GOVERNMENT OF INDIA
OFFICE OF THE DIRECTOR GENERAL OF CIVIL AVIATION
OPP SAFDURJUNG AIRPORT, NEW DELHI 110003

CIVIL AVIATION REQUIREMENTS
SECTION 8 – AIRCRAFT OPERATIONS
SERIES 'S', PART II
ISSUE I, 17th JANUARY, 2013 EFFECTIVE: FORTHWITH

File No: DGCA-22024/11/2023-FSD

SUBJECT: REQUIREMENTS FOR IMPLEMENTATION OF REDUCED VERTICAL SEPARATION MINIMUM (RVSM).

1. INTRODUCTION

1.1 Sub rule 3 of Rule 9 and Rule 57 of the Aircraft Rules, 1937 stipulate that every airplane shall be fitted with instrument and equipment, including radio apparatus and special equipment, as may be specified according to the use and circumstances under which the flight is to be conducted.

1.2 In the mid 1970's, the world fuel shortage and the resultant rapid increase in the fuel prices led to the growing demand for a more optimum and efficient utilization of the available airspace, emphasized the need for appraisal of the proposal to reduce the vertical separation minimum (VSM) above FL 290 from 600 m (2000 ft) to 300 m (1000 ft). Various studies by several countries revealed that a separation of 300 m (1000 ft) VSM above FL 290 is technically feasible and does not compromise with the safety of the aircraft.

1.3 Indian Airspace and neighbouring airspace has become RVSM airspace between FL 290 and FL 410, inclusive of FL 290 and FL 410 on 27thNovember, 2003.

1.4 This CAR is issued in supersession of CAR Section 2 Series ‘O’ Part XI Rev. 1 dated 24th November, 2003.

2. APPLICABILITY

2.1 This CAR is intended to provide necessary guidance for RVSM operations. It establishes an acceptable means, but not the only means, that can be used in the approval of aircraft and operators to conduct flight in airspace or on routes where Reduced Vertical Separation Minimum (RVSM) is applied. It lays down guidance and requirements on airworthiness, continuing airworthiness, and operations programs for RVSM operations.

2.2 This CAR is issued under the provisions of Rule 133A of the Aircraft Rules, 1937 for information, guidance and compliance by the concerned operators operating through and within the RVSM airspace. The contents of this CAR are consistent with the provisions of ICAO Annex 6 and ICAO Doc 9574 on the above subject.

3. DEFINITIONS:

3.1 **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.

3.2 **Altimetry System Error (ASE):** The difference between the pressure altitude displayed to the flight crew when referenced to the International Standard Atmosphere ground pressure setting (1013.25 hPa /29.92 in. Hg) and free stream pressure altitude.

3.3 **Assigned Altitude Deviation (AAD):** the difference between the transponder Mode C altitude and the assigned altitude/ flight level.

3.4 **Automatic Altitude Control System:** Any system that is designed to automatically control the aircraft to a referenced pressure altitude.

3.5 **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.

3.6 **Basic RVSM Envelope:** The range of Mach numbers and gross weights within the altitude ranges FL 290 to FL 410 (or maximum attainable) where an aircraft can reasonably be expected to operate most frequently.

3.7 **Flight Technical Error (FTE):** Difference between the altitude indicated by the altimeter display being used to control the aircraft and the assigned altitude/flight level.

3.8 **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.

3.9 **Height keeping Capability:** Aircraft height keeping performance that can be expected under nominal environmental operating conditions, with proper aircraft operating practices and maintenance.

3.10 **Height keeping Performance:** the observed performance of an aircraft with respect to adherence to a flight level.

3.11 **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.

3.12 **Residual Static Source Error:** The amount by which static source error (SSE) remains under-corrected or overcorrected after the application of SSEC.

3.13 **RVSM Airspace:** RVSM airspace is any designated airspace/route between FL 290 and FL 410 (both levels inclusive) where aircraft are separated vertically by 1000 ft (300 m)

3.14 **Static Source Error:** The difference between the pressure sensed by the static system at the static port and the undisturbed ambient pressure.

3.15 **Static Source Error Correction (SSEC):** A correction for static source error.

3.16 **Total Vertical Error (TVE):** Vertical geometric difference between the actual pressure altitude flown by an aircraft and its assigned pressure altitude (flight level).

3.17 **W/δ:** Aircraft weight, W, divided by the atmospheric pressure ratio, δ

4. BASIC REQUIREMENTS

No person shall operate Indian registered aircraft in airspace designated as Reduced Vertical Separation Minimum (RVSM) airspace unless;

4.1 The operator and the operator's aircraft comply with the requirements of this CAR;

4.2 The operator is authorised by DGCA to perform RVSM operations; and

4.3 The Operations Specifications of the Operating Permit are endorsed by DGCA, which authorizes the operator to conduct RVSM operations..

5. APPROVAL REQUIREMENTS

5.1 Airspace where RVSM is applied should be considered special qualification airspace. Both the individual aircraft and the specific aircraft type or types that the operator intends to use will need to be approved by

DGCA before the operator conducts flights in RVSM airspace. Requirements of this CAR shall be complied with for the approval of specific aircraft type or types and for airworthiness and operational approval.

5.2 Approval will encompass the following elements: -

a) Airworthiness aspects (including continued airworthiness)

b) Operational requirements

c) Provision for height monitoring of operator's aircraft

5.3 Operator shall apply for RVSM approval to Regional Airworthiness Office.

5.4 On satisfactory compliance with the requirements given in this CAR, the operator shall be given provisional approval for the specific aircraft. Approval may be regularized after the aircraft meets the Height Monitoring Performance using HMU/ GMU.

6. AIRWORTHINESS APPROVAL OF AIRCRAFT

6.1 Each aircraft type that the operator intends to use in RVSM airspace should have received RVSM airworthiness approval from the regulatory authority of country of manufacture/ design including the approval of continued airworthiness program. DGCA shall accept such RVSM approval and grant airworthiness approval to each aircraft on the compliance with the RVSM Data Packages.

6.2 RVSM Data Packages for each aircraft type/ group of aircraft shall be approved by the regulatory authority of country of manufacture/ design and may take the following form:

6.2.1 In-service Aircraft

a) Manufacturer's Service Bulletin
b) Aircraft Service Change
c) Supplemental Type Certificates
d) Airplane Flight manual

6.2.2 Aircraft manufactured as RVSM Complaint - AFM Statement of Compliance

6.3 The operator shall obtain approval from the State of Registry for each individual aircraft group and each individual aircraft to be used by the operator for RVSM operations.

6.4 Each aircraft of Indian operators shall have the airworthiness and the operational approval from the DGCA prior to it being approved for use by the operator in RVSM environment.

6.5 Each aircraft shall receive approval for continued airworthiness program prior to it being reviewed for operational approval.

7. OPERATIONAL APPROVAL

Operator is required to obtain DGCA approval to operate in airspace designated as RVSM airspace and maintain high levels of height keeping performance.

7.1 The operator shall submit operational programs including the flight crew training as well as operations manuals and check list for approval;

7.2 Each aircraft type group utilised by an operator shall be capable of height keeping performance which does not exceed a mean Total Vertical Error of 25m (80ft). DGCA may verify this by evaluating the Altimetry System Error (ASE) and Flight Technical Error (FTE) components of Total Vertical Error (TVE) separately;

7.3 The standard deviation about the mean TVE shall not exceed the following.

a) Standard Deviation (ft): $82 - 0.004z^2$ where z equals mean TVE for the aircraft type in fleet;

b) Standard Deviation (m): $25 - 0.016z^2$ where z equals mean TVE for the aircraft type in meters.

7.4 DGCA while granting operational approval shall evaluate airworthiness documents for each aircraft type group. It is necessary for the operator to demonstrate height keeping performance for the aircraft type.

7.5 If in-service experience shows that the height keeping performance of a particular aircraft type utilized by the operator does not meet the requirements of paras 6.3 and 6.4, the operator shall take steps to improve performance to the required level. If the performance is not improved, operational approval for the aircraft type may be withdrawn.

7.6 A Minimum Equipment List (MEL) adopted from the Master Minimum Equipment List (MMEL) and relevant operational regulations, should include items pertaining to the RVSM operations.

7.7 The requirements for the Flight Crew Training detailed in Annexure I shall be complied with.

8. AIRCRAFT SYSTEMS

8.1 The aircraft shall be equipped to meet the following minimum equipment for RVSM operations:

8.1.1 Two independent altitude measurement systems shall be installed.

Each system shall be composed of the following elements:

a) Cross-coupled static source/system, with ice protection if located in areas subject to ice accretion;

b) Equipment for measuring static pressure sensed by the static source, converting it to pressure altitude and displaying the pressure altitude to the flight crew;

c) Equipment for providing a digitally encoded signal corresponding to the displayed pressure altitude, for automatic altitude reporting purposes;

d) Static source error correction (SSEC)/Position Error Correction (PEC), if needed to meet the performance criteria of paras 3.3, 3.4 or 3.6 of Annexure II attached, as appropriate; and

e) Signals referenced to a pilot selected altitude for automatic control and alerting. These signals will need to be derived from altitude measurement system meeting the criteria of this CAR, and in all cases, enabling the criteria of paras 8.1.3 and 8.2.6 to be met.

8.1.2 One secondary surveillance radar transponder (meeting TSO C112 standards) with an altitude reporting system that can be connected to the altitude measurement system in use for altitude keeping.

8.1.3 Airborne Collision Avoidance System (ACAS II) (meeting TSO C119b standards) to improve the safety level of flights operating within RVSM airspace.

8.1.4 An altitude alerting system that alerts the crew aurally and visually if displayed altitude deviates from the selected altitude by more than ± 300 feet (for aircraft for which application for type certification was made on or before April 9, 1997) or ± 200 feet (for aircraft for which application for type certification is made after April 9, 1997).

8.1.5 An automatic altitude control system shall be required which shall be capable of controlling altitude within tolerance band of ± 15 metres (± 50 feet) about commanded altitude, when operated in the altitude hold mode in straight and level flight under non turbulent, non gust conditions.

8.2 Altimetry

8.2.1 System Composition

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.

b) Avionics equipment and/or instruments.

8.2.2 Altimetry System Outputs

The following altimetry system outputs are significant for RVSM operations:

a) Pressure altitude (Baro-corrected) for display.

b) Pressure altitude reporting data.

c) Pressure altitude or pressure altitude deviation for an automatic altitude control device.

8.2.3 Altimetry System Accuracy

The total system accuracy shall satisfy the criteria of paras 3.3, 3.4 or 3.6 of Annexure II attached.

8.2.4 Static Source Error Correction

If the design and characteristics of the aircraft and its altimetry system are such that the criteria of para 3.3, 3.4 or 3.6 of Annexure II are not satisfied by the location and geometry of the static sources alone, then suitable SSEC shall be applied automatically within the avionics equipment of the altimetry system.

8.2.5 Altitude Reporting Capability

The aircraft altimetry system shall provide an output to the aircraft transponder as required by applicable operating regulations.

8.2.6 Altitude Control Output

a) The altimetry system shall provide a signal that can be used by an automatic altitude control system to control the aircraft to a selected altitude. The signal may be used either directly or combined with other sensor signals. If SSEC is necessary to satisfy the criteria of paras 3.3, 3.4 or 3.6 of Annexure II, then an equivalent SSEC may be applied to the altitude control signal. The signal may be an altitude deviation signal, relative to the selected altitude or a suitable absolute altitude signal.

b) Whatever the system architecture and SSEC system, the difference between the signal output to the altitude control system and the altitude displayed to the flight crew shall be kept to the minimum.

8.2.6 Altimetry System Integrity

The RVSM approval process shall verify that the predicted rate of occurrence of undetected failure of the altimetry system does not exceed 1 x 10^{-5} per flight per 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 value. Other failures or failure combinations need not be considered.

9 PROVISION FOR MONITORING OF OPERATORS AIRCRAFT

9.1 The operator shall provide a plan for participation in the monitoring program. This program should normally entail a check of at least a portion of the operator's aircraft by an independent height monitoring system.

9.2 Monitoring of aircraft height-keeping performance may be done by either a ground based Height Monitoring Unit (HMU) or a portable GPS Height Monitoring Unit (GMU), which is carried on board the aircraft. In regions with HMUs, aircraft operators may meet the monitoring requirements without any specific action on their part, other than ensuring that the aircraft undertakes a flight with the area of coverage of an HMU within the time period within which monitoring should take place. For monitoring with the portable GMUs, operators need to arrange for a monitoring flight. Regional Monitoring Agency (RMAs) will notify operators sufficiently in advance regarding the time scales when specific aircraft require monitoring.

Note: The Regional Monitoring Agency for Asia region is known as MAAR (Monitoring Agency for Asia Region) located at Bangkok, Thailand.

9.3 A program to monitor or verify aircraft height keeping performance is a necessary element of RVSM approval process and RVSM implementation for at least the initial area where RVSM is implemented. Verification and monitoring program have the primary objective of observing and evaluating aircraft height keeping performance to gain confidence that airspace users are applying the airplane and/or operator approval process in an effective manner and that an equivalent level of safety will be maintained in when RVSM is implemented. **It is anticipated that necessity for such programs may be diminished or possibly eliminated after confidence is gained that RVSM programs are working as planned.**

10 PROCEDURE FOR GRANT OF AIRWORTHINESS APPROVAL

10.1 Grant of RVSM airworthiness approval

10.1.1 In the case of a **newly built aircraft**, the aircraft manufacturers obtain approval from the regulatory authority of the country of manufacture/design by submitting performance and analytical data supporting RVSM airworthiness approval. Compliance with the RVSM criteria shall be stated in the Aircraft Flight Manual including reference to the applicable build standard, related conditions, and limitations. The maintenance and repair manuals will give the associated airworthiness instructions.

10.1.2 In case of an aircraft **already in service**, the manufacturer shall submit the performance and analytical data to the regulatory authority of the country of manufacture/design. The data shall be supplemented with the 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 aircraft flight manual stating related conditions and limitations. Approval by the regulatory authority indicates acceptance of that aircraft type and build standard as complying with the RVSM airworthiness criteria.

10.1.3 The combination of performance and analytical data, service bulletin(s) or equivalent, continued airworthiness instructions, and the approved amendment or supplement to the Aircraft Flight Manual is known as the RVSM approval data package.

10.1.4 For airworthiness approval of specific aircraft, an aircraft operator is required to apply to DGCA. The application shall be supported by evidence that the 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 also confirm that the continued airworthiness instructions are available and that the approved Flight Manual amendment or supplement has been incorporated.

Note: For RVSM airspace where an operational approval is prescribed, airworthiness approval alone does not authorize flight in that airspace.

10.2 Contents of the RVSM approval data package - As a minimum, the data package will need to consist of the following items:

a) A statement of the aircraft group or non-group aircraft and applicable build standard to which the data package applies.

b) Definition of the applicable flight envelope(s).

c) Data showing compliance with the performance criteria of Annexure II and para 8 of this CAR.

d) The procedures to be used to ensure that all aircraft submitted for airworthiness approvals comply with RVSM criteria. These procedures will include the references of applicable service bulletin and the applicable approved aircraft flight manual amendment or supplement.

e) The maintenance instructions that ensure continued airworthiness for RVSM approval.

These items are explained further in the following paragraphs.

10.3 Aircraft Groupings

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

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.

Note: For derivative aircraft it may be possible to utilise the data from the parent configuration to minimise 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.

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 paragraph 7.1 of this CAR shall be manufactured to the manufacturer's same specification and have the same part number.

Note: Aircraft that have avionic 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 avionic equipment provides equivalent system performance.

d) The RVSM data package shall have been produced or provided by the airframe manufacturer or an approved design organisation.

10.3.2 Non-group Aircraft

If an airframe does not meet the conditions of paragraphs 10.3.1(a) to (d) 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.

10.4 Flight Envelopes

The RVSM operational flight envelope, is the Mach number W/δ and altitude ranges over which an aircraft can be operated in cruising flights within the RVSM airspace. The RVSM operational flight envelope for any aircraft may be divided into two parts as explained below:-

10.4.1 **Full RVSM Flight Envelope:** The full envelope will comprise the entire range of operational Mach number, W/δ and altitude values over which the aircraft can be operated within RVSM airspace. Table 1 establishes the parameters to be considered.

10.4.2 **Basic RVSM Flight Planning Envelope:** The boundaries for the Basic envelope are the same as those for the full envelope except for the upper Mach boundary.

TABLE 1 - FULL RVSM ENVELOPE BOUNDARIES

	Lower Boundary is defined by	**Upper Boundary is defined by**
Level	- FL 290	The lower of: - FL 410 - Aircraft maximum certified altitude - Altitude limited by; cruise thrust; buffet; other aircraft flight limitations.
Mach or Speed	The lower of: - Maximum endurance (holding speed) - Manoeuvre speed	The lower of - M_{MO}/V_{MO} - Speed limited by cruise thrust; buffet; other aircraft flight limitations.
Gross weight	- The lowest gross weight compatible with operations in RVSM airspace.	- The highest gross weight compatible with operations in RVSM airspace.

10.5 **Avionics Equipment:** Avionics equipment shall be identified by function and part number. A demonstration shall show that the avionic equipment can meet the design criteria established when the equipment is operated

in the environmental conditions expected to be met during RVSM operations.

10.6 **Compliance Procedure:** The data package furnished by the manufacturer shall define the procedures, inspections and tests and the limits that will be used to ensure that all aircraft approved against the data package "conform to type"; that is all future approvals, whether of new build or in service aircraft meet the allowances developed.

10.7 Continued Airworthiness:

10.7.1 The following items shall be reviewed and updated as applicable to RVSM :

a) The structural repair manual with special attention to the areas around each static source, angle of attack sensors, and doors if their rigging can affect air flow around the previously mentioned sensors.

b) The Master Minimum Equipment List (MMEL)

10.7.2 The data package shall include details of any procedures that are not covered in above said para, but may be needed to ensure continued compliance with RVSM approval criteria.

Examples follow –

a) 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 ground and flight test of the aircraft and its altimetry system at intervals to be agreed with DGCA. However, exemption from the flight test requirement may be granted if it can be demonstrated that the relationship between any subsequent airframe/system degradation and its effects on altimetry system accuracy is understood and that it can be compensated or corrected.

b) In-flight defect reporting procedures shall be defined for identification of altimetry system error sources. Such procedure shall cover acceptable differences between primary and alternate static sources, and others as appropriate.

c) For groups of aircraft, where approval is based on geometric inspection, periodic re-inspection shall be necessary and the intervals required should be specified.

10.8 **Post Approval Modification:** Any variation/modification from the initial installation that affects RVSM approval should be referred to aircraft manufacturer and accepted by DGCA.

11 CONTINUED AIRWORTHINESS (MAINTENANCE PROCEDURES)

11.1 General

a) The integrity of the design features necessary to ensure that altimetry systems continue to meet RVSM approval criteria shall be verified by scheduled tests and inspections in conjunction with an approved maintenance program. The operator shall review its maintenance procedures and address all aspects of continued airworthiness that may be relevant.

b) Adequate maintenance facilities shall be available to enable compliance with the RVSM maintenance procedures.

11.2 Maintenance Programs

Each operator requesting RVSM operational approval shall establish RVSM maintenance and inspection practices acceptable to DGCA that shall include any required maintenance specified in the data package. These practices shall be included in the operator's approved maintenance programme.

11.3 Maintenance Documents

The following manuals/documents shall be reviewed, as appropriate:

a) Maintenance Manuals.
b) Structural Repair Manuals.
c) Standard Practices Manuals.
d) Illustrated Parts Catalogues.
e) Maintenance Schedule
f) MMEL/MEL

11.4 Maintenance Practices

11.4.1 The aircraft altimetry and height keeping equipment shall be maintained in accordance with the manufacturer's approved procedures and servicing schedules.

11.4.2 The operator's maintenance program shall include, for each aircraft type, the maintenance practices stated in the applicable aircraft and component manufacturers' maintenance manuals. In addition, attention shall be given to the following items:

a) All RVSM equipment shall be maintained in accordance with the aircraft and component manufacturers' maintenance instructions and the performance criteria of the RVSM approval data package.

b) Any modification or design change, which in any way affects the initial RVSM approval, shall be subject to a design review acceptable to DGCA.

c) 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, shall be subject to a design review acceptable to DGCA.

d) Built-in Test Equipment (BITE) testing shall not be used for System calibration unless it is shown to be acceptable by the aircraft manufacturer/design organization, and with the agreement of the DGCA.

e) An appropriate system leak check (or visual inspection where permitted) shall be accomplished following reconnection of a quick disconnect static line.

f) Airframe and static systems shall be maintained in accordance with the aircraft 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 will need to be made, as specified by the aircraft manufacturer, to ensure adherence to RVSM tolerances. These checks should be performed following repairs, or alterations having an effect on airframe surface and airflow.

h) 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. This requirement will typically be satisfied with equipment inspections and serviceability checks.

i) Whenever the performance of the installed equipment has been demonstrated to be satisfactory for RVSM approval, the associated maintenance practices shall be consistent with continued RVSM approval. Examples of equipment to be considered are

   i) Altitude alerting
   ii) Automatic Altitude Control System
   iii) Secondary Surveillance Radar altitude reporting equipment
   iv) Altimetry system.

11.4.3 **Action for non-compliance aircraft** - Those aircraft positively identified as exhibiting height keeping performance errors that require investigation, shall not be operated in RVSM airspace until the following actions have been taken –

a) The failure or malfunction is confirmed and isolated; and
b) Corrective action is taken to comply with requirements for RVSM approval.

11.4.4 **Maintenance Training** - Additional training may be necessary to support RVSM approval. Areas needed to be highlighted for initial and recurrent training of relevant personnel are:

a) Aircraft geometric inspection technique.
b) Test equipment calibration and use of that equipment.
c) Any special instruction or procedures introduced for RVSM approval.

11.4.5 Test Equipment

a) Test equipment should have the capability to demonstrate continuing compliance with all the parameters established in the data package for RVSM approval.

b) Test equipment should be calibrated using reference standards at periodic intervals acceptable to DGCA. The approved maintenance program shall include an effective quality control program with the attention to the following:

(i) Definition of required test equipment accuracy.
(ii) 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 the degradation is small in relation to the required accuracy.
(iii) Regular audits of calibration facilities both in-house and outside.
(iv) Adherence to approved maintenance practices.
(v) Procedures for controlling operator errors and unusual environmental conditions which may affect calibration accuracy.

12. REPORTING ALTITUDE KEEPING ERRORS

Each operator shall develop a system of reporting each event in which the operator's aircraft has exhibited the height deviations which are in magnitude equal to or, greater than, the following criteria:

i. Total Vertical Error - 300 feet;

ii. Altimetry System Error - 245 feet; and

iii. Assigned Altitude Deviation - 300 feet.

13. REMOVAL OR AMENDMENT OF AUTHORITY

DGCA may amend Operations Specifications of the operator to revoke or restrict an RVSM authorisation if it is found that the operator is not complying, or is unable to comply with the requirements of this CAR.

(Vikram Dev Dutt)
Director General of Civil Aviation

ANNEXURE I

TRAINING PROGRAMMES AND OPERATING PRACTICES AND PROCEDURES

1. INTRODUCTION

Flight crews will need to have an awareness of the criteria for operating in RVSM airspace and be trained accordingly. The items detailed in paragraphs 2 to 6 of this Annexure shall be standardized and incorporated into training programs and operating practices and procedures. Certain items may already be adequately standardized in existing procedures. New technology may also remove the need for certain actions required of the flight crew. If this is so, then the intent of this guidance can be considered to be met.

Note: This document is written for all users of RVSM airspace, and as such is designed to present all required actions. It is recognized that some material may not be necessary for larger public transport operators.

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 and alerting, systems; and
(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 accomplished during the pre-flight procedure:

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

(b) During the external inspection of aircraft, particular attention 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 shall be accomplished by a qualified and authorized person other than the pilot (e.g. a flight engineer or ground engineer);

(c) Before take-off, 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.

Note: The maximum value for these checks cited in operating manuals should not exceed 23m (75ft).

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

4. PROCEDURES PRIOR TO RVSM AIRSPACE ENTRY

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

(a) Two primary altitude measurement systems.
(b) One automatic altitude-control system.
(c) One altitude-alerting device.

Note: Dual equipment requirements for attitude-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.

(d) Operating Transponder. 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: Should any of the required equipment fail prior to the aircraft entering RVSM airspace, the pilot shall request a new clearance to avoid entering this airspace;

5. IN-FLIGHT PROCEDURES

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

(a) Flight crews 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 1013.2 (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 manoeuvres;

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

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 done by reference to one of the two primary altimeters. Following loss of the automatic height keeping function, any consequential restrictions will be observed.

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

(g) At intervals of approximately one hour, crosschecks between the primary altimeters shall be made. A minimum of two will need to agree within ±60 m (±200 ft). 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 ±90 m (±300 ft) and/or an ASE greater than ±75 m (±245 ft) then the pilot should follow established regional procedures to protect the safe operation of the aircraft. This assumes that the monitoring system will identify the TVE or ASE within the set limits for accuracy. If the pilot is notified by ATC of an assigned altitude deviation which exceeds ±90 m (±300 ft) then the pilot should take action to return to cleared flight level as quickly as possible.

5.2 Contingency procedures after entering RVSM airspace are:

5.2.1 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 (CFL);

5.2.3 The pilot should notify ATC when encountering greater than moderate turbulence.

5.2.4 If unable to notify ATC and obtain an ATC clearance prior to deviating from the assigned CFL, the pilot shall follow the established contingency procedures and obtain ATC clearance as soon as possible.

6. POST FLIGHT

6.1 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.

6.2 The following information shall be recorded when appropriate:

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

7. SPECIAL EMPHASIS ITEMS: FLIGHT CREW TRAINING

7.1 The following items shall also be included in flight crew training programmes:

(a) knowledge and understanding of standard ATC phraseology used in each area of operations and relevant AIP and NOTAM information pertaining to the route to be flown;

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

(c) use and limitations in terms of accuracy of standby altimeters in contingencies. Where applicable, the pilot shall review the application of SSEC/PEC through the use of correction cards;

Note: Such correction data shall be readily available on the flight deck

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

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

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

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

ANNEXURE II

RVSM PERFORMANCE

1 General

The objectives set out by the ICAO Review of the General Concept of Separation Panel (RGCSP) have been translated into airworthiness standards by assessment of the characteristics of altimetry system error (ASE) and automatic altitude control.

2 RVSM Flight Envelopes

For the purposes of RVSM approval, the aircraft flight envelope may be considered as two parts; the Basic RVSM flight planning envelope and the Full RVSM flight envelope (referred to as the Basic envelope and the Full envelope respectively), as defined and explained in para 10.4 of this CAR. For the Full envelope, a larger ASE is allowed.

3 Altimetry System Error

3.1 To evaluate a system against the ASE performance statements established by RGCSP, it is necessary to quantify the mean and three standard deviation values for ASE, expressed as ASE_{mean} and ASE_{3SD}. 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 equipment.
(b) Effect of environmental operating conditions on avionics equipment.
(c) Airframe to airframe variability of static source error.
(d) Effect of flight operating conditions on static source error.

3.2 Assessment of ASE, whether based on measured or predicted data will need to consider sub-paragraphs (a) to (d) of 3.1. The effect of item (d) as a variable can be eliminated by evaluating ASE at the most adverse flight condition in an RVSM flight envelope.

3.3 The criteria to be met for the Basic envelope are:

(a) At the point in the envelope where the mean ASE reaches its largest absolute value that value should not exceed 25 m (80 ft);

(b) At the point in the envelope where absolute mean ASE plus three standard deviations of ASE reaches its largest absolute value, the absolute value should not exceed 60 m (200 ft).

3.4 The criteria to be met for the Full envelope are:

(a) At the worst point in the Full envelope where the mean ASE reaches its largest absolute value, the absolute value should not exceed 37 m (120 ft).

(b) At the point in the Full envelope where the mean ASE plus three standard deviations of ASE reaches its largest absolute value, the absolute value should not exceed 75 m (245 ft).

(c) If necessary, for the purpose of achieving RVSM approval for a group of aircraft (see para 10 of the CAR), an operating limitation may be established to restrict aircraft from conducting RVSM operations in parts of the Full envelope where the absolute value of mean ASE exceeds 37 m (120 ft) and/or the absolute value of mean ASE plus three standard deviations of ASE exceed 75 m (245 ft). When such a limitation is established, it should be identified in the data submitted to support the approval application, and documented in appropriate aircraft operating manuals. However, visual or aural warning/indication associated with such a limitation need not be provided in the aircraft.

3.5 Aircraft types for which an application for type certification is made after 1 January 1997, should meet the criteria established for the Basic envelope in the Full RVSM envelope.

3.6 The standard for aircraft submitted for approval as non-group aircraft, as defined in para 10.7.2 of the CAR, is as follows:

(a) For all conditions in the Basic envelope:

- $|$ Residual static source error + worst case avionics $|$ < 50 m (160 ft)

(b) For all conditions in the Full envelope:

- $|$Residual static source error + worst case avionics $|$ < 60 m (200 ft)

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

4. **Altitude Keeping**

An automatic altitude control system is required capable of controlling altitude within ±20 m (±65 ft) about the selected altitude, when the aircraft is operated in straight and level flight under non turbulent non-gust conditions.

Note: Automatic altitude control systems with flight management system/ performance (Management system inputs allowing variations up to ±40 m (±130 ft) under non-turbulent, non-gust conditions, installed in aircraft types for which an application for type certification was made prior to January 1, 1997, need not be replaced or modified.