International Civil Aviation Organization

MIDANPIRG/21 & RASG-MID/11 Meetings

(Abu Dhabi, UAE, 4 – 8 March 2024)

Agenda Item 5.3: ANS (AIM, PBN, AGA-AOP, ATM-SAR, CNS and MET)

MIDRMA ADS-B HEIGHT MONITORING SYSTEM (AHMS)

(Presented by the MIDRMA)

SUMMARY

With the official endorsement of the ADS-B Height Monitoring methodology by ICAO, it becomes possible to utilize ADS-B data for the calculation of the Altimetry System Error (ASE) to meet ICAO requirement for aircraft operating in RVSM airspace related to the periodic monitoring on height-keeping performance. The existing methods to estimate aircraft ASE include use of a portable device, Enhanced GPS Monitoring Unit (EGMU), or ground-based systems called Height Monitoring Unit (HMU) /Aircraft Geometric Height Measurement Element (AGHME). The use of ADS-B data for height-keeping performance monitoring, on top of providing enhanced and alternative means of surveillance, will provide another option for height monitoring and keeping performance as per ICAO Annex 6 Part 1 requirement. States are encouraged to provide access to ADS-B data to MIDRMA to support the height-keeping performance monitoring for RVSM approved aircraft registered within and outside the ICAO Middle East region.

Action by the meeting is at paragraph 3.

REFERENCES

- ICAO Annex 6 Part 1.
- ICAO Doc 9574.
- ICAO Doc 9937.
- MIDRMA/19 (Manama, Bahrain, 10 – 11 October 2023) meeting Report.

1. INTRODUCTION

1.1 Altimetry System Error (ASE) is the difference between the altitude indicated by the altimeter display, assuming a correct altimeter barometric setting, and the pressure altitude corresponding to the undisturbed ambient pressure. In airspace where RVSM applied, the importance of accurate aircraft height-keeping performance is magnified. Aircraft use a barometric altimeter to determine height and follow common pressure levels in RVSM airspace. The errors in the aircraft altimetry sensing systems are not apparent during routine operations as the altimeter displays to the aircrew and Air Traffic Control a flight level which contains the ASE. Due to the existence of aircraft ASE, the observed flight level by the pilot and ATC is different than the actual height of the aircraft.

1.2 The altimetry system utilizes parts that can wear over time (e.g., the pitot-static probe); can be damaged (e.g., skin flexing/deformation during operations); and can be affected by modifications made to the airframe (e.g., the application of paint or mounting of accessories in the vicinity of the static pressure port). These activities can affect in a negative way the performance of altimetry system onboard aircraft, producing a significant error in true height. Other factors from normal operations of high-speed flight such as aerodynamic loading and exposure to ranges of atmospheric conditions (temperature, moisture, and contaminants), are also capable of producing significant variation in the sensed pressure of the altimetry system. Since the ASE is not detectible in routine operations; ICAO adopted two methods to measure aircraft ASE, either by the Enhanced GPS Monitoring Unit (EGMU) or by the Height Monitoring Unit (HMU)/ Aircraft Geometric Height Measurement Element (AGHME) and recently another method was adopted to measure aircraft ASE which is by the use of geometric height data from ADS-B systems.

2. DISCUSSION

2.1 Using ADS-B for height-keeping performance monitoring requires that the aircraft employ ADS-B Out and operate within the coverage area of an ADS-B ground station receiver. In comparison to other existing ground-based monitoring systems, such as the Height Monitoring Units (HMU) and Aircraft Geometric Height Monitoring Element (AGHME), which have a coverage area of 40 NM, the defined coverage area of the monitoring system utilizing ADS-B data is much larger. The coverage area for a single ADS-B ground station could reach approximately 200 NM. In this case, the ADS-B ground station potentially serves two purposes; providing information needed for ATC services and monitoring aircraft height-keeping performance.

2.2 ADS-B monitoring is undertaken by processing of large data sets of ADS-B messages captured in the coverage area of ADS-B Network. The data is processed to enable the calculation of Altimetry System Errors (ASEs) for each ADS-B message obtained from a specific aircraft or group of aircraft. The value is then assessed to calculate ASE for each observed aircraft.

2.3 There are two significant advantages to obtaining aircraft geometric height data through ADS-B:

a. Data Collection: The process of collecting this data is entirely passive and does not necessitate any special arrangements with aircraft operators, as long as the aircraft comply with monitoring requirements. There is no need for direct interaction with flight crews. This passive data collection approach ensures flexibility and minimizes disruptions to regular flight operations. It allows for frequent ASE measurements without significantly affecting processing times.

b. Expansive Geographic Coverage: The geographic scope within which flight data can be captured is virtually limitless, primarily determined by the extent of the ground station network. Ground stations are cost-effective and straightforward units, often co-located with existing CNS installations (like VHF antennas). As a result, the monitoring range can extend from a state-wide level to even broader areas. All ADS-B transmissions received by a ground station from equipped aircraft are typically archived. This rich dataset makes it possible to conduct aircraft height-keeping performance monitoring at a fleet level operating within the RVSM Airspace and generate comprehensive ASE history profiles for individual airframes.

Note: These advantages not only enhance the efficiency of ASE measurements but also facilitate comprehensive monitoring of aircraft height-keeping performance at the fleet level, benefiting both

aviation authorities and operators alike.

2.4 The meeting is urged to take note of the discussions held regarding the implementation of the ADS-B Height Monitoring System (AHMS) for the Middle East Region during the last MIDRMA Board/18. During this meeting, comprehensive information pertaining to the ADS-B coverage within the MID Region was presented, alongside an overview of the equipage status of fleets from certain member states. It should be noted that some of these member states had not provided the necessary data for the study conducted to assess the prevalence of ADS-B equipage in the Middle East Region.

2.4 Update of ADS-B Coverage and Aircraft Equipage in the Middle East Region

2.4.1 As far as the MIDRMA aware, ADS-B is available for surveillance in the following MIDRMA Member States airspace:

- Kuwait.
- Qatar.
- Oman.
- Sudan.
- UAE.
- Bahrain.
- KSA (Under Installation).
- Jordan – The System is not used for surveillance.

2.4.2 MIDRMA conducted a statistical study of all RVSM-approved aircraft registered in the ICAO Middle East region and has continued to update this study to verify the ADS-B equipage status of all MID RVSM-approved aircraft.

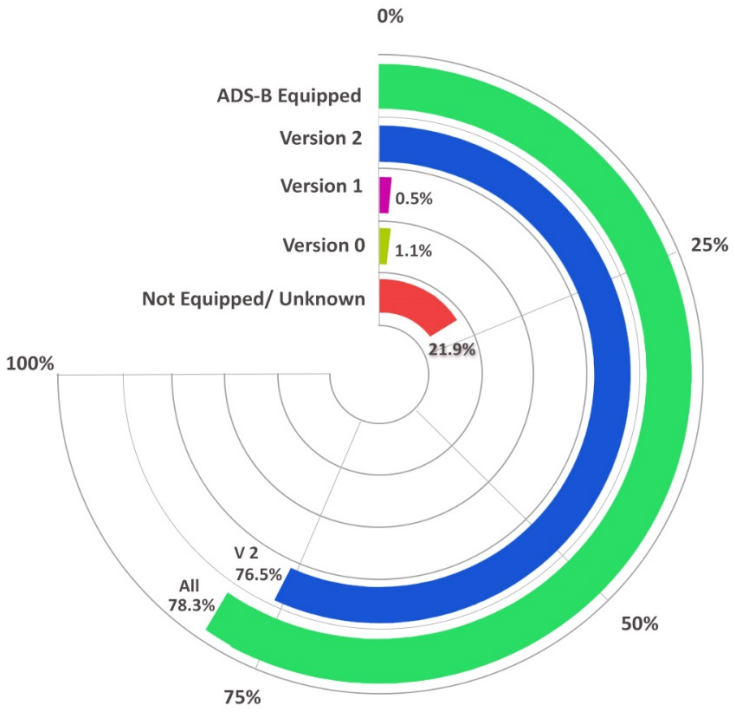
2.4.3 The results of the study that was conducted for the updated MID RVSM approved aircraft database for all member states (depicted in the table below)

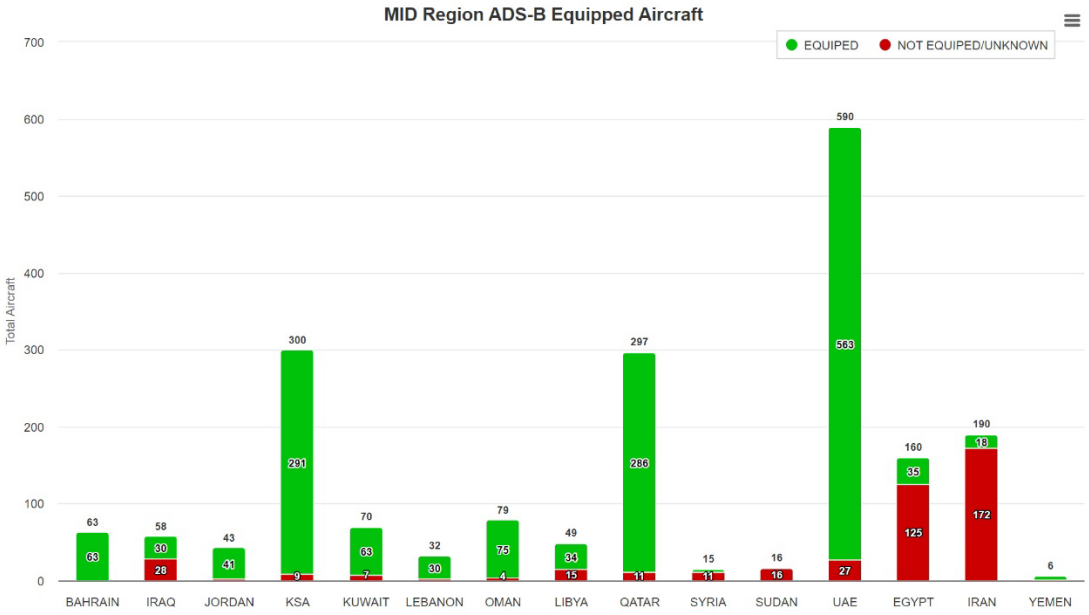
2.4.4 The study was targeting the equipage of ADS-B Out in the MID RVSM approved aircraft in order to know the benefit of conducting RVSM height monitoring by using the ADS-B Out archived data and to know what versions are installed in these aircraft which they should be as follows:

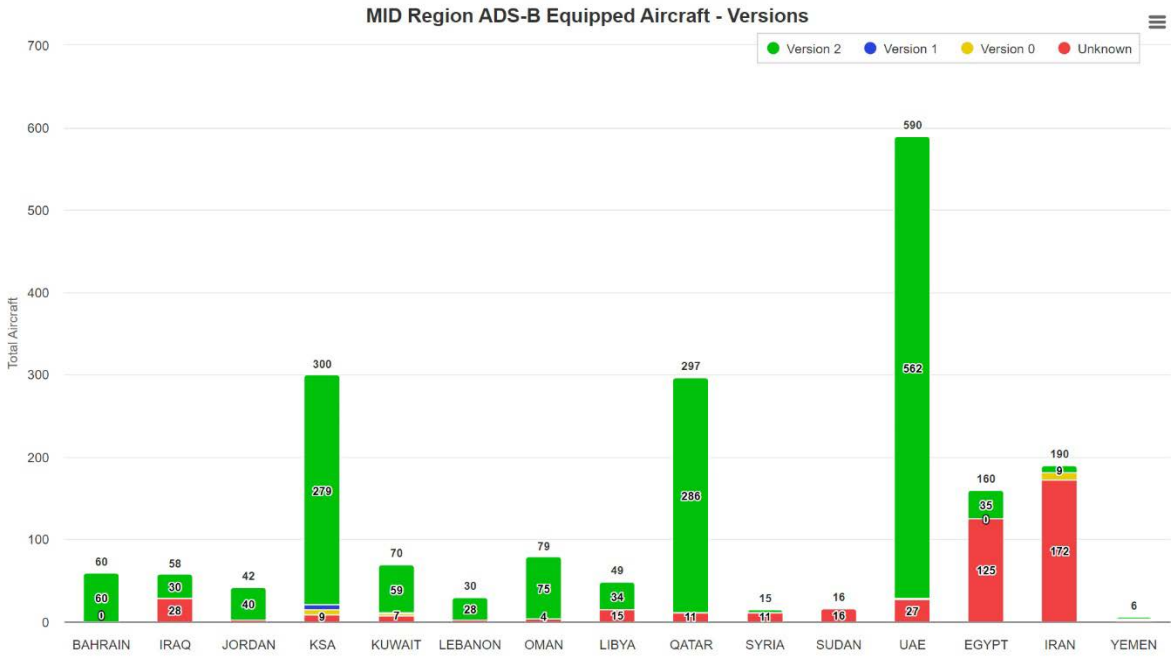
a) DO-260 (Version 0)
b) DO-260A (Version 1)
c) DO-260B (Version 2)
d) DO-260C (Version 3), approved by December 2020

ABSB	TOTAL	EQUIPPED	NOT EQUIPPED/ UNKNOWN	V2	V1	V0
BAHRAIN	**63**	**63**	**0**	**60**	**0**	**0**
IRAQ	**58**	**30**	**28**	**30**	**0**	**0**
JORDAN	**42**	**41**	**2**	**40**	**0**	**0**
KSA	**300**	**291**	**9**	**279**	**6**	**6**
KUWAIT	**70**	**63**	**7**	**59**	**1**	**3**
LEBANON	**31**	**30**	**2**	**28**	**0**	**0**

OMAN	**79**	**75**	**4**	**75**	**0**	**0**
LIBYA	**49**	**34**	**15**	**34**	**0**	**0**
QATAR	**297**	**286**	**11**	**286**	**0**	**0**
Syria	**15**	**4**	**11**	**4**	**0**	**0**
SUDAN	**16**	**0**	**16**	**0**	**0**	**0**
UAE	**590**	**563**	**27**	**562**	**0**	**1**
Egypt	**160**	**35**	**125**	**35**	**0**	**0**
Iran	**190**	**18**	**172**	**9**	**0**	**9**
Yemen	**6**	**5**	**1**	**2**	**2**	**1**
TOTAL	**1966**	**1538**	**430**	**1503**	**9**	**20**
%		**78.3**	**21.9**	**76.5**	**0.5**	**1.1**







2.4.5 The results of the statistical study are highly encouraging, indicating a substantial percentage of RVSM-approved aircraft equipped with ADS-B Out, which stands at an impressive 80%. Furthermore, a significant majority of these aircraft, amounting to 97.4%, are equipped with

ADS-B Out Version 2, while only a negligible percentage is equipped with Version 0 and 1. The two graphs presented above illustrate the aircraft equipage rate, specifically showing the percentage of ADS-B Version 2-equipped aircraft in relation to the total aircraft fleet.

2.5 The successful implementation of this height monitoring method using ADS-B Out data will undoubtedly require a concerted effort, collaboration, and training. We extend the appreciation and gratitude to the Monitoring Agency for Asia Region (MAAR) for generously offering their expertise and training resources. Their support is invaluable and greatly supported the development of this study, as it will play a pivotal role in ensuring the seamless adoption of this crucial technology within the MIDRMA member states.

2.6 Additionally, MIDRMA acknowledges the importance of coordination with the authorities responsible for providing archived ADS-B data for monitoring purposes. We understand the significance of their role in facilitating the smooth operation of this system. MIDRMA is committed to working closely with these authorities to establish effective data-sharing protocols and to provide the necessary training and briefing to the dedicated engineers from member states who have volunteered to contribute their ADS-B data. Together, through collaboration, training, and coordination, we are confident that we can usher in a new era of enhanced aviation safety and efficiency within the MIDRMA region.

2.7 Proposal for MID Region ADS-B Height Monitoring System (MID-AHMS) Implementation Plan:

2.7.1 The MIDRMA proposes the following Actions for the implementation plan:

a. MIDRMA to request all member States currently implementing ADS-B, to share the archived data for evaluation and analysis.

b. MIDRMA to coordinate with MAAR for:

i. sharing their experience in evaluating and analyzing samples of the received ADS-B data.
ii. Providing required training related to AHMS implementation for MIDRMA Staff.

c. MIDRMA to develop a mechanism and tools for submitting the ADS-B data by States.

d. MIDRMA provides the required training for CNS engineers from member states responsible for extracting ADS-B data from their systems and submitting it to MIDRMA at regular, mutually agreed intervals.

e. MIDRMA to develop and document all required processes and procedures for the AHMS implementation, to be incorporated in the MIDRMA Tasks and responsibilities.

f. MIDRMA shall continue to provide GMU monitoring service until the AHMS is fully operational, and for the Aircraft not included in the MID-AHMS.

2.8 The MIDRMA is committed to provide regular updates on the progress on the implementation plan including timelines based on the responses of States and the availability of the tools and procedures within the MIDRMA.

3. ACTION BY THE MEETING

a) The meeting is invited to review and discuss the contents of this working paper;

b) Encourage States to share their archived ADS-B data with the MIDRMA for RVSM height monitoring; and

c) Review and Agree on the implementation Plan in para 2.8.

- END -