



## Civil Aviation Authority of Sri Lanka

### AVIATION SAFETY NOTICE

ASN No: 095	Ref No: OPS/2006/07	File Ref: OP/03/01/03/03
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- Recipients:
1. Holders of Air Operator Certificates issued by DGCA, for International Commercial Air Transport Operations
  2. Prospective applicants for Air Operator Certificates for International Commercial Air Transport Operations.
01. Subject : **Requirements for Approval of Reduced Vertical Separation Minimum (RVSM) as per ASN 046 paragraph 2.4.**
02. Nature : Compulsory
03. Issue No : 01
04. Status : Supplement to ASN 046.
05. Effective Date : With immediate effect
06. Validity : Until further notice
07. Contact Person : Inquiries may be directed, preferably by letter to, Deputy Director (Operations), Civil Aviation Authority, No. 64, Galle Road, Colombo 3, Sri Lanka. Telephone: 94 11 2399534
08. Availability : A copy of this document is available for reference at the technical library of the Civil Aviation Authority. Copies can be collected at reproduction cost.
09. Applicability : Holders of Air Operator Certificates issued by DGCA for International Commercial Air Transport Operations.
10. Comments : Comments (if any) on the contents of this Aviation Safety Notice may be forwarded to the contact person. However the Aviation Safety Notice will come into effect on the date shown therein notwithstanding any objection or comment made by any person or party unless and until an amendment to the Aviation Safety Notice is issued afresh by the Director General.
11. Notice : Any operator who is engaged in International Commercial Air Transport Operation under an Air Operator Certificate issued by Director General of Civil Aviation Sri Lanka shall comply with the requirements in this attachment hereto.
12. History of Revision : Nil



## **REDUCED VERTICAL SEPARATION MINIMUM (RVSM) APPROVAL REQUIREMENTS**

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## **REDUCED VERTICAL SEPARATION MINIMUM (RVSM) APPROVAL REQUIREMENTS**

### **1. Purpose:**

This document stipulates the requirements that should be complied with by Aircraft Operators holding Aircraft Operator Certificates issued by the Director General of Civil Aviation Sri Lanka to receive approval for the conduct of flights in airspace or on routes at FL 290 and above where a vertical separation minimum (VSM) of 1000 ft is applied in airspace designated as Reduced Vertical Separation Minimum (RVSM) airspace. These requirements are applicable in respect of RVSM *airworthiness approvals* and *RVSM operational approvals* for Sri Lankan operators who operate either Sri Lanka registered or foreign registered aircraft.

### **2. Scope:**

The requirements specified in this document are applicable for RVSM airworthiness approvals/validation for Sri Lanka /foreign registered aircraft and RVSM operational approvals for Sri Lankan operators operating with Sri Lanka registered or foreign aircraft. It also provides:

- Sri Lankan aircraft owners and operators with comprehensive information on means of gaining airworthiness and operational approvals for RVSM operations.
- Sufficient knowledge to flight crew on RVSM operations to enable them to conduct operations safely.

### **3. References:**

An applicant for RVSM on the Implementation of a 300 m (1,000 ft) Vertical Separation Minimum shall be familiar with the following documents:

- a) ICAO Doc. 9574, Manual Between FL 290 - FL 410 Inclusive.
- b) ICAO Doc. 7030, Special Procedures for RVSM in-Flight Contingencies for Individual ICAO Regions
- c) Federal Aviation Administration (FAA) -91-RVSM (Change 1) Interim Guidance Material on the Approval of Operators/Aircraft for RVSM Operations.

### **4. Definitions and Abbreviations:**

The following definitions are intended to clarify certain specialized terms used in this document.

- a) Aircraft Group: A group of aircraft that are of nominally identical design and built with respect to all details that could influence the accuracy of height keeping performance (refer section 8.2.2 for further explanation).
- b) Altimetry System Error (ASE): 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.
- c) Assigned Altitude Deviation (AAD): The difference between the transponder Mode C altitude and the assigned altitude/flight level.
- d) Automatic Altitude Control System: Any system, which is designed to automatically control the aircraft to a referenced pressure altitude.
- e) Avionics Error (AVE): 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.
- f) Basic RVSM Envelope: The range of Mach numbers and gross weights within the altitude ranges FL 290 to FL 410 (or maximum available altitude where an aircraft can reasonably be expected to operate most frequently (refer section 8.2.4 (b)).
- g) Full RVSM Envelope: The entire range of operational Mach numbers, w/d, and altitude values over which the aircraft can be operated within RVSM airspace (refer section 8.2.4(a)).

- h) Height-Keeping Capability: Aircraft height-keeping performance, which can be expected under nominal environmental operating conditions with proper aircraft operating practices and maintenance.
- i) Height-Keeping Performance: The observed performance of an aircraft with respect to adherence to a flight level.
- i) Non-Group Aircraft: An aircraft for which the operator applies for approval based on the characteristics of the unique airframe rather than on a group basis (refer [section 8.2.3](#) for further explanation).
- j) Residual Static Source Error: The amount by which static source error (SSE) remains under-corrected or overcorrected after the application of SSEC.
- k) Static Source Error (SSE): The difference between the pressure sensed by the static system at the static port and the undisturbed ambient pressure.
- l) Static Source Error Correction (SSEC): A correction for static source error.
- m) Total Vertical Error (TVE): Vertical geometric difference between the actual pressure altitude flown by an aircraft and its assigned pressure altitude (flight level).
- n) W/? : Aircraft weight (W), divided by the atmospheric pressure (?) ratio,

### Abbreviations

- a) **AAD** Assigned Altitude Deviation
- b) **AFM** Aircraft Flight Manual
- c) **APARMO** Asia Pacific Approvals Registry and Monitoring Organization
- d) **ASE** Altimetry System Error
- e) **ATC** Air Traffic Control
- f) **AVE** Avionics Error
- g) **BITE** Built-In Test Equipment
- h) **ANO** Air Navigation Order
- i) **CARs** Civil Aviation Regulations
- j) **CAA** Civil Aviation Authority
- k) **DFDR** Digital Flight Data Recorder
- l) **FIF** Flight Information Form
- m) **FIR** Flight Information Region
- n) **FL** Flight Level
- o) **GPS** Global Positioning System (of the United States)
- p) **GMS** GPS-Based (Height) Monitoring System
- q) **GMU** GPS Monitoring Unit
- r) **hPa** Hectopascals
- s) **ICAO** International Civil Aviation Organization
- t) **in.Hg** Inches of Mercury
- u) **MAAR** Monitoring Agency for Asian Region
- v) **MASPS** Minimum Aviation System Performance Specification
- w) **MEL** Minimum Equipment List
- x) **MMEL** Master Minimum Equipment List
- y) **MMO/VMO** Maximum Operating Limit Speed
- z) **MNPS** Minimum Navigation Performance Specification
- aa) **NAT** North Atlantic (airspace)
- bb) **OIF** Operator Information Form
- cc) **QFE** Atmospheric pressure at aerodrome elevation (or at runway threshold)
- dd) **QNH** Altimeter sub-scale setting to obtain elevation when on the ground
- ee) **RGCSP** Review of the General Concept of Separation Panel
- ff) **RSS** Root-Sum-Square
- gg) **RVSM** Reduced Vertical Separation Minimum
- hh) **SSE** Static Source Error
- ii) **SSEC** Static Source Error Correction
- jj) **SSR** Secondary Surveillance Radar
- kk) **TC** Type Certificate

ll) <b>TVE</b>	Total Vertical Error
mm) <b>VSM</b>	Vertical Separation Minimum
nn) <b>W</b>	Aircraft Weight
oo) <b>3SD</b>	Three standard deviations

## 5. The Approval Process

### 5.1. General

Airspace where RVSM is applied shall be considered special qualification airspace. Sri Lankan operators and the aircraft they intend operating in the RVSM airspace shall be approved by DGCA before an operator engage in operation of flights in RVSM airspace.

### 5.2. Approval of Aircraft:

Each aircraft that a Sri Lankan operator intends operating in RVSM airspace shall have an RVSM airworthiness approval or an RVSM foreign airworthiness approval before an RVSM operational approval is granted by DGCA.

#### 5.2.1. RVSM Airworthiness Approval

An RVSM airworthiness approval, in the context of this document, is a written approval granted by DGCA for a Sri Lankan aircraft (i.e. an aircraft registered in Sri Lanka) indicating that it is suitable to be operated in RVSM airspace.

#### 5.2.2. RVSM Foreign Airworthiness Approval

An RVSM foreign airworthiness approval is an approval granted for a foreign aircraft by a competent authority of the country in which the aircraft is registered indicating that the aircraft is suitable to be operated in RVSM airspace. Section 8 provides guidance for the approval of aircraft that have already entered service and for newly built aircraft. An operator requesting approval may apply to the Director (Flight Safety) to determine/coordinate the process for RVSM approval.

### 5.3. Approval of Operator: Operational Approval

#### 5.3.1. RVSM Operational Approval

RVSM operational approval, in the context of this document, is a written approval granted by DGCA to operate the aircraft specified in the certificate of approval in RVSM airspace. Section 9 contains guidance on the operational procedures and programmes, which an operator shall adopt for RVSM operation. Operators shall submit these programmes to DGCA at least 60 days prior to proposed date of operation.

## 6. RVSM Performance

### 6.1. General

The statistical performance statements of ICAO Doc. 9574 for a population of aircraft have been translated into airworthiness standards by assessment of the characteristics of Altimetry System errors (ASE) and altitude control. The standards in this document (ASN) are consistent with the requirements of RVSM.

### 6.2. RVSM Flight Envelopes

For the purposes of RVSM approval, the aircraft flight envelope may be considered in two parts: the Basic RVSM Envelope and the Full RVSM Envelope (the parameters for these envelopes are detailed in section 8.2.4). The Basic RVSM Envelope is the part of the flight envelope where aircraft operate the majority of time. The Full RVSM Envelope includes parts of the flight envelope where the aircraft operates less frequently and where a larger ASE tolerance is allowed (refer sections 6.3.3 and 6.3.4).

### 6.3. Altimetry System Error (ASE)

#### 6.3.1. Factors Affecting ASE

In order to evaluate a system against the ASE performance statements, it is necessary to quantify the mean and three standard deviation values for ASE, expressed as ASE mean and ASE - 3SD (three standard deviations). In order to do this, it is necessary to take into account the different ways in which variations in ASE can arise. The factors that affect ASE are:

- (a) Unit to unit variability of avionics;
- (b) Effect of environmental operating conditions on avionics;
- (c) Airframe to airframe variability of static source error; and
- (d) Effect of flight operating condition on static source error.

#### 6.3.2. Assessment

The assessment of ASE mean and ASE -3SD, whether based on measured or predicted data, must, therefore, cover section 6.3.1. The effect of section 6.3.1d) as a variable factor can be eliminated by evaluating ASE at the most adverse flight condition in an RVSM flight envelope.

#### 6.3.3. Basic RVSM Envelope

The requirements in the Basic RVSM Envelope are:

- (a) At the point in the Basic RVSM Envelope where mean ASE reaches its largest absolute value, the absolute value shall not exceed 80 ft (25 m); and
- (b) At the point in the Basic RVSM Envelope where mean ASE plus three standard deviations of ASE reaches its largest absolute value, the absolute value shall not exceed 200 ft (60 m).

#### 6.3.4. Full RVSM Envelope

The requirements in the Full RVSM Envelope are:

- (a) At the point in the Full RVSM Envelope where mean ASE reaches its largest absolute value, the absolute value shall not exceed 120 ft (37 m);
- (b) At the point in the Full RVSM Envelope where mean ASE plus three standard deviations of ASE reaches its largest absolute value, the absolute value shall not exceed 245 ft (75 m); and;
- (c) If necessary, for the purpose of achieving RVSM approval for an aircraft group, an operating restriction may be established to restrict aircraft from conducting RVSM operations in areas of the Full RVSM Envelope where the absolute 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). When such a restriction is established, it shall be identified in the data package and documented in appropriate aircraft operating manuals, however, visual or aural warning/indication systems shall not be required to be installed on the aircraft.

#### 6.3.5. Aircraft Types

Aircraft types for which application for type certification or major change in type design is made after 1 January 1997 shall meet the criteria established for the Basic RVSM Envelope in the Full RVSM Envelope (refer section 6.3.3).

#### 6.3.6. Interpretation of ICAO Requirements

The standards of sections 6.3.3, 6.3.4, and 6.3.5 may not apply to non-group aircraft approval because there can be no group data with which to develop airframe-to-airframe variability. Therefore, a single ASE value is established that controls the simple sum of the altimetry system errors. In order to control the overall population distribution, this limit is set at a value less than that for group approval. Accordingly the standard for aircraft submitted for approval as non-group aircraft, as defined in section 8.2.3 is:

- (a) For all conditions in the Basic RVSM Envelope:  
Residual static source error + worst case avionics 160 ft (50 m)

(b) For all conditions in the Full RVSM Envelope:

Residual static source error + worst case avionics 200 ft (60 m)

**Note:** Worst-case avionics means that combination of tolerance values, specified by the manufacturer for the altimetry fit into the aircraft, which gives the largest combined absolute value for residual SSE plus avionics errors.

#### 6.4. Altitude Keeping

An automatic altitude control system is required and must be capable of controlling altitude within  $\pm 65$  ft ( $\pm 20$  m) about the acquired altitude when operated in straight and level flight under non-turbulent, non-gust conditions.

**Note:** Aircraft types for which application for type certification or major change in type design is made prior to 1 January 1997 which are equipped with automatic altitude control systems with flight management system/performance management system inputs allowing variations up to  $\pm 130$  ft ( $\pm 40$  m) under non-turbulent, non-gust conditions do not require retrofit or design alteration.

### 7. Aircraft Systems

#### 7.1. Equipment For RVSM Operations (Details required with application by Airworthiness Section)

The minimum equipment fit is:

- (a) Two independent altitude measurement systems. Each system shall comprise of the following elements:
  - (i) Cross-coupled static source/system, provided with ice protection if located in areas subject to ice accretion;
  - (ii) Equipment for measuring static pressure sensed by the static source, converting it to pressure altitude and displaying the pressure altitude to the flight crew;
  - (iii) Equipment for providing a digitally coded signal corresponding to the displayed pressure altitude, for automatic altitude reporting purposes;
  - (iv) SSEC, if needed to meet the performance requirements of sections 6.3.3, 6.3.4, or 6.3.6(a) and (b), as appropriate; and
  - (v) The equipment fit shall provide reference signals for automatic control and alerting at selected altitude. These signals shall preferably be derived from an altitude measurement system meeting the full requirements of this document, but must in all cases enable the requirements of sections 7.2.6 and 7.3 to be met.
- (b) One Secondary Surveillance Radar (SSR) altitude reporting transponder. If only one is fitted, it shall have the capability for switching to operate from either altitude measurement system;
- (c) An altitude alert system; and
- (d) An automatic altitude control system.

#### 7.2. Altimetry

##### 7.2.1. System Definition

The altimetry system of an aircraft comprises all those elements involved in the process of sampling free stream static pressure and converting it to a pressure altitude output.

The elements of the altimetry system fall into two main groups:

- (a) Airframe plus static sources; and
- (b) Avionics and/or instruments.

##### 7.2.2. Altimetry System Outputs

The following altimetry system outputs are significant for RVSM operations:

- (a) Pressure altitude (Baro Corrected) display;
- (b) Pressure altitude reporting data; and
- (c) Pressure altitude or pressure altitude deviation for an automatic altitude control device.

**7.2.3. Altimetry System Accuracy**

The total system accuracy shall satisfy the requirements of sections 6.3.3, 6.3.4 or 6.3.6 (a) and (b), as appropriate.

**7.2.4. Static Source Error Correction (SSEC)**

If the design and characteristics of the aircraft and altimetry system are such that the standards of sections 6.3.3, 6.3.4, or 6.3.6 (a) and (b) are not satisfied by the location and geometry of the static sources alone, then suitable SSEC shall be applied automatically within the avionics part of the altimetry system. The design aim for static source error correction, whether aerodynamic/geometric or avionics, shall be to produce a minimum residual static source error, but in all cases it shall lead to satisfaction of the above standards, as appropriate.

**7.2.5. Altitude Reporting Capability**

The aircraft altimetry system shall provide an output to the aircraft transponder.

**7.2.6. Altitude Control Output**

The requirements are:

- (a) The altimetry system shall provide an output, which can be used by an automatic altitude control system to control the aircraft at a commanded altitude. The output may be used either directly or combined with other sensor signals. If SSEC is necessary in order to satisfy the requirements of sections 6.3.4, 6.3.4 or 6.3.6(a) and (b) of this ANO, then an equivalent SSEC must be applied to the altitude control output. The output may be an altitude deviation signal, relative to the selected altitude, or a suitable absolute altitude output; and
- (b) Whatever the system architecture and SSEC system the difference between the output to the altitude control system and the altitude displayed must be kept to the minimum.

**7.2.7. Altimetry System Integrity**

During the RVSM approval process it must be verified analytically that the predicted rate of occurrence of undetected altimetry system failures does not exceed  $1 \times 10^{-5}$  per flight hour. All failures and failure combinations whose occurrence would not be evident from cross-cockpit checks, and which would lead to altitude measurement/display errors outside the specified limits, need to be assessed against this budget. No other failures or failure combinations need to be considered.

**7.3. Altitude Alert**

The altitude deviation warning system must signal an alert when the altitude displayed to the flight crew deviates from selected altitude by more than a nominal value. For aircraft for which application for type certification or major change in type design is made before 1 January 1997, the nominal value shall not be greater than  $\pm 300$  ft ( $\pm 90$  m). For aircraft for which application for type certification or major change in type design is made after 1 January 1997, the nominal value shall not be greater than  $\pm 200$  ft ( $\pm 60$  m). The overall equipment tolerance in implementing these nominal threshold values shall not exceed  $\pm 50$  ft ( $\pm 15$  m).

**7.4. Automatic Altitude Control System**

- a) As a minimum, a single automatic altitude control system must be installed which is capable of controlling aircraft height within a tolerance band of  $\pm 65$  ft ( $\pm 20$  m) about the acquired altitude when the aircraft is operated in straight and level flight under non-turbulent, non-gust conditions.

**Note:** Aircraft types for which application for type certificates was made prior to 1 January 1997, which are equipped with automatic altitude control system with flight management system/performance management system inputs which allow variations up to  $\pm 130$  ft ( $\pm 40$  m) under non-turbulent, non-gust conditions do not require retrofit or design alteration.

- b) Where an altitude select/acquire function is provided, the altitude select/acquire control panel must be configured such that an error of no more than  $\pm 25$  ft ( $\pm 8$  m) exists between the display selected by the flight crew and the corresponding output to the control system.

## 8. RVSM Airworthiness Approval

### 8.1. General

Obtaining RVSM airworthiness approval is a two-stage process, which may involve more than one authority:

- a) In the case of a newly built aircraft, the aircraft manufacturer develops and submits the performance and analytical data that supports the RVSM airworthiness approval of a defined build standard to the responsible Authority of the State of Manufacture. The data will be supplemented with maintenance and repair manuals giving associated continued airworthiness instructions. Compliance with RVSM criteria will be stated in the Aircraft Flight Manual (AFM) including reference to the applicable build standard, related conditions and limitations. Approval by the responsible authority, and, where applicable, validation of that approval by other authorities, indicates acceptance of newly built aircraft, conforming to that type and build standard, as complying with the RVSM airworthiness criteria; and,
- b) In the case of an aircraft already in service, the aircraft constructor (or an approved design organization), submits to the responsible Authority, either in the state of manufacture or the state in which the aircraft is registered, the performance and analytical data that supports RVSM airworthiness approval of a defined build standard. The data will be supplemented with a Service Bulletin, or its equivalent, that identifies the work to be done to achieve the build standard, continued airworthiness instructions, and an amendment to the AFM stating related conditions and limitations. Approval by the responsible Authority, and, where applicable, validation of that approval by other Authorities, indicates acceptance of that aircraft type and build standard as complying with the RVSM airworthiness criteria.
- c) For the second step, an aircraft operator shall apply to the DGCA Sri Lanka for Sri Lanka registered aircraft in which the aircraft is registered for airworthiness approval of specific aircraft. The application shall be supported by evidence confirming that the specific aircraft has been inspected and, where necessary, modified in accordance with applicable Service Bulletins, and is of a type and build standard that meets the RVSM airworthiness criteria. The operator shall confirm that the continued airworthiness instructions are available and that the approved AFM amendment or supplement has been incorporated. Approval will indicate that the aircraft is suitable for RVSM operations. The DGCA will notify the designated monitoring agency (MAAR) accordingly.

### 8.2. Contents of the Data Package

The combination of performance and analytical data, Service Bulletin(s) or equivalent, continued airworthiness instructions, and the approved amendment or supplement to the AFM is known as the RVSM approval data package.

#### 8.2.1. Scope

As a minimum, the data package shall consist of the following:

- a) A definition of the aircraft group or non-group aircraft to which the data package applies;
- b) A definition of the flight envelope(s) applicable to the subject aircraft;
- c) The data needed to show compliance with the requirements of sections 6 and 7;
- d) The compliance procedures to be used to ensure that all aircraft submitted for airworthiness approval meet RVSM requirements; and
- e) The engineering data to be used to ensure continued in-service RVSM approval integrity.

### 8.2.2. Aircraft Group

For aircraft to be considered as members of a group for purposes of RVSM approval, they shall satisfy all of the following conditions:

- a) Aircraft shall have been manufactured to a nominally identical design and be approved by the same Type Certificate (TC), TC amendment, or Supplemental TC, as applicable;
- b) The static system of each aircraft shall be installed in a nominally identical manner and position. The same SSE corrections shall be incorporated in all aircraft of the group;
- c) The avionics units installed on each aircraft to meet the minimum RVSM equipment requirements of section 7.1 shall be manufactured to the manufacturer's same specification and have the same part number; and
- d) The RVSM data package shall have been produced or provided by the airframe manufacturer or design organization.

**Note 1:** For derivative aircraft it may be possible to utilize the database from the parent configuration to minimize the amount of additional data required to show compliance. The extent of additional data required will depend on the nature of the changes between the parent aircraft and the derivative aircraft.

**Note 2:** Aircraft, which have avionics units that are of a different manufacturer or part number, may be considered part of the group, if it is demonstrated that this standard of avionics equipment provides equivalent system performance.

### 8.2.3. Non-Group Aircraft

If an airframe does not meet the conditions of section 8.2.2 to qualify as a member of a group or is presented as an individual airframe for approval, then it must be considered as a non-group aircraft for the purposes of RVSM approval.

### 8.2.4. Flight Envelopes

The RVSM flight envelope is defined as the Mach number, Gross Weight and altitude ranges over which an aircraft can be operated in cruising flight within the RVSM airspace. As noted in section 6.2, the RVSM operational flight envelope for any aircraft may be divided into two zones as defined below.

#### a) Full RVSM Envelope

The Full RVSM Envelope shall comprise the entire range of operational Mach number and altitude values over which the aircraft can be operated within RVSM airspace. Parameters that shall be considered are:

	Lower Boundary is Identified by	Upper Boundary is defined by
<b>Altitude</b>	FL 290	The lower of the following: <ul style="list-style-type: none"> <li>• FL 410</li> <li>• Aircraft maximum certified altitude</li> <li>• Altitude limited by cruise thrust, buffet, other aircraft flight limitations</li> </ul>
<b>Mach or Airspeed</b>	The lower of the following: <ul style="list-style-type: none"> <li>• Maximum endurance (holding) speed</li> <li>• Maneuver Speed</li> </ul>	MMO/VMO <ul style="list-style-type: none"> <li>• Speed limited by cruise thrust, buffet, other aircraft flight limitations</li> </ul>
<b>Gross Weight</b>	<ul style="list-style-type: none"> <li>• The lowest gross weight compatible with operation in RVSM airspace</li> </ul>	<ul style="list-style-type: none"> <li>• The highest gross weight compatible with operation in RVSM airspace</li> </ul>

#### (b) Basic RVSM Envelope

- i) The boundaries for the Basic RVSM Envelope are the same as those for the Full RVSM Envelope except in regard to the upper Mach boundary.

- ii) For the Basic RVSM Envelope, the upper Mach boundary may be limited to a range of airspeeds over which the aircraft group can reasonably be expected to operate most frequently. The manufacturer or design organization shall declare this boundary for each aircraft group. The boundary may be defined as equal to the upper Mach/airspeed boundary defined for the Full RVSM Envelope or a specified lower value. This lower value shall not be less than the Long Range Cruise Mach Number plus 0.04 Mach, unless limited by available cruise thrust, buffet, or other aircraft flight limitations.

**Note:** Long Range Cruise Mach number is the Mach for 99% of best fuel mileage at the particular gross Weight under consideration.

### 8.2.5. Data Package Requirements

The data package shall contain data sufficient to substantiate that the accuracy standards of section 6 are met.

#### a) General

- i) Altimetry System Error (ASE) will generally vary with flight condition. The data package shall provide coverage of the RVSM envelope sufficient to define the largest errors in the basic and full RVSM envelopes. Note that in the case of group approval the worst flight condition may be different for each of the requirements of sections 6.3.3 and 6.3.4 and each shall be evaluated.
  - ii) Where precision flight calibrations are used to quantify or verify altimetry system performance they may be accomplished by any of the following methods. Flight calibrations shall only be performed once appropriate ground checks have been completed. Uncertainties in application of the method must be assessed and taken into account in the data package. The methods are:
    - Precision tracking radar in conjunction with pressure calibration of atmosphere at test altitude;
    - Trailing cone;
    - Pacer aircraft; or
    - Any other method acceptable to DGCA.
- b) Altimetry System Error Budget: It is implicit in the intent of section 6.3, for group approvals and for non-group approvals that a trade may be made between the various error sources, which contribute to ASE. Separate limits are not specified for the various error sources, which contribute to the mean and variable components of ASE as long as the overall ASE accuracy requirements are met. In all cases the trade-off adopted shall be presented in the data package in the form of an error budget, which includes all significant error sources.
- c) Avionics: Avionics equipment shall be identified by function and part number. It shall be demonstrated that the avionics equipment can meet the requirements established according to the error budget when the equipment is operated in the environmental conditions expected to be met during RVSM operations.
- d) Groups of Aircraft: Where approval is sought for an aircraft group, the data package shall be sufficient to show that the requirements of sections 6.3.3 and 6.3.4 are met. Because of the statistical nature of these requirements, the content of the data package may vary considerably from group to group.
- i) The mean and airframe-to-airframe variability of ASE shall be established based on precision flight test calibration of a number of aircraft. Where analytical methods are available, it may be possible to enhance the flight test database and to track subsequent change in the mean and variability based on geometric inspections and bench test or any other method acceptable to the approving authority. In the case of derivative aircraft it may be possible to utilize data from the parent as part of the database.

- ii) An assessment of the aircraft-to-aircraft variability of each error source shall be made. The error assessment may take various forms as appropriate to the nature and magnitude of the source and the type of data available. For some error sources (especially small ones) it may be acceptable to use specification values to represent 3SD. For other error sources (especially larger ones) a more comprehensive assessment may be required; this is especially true for airframe error sources where 'specification' values of ASE contribution may not have been previously established.
  - iii) In many cases one or more of the major ASE error sources will be aerodynamic in nature (such as variations in the aircraft surface contour in the vicinity of the static pressure source). If evaluation of these errors is based on geometric measurements, substantiation shall be provided that the methodology used is adequate to ensure compliance.
  - iv) An error budget shall be established to ensure that the standards of sections 6.3.3 and 6.3.4 are met. The worst flight condition may be different for each of these standards and therefore the component error values may also be different.
  - v) In showing compliance with the overall requirements, the component error sources shall be combined in an appropriate manner. In most cases this will involve the algebraic summation of the mean components of the errors, Root-Sum-Square (RSS) combination of the variable components of the errors, and summation of the RSS value with the absolute value of the overall mean. Care shall be taken those only variable component error sources, which are independent of each other, are combined by RSS.
- e) Non-Group Aircraft: Where an aircraft is submitted for approval as a non-group aircraft, the data shall be sufficient to show that the requirements of section 6.3.6(a) and (b) are met. The data package shall specify how the ASE budget has been allocated between residual SSE and avionics error. The following data shall be established.
- i) Precision flight-test calibration of the aircraft to establish its ASE or SSE over the RVSM envelope shall be required. Flight calibration shall be performed at points in the flight envelope(s) as agreed by the certifying authority. One of the methods prescribed in section 8.2.5(a) (ii) shall be used.
  - ii) Calibration of the avionics used in the flight test as required to establish residual SSE. The number of test points shall be agreed by the certifying authority. Since the purpose of the flight test is to determine the residual SSE, specially calibrated altimetry equipment may be used.
  - iii) Specifications for the installed altimetry avionics equipment indicating the largest allowable errors will be presented.
  - iv) Using sections 8.2.5(e)(i) to 8.2.5(e)(iii) above demonstrate that the requirements of section 6.3.6(a) and (b) are met. If subsequent to aircraft approval for RVSM operation avionics units, which are of a different manufacturer or part number, are fitted, it shall be demonstrated that the standard of avionics equipment provides equivalent altimetry system performance.

#### **8.2.6. Compliance Procedures**

The data package shall include a definition of the procedures, inspections/tests and limits which will be used to ensure that all aircraft approved against the data package 'conform to type', and that all future approvals, whether of newly built or in-service aircraft, meet the budget allowances developed according to section 8.2.5(b). The budget allowances will be established by the data package and include a methodology that allows for tracking the mean and SD for newly built aircraft. Compliance requirements must be defined for each potential source of error.

#### **8.2.7. Operating Restrictions**

Where an operating restriction has been adopted (section 6.3.4(c)), the package shall contain data and information necessary to document and establish that restriction.

### **8.2.8. Continued Airworthiness**

For the purposes of continued airworthiness:

- a) The following items shall be reviewed and updated as appropriate to include the effects of RVSM implementation:
  - i) Aircraft Maintenance Manual
  - ii) The Structural Repair Manual with special attention to the areas around the static source, angle of attack sensors and doors if their rigging can affect airflow around the previously mentioned sensors; and
  - iii) The Master Minimum Equipment List (MMEL)/MEL; and
- b) The data package shall include descriptions of any special procedures which are not covered in section 8.2.8(a) but may be needed to ensure continued compliance with RVSM requirements as follows:
  - i) For non-group aircraft where airworthiness approval has been based on flight test, the continuing integrity and accuracy of the altimetry system shall be demonstrated by periodic ground and flight tests of the aircraft and its altimetry system at periods to be agreed with the approving authority. However, alleviation of the flight test requirement may be given if it can be adequately demonstrated that the relationship between any subsequent airframe/system degradation and its effects on altimetry system accuracy is understood and adequately compensated/corrected for;
  - ii) To the extent possible, in-flight defect reporting procedures shall be defined to facilitate identification of altimetry system error sources. Such procedures could cover acceptable differences between primary and alternate static sources, and others as appropriate; and
  - iii) For groups of aircraft where approval is based on geometric inspection, there may be a need for periodic re-inspection, and the interval required shall be specified.

### **8.3. RVSM Airworthiness Approval**

All necessary data shall be submitted to the DGCA for action. The approved data package shall be used by the operator to demonstrate compliance with RVSM performance standards.

### **8.4. Post-Approval Modification**

Any variation/modification from the initial installation that affects RVSM approval shall require clearance by the airframe manufacturer or approved design organization and be cleared with DGCA to show that RVSM compliance has not been impaired.

## **9. Continued Airworthiness (Maintenance Requirements)**

### **9.1. General**

The integrity of the design features necessary to ensure that altimetry systems continue to meet RVSM standards shall be verified by scheduled tests and/or inspections in conjunction with an approved maintenance program. The operator shall review its maintenance procedures and address all aspects of continuing airworthiness, which are affected by RVSM requirements. Each operator shall demonstrate that adequate maintenance facilities are available to ensure continued compliance with the RVSM maintenance requirements.

### **9.2. Maintenance Program Approval Requirements**

Each operator requesting an RVSM operational approval shall submit a maintenance and inspection program which includes any maintenance requirements defined in the approved data package as part of a continued airworthiness maintenance program approval or an equivalent program approved by DGCA.

### 9.3. Maintenance Documents Requirements

The following items shall be reviewed as appropriate for RVSM maintenance approval:

- (a) Maintenance Manuals;
- (b) Structural Repair Manuals;
- (c) Standards Practices Manuals;
- (d) Illustrated Parts Catalogues;
- (e) Maintenance Schedule;
- (f) MMEL/MEL;
- (g) Maintenance Control Manuals; and
- (h) Equipment Lists/Wiring Diagram Manuals.

### 9.4. Maintenance Practices

If the operator is subject to an ongoing approved maintenance program, that program shall contain the maintenance practices outlined in the applicable aircraft and component manufacturer's maintenance manuals for each aircraft type. The following items shall be reviewed for compliance and if the operator is not subject to an approved maintenance program the following items shall be followed:

- a) All RVSM equipment shall be maintained in accordance with the component manufacturer's maintenance requirements and the performance requirements outlined in the approved data package;
- b) Any modification, repair, or design change, which in any way alters the initial RVSM approval, shall be subject to a design review by persons approved by the DGCA ;
- c) Any maintenance practices which may affect the continuing RVSM approval integrity, e.g. the alignment of pitot /static probes, dents, or deformation around static plates, shall be referred to DGCA or to persons delegated by DGCA;
- d) Built-In Test Equipment (BITE) testing is not an acceptable basis for system calibrations, (unless it is shown to be acceptable by the airframe manufacturer with DGCA s agreement) and shall only be used for fault isolation and troubleshooting purposes;
- e) Some aircraft manufacturers have determined that the removal and replacement of components utilizing quick disconnects and associated fittings, when properly connected, will not require a leak check. While this approach may allow the aircraft to meet static system certification standards when properly connected, it does not always ensure the integrity of the fittings and connectors, nor does it confirm system integrity during component replacement and re-connections. Therefore, a system leak check or visual inspection shall be accomplished any time a quick disconnect static line is broken;
- f) Airframe and static systems shall be maintained in accordance with the airframe manufacturer's inspection standards and procedures;
- g) 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 shall be made if needed to ensure adherence to the airframe manufacturer's RVSM tolerances. These tests and inspections shall be performed as established by the airframe manufacturer. These checks shall also be performed following repairs, or alterations having an effect of airframe surface and airflow;
- h) The maintenance and inspection program for the autopilot shall ensure continued accuracy and integrity of the automatic altitude control system to meet the height-keeping standards for RVSM operations. This requirement will typically be satisfied with equipment inspections and serviceability checks; and
- i) Where the performance of existing equipment is demonstrated as being satisfactory for RVSM approval, it shall be verified that the existing maintenance practices are also consistent with continued RVSM approval integrity.

## 9.5. Maintenance Practices for Non-Compliant Aircraft

Those aircraft positively identified as exhibiting height-keeping performance errors that require investigation as specified in section 10.9 (para 1) shall not be operated in airspace where RVSM is applied until the following actions have been taken:

- (a) The failure or malfunction is confirmed and isolated by maintenance action; and
- (b) Corrective action is carried out as required to comply with section 8.2.5(d)(vi) and verified to ensure RVSM approval integrity.

## 9.6. Maintenance Training Requirements

Training requirements shall be provided for RVSM approvals processes. Areas that may need to be highlighted for initial and recurrent training of maintenance personnel are:

- a) Aircraft geometric inspection techniques;
- b) Test equipment calibration/usage techniques; and
- c) Any special documentation or procedures introduced by RVSM approval.

## 9.7. Test Equipment

### 9.7.1. General

The test equipment shall have the capability to demonstrate continuing compliance with all the parameters established for RVSM approval in the initial data package or as approved by the approving authority.

### 9.7.2. Standards

Test equipment shall be calibrated utilizing reference standards whose calibration is certified as being traceable to the national standard. It shall be calibrated at periodic intervals as accepted by the DGCA. The approved maintenance program shall encompass an effective quality control program, which includes the following:

- a) Definition of required test equipment accuracy;
- b) Regular calibrations of test equipment traceable to a master in-house standard. Determination of calibration interval shall be a function of the stability of the test equipment. The calibration interval shall be established on the basis of historical data so that degradation is small in relation to the required accuracy;
- c) Regular audits of calibration facilities both in-house and outside;
- d) Adherence to acceptable maintenance practices; and
- e) Procedures for controlling operator errors and unusual environmental conditions which may affect calibration accuracy.

## 10. RVSM Operational Approval

### 10.1. Purpose and Organization

Section 5 described, in general terms, the administrative process which an operator shall follow to receive approval to operate an aircraft in RVSM airspace - the application, DGCA's evaluation of the application, and the granting of an approval to operate. This section provides detailed information on the content of operational programs, practices and procedures, and on the operational approval process.

### 10.2. General

#### 10.2.1. DGCA Responsibilities

DGCA will ensure that each operator can demonstrate that the operator's aircraft can maintain high levels of height-keeping performance. DGCA must be satisfied on operational programs for adequacy. Flight crew training as well as operations manuals will be evaluated by Operations Sections of the CAA.

### **10.2.2. RVSM Operational Approval**

RVSM operational approval covers not only the operator but also each individual aircraft group and each individual aircraft to be used by the operator in RVSM operations. Each aircraft must have received an RVSM airworthiness approval in accordance with section 9 or have a current RVSM foreign airworthiness approval before it will be listed on an operator's RVSM operational approval in the respective Aircraft Operator Certificate.

### **10.3. Content of Operator RVSM Application**

An operator applying for RVSM approval shall provide to Director (Flight Safety) the following for review and evaluation at least 60 days prior to the intended start of RVSM operations

#### **10.3.1. Airworthiness Documents**

Sufficient documentation shall be available to show that the aircraft has been issued with an RVSM airworthiness approval.

- (a) In-service aircraft: Documents that contain the inspections and/or modifications which are required to make an in-service aircraft RVSM compliant can take the form of approved Service Bulletins, Aircraft Service Changes, Supplemental Type Certificates or any other format that CAA finds acceptable;
- (b) In-production or new-production aircraft: For such aircraft, statements of eligibility to conduct RVSM operations can be included in the AFM. Also, Type Certificate Data Sheets can be used to show RVSM eligibility by describing RVSM related avionics configurations and continued airworthiness criteria or providing reference to DGCA approved documentation in the form of a report. Eligibility can be shown in any other format found acceptable to DGCA. In the case of a foreign registered aircraft with an RVSM foreign airworthiness approval, evidence shall be produced to show that the approval is current.

#### **10.3.2. Description of Aircraft Equipment**

The applicant shall provide a configuration list, which details all components and equipment relevant to RVSM operations (section 6 discusses equipment for RVSM operations).

#### **10.3.3. Operations Training Programs & Operating Practices/ Procedures**

Operators shall submit training syllabi and other appropriate material to DGCA to show that the operating practices and procedures and training items related to RVSM operations are incorporated in initial and, where warranted, recurrent training programs (training for operations control or dispatch personnel shall be included, where appropriate). The DGCA:

- a) May evaluate a training course prior to accepting a training certificate;
- b) May accept a statement in the operator's application that the operator will ensure that its pilots will be knowledgeable on RVSM procedures contained in Appendix 1; or
- c) May accept a statement by the operator that it has or will conduct an in-house training program. Practices and procedures in the following areas shall be standardized using the guidelines of Appendix 1:
  - Flight planning;
  - Pre-flight procedures at the aircraft for each flight;
  - Procedures prior to RVSM airspace entry;
  - In-flight procedures; and
  - Flight crew training procedures.

Also, flight crew and, where applicable, operations control and flight dispatchers shall be knowledgeable on contingency and other procedures unique to specific areas of operation.

#### **10.3.4. Operations Manuals and Checklists**

The appropriate manuals and checklists shall be revised to include information/guidance on the standard operating procedures detailed in Appendix 1. Appropriate manuals shall 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 (refer section 6.3.4(c)). Manuals and checklists shall be submitted for DGCA review as part of the application process.

**10.3.5. Past Performance**

An operating history shall be included in the application. The applicant shall show 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.

**10.3.6. Minimum Equipment List**

A MEL, based on the MMEL, shall include items pertinent to operating in RVSM airspace.

**10.3.7. Maintenance Programme**

The operator shall submit a maintenance program for approval in accordance with section 9 at the time the operator applies for operational approval.

**10.3.8. Plan for participation in Verifications/Monitoring Program**

The operator shall provide a plan for participation in the verification or monitoring program. This program shall normally entail a check of at least a portion of the operator's aircraft by an independent height-monitoring system (refer to section 10.8 for verification/monitoring programs).

**10.4. DGCA Review and Evaluation of Applications**

Once the application has been submitted, DGCA will begin the process of review and evaluation. If the content of the application is insufficient, DGCA will ask for additional information from the operator. When all the airworthiness and operational requirements of the application are met, DGCA will proceed with the approval process.

**10.5. Validation Flight (s)**

In some cases, the review of the RVSM application and programs may suffice for validation purposes. However, the final step of the approval process may be the completion of a validation flight. DGCA Inspectors (Operations & Airworthiness) may accompany the operator on a flight through airspace where RVSM is applied to verify that operations and maintenance procedures and practices are applied effectively.

**10.6. Approvals**

Two approvals will be issued: an RVSM airworthiness approval and an RVSM operational approval. They may be issued at the same time, but an RVSM operational approval will only be issued if the RVSM airworthiness approval or RVSM foreign airworthiness approval are in force. The approvals will take the form of a certificate and will identify the operator, each individual aircraft the approval covers, and any conditions on the approval (e.g. height monitoring program to be completed within a specified time of the approval being issued).

**10.7. Verification/Monitoring Programs****10.7.1. General**

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. A height-monitoring system based on Global Positioning System (GPS) satellites or an earth-based system may fulfill this function.

**10.7.2. Monitoring Agency for Asian Region (MAAR)**

MAAR is the agency responsible for this function in the Asian region. Current RVSM minimum monitoring requirements and information on GMS flights are detailed in MAAR website <http://www.aerothai.co.th/maar>. It is anticipated that the necessity for such programs may be diminished or possibly eliminated after confidence is gained that RVSM programs are working as planned. MAAR website has all the necessary Forms i.e. F1 & F2 and guidance for procedure to be followed for monitoring programme. MAAR website subject material is not included in this document as it is likely to change. Monitoring can only be undertaken after DGCA has issued an RVSM approval for the aircraft or group of aircraft.

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## **10.8. Conditions for Removal of RVSM Approval**

### **10.8.1. Height-Keeping Errors and Operator Responsibilities**

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 shall also report the event to DGCA within 24 hours with initial analysis of causal factors and measures to prevent further events. DGCA will determine the requirement for follow-up reports.

### **10.8.2. Types of Errors**

Errors that shall be reported and investigated are:

- TVE equal to or greater than  $\pm 300$  ft ( $\pm 90$  m),
- ASE equal to or greater than  $\pm 245$  ft ( $\pm 75$  m), and
- AAD equal to or greater than  $\pm 300$  ft ( $\pm 90$  m).

Height-keeping errors fall into two broad categories: errors caused by malfunction of aircraft equipment and operational errors. An operator showing a history of errors of either variety may be required to forfeit approval for RVSM operations. If a problem is identified which is related to one specific aircraft type, the RVSM approval may be suspended/cancelled for that specific type.

### **10.8.3. DGCA Actions**

The operator shall make an effective, timely response to each height-keeping error. DGCA may consider suspending/canceling an operator's RVSM operational approval if the operator's response to a height-keeping error is unsatisfactory. DGCA 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, 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.

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**11. Example Operator Application**

The operator shall use the following sample cover letter for requesting for RVSM approval.

Date:

Director General of Civil Aviation,  
64, Galle Road,  
Colombo 03.

**Subject:** Application for Approval for Operation of Aircraft under Reduced Vertical Separation Minimum (RVSM) condition.

**Reference:** CAA Aviation Safety Notice No. 095 issue No.(*current issue no*) as Guidance Material on the Reduced Vertical Separation Minimum (RVSM) Approval Requirements.

(*Name of the Airline*) requests approval of DGCA-SL to conduct flight operations as specified in the following table.

In support of this request, we have prepared the attached approval package. This document has been developed in accordance with the requirements of the referenced guidance material. In addition, this document will satisfy all requirements for issuance of approved Operations Specifications authorizing RVSM operations utilizing aircraft mentioned in the table, as outlined in the ASN.

1. Name of airspace area
2. Flight Levels
3. Vertical Separation
4. Aircraft

(signature)  
CTO/CEO

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## Appendix A

### Training Programs and Operating Practices/Procedures

#### 1. Introduction

Flight crew will need to have an awareness of the criteria for operating in RVSM airspace and be trained accordingly. The items detailed in sections 2 to 7 of this appendix shall be standardized and incorporated into training programs and operating practices and procedures. Certain items may already be adequately standardized in existing procedures.

#### 2. Flight Planning

During flight planning the flight crew shall 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 & alerting systems;
- (d) Any airframe or operating restriction related to RVSM approval.

#### 3. Pre-Flight Procedures at the Aircraft for Each Flight

The following actions shall be carried out during the pre-flight procedure:

- a) Review technical logs and forms to determine the condition of equipment required for flight in RVSM airspace. Ensure that maintenance action has been taken to correct defects to required equipment;
- b) During the external inspection of aircraft, particular attention shall 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 authorized person other than the pilot (e.g. a flight engineer or ground engineer);
- c) Before takeoff, the aircraft altimeters shall be set to the QNH of the airfield and shall display a known altitude, within the limits specified in the aircraft operating manuals. The two primary altimeters shall also agree within limits specified by the aircraft operating manual. An alternative procedure using QFE may also be used. Any required functioning checks of altitude indicating systems shall be performed; and
- d) Before take-off, equipment required for flight in RVSM airspace shall be operative, and any indications of malfunction shall be resolved.

#### 4. In-Flight Procedures

##### 4.1 General

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

- a) Flight crew shall comply with any aircraft operating restrictions, if required for the specific aircraft group, e.g. limits on indicated Mach number, given in the RVSM airworthiness approval.
- b) Emphasis shall be placed on promptly setting the sub-scale on all primary and standby altimeters to 1013.25 hPa (29.92 in.Hg) 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 shall not intentionally depart from cleared Flight Level without a positive clearance from ATC unless the crew are conducting contingency or emergency maneuvers;
- d) When changing levels, the aircraft shall 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 altitude capture feature of the automatic altitude-control system, if installed.

- e) 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. In any event, adherence to cruise altitude shall be accomplished by reference to one of the two primary altimeters. Following loss of the automatic height keeping function, any consequential restrictions will need to be observed;
- f) Ensure that the altitude-alerting system is operative;
- g) At intervals of approximately one hour, cross-checks between the primary altimeters shall be made. A minimum of two will need to agree within  $\pm 200$  ft ( $\pm 60$  m). Failure to meet this condition will require that the altimetry system be reported as defective and notified to ATC:
  - i) The usual scan of flight deck instruments shall suffice for altimeter cross-checking on most flights;
  - (ii) Before entering RVSM airspace, the initial altimeter cross check of primary and standby altimeters shall be recorded;

**Note:** Some systems may make use of automatic altimeter comparators.

- h) In normal operations, the altimetry system being used to control the aircraft shall be selected for the input to the altitude reporting transponder transmitting information 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 TVE greater than  $\pm 300$  ft ( $\pm 90$  m) and/or an ASE greater than  $\pm 245$  ft ( $\pm 75$  m) then the pilot shall follow established regional procedures to protect the safe operation of the aircraft. This assumes that the monitoring system will identify the TVE or ASE within the set limits for accuracy; and

If the pilot is notified by ATC of an assigned altitude deviation, which exceeds  $\pm 300$  ft ( $\pm 90$  m) then the pilot shall take action to return to the cleared Flight Level as quickly as possible.

#### **4.2 Procedures Prior to RVSM Airspace Entry**

**The following equipment must be operating normally for entry into RVSM airspace:**

- a) **Two primary altitude measurement systems;**
- b) **One automatic altitude -control system;**
- c) **One altitude -alerting device; and**
- d) **An operating transponder.**

**Note:** Dual equipment requirements for altitude-control systems will be established by regional agreement after an evaluation of criteria such as mean time between failures, length of flight segments and availability of direct pilot controller communications and radar surveillance.

**Note:** An operating transponder may not be required for entry into all designated RVSM airspace. The operator shall determine the requirement for an operational transponder in each RVSM area where operations are intended. The operator shall also determine the transponder requirements for transition areas next to RVSM airspace.

**Note:** If any of the required equipment fail prior to the aircraft entering RVSM airspace, the pilot must request a new clearance to avoid entering this airspace.

#### **4.3 Contingency Procedures after Entering RVSM Airspace**

The pilot shall notify ATC of contingencies (equipment failures, weather), which affect the ability to maintain the cleared Flight Level, and co-ordinate a plan of action appropriate to the airspace concerned. Examples of equipment failures, which shall be notified, to ATC are:

- a) Failure of all automatic altitude -control systems aboard the aircraft;
- b) Loss of redundancy of altimetry systems;
- c) Loss of thrust on an engine necessitating descent; or
- d) Any other equipment failure affecting the ability to maintain cleared Flight Level; the pilot shall notify ATC when encountering greater than moderate turbulence. If unable to notify ATC and obtain an ATC clearance prior to deviating from the cleared Flight Level, the pilot shall follow any established contingency procedures and obtain ATC clearance as soon as possible.

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**5. Post-Flight Procedures**

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

- a) Primary and standby altimeter readings.
- b) Altitude selector setting.
- c) Sub-scale setting on altimeter.
- d) Autopilot used to control the aeroplane and any differences when an alternative autopilot system was selected.
- e) Differences in altimeter readings, if alternate static ports selected. Use of air data computer selector for fault diagnosis procedure.
- f) The transponder selected to provide altitude information to ATC and any difference noted.

**6. Special Emphasis Items:**

The following items shall also be included in crew training:

- a) Knowledge and understanding of standard ATC phraseology used in each area of operations;
- b) Importance of crew members cross-checking each other to ensure that ATC clearances are promptly complied with;
- c) Use and limitations in terms of accuracy of stand-by altimeters in contingencies. Where applicable, the pilot shall review the application of static source error correction/position error correction through the use of correction cards (note: such correction data will need to be readily available on the flight deck);
- d) Problems of visual perception of other aircraft at 1 000ft (300m) planned separation during night conditions, 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 the occurrence of overshoots;
- f) Relationship between altimetry, automatic altitude control, and transponder systems in normal and abnormal situations; and
- g) Any airframe operating restrictions, if required for a specific aircraft group, related to an RVSM airworthiness approval.

## Appendix - B

### Contingency Procedures

#### 1. The basic concepts for contingencies are:

- a) Guidance for contingency procedures shall not be interpreted in any way, which prejudices the final authority and responsibility of the pilot in command for the safe operation of the aircraft.
- b) If the pilot is unsure of the vertical or lateral position of the aircraft or the aircraft deviates from its assigned altitude or track for cause without prior ATC clearance, then the pilot must take action to mitigate the potential for collision with aircraft on adjacent routes or flight levels. In this situation, the pilot should alert adjacent aircraft by making maximum use of aircraft lighting and broadcasting position, flight level, and intentions on 121.5 MHz (as a back-up, the appropriate VHF inter-pilot air-to-air frequency may be used);
- c) Unless the nature of the contingency dictates otherwise, the pilot should advise ATC as soon as possible of a contingency situation and if possible, request an ATC clearance before deviating from the assigned route or flight level.
- d) If a revised ATC clearance cannot be obtained in a timely manner and action is required to avoid potential conflict with other aircraft, then the aircraft should be flown at an altitude and/or on a track where other aircraft are least likely to be encountered. This can be accomplished by offsetting from routes or altitudes normally flown in the airspace. The recommendations on the order of preference for pilot actions are:
  - i. The pilot may offset half the lateral distance between routes or tracks.
  - ii. The pilot may offset half the vertical distance between altitudes normally flown.
  - iii. The pilot may also consider descending below FL 285 or climbing above FL 410.
- e) When executing a contingency maneuver the pilot should:
  - i. Watch for conflicting traffic both visually and by reference to ACAS, if equipped.
  - ii. Continue to alert other aircraft using 121.5 MHz (as a back-up, the VHF inter-pilot air- to-air frequency may be used) and aircraft lights.
  - iii. Continue to fly offset tracks or altitudes until an ATC clearance is obtained.
  - iv. Obtain an ATC clearance as soon as possible.

#### 2. **Guidance to the Pilot (Including Expected ATC Actions) in the Event of Equipment Failures or Encounters with Turbulence after Entry into RVSM Airspace .**

- a) 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 realtime situation.
- b) **Objective:** The following material is provided with the purpose of giving the pilot 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. It is recognized that the pilot and controller will use judgment to determine the action most appropriate to any given situation. For certain equipment failures, the safest course of action may be for the aircraft to maintain the assigned FL and route while the pilot and controller take precautionary action to protect separation. For extreme cases of equipment failure, however, the safest course of action may be for the aircraft to depart from the cleared FL or route by obtaining a revised ATC clearance or if unable to obtain prior ATC clearance, executing the established contingency maneuvers for the area of operation.
- c) **Contingency Scenarios.** These scenarios summarize pilot actions to mitigate the potential for conflict with other aircraft in certain contingency situations. These should be reviewed in conjunction with the expanded contingency scenarios detailed in Paragraph 3 of the appendix, which contain additional technical and operational detail.

**Scenario 1: The pilot is:**

- 1) **Unsure of the vertical position of the aircraft due to the loss or degradation of all primary altimetry systems, or**
- 2) **Unsure of the capability to maintain CFL due to turbulence or loss of all automatic altitude control systems.**

<b>The Pilot should:</b>	
Maintain CFL while evaluating the situation; Watch for conflicting traffic both visually and by reference to ACAS, if equipped;	
If considered necessary, alert nearby aircraft by 1) Making maximum use of exterior lights; 2) Broadcasting position, FL, and intentions on 121.5MHz (as a back up, the VHF inter-pilot air-to-air frequency may be used).	
	<b>ATC can be expected to:</b>
Notify ATC of the situation and intended course of action. Possible courses of action include:	Obtain the pilot's intentions and pass essential traffic information.
1) Maintaining the CFL and route provided that ATC can provide lateral, longitudinal or conventional vertical separation.	1) If the pilot intends to continue in RVSM airspace, assess traffic situation to determine if the aircraft can be accommodated through the provision of lateral, longitudinal, or conventional vertical separation, and if so, apply the appropriate minimum.
2) Requesting ATC clearance to climb above or descend below RVSM airspace if the aircraft cannot maintain CFL and ATC cannot establish adequate separation from other aircraft.	2) If the pilot requests clearance to exit RVSM airspace, accommodate expeditiously, if possible.
3) Executing the Doc 7030 contingency maneuver to offset from the assigned track and FL, if ATC clearance cannot be obtained and the aircraft cannot maintain CFL.	3) If adequate separation cannot be established and it is not possible to comply with the pilot's request for clearance to exit RVSM airspace, advise the pilot of essential traffic information, notify other aircraft in the vicinity and continue to monitor the situation.
	4) Notify adjoining ATC facilities/sectors of the situation.

**Scenario 2: There is a failure or loss of accuracy of one primary altimetry system (e.g., greater than 200 foot difference between primary altimeters)**

<b>The Pilot should</b>
Cross check standby altimeter, confirm the accuracy of a primary altimeter system and notify ATC of the loss of redundancy. If unable to confirm primary altimeter system accuracy, follow pilot actions listed in the preceding scenario.

**3. Expanded Equipment Failure and Turbulence Encounter Scenarios:** Operators may consider this material for use in training programs.

**Scenario 1: All automatic altitude control systems fail (e.g., Automatic Altitude Hold).**

<b>The Pilot should: Initially</b>	
Maintain CFL	
Evaluate the aircraft's capability to maintain altitude through manual control.	
<b>Subsequently</b>	
Watch for conflicting traffic both visually and by reference to TCAS, if equipped.	
If considered necessary, alert nearby aircraft by	
1) Making maximum use of exterior lights;	
2) Broadcasting position, FL, and intentions on 121.5MHz (as a back-up, the VHF inter-pilot air-to-air frequency may be used.)	
Notify ATC of the failure and intended course of action. Possible courses of action include:	<b>ATC can be expected to</b>
1) Maintaining the CFL and route, provided that the aircraft can maintain level.	1) If the pilot intends to continue in RVSM airspace, assess traffic situation to determine if the aircraft can be accommodated through the provision of lateral, longitudinal, or conventional vertical separation, and if so, apply the appropriate minimum.
2) Requesting ATC clearance to climb above or descend below RVSM airspace if the aircraft cannot maintain CFL and ATC cannot establish lateral, longitudinal or conventional vertical separation.	2) If the pilot requests clearance to exit RVSM airspace, accommodate expeditiously, if possible.
3) Executing the contingency manoeuvre to offset from the assigned track and FL, if ATC clearance cannot be obtained and the aircraft cannot maintain CFL.	3) If adequate separation cannot be established and it is not possible to comply with the pilot's request for clearance to exit RVSM airspace, advise the pilot of essential traffic information, notify other aircraft in the vicinity and continue to monitor the situation.
	4) Notify adjoining ATC facilities/ sectors of the situation.

**Scenario 2: Loss of redundancy in primary altimetry systems**

<b>The Pilot should</b>	<b>ATC can be expected to</b>
If the remaining altimetry system is functioning normally, couple that system to the automatic altitude control system, notify ATC of the loss of redundancy and maintain vigilance of altitude keeping.	Acknowledge the situation and continue to monitor progress

**Scenario 3: The primary altimeters diverge by more than 200ft (60m)**

<b>The Pilot should</b>
Attempt to determine the defective system through established trouble-shooting procedures and/or comparing the primary altimeter display to the standby altimeter (as corrected by the correction cards, if required).
If the defective system can be determined, couple the functioning altimeter system to the altitude keeping device.
If the defective system cannot be determined, follow the guidance in Scenario 3 for failure or unreliable altimeter indications of all primary altimeters.

**Scenario 4: All primary altimetry systems are considered unreliable or fail:**

<b>The Pilot should</b>	
Maintain CFL by reference to the standby altimeter (if the aircraft is so equipped).	
Alert nearby aircraft by 1) Making maximum use of exterior lights; 2) Broadcasting position, FL, and intentions on 121.5 MHz (as a back-up, the VHF inter-pilot air-to-air frequency may be used).	
	<b>ATC can be expected to</b>
Consider declaring an emergency. Notify ATC of the failure and intended course of action. Possible courses of action include:	Obtain pilot's intentions, and pass essential traffic information.
1) Maintaining CFL and route provided that ATC can provide lateral, longitudinal or conventional vertical separation.	1) If the pilot intends to continue in RVSM airspace, assess traffic situation to determine if the aircraft can be accommodated through the provision of lateral, longitudinal, or conventional vertical separation, and if so, apply the appropriate minimum.
2) Requesting ATC clearance to climb above or descend below RVSM airspace if ATC cannot establish adequate separation from other aircraft.	2) If the pilot requests clearance to exit RVSM airspace, accommodate expeditiously, if possible.
3) Executing the Doc 7030 contingency maneuver to offset from the assigned track and FL, if ATC clearance cannot be obtained.	3) If adequate separation cannot be established and it is not possible to comply with the pilot's request for clearance to exit RVSM airspace, advise the pilot of essential traffic information, notify other aircraft in the vicinity and continue to monitor the situation.
	4) Notify adjoining ATC facilities/sectors of the situation.

**Scenario 5: Turbulence (greater than moderate) which the pilot believes will impact the aircraft's capability to maintain flight level.**

<b>The Pilot should</b>	
Watch for conflicting traffic both visually and by reference to TCAS, if equipped.	
If considered necessary, alert nearby aircraft by: 1) Making maximum use of exterior lights; 2) Broadcasting position, FL, and intentions on 121.5MHz (as a back-up, the VHF inter-pilot air-to-air frequency may be used).	
Notify ATC of intended course of action as soon as possible. Possible courses of action include:	<b>ATC can be expected to</b>
1) Maintaining CFL and route provided ATC can provide lateral, longitudinal or conventional vertical separation.	1) Assess traffic situation to determine if the aircraft can be accommodated through the provision of lateral, longitudinal, or conventional vertical separation, and if so, apply the appropriate minimum.
2) Requesting flight level change, if necessary.	2) If unable to provide adequate separation, advise the pilot of essential traffic information and request pilot's intentions.
3) Executing the Doc 7030 contingency maneuver to offset from the assigned track and FL, if ATC clearance cannot be obtained and the aircraft cannot maintain CFL.	3) Notify other aircraft in the vicinity and monitor the situation
	4) Notify adjoining ATC facilities/ sectors of the situation.

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**4. Special Procedures for In-Flight Contingencies Published for Individual ICAO Regions in Doc 7030.**

- a) The Doc 7030 should be considered the source document for specific contingency procedures applicable to individual ICAO regions. Doc 7030 should always be consulted before training material or manuals are developed.
- b) In-flight contingency procedures applicable to Pacific oceanic operations are published in paragraph 4.0 of the Regional Supplementary Procedures for the Pacific and the Middle East/Asia (Mid/Asia).
- c) In-flight contingency procedures applicable to NAT oceanic operations are published in paragraph 5.0 of NAT Regional Supplementary Procedures.

**5. Wake Turbulence Procedures.**

These procedures provide for the contingency use of a 2 NM lateral offset to avoid exposure to wake turbulence. The procedures are published in NOTAMS, AIPs, and Regional Supplementary Procedures. These procedures should be incorporated in pilot training programs and manuals.

**6. Transponder Failure and RVSM Transition Areas.**

Transition areas are planned to be established between airspaces where different vertical separation standards are applied. The specific actions that ATC will take in the event of transponder failure in RVSM transition areas will be determined by the provider States.

13. Related ASNs : ASN No 046

14. Action Required : For strict compliance by the holders of Air Operator Certificates engaged in International Commercial Air Transport Operations.

15 Checklist : List of current ASNs is as follows:

ASN No	Issue No	Date of Applicability	Remarks
ASN002	01	10.03.2001	nil
ASN004	01	13.02.2001	nil
ASN005	01	26.03.2001	nil
ASN007	01	15.09.2001	nil
ASN009	01	18.02.2002	nil
ASN010	01	18.02.2002	nil
ASN011	01	18.02.2002	nil
ASN012	01	18.02.2002	nil
ASN013	01	08.02.2002	nil
ASN014	01	01.03.2002	nil
ASN015	01	01.03.2002	nil
ASN016	01	01.03.2002	nil
ASN017	02	10.03.2005	Replaced Issue No. 01
ASN018	01	20.03.2002	nil
ASN019	01	01.04.2002	nil
ASN021	01	01.04.2002	nil
ASN022	01	08.04.2002	nil
ASN023	02	01.06.2002	Replaced ASN 003
ASN024	01	02.09.2002	nil
ASN025	02	15.10.2002	Replaced ASN 001
ASN026	01	15.10.2002	nil
ASN027	01	12.12.2002	nil
ASN028	01	12.03.2003	nil
ASN029	01	21.03.2002	nil
ASN030	01	10.07.2002	nil
ASN031	02	15.07.2003	Replaced ASN 006
ASN032	01	25.07.2003	nil
ASN033	02	25.08.2005	Replaced issue no 01
ASN034	01	11.09.2003	nil
ASN035	01	12.09.2003	nil
ASN036	01	12.09.2003	nil
ASN037	01	13.10.2003	nil
ASN038	01	07.06.2004	nil
ASN039	01	12.06.2004	nil
ASN040	01	07.07.2004	nil
ASN041	01	16.07.2004	nil
ASN042	02	21.12.2005	Replaced ASN 050 and 1 <sup>st</sup> issue of ASN 042
ASN043	02	12.08.2004	Amendment to ASN 013
ASN044	02	13.03.2006	Replaced issue no 01
ASN045	01	10.09.2004	nil
ASN046	01	14.09.2006	nil
ASN047	02	30.01.2006	Replaced issue no 01
ASN048	01	17.09.2004	nil
ASN049	01	20.09.2004	nil
ASN051	01	20.09.2004	nil
ASN052	01	20.09.2004	nil
ASN053	01	11.11.2004	nil
ASN054	01	01.04.2005	nil
ASN055	01	01.04.2005	nil
ASN056	01	01.12.2005	nil
ASN057	01	01.12.2005	nil

ASN058	01	01.12.2005	nil
ASN059	-	-	Not yet issued
ASN060	02	05.08.2005	Replaced issue no 01
ASN061	02	05.08.2005	Replaced issue no 01
ASN062	01	01.04.2005	nil
ASN063	01	20.12.2004	nil
ASN065	01	06.04.2005	nil
ASN066	01	16.05.2005	nil
ASN067	01	16.05.2005	nil
ASN068	01	18.05.2005	nil
ASN069	01	18.05.2005	nil
ASN070	01	18.05.2005	nil
ASN071	01	18.05.2005	nil
ASN072	01	18.05.2005	nil
ASN073	01	19.05.2005	nil
ASN074	01	19.05.2005	nil
ASN075	01	19.05.2005	nil
ASN076	01	16.06.2005	nil
ASN077	01	08.08.2005	nil
ASN078	01	21.12.2005	nil
ASN079	01	16.09.2005	nil
ASN080	01	07.11.2005	nil
ASN081	02	25.06.2006	Replaced Issue No 01
ASN082	01	23.11.2005	nil
ASN083	01	01.12.2005	nil
ASN084	01	16.12.2005	nil
ASN085	01	05.01.2006	nil
ASN086	01	06.04.2006	nil
ASN087	01	06.04.2006	nil
ASN088	01	06.04.2006	nil
ASN089	01	06.04.2006	nil
ASN090	01	02.05.2006	nil
ASN091	01	15.06.2006	nil
ASN094	01	02.06.2006	nil

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