TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{wl}(1000)$): 0

(*) TVR due to levelled off at a wrong flight level: 0

Bahrain FIR Overall Risk

Technical Risk (N_{az}):

(*) Average Probability of Vertical Overlap (**$P_z(1000)$**): **1.3E-09**

(*) **TVR due technical: 3.0422E-12**

Vertical Risk not involving whole number of flight level (N_{nonwhl}):

(*) Probability of Vertical Overlap ($P_z_{nonwhl}(1000)$): 0

(*) TVR due to nonwhole flight level: 0

Vertical Risk involving aircraft climbing/descending through a flight level ($N_{cl/d_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{cl_d}(1000)$): 0

(*) TVR involving aircraft climbing/descending through a flight level: 0

Vertical Risk involving aircraft levelled off at a wrong flight level ($N_{wl_{az}}$):

(*) Probability of Vertical Overlap ($P_z_{wl}(1000)$): 0

(*) TVR due to levelled off at a wrong flight level: 0

Bahrain FIR Overall Risk (N_{total}): **3.0422E-12**

Note: The calculated overall risk value coincides with the technical risk value, attributable to the absence of LHD reports within the RVSM airspace of Bahrain FIR for this month.

APPENDIX A

Conclusion and Recommendations

While the assessment shows no significant RVSM issues within Phase 1 of the Doha FIR, considering the limited number of airways and low volume of traffic, however, the Bahrain FIR continues to face traffic congestion and operational bottlenecks.

Given the limitations of the assessment, the MIDRMA recommends the following:

- a. Continued monitoring and data collection in Bahrain FIR, particularly in relation to operational error reports and LHDs, to enable a more thorough safety risk assessment in the future.
- b. Ongoing evaluation of air traffic flow in Doha FIR to ensure the continued safe and efficient management of RVSM airspace.

Note: This report is intended solely for the consideration of the ICAO Middle East Air Navigation Planning and Implementation Regional Group (MIDANPIRG) and should not be used for any other purpose without proper authorization.

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