



# ***ADVISORY CIRCULAR***

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AC approval date: 5<sup>th</sup> AUG 2021

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**SUBJECT:    PROCESS & APPLICATION: REDUCED VERTICAL SEPARATION MINIMA (RVSM)**

**EFFECTIVE DATE:    6<sup>th</sup> AUGUST 2021**

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**APPROVAL SIGNATURE:** \_\_\_\_\_

**HON. MOSES Y. KOLLIE**

**DIRECTOR GENERAL**

# PROCESS & APPLICATION REDUCED VERTICAL SEPARATION MINIMA (RVSM)

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## SECTION 1: POLICY & GENERAL INFORMATION

### 1.1 PURPOSE

This advisory circular (AC) provides a means for air operators to obtain operational authority to operate within Reduced Vertical Separation Minimum (RVSM) Airspace.

No person may operate a civil aircraft of Liberia registry in RVSM airspace (FL290+) without a written authorization issued by the LCAA.

### 1.2 STATUS OF THIS AC

This AC is an original issuance.

### 1.3 BACKGROUND

- (a) In the late 1970s, faced with rising fuel costs and growing demands for a more efficient use of available airspace, the International Civil Aviation Organization (ICAO) initiated a comprehensive project of studies to examine the feasibility of reducing the Vertical Separation Minimum (VSM) applied above FL 290 from 2000 ft. to 1000 ft.
- (b) Studies demonstrated that RVSM is safe, feasible and provides significant benefits in terms of economy and en route airspace capacity.
- (c) All air carriers and operators of private aircraft (the operator) intending to operate within RVSM airspace are required to be equipped with altimetry and height-keeping systems, which meet RVSM performance specifications.

Operators without this authorization are excluded from flying within RVSM airspace.

### 1.4 APPLICABILITY

The requirement for LCAA approval before operations in RVSM airspace applies to operators of Liberia-registered aircraft involved in general aviation, aerial work and commercial air transport.

### 1.5 RELATED DIRECTIVES

- (a) The following Liberia Civil Aviation Regulations (LCARs) are applicable to the RVSM requirements—
  - (1) Part 7 – Equipment for Special Altimetry Accuracy (RVSM)
  - (2) Part 08 – Operations IN RNP, MNPS or RVSM Airspace

- Advisory Circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the directives, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.
- Where a directive contains the words “prescribed by the Authority,” the AC may consider to “prescribe” a viable method of compliance, but status of that “prescription” is always “guidance” (never directive).

## 1.6 RELATED PUBLICATIONS

- (a) These ICAO publications are source documents for this advisory circular—
- (1) International Civil Aviation Organization (ICAO) Doc. 9574, Manual on the Implementation of a 300 m (1,000 ft.) Vertical Separation Minimum Between FL 290 - FL 410 Inclusive.
  - (2) ICAO Doc 7030/4, Regional Supplementary procedures.
  - (3) North Atlantic MNPS Manual (9th edition) can be downloaded from the North Atlantic Program Coordination Office (NAT PCO) website at the following address: [www.nat-pco.org](http://www.nat-pco.org).

Copies may be obtained from Document Sales Unit, ICAO, 999 University Street, Montreal, Quebec, Canada H3C 5H7.

## 1.7 ACRONYMS & DEFINITIONS

### 1.7.1 ACRONYMS & ABBREVIATIONS

- (a) The following acronyms and abbreviations are used in this circular—
- (1) **AAD** – Assigned Altitude Deviation
  - (2) **AC** – Advisory Circular
  - (3) **AOC** – Air Operator Certificate
  - (4) **ASE** – Altimetry Systems Error
  - (5) **ASI** – Aviation Safety Inspector
  - (6) **AVE** – Avionics Error
  - (7) **LCADs** – Liberia Civil Aviation Directives
  - (8) **LCAA** – Liberia Civil Aviation Authority
  - (9) **BITE** – Built In Test Equipment
  - (10) **CFL** – Cruising Flight Level
  - (11) **FAC** - Formal Application Checklist
  - (12) **GMU** – GPS Monitoring Unit
  - (13) **HMU** – Height Monitoring Unit
  - (14) **ICAO** – International Civil Aviation Organization
  - (15) **LOA** – Letter of Authorization
  - (16) **MASPS** – Minimum Aircraft System Performance Specifications
  - (17) **MEL** – Minimum Equipment List
  - (18) **MMEL** – Master Minimum Equipment List
  - (19) **Ops Specs** – Operations Specifications
  - (20) **PASI** – Pre-Application Statement of Intent
  - (21) **RVSM** – Reduced Vertical Separation Minima
  - (22) **SSEC** – Static Source Error Correction
  - (23) **STC** – Supplemental Type Certification
  - (24) **TC** – Type Certificate

- (25) **TVE** – Total Vertical Error
- (26) **VSM** – Vertical Separation Minimum
- (27) **W/δ** – Aircraft weight, W, divided by the atmospheric pressure ratio, δ.

### 1.7.2 DEFINITIONS

(a) The following definitions apply to the text of this circular—

- (1) **Aircraft group** – A group of aircraft that are of nominally identical design and build with respect to all details that could influence the accuracy of height keeping performance.
- (2) **Altimetry system error** – The difference between the pressure altitude displayed to the flight crew when referenced to ISA standard ground pressure setting (29.92 in. Hg/ 1013.25 hPa) and free stream pressure altitude.
- (3) **Applicant** – Any Liberia AOC Holder or Aircraft Operator seeking to operate its aircraft in RVSM airspace.
- (4) **Assigned altitude deviation** – The difference between the transponder Mode C altitude and the assigned altitude/flight level.
- (5) **Automatic altitude control system** – Any system which is designed to automatically control the aircraft to a referenced pressure altitude.
- (6) **Avionics error** – The error in the processes of converting the sensed pressure into an electrical output, of applying any static source error correction (SSEC) as appropriate, and of displaying the corresponding altitude.
- (7) **Basic RVSM envelope** – The range of Mach numbers and gross weights within the altitude ranges FL290 to FL410 (or max available altitude) where an aircraft can reasonably be expected to operate most frequently.
- (8) **Full RVSM Envelope** – The entire range of operational Mach numbers, w/δ and altitude values over which the aircraft can be operated within RVSM airspace.
- (9) **Height-keeping capability** – Aircraft height-keeping performance which can be expected under nominal environmental operating conditions with proper aircraft operating practices and maintenance.
- (10) **Height-keeping performance** – The observed performance of an aircraft with respect to adherence to a flight level.
- (11) **Non-group aircraft** – An aircraft for which the operator applies for approval on the characteristics of the unique airframe rather than on a group basis.
- (12) **Residual static source error** – The amount by which static source error (SSE) remains undercorrected or overcorrected after the application of SSEC.
- (13) **Static source error** – The difference between the pressure sensed by the static system at the static port and the undisturbed ambient pressure.
- (14) **Static source error correction** – A correction for static source error.
- (15) **Supplemental type certificate** – A certificate approving the change in the type design of an aircraft. An STC is a type certificate issued when an applicant has received State of Design approval to modify an aircraft from its original design. The STC, which incorporates by reference the related TC, approves not only the modification but also how that modification affects the original design.

This list of definitions is applicable in the con-text of this advisory circular only. Words, such as "Applicant" may be found in other publications with a different definition.

- (16) **Total vertical error** – Vertical geometric difference between the actual pressure altitude flown by an aircraft and its assigned pressure altitude (flight level).

## SECTION 2: GENERAL POLICY

- (a) **Airspace where RVSM is applied is special qualification airspace—.**
- (1) The specific aircraft type or types that the operator intends to use must be approved by the LCAA before the operator conducts flight in RVSM airspace.
  - (2) Additionally, where operations in specified airspace require approval in accordance with an ICAO Regional Navigation Agreement, an operational approval is needed.
  - (3) This document provides guidance for the approval of specific aircraft type or types, and for operational approval.
  - (4) The LCAA must record, retain and maintain a description of each aircraft and operator approved to conduct flight in RVSM Airspace.
- (b) Each aircraft type that an operator intends to use in RVSM airspace should have received RVSM airworthiness approval from the aircraft certificating authority prior to approval being granted for RVSM operations, including the approval of continued airworthiness programs.
- (c) The LCAA will accept that aircraft that have been approved in compliance with JAA Information Leaflet No. 23, or FAA Interim Guidelines 91-RVSM, satisfy LCAARs airworthiness criteria.
- Operators are advised to check existing approvals and the Aircraft Flight Manual for regional constraints.
- (1) The integrity of the design features necessary to ensure that altimetry systems continue to meet RVSM criteria should be verified by scheduled tests and inspections in conjunction with an approved maintenance program.
  - (2) The operator should review its maintenance procedures and address all aspects of continued airworthiness that may be relevant.
- (d) Adequate maintenance facilities are required to enable compliance with RVSM maintenance procedures.
- (1) Each operator requesting RVSM operational approval must establish RVSM maintenance and inspection practices acceptable to the LCAA that include any required maintenance specified in the data package.
  - (2) Operators of aircraft subject to a continuous airworthiness maintenance program must incorporate these practices in their program.

## SECTION 3: OPERATIONAL APPROVAL PROCESS

### 3.1 GENERAL INTERNATIONAL REQUIREMENTS

#### 3.1.1 COMPLETE CERTIFICATION REQUIREMENTS

- (a) Prior to operating a civil aircraft of Liberia registry in RVSM airspace, aircraft operator(s) must first—
- (1) Satisfactorily complete a certification process;

If an aircraft is capable of flying within RVSM airspace but the operator does not intend to conduct flight there, then the aircraft operator should not be issued an RVSM authorization.

- (2) Obtain an approval document for the specific aircraft or fleet from the LCAA.

### **3.1.2 CERTIFICATION EVALUATION REQUIRED**

- (a) In making this certification evaluation, the Authority shall take into account—
  - (1) The route to be flown;
  - (2) The anticipated operating conditions; and
  - (3) The suitability of the aircraft.

### **3.1.3 CRITERIA FOR GRANTING THE APPROVAL DOCUMENT**

- (a) The Authority shall be satisfied that—
  - (1) The vertical navigation performance capability of the aeroplane satisfies the specified requirements.
  - (2) The AOC holder has instituted appropriate procedures in respect to continued airworthiness (maintenance and repair) practices and programmes; and
  - (3) The AOC holder has instituted appropriate flight crew procedures in the operations manual for operations in RVSM airspace.
  - (4) manual for operations in RVSM airspace.

## **3.2 GENERAL LCAA REQUIREMENTS**

### **3.2.1 5-PHASE CERTIFICATION PROCESS**

- (a) The phases of RVSM certification will be—
  - (1) Pre-Application
  - (2) Initial Application Review
  - (3) Document Conformance
  - (4) Inspection & Demonstration
  - (5) Final Certification Actions

### **3.2.2 PRE-APPLICATION**

- (a) This is the period of time before the formal application is submitted, when the applicant is developing the documentation and discussing the minimum requirements with the LCAA inspector personnel.
- (b) The applicant should complete a Pre-Application Statement of Intent (PASI) to officially start this phase of certification.

Refer to AC-AOC/001 for more specific guidance for the completion of the PASI.

### **3.2.3 SPECIFIC APPLICATION CONTENTS**

- (a) The LCAA will, during a formal Pre-Application meeting, outline the requirements for RVSM certification.
- (b) The applicant will be required to submit, with the formal application package, a completed Formal Application Checklist (FAC) including a listing of each aircraft type.

Refer to AC 09-001 for more specific guidance for the completion of the FAC.

- (c) The formal application package will also include all manuals and documents necessary to ensure adequate maintenance and safe operations of aircraft in RVSM airspace

Refer to Section 3 for of this AC for more specific guidance for the contents of the formal application.

### 3.2.4 INITIAL APPLICATION REVIEW

- (a) This is the period of time immediately following the applicant's submission of the complete formal application.

The applicant shall submit the formal application for RVSM operations at least 60 days prior to intended date to start operations.

- (b) The LCAA personnel review the total application package during an internal meeting and determine if the application package is complete enough to accept for evaluation.

The entire application package may be rejected following this internal meeting if it is found to be deficient in one or more critical areas

- (c) Shortly after that meeting (generally within 15 days after submission of the application package), a formal meeting will be held with the applicant to discuss the—
  - (1) Basis for rejection; or
  - (2) Formal acceptance.

### 3.2.5 DOCUMENT CONFORMANCE

- (a) This is the period of time after the formal acceptance of the certification package when each document is separately evaluated for conformance to the minimum acceptable standards,

- (b) During this phase, the individual documents may be returned to the applicant for correction. It is in the applicant's interest to track these documents to ensure that they are re-submitted in a timely manner to the LCAA for continuation of the conformance evaluation.

All individual documents that are re-submitted to the LCAA are subject to an "initial application review" to ensure that they are accept-able for processing.

- (c) This phase is considered complete when all submitted documents have been—
  - (1) Evaluated;
  - (2) Found to be acceptable for use in aviation; and
  - (3) Issued a formal instrument of approval or acceptance.

### 3.2.6 INSPECTION & DEMONSTRATION

- (a) This is the period of time that the LCAA conducts a series of inspections to determine that applicant's organization and personnel are qualified to conduct RVSM operations.

- (b) The applicant's aircraft, support organizations and training will receive close scrutiny as they meet the requirements that will qualify them for the RVSM operations.

- (c) At some point, during this phase, the applicant will be issued an LOA to conduct RVSM operations under the close

AOC holders shall be required to conduct a minimum of 2 satisfactory validation flights before completing this phase.

### 3.2.7 VALIDATION FLIGHTS

- (a) When all other airworthiness and operational requirements of the application are met, the LCAA will authorize validation flight(s).
- (b) The AOC applicant must be found to have adopted RVSM operating policies and procedures for pilots and, if applicable, flight dispatchers.
- (c) The inspector must verify that each pilot has adequate knowledge of RVSM requirements, policies, and procedures.

These flights may be conducted in conjunction with the verification/monitoring program.

### 3.2.8 FINAL CERTIFICATION ACTIONS

- (a) This is the period of time that the LCAA completes the necessary documentation to formalize the approval of the applicant to conduct RVSM operations in specific aircraft type(s).
- (b) That approval will be in the form of—
  - (1) For general aviation operators; an LOA valid for a period of 24 months; and
  - (2) For AOC holders, a revision to the—
    - (i) Master (formal) ops specs; and
    - (ii) Aircraft Display Ops Specs (for each type of aircraft).

## SECTION 4: CONTENTS OF FORMAL APPLICATION PACKAGE

### 4.1 GENERAL REQUIREMENTS

- (a) The following documents will be considered individually—
  - (1) Formal Application Checklist;
  - (2) RVSM Conformance Checklist;
  - (3) Summary of relevant past operating history (where available);
  - (4) Policies and procedures for participation in verification and monitoring programs;
  - (5) Policies and procedures for reporting altitude-keeping errors;

### 4.2 FOR AIRCRAFT TYPE

- (a) The following documents must be submitted for each aircraft type—
  - (1) RVSM Airworthiness Approval from Aircraft Certifying Authority;
  - (2) Description of aircraft equipment;
  - (3) Aircraft Maintenance Program (Schedule)
  - (4) Operations manuals (or proposed revisions to existing manuals) providing specific procedures or procedure steps to include RVSM;
  - (5) Operations checklists (and/or proposed revisions to existing checklists);



- (6) For AOC holders, training programs that include initial and recurrent training that provides pilots and airworthiness personnel with adequate knowledge of RVSM requirements and practices;
- (7) Proposed Minimum Equipment List (MEL) revisions;
- (8) Current Master Minimum Equipment List (MMEL)

### **4.3 AVAILABLE FOR CONSULTATION**

(a) The following documents (for each type of aircraft) must be available at the applicant's facilities for consultation—

- (1) Maintenance Manuals;
- (2) Structural repair manuals;
- (3) Standard practices manuals; and
- (4) Illustrated parts catalogues.

- LCAA inspectors shall have unobstructed ability to refer to these documents.
- If this criteria is not met, copies of these manuals will be required to be submitted to the LCAA as a part of the application

## **SECTION 5: MAINTENANCE DOCUMENT CONSIDERATIONS**

### **5.1 AIRCRAFT ELIGIBILITY**

- (a) Aircraft may be manufactured in RVSM-compliant status.
- (b) Alternatively, aircraft may be brought into compliance through modifications approved by the State of Original Manufacture which apply to the specific aircraft type or group and, if applicable, the specific aircraft serial number, including—
  - (1) Service bulletins;
  - (2) Service letters; and/or
  - (3) STC.
- (c) The LCAA inspectors will make a determination of aircraft RVSM eligibility after reviewing substantiating documentation submitted to demonstrate compliance with the following applicable requirements—
  - (1) For aircraft not produced under type certificate in accordance with RVSM requirements—
    - (i) The LCAA inspectors ensure that the inspections and/or modifications required to meet the specified performance have been performed and documented.
  - (2) Aircraft produced under TC in accordance with RVSM requirements, the LCAA inspectors ensure that:
    - (i) RVSM eligibility is denoted in the Airplane Flight Manual (AFM) or aircraft type certificate data sheet (TCDS); and

- The determination that an aircraft is RVSM-compliant may be accomplished entirely through the examination of documents and/or data.
- Physical inspection of an airframe may not be required if the submitted documentation is sufficient.

- (ii) The initial finding of conformity with type design has been approved by the State of Original Design/Manufacture.

## **5.2 PAST PERFORMANCE**

An operating history of the aircraft to be used should be included in the application to show any events or incidents related to poor height-keeping performance that may indicate weaknesses in training, procedures, maintenance or the aircraft group of intended use.

## **5.3 AOC AIRWORTHINESS RVSM TRAINING**

AOC holders shall submit training curriculums and other appropriate material to the LCAA to show that the airworthiness standards, practices, procedures and training items related to RVSM operations are incorporated in initial and, where warranted, in the recurrent training program.

## **5.4 MINIMUM EQUIPMENT LIST**

- (a) An MEL, adopted from the MMEL, should include items pertinent to operating in RVSM airspace. 

The MEL will be coordinated with qualified the LCAA operations inspectors.
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- (b) The minimum equipment list (MEL) is evaluated for conformity to the master minimum equipment list (MMEL).
  - (i) MEL items should reflect only equipment actually installed in the operator's aircraft.
  - (ii) The MEL, if used, must incorporate RVSM required changes stated in MMEL approved by the State of Original Manufacture.

## **5.5 MAINTENANCE MANUALS**

- (a) If the operator is subject to an approved maintenance program, that program should include, for each aircraft type, the maintenance practices stated in the applicable aircraft and component manufacturers' maintenance manuals.
- (b) Additionally, for all aircraft, including those not subject to an approved maintenance program, attention should be given to the following items—
  - (1) All RVSM equipment should be maintained in accordance with the component manufacturers' maintenance instructions and the performance criteria of the RVSM approval data package.
  - (2) Any modification or design change that in any way affects the initial RVSM approval should be subject to a design review acceptable to the responsible authority.
  - (3) Any repairs not covered by approved maintenance documents that may affect the integrity of the continuing RVSM approval, e.g. those affecting the alignment of pitot/static probes, repairs to dents or deformation around static plates, should be subject to a design review acceptable to the responsible authority.
  - (4) Built-in Test Equipment (BITE) testing should not be used for system calibration unless it is shown to be acceptable by the aircraft manufacturer or an approved design organization, and with the agreement of the responsible authority.

- (5) An appropriate system leak check (or visual inspection where permitted) should be accomplished following reconnection of a quick-disconnect static line.
- (6) Airframe and static systems should be maintained in accordance with the aircraft manufacturer's inspection standards and procedures.

### **5.5.1 STRUCTURAL REPAIR MANUALS**

- (a) To ensure the proper maintenance of airframe geometry for proper surface contours and the mitigation of altimetry system error, surface measurements or skin waviness checks will need to be made, as specified by the aircraft manufacturer, to ensure adherence to RVSM tolerances.
  - (1) These checks should be performed following repairs, or alterations having an effect on airframe surface and airflow.

### **5.5.2 MAINTENANCE PRACTISES**

- (a) The maintenance and inspection program for the autopilot will need to ensure continued accuracy and integrity of the automatic altitude control system to meet the height keeping standards for RVSM operations.
  - (i) This requirement will typically be satisfied with equipment inspections and serviceability checks.
- (b) Whenever the performance of installed equipment has been demonstrated to be satisfactory for RVSM approval, the associated maintenance practices will be verified to be consistent with continued RVSM approval.
- (c) The equipment that must be considered includes, but is not limited to—
  - (1) Altitude alerting;
  - (2) Automatic altitude control system;
  - (3) Secondary surveillance radar altitude reporting equipment; and
  - (4) Altimetry systems.
- (d) Maintenance procedures should provide that aircraft identified as exhibiting height keeping performance errors that require investigation should not be operated in RVSM airspace until the following actions have been taken—
  - (1) The failure or malfunction is confirmed and isolated; and,
  - (2) Corrective action is taken as necessary and verified to support RVSM approval.
- (e) Evaluate maintenance training as additional instruction may be necessary to support RVSM approval. Areas that may need to be highlighted for initial and recurrent training of relevant personnel are—
  - (1) Aircraft geometric inspection techniques.
  - (2) Test equipment calibration and use of that equipment.
  - (3) Any special instructions or procedures introduced for RVSM approval.
- (f) Test equipment should have the capability to demonstrate continuing compliance with all the parameters established in the data package for RVSM approval or as approved by the responsible authority.
  - (1) Test equipment should be calibrated at periodic intervals using reference standards whose calibration is certified as being traceable to national standards acceptable to the LCAA.

### 5.5.3 ILLUSTRATED PARTS CATALOGS

Illustrated parts catalogs must contain references for all equipment in the aircraft that relates to RVSM requirements.

## 5.6 RVSM MAINTENANCE PROGRAM

- (a) The application for authorization to operate within RVSM airspace must include an approved RVSM maintenance program.
- (b) The maintenance program should reflect manufacturer recommended or other approved frequencies for—
  - (1) Maintenance
  - (2) Preventative Maintenance, and
  - (3) Inspection

This program must outline procedures to maintain aircraft in accordance with the requirements of—

- LCARs Part 09 and
- The Manufacturers MPD and MMEL.

### 5.6.1 DEVELOPING AN RVSM MAINTENANCE PROGRAM

- (a) Operators without an approved aircraft maintenance program are required to develop and obtain approval of an RVSM maintenance program.
  - (1) The approved RVSM maintenance program is not required to include elements not related to RVSM maintenance.
  - (2) Inspection programs such as an Approved Aircraft Inspection Program (AAIP) or manufacturer's recommended inspection program do not satisfy the RVSM requirements unless they contain procedures to maintain RVSM aircraft.
  - (3) Operators who maintain their aircraft under a continuous airworthiness maintenance program (CAMP) may choose to incorporate RVSM maintenance requirements into the program.

### 5.6.2 RVSM MAINTENANCE COMPONENTS

- (a) Each RVSM maintenance program must include the following—
  - (1) Identification of components considered to be RVSM critical, and identification of structural areas noted as RVSM critical areas.
  - (2) The name or title of the responsible person who will ensure that the aircraft is maintained in accordance with LCAR requirements.
  - (3) The method the operator will use to ensure that all personnel performing maintenance on the RVSM system are properly trained, qualified, and knowledgeable of that specific system.
  - (4) The method the operator will use to notify the crew if the aircraft has been restricted from RVSM but is airworthy for an intended flight.
  - (5) The method the operator will use to ensure conformance to the RVSM maintenance standards, including the use of calibrated and appropriate test equipment and a quality assurance program for ensuring continuing accuracy and reliability of test equipment, especially when outsourced.

Approved RVSM Maintenance program elements are specific to the operator and aircraft and are not transferable.

- (6) The method the operator will use to verify that components and parts are eligible for installation in the RVSM system, as well as to prevent ineligible components or parts from being installed.
- (7) The method the operator will use to return an aircraft to service after maintenance has been performed on an RVSM component/system or after the aircraft was determined to be non-compliant.
- (8) Periodic inspections, functional flight tests, and maintenance and inspection procedures with acceptable maintenance practices for ensuring continued compliance with the RVSM aircraft requirements.
- (9) These elements may be listed in detail or described by reference to an acceptable program that is identified and controlled by revision or issue number.
- (10) The need for functional flight tests may be only be required for repairs or modifications that are deemed to warrant such testing and may be accomplished through monitoring height-keeping performance.
- (11) The maintenance requirements listed in Instructions for Continued Airworthiness (ICA) associated with any RVSM associated component or modification.
- (12) Any other maintenance requirement that needs to be incorporated to ensure continued compliance with RVSM requirements.

## **5.7 QUALITY ASSURANCE**

- (a) The approved maintenance program should include an effective quality control program with attention to the following—
  - (1) Definition of required test equipment accuracy.
  - (2) Regular calibrations of test equipment traceable to a master standard. Determination of the calibration interval should be a function of the stability of the test equipment. The calibration interval should be established using historical data so that degradation is small in relation to the required accuracy.
  - (3) Regular audits of calibration facilities both in-house and outside.
  - (4) Adherence to approved maintenance practices.
  - (5) Procedures for controlling operator errors and unusual environmental conditions that may affect calibration accuracy.
  - (6) Illustrated Parts Catalogues.

## **5.8 SERVICE PROVIDERS**

- (a) Each maintenance services provider will be evaluated for capability to support an RVSM maintenance program.
- (b) Quality assurance programs must include provisions to audit these service providers periodically.

Operators using the services of an Approved Maintenance Organizations (AMO) must include provisions to ensure that the requirements of their RVSM programs are being met.

## SECTION 6: OPERATIONS DOCUMENT CONSIDERATIONS

### 6.1 OPERATIONS MANUALS & CHECKLISTS

- (a) Aircraft operations manuals and checklists should be revised to include information and guidance on standard operating procedures (SOP) applicable to conducting flight in RVSM airspace including TCAS considerations in—
- (1) Level flight; and
  - (2) Climbing; or
  - (3) Descending
- (b) Manuals should also include a statement of the airspeeds, altitudes and weights considered in RVSM aircraft approval to include identification of any operating restrictions established for that aircraft group.
- (1) For example, an aircraft is restricted from conducting RVSM operations in areas of the full RVSM envelope where the value of mean ASE exceeds 120 ft. (37 m) and/or the absolute value of mean ASE plus three standard deviations of ASE exceed 245 ft. (75 m).
  - (2) When such a restriction is established, it should be identified in the data package and documented in appropriate aircraft operating manuals; however, visual or aural warning/indication systems are not be required to be installed on the aircraft.
- (c) Practices and procedures should be standardized using the guidelines described in the appendices to this AC for each of the following—
- (1) Flight planning,
  - (2) Aircraft pre-flight procedures for each flight,
  - (3) Procedures prior to RVSM airspace entry,
  - (4) In-flight procedures and
  - (5) Contingencies.

- Certain items may already be adequately addressed in existing operator training programs.
- New technologies may also eliminate the need for certain crew actions.
- If this is found to be the case, then the intent of this guidance can be considered to be met

### 6.2 TRAINING PROGRAM & CURRICULUMS

#### 6.2.1 AOC OPERATIONS RVSM TRAINING

- (a) AOC holders shall submit training curriculums and other appropriate material to the LCAA to show that the operating practices, procedures and training items related to RVSM operations are incorporated in initial and, where warranted, in the recurrent training program.
- (1) Training for flight dispatchers shall also be included.

#### 6.2.2 GENERAL AVIATION COMPETENCY

General aviation operators shall demonstrate to the LCAA through oral or written tests that their knowledge of RVSM operating practices and procedures is equivalent to AOC holders and is sufficient to warrant granting required approval to conduct RVSM operations.

### **6.2.3 MINIMUM TRAINING REQUIREMENTS**

- (a) At a minimum, the following items should also be included in RVSM flight crew training programs—
- (1) Regulatory requirements pertaining to flight operations in RVSM Airspace;
    - (i) With particular emphasis on distinctions between requirements in each proposed area of RVSM operations.
  - (2) Knowledge and understanding of standard ATC phraseology used in each area of operations;
  - (3) Cockpit scan, resource coordination and cross-check procedures;
  - (4) Accuracy limitations when using standby altimeters;
  - (5) Visual perception of other aircraft at 1,000 ft. (300 m);
  - (6) Planned separation during night conditions, when encountering local phenomena such as northern lights, for opposite and same direction traffic and during turns;
  - (7) Characteristics of aircraft altitude capture systems that may lead to the occurrences of over- or undershoots;
  - (8) TCAS considerations, particularly during climbs/descents in RVSM airspace;
  - (9) Relationship between the altimetry, automatic altitude control and transponder systems in normal and abnormal situations;
  - (10) Aircraft operating restrictions (if required for the specific aircraft group) related to RVSM airworthiness approval;
  - (11) Contingency procedures in the event of equipment failures, including reporting procedures in the event of altitude errors exceeding requirements;
  - (12) Post Flight and Maintenance Discrepancy Reporting Procedures.

### **6.3 MONITORING PROGRAM**

- (a) A program to monitor or verify aircraft height-keeping performance is considered a necessary element of RVSM implementation for at least the initial area where RVSM is implemented.
- (1) Verification/monitoring programs have the primary objective of observing and evaluating aircraft height-keeping performance to validate crew procedures, aircraft performance and maintenance procedures.
  - (2) Each aircraft or group of aircraft is required to receive HMU or GPU approval to confirm the aircraft meets RVSM performance criteria before operational approval is given.
  - (3) Arrangements may be accomplished by contacting an approved GMU monitoring vendor; e.g. ARINC Inc., Annapolis, Maryland, USA (telephone 410-266-4931 or fax 410-573-3007). The ARINC website is <http://www.arinc.com> for additional information.

## SECTION 7: MONITORING RVSM STANDARDS

### 7.1 OPERATOR REPORTING

- (a) The purpose of this section is to provide guidance to AOC Holders in the means utilized by Aviation Safety Inspectors to monitor and maintain RVSM standards.
- (b) The incidence of height keeping errors that can be tolerated in an RVSM environment is small—
  - (1) Each operator is expected to take immediate action to rectify conditions that cause an altitude keeping error.
  - (2) The operator should report an occurrence involving poor height keeping to the responsible authority within 72 hours.
    - (i) The report should include an initial analysis of causal factors and measures taken to prevent repeat occurrences
    - (ii) The assigned inspector will determine any need for follow up reports.
- (c) Occurrences that should be reported and investigated are errors of—
  - (1) TVE equal to or greater than  $\pm 90$  m ( $\pm 300$  ft.);
  - (2) ASE equal to or greater than  $\pm 75$  m ( $\pm 245$  ft.); and
  - (3) Assigned altitude deviation equal to or greater than  $\pm 90$  m ( $\pm 300$  ft.).

### 7.2 HEIGHT KEEPING ERRORS

- (a) Height keeping errors fall into two broad categories—
  - (1) Errors caused by malfunction of aircraft equipment; and
  - (2) Operational errors.
- (b) The LCAA inspector will review all reports submitted by the organization to—
  - (1) Evaluate trends;
  - (2) Evaluate margin of error;
  - (3) Assess reported corrective actions;
  - (4) Assess results of corrective action and any follow-up that may be necessary;
  - (5) Confirm that the operator has procedures in place that provide an effective, timely response to each height keeping error;
  - (6) Review the calibration of precision test equipment used in the maintenance of instruments and systems relating to RVSM to ensure that all equipment is within the required tolerances; and
  - (7) Review the training records for employees involved in the maintenance/inspection of the RVSM systems to ensure all are current and complete.



## SECTION 8: REMOVAL OF RVSM AUTHORITY

- (a) Operators should make an effective, timely response to each height-keeping error.
  - (1) The LCAA may consider removing RVSM operational approval if the operator's response to a height-keeping error is not effective or timely.
- (b) The LCAA will consider the operator's past performance in determining the action to be taken. If an operator shows a history of operational and/or airworthiness errors, then approval may be removed until the root causes of these errors are shown to be
  - (1) Corrected,
  - (2) Eliminated; and
  - (3) RVSM program and procedures are restored to an effective status.
- (c) An operator that experiences repeated altitude keeping errors should have approval for RVSM operations suspended or revoked until the required reliability can be achieved.
- (d) If a problem is identified which is related to a specific aircraft type, then RVSM approval may be suspended or revoked for that specific type within that operator's fleet.
- (e) In order to maintain RVSM approval, the operator must satisfy the LCAA that the causes of height keeping errors are understood, are consistently monitored and addressed, and that the operator's RVSM programs and procedures are effective.
  - (1) At its discretion and to restore confidence, the LCAA may require an independent height monitoring check of affected aircraft be performed.

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## APPENDIX A

# Normal Operating Procedures for Operating in RVSM Airspace

### 1. General

The following is draft guidance for a wide variety of operator types and therefore, certain items have been included for purposes of readability and completeness.

- Certain items may already be adequately standardized in the existing aircraft operator training program and operating practices.
- New technologies may also eliminate the need for certain crew actions.
- If this is found to be the case, then the intent of this guidance has been met.

### 2. Flight Planning

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

- Verifying that the aircraft is approved for RVSM operations,
- Reported and forecast weather conditions on the route of flight,
- Minimum equipment requirements pertaining to height-keeping systems, and
- If required for the specific aircraft group, account for any aircraft operating restriction related to RVSM airworthiness approval.

### 3. Aircraft Pre-flight Procedures

(a) The following actions should be accomplished during pre-flight—

- (1) Review maintenance logs and forms to ascertain the condition of equipment required for flight in RVSM airspace.

◆ Ensure that maintenance action has been taken to correct any defects to required equipment.

- (2) During external inspection of the aircraft, confirm—

- ◆ Condition of static sources
- ◆ Condition of the fuselage skin in the vicinity of each static source, and
- ◆ Any other component that affects altimetry system accuracy

The external inspection of the aircraft may be accomplished by a qualified and authorized person other than the pilot such as a flight engineer.

### 4. Before Takeoff

(a) The following actions should be accomplished during pre-flight—

- (1) Aircraft altimeters should be set to the local altimeter (QNH) setting and should display a known elevation (e.g. field elevation) within the limits specified in aircraft operating manuals.

An alternative procedure using QFE may also be used.

- (2) The two primary altimeters should also agree within the limits specified by the aircraft operating manual.

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

- (b) Before take-off, the equipment required for flight in RVSM airspace should be operational and any indication of malfunction should be resolved.

## **5. Prior to RVSM Airspace Entry**

- (a) The following equipment should be operating normally at entry into RVSM airspace—

- (1) Two primary altitude measurement systems
- (2) One automatic altitude-control system
- (3) One altitude-alerting device
- (4) Operating Transponder.

Should any of the required equipment fail prior to the aircraft entering RVSM airspace, the pilot should request a new clearance so as to avoid flight in this airspace.

## **6. In-flight Procedures**

- (a) The following policies should be incorporated into flight crew training and procedures—

- (1) Flight crews should comply with aircraft operating restrictions (if required for the specific aircraft group) related to RVSM airworthiness approval.
- (2) Emphasis should be placed on promptly setting the sub-scale on all primary and standby altimeters to 29.92 in Hg/1013.2 mb (Hp) when passing the transition altitude and rechecking for proper altimeter setting when reaching the initial cruising flight level (CFL).
- (3) In level cruise it is essential that the aircraft maintains the CFL.
  - ◆ This requires that particular care is taken to ensure that ATC clearances are fully understood and followed.
  - ◆ Except in contingency or emergency situations, the aircraft should not intentionally depart from CFL without a positive clearance from ATC.
- (4) During transitions between flight levels, the aircraft should not be allowed to overshoot or undershoot the assigned flight level by more than 150 ft. (45 m).
- (5) An automatic altitude-control system shall be operative and engaged during level cruise, except when circumstances such as the need to re-trim the aircraft or turbulence require disengagement.
  - ◆ Adherence to cruise altitude should be done by reference to one of the two primary altimeters
- (6) The altitude-alerting system shall be operational
- (7) At intervals of approximately one hour, cross-checks between the primary altimeters should be made.
  - (i) A minimum of two should agree within 200ft (60m).
  - (ii) Failure to meet this condition will require that the altimetry system be reported as defective and ATC must be notified.
- (8) Crosscheck procedures include—

Refer to Appendix B: Contingency Procedures when altimeter cross-check unsatisfactory.

- ◆ The normal pilot scan of cockpit instruments should suffice for altimeter cross-checking on most flights.
  - ◆ At least the initial altimeter crosscheck in the vicinity of the point of maximum range of ICAO standard nav aids (VOR/NDB) should be recorded (e.g. on coast out).
  - ◆ The readings of the primary and standby altimeters should be recorded and available for use in contingency situations.
- (9) It is recommended that the climb or descent be accomplished using a vertical speed of 500 fpm or less and that level off be accomplished using the altitude capture feature of the automatic altitude-control system.
- (10) Normally, the altimetry system being used to control the aircraft should be selected to provide the input to the altitude-reporting transponder transmitting information to ATC.
- An operating transponder may not be required for entry into all designated RVSM airspace
- (11) If the pilot is advised that the aircraft has been identified by a height-monitoring system as exhibiting a TVE greater than 300 ft. (90 m) and/or ASE greater than 245 ft. (75 m) then the pilot should follow established regional procedures to protect the safe operations of the aircraft.
- ◆ This assumes that the monitoring system will identify TVE or ASE within agreed levels of accuracy and confidence.
  - ◆ If the pilot is notified by ATC of an AAD error that exceeds 300 ft. (90 m) then the pilot should take action to return to the CFL as quickly as possible.

*End of Appendix A*

## APPENDIX B

# Contingency Procedures for Operating in RVSM Airspace

### 1. Objective

(a) The guidance material is presented in this appendix to give pilots guidance on actions to take under certain conditions of equipment failure and encounters with turbulence.

- It also describes the expected ATC controller actions in these situations.
- Although contingency procedures are generally the same worldwide, each operator must be aware of the specifics for his/her area of operation.

ICAO Doc 7030, *Regional Supplementary Procedures*, is the primary reference document for contingency procedures.

(b) The following paragraphs deal with contingencies affecting the ability of the aircraft to properly operate in RVSM airspace.

- In addition to emergency conditions that require immediate descent, such as loss of thrust or pressurization, ATC should be made aware of the less explicit conditions that may make it impossible for an aircraft to maintain its CFL appropriate to RVSM.
- Controllers should react to such conditions but these actions cannot be specified, as they will be dynamically affected by the real-time situation.

### 2. ATC-Pilot Coordination

(a) The pilot should notify ATC of contingencies (equipment failures, weather conditions) which affect the ability to maintain the CFL and coordinate a plan of action.

(b) Examples of instances in which ATC should be notified—

- Failure of all automatic altitude-control systems; aboard the aircraft
- Loss of redundancy of altimetry systems
- Loss of thrust on an engine necessitating descent
- Turbulence greater than Moderate, or
- Any equipment failure affecting the ability to maintain CFL

The pilot and controller will use judgement to determine the action most appropriate to any given situation.

### 3. Equipment Failures

(a) For certain equipment failures, the safest course of action may be for the aircraft to continue in RVSM airspace while the pilot and controller take precautionary action to protect separation.

(b) For extreme cases of equipment failure, the safest course of action may be for the aircraft to leave RVSM airspace by—

- (1) Obtaining a revised ATC clearance; or
- (2) If unable to obtain prior ATC clearance, executing the established contingency maneuver to leave RVSM Airspace (climb or descend).

## **4. Unable to Contact ATC**

- (a) If unable to notify ATC and obtain an ATC clearance prior to deviating from the assigned CFL, the pilot should—
- (1) Follow established contingency procedures; and
  - (2) Obtain ATC clearance as soon as possible.

## **5. Post Flight**

- (a) In making maintenance log book entries against malfunctions in height-keeping systems, the pilot should provide sufficient detail to enable maintenance personnel to effectively troubleshoot and repair the system.
- (1) The pilot should describe the actual defect and the crew action taken to try to isolate and rectify the fault.
  - (2) The following information should be noted when appropriate—
    - ◆ Primary and standby altimeter readings
    - ◆ Altitude selector setting
    - ◆ Subscale setting on altimeter
    - ◆ Autopilot used to control the aeroplane and any differences when the alternate system was selected
    - ◆ Differences in altimeter readings if alternate static ports selected
    - ◆ Use of air data computer selector for fault diagnosis procedure
    - ◆ Transponder selected to provide altitude information to ATC and any difference if alternate transponder or altitude source was manually selected.

## **6. Contingency Scenarios**

(a) **Scenario— Loss of all automatic altitude control systems.**

- (1) Initial actions. The pilot should—
  - ◆ Maintain CFL manually
  - ◆ Evaluate the aircraft's capability to maintain altitude through manual control.
  - ◆ Notify ATC of the failure and the intended course of action.
- (2) Subsequent actions.
  - ◆ Provided that the aircraft can maintain the CFL, continue in RVSM airspace
  - ◆ If the aircraft cannot maintain flight level and/or ATC cannot establish increased vertical, longitudinal or lateral separation, request clearance to climb above or descend below RVSM airspace.

(3) Expected ATC actions. ATC can be expected to—

- ◆ Obtain the pilot's intentions,
- ◆ Establish increased vertical, longitudinal or lateral separation, and
- ◆ Pass traffic information to other aircraft.
- ◆ If the pilot requests a clearance to exit RVSM airspace, accommodate expeditiously.

All scenarios—

- If increased vertical, longitudinal or lateral separation cannot be established and it is not possible to comply with the pilot's request for clearance to exit RVSM airspace, ATC can be expected to notify other aircraft in the vicinity and continue to monitor the situation.
- In this situation, the pilot may need to execute his emergency authority to protect the safety of the aircraft by flying the established contingency procedures to leave the assigned route or track and advise adjoining ATC facilities/sectors of the situation.

(4) If unable to contact ATC, the pilot should—

- ◆ Watch for conflicting traffic
- ◆ Alert nearby aircraft by making maximum use of exterior lights, and
- ◆ Broadcast position, flight level and immediate intentions on 121.5 Mhz (refer to en route publications for back-up frequency)
- ◆ If prior ATC clearance cannot be obtained and the aircraft cannot maintain level, execute ICAO Doc. 7030 contingency maneuver to leave the assigned route or track.

(b) Scenario— Primary altimeters diverge by more than  $\pm 200$  ft. (60 m) or altimetry system failure

(1) Initial actions. The pilot should—

- ◆ Attempt to determine the defective system through established trouble-shooting procedures and/or comparing the primary altimeter displays to the standby altimeter (using correction cards, if required),
- ◆ If the defective system can be determined, couple the functioning altimetry system to another altitude keeping device, or
- ◆ If it cannot be determined which system is defective, maintain altitude by reference to Global Positioning System (GPS) information as may be depicted in INS or Flight Management System.
- ◆ Notify ATC

(2) Expected ATC actions. ATC can be expected to—

- ◆ Obtain the pilot's intentions,
- ◆ Establish increased vertical, longitudinal or lateral separation
- ◆ Pass traffic information to other aircraft.
- ◆ If the pilot requests a clearance to exit RVSM airspace, accommodate expeditiously.

(3) If unable to contact ATC—

- ◆ Watch for conflicting traffic
- ◆ Alert nearby aircraft by making maximum use of exterior lights, and
- ◆ Broadcast position, flight level and immediate intentions on 121.5 Mhz (refer to en route publications for back-up frequency)
- ◆ If prior ATC clearance cannot be obtained and the aircraft cannot confirm flight level, execute ICAO Doc. 7030 contingency maneuver to leave RVSM airspace.

(c) Scenario— Aircraft encounters turbulence (greater than moderate) which the pilot believes will impact the aircraft's capability to maintain flight level.

- (1) Initial actions. The pilot should—
    - ◆ Notify ATC as soon as possible and request flight level change if necessary, or
    - ◆ If the aircraft cannot maintain flight level and/or ATC cannot establish increased vertical, longitudinal or lateral separation, request clearance to climb above or descend below RVSM airspace.
    - ◆ Watch for conflicting traffic and make maximum use of exterior lights
  - (2) Expected ATC actions. ATC can be expected to—
    - ◆ Obtain the pilot's intentions,
    - ◆ If the pilot intends to continue in RVSM airspace, establish increased vertical, longitudinal or lateral separation
    - ◆ Pass traffic information to other aircraft.
    - ◆ If the pilot requests a clearance to exit RVSM airspace, accommodate expeditiously.
  - (3) If unable to contact ATC, the pilot should—
    - ◆ Watch for conflicting traffic
    - ◆ Alert nearby aircraft by making maximum use of exterior lights, and
    - ◆ Broadcast position, flight level and immediate intentions on 121.5 Mhz (refer to en route publications for back-up frequency)
    - ◆ If prior ATC clearance cannot be obtained and the aircraft cannot maintain level, execute ICAO Doc. 7030 contingency maneuver to leave the assigned route or track.
- (d) **Transponder Failure in RVSM Airspace or Transition Areas.**
- The specific actions that ATC will take in the event of transponder failure in RVSM transition areas is determined by regulatory requirements of the specific provider State.