

AERONAUTICAL CIRCULAR CIVIL AVIATION AUTHORITY – MACAO, CHINA

SUBJECT: *Operation in Reduced Vertical Separation Minimum (RVSM) Airspace*

EFFECTIVE DATE:

15 September 2013

CANCELLATION:

AC/OPS/020R00

GENERAL:

The President of Civil Aviation Authority – Macao, China, in exercise of his power under Paragraph 89 of the Air Navigation Regulation of Macao (ANRM) and Article 35 of the Statutes of Civil Aviation Authority, approved by the Decree-Law 10/91/M, established this Aeronautical Circular (AC).

1 Introduction

In Sub-paragraph (2)(e) in Paragraph 2 “Table of Radio and Navigation Equipment to be Carried in Aircraft” of the Sixth Schedule in the ANRM, equipment defined in Scale I is required for all aircraft registered in Macao intended for flights in defined portions of airspace where, based on Regional Air Navigation Agreement, a vertical separation minimum (VSM) of 300 m (1 000 ft) is applied above FL 290. Following the latest International Civil Aviation Organization (ICAO) requirement regarding Reduced Vertical Separation Minimum (RVSM) operations, AACM establishes this AC to update the requirements in relation to RVSM operations.

The purpose of this AC is to:

- (a) Amend the relevant paragraph regarding RVSM operations in the Sixth Schedule to the ANRM in accordance with ICAO Annex 6;
- (b) Provide Macao operators with the guidance to obtain RVSM approval and the conditions to maintain their eligibility to operate in RVSM airspace.

2 Applicability

This AC applies to all Macao operators who conduct, or intend to conduct flight in airspace or on routes where RVSM is applied. Operators in possession of RVSM approvals prior to the effective day of this AC shall also review this AC and ensure their operations are in compliance with the requirements herein.

3 Operations in RVSM Specified Airspace

For flights in defined portions of airspace where, based on Regional Air Navigation Agreement, a Reduced Vertical Separation Minimum (RVSM) of 300 m (1,000 ft) is applied between FL 290 and FL 410 inclusive, an aircraft:

- (a) shall be provided with equipment which is capable of:
 - (1) indicating to the flight crew the flight level being flown;
 - (2) automatically maintaining a selected flight level;
 - (3) providing an alert to the flight crew when a deviation occurs from the selected flight level. The threshold for the alert shall not exceed $\pm 90\text{m}$ (300 ft); and
 - (4) automatically reporting pressure-altitude; and
- (b) shall be authorized by the state of operator for operation in the airspace concerned;
- (c) shall demonstrate a vertical navigation performance in accordance with ICAO Annex 6 Part I Appendix 4 (or Part II Appendix 2, whichever is applicable).
- (d) shall be sufficiently provided with navigation equipment to ensure that, in the event of the failure of one item of equipment at any stage of the flight, the remaining equipment will enable the aircraft to navigate in accordance with (a), (b) and (c) above.

4 Approval for Operation in RVSM Airspace

Operator requesting an approval to operate in RVSM airspace as required by paragraph 3(b) shall demonstrate to AACM that:

- (a) the vertical navigation performance capability of the aircraft satisfies the requirements specified in 3(c);
- (b) he/she has instituted appropriate procedures in respect of continued airworthiness (maintenance and repair) practices and programmes; and
- (c) he/she has instituted appropriate flight crew procedures for operations in RVSM airspace.

Note: 1) Guidance on the approval for operation in RVSM airspace is set out in Appendix 1 of this AC.

2) An RVSM approval is valid globally on the understanding that any operating procedures specific to a given region will be stated in the operations manual or appropriate crew guidance.

5 Height-keeping Performance Monitoring

All operators that operate or intend to operate in airspace where RVSM is applied are required to participate in the RVSM monitoring program which is a two-phase process.

- (a) Phase I – Initial Monitoring Associated with the RVSM Approval Process
 - (1) Operator must go through the monitoring process and satisfy the RVSM Minimum Monitoring Requirements (MMR) as required by the appropriate Regional Monitoring Agencies (RMA).
 - (2) In the application to AACM for RVSM approval, operators must show a plan for meeting the applicable initial monitoring requirements set out by the RMA.

Monitoring should be completed as soon as possible but not later than 6 months after the issue of RVSM approval.

- (3) Operator shall ensure that monitoring reports issued by the appropriate RMA are submitted to AACM.

(b) Phase II – Long-Term Height Monitoring

RVSM monitoring is an on-going program that will continue after the initial RVSM implementation phase.

- (1) Operator who has been issued with an RVSM approval must ensure 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 1,000 flight hours per aeroplane, whichever period is longer; and
- (2) If an operator aircraft type grouping consists of a single aeroplane, monitoring of that aeroplane shall be accomplished within the specified period stated in item (b)(1) above.
- (3) In addition, operator should consult the appropriate RMA (MAAR for Asia Region) for Long-Term Height Monitoring in order to satisfy the regional monitoring requirement and process as required by the RMA.
- (4) Operator shall establish a Monitoring Plan for different aircraft type grouping and provide AACM with a plan of the monitoring to be completed in the succeeding two years and the latest two monitoring completed for each aircraft type grouping on an annual basis or when required.
- (5) Operator shall ensure that monitoring reports issued by the appropriate RMA are submitted to AACM.

Note: More guidance on the Height-keeping Performance Monitoring is set out in Appendix 1 paragraph 5 of this AC.

6 Withdrawal of RVSM Approval

AACM may withdraw the RVSM approval issued to an operator if there are reasonable grounds for believing that the holder of the approval:

- (a) does not meet, or does not continue to meet, the requirements for approval to operate in RVSM airspace as prescribed in paragraph 4; or
- (b) is no longer able to operate an aircraft covered by the approval safely in RVSM airspace because of inaccurate or unreliable height-keeping caused by the failure, or malfunctioning, of any of the aircraft's equipment mentioned in paragraph 3(a); or
- (c) is no longer able to carry out operation in RVSM airspace safely because of inaccurate or unreliable height-keeping by flight crew members during the operation.

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Appendix 1 Guidance on the Approval for Operation in RVSM Airspace

1 Introduction

- 1.1 Reduced Vertical Separation Minimum (RVSM) airspace is any airspace between FL290 and FL410 inclusive where aircraft are separated vertically by 300m (1000ft). Airspace where RVSM is applied should be considered special qualification airspace. Macao operator and the specific aircraft it intends to operate must be approved by AACM before conducting flight in RVSM airspace.
- 1.2 The purpose of this appendix is to outline the specification and provide an acceptable means, but not the only means, that can be applied by Macao operator to gain approval to conduct flight in airspace or on routes where RVSM is applied. It also provides reference for guidance on airworthiness, continuing airworthiness, operating procedures and practices related to operations in RVSM airspace.
- 1.3 The following documents should be referenced for information relating to the approval of operation in RVSM airspace:
 - a) ICAO Doc 9574 – *Manual on Implementation of a 300 m (1000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive*;
 - b) JAA Administrative & Guidance Material – Section One: General Part 3: Temporary Guidance Leaflet (TGL) No. 6 – *Guidance Material on the Approval of Aircraft and Operators for Flight in Airspace Above Flight Level 290 where a 300 m (1,000 ft) Vertical Separation Minimum is Applied*.
 - c) FAA Guidance 91-RVSM – *Guidance Material on the Approval of Operators/Aircraft for RVSM Operations*;
- 1.4 Definition
 - a) *Altimetry system error (ASE)*. 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.
 - b) *Target level of safety (TLS)*. A generic term representing the level of risk which is considered acceptable in particular circumstances.
 - c) *Total vertical error (TVE)*. The vertical geometric difference between the actual pressure altitude flown by an aircraft and its assigned pressure altitude (flight level).

2 Background

- 2.1 In the late 1950s it was recognized that, as a result of the reduction in pressure-sensing accuracy of barometric altimeters with increasing altitude, there was a need above a certain Flight Level (FL) to increase the prescribed vertical separation minimum (VSM) of 300m (1000 ft).
- 2.2 In 1960, an increased VSM of 600m (2000 ft) was established for use between aircraft operating above FL 290 except where, on the basis of regional air navigation agreement, a lower flight level was prescribed for the increase. The selection of FL 290 as the vertical limit for the 300 m (1000 ft) VSM was not so much an empirically

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based decision but rather a function of the operational ceiling of the aircraft at that time.

- 2.3 In 1966, this changeover level was established at FL 290 on a global basis. At the same time, it was considered that the application of a reduced VSM above FL 290, on a regional basis and in carefully prescribed circumstances, was a distinct possibility in the not too distant future. Accordingly, ICAO provisions stated that such a reduced VSM could be applied under specified conditions within designated portions of airspace on the basis of regional air navigation agreement.
- 2.4 In the mid-1970s, the series of world fuel shortages and the resultant rapid escalation of fuel costs, allied to the growing demand for a more efficient utilization of the available airspace, emphasized the necessity for a detailed appraisal of the proposal to reduce the VSM above FL290. Thus, at its fourth meeting (in 1980), the ICAO Review of the General Concept of Separation Panel (RGCSP) concluded that, despite the cost and time involved, the potential benefits of reducing the VSM above FL 290 to 300 m (1000 ft) were so great that States should be encouraged to conduct the major evaluations necessary.
- 2.5 In 1982, coordinated by the RGCSP, States initiated programmes to study comprehensively the question of reducing the VSM above FL 290. Studies were carried out by Canada, Japan, Member States of EUROCONTROL, Union of Soviet Socialist Republics (USSR) and the United States, and in December 1988 the results were considered by the RGCSP at its sixth meeting.
- 2.6 These studies employed quantitative methods of risk assessment to support operational decisions concerning the feasibility of reducing the VSM. The risk assessment consisted of two elements: first, risk estimation, which concerns the development and use of methods and techniques with which the actual level of risk of an activity can be estimated; and second, risk evaluation, which concerns the level of risk considered to be the maximum tolerable value for a safe system. The level of risk that is deemed acceptable was termed the target level of safety (TLS).
- 2.7 Two major reports were published by the ICAO RGCSP and have provided the basis for the development of RVSM implementation documents:
- a) The Report of RGCSP/6 (Montreal, 28 November – 15 December 1988) published in two volumes: Volume 1 summarized the major conclusions reached by the panel and by individual states. Volume 2 presented the complete RVSM study reports of the US, Canada, EUROCONTROL, Japan and the USSR. The major conclusions of this report are:
 - i) RVSM is "technically feasible without imposing unreasonably demanding technical requirements on the equipment"; and
 - ii) RVSM would provide "significant benefits in terms of economy and en route airspace capacity".
 - b) The Report of RGCSP/7 (Montreal, 30 October – 20 November 1990) contains the draft "Manual on Implementation of a 300m (1,000 ft) Vertical Separation Minimum (VSM) Between FL 290 and 410 Inclusive." This material was

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approved by the ICAO Air Navigation Commission in February 1991 and published as ICAO Document 9574. This manual provides guidance for RVSM implementation planning, airworthiness requirements, flight crew procedures, ATC considerations and system performance monitoring.

- 2.8 A reduced vertical separation minimum of 1000 feet was also introduced in parts of the North Atlantic Minimum Navigation Performance Specification (NAT MNPS) airspace in 1997 and has currently been extended to the airspace from flight levels FL290 – FL410 inclusive.

3 RVSM Approval

- 3.1 Airspace where RVSM is applied should be considered special qualification airspace. Macao operators and the specific aircraft they intend to use must be approved by AACM before conducting flights in RVSM airspace. The two-fold approval process includes the *approval of aircraft* and the *approval of operator*.

3.2 Approval of Aircraft

- 3.2.1 An *RVSM Airworthiness Approval*, in the context of this appendix, is an approval granted by AACM for an aircraft indicating that it is suitable to be operated in RVSM airspace.

- 3.2.2 Each aircraft that an operator intends to use in RVSM airspace must have received the RVSM Airworthiness Approval prior to the Operational Approval being granted by AACM. Paragraph 4.2 provides guidance for the RVSM Airworthiness Approval application.

3.3 Approval of Operator

- 3.3.1 An *RVSM Operational Approval*, in the context of this appendix, is an approval granted by AACM to a Macao operator approving the operator to operate the aircraft covered by the approval in RVSM airspace. Each aircraft relevant to RVSM operations must have also received an RVSM airworthiness approval. Paragraph 4.3 provides guidance for the RVSM Operational Approval application.

- 3.3.2 Reference in paragraph 1.3b) contains guidance on the operational procedures, practices and training and also guidance on the continuous airworthiness (maintenance) programs for RVSM operations which an operator should adopt for RVSM operation. Each individual operator should plan on presenting these programmes/procedures to AACM at least 60 days prior to the proposed operation.

4 Application and Approval Process

- 4.1 Pre-application meeting should be scheduled between the operator and the AACM. The purpose of the meeting is to inform the operator of AACM's expectations in regard to the RVSM approval process.

4.2 Airworthiness Approval

- 4.2.1 Application for RVSM airworthiness approval of an individual aircraft to be used by the operator in RVSM operations shall be submitted to AACM in writing and should, as a minimum, consist of the following:

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- a) Airworthiness certification documents, such as an Approved Flight Manual (AFM), AFM supplement, or other evidence that documents RVSM capability, shows that the aircraft has been RVSM certified based on the references in paragraph 1.3b) or 1.3c), in order to show the compliance of ICAO requirements stated in paragraph 1.3a);
- b) Description of Aircraft Equipment which details all components and equipment relevant to RVSM operations; and
- c) Service bulletin, supplemental type certificate (STC) or major modification approval documentation to which the approval of the RVSM systems installation is based on (except covered by item 4.2.1 a) above).

4.2.2 After the RVSM airworthiness approval application has been submitted, AACM will conduct a technical evaluation of its content. If the content of the application is insufficient, AACM will request additional information from the operator. Issuance of airworthiness approval is subject to satisfactory completion of technical evaluation.

4.3 Operational Approval

4.3.1 Application for approval of RVSM operation shall be submitted to AACM in writing and substantiated by supplementary documentation, which shall be presented in the form of, but not limited to, the following documents:

- a) Application letter stating the details of the intended operations;
- b) Operations manuals and specific operational checklists, or their amendments thereof, incorporated with RVSM operating practices & procedures and training programme for flight crew and operational staff which are developed using the guidance materials of paragraph 1.3 and cover the following aspects:
 - i) Flight planning;
 - ii) Pre-flight procedures at the aircraft for each flight;
 - iii) Procedures prior to RVSM airspace entry;
 - iv) In-flight procedures; and
 - v) Contingency procedures.
- c) Demonstration of sufficient training to maintenance staff in order to provide maintenance in respect to RVSM operations if applicable;
- d) Past Performance. Operating history showing any events or incidents related to poor height keeping performance which may indicate weaknesses in training, procedures, maintenance, or the aircraft group intended to be used.
- e) Minimum Equipment List (MEL) which should include items pertinent to operating in RVSM airspace;
- f) Maintenance programme or amendment thereof which addresses the items pertinent to the equipment for RVSM operations;
- g) Maintenance practices & procedures pertinent to RVSM operation (Company procedures, or stand-alone RVSM document, etc.);

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- h) Plan for participation in RVSM Monitoring Programme including both initial and long-term monitoring (more on paragraph 5); and
- i) Height-keeping error reporting scheme or documented reporting procedures.

4.3.2 If the content of the application for operational approval is insufficient, AACM will request additional information from the applicant. If the assessment for both flight operations and airworthiness render satisfactory results, the operator is technically approved for RVSM operations.

4.4 The RVSM Operational approval will be issued in one of the following ways:

- a) For operator in possession of an Air Operator Certificate (AOC) covering the aircraft for which the approval is applied, the operational approval should be granted through update/variation of AOC Operations Specification;
- b) For operator not in possession of an AOC, the operational approval will take the form of a certificate and will identify the operator, each individual aircraft the approval covers, and any conditions applied on the operational approval.

4.5 In case the operator's aircraft is required to participate in the mandatory initial height-keeping performance monitoring with reference to the minimum monitoring requirement (MMR), the operator may be issued with a temporary operational approval with a limited validity. According to the MMR, the initial height keeping performance monitoring shall be completed as soon as possible but no later than 6 months after the operational approval is granted. The definitive RVSM operational approval will be issued after the satisfactory completion of the initial monitoring requirement.

5 Height-Keeping Performance Monitoring

5.1 RVSM Monitoring Requirements in Asia Region

5.1.1 For initial monitoring associated with the RVSM approval process:

- a) Asia operators that operate or intend to operate in airspace where RVSM is applied are required to participate in the RVSM monitoring program. In the application to the AACM for RVSM approval, operators must show a plan for meeting the applicable monitoring requirements.
- b) Operator which has received an operational approval may operate in the RVSM airspace under the condition that the Aircraft Height-Keeping Performance Monitoring must be completed as soon as possible, but no later than 6 months after the operational approval is granted.

5.1.2 For RVSM Long-Term Height Monitoring:

- a) In accordance with ICAO Annex 6, it is required that a minimum of two aeroplanes of each aircraft type grouping of the operator 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.

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- b) If an operator aircraft type grouping consists of a single aeroplane, monitoring of that aeroplane shall be accomplished within the specified period as stated in item a) above.
- c) In addition, operator should consult the appropriate RMA (MAAR for Asia Region) for Long-Term Height Monitoring in order to satisfy the regional monitoring requirement and process as required by the RMA.
- d) The Monitoring Plan should be submitted by the end of every December.

5.2 Monitoring Agency for Asia Region (MAAR)

- 5.2.1 Monitoring Agency for Asia Region (MAAR) was established by Aeronautical Radio of Thailand, Ltd. (AEROTHAI) under the approval of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) to assume the duties and responsibilities of the Regional Monitoring Agency (RMA) for the Asia Region.
- 5.2.2 In order to support preparation for the RVSM implementation in the Asia/Pacific Region, the APANPIRG established the Asia/Pacific Approvals Registry and Monitoring Organization (APARMO) as the Regional Monitoring Agency (RMA). At the 14th APANPIRG meeting held in Bangkok, the duties and responsibilities of the RMA for the Asia Region were transferred from the APARMO to MAAR.
- 5.2.3 The principal role of the MAAR is to assist the International Civil Aviation Organization (ICAO) in the continuation of the safety assessment program for the implementation of Reduced Vertical Separation Minimum (RVSM) and other monitoring requirements as determined by the APANPIRG.
- 5.2.4 Detailed information of the monitoring requirements and the monitoring process can be found on MAAR website (<http://www.aerothai.co.th/maar>).

6 Conditions for Withdrawal of Approval

- 6.1 The incidence of height-keeping errors which can be tolerated in an RVSM environment is very small. It is incumbent upon each operator to take immediate action to rectify the conditions which caused the error. The operator should also report the event to AACM within 72 hours with initial analysis of causal factors and measures to prevent further events. The requirement for follow up reports should be determined by AACM.
- 6.2 Errors which should be reported and investigated are:
 - a) *Total Vertical Error (TVE)* equal to or greater than ± 300 ft (± 90 m);
 - b) *Altimetry System Error (ASE)* equal to or greater than ± 245 ft (± 75 m); and
 - c) *Assigned Altitude Deviation (AAD)* equal to or greater than ± 300 ft (± 90 m).

Note: AAD are defined in the reference material of paragraph 1.3a)
- 6.3 Height-keeping errors fall into two broad categories: errors caused by malfunction of aircraft equipment and operational errors. An operator which consistently commits errors of either variety may be required to forfeit authorization for RVSM operations.

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If a problem is identified which is related to one specific aircraft type, then RVSM authorization may be removed for the operator for that specific type.

- 6.4 The operator should make an effective, timely response to each height-keeping error. AACM may consider suspension or revocation of an operator's RVSM operational approval if the operator response to a height-keeping error is not effective or timely. AACM 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 suspended until the root causes of these errors are shown to be eliminated and RVSM programs and procedures are shown to be effective. AACM will review each situation on a case-by-case basis.

– END –