KINGDOM OF BAHRAIN
Ministry of Transportation and Telecommunications

مملكة البحرين
وزارة المواصلات والاتصالات

# CIVIL AVIATION PUBLICATION

# CAP 27

# RVSM

**INDEX**

*This Page Intentionally Left Blank*

# CIVIL AVIATION PUBLICATIONS

## CAP 27

## RVSM

## *INDEX*

# Bahrain CAA Publication Revisions Highlight Sheet

☒ CAP: 27 ☐ TPM: __

The following pages have been revised to Revision 07 dated 17 September 2024.

| Item | Paragraph Number | Page(s) | Reason |
|---|---|---|---|
| 1 | Revision Highlights | ii | To indicate the current revision highlights |
| 2 | LEP | iii | To indicate the current revision status |
| 3 | Revision Record | iv | Addition of revision record |
| 4 | 3.2.2 | 3 | Amendment to correct the type design acceptance |
| 5 | 3.2.6 | 4 | Amendment to correct the type design acceptance |

# CIVIL AVIATION PUBLICATIONS

## LIST OF EFFECTIVE PAGES

### CAP 27

| | |
|---|---|
| i | 17 Sep 24 |
| ii | 17 Sep 24 |
| iii | 17 Sep 24 |
| iv | 17 Sep 24 |
| v | 17 Sep 24 |

### Section I

| | |
|---|---|
| 1 | 17 Sep 24 |
| 2 | 17 Sep 24 |
| 3 | 17 Sep 24 |
| 4 | 17 Sep 24 |
| 5 | 17 Sep 24 |
| 6 | 17 Sep 24 |
| 7 | 17 Sep 24 |
| 8 | 17 Sep 24 |
| 9 | 17 Sep 24 |
| 10 | 17 Sep 24 |

# REVISION RECORD

## CAP 27 RVSM

| Revision No. | Date of Issue |
|---|---|
| Revision 03 | 01 August 2010 |
| Revision 04 | 01 April 2013 |
| Revision 05 | 27 June 2022 |
| Revision 06 | 01 February 2023 |
| Revision 07 | 17 September 2024 |

***This Page Intentionally Left Blank***

# 1. INTRODUCTION

## 1.1 Purpose

This guidance material is intended for operators of Bahraini registered aircraft planning to operate in Reduced Vertical Separation Minima (RVSM) airspace. This CAP provides information on the implementation plan, required equipment, the approval process, as well as guidance on operational procedures and training. All Bahraini registered aircraft planning to operate in RVSM airspace shall be required to obtain an approval from the BCAA before the commencement of operations. Operators must be aware that airspace restrictions and operational penalties may be incurred if the aircraft is not approved for operations in RVSM airspace.

## 1.2 General

Airspace where RVSM is applied should be considered special qualification airspace. The specific aircraft type or types that the operator intends to use will need to be approved by the BCAA before the operator conducts flight in RVSM airspace. In addition, where operations in specified airspace require approval in accordance with an ICAO Regional Navigation Agreement, an operational approval will be needed.

Each aircraft type that an operator intends to use in RVSM airspace must receive RVSM airworthiness approval from the BCAA prior to approval being granted for RVSM operations, including the approval of continued airworthiness programmes.

For certain airspace, as defined by ICAO Regional Navigation Agreements, operators are required to hold State approval to operate in that airspace, which may or may not include RVSM. The AOC/Authorisation and Operations Specifications states the permissible airspace, which is based on the operator's Operations Manual procedures for the applicable airspace.

In 1958 the standard vertical separation of aircraft in controlled airspace was set at 1,000 feet from ground level or sea level to flight level 290, and at 2,000 feet above flight level 290. The larger minimum separations at higher altitudes was necessary because the accuracy of altimeters, used to determine altitude by measuring air pressure, decreases with height. Efforts to reduce this separation above flight level 290 began almost immediately, but doing so without compromising safety required improvements in altimeters and other equipment, due in part to inherent difficulties in accurately determining and maintaining aircraft altitudes and, therefore, the actual vertical distance between aircraft. It was not until the 1990s that air data computers (ADCs), altimeters, and autopilot systems became sufficiently accurate to safely reduce vertical separation minima.

Between 1997 and 2005 RVSM was implemented in all of Europe, North Africa, Southeast Asia and North America, South America, and over the North Atlantic, South Atlantic, and Pacific Oceans. The North Atlantic implemented initially in March 1997 at flight levels 330 through 370. The entire western hemisphere implemented RVSM FL290–FL410 on January 20, 2005.

The Russian Federation implemented RVSM and flight levels in feet on November 17, 2011. However, in some FIRs, meters are still in use below transition level.

## 1.3 References

I. International Civil Aviation Organisation (ICAO)

(1) ICAO Doc. 9574 – Manual on the Implementation of a 300 m (1000 ft) Vertical Separation Minimum Between FL 290 – FL 410 Inclusive.

(2) ICAO Doc. 7030/4 – Regional Supplementary Procedures (for appropriate region) contain operational and contingency procedures unique to the regional airspace concerned, specific flight planning requirements, and the approval requirements for aircraft in the designated region.

II. ANTR OPS-1

## 2. AIRCRAFT EQUIPMENT FOR RVSM OPERATIONS

The minimum equipment fit will be subject to BCAA Airworthiness approval and should be:

(a) Two independent altitude measurement systems. Each system should be composed of the following elements:

(1) Cross-coupled static source/system, provided with ice protection if located in areas subject to ice accretion.

(2) Equipment for measuring static pressure sensed by the static source, converting it to pressure altitude and displaying the pressure altitude to the flight crew.

(3) Equipment for providing a digitally coded signal corresponding to the displayed pressure altitude, for automatic altitude reporting purposes.

(4) Static source error correction (SSEC), if needed to meet performance requirements; and

(5) The equipment fit should provide reference signals for automatic control and alerting at a selected altitude. These signals should preferably be derived from an altitude measurement system.

(b) One SSR altitude reporting transponder. If only one is fitted, it should have the capability for switching to operate from either altitude measurement system.

(c) An altitude alert system.

(d) An automatic altitude control system.

(e) Aircraft equipped with ADS-B may use that system to qualify for RVSM without additional approval. ADS-B however is not required for RVSM operations.

## 3. APPLICATION PROCESS

### 3.1 General

Once the application (Form: ALD / AIR / F117) for RVSM approval is submitted, the approval process involves three separate processes;

(a) the BCAA determines the airworthiness requirements and, if satisfied, issues an airworthiness approval; and

(b) the BCAA then notifying the appropriate Regional Monitoring Agency (RMA) that the aircraft is eligible for height monitoring. Notification to the RMA is only made after the operator meets the airworthiness requirements and the BCAA is satisfied that each operator can maintain high levels of height keeping performance.

Upon compliance to the Para 3.1 & 3.2 above, the BCAA issues a Letter of Airworthiness Approval along with the MIDRMA Form 2 and the list of amended aircraft details (https://midrma.com/en/rvsm/approvalList/bh). Then operator shall apply to the MIDRMA using the form "ICAO MIDRMA RVSM Height Keeping Monitoring Application Form" - https://midrma.com/assets/docs/forms/RVSM_Height_Monitoring_Application_Form.docx

Once the RMA has confirmed the height accuracy, the BCAA further evaluates operational areas such as flight crew training, flight dispatch and operations manuals before a final operational approval can be issued.

### 3.2 Content of Operator RVSM Application

3.2.1 General

The following describes the material that an operator should provide to the BCAA for evaluation, at least 60 days before the intended start of RVSM operations.

3.2.2 Airworthiness

(a) Airworthiness Documents. Documentation should be available to show that the aircraft has been approved for RVSM by the appropriate airworthiness authorities (e.g.; State of Design as accepted by BCAA, in accordance with ANTR PART-V). This documentation must be either the Aircraft Flight Manual (AFM), Service Bulletin (S/B) or Supplemental Type Certificate (STC).

(b) Description of Aircraft Equipment A description of the aircraft equipment appropriate to operations in an RVSM environment.

(c) Maintenance. At the time application is made for operational approval, the operator should submit an amendment to the maintenance programme for approval. The programme must address continuing airworthiness procedures.

(d) Aircraft equipped with ADS-B Out do not require additional approval.

3.2.3 Training Programmes and Standard Operating Procedures (SOP's)

All operators should submit training syllabi and other appropriate material for approval to the BCAA to show that the operating practices, procedures and training items related to RVSM operations are incorporated in initial, and where appropriate, recurrent training programmes.

3.2.4 Operations Manuals and Checklists

The manuals referred to include Operations, Aircraft Operating, Dispatch, Training and Engineering Manuals. Appropriate manuals should include a statement of the airspeeds, altitudes and weights considered in RVSM aircraft approval, including identification of any operating restrictions established for that aircraft group. Manuals and checklists shall be submitted for approval by the BCAA as part of the application process.

3.2.5 Past Performance

An operating history should be included in the application. The applicant should show any events or incidents related to poor height keeping performance that may indicate changes are needed in training, operating or maintenance practices.

3.2.6 Minimum Equipment List

A BCAA approved minimum equipment list (MEL), adapted from the master minimum equipment list (MMEL), from the State of Design (as accepted by BCAA in accordance with ANTR PART-V) should include items pertinent to operating in RVSM airspace.

3.2.7 Authority Review and Evaluation of Applications

Once the application has been submitted and the BCAA Airworthiness Inspection Section is satisfied with the information provided, the BCAA will continue with the approval process and notify the Regional Monitoring Agency When, through monitoring, an operator has demonstrated acceptable height keeping performance by its fleet of the same type of aircraft, (or individual aircraft), the appropriate RMA will inform the BCAA so that the BCAA may grant RVSM approval for that particular fleet (or aircraft).

## 3.3 Over flight Assessment

Once the aircraft has successfully conducted an over flight assessment, there is no requirement for further assessments unless there is a change to the required aircraft equipment. A successful over flight assessment conducted by a RMA is acceptable for all RMAs. An over flight assessment may not be a prerequisite for “group aircraft” but it is for “non group aircraft”. After the BCAA has granted airworthiness approval, operators of non-group aircraft should take steps to either overfly the Height Monitoring Unit (HMU) nearthe following locations;

(a) Strumble, UK

(b) Linz, Austria

(c) Nattenheim, Germany

(d) Geneva, Switzerland

or arrange with EUROCONTROL or ARINC (Tel: 001 410 2664931, or facsimile 001 410 5733007), for the carriage of a global positioning system (GPS) monitoring unit (GMU). If monitoring occurs before the BCAA has informed the appropriate RMA, the accrued data may still be used provided that it is dated after the modification/inspection was completed. In the case of aircraft added to an operator’s fleet of the same type, after initial application for RVSM operating authority, the appropriate RMA will determine whether any further monitoring is required and will inform the BCAA, which in turn will inform the operator.

Any monitoring conducted by a RMA is acceptable to the BCAA and to other RMAs. Operators can consult the ARINC Bulletin Board, EUROCONTROL (www.eur-rvsm.com), or the appropriate RMA to ascertain if its aircraft have been monitored and acceptable performance has been demonstrated.

*Note 1: "Group aircraft" means aircraft that are of nominally identical design and build with respect to all details that could influence the accuracy of height keeping performance. (e.g.; Passenger configuration Boeing 777, Airbus A330)*

*Note 2: "Non-group aircraft". Operators of these aircraft (e.g.; GIV, LR 60 etc) must apply on an individual aircraft basis and monitoring by an HMU or GMU is a pre- requisite to obtain RVSM (operational) approval unless flight test evidence can be provided to the BCAA to show that each airframe is compliant with Altimetry System Error (ASE) targets.*

### 3.4 Approval Process

3.4.1 Validation Flight(s)

The content of the RVSM application and programmes may be sufficient to validate the aircraft. However, the final step of the approval process may require a validation flight through RVSM airspace with a BCAA Operations Inspector to verify that all relevant procedures are applied effectively. If the performance is satisfactory, operational approval for RVSM airspace may be granted. If the performance is not adequate, then approval will be delayed.

3.4.2 Approval

Approval to operate in RVSM airspace will be granted by inclusion in the Operations Specifications of the AOC holder. For private category aircraft a Certificate will be issued.

## 4. TRAINING & OPERATING PROCEDURES

### 4.1 Introduction

The following items detailed in paragraphs 4.2 to 4.8 below should be standardised and incorporated into training programmes and operating practices and procedures. This document is written for all users of RVSM airspace, and as such is designed to present all required actions.

All operators should refer to the applicable ICAO Doc 7030/4 to ensure appropriate regional supplementary procedures are addressed in the approved Operations Manual and training programmes.

### 4.2 Training

Training is required for flight crew and dispatchers. In addition to the operating procedures below, the following items should also be included in flight crew training programmes:

(a) knowledge and understanding of standard ATC phraseology used in each area of operations;

(b) importance of crew members cross checking to ensure that ATC clearances are promptly and correctly complied with;

(c) use and limitations in terms of accuracy of standby altimeters in contingencies. Where applicable, the pilot should review the application of static source error and pressure error correction through the use of correction cards;

(d) problems of visual perception of other aircraft at 1,000 ft (300 m) planned separation during darkness, when encountering local phenomena such as northern lights, for opposite and same direction traffic, and during turns;

(e) characteristics of aircraft altitude capture systems, which may lead to flight level overshoots.

(f) relationship between the aircraft's altimetry, automatic altitude control and transponder systems in normal and abnormal conditions.

(g) any airframe operating restrictions, if required for the specific aircraft group, related to RVSM airworthiness approval.

(h) use of TCAS in RVSM airspace.

(i) effect of wake turbulence.

## 4.3 Flight Planning

During flight planning the flight crew and the dispatcher should pay particular attention to conditions that may affect operation in RVSM airspace. These include, but may not be limited to:

(a) verifying that the airframe is approved for RVSM operations;

(b) reported and forecast weather on the route of flight;

(c) minimum equipment requirements pertaining to height-keeping systems;

(d) if required for the specific aircraft group, accounting for any aircraft operating restriction related to RVSM airworthiness approval.

(e) Any airframe or operating restriction related to RVSM approval;

(f) ensuring that **"W"** is stated in item 10 of the ATC flight plan to indicate RVSM approval.

## 4.4 Pre-flight Procedures

The following actions should be accomplished by flight crew during the pre-flight procedure:

(a) review technical logs and forms to determine the condition of equipment required for flight in the RVSM airspace. Ensure that maintenance action has been taken to correct defects to required equipment;

(b) during the external inspection of aircraft, particular attention should be paid to the condition of static sources and the condition of the fuselage skin near each static source and any other component that affects altimetry system accuracy. This check may be accomplished by a qualified and authorised person other than the pilot (e.g., aflight engineer or ground engineer);

(c) before take-off, the aircraft altimeters should be set to the QNH of the airfield and should display a known altitude, within the limits specified in the aircraft operating manuals. The two primary altimeters should also agree within limits specified by the aircraft operating manual.

*Note: The maximum value for these checks cited in operating manuals should not exceed 75 ft.*

(d) before take-off, equipment required for flight in RVSM airspace should be operative, and any indications of malfunction should be resolved.

## 4.5 Procedures Prior to RVSM Airspace Entry

The following equipment should be operating normally at entry into RVSM airspace:

(a) Two primary altitude measurement systems.

(b) One automatic altitude-control system.

(c) One altitude-alerting device.

(d) Operating Transponder (subject to operational area requirements)

*Note: Should any of the required equipment fail prior to the aircraft entering RVSMairspace, the pilot should request a new clearance to avoid entering this airspace.*

## 4.6 In-flight Procedures

The following practices should be incorporated into flight crew training and procedures:

(a) Flight crews must comply with any aircraft operating restrictions, if required for the specific aircraft group, given in the RVSM airworthiness approval.

(b) Emphasis should be placed on promptly setting the sub-scale on all primary and standby altimeters to 1013.2 (hPa) when passing the transition altitude, and rechecking for proper altimeter setting when reaching the initial cleared flight level;

(c) In level cruise it is essential that the aircraft is flown at the cleared flight level. This requires that particular care is taken to ensure that ATC clearances are fully understood and followed. The aircraft should not intentionally depart from the cleared flight level without a positive clearance from ATC unless the crew is conducting contingency or emergency manoeuvres;

(d) When changing levels, the aircraft should not be allowed to overshoot or undershoot the cleared flight level by more than 150 ft (45 m);

*Note: It is recommended that the level off be accomplished using the altitudecapture feature of the automatic altitude-control system, if installed.*

(e) An automatic altitude-control system should be operative and engaged during level cruise, except when circumstances such as the need to re-trim the aircraft or turbulence require disengagement. In any event, adherence to cruise altitude should be done by reference to one of the two primary altimeters;

(f) Ensure that the altitude-alerting system is operative;

(g) At intervals of approximately one hour, cross-checks between the primary altimeters should be made. A minimum of two must agree within ±200 ft (±60 m). Failure to meet this condition will require that the altimetry system be reported as defective and notified to ATC;

(1) The usual scan of flight deck instruments should suffice for altimeter cross-checking on most flights.

(2) Before entering oceanic RVSM airspace, the initial altimeter cross check of primary and standby altimeters should be recorded

(h) In normal operations, the altimetry system being used to control the aircraft should be selected for the input to the altitude reporting transponder transmittinginformation to ATC.

(i) If the pilot is advised in real time that the aircraft has been identified by a height-monitoring system as exhibiting a Total Vertical Error greater than ± 300 ft (± 90 m) and/or an ASE greater than ± 245 ft (± 75 m) then the pilot should follow established regional procedures to protect the safe operation of the aircraft. This assumes that the monitoring system will identify the Total Vertical Error or Altimetry System Error within the set limits for accuracy.

(j) If the pilot is notified by ATC of an Assigned Altitude Deviation error whichexceeds ±300 ft (±90 m) then the pilot should take action to return to the cleared flight level as quickly as possible.

## 4.7 Contingency procedures after entering RVSM airspace

4.7.1 Notification

The pilot should notify ATC of contingencies, such as equipment failures, system inaccuracies and severe turbulence, which affect the ability to maintain the cleared flight level, and co-ordinate a plan of action. If unable to contact ATC and obtain an ATC clearance prior to deviating from the cleared flight level, the pilot should follow established contingency procedures as defined by the region of operation and obtain ATC clearance as soon as possible.

4.7.2 Notifiable Equipment Failures

The types of equipment failures, which should be notified to ATC are:

(a) Failure of all automatic altitude-keeping devices.

(b) Loss of redundancy of all, or part of, altimetry systems.

(c) Failure of all altitude reporting transponders.

(d) Loss of thrust on an engine necessitating descent.

(e) Any other equipment failure affecting the ability to maintain the cleared Flight Level.

## 4.8 Post Flight

In making technical log entries against malfunctions in height-keeping systems, the pilot should provide sufficient detail to enable maintenance to effectively trouble shoot and repair the system. The pilot should detail the actual defect and the crew action taken to try to isolate and rectify the fault. The following information should be noted when appropriate:

(a) Primary and standby altimeter readings.

(b) Altitude selector setting.

(c) Subscale setting on altimeter.

(d) Autopilot used to control the aeroplane and any differences when the alternatesystem was selected.

(e) Differences in altimeter readings, if alternate static ports selected.

(f) Use of air data computer selector for fault diagnosis procedure.

(g) The transponder selected to provide altitude information to ATC and any difference noted when an alternative transponder was manually selected.

# 5. OPERATOR/BCAA OVERSIGHT

## 5.1 Operator Responsibilities

The incidence of height-keeping errors that can be tolerated in an RVSM environment is small. It is incumbent upon each operator to take immediate action to rectify the conditions that cause an error. The operator should also report the event to the BCAA within 72 hours, through the appropriate channels, with initial analysis of causal factors and measures takento prevent further events.

### 5.1.1 Error Reporting

Height-keeping errors fall into two broad categories; errors caused by malfunction of aircraft equipment and operational errors. Errors that should be reported to the BCAA and investigated are:

(a) Total Vertical Error (TVE), which is the vertical geometric difference between the actual pressure altitude flown by an aircraft and its assigned pressure altitude (flight level) equal to or greater than ± 300 ft (± 90 m).

(b) Altimetry System Errors (ASE), which is the difference between the pressure altitude displayed to the flight crew when referenced to ISA standard ground pressure setting of 1013.2 hPa, and the free stream pressure altitude, equal to or greater than ± 245 ft (± 75 m).

(c) Reported Assigned Altitude Deviation (AAD), which is the difference between the transponder Mode C altitude and the assigned altitude flight level, equal to or greater than ± 300 ft (± 90 m).

(d) Operational errors.

*Note: The Report of Large Height Deviation of 300 Ft or more between FL290 & FL410 are notified to the MIDRMA upon receipt of the reported error from the operator using the MIDRMA Form 4 - https://midrma.com/assets/docs/forms/MIDRMALHDFORMF4.doc.*

5.1.2 Aircraft Modification

The operator shall advise the BCAA of any rectification work or modifications, which may affect RVSM capability.

## 5.2 RVSM PERIODIC MONITORING PROGRAM

Considering ICAO Annex 6 Part I & II, Amendment 9 concerning RVSM long term monitoring requirements.

BCAA requires all operators, to perform periodic height monitoring on their RVSM approved fleet.

Operator would be required to establish a requirement which ensures that a minimum of two aeroplanes of each aircraft type grouping have their height keeping performance monitored, at least once every two years or within intervals of 1000 flight hours per aeroplane, whichever period is longer.

If an operator aircraft type grouping consists of a single aeroplane, monitoring of thataeroplane shall be accomplished within the specified period.

Aircraft that use ADS-B Out for RVSM operations are automatically continuously monitored.

## 5.3 BCAA Action

5.3.1 Investigation

Any Bahraini operator found to be operating in RVSM airspace without approval or with faulty equipment could jeopardise the safety of other users of the airspace. An operator that consistently incurs equipment or operational errors may be required to forfeit authority for RVSM operations. The BCAA may consider revoking RVSM operational approval if the operator response to a height-keeping error is not effective or timely. The BCAA will also consider the operator's past performance record in determining the action to be taken. If an operator shows a history of operational and/or airworthiness errors, then approval may be revoked until the root causes of these errors are shown to be eliminated and RVSM programmes and procedures effective.

If a problem is identified, which is related to one specific aircraft type then RVSM authority may be removed from the operator for that specific type. The BCAA will review each situation on a case-by-case basis. Should a RVSM approval be withdrawn, advice shall be sent to the appropriate RMA using the MIDRMA Form 3- https://midrma.com/assets/docs/forms/MIDRMAFORM_F3.doc.

5.3.2 Reinstatement of Approval

Following any rectification work the operator would again be expected to demonstrate compliance with the RVSM requirements for monitoring by an independent height monitoring system.