CIVIL AVIATION AUTHORITY
OF NEW ZEALAND
Te Mana Rererangi Tūmatanui o Aotearoa

Advisory Circular
AC91-4

Revision 3

5 April 2025

Reduced Vertical Separation Minimum (RVSM)

General

Civil Aviation Authority advisory circulars (ACs) contain information about standards, practices, and procedures that the Director has found to be an **acceptable means of compliance** with the associated rule.

Consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices, or procedures are found to be acceptable they will be added to the appropriate AC.

Purpose

This AC describes an acceptable means of compliance with requirements relating to the approval of operators for RVSM operations.

Related Rules

This AC relates specifically to Civil Aviation Rule 91.519.

Change Notice

Revision 3 removes specific form numbers and updates contact details. It also adds a version history and makes stylistic changes to align with current AC format.

Version History

History Log

Revision No.	Effective Date	Summary of Changes
AC91-4, Rev 0	9 Dec 1997	Initial issue
AC91-4, Rev 1	24 Jan 2000	Updated the RVSM information for the North Atlantic Region and added information on the introduction of RVSM in the Pacific region.
AC91-4, Rev 2	2 Dec 2014	Provided information on initial and on-going requirements for approval to conduct RVSM

		operations between flight level (FL) 290 and FL 410.
AC91-4, Rev 3	5 April 2025	Removes specific form numbers. Updates contact details. Adds a version history. Makes stylistic changes to align with current AC format.

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1. Introduction

RVSM airspace is any airspace or route where aircraft are separated by 1,000 ft vertically, between FL 290 and FL 410, inclusive Generally, aircraft and operators that have not been authorised to conduct RVSM operations cannot operate at flight levels where RVSM is applied. Exceptions to this rule are published by individual air traffic service providers.

RVSM was first implemented in the North Atlantic in March 1997. Since that time, it has been implemented in most regions of the world, and RVSM approval is required for flight operations conducted between FL 290 and FL 410, although in some locations it is only required between FL 310 and FL 390.

The intention of this AC is to provide:

(a) information on the approvals process

(b) guidance on the arrangements and need for monitoring.

2. Abbreviations

	Abbreviations
AAD	Assigned altitude deviation
AC	Advisory circular
ACAS	Airborne collision avoidance system
ADC	Air data computer
AFM	Airplane flight manual
ADS-B	Automatic dependant surveillance - broadcast
AGHMEs	Aircraft geometric height measurement elements
AHMS	ADS-B height monitoring system
ASE	Altimetry system error
ATC	Air traffic control
BITE	Built-in test equipment
CAA	Civil Aviation Authority
CFL	Cleared flight level
FAA	Federal Aviation Administration
FL	Flight level
GMU	Global positioning system monitoring unit
GPS	Global positioning system
HME	Height monitoring element
HMU	Height monitoring unit
IATA	International Air Transport Association
ICA	Instructions for continued airworthiness
ICAO	International Civil Aviation Organisation
IFALPA	International Federation of Airline Pilots Associations

IFATCA	International Federation of Air Traffic Controllers Associations
MASPS	Minimum aircraft system performance specification
MEL	Minimum equipment list
MNPS	Minimum navigation performance specification
NM	Nautical mile
PARMO	Pacific Approvals Registry and Monitoring Organization
PEC	Position correction error
PIC	Pilot-in-command
RGCSP	Review of the general concept of separation
RMA	Regional monitoring agency
RVSM	Reduced vertical separation minimum of (300m) 1,000 ft between flight levels
SB	Service bulletin
SL	Service letter
SLOP	Strategic lateral offset procedures
SSEC	Static source correction error
SSR	Secondary surveillance radar
STC	Supplemental type certificate
TCAS	Traffic alert and collision avoidance system
TCDS	Type certificate data sheet
TLS	Target level of safety
TMU	Total vertical error monitoring unit
TVE	Total vertical error
VHF	Very high frequency
VSM	Vertical separation minimum

3. Definitions

Definitions	
Automatic dependant surveillance – broadcast (ADS-B)	An on-board surveillance application that periodically transmits aircraft parameters, such as identification, pressure altitude, position and position integrity, via a broadcast data link that is available to any receiver, either airborne or ground-based, within range of the transmitter.
Aircraft type groupings	Aircraft are considered to be members of the same group if they are designed and assembled by one manufacturer and are of nominally identical design and build with respect to all details which could influence the accuracy of height-keeping performance.
Altimetry system error (ASE)	The difference between the altitude indicated by the altimeter display (assuming a correct altimeter barometric setting) and the pressure altitude corresponding to the undisturbed ambient pressure
Assigned altitude deviation (AAD)	The difference between the transponded altitude and the assigned altitude/flight level.

Non-compliant aircraft	An aircraft whose true absolute TVE, ASE or AAD is greater than the maximum acceptable value for RVSM-approved aircraft.
RVSM approval	The term used to describe the successful completion of the airworthiness approval and operational approval.
QFE	Atmospheric pressure at aerodrome elevation (or at runway threshold)
QNH	Altimeter sub-scale setting to obtain elevation when on the ground
Target level of safety (TLS)	A generic term representing the level of risk which is considered acceptable in particular circumstances.
Total vertical error (TVE)	The vertical geometric difference between the actual pressure altitude flown by an aircraft and its assigned pressure altitude (flight level).

4. Background

In 1982 the ICAO initiated a series of world-wide studies to assess the feasibility of a reduction of the VSM above FL 290 from 2,000 ft to 1,000 ft. The studies were co-ordinated by the review RGCSP which included representation from the IATA, IFALPA and the IFATCA. The principal benefits which the implementation of the reduced VSM were expected to provide were:

(a) a theoretical doubling of the airspace capacity between FL 290 and FL 410

(b) the opportunity for aircraft to operate at/closer to their optimum flight levels, with resulting fuel economy.

Studies and data collections were conducted in Canada, Japan, USA, USSR and four member states of Eurocontrol: France, Germany, Netherlands and United Kingdom. These studies were essentially intended to determine the following:

(a) the height keeping accuracy of the current aircraft population at/above FL 290

(b) the causes of height deviations greater than 300 ft and to define corrective measures

(c) the basis of the MASPS to support the use of a 1,000 ft vertical separation above FL 290.

As a result, the RGCSP concluded that a 1,000 ft VSM between FL 290 and FL 410 was technically feasible without imposing unreasonably demanding technical or operational requirements. The ICAO Air Navigation Commission endorsed these findings in 1990.

With the exception of a small number of states, RVSM was progressively introduced globally between 1997 and 2011, and operation within this airspace is prohibited unless the operator has RVSM approval for the aircraft being flown, or an exception has been granted for a specific flight.

5. RVSM Approval Overview

5.1 General

Before granting an RVSM approval the aircraft and operator must satisfy the following requirements:

(a) the aircraft must be eligible for RVSM (i.e. must satisfy the vertical navigation performance)

(b) the operator has instituted appropriate procedures in respect of continued airworthiness (maintenance and repair) practices and programmes

(c) the operator has instituted appropriate flight crew procedures and training for operations in RVSM airspace

(d) the operator has instituted RVSM monitoring programmes.

The RVSM approval process consists of two discrete approvals, an airworthiness approval and an operational approval.

5.2 Airworthiness approval (including continued airworthiness)

The RVSM airworthiness approval ensures that the aircraft is eligible to operate in RVSM airspace. During the RVSM airworthiness approval process CAA will determine whether the operator's aircraft is eligible for RVSM. This includes the aircraft's ICA (i.e. maintenance programme, maintenance manuals and maintenance training). Aircraft compliance will be conducted through one of three broad categories.

(a) Existing RVSM compliance by manufacturer. For aircraft manufactured in an RVSM-compliant condition, CAA will determine that the AFM or TCDS contains an appropriate statement of RVSM eligibility and that approval of the RVSM eligibility was made by an authority acceptable to the Director. For aircraft that qualify for this approach, validation height monitoring will typically be conducted after an RVSM approval is granted.

(b) Existing RVSM compliance by inspection/modification. This approach is suitable for aircraft that are brought up to RVSM-compliant condition in accordance with SB, SL, or STC, which have had the RVSM eligibility approved by an authority acceptable to the Director. These documents contain requirements that are specific to individual aircraft types or aircraft type groups and generally require inspections and/or hardware or software modifications. The operator must submit documents to CAA to show that the required actions have been completed for each airframe that will operate in RVSM airspace. For aircraft that qualify for this approach, validation height monitoring will typically be conducted after an RVSM approval is granted.

(c) Bespoke RVSM compliance by inspection/modification. This approach will be taken where an operator intends to gain RVSM approval for aircraft of a type or aircraft type group which have not previously gained the RVSM airworthiness approval of the RVSM approval. In this case CAA, in consultation with the applicant, will tailor an airworthiness approval process in order to demonstrate compliance. Further detail regarding performance requirements and means of demonstrating RVSM airworthiness can be found in FAA AC AC91-85B *Authorization of Aircraft and Operators for Flight in Reduced Vertical Separation Minimum (RVSM) Airspace*, and ICAO document 9574 *Manual on Implementation of a 300m (,1,000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive*. For aircraft which require this approach, validation monitoring will typically be conducted prior to an RVSM approval being granted.

In all cases, the operator is to provide CAA with supporting documentation to demonstrate RVSM airworthiness compliance (including continued airworthiness compliance) of all the aircraft they intend to operate in RVSM airspace. Dependent upon the specific situation, relevant documents might include the following.

(a) AFM or AFMS

(b) TCDS

(c) SB or STC

(d) MEL

(e) Initial height validation monitoring plan.

(f) Instructions for RVSM Continued Airworthiness (for example: maintenance manuals).

Note: *As part of the RVSM airworthiness approval the aircraft's height performance is to be validated. Initial height validation monitoring requirements will be determined during the initial application phase. Appendix 4 provides more detail on initial height validation monitoring. It is recommended that applicants contact CAA at certification@caa.govt.nz or info@caa.govt.nz to discuss monitoring requirements and acceptable methods available at the time of application.*

5.3 Operational approval

The RVSM operational approval ensures that the operator can maintain the RVSM integrity of each aircraft that is to be operated in RVSM airspace. During the RVSM operational approval process CAA will assess the operator's flight crew procedures, maintenance procedures, training programmes and RVSM continued height monitoring programme for each aircraft type. Operators are to provide supporting documentation to demonstrate RVSM operational compliance, relevant documents include:

(a) operations manual (RVSM flight operations)

(b) maintenance programme (RVSM continued airworthiness)

(c) RVSM continued height monitoring plan

(d) RVSM training programmes:

(i) maintenance training

(ii) flight crew training.

Note: *In 2010 ICAO identified the requirement for continued height-keeping performance monitoring of RVSM capable aircraft to ensure continued RVSM suitability. Appendix 4 provides more detail on continued height monitoring. The operator is to have a programme in place to ensure that their RVSM approved aircraft are involved in a continued RVSM height monitoring programme.*

Appendix 1 provides detailed information on RVSM continued airworthiness (maintenance requirements). Appendix 2 provides detailed information on flight crew training programmes, operating practices and procedures. Appendix 3 provides detailed information on RVSM specific procedures for oceanic airspace and Appendix 4 provides detailed information on RVSM monitoring.

6. Application and Issue of Approval

An application for an RVSM approval must be submitted on the applicable CAA form for operational approval, with a covering letter requesting RVSM approval and any pertinent information pertaining to the application, including:

(a) operator details

(b) aircraft type and series

(c) registration number

(d) manufacturer's serial number

(e) aircraft mode S address code in hexadecimal format

(f) sufficient documentation demonstrating RVSM compliance as detailed in this AC.

Note: *For aircraft manufactured to the same aircraft type group, only one application is required. Aircraft are members of the same group if they are designed and assembled by one manufacturer and are of nominally identical design and build with respect to all details which could influence the accuracy of height-keeping performance. In all other cases an application for each aircraft is required.*

The applicable forms for the approval or revision of a Minimum Equipment List (MEL) and for the approval/amendment of a maintenance programme are also to be submitted as part of the application. To find these forms, go to the 'Forms' tab on the CAA website and click on the filter for Part 91.

When all the requirements of the airworthiness approval and operational approval have been assessed as satisfactory, CAA will issue a letter of notification of approval and the operator's air operator certificate – operations specifications will be updated to reflect the RVSM approval. An RVSM approval issued by CAA is valid for all regions operating RVSM airspace, provided that CAA has not imposed specific restrictions on the operator.

Once an RVSM approval has been granted, CAA will notify PARMO. The notification will include:

(a) state of registry of the aircraft

(b) name of the operator

(c) state of the operator

(d) aircraft type

(e) aircraft series

(f) aircraft serial number(s)

(g) registration mark

(h) Mode S address code(s)

(i) date of RVSM airworthiness approval

(j) date of RVSM approval.

Note: *The date of airworthiness approval issued by CAA should be the actual date that the modifications/inspections were completed for each airframe.*

7. Conditions for Removal of an RVSM Approval

The incidence of height-keeping errors that can be tolerated in an RVSM environment is very small. Each operator needs to take immediate action to rectify the conditions that caused the error. The operator should also report the event to CAA within 72 hours with initial analysis of causal factors and measures to prevent further events. CAA will determine the requirement for follow up reports. Errors which should be reported and investigated are: TVE equal to or greater than ±300 ft (±90 m), ASE equal to or greater than ±245 ft (±75 m), and AAD equal to or greater than ±300 ft (±90 m).

Height-keeping errors fall into two broad categories:

(a) errors caused by malfunction of aircraft equipment

(b) operational errors.

An operator who consistently makes errors of either kind may be required to forfeit authority for RVSM operations. If a problem is identified that is related to one specific aircraft type, then RVSM approval may be removed for the operator for that specific type.

Another condition for the removal of RVSM approval is the change of ownership of RVSM approved aircraft. As part of the RVSM approval, CAA assesses the operator to ensure that they have implemented the required programmes and procedures to ensure that the integrity of RVSM is maintained – this cannot be transferred with the aircraft.

APPENDIX 1: RVSM Continued Airworthiness (Maintenance Requirements)

ICAs verify the integrity of the design features necessary to ensure that altimetry systems continue to meet RVSM standards through scheduled tests and/or inspections in conjunction with an approved maintenance programme. The operator should review its maintenance procedures and address all aspects of continuing airworthiness affected by RVSM requirements.

Each person or operator should demonstrate that the maintenance facility is adequate to ensure continued compliance with the RVSM maintenance requirements.

A1.1 Maintenance programme approval requirements

Each operator requesting an RVSM operational approval should submit a maintenance and inspection programme that includes any maintenance requirements defined in the airworthiness approval.

A1.2 Maintenance document review requirements

Review the following items as appropriate for an RVSM operational approval:

(a) maintenance manuals

(b) structural repair manuals

(c) standards practices manuals

(d) illustrated parts catalogues

(e) maintenance schedule

(f) MMEL / MEL.

A1.3 Maintenance practices

If the operator's aircraft are subject to an approved maintenance programme, that programme should contain the maintenance practices outlined in the applicable aircraft and component manufacturer's maintenance manuals for each aircraft type. Review the following items for compliance for RVSM approval. If the operator's aircraft is not subject to an approved maintenance programme, the following items should be followed.

(a) Maintain all RVSM equipment in accordance with the component manufacturer's maintenance requirements.

(b) Any modification, repair, or design change that in any way alters the initial RVSM approval should be subject to a design review by persons approved by the approving authority.

(c) Refer any maintenance practices that may affect the continuing RVSM approval integrity (for example: the alignment of pitot/static probes, dents, or deformation around static plates) to the approving authority or persons delegated by the authority.

(d) BITE testing is not an acceptable basis for system calibrations (unless it is shown to be acceptable by the airframe manufacturer with the approval authority's agreement) and should only be used for fault isolation and troubleshooting purposes.

(e) Some aircraft manufacturers have determined that the removal and replacement of components utilising 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 reconnections. Therefore, a system leak check or visual inspection should be accomplished any time a quick disconnect static line is broken.

Note: *If both quick disconnects are broken for any reason, a leak-check must be done.*

(f) Maintain airframe and static systems in accordance with the airframe manufacturer's inspection standards and procedures.

(g) If necessary, 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 should be made to ensure adherence to the airframe manufacturer's RVSM tolerances. Perform these tests and inspections as established by the airframe manufacturer. Perform these checks following repairs, or alterations that affect RVSM by having an effect on the airframe surface and airflow.

(h) The maintenance and inspection programme for the autopilot should 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 to ensure the equipment is serviceable.

(i) Where the applicant demonstrates the performance of existing equipment is satisfactory for RVSM approval, CAA should verify that the existing maintenance practices are also consistent with continued RVSM approval integrity. Examples include:

(i) altitude alert

(ii) automatic altitude control system

(iii) ATC altitude reporting equipment

(iv) altimetry systems.

A1.4 Maintenance practices for noncompliant aircraft

Aircraft positively identified as exhibiting height-keeping performance errors which require investigation should not be operated under an RVSM approval 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

(b) corrective action is carried out and verified to ensure RVSM approval integrity.

A1.5 Maintenance training requirements

The RVSM approval process should include a review of the operator's maintenance training programme as it relates to the equipment required for RVSM operations. Emphasise the following curriculum segments for initial and recurrent training of shop and line personnel:

(a) aircraft geometric inspection techniques

(b) test equipment calibration/usage techniques

(c) any special documentation or procedures introduced by RVSM approval.

A1.6 Test equipment

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

Test equipment should be calibrated using approved reference standards traceable to the national standard. Calibrate at periodic intervals as agreed by the approving authority. The approved maintenance programme should incorporate effective quality control measures including the following:

(a) Definition of required test equipment accuracy.

(b) Regular calibrations of test equipment traceable to the approved standard.

Note: *Determination of calibration interval should be a function of the stability of the test equipment. Establish the calibration interval based on historical data so that degradation is small in relation to the required accuracy.*

(c) Procedures to ensure conducting of regular audits of calibration facilities both in-house and outside.

(d) Adherence to acceptable shop and line maintenance practices.

(e) Procedures for controlling operator errors and unusual environmental conditions that may affect calibration accuracy.

APPENDIX 2: Flight Crew Training Programmes, Operating Practices and Procedures

The following items (detailed in A2.2 to A2.8) should be standardised and incorporated into training programmes and operating practices and procedures. Certain items may already be adequately standardised in existing operator programmes and procedures. New technologies may also eliminate the need for certain crew actions.

A2.1 Flight planning

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

(a) verifying that the aircraft is approved for RVSM operations

(b) block 10 (equipment) of the ICAO flight plan should be annotated with the letter W for filing in RVSM airspace

(c) reported and forecast weather conditions on the route of flight

(d) minimum equipment requirements pertaining to height-keeping systems

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

A2.2 Pre-flight procedures

The following actions should take place during pre-flight:

(a) Review maintenance logs and forms to ascertain the condition of equipment required for flight in the RVSM airspace. Ensure that maintenance action has been taken to correct defects to required equipment and that minimum equipment requirements pertaining to height-keeping systems are met.

(b) During the external inspection of aircraft, pay particular attention 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. (A qualified and authorised person other than the pilot, for example a flight engineer or maintenance personnel, may perform this check).

(c) Before take-off, the aircraft altimeters should be set to the local altimeter atmospheric pressure at nautical height (QNH) setting and should display a known elevation (for example field elevation) within the limits specified in aircraft operating manuals. The difference between the known elevation and the elevation displayed on the altimeters should not exceed 75 ft. The two primary altimeters should also agree within limits specified by the aircraft operating manual. An alternative procedure using atmospheric pressure at field elevation (QFE) may also be used.

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

A2.3 Procedures before RVSM airspace entry

If any of the required equipment fails before the aircraft entering RVSM airspace, the pilot should request a new clearance to avoid flight in this airspace. The following equipment should be operating normally at entry into RVSM airspace:

(a) two serviceable independent primary altitude measurement systems

(b) one automatic altitude-control system, and

(c) one altitude-alerting device.

Note: *Single source dependency following ADC failure does not meet the criteria for RVSM operation.*

The operator should ascertain the requirement for an operational transponder in each RVSM area where operations are intended.

A2.4 In-flight procedures

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

(a) Flight crews should comply with aircraft operating restrictions (if required for the specific aircraft group) related to RVSM airworthiness approval.

(b) Place emphasis on promptly setting the sub-scale on all primary and standby altimeters to 29.92 in. Hg/1013.2 (hPa) when passing the transition altitude and rechecking for proper altimeter setting when reaching the initial cleared flight level (CFL).

(c) In level cruise, it is essential that the aircraft is flown at the CFL. This requires that particular care is taken to ensure that ATC clearances are fully understood and followed. Except in contingency or emergency situations, the aircraft should not intentionally depart from CFL without a positive clearance from ATC.

(d) During cleared transition between levels, the aircraft should not be allowed to overshoot or undershoot the CFL 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.*

High rates of climb or descent may result in nuisance TCAS alerts on older TCAS equipment (TCAS 7.0) when in vicinity of other traffic or in areas of high traffic density. For this reason, it may be advisable to reduce the rate of climb/descent to less than 1,000 ft/min within 1,000 ft of the cleared flight level.

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

(f) The altitude-alerting system should be operational.

(g) At intervals of approximately one hour, make cross-checks between the primary altimeters and the stand-by altimeter. A minimum of two primary altimeters should agree within 200 ft (60 m) or a lesser value if specified in the aircraft operating manual. (Failure to meet this condition will require that the altimetry system be reported as defective and

notified to ATC). Note the difference between the primary and stand-by altimeters for use in contingency situations.

(i) The normal pilot scan of cockpit instruments should be enough for altimeter crosschecking on most flights.

(ii) When operating under positive radar control, the initial altimeter cross-check should be performed after level off. On Class II navigation legs, a cross-check should be performed and recorded in the vicinity of the point where Class II navigation is begun (for example, on coast out). The readings of the primary and standby altimeters should be recorded and available for use in contingency situations.

(iii) Some aircraft have automatic comparators that compare the two primary altimetry systems. The comparators include a monitoring, warning, and fault function. The faults may be recorded automatically by the system but a record of the differences in the primary altimetry systems may not be easily derived.

Note: *Future systems may make use of automatic altimeter comparators instead of cross-checks by the crew.*

(h) Crew should ensure the autopilot used and the transponder selected use the same air data source for altitude information.

(i) If ATC notifies the pilot of an AAD error that equals or exceeds 300 ft (90 m) then the pilot should take action to return to CFL as quickly as possible.

(j) Contingency procedures after entering RVSM airspace. The pilot should notify ATC of contingencies (aircraft system failures, weather conditions) which affect the ability to maintain the CFL and coordinate a plan of action.

A2.5 Equipment failures

CAA must be informed as soon as practicable of the following equipment failures:

(a) loss of one or more primary altimetry systems

(b) failure of any relevant altitude control systems.

A2.6 Post flight

In making maintenance logbook entries against malfunctions in height-keeping systems, the pilot should provide enough detail to enable maintenance to effectively troubleshoot and repair the system. The pilot should detail the actual defect and the crew action taken to try to isolate and rectify the fault. Note the following information when appropriate:

(a) primary and standby altimeter readings

(b) altitude selector setting

(c) subscale setting on altimeter

(d) autopilot used to control the airplane 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) transponder selected to provide altitude information to ATC and any difference if alternate transponder or altitude source is manually selected.

A2.7 Special emphasis items: flight crew training

The following items should also be included in flight crew training programmes.

(a) Area of operations specific policy and procedures including standard ATC phraseology.

(b) Importance of crew members cross checking each other to ensure that ATC clearances are promptly and correctly complied with.

(c) Use and limitations in terms of accuracy of standby altimeters in contingencies. Where applicable, the pilot should review the application of SSEC/PEC with correction cards.

(d) Problems of visual perception of other aircraft at 1,000 ft (300 m) 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 that may lead to the occurrence of overshoots.

(f) Operational procedures and operating characteristics related to TCAS / ACAS operation in an RVSM operation.

(g) Relationship between the altimetry, automatic altitude control, and transponder systems in normal and abnormal situations.

(h) Aircraft operating restrictions (if required for the specific aircraft group) related to RVSM airworthiness approval.

(i) For those operators authorised to conduct oceanic operations – use of SLOP in oceanic airspace to mitigate the effect of wake turbulence and the effect of operational errors.

APPENDIX 3: Specific Procedures for Oceanic Airspace

RVSM was initially implemented in North Atlantic MNPS airspace in March 1997. The guidance that follows has been applied in the North Atlantic region since that time. It is also applied to RVSM operations in the Pacific, West Atlantic and other oceanic airspace.

This appendix contains information on procedures that are unique to oceanic RVSM airspace where direct voice communications between pilots and ATC is not available.

A3.1 Basic concepts for contingencies

A3.1.1 Specific guidance for contingencies

The basic concepts for contingencies described in this paragraph were developed from the specific guidance contained in ICAO Document 4444, Chapter 15, *Special In-Flight Contingencie*s. Contingency procedures become complicated when specific situations are detailed. However, if the details are examined in the context of certain basic concepts, then they are more easily understood. Reviewing these concepts should serve to aid pilots' understanding of the specific contingency procedures detailed in ICAO Document 4444. Contingency procedures published in ICAO Document 7030, *Regional Supplementary Procedures*, provide differences for individual regions of the world.

A3.1.2 Basic concepts for contingencies

Pilots should not interpret guidance for contingency procedures in any way that prejudices the final authority and responsibility of the PIC for the safe operation of the aircraft.

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.

Note: *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 megahertz (MHz) (as a back-up, the appropriate VHF inter-pilot air-to-air frequency may be used).*

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 FL.

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 a flight level and on an offset track where other aircraft are least likely to be encountered. Specifically, the pilot must:

(a) Acquire and maintain in either direction a track laterally separated by 28 km (15 NM) from the assigned route

(b) Once established on the offset track, climb or descend to select a FL which differs from those normally used by 150 m (500 ft)

(c) Also consider descending below FL 285 or climbing above FL 410. (The vast majority of oceanic traffic operates between FL 290 and 410. Flight above FL 410 or below FL 285 may limit exposure to conflict with other aircraft).

When executing a contingency manoeuvre the pilot should:

(a) watch for conflicting traffic both visually and by reference to ACAS or TCAS, if equipped

(b) continue to alert other aircraft using 121.5 MHz (as a back-up, the VHF inter-pilot air-to-air frequency (VHF 123.45) may be used) and aircraft lights

(c) continue to fly offset tracks or altitudes until an ATC clearance is obtained

(d) obtain an ATC clearance as soon as possible.

A3.2 Guidance to the pilot in the event of equipment failures or encounters with turbulence after entry into RVSM airspace (including expected ATC actions)

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

A3.2.1 Objective of the guidance material

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 recognised that the pilot and controller will use judgment to determine the action most appropriate to any given situation.

The guidance material recognises that 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 guidance recognises that 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 ICAO Document 4444 and Document 7030 contingency manoeuvres for the area of operation.

A3.2.2 Contingency scenarios

The following paragraphs summarise pilot actions to mitigate the potential for conflict with other aircraft in certain contingency situations. They should be reviewed in conjunction with the expanded contingency scenarios.

Scenario 1: The pilot is unsure of the:

(a) vertical position of the aircraft due to the loss or degradation of all primary altimetry systems, or

(b) capability to maintain CFL due to turbulence or loss of all automatic altitude control systems.

The pilot should do the following actions:	ATC can be expected to do the following actions:
Maintain CFL while evaluating the situation.	
Watch for conflicting traffic both visually and by reference to ACAS (TCAS), if equipped.	
If considered necessary, alert nearby aircraft by: (i) making maximum use of exterior lights (ii) broadcasting position, FL, and intentions on 121.5 MHz (as a back-up, the VHF inter-pilot air-to-air frequency may be used).	

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.
a) Maintaining the CFL and route provided that ATC can provide lateral, longitudinal or conventional vertical separation.	a) 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 increased vertical separation, and if so, apply the appropriate minimum.
b) 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.	b) If the pilot requests clearance to exit RVSM airspace, accommodate expeditiously, if possible.
c) Executing the ICAO Document 4444 contingency manoeuvres to offset from the assigned track and FL, if ATC clearance cannot be obtained and the aircraft cannot maintain CFL.	c) 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.
	d) Notify adjoining ATC facilities/sectors of the situation.

Scenario 2: A failure or loss of accuracy of one primary altimetry system (for example: greater than 200 ft difference between primary altimeters)

The pilot should:
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.

A3.3 Expanded equipment failure and turbulence encounter scenarios (operators may consider this material for use in training programmes)

Scenario 1: All automatic altitude control systems fail (for example: automatic altitude hold)

The pilot should do the following action:	**ATC can be expected to do the following:**
Initially maintain CFL, and	
Evaluate the aircraft's capability to maintain altitude through manual control.	
Subsequently watch for conflicting traffic both visually and by reference to TCAS, if equipped.	
If considered necessary, alert nearby aircraft by: (i) making maximum use of exterior lights (ii) broadcasting position, FL, and intentions on 121.5 MHz (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:	
a) Maintaining the CFL and route, provided that the aircraft can maintain level.	a) 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

	increased vertical separation, and if so, apply the appropriate minimum.
b) 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.	b) If the pilot requests clearance to exit RVSM airspace, accommodate expeditiously, if possible.
c) Executing the ICAO Document 4444 contingency manoeuvre to offset from the assigned track and FL, if ATC clearance cannot be obtained and the aircraft cannot maintain CFL.	c) 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.
	d) Notify adjoining ATC facilities/ sectors of the situation.

Scenario 2: Loss of redundancy in primary altimetry systems

The pilot should do the following actions:	**ATC can be expected to do the following actions:**
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: All primary altimetry systems are considered unreliable or fail

The pilot should do the following actions:	**ATC can be expected to do the following actions:**
Maintain CFL by reference to the standby altimeter (if the aircraft is so equipped).	
Alert nearby aircraft by: (i) making maximum use of exterior lights (ii) broadcasting position, FL, and intentions on 121.5 MHz (as a back-up, the VHF inter-pilot air-to-air frequency may be used).	
Consider declaring an emergency. Notify ATC of the failure and intended course of action. Possible courses of action include the following.	Obtain pilot's intentions, and pass essential traffic information.
a) Maintaining CFL and route provided that ATC can provide lateral, longitudinal, or conventional vertical separation.	a) 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 increased vertical separation, and if so, apply the appropriate minimum.
b) Requesting ATC clearance to climb above or descend below RVSM airspace if ATC cannot establish adequate separation from other aircraft.	b) If the pilot requests clearance to exit RVSM airspace, accommodate expeditiously, if possible.
c) Executing the ICAO Document 4444 contingency manoeuvre to offset from the	c) If adequate separation cannot be established and it is not possible to comply with the pilot's request for clearance to exit RVSM airspace,

assigned track and FL, if ATC clearance cannot be obtained.	advise the pilot of essential traffic information, notify other aircraft in the vicinity and continue to monitor the situation.
	d) Notify adjoining ATC facilities/sectors of the situation.

Scenario 4: The primary altimeters diverge by more than 200 ft (60 m)

The pilot should do the following actions:
Attempt to determine the defective system through established trouble-shooting procedures and/or comparing the primary altimeter displace 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 5: Turbulence (greater than moderate) which the pilot believes will impact the aircraft's capability to maintain FL

The pilot should do the following action:	**ATC can be expected to do the following:**
Watch for conflicting traffic both visually and by reference to TCAS, if equipped.	
If considered necessary, alert nearby aircraft by: (i) making maximum use of exterior lights (ii) broadcasting position, FL, and intentions on 121.5 MHz (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:	
a) Maintaining CFL and route provided ATC can provide lateral, longitudinal or conventional vertical separation.	a) Assess traffic situation to determine if the aircraft can be accommodated through the provision of lateral, longitudinal, or increased vertical separation, and if so, apply the appropriate minimum.
b) Requesting flight level change, if necessary.	b) If unable to provide adequate separation, advise the pilot of essential traffic information and request pilot's intentions.
c) Executing the ICAO Doc.4444 contingency maneuverer to offset from the assigned track and FL, if ATC clearance cannot be obtained and the aircraft cannot maintain CFL.	c) Notify other aircraft in the vicinity and monitor the situation.
	d) Notify adjoining ATC facilities/ sectors of the situation

A3.4 Special procedures for in-flight contingencies published for individual ICAO regions in Document 7030

Basic contingency procedures are in ICAO Document 4444, Chapter 15, *Procedures Relating to Emergencies, Communications Failures and Contingencies*.

ICAO Document 4444 and Document 7030 are the source documents for specific contingency procedures applicable to individual ICAO regions. Always consult Document 7030 before training material or manuals are developed.

A3.5 Wake turbulence procedures

SLOP allows aircraft to offset from the centre line of its track by one NM or two NMs to the right for wake turbulence avoidance and for increased safety.

A3.6 Transponder failure

The provider states will determine the specific actions that ATC will take in the event of transponder failure in RVSM.

APPENDIX 4: RVSM Monitoring

A4.1 RVSM height monitoring programmes

A programme to monitor or verify aircraft height-keeping performance is considered a necessary element of RVSM. RVSM monitoring programmes have the primary objective of observing and evaluating aircraft height-keeping performance to gain confidence that airspace users are applying the airplane/operator RVSM approval in an effective manner and that an equivalent level of safety will be maintained.

A4.1.1 Initial height validation monitoring

The RVSM airworthiness approval of an RVSM approval requires that the aircraft and operator be involved in an RVSM initial height validation monitoring programme. The initial height validation monitoring programme validates the aircraft's height performance for RVSM operations. For most aircraft types, monitoring is not required to be completed prior to operational approval being granted. The categories of monitoring are detailed below:

(a) Aircraft type group approved aircraft (data indicates compliance with RVSM MASPS). Two airframes from each fleet of an operator are to be monitored as soon as possible but not later than 6 months after the issue of an RVSM approval.

(b) Aircraft type group approved aircraft (insufficient data on approved aircraft). Sixty percent of airframes (round up if fractional) from each fleet of an operator are to monitor or individual monitoring, as soon as possible but not later than six months after the issue of an RVSM approval.

(c) Bespoke / non-group aircraft. One hundred percent of aircraft must be monitored prior to the granting of an RVSM approval.

Note: *Operators should contact CAA to clarify / confirm that the operator's aircraft are in the appropriate category.*

(d) Aircraft status for monitoring. Aircraft engineering work required for the aircraft to receive RVSM airworthiness approval must be completed before the aircraft is monitored.

(e) Monitoring of airframes that are RVSM compliant on delivery. If an operator adds new RVSM compliant airframes of a type for which it already has RVSM approval, providing the operator has completed monitoring requirements for the type, the new airframes are not required to be monitored – except as targeted at a later date in the continued monitoring programme. If an operator adds new RVSM-compliant airframes of an aircraft type for which it has not previously received RVSM approval, then the operator needs ~~is~~ to complete monitoring in accordance with this AC.

(f) Applicability of monitoring from other regions. Monitoring data obtained in conjunction with monitoring programmes from other regions can be used to meet pacific monitoring requirements. PARMO administers the monitoring programme in the FIRs for which it is responsible, and has access to monitoring data from other regions and will coordinate with states and operators to inform them on the status of individual operator monitoring requirements.

A4.1.2 Continued height monitoring programme

A requirement of the RVSM operational approval is that the operator establishes a continued height monitoring programme. This programme is to ensure that a minimum of two aircraft of each aircraft type grouping of the operator have their height-keeping performance monitored, at

least once every two years or within intervals of 1,000 flight hours per aircraft, whichever period is longer. If an operator aircraft type grouping consists of a single aeroplane, monitoring of that aeroplane must be accomplished within the specified period.

Note: *A height-monitoring system based on global positioning satellites or an earth-based system may fulfil this function.*

Monitoring data from any regional monitoring programme established in accordance with ICAO Annex 11, 3.3.5.2, may be used to satisfy the requirement.

A4.2 RVSM monitoring methods

There are multiple methods and agencies for performing RVSM height monitoring. There are four categories.

(a) **Height monitoring units (HMUs).** In operation in Europe, US and Japan. HMU is a ground-based system consisting of two main components – height monitoring element (HME) and total vertical error monitoring unit (TMU).

(i) The HME captures SSR transponder signals from aircraft replying to interrogations from radar stations. The signals contain the information from mode S and mode A / C transmissions. The HME determines the geometric height and position of an aircraft by comparing the time of reception of the SSR transponder signals at different receiver locations. This information is transmitted to the TMU as one plot per second. The data is collated by the TMU to create a track history of the aircraft passing through the area of coverage. The track information is then combined with meteorological data to evaluate the overall value for TVE.

(ii) When completed, the monitoring process produces TVE, AAD and ASE readings for each aircraft measured. This data is fed to the region's monitoring agency. Currently there are no HMUs in the pacific region but there are multiple HMUs available in other regions. Contact CAA for further information.

(b) **Aircraft geometric height measurement elements (AGHMEs).** A ground-based height monitoring system in operation in the US and Canada. The AGHME system does not require that any special monitoring devices be installed on an aircraft so it is monitored. It is necessary, however, that the aircraft have an operational mode S transponder. Straight and level flight through the centre of the AGHME coverage area between FL 290 and FL 410 is required. Contact CAA for further information.

(c) **ADS-B height monitoring system (AHMS).** A ground-based height keeping performance monitoring system that utilises geometric height data available from automatic dependant surveillance - broadcast (ADS-B) equipped aircraft to calculate the ASE. Monitoring in airspace where a wide-area ADS-B network is available will not require an aircraft to specifically overfly any specific AHMS site, as normal flight operations can be monitored on a continuous basis with no operational impact. Currently, the use of ADS-B for continued height-keeping monitoring purposes is operational in the US, Australia, China and Asian RVSM regions. Contact CAA for further information.

Note: *ICAO has endorsed AHMS (ADS-B) as a means for continued height-keeping monitoring. AHMS (ADS-B) is also a means to meet the initial validation height-keeping monitoring requirements.*

(d) **GPS monitoring units (GMU).** GMUs are a portable aircraft-based height monitoring unit. The GMU process requires straight and level flight between FL 290 and FL 410 where the

GMU provider or operator will monitor the aircraft's height performance. The GMU provider will then process the data by applying differential corrections to the raw GPS data. They then submit it to PARMO where they determine the TVE. GMU monitoring is conducted globally. Contact CAA for further information.

A4.3 RVSM regional monitoring agencies (RMAs)

RMAs are agencies that ICAO has approved following the global implementation of RVSM. These agencies ensure the safe use of specific airspace designated by regional agreement by assessing how successfully the airspace meets the agreed TLS. The target is determined by ICAO and depends on satisfactory aircraft height-keeping performance and measurement of risk associated with operational errors.

A4.3.1 Pacific approvals registry and monitoring organisation (PARMO)

New Zealand-registered aircraft with an RVSM approval are registered with PARMO. PARMO maintains a central registry of state RVSM approvals of operators and aircraft using the pacific region airspace where RVSM is applied. PARMO is responsible for determining whether an operator's fleet has demonstrated acceptable height keeping performance.

Aircraft that are registered with PARMO and have demonstrated an acceptable height keeping performance can be found in the 'PARMO RVSM approvals' database located under 'PARMO documents' on the FAA website. RVSM height monitoring information is also provided to PARMO from other RMAs and the database is updated accordingly. Contact CAA in the first instant on the registration of RVSM approved aircraft or if any discrepancies are found in the above database.

8. Further resources

(a) FAA RVSM documentation web site: Reduced Vertical Separation Minimum (RVSM) | Federal Aviation Administration (faa.gov)

(b) International Civil Aviation Organization (ICAO) Document 4444, *Procedures for Air Navigation Services, Air Traffic Management.*

(c) AC 91-85B - Authorization of Aircraft and Operators for Flight in Reduced Vertical Separation Minimum (RVSM) Airspace (faa.gov)

(d) ICAO Annex 6, *Operation of Aircraft. Part I–International Commercial Air Transport–Aeroplanes and Part II–International General Aviation–Aeroplanes.*

(e) ICAO Document 7030, *Regional Supplementary Procedures.*

(f) ICAO Document 9574, *Manual on Implementation of a 300 m (1,000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive.*