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Manual of Operating Procedures and Practices for Regional Monitoring Agencies in Relation to the Use of a 300 m (1 000 ft) Vertical Separation Minimum above FL 290

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Advance edition (unedited)

FOREWORD

The requirements and procedures for the introduction of 300 m (1 000 ft) vertical separation between FL 290 and FL 410, generally referred to as the reduced vertical separation minimum (RVSM) were developed by the Review of the General Concept of Separation Panel (RGCSP), which has since been renamed the Separation and Airspace Safety Panel (SASP). The provisions necessary for the application of RVSM have been incorporated in Annex 2 — *Rules of the Air*, Annex 6 — *Operation of Aircraft,* Annex 11 — *Air Traffic Services* and the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444). More detailed guidance material was provided in the *Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive* (Doc 9574).

In order to ensure that the overall safety objectives of the air traffic services (ATS) system can be met, all aircraft operating in airspace where RVSM is implemented are required to hold an approval, issued by the State of the Operator or State of Registry as appropriate, indicating that they meet all the technical and operational requirements for such operations. This requirement, and the responsibility of States with regard to the issuance of these approvals, are specified in Annex 6, Part I — *International Commercial Air Transport — Aeroplanes*, 7.2.4 b) and Annex 6, Part II — *International General Aviation — Aeroplanes*, 7.2.4 b).

Doc 9574 states that there is a need for system performance monitoring during both implementation planning and the post-implementation operational use of RVSM. The principles and objectives of monitoring are described in Chapter 6 of Doc 9574. In all regions where RVSM has been implemented, regional monitoring agencies (RMAs) have been established, by the appropriate planning and implementation regional groups (PIRGs), to undertake these functions. The objectives of the RVSM monitoring programme include, inter alia:

a) verification that the RVSM approval process remains effective;

b) verification that the target level of safety will be met on implementation of RVSM and will continue to be met thereafter;

c) monitoring of the effectiveness of the altimetry system modifications which have been implemented to enable aircraft to meet the required height-keeping performance criteria; and

d) evaluation of the stability of altimetry system error (ASE).

This manual was developed to provide guidance for RMAs in the performance of these functions.

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LIST OF ACRONYMS

AAD	Assigned altitude deviation
AAMA	Australian Airspace Monitoring Agency
ACAS	Airborne collision avoidance system
ACC	Area control centre
ADSB	Automatic dependent surveillance – broadcast
AGHME	Aircraft geometric height measurement element
ARMA	AFI regional monitoring agency
ASE	Altimetry system error
ATC	Air traffic control
ATS	Air traffic services
CARSAMMA	Caribbean/South American Regional Monitoring Agencvy
CFL	Cleared flight level
CMA	Central Monitoring Agency
CRM	Collision risk model
EUR RMA	Regional Monitoring Agency for European EUR RVSM airspace
FTE	Flight technical error
GMS	GPS-based monitoring system
GMU	GPS-based positioning system
HF	High frequency
HMU	Height monitoring unit
JAA	Joint Aviation Authorities
JCAB RMA	Japan Regional Monitoring Agency
LHD	Large height deviation
MAAR	Monitoring Agency for the Asia Region
MASPS	Minimum aircraft system performance specification
MID RMA	Middle East Regional Monitoring Agency
MMR	Minimum monitoring requirements
NAARMA	North American Approvals Registry and Monitoring Organization
NAT	North Atlantic
NAT CMA	North Atlantic Central Monitoring Agency
NAT SPG	North Atlantic Systems Planning Group
NOTAM	Notice to airmen
PARMO	Pacific Approvals Registry and Monitoring Organization
RGCSP	Review of the General Concept of Separation Panel
RMA	Regional Monitoring Agency
RVSM	Reduced vertical separation minimum
SASP	Separation and Airspace Safety Panel
SATMA	South Atlantic Monitoring Agency
SD	Standard deviation
SSR	Secondary surveillance radar
TLS	Target level of safety
TVE	Total vertical error
VSM	Vertical separation minimum

EXPLANATION OF TERMS

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

Aberrant aircraft. Aircraft which exhibit measured height-keeping performance that is significantly different from the core height-keeping performance measured for the whole population of aircraft operating in RVSM airspace.

Aircraft type group. 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 that 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.

Altimetry system error stability. Altimetry system error for an individual aircraft is considered to be stable if the statistical distribution of altimetry system error is within agreed limits over an agreed period of time.

Altitude. The vertical distance of a level, point or an object considered as a point, measured from mean sea level (MSL).

Assigned altitude deviation (AAD). The difference between the transponder Mode C altitude and the assigned altitude/flight level.

Automatic altitude-control system. A system that is designed to automatically control the aircraft to a referenced pressure altitude.

Collision risk. The expected number of mid-air aircraft accidents in a prescribed volume of airspace for a specific number of flight hours due to loss of planned separation.

Note.— One collision is considered to result in two accidents.

Exclusionary RVSM airspace. Airspace in which flight cannot be planned by civil aircraft which do not hold a valid RVSM approval from the appropriate State authority.

Flight level. A surface of constant atmospheric pressure which is related to a specific pressure datum, 1013.2 hectopascals (hPa), and is separated from other such surfaces by specific pressure intervals.

Note 1. – A pressure type altimeter calibrated in accordance with the standard atmosphere:

a) when set to a QNH altimeter setting, will indicate altitude;

b) when set to a QFE altimeter setting, will indicate height above the QFE reference datum;

c) when set to 1013.2 hPa, may be used to indicate flight levels.

Note 2.– The terms "height" and "altitude, used in Note 1 above, indicate altimetric rather than geometric heights and altitudes.

Flight technical error (FTE). The difference between the altitude indicated by the altimeter display being used to control the aircraft and the assigned altitude/flight level.

Height. The vertical distance of a level, a point or an object considered as a point, measured from a specified datum.

Height-keeping capability. Aircraft height-keeping performance that can be expected under nominal environmental operating conditions with proper aircraft operating practices and maintenance.

Height-keeping performance. The observed performance of an aircraft with respect to adherence to flight crew prescribed flight level. This includes both technical and operational errors.

Large Height deviation. A deviation of 90m (300ft) or more in magnitude from the cleared flight level.

Non-compliant aircraft. An aircraft configured to comply with the requirements of the RVSM MASPS which, through height monitoring, is found to have a total vertical error (TVE) or an assigned altitude deviation (AAD) of 90 m (300 ft) or greater, or an altimetry system error (ASE) greater than 75 m (245 ft) .

Non-exclusionary RVSM airspace. Airspace where a vertical separation of 300 m (1 000 ft) is applied between RVSM-approved aircraft, but in which flight may be planned by civil aircraft that do not hold a valid RVSM approval from the appropriate State authority. In such airspace, a vertical separation of 600 m (2 000 ft) must be applied between any non-RVSM approved aircraft and all other aircraft.

Occupancy. A parameter of the collision risk model which is twice the number of aircraft proximate pairs in a single dimension divided by the total number of aircraft flying the candidate paths in the same time interval.

Operational error. Any vertical deviation of an aircraft from the correct flight level as a result of incorrect action by ATC or the flight crew.

Overall risk. The risk of collision due to all causes, which includes the technical risk (see definition) and the risk due to operational errors and in-flight emergencies.

Passing frequency. The frequency of events in which two aircraft are in longitudinal overlap when travelling in the same or opposite direction on the same route at adjacent flight levels and at the planned vertical separation.

RVSM Airworthiness a**pproval**. The process by which the State authority ensures that aircraft meet the RVSM minimum aviation system performance specification (MASPS). Typically, this would involve an operator meeting the requirements of the aircraft manufacturer service bulletin for the aircraft and having the State authority verify the successful completion of this work.

RVSM approval. The term is used synonymously with RVSM operational approval.

RVSM Operational approval. The process by which the State authority ensures that an operator meets all the requirements for operating aircraft in RVSM airspace. RVSM Airworthiness approval is a prerequisite for Operational approval.

Target level of safety (TLS). A generic term representing the level of risk which is considered acceptable in particular circumstances.

Technical risk. The risk of collision associated with aircraft technical height-keeping performance, which specifically refers to the performance affected by the avionics of the aircraft, not the flight crew.

Total vertical error (TVE). The vertical geometric difference between the actual pressure altitude flown by an aircraft and its assigned pressure altitude (flight level).

Track. The projection on the earth's surface of the path of an aircraft, the direction of which path at any point is usually expressed in degrees from North (true, magnetic, or grid).

Vertical separation. The spacing provided between aircraft in the vertical plane.

Vertical separation minimum (VSM). VSM is documented in the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) as being a nominal 300 m (1 000 ft) below FL 290 and 600 m (2 000 ft) above FL 290 except where, on the basis of regional agreement, a value of less than 600 m (2 000 ft) but not less than 300 m (1 000 ft) is prescribed for use by aircraft operating above FL 290 within designated portions of the airspace.

CHAPTER 1

INTRODUCTION

1.1 Purpose of the Manual

1.1.1 The intent of this manual is to provide guidance on RMA operating procedures, in order to achieve a standardized approach to the way in which RMAs carry out these functions and the associated detailed duties and responsibilities of Doc 9574. It is not intended to provide exhaustive guidance on how to operate a regional monitoring agency (RMA). Information on what is required of an RMA will be found in the *Manual on Implementation of a 300 M (1 000 ft) Vertical Separation Minimum between FL 290 and FL 410 inclusive* (Doc 9574).

1.2 General description of RMA functions

1.2.1 An RMA supports the implementation and continued safe use of RVSM within a designated airspace. In the context of RVSM, “safe” has a quantitative meaning: satisfaction of the agreed safety goal, or target level of safety (TLS). Section 2.1 of Doc 9574 describes the safety objectives associated with RVSM implementation and use. Paragraph 2.1.4 of Doc 9574 specifies that the TLS attributable to aircraft height-keeping performance, or the technical TLS, should be no greater than 2.5×10^{-9} fatal accidents per aircraft flight hour. Paragraph 2.1.6 specifies that the safety goal for overall risk in connection with RVSM should be set by regional agreement, with several examples of precedent indicating that the value used in practice should be consistent with 5×10^{-9} fatal accidents per aircraft flight hour.

1.2.2 Doc 9574 describes the RMA duties and responsibilities. These are fully explained in Appendix A to this manual. For the purposes of this overview, the functions of an RMA can be summarized as:

a) establish and maintain a database of RVSM approvals;

b) monitor aircraft height-keeping performance and the occurrence of large height deviations, and report results appropriately;

c) conduct safety and readiness assessments and report results appropriately;

d) monitor operator compliance with State approval requirements; and

e) initiate necessary remedial actions if RVSM requirements are not met.

1.2.3 The manual also lists, in Appendix A, the RMA responsible for the provision of monitoring and safety assessment activities in each FIR in which RVSM has been implemented.

1.3 Requirements for establishment and operation of an RMA

1.3.1 An RMA must have both the authority and technical competence to carry out its functions. In establishing an RMA, it is therefore necessary to ensure that:

a) the organization receive authority to act as an RMA as the result of a decision by a State, a group of States or a planning and implementation regional group (PIRG); and

b) the organization acting as an RMA has adequate personnel with the technical skills and experience to carry out the functions listed in 1.2.2.

1.3.2 It is the responsibility of the body authorizing establishment of an RMA to ensure that these requirements are met. An example of a process satisfying this requirement would be for the organization intending to be an RMA to participate in a training programme under the guidance of one of the established RMAs. For an organization with no prior experience with RVSM monitoring, such a programme could take as long as one year and should include both formal and on-the-job training.

CHAPTER 2

WORKING PRINCIPLES COMMON TO ALL REGIONAL MONITORING AGENCIES

This chapter presents the working principles common to all RMAs and describes the activities associated with the five main RMA functions listed in Chapter 1, Section 1.2. More detailed information, including agreed data formats, required communication linkages and appropriate references to ICAO documents and regional materials, is provided in the Appendices.

2.1 Establishment and maintenance of an RVSM approvals database

2.1.1 One of its functions is to establish a database of aircraft approved by their respective State authorities for operations in RVSM airspace in the region for which the RMA has responsibility. This information is necessary for two reasons, first the RMA is responsible for verifying the approval status of all aircraft operating within its region and secondly because height keeping performance data must be correlated to an approved airframe. This information is of vital importance if the height-keeping performance data collected by the height-monitoring systems is to be effectively utilized in the risk assessment

2.1.2 Aviation is a global industry and many aircraft operating in a region where RVSM has not previously been implemented may, nevertheless, be approved for RVSM operations and will have their approvals registered with another RMA. While each RMA will need to establish an RVSM approvals database, there is considerable scope for database sharing. So while a region introducing RVSM will need its own RMA to act as a focal point for the collection and collation of RVSM approvals for aircraft operating under its jurisdiction, it may not need to maintain a complete database of all aircraft in the world that are RVSM-approved. It will, however, need to establish links with other RMAs in order to determine the RVSM status of aircraft it has monitored, or intends to monitor, so that a valid assessment of the technical height-keeping risk can be made.

2.1.3 To avoid duplication by States in registering approvals with RMAs, the concept of a designated RMA for the processing of approval data has been established in this guidance material.. Under the designated RMA concept, all States are associated with a particular RMA for the processing of RVSM approvals. Appendix B provides a proposed listing of States and the respective designated RMA for RVSM approvals. However, this list should be endorsed by PIRGs and/or bi-lateral agreements produced detailing the respective responsibilities. RMAs may contact any State to address safety matters without regard to the designated RMA. The correspondence between the RMA and such particular State should be coordinated with the respective designated RMA.

2.1.4 Appendix C provides the pertinent forms that an RMA should supply to a State authority to obtain information on aircraft RVSM approval status, together with a brief description of their use.

2.1.5 To facilitate data sharing each RMA should maintain its approval database in a common format and in electronic form.

2.1.6 Appendix D suggests the minimum database content, and the format in which it should be maintained by an RMA. Appendix D also contains a description of the data to be shared by RMAs and the procedures for sharing.

2.2 Monitoring and reporting aircraft height-keeping performance and the occurrence of large height deviations

2.2.1 An RMA must be prepared to collect the information necessary to assess the in-service technical height-keeping performance of the aircraft operating in the airspace for which it has the monitoring responsibility. In addition, it must establish procedures for the collection of information concerning large deviations from cleared flight level and operational errors caused by non-compliance with air traffic control (ATC) instructions or loop errors within the ATC system.

2.2.2 Experience has shown that monitoring of aircraft technical height-keeping performance is a challenging task requiring specialized systems. Experience has also shown that organizing and overseeing the collection of large height deviation information necessitates special procedures. These two topics will be treated separately in this section.

Monitoring aircraft height-keeping performance

2.2.3 Monitoring of aircraft height-keeping performance is a demanding enterprise, particularly as regards estimation of ASE. The following discussion of height-keeping performance monitoring first considers the technical requirements for a monitoring system, and then examines the application of monitoring before and after RVSM implementation in an airspace. Guidance on monitoring requirements for RVSM-approved aircraft is also provided along with suggested formats for storing monitoring data to facilitate data exchange with other RMAs.

Establishment of a technical height monitoring function

2.2.4 The principal objectives of an RVSM monitoring programme are to:

a) provide evidence of the effectiveness of the RVSM minimum aviation performance specifications (MASPS), and altimetry system modifications made in order to comply with the MASPS, in achieving the desired height-keeping performance;

b) provide confidence that the technical TLS will be met when RVSM is implemented, and will continue to be met thereafter; and

c) provide evidence of ASE stability.

2.2.5 In order to achieve these objectives, a technical height-monitoring function has to be established. To date, regions which have implemented RVSM have used either ground-based height monitoring units (HMUs) or air portable global positioning system (GPS) monitoring units (GMUs). Whatever system(s) a region decides to use, the quality and reliability of the monitoring infrastructure and its output data must be ensured through correct specification of the systems and thorough verification of performance.

2.2.6 It is particularly important for RMAs to verify that height-monitoring data from whatever sources it uses can be combined for the purposes of the data analysis. The combination of data for collision risk evaluation should be avoided unless the error characteristics of the two monitoring systems have been determined to be identical. For example, this is especially important in any work to establish ASE stability, as the different measurement errors in individual systems could distort the results and indicate ASE instability when none exists, or vice-versa.

2.2.7 As a means of ensuring both adequate accuracy in estimating total vertical error (TVE) and transferability of monitoring results, an RMA must establish that any TVE estimation system which it administers has a mean measurement error close to zero, and a standard deviation of measurement error not greater than 15 m (50 ft). Estimates of measurement errors associated with the HMU and the GPS-based monitoring system (GMS), which employs GMUs, indicate that each system satisfies these requirements.

2.2.8 An RMA should coordinate with the PIRG for its region to ensure that sufficient monitoring infrastructure is available to meet the region's requirements. A suitable monitoring infrastructure could be established through an arrangement to share GMU facilities with an existing RMA, the acquisition of fixed ground-based monitoring facilities within the region, or by engaging a suitable contractor to operate the monitoring programme. If the latter option is selected, the choice of a support contractor should take into account their prior experience, and the suitability of the monitoring procedures and facilities which they propose using.

2.2.9 For further information on the merits and requirements of HMU and GMU monitoring systems, see Appendix O. If a new method of monitoring is proposed, the new system should, in addition to meeting the requirements of 2.2.7, be evaluated against existing systems, to ensure that the results are comparable.

2.2.10 For regions that have a limited monitoring capability, data from other regions may be acceptable for the evaluation of technical risk. This should be considered before determining the minimum technical height-monitoring facilities necessary to meet the requirements of Annex 11.

Technical height monitoring requirements

2.2.11 The three objectives stated in Doc 9574, and noted in the previous section for aircraft height-keeping performance monitoring are applicable to both the pre- and post-implementation phases. However, in general, evidence of ASE stability would not normally be expected to be a product of the pre-implementation phase monitoring as this is a long-term consideration.

2.2.12 During the pre-implementation phase of an RVSM programme, it is necessary to verify that a sufficiently high proportion of the anticipated RVSM aircraft population meets the requirements of the RVSM MASPS. This is the purpose of a pre-implementation technical height monitoring programme.

2.2.13 The majority of current aircraft types are eligible for RVSM airworthiness approval under group approval provisions. These provisions permit the defining of aircraft type groups consisting of aircraft types which are designed and assembled by one manufacturer and are of nominally identical design and build with respect to all details that could influence the accuracy of height-keeping performance. It is not normally necessary to monitor all airframes within a monitoring group providing an adequate sample is available and the performance of the group is within parameters as specified below. The Minimum Monitoring Requirements (MMR) document lists the aircraft types which are eligible for RVSM approval under the group provisions, and the groups to which they belong. It also suggests the level of monitoring that should be expected for each operator.

2.2.14 The analysis of aircraft technical height keeping performance should demonstrate that:

a) the technical TLS of 2.5×10^{-9} fatal accidents per flight hour has been met;

b) the number of aircraft monitored for each operator/aircraft-type combination must meet a pre-determined level;

c) aircraft type-groups must demonstrate performance such that the absolute value of the group mean ASE is not in excess of 25 m (80 ft) and that the sum of the absolute value of the mean ASE and 3 standard deviations (SD) of ASE is not in excess of 75 m (245 ft). No individual measurement should exceed 245 ft in magnitude, excluding monitoring system measurement error; and

d) no individual measurement of ASE for each aircraft approved on a non-group basis for RVSM operations may exceed 49 m (160 ft) in magnitude, excluding monitoring system measurement error.

Note 1.— Data from other regions may be used to meet the above objectives providing it is contemporary with the assessment period.

Note 2.— With reference to item b) above, the minimum number of aircraft of a particular group to be monitored is normally expressed as a percentage of the operator's fleet of that group, with a further provision that the number of aircraft must not be less than 2 unless the operator only has a single airframe of the group.

Note 3.— With reference to item (a) above, the technical TLS is normally only evaluated on an annual basis or as determined by the PIRG. The other activities may be continuous

2.2.15 Guidance regarding the conduct of a safety assessment leading to an estimate of risk for comparison with the TLS referred to in 2.2.14 a) is provided in Section 2.3.

2.2.16 With regard to 2.2.14 b) above, the MMR should be reviewed at regular intervals preferably coordinated with all RMAs. The reviewed version would be available in the ICAO RMA KSN website. An RMA in conjunction with its Planning and Implementation Regional Group (PIRG) may require a higher level on monitoring than defined in the MMR. The MMR itself should be subject to periodic review, *either in collaboration with other RMAs or through ICAO*. This review should be based on quality and quantity of data available.

2.2.17 It is especially important that an RMA takes appropriate action if the height-keeping performance monitoring system detects an individual aircraft whose ASE, after accounting for measurement error, is in excess of the 75 m (245 ft) limit noted in 2.2.14 c). Similarly, appropriate action should be taken if either an aircraft's observed TVE after accounting for measurement error, or its assigned altitude deviation (AAD), is 90 m (300 ft) or more. In all cases, the action should include notifying the aircraft operator and the State authority which granted the aircraft's RVSM approval. Appendix E contains an example of such a letter of notification.

2.2.18 Procedures also need to be established whereby the PIRG is provided with timely notification of all actions taken under the provisions of 2.2.17.

2.2.19 In order to facilitate the exchange of aircraft height-keeping performance monitoring data between RMAs, an RMA should maintain the minimum information identified in Appendix F for each observation of aircraft height-keeping performance obtained from the airspace within which it exercises its functions.

Reporting of aircraft height-keeping performance statistics

2.2.20 Where an RMA is employing a height-keeping performance monitoring system producing substantial estimates of aircraft ASE, tabulations of ASE by aircraft type groups, as identified in the MMR, should be kept. For each group, the magnitude of mean ASE and the magnitude of mean ASE + 3SD of ASE should be calculated and compared to the group performance limits, which are (25 m) 80 ft and 75 m (245 ft), as noted above. Groups exceeding the performance requirements must be investigated and reported annually, or more frequently as required, to the body which authorized the establishment of the RMA. Note that a minimum dataset of results is required before the group results can be considered valid.

2.2.21 In order to provide for situations where one or both of these limits is exceeded for an aircraft type group, an RMA should have a process in place to examine the findings, e.g. through consultation with airworthiness and operations specialists. This could be achieved, where necessary, by establishing a group within the region consisting of specialists in these fields. Alternatively, and in particular in cases where the observed performance deficiency is affecting more than one region, it may be possible to achieve this through cooperation with other regions which have established airworthiness and operations groups.

2.2.22 It is the RMA's responsibility to bring performance issues having an impact on safety to the attention of State authorities, aircraft manufacturers and PIRGs. Should the examination of monitoring results indicate a potential systematic problem in group performance, the RMA, or other appropriate body, should notify both the State authority that issued the airworthiness approval for the aircraft type group in question and the aircraft manufacturer. Where applicable, the RMA may also propose remedial measures. An RMA does not have the regulatory authority to require that improvements to performance be made; only the State which approved the RVSM airworthiness documents for the aircraft type group has such authority. However, the State is required, under the provisions of Annex 6, Parts I and II, to take immediate corrective action with regard to aircraft which are reported by an RMA as not complying with the height-keeping requirements.

2.2.23 The RVSM airworthiness approval documents — in the form of an approved service bulletin, supplementary type certificate or similar State-approved material — provide directions to an operator regarding the steps necessary to bring an aircraft type into compliance with RVSM requirements. If there is a flaw in the ASE performance of an aircraft type, the ultimate goal of the RMA is to influence appropriate corrections to the compliance method, which would then be incorporated into the applicable

RVSM airworthiness approval documents. An RMA's actions to achieve this goal should be the following:

a) assemble all ASE monitoring data for the aircraft type from the airspace for which the RMA is responsible in accordance with the approach shown in Appendix G;

b) assemble the measurement-error characteristics of the monitoring system or systems used to produce the results in a);

c) as deemed relevant by the RMA, assemble all summary monitoring data — consisting of mean ASE, ASE SD, minimum ASE, maximum ASE, and details of any flights found to be non-compliant with ASE requirements — from other regions or airspace where the aircraft type has been monitored; and

d) by means of an official RMA letter, similar in form to that shown in Appendix G, inform the State authority which approved the airworthiness documents for the aircraft type group, and the manufacturer, of the observation of allegedly inadequate ASE performance, citing:

    1) the requirement that the absolute value of an aircraft-type group's mean ASE be no greater than 25 m (80 ft), and that the sum of the absolute value of the group's mean ASE and 3SD of ASE be no greater than 75 m (245 ft);

    2) the data described in a) and b) and, as necessary, c), which will be provided on request;

    3) the need for compliance with these requirements in order to support safe RVSM operations; and

    4) a request to be informed of consequent action taken by the State and/or manufacturer to remedy the cause or causes of the observed performance, including any changes to the State airworthiness approval documents.

Monitoring the occurrence of large height deviations

2.2.24 Experience has shown that large height deviations — errors of 90 m (300 ft) or more in magnitude — have had significant influence on the outcome of safety assessments before and after implementation of RVSM. RMAs play a key role in the collection and processing of reports of such occurrences.

2.2.25 The causes of such errors have been found to be:

a) an error in the altimetry or automatic altitude control system of an aircraft;

b) turbulence and other weather-related phenomena;

c) an emergency descent by an aircraft without the crew following established contingency procedures;

d) response to airborne collision avoidance system (ACAS) resolution advisories;

e) not following an ATC clearance, resulting in flight at an incorrect flight level;

f) an error in issuing an ATC clearance, resulting in flight at an incorrect flight level; and

g) errors in coordination of the transfer of control responsibility for an aircraft between adjacent ATC units, resulting in flight at an incorrect flight level.

2.2.26 The aircraft technical height-keeping performance monitoring programme administered by an RMA addresses the first of these causes. There is, however, a need to establish, at a regional level, the means to detect and report the occurrence of large height deviations (LHDs) due to the remaining causes. A sample large height deviation reporting form is included in Appendix H. While the RMA will be the recipient and archivist for reports of large height deviations, it is important to note that the RMA alone cannot be expected to conduct all activities associated with a comprehensive programme to detect and report large height deviations. This needs to be addressed through the appropriate PIRG and its subsidiary bodies, as part of an overall regional safety management programme.

2.2.27 Typically, a program to assess large height deviations will usually include a regional or State based Scrutiny Group to support the RMA monitoring function. A Scrutiny Group is comprised of operational and technical subject matter experts that support the evaluation and classification of LHDs. The RMA should coordinate with the PIRG to establish a Regional Scrutiny Group, or relevant State organizations to establish a State based Scrutiny Group that will examine reports of large height deviations. Scrutiny Group guidance is contained in Appendix I.

2.2.28 Experience has shown that the primary sources for reports of large height deviations are the ATC units providing air traffic control services in the airspace where RVSM is or will be applied. The information available to these units, in the form of voice reports, Automatic Dependent Surveillance-contract (ADS-C) reports and through the use of ATS surveillance systems such as radar, Automatic Dependent Surveillance – Broadcast (ADS-B) or multilateration (MLAT), provides the basis for identifying large height deviations. A programme for identifying large height deviations should be established and ATC units should report such events monthly. A recommended, monthly report format is provided in Appendix J. It is the responsibility of the RMA to collect this information, and to provide periodic reports of observed height deviations to the appropriate PIRG and/or its subsidiary bodies, in accordance with procedures prescribed by the PIRG.

2.2.29 For all involved aircraft the individual LHD reports from ATC units to the RMA should contain, as a minimum, the following information:

a) reporting unit;

b) location of deviation, either as latitude/longitude or a bearing and distance from a significant point;

c) date and time of large height deviation;

d) sub-portion of airspace, such as established route system, if applicable;

e) flight identification and aircraft type;

f) assigned flight level;

g) final reported flight level or altitude and basis for establishment (e.g. pilot report or Mode C);

h) duration at incorrect level or altitude;

i) cause of deviation;

j) any other traffic in potential conflict during deviation;

k) crew comments when notified of deviation; and

l) remarks from ATC unit making report.

2.2.30 Other sources for reports of large height deviations should also be explored. For example, an RMA should investigate, in conjunction with the responsible PIRG, whether operators within the airspace for which it is responsible would be prepared to share pertinent summary information from internal safety occurrence databases. Arrangements should also be made for access to information which may be pertinent to the RVSM airspace from State databases of air safety incident reports and voluntary reporting safety databases, such as the Aviation Safety Reporting System administered by the United States National Aeronautics and Space Administration (NASA), all of which could be possible sources of information concerning large height deviation incidents in the airspace for which the RMA is responsible.

2.3 Conducting safety and readiness assessments and reporting results before RVSM implementation

2.3.1 A safety assessment consists of estimating the risk of collision associated with RVSM and comparing this risk to the agreed RVSM safety goal, the TLS. An RMA needs to acquire an in-depth knowledge of the use of the airspace within which RVSM will be implemented. This requirement will continue after implementation. Experience has shown that such knowledge can be gained, in part, through a review of charts and other material describing the airspace, and through periodic collection of samples of traffic movements within the airspace. However, it is also important that the personnel of the RMA have sufficient understanding of the way in which an ATC system operates to enable them to correctly interpret the information from these sources.

2.3.2 It should also be noted that currently, there is no standard collision risk model (CRM) applicable to all airspace. Development and application of a CRM is a complicated activity and should only be conducted by trained and experienced personnel. Emerging RMAs that do not have the requisite skills should seek assistance from external sources or established RMAs before adapting a CRM or attempting to conduct risk calculations. Additional guidance can be obtained from previous RGCSP and

SASP documentation. It will be necessary to adapt existing CRM parameters to take account of regional variations.

2.3.3 A readiness assessment is an examination of the approval status of operators and aircraft using airspace where RVSM is planned in order to evaluate whether a sufficiently high proportion of operations will be conducted by approved operators and aircraft when RVSM is introduced.

2.3.4 An RMA is responsible for conducting both safety and readiness assessments prior to RVSM implementation. The responsibility for conducting safety assessments continues after RVSM is introduced.

Safety assessment

2.3.5 One of the principal duties of an RMA is to conduct a safety assessment prior to RVSM implementation. It is strongly recommended that an RMA conduct a series of safety assessments prior to RVSM implementation. These should start at least one year prior to the planned implementation date, in order to provide the body overseeing RVSM introduction with early indications of any problems which must be remedied before RVSM may be implemented.

2.3.6 The PIRG will specify the safety reporting requirements for the RMA.

Establishing the competence necessary to conduct a safety assessment

2.3.7 Conducting a safety assessment is a complex task requiring specialized skills that are not widely available. As a result, an RMA will need to pay special attention to ensuring that it has the necessary competence to complete this task prior to and after RVSM implementation.

2.3.8 Ideally, an RMA should have the internal competence to conduct a safety assessment. However, recognizing that personnel with the required skills may not be available internally, it may be necessary for the RMA to augment its internal staff capabilities, through arrangements with another RMA or some other organization possessing the necessary competence.

2.3.9 If it is necessary to use an external organization to conduct a safety assessment, the RMA must nevertheless have the internal competence to judge that such an assessment is done properly. This competence should be acquired through an arrangement with an RMA that has experience in the conduct of safety assessments.

Preparations for conduct of a safety assessment

2.3.10 In preparing to support an RVSM implementation, the responsible RMA needs to ensure that the safety assessment takes account of all the factors which influence collision risk within the airspace where RVSM will be applied. RMAs therefore need to establish the means for collecting and organizing the pertinent data and other information that is needed to adequately assess all the relevant airspace factors. As is noted below, some data sources from other airspace where RVSM has been implemented may assist an RMA in conducting a safety assessment. However, the overall safety assessment results from another portion of worldwide airspace may not be used as the sole justification for concluding that the TLS will be met in the airspace where the RMA has safety assessment responsibility.

Assembling a sample of traffic movements from the airspace

2.3.11 Samples of traffic movements should be collected for the entire airspace where RVSM will be implemented. As a result, ATC providers within the airspace may need to cooperate in the collection of samples. In this case, the RMA will need to coordinate collection of traffic movement samples through the body overseeing RVSM implementation.

2.3.12 The first sample of traffic movement data should be collected as soon as is practicable after the decision to implement RVSM within a particular airspace has been made. However, it is also necessary that the operational details of the implementation are agreed prior to the data collection. For example, RVSM may be implemented as exclusionary airspace, in which an aircraft must have RVSM approval to flight plan through the airspace, or as non-exclusionary airspace, in which flight by non-RVSM approved aircraft is permitted. In the latter case, a minimum of 600 m (2 000 ft) vertical separation must be provided between the non-approved aircraft and all other aircraft. The RMA also needs to be aware of any changes to the ATS route structure, including changes to the permitted directions of flight on existing routes. Operational factors such as these need to be taken into account in the safety assessment.

2.3.13 The RMA should plan to collect at least two samples of traffic movement data prior to RVSM implementation, with the timing of the first as noted in the previous paragraph. The timing of the second sample should be as close to the planned time of implementation as is practicable in light of the time required to collect, process and analyze the sample, and to extract information necessary to support final safety and readiness assessments.

2.3.14 In planning the time and duration of a traffic sample, the RMA should take into account the importance of capturing any periods of heavy traffic flow which might result from seasonal or other factors. The duration of any traffic sample should be at least 30 days, or any other statistically significant period, with a longer sample period left to the judgment of the RMA.

2.3.15 The following information should be collected for each flight in the sample:

a) date of flight (mm/dd/yyyy) or (dd/mm/yyyy);

b) flight identification or aircraft call sign, in standard ICAO format;

c) aircraft type designator, as listed in ICAO Doc 8643, Aircraft Type Designators;

d) aircraft registration mark, if available;

e) does Item 10 of Flight Plan Indicate that the Operator and Aircraft are RVSM approved? (Does a "W" appear in Item 10 of Flight Plan?)

f) location indicator for the origin aerodrome, as listed in ICAO Doc 7910, Location Identifiers;

g) location indictor for the destination aerodrome, as listed in ICAO Doc 7910, Location Identifiers ;

h) entry point into RVSM airspace (as a significant point or latitude/longitude);

i) time at entry point;

j) flight level at entry point;

k) exit point from RVSM airspace (as a significant point or latitude/longitude);

l) time at exit point;

m) flight level at exit point; and

n) as many additional position/time/flight-level combinations as the RMA judges are necessary to capture the traffic movement characteristics of the airspace.

2.3.16 Where possible, in coordinating the collection of the sample, the RMA should specify that information be provided in electronic form, for example, in a spreadsheet. Appendix K contains a sample specification for the collection of traffic movement data in electronic form, where the entries in the first column may be used as column headings on a spreadsheet template.

2.3.17 Acceptable sources for the information required in a traffic movement sample are one or more of the following: special ATC observations, ATC automation systems, automated air traffic management systems, and secondary surveillance radar (SSR) reports.

Review of operational procedures and airspace organization

2.3.18 Experience has shown that the operational procedures and airspace organization associated with an RVSM implementation can substantially affect the collision risk in RVSM airspace. A further example of this, in addition to those already given in 2.3.11, would be a decision to apply the Table of Cruising Levels in Appendix 3 of Annex 2 — *Rules of the Air*, while using routes in a unidirectional manner. The consequence of this decision would be to provide an effective 600 m (2 000 ft) vertical separation between aircraft at adjacent usable flight levels on these routes.

2.3.19 In light of such possibilities, the RMA should carefully review the proposed operational procedures and airspace organization in order to identify any features that might influence risk. The body responsible for the planning and oversight of the RVSM implementation should be informed about any aspects of the proposals which could adversely affect risk.

Agreed process for determining whether the TLS is met as the result of a safety assessment

2.3.20 "Technical risk" is the term used to describe the risk of collision associated with aircraft height-keeping performance. Some of the factors which contribute to technical risk are:

a) errors in aircraft altimetry and automatic altitude control systems;

b) aircraft equipment failures resulting in unmitigated deviation from the cleared flight level, including those where not following the required procedures further increased the risk; and

c) responses to false ACAS resolution advisories.

Intuitively, such factors affect risk more if the planned vertical separation between a pair of aircraft is 300 m (1 000 ft) than if a 600 m (2 000 ft) standard is in use.

2.3.21 The term "operational error" is used to describe any vertical deviation of an aircraft from the correct flight level as a result of incorrect action by ATC or the flight crew. Examples of such actions are:

a) a flight crew misunderstanding an ATC clearance, resulting in the aircraft operating at a flight level other than that issued in the clearance;

b) ATC issuing a clearance which places an aircraft at a flight level where the required separation from other aircraft cannot be maintained;

c) a coordination failure between ATC units in the transfer of control responsibility for an aircraft, resulting in either no notification of the transfer or in transfer at an unexpected flight level;

d) inappropriate response to a valid ACAS resolution advisory; and

e) incorrect pressure setting on the altimeters, e.g. QNH remains set.

2.3.22 On initial consideration, the relation between the required vertical separation and the risk due to operational errors may be less clear than is the case with technical risk. However, as will be pointed out during subsequent discussion of risk modelling, introduction of RVSM does increase the risk associated with such errors if all other factors remain unchanged when transitioning from a 600 m (2 000 ft) to a 300 m (1 000 ft) vertical separation minimum. When carrying out the risk assessment, care should be taken to avoid including a single event in both the assessment of technical and operational risk.

2.3.23 The overall RVSM safety goal which must be satisfied is a TLS value of 5×10^{-9} fatal accidents per flight hour due to all causes of risk associated with RVSM. However, as noted in 1.2.1, there is also an upper limit to the permissible technical risk. In order to declare that the safety goal has been met, the RMA must therefore show that the following two conditions are satisfied simultaneously:

a) the technical risk does not exceed 2.5×10^{-9} fatal accidents per flight hour; and

b) the sum of the technical risk and the risk resulting from operational errors does not exceed 5×10^{-9} fatal accidents per flight hour.

2.3.24 While there is a firm bound on technical risk of 2.5×10^{-9} fatal accidents per flight hour, there is no similar maximum tolerable value for risk due to operational errors. Thus, it is possible that the application of risk modeling can result in an estimate of technical risk less than 2.5×10^{9} fatal accidents per flight hour and an estimate of operational risk in excess of this value, with the sum of the two still satisfying the overall TLS. On the other hand, if the estimate of technical risk exceeds 2.5 x 10^{-9} fatal accidents per flight hour, it is not possible to satisfy the overall safety goal, even if the sum of the estimated technical and operational risks does not exceed 5 x 10^{-9} fatal accidents per flight hour.

The collision risk model used in safety assessment

2.3.25 This guidance will not present derivation or details of the collision risk model to be used in conducting a safety assessment. An RMA should acquire that background knowledge through review of the following publications:

a) *Report of the Sixth Meeting of the Review of the General Concept of Separation Panel* (RGCSP/6) (Doc 9536) Montreal, 28 November to 15 December 1988, Volume 1 *(History and Report)* and Volume 2 *(Annexes A to E)*;

b) *Risk Assessment and System Monitoring*[1], August 1996, available from the ICAO European and North Atlantic Office;

c) *EUR RVSM Mathematical Supplement*, Document RVSM 830, European Organization for the Safety of Air Navigation (Eurocontrol), August 2001; and

d) *Guidance Material on the Implementation of a 300 m (1 000 ft) Vertical Separation Minimum (VSM) for Application in the Airspace of the Asia Pacific Region*, Appendix C, ICAO Asia and Pacific Office, Bangkok, October 2000.

2.3.26 The report of RGCSP/6 contains the derivation of the basic mathematical vertical collision risk model, as well as a description of the choice of a value for the portion of the TLS applied to technical risk.

2.3.27 The North Atlantic and Eurocontrol documents contain the detailed safety assessment processes and procedures applied in the two Regions in preparation for RVSM implementation. Appendix L presents an overview of the mathematical models used in the North Atlantic safety assessment process.

Readiness assessment

2.3.28 A readiness assessment is a comparison of the actual and predicted proportion of operations conducted by State-approved operators and aircraft in an airspace prior to RVSM implementation to a threshold proportion established by the body overseeing the implementation. Such an assessment is most meaningful when the oversight body has agreed that RVSM will be applied on an exclusionary basis, that is, that all flights planned to be operated in the airspace must be conducted by an operator and aircraft with State RVSM approval.

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[1] This material was contained in NAT Doc 002 which is no longer in print; however, the Supplement is still available.

2.3.29 A readiness assessment requires information from two sources; a sample of traffic movements in the relevant airspace, and the database of State RVSM approvals.

2.3.30 The RMA should organize the traffic movement sample by the number of operations for each operator/aircraft-type pair and then, if registration marks are available in the sample, by the number of operations for the individual aircraft within each operator/aircraft-type pair. The approval status of each aircraft should then be checked using the database of State approvals. If registration marks are not available in the sample data, it will be necessary to make some assumptions about the proportion of the operations by the operator/aircraft-type pair in question that were flown by RVSM approved aircraft. In the absence of more specific data, this could be based on the proportion of the operator's fleet of aircraft of that type which were RVSM approved.

2.3.31 Once the classification of all operations as approved or non-approved is complete, the sum of RVSM approved operations is divided by the total number of operations in the sample, to give the proportion of operations conducted by RVSM-approved operators and aircraft. This can then be compared to the readiness threshold.

2.3.32 The RMA should prepare periodic reports of the readiness status of operators and aircraft during the period of preparation for RVSM implementation. Typically, such a report would be provided for each meeting of the body overseeing RVSM implementation.

2.3.33 Experience indicates that it is important to take into account the future plans of operators regarding RVSM approval when conducting a readiness assessment. The RMA should, therefore, attempt to establish the intentions of operators regarding the approval of existing aircraft, and acquisition of new aircraft types, and include this information as a companion report to the readiness assessment.

2.4 Safety reporting and monitoring operator compliance with State approval requirements after RVSM implementation

2.4.1 The responsibilities of an RMA continue after RVSM implementation. The overall function of RMA activities after implementation is to support the continued safe use of RVSM.

2.4.2 After RVSM implementation, the RMA should conduct periodic safety assessments in order to determine whether the TLS continues to be met. The frequency of these reports would be as required by the responsible PIRG. The minimum requirement should be annual reports.

2.4.3 One important post-implementation activity is to carry out periodic checks of the approval status of operators and aircraft using airspace where RVSM is applied. This activity is especially important in flight information region (FIR) or other areas of responsibility (AORs) where RVSM is applied on an exclusionary basis. This activity is termed monitoring operator compliance with State approval requirements.

2.4.4 An RMA will require two sources of information to monitor operator compliance with State approval requirements: a listing of the operators, and the type and registration marks of aircraft operating in the airspace; and the database of State RVSM approvals.

2.4.5 Ideally, this compliance monitoring should be done for the entire airspace on a daily basis. Difficulties in accessing traffic movement information may make such daily monitoring impossible. As a minimum, the responsible RMA should conduct compliance monitoring of the complete airspace for at least a 30-day period annually.

2.4.6 When conducting compliance monitoring, the filed RVSM approval status shown on the flight plan of each traffic movement should be compared to the database of State RVSM approvals. When a flight plan shows an aircraft as RVSM approved, but the approval is not recorded in the database, the appropriate State authority should be contacted for clarification of the discrepancy. The RMA should use a letter similar in form to that shown in Appendix M for the official notification.

2.4.7 RMAs should keep in mind that it is the responsibility of the State authority to take appropriate action should an operator be found to have filed a false declaration of RVSM approval status.

2.5 Remedial actions

2.5.1 Remedial actions are those measures taken to remove causes of systematic problems associated with factors affecting safe use of RVSM. RMAs must be proactive in the identification, reporting and resolution of all causes of risk. Remedial actions may be necessary to remove the causes of problems such as the following:

a) failure of an aircraft type group to comply with group ASE requirements;

b) failure of individual airframes to meet ASE compliance requirements;

c) aircraft operating practices resulting in large height deviations; or

d) operational errors.

2.5.2 All RMAs should periodically review monitoring results in order to determine if there is evidence of any recurring problems.

2.5.3 An RMA should design its height-keeping performance monitoring programme to provide ongoing summary information of ASE performance by aircraft type group so that adverse trends can be identified quickly. When non-compliant ASE performance is confirmed for an aircraft type group or individual airframe, the RMA should follow the guidance material described in this manual.

2.5.4 The RMA should report any issue that impacts on the safe operation of RVSM to the PIRG in accordance with agreed procedures. It is especially important that RMAs conduct an annual review of reports of large height deviations with a view toward uncovering systematic problems. Should such a problem be discovered, the RMA should report its findings to the body overseeing RVSM implementation if RVSM has not yet been introduced. Post-implementation, these reports should be submitted in accordance with the requirements specified by the body that authorized the establishment of the RMA. The reports should include details of large height deviations suggesting the existence of a systematic problem.

APPENDIX A

REGIONAL MONITORING AGENCY DUTIES AND RESPONSIBILITIES

Based on paragraphs 6.4.4 and 6.4.5 of the Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive *(Doc 9574)*

The duties and responsibilities of a regional monitoring agency are to:

1. establish and maintain a database of aircraft approved by the respective State authorities for operations within RVSM airspace in that region.

2. receive reports of height deviations of aircraft observed to be non-compliant, based on the following criteria:

    a) TVE ≥ 90 m (300 ft);
    b) ASE ≥ 75 m (245 ft);
    c) AAD ≥ 90 m (300 ft).

3. take the necessary action with the relevant State and operator to:

    determine the likely cause of the height deviation; and
    verify the approval status of the relevant operator.

4. recommend, wherever possible, remedial action;

5. analyze data to detect height deviation trends and, hence, to take action as in the previous item;

6. undertake such data collections as are required by the PIRG to:

    a) investigate height-keeping performance of the aircraft in the core of the distribution;

    b) establish or add to a database on the height-keeping performance of:

        — the aircraft population
        — aircraft types or categories; and
        — individual airframes

7. monitor the level of risk as a consequence of operational errors and in-flight contingencies as follows:

    a) establish a mechanism for collation and analysis of all reports of height deviations of 90 m (300 ft) or more resulting from the above errors/actions;

    b) determine, wherever possible, the root cause of each deviation together with its size and duration;

    c) calculate the frequency of occurrence;

   d) assess the overall risk (technical combined with operational and in-flight contingencies) in the system against the overall safety objectives (see Doc 9574); and

   e) initiate remedial action as required.

8. initiate checks of the "approval status" of aircraft operating in the relevant RVSM airspace, identify non-approved operators and aircraft using RVSM airspace and notify the appropriate State of Registry/State of the Operator accordingly;

9. circulate regular reports on all height-keeping deviations, together with such graphs and tables necessary to relate the estimated system risk to the TLS, employing the criteria detailed in Doc 9574, for which formats are suggested in Appendix A to Doc 9574; and

10. submit annual reports to the PIRG.

Flight Information Regions and Responsible Regional Monitoring Agency
(Sample Table Only. Controlled Version Available on RMA KSN Site)

Responsible RMA	FIR
AAMA	Brisbane
AAMA	Honiara
AAMA	Jakarta
AAMA	Melbourne
AAMA	Nauru
AAMA	Port Moresby
AAMA	Ujung Pandang
ARMA	Accra
ARMA	Algiers
ARMA	Addis Ababa
ARMA	Antananarivo
ARMA	ASMARA
ARMA	Beirra
ARMA	Brazzaville
ARMA	Cape Town
ARMA	Dakar
ARMA	Dar Es Salam
ARMA	Entebbe
ARMA	Gaberone
ARMA	Harare
ARMA	Johannesburg
ARMA	Kano
ARMA	Kingshasa
ARMA	Khartoum
ARMA	Lilongwe
ARMA	Luanda
ARMA	Lusaka
ARMA	Mauritius
ARMA	Mogadisho
ARMA	N'Djamena
ARMA	Nairobi
ARMA	Niamey
ARMA	Roberts
ARMA	Seychelles
ARMA	Tripoli
ARMA	Windhoek
CARSAMMA	Amazonica
CARSAMMA	Antofagasta
CARSAMMA	Asuncion
CARSAMMA	Barranquilla
CARSAMMA	Bogota

Responsible RMA	FIR
CARSAMMA	Brasilia
CARSAMMA	Central American
CARSAMMA	Comodoro Rivadavia
CARSAMMA	Cordoba
CARSAMMA	Curacao
CARSAMMA	Curitiba
CARSAMMA	Easter Island
CARSAMMA	Ezeiza
CARSAMMA	Georgetown
CARSAMMA	Guayaquil
CARSAMMA	Havana
CARSAMMA	Kingston
CARSAMMA	La Paz
CARSAMMA	Lima
CARSAMMA	Maiquetia
CARSAMMA	Mendoza
CARSAMMA	Montevideo
CARSAMMA	Panama
CARSAMMA	Paramaribo
CARSAMMA	Piarco
CARSAMMA	Port Au Prince
CARSAMMA	Puerto Montt
CARSAMMA	Punta Arenas
CARSAMMA	Recife
CARSAMMA	Resistencia
CARSAMMA	Rouchambeau
CARSAMMA	Santiago
CARSAMMA	Santo Domingo
China RMA	Beijing
China RMA	Guangzhou
China RMA	Kunming
China RMA	Lanzhou
China RMA	Pyongyang
China RMA	Sanya
China RMA	Shanghai
China RMA	Shenyang
China RMA	Urumqi
China RMA	Wuhan
CMA	Bodo Oceanic
CMA	Gander
CMA	New York Oceanic
CMA	Reykjavik
CMA	Santa Maria
CMA	Shanwick
EUR RMA	Ankara

Responsible RMA	FIR
EUR RMA	Athinai
EUR RMA	Barcelona
EUR RMA	Beograd
EUR RMA	Berlin
EUR RMA	Bodø
EUR RMA	Bratislava
EUR RMA	Bremen
EUR RMA	Brest
EUR RMA	Brindisi
EUR RMA	Bruxelles
EUR RMA	Bucuresti
EUR RMA	Budapest
EUR RMA	Casablanca
EUR RMA	Chisinau
EUR RMA	Düsseldorf
EUR RMA	France
EUR RMA	Frankfurt
EUR RMA	Hannover
EUR RMA	Istanbul
EUR RMA	Kaliningrad
EUR RMA	Kharkiv
EUR RMA	København
EUR RMA	Kyiv
EUR RMA	Lisboa
EUR RMA	Ljubljana
EUR RMA	London
EUR RMA	L'viv
EUR RMA	Madrid
EUR RMA	Malmö
EUR RMA	Malta
EUR RMA	Milano
EUR RMA	Minsk
EUR RMA	München
EUR RMA	Nicosia
EUR RMA	Odesa
EUR RMA	Oslo
EUR RMA	Praha
EUR RMA	Rhein
EUR RMA	Riga
EUR RMA	Roma
EUR RMA	Rovaniemi
EUR RMA	Sarajevo
EUR RMA	Scottish
EUR RMA	Shannon

Responsible RMA	FIR
EUR RMA	Simferopol
EUR RMA	Skopje
EUR RMA	Sofia
EUR RMA	Stavanger
EUR RMA	Stockholm
EUR RMA	Sundsvall
EUR RMA	Switzerland
EUR RMA	Tallinn
EUR RMA	Tampere
EUR RMA	Tirana
EUR RMA	Trondheim
EUR RMA	Tunis
EUR RMA	Varna
EUR RMA	Vilnius
EUR RMA	Warszawa
EUR RMA	Wien
EUR RMA	Zagreb.
EUR RMA	Amsterdam
JAPAN RMA	Fukuoka
MAAR	Bangkok
MAAR	Calcutta
MAAR	Chennai
MAAR	Colombo
MAAR	Delhi
MAAR	Dhaka
MAAR	Hanoi
MAAR	Ho Chi Minh
MAAR	Hong Kong
MAAR	Karachi
MAAR	Kathmandu
MAAR	Kota Kinabalu
MAAR	Kuala Lumpur
MAAR	Lahore
MAAR	Male
MAAR	Manila
MAAR	Mumbai
MAAR	Phnom Penh
MAAR	Singapore
MAAR	Taipei
MAAR	Ulaanbaatar
MAAR	Vientiane
MAAR	Yangon
MID RMA	Amman
MID RMA	Bahrain

Responsible RMA	FIR
MID RMA	Bahgdad
MID RMA	Beirut
MID RMA	Cairo
MID RMA	Jeddah
MID RMA	Damascus
MID RMA	Kabul
MID RMA	Kuwait
MID RMA	Muscat
MID RMA	Sanaa
MID RMA	Tehran
MID RMA	Emirates
NAARMO	Albuquerque
NAARMO	Anchorage Oceanic
NAARMO	Anchorage Arctic
NAARMO	Anchorage Continental
NAARMO	Atlanta
NAARMO	Boston
NAARMO	Chicago
NAARMO	Cleveland
NAARMO	Denver
NAARMO	Edmonton
NAARMO	Fort Worth
NAARMO	Gander Domestic
NAARMO	Houston
NAARMO	Houston Oceanic
NAARMO	Indianapolis
NAARMO	Jacksonville
NAARMO	Kansas City
NAARMO	Los Angeles
NAARMO	Mazatlan
NAARMO	Mazatlan Oceanic
NAARMO	Memphis
NAARMO	Merida
NAARMO	Mexico
NAARMO	Miami
NAARMO	Miami Oceanic
NAARMO	Minneapolis
NAARMO	Monkton
NAARMO	Monterrey
NAARMO	Montreal
NAARMO	New York
NAARMO	Oakland
NAARMO	Salt Lake
NAARMO	San Juan

Responsible RMA	FIR
NAARMO	Seattle
NAARMO	Toronto
NAARMO	Vancouver
NAARMO	Washington
NAARMO	Winnipeg
PARMO	Anchorage Oceanic
PARMO	Auckland Oceanic
PARMO	New Zealand Domestic
PARMO	Bermuda
PARMO	Incheon
PARMO	Nadi
PARMO	Oakland Oceanic
PARMO	Tahiti
SATMA	Atlantic
SATMA	Canarias South
SATMA	Dakar Oceanic
SATMA	Sal Oceanic

APPENDIX B

STATES AND DESIGNATED RMA FOR THE REPORTING OF RVSM APPROVALS

(Sample Table Only. Controlled Version Available on RMA KSN Site)

The following table provides a listing of States and the respective designated RMA for the reporting of RVSM approvals, for distribution by the designated RMA.

ICAO Contracting State	Designated RMA for RVSM Approvals
Afghanistan	MID RMA
Albania	EUR RMA
Algeria	ARMA
Andorra	EUR RMA
Angola	ARMA
Antigua and Barbuda	CARSAMMA
Argentina	CARSAMMA
Armenia	EUR RMA
Aruba	CARSAMMA
Australia	AAMA
Austria	EUR RMA
Azerbaijan	EUR RMA
Bahamas	CARSAMMA
Bahrain	MID RMA
Bangladesh	MAAR
Barbados	CARSAMMA
Belarus	EUR RMA
Belgium	EUR RMA
Belize	CARSAMMA
Benin	ARMA
Bhutan	MAAR
Bolivia	CARSAMMA
Bosnia and Herzegovina	EUR RMA
Botswana	ARMA
Brazil	CARSAMMA
Brunei Darussalam	PARMO
Bulgaria	EUR RMA
Burkina Faso	ARMA
Bermuda	PARMO
Burundi	ARMA
Cambodia	MAAR
Cameroon	ARMA
Canada	NAARMO
Cape Verde	ARMA
Central African Republic	ARMA
Chad	ARMA

ICAO Contracting State	Designated RMA for RVSM Approvals
Chile	CARSAMMA
P.R. China	CHINA RMA
Colombia	CARSAMMA
Comoros	ARMA
Congo	ARMA
Cook Islands	PARMO
Costa Rica	CARSAMMA
Côte d'Ivoire	ARMA
Croatia	EUR RMA
Cuba	CARSAMMA
Cyprus	EUR RMA
Czech Republic	EUR RMA
Democratic People's Republic of Korea	China RMA
Democratic Republic of the Congo	ARMA
Denmark	EUR RMA
Djibouti	ARMA
Dominican Republic	CARSAMMA
Ecuador	CARSAMMA
Egypt	MID RMA
El Salvador	CARSAMMA
Equatorial Guinea	ARMA
Eritrea	ARMA
Estonia	EUR RMA
Ethiopia	ARMA
Fiji	PARMO
Finland	EUR RMA
France	EUR RMA
Gabon	ARMA
Gambia	ARMA
Georgia	EUR RMA
Germany	EUR RMA
Ghana	ARMA
Greece	EUR RMA
Grenada	CARSAMMA
Guatemala	CARSAMMA
Guinea	ARMA
Guinea-Bissau	ARMA
Guyana	CARSAMMA
Haiti	CARSAMMA
Honduras	CARSAMMA
Hong Kong	MAAR
Hungary	EUR RMA
Iceland	CMA
India	MAAR
Indonesia	AAMA

ICAO Contracting State	Designated RMA for RVSM Approvals
Iran (Islamic Republic of)	MID RMA
Iraq	MID RMA
Ireland	CMA
Israel	EUR RMA
Italy	EUR RMA
Jamaica	CARSAMMA
Japan	JAPAN RMA
Jordan	MID RMA
Kazakhstan	EUR RMA
Kenya	ARMA
Kiribati	PARMO
Kuwait	MID RMA
Kyrgyzstan	EUR RMA
Lao People's Democratic Republic	MAAR
Latvia	EUR RMA
Lebanon	MID RMA
Lesotho	ARMA
Liberia	ARMA
Libyan Arab Jamahiriya	ARMA
Lithuania	EUR RMA
Luxembourg	EUR RMA
Madagascar	ARMA
Malawi	ARMA
Malaysia	MAAR
Maldives	MAAR
Mali	ARMA
Malta	EUR RMA
Marshall Islands	PARMO
Mauritania	ARMA
Mauritius	ARMA
Mexico	NAARMO
Micronesia (Federated States of)	PARMO
Monaco	EUR RMA
Mongolia	MAAR
Morocco	EUR RMA
Mozambique	ARMA
Myanmar	MAAR
Namibia	ARMA
Nauru	AAMA
Nepal	MAAR
Netherlands, the Kingdom of	EUR RMA
New Zealand	PARMO
Nicaragua	CARSAMMA
Niger	ARMA
Nigeria	ARMA

ICAO Contracting State	Designated RMA for RVSM Approvals
Norway	CMA
Oman	MID RMA
Pakistan	MAAR
Palau	PARMO
Panama	CARSAMMA
Papua New Guinea	AAMA
Paraguay	CARSAMMA
Peru	CARSAMMA
Philippines	MAAR
Poland	EUR RMA
Portugal	CMA
Qatar	MID RMA
Republic of Korea	PARMO
Republic of Moldova	EUR RMA
Romania	EUR RMA
Russian Federation	EUR RMA
Rwanda	ARMA
Saint Kitts and Nevis	CARSAMMA
Saint Lucia	CARSAMMA
Saint Vincent and the Grenadines	CARSAMMA
Samoa	APARMO
San Marino	EUR RMA
Sao Tome and Principe	ARMA
Saudi Arabia	MID RMA
Senegal	ARMA
Serbia and Montenegro	EUR RMA
Seychelles	ARMA
Sierra Leone	ARMA
Singapore	MAAR
Slovakia	EUR RMA
Slovenia	EUR RMA
Solomon Islands	AAMA
Somalia	ARMA
South Africa	ARMA
Spain	EUR RMA
Sri Lanka	MAAR
Sudan	ARMA
Suriname	CARSAMMA
Swaziland	ARMA
Sweden	CMA
Switzerland	EUR RMA
Syrian Arab Republic	MID RMA
Taiwan	MAAR
Tajikistan	EUR RMA
Thailand	MAAR

ICAO Contracting State	Designated RMA for RVSM Approvals
The former Yugoslav Republic of Macedonia	EUR RMA
Togo	ARMA
Tonga	PARMO
Trinidad and Tobago	CARSAMMA
Tunisia	EUR RMA
Turkey	EUR RMA
Turkmenistan	EUR RMA
Uganda	ARMA
Ukraine	EUR RMA
United Arab Emirates	MID RMA
United Kingdom	EUR RMA
United Republic of Tanzania	ARMA
United States	NAARMO
Uruguay	CARSAMMA
Uzbekistan	EUR RMA
Vanuatu	PARMO
Venezuela	CARSAMMA
Viet Nam	MAAR
Yemen	MID RMA
Zambia	ARMA
Zimbabwe	ARMA

APPENDIX C

RMA FORMS FOR USE IN OBTAINING RECORD OF RVSM APPROVALS FROM A STATE AUTHORITY

1. It is important for the RMAs to have an accurate record of a point of contact for any queries that might arise from on-going height monitoring investigation or approval status inquiry. Originators are therefore requested to include a completed RMA F1 with their first communication with. the RMA and subsequently whenever the point of contact details change.

2. Ideally originators will submit information to the RMA in electronic form. Alternatively by fax or post. A separate RMA F2 must be completed for each aircraft granted RVSM approval. The numbers below refer to the superscript numbers on the blank RMA F2.

3. Form RMA F3, *Withdrawal of Approval to Operate in RMA RVSM Airspace,* must be completed and forwarded to the RMA immediately when the State of Registry has cause to withdraw the approval of an operator/aircraft for operations in RVSM airspace. The same superscript numbers as used in Form RMA F2 also appear on Form RMA F3. The instructions in section 3 above also apply to form RMA F3.

4. Notes to aid completion of RMA forms F1, F2 and F3:

a) State of Registry – Enter the one- or two-letter ICAO identifier as contained in the most current ICAO Doc 7910. If more than one identifier is designated for the State, use the letter identifier that appears first;

b) Name of Operator – Enter the operator’s 3-letter ICAO identifier as contained in the most current ICAO Doc 8585. For general aviation aircraft, enter “IGA”. For military aircraft, enter “MIL”. If none, place an X in this field and write the name of the operator/owner in the remarks row;

c) State of the Operator – Enter the one- or two- letter ICAO identifier as contained in the most current ICAO Doc 7910. In the case of their being more than one identifier designated for the State, use the letter identifier that appears first;

d) Aircraft type – Enter the ICAO designator as contained in the most current ICAO Doc 8643, e.g. for Airbus A320-211, enter A320; for Boeing B747-438 enter B744;

e) Aircraft series – Enter series of aircraft, or manufacturer’s customer designation, e.g. for Airbus A320-211 enter 211; for Boeing B747-438, enter 400 or 438;

f) Manufacturer’s serial number – Enter manufacturer’s serial number;

g) Registration mark – Enter registration number of aircraft, e.g. for AA-XYZ write AAXYZ;

h) Mode S aircraft address – Enter ICAO allocated aircraft Mode S (6 characters, hexadecimal) address code;

i) Airworthiness approval – Enter yes or no;

j) Date airworthiness approved issued – MM/DD/YY. Example for October 26, 1998 write 10/26/98;

k) RVSM approval – Enter yes or no;

l) Date RVSM approval issued – MM/DD/YY. Example for October 26, 1998 write 10/26/98;

m) Date of expiry – MM/DD/YY. Example for October 26, 1998 write 10/26/98;

n) Date of withdrawal expiry – MM/DD/YY. Example for October 26, 1988 write 10/26/98;

o) Reason for withdrawal;

p) Remarks; and

q) Surname – Enter your family name.

RMA F1
STATE POINT OF CONTACT DETAILS/CHANGE OF POINT OF CONTACT DETAILS FOR MATTERS RELATING TO RVSM APPROVALS

This form should be completed and returned to the address below on the first reply to the RMA or when there is a change to any of the details requested on the form (PLEASE USE BLOCK CAPITALS).

STATE:

ICAO 1 OR 2 LETTER IDENTIFIER FOR STATE[1]

ADDRESS:

CONTACT PERSON FOR MATTERS CONCERNING RVSM APPROVALS:

Full Name:

Title: Surname[17]: Initials:

Post/Position:

Telephone #: Fax #:

E-mail:

Initial Reply*/Change of Details* (*Delete as appropriate)*

When complete, please return to the following address:

(RMA Address)

Telephone: Fax:
E-Mail:

RMA F2
RECORD OF APPROVAL TO OPERATE IN RVSM AIRSPACE

1. When a State of Registry OR State of the Operator approves or amends the approval of an operator/aircraft for RVSM operations, details of that approval must be recorded and sent to the appropriate RMA without delay.

2. *Before providing the information requested below, reference should be made to the accompanying notes* **(PLEASE USE BLOCK CAPITALS)**.

State of Registry[1]:

Name of Operator[2]:

State of the Operator[3]:

Aircraft Type[4]:

Aircraft Series[5]:

Manufacturer's Serial No[6]:

Registration Mark[7]:

Mode S aircraft address[8]:

Airworthiness Approval[9]:

Date Issued[10]:

RVSM Approval[11]:

Date Issued[12]:

Date of Expiry[13] (If Applicable):

Method of Compliance (Service Bulletin, STC etc):

Remarks[16]:

When complete, please return to the following address.

(RMA Address)

Telephone: Fax:
E-Mail:

RMA F3
DE-REGISTRATION OF AIRCRAFT OR WITHDRAWAL OF APPROVAL TO OPERATE IN RVSM AIRSPACE

1. When a State of Registry or State of the Operator has cause to withdraw the approval of an operator/aircraft for operations within the RVSM airspace, details as requested below must be submitted to the RMA by the most appropriate method. This form should also be used to notify the RMA of a de-registration from a state's registry.

2. *Before providing the information as requested below, reference below, reference should be made to the accompanying notes* **(PLEASE USE BLOCK CAPITALS)**.

State of Registry[1]:

Name of Operator[2]:

State of the Operator[3]:

Aircraft Type[4]:

Aircraft Series5[4]:

Manufacturer's Serial No[6]:

Registration Mark[7]:

Mode S aircraft address[8]:

Date of Withdrawal of RVSM Approval[14]:

Reason for Withdrawal of RVSM Approval[15]:

Remarks[16]:

When complete, please return to the following address.

(RMA Address)

Telephone: Fax:
E-Mail:

APPENDIX D

MINIMUM INFORMATION FOR EACH STATE RVSM APPROVAL TO BE MAINTAINED IN ELECTRONIC FORM BY AN RMA

1. Aircraft RVSM approvals data

1.1. To properly maintain and track RVSM approval information, some basic aircraft identification information is required (e.g. manufacturer, type, serial number, etc.) as well as details specific to an aircraft's RVSM approval status. Table D-1 lists the minimum data fields to be collected by an RMA for an individual aircraft. Table D-2 describes the approvals database record format.

Note.— This appendix primarily details the different data elements to be stored by and/or exchange between RMAs. The details of data types, unit and format are defined in Table D-2.

Table D-1. Aircraft RVSM Approvals Data

Field	Description
State of Registry	Nationality identifier as specified in Doc 7910 for current State of Registry.
ICAO Operator designator	ICAO designator for the current Operator as defined in Doc 8585.
State of the Operator	State of the Operator, using the 1 or 2 letter nationality indicator specified in Doc 7910.
ICAO Aircraft Type designator	Aircraft type designator as specified in Doc 8643.
Series	Aircraft generic series as described by the aircraft manufacturer (e.g. 747-100, series = 100).
Serial number	Aircraft serial number as given by manufacturer.
Registration mark	Aircraft's current registration mark.
Mode S	Current Mode S aircraft address (6 hexadecimal digits).
RVSM Airworthiness (MASPS) approved	Yes or no indication of RVSM airworthiness approval.
Date RVSM Airworthiness approved	Date of RVSM airworthiness approval.
RVSM Operational approved	Yes or no indication RVSM operational approval.
Date RVSM Operational approved	Date of RVSM approval.
Date of RVSM Operational approval expiry	Date of expiry of RVSM operational approval.
Method of compliance (service bulletin or STC)	Reference number/name of compliance method used to make the aircraft MASPS compliant.
Remarks	Open comments.
Region(s) for RVSM approval	Name of region(s) where the RVSM approval is applicable. (Only required if RVSM Approval is issued for a specific region(s).)
Operator Name	Name of the current Operator.
Registration Date	Date registration was active for current operator.
State issuing the RVSM approval	State granting RVSM approval, using the 1 or 2 letter nationality indicator specified in Doc 7910.
Date of withdrawal of RVSM Airworthiness (MASPS) approval	Date of withdrawal of the aircraft's RVSM airworthiness approval (if applicable).

Date of withdrawal of RVSM Operational approval	Date of withdraw of the aircraft's RVSM operational approval (if applicable).
Info by Authority	Yes or no indication "Was the information provided to the RMA by a State Authority?"
Civil or military indication *	Aircraft is civil or military.

* Not necessarily a separate field. Can be a field on its own. It is indicated in the ICAO Operator designator as MIL except when the military has an ICAO code designator.

Table D-2. Approvals Database Record Format

Field	Type	Size
State of Registry	Text	2
ICAO Operator Designator	Text	3
State of the Operator	Text	2
ICAO Aircraft Type Designator	Text	4
Series	Text	40
Serial Number	Text	20
Registration Mark	Text	11
ModeS (Hexadecimal)	Text	6
RVSM Airworthiness (MASPS) Approved: "Y", "N" for Yes or No	Text	1
Date RVSM Airworthiness Approved (dd/mm/yyyy)	Date	8
RVSM Operational Approved: "Y", "N" for Yes or No	Text	1
Date RVSM Operational Approved (dd/mm/yyyy)	Date	8
Date of RVSM Operational Approval Expiry (dd/mm/yyyy)	Date	8
Method of Compliance (service bulletin or STC)	Text	50
Remarks	Text	200
Region for RVSM Approval	Text	20
Operator Name	Text	200
Registration Date	Date	8
State issuing the RVSM Approval	Text	2
Date of Withdraw of RVSM Airworthiness(MASPS) Approval (dd/mm/yyyy)	Date	8
Date of Withdraw of RVSM Operational approval (dd/mm/yyyy)	Date	8
Info by Authority: "Y", "N" for Yes or No	Text	1
Civil or military indication	Text	8

2. Aircraft registration/operating status change data

2.1. Aircraft frequently change registration information. Change of registration and/or operating status information is required to properly maintain an accurate list of the current population as well as to correctly identify height measurements. Table D-3 lists the minimum data fields to be maintained by an RMA to manage aircraft registration/operating status change data. Table D-4 describes the aircraft registration/operating status change data record format.

Table D-3. Aircraft registration/operating status change data

Field	***Description***
Reason for change	Reason for change. e.g. aircraft was re-registered, de-registered, destroyed, parked, etc.
Previous registration mark	Aircraft's previous registration mark
Previous Mode S aircraft address	Aircraft's previous Mode S address.
Previous operator name	Name of previous operator of the aircraft.
Previous ICAO operator designator	ICAO designator for previous aircraft operator.
Previous State of the Operator	ICAO nationality identifier for the previous State of the Operator.
State of the New Operator	ICAO nationality identifier for the State of the Operator for the current aircraft operator.
New registration mark	Aircraft's current registration mark.
New State of Registry	Aircraft's current State of Registry.
New operator name	Name of the current operator of the aircraft.
New ICAO operator designator	ICAO designator for the current aircraft operator.
Aircraft ICAO type designator	Aircraft type designator as specified in ICAO Doc 8643.
Aircraft Series	Aircraft generic series as described by the aircraft manufacturer (e.g., 747-100, series = 100).
Serial Number	Aircraft serial number as given by manufacturer.
New Mode S aircraft address	Aircraft's current Mode S address as 6 hexadecimal digits.
Date change is effective (dd/mm/yyyy)	Date new registration/change of status became effective.

Table D-4. Aircraft registration/operating status change data format

Field	Type	Size
Reason for change	Text	20
Previous Registration Mark	Text	11
Previous Mode S aircraft address	Text	6
Previous Operator Name	Text	200
Previous ICAO Operator Designator	Text	3
Previous State of the Operator		
State of New Operator	Text	2
New Registration Mark	Text	11
New State of Registry	Text	2
New Operator Name	Text	200
New ICAO Operator Designator	Text	3
Aircraft ICAO Type designator	Text	4
Aircraft Series	Text	40
Serial Number	Text	20
New Mode S Aircraft Address	Text	6
Date change is effective (dd/mm/yyyy)	Date	8

3. Contact data

3.1. An accurate and up to date list of contacts is essential for an RMA to do business. Table D-5 lists the minimum content for organizational contacts and Table D-7 lists the minimum content for individual points-of-contact. Tables D-6 and D-8 describe the recommended data formats, respectively.

Table D-5. Organizational Contact Data

Field	***Description***
Type	Type of contact (e.g. Operator, Airworthiness Authority, Manufacturer)
State	Full name of State in which the organization is located.
State – ICAO identifier	ICAO nationality identifier for the State in which the organization is located.
Company/Authority	Name of the company/authority (e.g. Bombardier)
Fax No.	Fax number for the organization.
Telephone No.	Telephone number for the organization.
Address (1-4)	Address lines 1-4 filled as appropriate for the organization.
Place	Place (city, etc.) in which the organization is located.
Postal code	Postal code for the organization.
Country	Country in which the organization is located.
Remarks	Open comments
Modification date	Last modification date.
Web Site	Organization's web address.
E-mail	Company e-mail address.
Civil/Mil.	Civil or military.

Table D-6. Organizational Contact Data Format

Field	Type	Size
Type	Text	25
State	Text	50
State – ICAO identifier	Text	2
Company/Authority	Text	200
Fax No	Number	50
Telephone No.	Number	50
Address (1-4)	Text	255
Place	Text	50
Postal code	Text	50
County	Text	50
Remarks	Free Text	200
Modification Date (dd/mm/yyyy)	Date	8
Web Site	Text	200
e-mail	Text	100

Field	Type	Size
civ/mil	Text	8

Table D-7. Individual Point of Contact Data

Field	***Description***
Title contact	Mr., Mrs., Ms., etc.
Surname contact	Surname of point of contact (family name)
Name contact	Name of point of contact.
Position contact	Work title of the point of contact.
Company/authority	Name of the company/authority (e.g. Bombardier).
Department	Department for the point of contact.
Address (1-4)	Address lines 1-4 filled as appropriate for the point of contact.
Place	Place (city, etc.) in which the point of contact is located.
Postal code	Postal code for the location of the point of contact.
Country	Country in which the point of contact is located.
State	State in which the point of contact is located.
E-mail	E-mail of the point of contact.
Telex	Telex number of the point of contact.
Fax No.	Fax number of the point of contact.
Telephone No. 1	First telephone number for the point of contact.
Telephone No. 2	Second telephone number for the point of contact.

Table D-8. Individual Point of Contact Data Format

Field	**Type**	**Size**
Title contact	Text	20
Surname contact	Text	80
Name contact	Text	80
Position contact	Text	80
Company/authority	Text	200
Department	Text	200
Address (1-4)	Text	255
Place	Text	50
Postal code	Text	50
Country	Text	50
State	Text	50
E-mail	Text	100
Telex	Number	50
Fax No.	Number	50
Telephone no. 1	Number	50
Telephone no. 2	Number	50

4. **Data exchange between RMAs**

4.1. The following sections describe how data is to be shared between RMAs as well as the minimum data set that should be passed from one RMA to another.

4.2. All RMAs receiving data have responsibility to help ensure data integrity. A receiving RMA must report back to the sending RMA any discrepancies or incorrect information found in the sent data. Also, for detailed questions about a height measurement, an RMA must refer the Operator or Authority to the RMA responsible for taking the measurement.

4.3. The following sections define the procedures for sharing data (e.g., frequency) and detail special rules for each data type. For each data type, every data field is defined as "mandatory", "desirable", or "no".

– Mandatory – These fields must contain data for the record to be shared.

– Desirable - While some data are very useful it is not always available and the lack of this data would not prevent another RMA from using the data. It is preferred that this field contain data; however, data are not required for this record to be shared.

– No – These fields are not required by another RMA and should be maintained solely for the collecting RMA's internal use.

5. Data exchange procedures

5.1. Data should be posted onto a protected web site accessible to all RMAs. In the event that data have to be sent from point to point the two RMAs will agree to a common file format.

Table D-9. RMA Data Exchange Procedures

Data type	Data Subset	Frequency	When
RVSM approvals	All	Monthly	First week in month
Aircraft re-registration/status	New since last broadcast	Monthly	First week in month
Contact	All	Monthly	First week in month
Height monitoring data	As specified (HMU, GMS, AGHME, etc.) height-monitoring data from region that created the data	As requested	
Monitoring targets	All	As required	Whenever changed
Non-compliant aircraft/group	All	As required	As occurs

5.2. In addition to regular data exchanges, responses to one-off queries from another RMA shall be given on request. This includes requests for data in addition to the minimum exchanged data set such as additional height measurement fields or service bulletin information.

6. Exchange of aircraft approvals data

6.1. An RMA shall only exchange RVSM Approvals data with another RMA when an aircraft is, as a minimum, Airworthiness Approved. The following table defines the fields required for sharing a record with another RMA.

Table D-10. Exchange of Aircraft Approvals Data

Field	Needed to Share
Registration mark	Mandatory
Mode S aircraft address	Desirable
Serial number	Mandatory
ICAO aircraft type designator	Mandatory
Series	Mandatory
State of Registry	Mandatory
Registration date	Desirable
Operator – ICAO designator	Mandatory
Operator name	Desirable
State of the Operator	Mandatory
Civil or military indication (not a field on its own. It is indicated in the ICAO operator code as MIL except when the military has a code)	Desirable
Airworthiness (MASPS) approved	Mandatory
Date airworthiness approved	Mandatory
RVSM approved	Mandatory
Region(s) for RVSM approval (Only required if RVSM Approval is issued for a specific region(s).)	Desirable
State issuing RVSM operational approval	Mandatory
Date of RVSM operational approval	Mandatory
Date of expiry of RVSM approval	Mandatory
Method of compliance (e.g. service bulletin or STC)	Desirable
Remarks	No
Date of withdrawal of airworthiness (MASPS) approval	Mandatory
Date of withdrawal of RVSM operational approval	Mandatory
Info by State authority? (Was the information provided by a State Authority?) [1]	Mandatory

[1] Important for RMAs that accept approvals information from sources other than State Authority

7. Aircraft registration/operating status change data

7.1. An RMA shall share all registration/operating status information.

Table D-11. Exchange of aircraft registration/operating status change data

Field	Need to Share
Reason for change (ie. re-registered, de-registered, destroyed, parked)	Mandatory
Previous registration mark	Mandatory
Previous Mode S aircraft address	Desirable
Previous operator name	Desirable
Previous ICAO operator designator	Mandatory
Previous State of the Operator	Mandatory

State of the new Operator	Mandatory
New registration mark	Mandatory
New State of Registry	Mandatory
New operator name	Desirable
New ICAO operator designator	Desirable
Aircraft ICAO type designator	Mandatory
Aircraft series	Mandatory
Serial number	Mandatory
New Mode S aircraft address	Mandatory
Date change is effective	Desirable

8. Exchange of height measurement data

8.1. Height measurement data shall only be exchanged when the data can be positively linked to an aircraft that is RVSM airworthiness approved. In addition, this data must be reliable as measured by appropriate quality control checks.

Table D-12. Exchange of height measurement data

Field	Need to Share
Date of measurement	Mandatory
Time of measurement	Mandatory
Measurement instrument	Mandatory
Mode S aircraft address	If available
Aircraft registration mark	Mandatory
Aircraft serial number	Mandatory
Operator – ICAO designator	If available
ICAO aircraft type designator	Mandatory
Aircraft series	Mandatory
Mean Mode C altitude during measurement (This field may be Null for GMS)	Mandatory
Assigned altitude at time of measurement	If available
Estimated TVE	Mandatory
Estimated AAD	Mandatory
Estimated ASE	Mandatory

9. Exchange of contact data

9.1. Only State data, manufacturer and design organizations.

Field	Need to Share
Type	Mandatory
State	Mandatory
State – ICAO indicator	Desirable
Company/Authority	Mandatory

Field	Need to Share
Fax No.	Desirable
Telephone No.	Desirable
Address (1-4)	Desirable
Place	Desirable
Postal code	Desirable
Country	Desirable
E-mail	Desirable
Civ/mil.	Desirable

Table D-13. Exchange of organizational contact data fields

Field	Need to Share
Title contact	Desirable
Surname contact	Mandatory
Name contact	Desirable
Position contact	Desirable
Company/authority	Mandatory
Department	Desirable
Address (1-4)	Desirable
Place	Desirable
Postal code	Desirable
Country	Desirable
State	Desirable
E-mail	Desirable
Fax No.	Desirable
Telephone No. 1	Desirable
Telephone No. 2	Desirable

Table D-14. Exchange of individual point of contact data fields

10. **Monitoring targets**

10.1. All data that define an RMA's monitoring targets shall be shared.

11. **Confirmed non-compliant information**

11.1. As part of its monitoring assessments an RMA may identify a non-compliant aircraft or discover an aircraft group that is not meeting the ICAO performance requirements or the MASPS. This should be made available to other RMAs.

11.2. When identifying a non-compliant aircraft an RMA should include:

a) Notifying RMA;
b) Date sent;
c) Registration mark;

d) Mode S aircraft address;
e) Serial number;
f) ICAO aircraft type designator;
g) State of Registry;
h) Registration date;
i) ICAO designator for the Operator;
j) Operator name;
k) State of the Operator;
l) Date(s) of non-compliant measurement(s);
m) ASE value;
n) Action started (y/n);
o) Date aircraft fixed.

11.3. When identifying an aircraft group that is not meeting the MASPS an RMA should include:

a) Notifying RMA;
b) Date sent;
c) Aircraft type group;
d) Specific monitoring data analysis information;
e) Action started (y/n);
f) Action closed (y/n);
g) Date closed;
h) New Service Bulletin number (if applicable);
i) Date of new Service Bulletin (if applicable).

12. Data specific to height monitoring and risk assessment

12.1. This data will **not** be shared between RMAs as it is specific to the airspace being assessed and in some cases, may contain confidential information. This includes flight plan data, operational error data, occupancy data, aircraft type proportions, and flight time information.

13. Fixed parameters — Reference Data Sources

13.1. Some of the data that are used internally within an RMA and form some of the standard for data formats are listed below.

ICAO documents:

— *Location Indicators* (Doc 7910)
— *Designators for Aircraft Operating Agencies, Aeronautical Authorities, and Services* (Doc 8585)
— *Aircraft Type Designators* (Doc 8643)

IATA documents:

— *Airline Coding Directory*

APPENDIX E

ACTION UPON AN INDIVIDUAL AIRFRAME ASSESSED AS NON-COMPLIANT WITH ASE PERFORMANCE REQUIREMENTS

SAMPLE LETTER TO AN OPERATOR AND STATE AUTHORITY OF AN AIRCRAFT OBSERVED TO HAVE EXHIBITED AN ALTIMETRY SYSTEM ERROR IN EXCESS OF 245 FT IN MAGNITUDE

(Name and address of Operator)

HEIGHT-KEEPING PERFORMANCE IN RVSM AIRSPACE

Dear *(Contact name)*,

On *(date)*, a 1 000 ft reduced vertical separation minimum (RVSM) was introduced in *(name or description of airspace)*. The introduction and continued operation of RVSM is conditional on the risk of collision as a consequence of the loss of vertical separation being less that the agreed target level of safety (TLS) of 5×10^{-9} fatal accidents per flight hour.

Since *(date of implementation of RVSM)*, as part of the process of verifying that the TLS is being achieved, the height-keeping performance of aircraft holding RVSM minimum aircraft system performance specification (MASPS) approval has been monitored in accordance with ICAO requirements.

On *(date)* a flight, aircraft registration *(insert aircraft registration),* Modes S aircraft address *(insert Mode S address)*, which we believe to be operated by you and identified as being RVSM MASPS compliant by *(operator/State)*, was monitored by the *(Monitoring unit)* and an altimetry system error (ASE) of *(value)* was observed.

For a detailed explanation on the height-keeping requirements you may wish to refer to *(JAA TGL 6, FAA 91-RVSM, or other appropriate document).*

This measurement indicates that the aircraft **may not be** compliant with the height keeping accuracy requirements for RVSM airspace. It is therefore requested that an immediate investigation be undertaken into this discrepancy and that the necessary arrangements be made for a repeat measurement at the earliest opportunity, following any rectification or inspection of the altimetry system.

The findings of your investigation should be summarized in the enclosed "Height-Keeping Error Investigation Form" and returned to *(name of RMA)* at the address given.

We would ask that you acknowledge receipt of this communication as soon as possible by fax or telephone to:

(RMA Contact details)

Thank you for your continued cooperation.

Yours faithfully,

CC: *(State authority issuing RVSM approval)*

HEIGHT-KEEPING ERROR INVESTIGATION FORM

Part 1 — General information

State of Registry	
Operator	
State of the Operator	
Aircraft type and series	
Registration mark	
Serial number	
Mode S aircraft address	

Part 2 — Details of height-keeping error

A shaded box with bold figures indicates an excess of the JAA TGL6 requirements (taking into account measurement error).

Date and time of measurement	Assigned flight level	Altimetry system error (feet)	Assigned altitude deviation (feet)	Total vertical error (feet)

Provide details below of the fault found (if any) plus date and nature of the rectification work. Please also include an estimate of the number of flights the aircraft has performed in RVSM airspace between the date of measurement and rectification.

When complete, please return to:

(RMA Contact details)

APPENDIX F

MINIMIM INFORMATION FOR EACH MONITORED AIRCRAFT TO BE MAINTAINED IN ELECTRONIC FORM BY AN RMA

AIRCRAFT HEIGHT-KEEPING PERFORMANCE MONITORING DATA RECORD FORMAT

FIELD	FIELD IDENTIFIER	FIELD DATA TYPE	WIDTH	RANGE
1	Validity Indicator	Alphabetic	1	C: Compliant A: Aberrant N: Non-Compliant
2	Date of Measurement (dd/mm/yyyy)	Date (UTC)	8	e.g. 01/01/1996
3	Time of Measurement (hh:mm:ss)	Time (UTC)	8	e.g. 12:00:00
4	Measuring Instrument	Alphanumeric	4	e.g. “HYQX” “G123”
5	Aircraft Mode A code (octal)	Alphanumeric	4	
6	Mode S aircraft address (hexadecimal) (Only provided for Mode-S equipped aircraft)	Alphanumeric	6	This field may be Null for GMS
7	Aircraft Registration Mark	Alphanumeric	10	Required for GMS
8	Flight Call Sign	Alphanumeric	7	Required for GMS
9	Operator	Alphabetic	3	Required for GMS
10	Aircraft Type	Alphanumeric	4	Required for GMS
11	Aircraft Mark/Series	Alphanumeric	6	Required for GMS
12	Flight Origin	Alphabetic	4	Required for GMS
13	Flight Destination	Alphabetic	4	Required for GMS
14	Mean Mode C Altitude During Measurement[1]	Numeric (ft)	5	0-99999 This field may be Null for GMS
15	Assigned Altitude at Time of Measurement[1]	Numeric (ft)	5	0-99999
16	Mean Estimated Geometric Height of Aircraft	Numeric (ft)	5	0-99999
17	SD of Estimated Geometric Height of Aircraft	Numeric (ft)	5	0-99999
18	Mean Geometric Height of Assigned Altitude	Numeric (ft)	5	0-99999
19	Estimated TVE	Numeric (ft)	4	0-9999
20	Minimum Estimated TVE*	Numeric (ft)	4	0-9999
21	Maximum Estimated TVE*	Numeric (ft)	4	0-9999
22	SD of Estimated TVE*	Numeric (ft)	4	0-9999
23	Estimated AAD	Numeric (ft)	4	0-9999
24	Minimum Estimated AAD*	Numeric (ft)	4	0-9999
25	Maximum Estimated AAD*	Numeric (ft)	4	0-9999
26	SD of Estimated AAD*	Numeric (ft)	4	0-9999
27	Estimated ASE	Numeric (ft)	4	0-9999
28	Minimum Estimated ASE*	Numeric (ft)	4	0-9999
29	Maximum Estimated ASE*	Numeric (ft)	4	0-9999
30	SD of Estimated ASE*	Numeric (ft)	4	0-9999
31	Indicator for Reliability of Geometric Height Measurement (0 for max. reliability)	Numeric	3	HMU: 0.0-1.0 GMU: 0.0-9..9
32	Indicator of Reliability of Met Data (0 for max.)	Numeric	1	0, 1
33	Aircraft Serial/Construction Number	Alphanumeric	20	e.g. 550-0848

* Standard deviations are undefined when only one data point is available.

[1] These fields are in feet, to a resolution of 1 foot (Enter feet, not Flight Level)

APPENDIX G

ACTION UPON A MONITORING GROUP ASSESSED AS NON-COMPLIANT WITH ASE PERFORMANCE REQUIREMENTS

ALTIMETRY SYSTEM ERROR DATA AND ANALYSIS TO BE PROVIDED TO STATE AND MANUFACTURER BY AN RMA

When an RMA judges that monitoring data from the airspace for which it is responsible indicates that an aircraft group may not meet ASE requirements for mean magnitude and standard deviation (SD), the following monitoring results should be assembled:

a) The mean magnitude of ASE and ASE SD of all monitored flights;

b) The following information for each monitored flight:

   1) the ASE estimate;

   2) the date on which monitoring took place;

   3) the registration mark of the aircraft conducting the flight;

   4) the Mach number flown during monitoring (if available);

   5) the altimetry system — captain's or first officer's — observed by the monitoring system (if available);

   6) the date on which RVSM airworthiness approval was granted for the monitored aircraft;

   7) the date on which the aircraft was first put into service by an operator (if available);

   8) the monitoring system used to obtain the estimate; and

   9) the location where the monitoring took place.

SAMPLE LETTER

To: *(State concerned)*

Dear *(Name and title),*

RE: *(aircraft type)* RVSM HEIGHT-KEEPING PERFORMANCE

As you are aware, *(name of organization*), acting as the Regional Monitoring Agency (RMA) for *(region or area of responsibility),* is required to perform height-keeping performance assessment to enable the identification of performance issues, and for ongoing safety assessments, in connection with the application of RVSM in *(specify airspace).*

As a basis for the safety of RVSM operations, ICAO has set a height-keeping performance requirement for aircraft type groups. The requirement is that the mean altimetry system error (ASE) must not be greater than 25 m (80 ft) and the absolute value of the mean ASE plus 3 standard deviations of ASE must not be greater than 75 m (245 ft). From this requirement, RVSM certification requirements have been derived which are laid down in *(JAA TGL6, FAA 91-RVSM, or other appropriate document),* to ensure that this important safety requirement is not exceeded.

When monitored altimetry system performance indicates that an aircraft type group is not meeting the above requirements, and is continuing to operate as RVSM approved in RVSM airspace, this may have unacceptable safety implications. Therefore, in this situation, immediate action needs to be taken to ensure the on-going safety of RVSM operations, and to bring the performance of the group into compliance with the group performance requirements. This may be achieved by (1) withdrawing the RVSM approval for the aircraft type(s) involved, in order to reconsider the effectiveness of the RVSM solution for the aircraft type, or by (2) removing the approval for those aircraft for which available performance data indicates that without these aircraft the group performance requirement would be met, until such time as the cause of the problem is identified, and the performance is brought into compliance.

After adjusting the data set regarding the latest approval status of *(aircraft type)* aircraft and the associated measurement history, the present group performance has been reassessed. The data as of the *(date)* shows that the group performance is exceeding the requirements set by ICAO. The current group performance has been determined to be:

	(*aircraft type*)
Mean ASE	(*insert value*)
|Mean ASE| + 3 SD	(*insert value*)

As previously stated this performance may have safety implications. We therefore request that you take the necessary action to ensure that the group performance of the RVSM approved *(aircraft type)* aircraft operating in RVSM airspace complies with the ICAO requirement with immediate effect, or that these aircraft no longer operate in RVSM airspace until group compliance with the ICAO requirement can be achieved.

Please do not hesitate to inquire if we can help you in any way to support your activities to resolve this issue.

Your urgent response would be appreciated.

Yours sincerely,

CC: *(Manufacturer)*

Appendix H
LARGE HEIGHT DEVIATION REPORTING FORM

Monitoring Agency

The information contained in this form is confidential and will be used for statistical safety analysis purposes only.

Large Height Deviation Form

Report any altitude deviation of 300ft or more, **including** those due to TCAS, Turbulence and Contingency Events

1. Today's date:	2. Reporting Unit:		
DEVIATION DETAILS			
3. Operator Name:	4. Call Sign: ACFT Registration Number:	5. Aircraft Type:	6. Altitude Displayed:
7. Date of Occurrence:	8. Time UTC:	9. Occurrence Position (lat/long or Fix):	
10. Cleared Route of Flight:			
11. Cleared Flight Level:	12. Estimated Duration at Incorrect Flight Level (seconds):		13. Observed Deviation (+/- ft):
14. Other Traffic Involved:			
15. Cause of Deviation (*brief title*): (Examples: Turbulence, Equipment Failure)			
AFTER DEVIATION IS RESTORED			
16. Observed/Reported Final Flight Level*: *Please indicate the source of information: ❑ Surveillance system ❑ Pilot	Mark the appropriate Box 17. Is the FL above the cleared level: ❑ 18. Is the FL below the cleared level: ❑	19. Did this FL comply with the ICAO Annex 2 Tables of Cruising Levels? ❑ Yes ❑ No	

NARRATIVE
20. Detailed Description of Deviation (*Please give your assessment of the actual track flown by the aircraft and the cause of the deviation.*)

21 - CREW COMMENTS (IF ANY)

When complete please forward the report(s) to:
Details of Regional Monitoring Agency

Appendix I

Scrutiny Group Composition, Objectives and Methodology

1. Composition

   1.1. The Scrutiny Group requires a diverse set of subject-matter expertise. The Group is composed of subject matter experts in air traffic control, aircraft operation, operational pilot groups, regulation and certification, data analysis, and risk modelling from the involved regions.

   1.2. RMAs establish Scrutiny Sub-Groups, consisting of subject matter experts and specialists from member States. The Sub-Group is responsible for executing the preparatory work for a meeting of the Regional Scrutiny Group, including the analysis and categorization of selected large height events.

   1.3. Representatives from the RMA, Aviation Authorities, and pilot associations also participate in the Scrutiny Sub-Group.

2. Purpose

   2.1. The initial goal at a meeting of the Scrutiny Group is to examine possible reports of large height deviations from archives maintained by the States with the objective of determining which reports from those archives influence the risk of collision associated with application of the RVSM. Once the initial volume of reports has been reduced to those associated with application of the RVSM, the Scrutiny Group produces an estimate of flight time spent at an incorrect flight level. This value is the primary contributor to the estimation of operational risk in RVSM airspace. An illustration of how it contributes to operational risk can be found in Attachment A to this Appendix. The Group examines both technical risk (affected by reliability and accuracy of the avionics within the aircraft and by external meteorological events) and operational risk (affected by the human element) in the development of the safety assessment.

   2.2. Once the Group has made its initial determination, the data are reviewed to look for performance trends. If any adverse trends exist, the Group may make recommendations to either air traffic service providers or regulatory authorities for reducing or mitigating the effect of those trends as a part of ongoing RVSM safety oversight.

3. Process

   3.1. The methodology employed is to examine existing reports, databases and other sources and analyze events resulting in a large height deviation of 300-ft or greater within the band FL290-FL410 in the involved airspaces. These events are usually the result of Air Traffic Control (ATC) loop errors (flight crew errors in executing valid ATC clearances or controller errors in granting conflict-free clearances), instances wherein a controller fails to capture an inaccurate read-back of a clearance, an altitude overshoot or undershoot, turbulence situations, emergencies, errors in coordination, weather complications, responses to a TCAS resolution advisory, among others. The largest source of reports useful for these purposes comes from existing reporting systems, such as the reporting system established by the RMA. However, in many instances these reports are designed for other purposes, and so may lack the clarity of information desirable. Thus, the experience of the members of the Scrutiny Group is essential to inferring the effect of the occurrences on the airspace risk. All data sources undergo an initial review using key RVSM parameters and all reports of interest are extracted.

3.2. The Scrutiny Sub-Group should meet regularly to analyze reports of large height deviations so that adverse trends can be identified quickly and remedial actions can be taken to ensure that risk due to operational errors has not increased following the implementation of RVSM.

4. Analysis and Methodology

4.1. The Sub-Group is tasked with the responsibility of analyzing the reports of interest and assigning a category and parameter values to each event. The values consist of cleared flight level, event flight level, levels crossed, levels final, duration at unplanned flight level, and total vertical deviation. Sample event categories and parameter definitions can be found in Attachment A to this Appendix.

4.2. Since the archived reports are not tailored for the needs of the Scrutiny Group, these values are often not readily available from the reports in their original forms. The Sub-Group must rely on its expert judgment and operational experience to assign these values. Upon completion of their preliminary analysis, the Sub-Group will present the results to the Scrutiny Group for final approval.

4.3. The Scrutiny Group examines its Sub-Group’s analysis results. Events of interest, typically those consisting of long–duration errors, are reviewed further.

LARGE HEIGHT DEVIATION ANALYSIS

DESCRIPTION OF CRITERIA

ATC Loop Errors – any incident where there is a misunderstanding between the pilot and the controller, failure to properly coordinate altitude information or unable to maintain situational awareness.

Cleared Flight Level – the flight level at which the pilot was cleared or currently operating (eg, Aircrew accepts a clearance intended for another aircraft and ATC fails to capture the read back error or aircrew conforms to a flawed clearance delivered by ATC).

Code – a category and a subcategory assigned to each event (See Attachment B to this Appendix)

Duration - length of time that an aircraft was level at an altitude that was not cleared by air traffic control, recorded in one second increments (See Attachment A to this Appendix)

Event Flight Level – the flight level of error, the incorrect altitude of operation for an identifiable period of time without having received an ATC clearance.

Hazard Zone – 300ft buffer zone above and below each flight level in (See Attachment A to this Appendix)

Large Height Deviation – any altitude variation of 300ft or greater from the assigned altitude, these variations can be the result of turbulence, equipment malfunction, ATC loop errors, etc.

Levels Crossed – the total number of flight levels between the point that the aircraft exits the cleared flight level and is once again under ATC supervision

Levels Final – the cleared flight level after the error/deviation

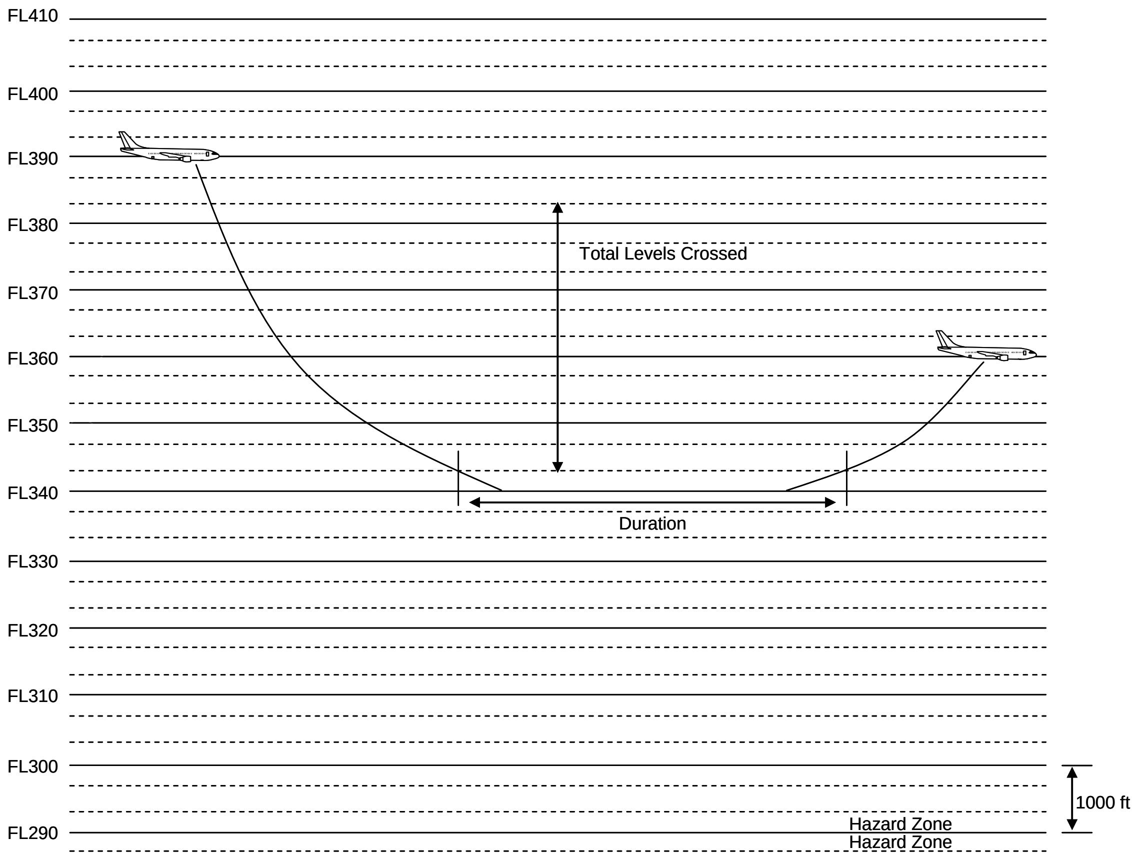
Reference Flight Level – The altitude that would have provided at least the minimum separation (vertical or horizontal) required.
That flight level from which the Height Deviation is calculated; this level may be different from the Cleared Flight Level and must often be determined by the Scrutiny Group operational experts from the data in the Large Height Deviation report.

Total Deviation – the total amount of feet between the altitudes of current operation prior to the deviation and the point at which the aircraft is once again under ATC supervision, a deviation that resulted in an increase of altitude will be recorded as a positive number, a deviation that resulted in a decrease of altitude will be recorded as a negative number.

<u>Rate of Descent</u>		<u>Rate of Climb</u>	
Drift	1000 ft per minute	Minimum	TBD
Normal	1500+ ft per minute	Normal	TBD
Rapid	2500+ ft per minute	Expedite	TBD

Attachment A

RVSM Flight Levels



Attachment B

Table 1 Codes for Large Height Deviations

Code	LHD Cause
A	Flight crew failing to climb/descend the aircraft as cleared
B	Flight crew climbing/descending without ATC Clearance
C	Incorrect operation or interpretation of airborne equipment (e.g. incorrect operation of fully functional FMS, incorrect transcription of ATC clearance or re-clearance, flight plan followed rather than ATC clearance, original clearance followed instead of re-clearance etc)
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)
E	Coordination errors in the ATC to ATC transfer or control responsibility as a result of human factors issues (e.g. late or non-existent coordination, incorrect time estimate/actual, flight level, ATS route etc not in accordance with agreed parameters)
F	Coordination errors in the ATC to ATC transfer or control responsibility as a result of equipment outage or technical issues
Aircraft Contingency Events	
G	Deviation due to aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure)
H	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level
Deviation due to Meteorological Condition	
I	Deviation due to turbulence or other weather related cause
Deviation due to TCAS RA	
J	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory
K	Deviation due to TCAS resolution advisory, flight crew incorrectly following the resolution advisory
Other	
L	An aircraft being provided with RVSM separation is not RVSM approved (e.g. flight plan indicating RVSM approval but aircraft not approved, ATC misinterpretation of flight plan)
M	Other – this includes situations of flights operating (including climbing/descending) in airspace where flight crews are unable to establish normal air-ground communications with the responsible ATS unit.

APPENDIX J

SUGGESTED FORM FOR ATC UNIT MONTHLY REPORT OF LARGE HEIGHT DEVIATIONS

REGIONAL MONITORING AGENCY NAME

Report of Large Height Deviation

Report to the *(Regional Monitoring Agency Name)* of a height deviation of 90 m (300 ft) or more, including those due to ACAS, turbulence and contingency events.

Name of ATC unit:____

Please complete Section I or II as appropriate

SECTION I:

There were no reports of large height deviations for the month of __________

SECTION II:

There was/were _____ report(s) of a height deviation of 90 m (300 ft) or more between FL 290 and FL 410. Details of the height deviation are attached.

(Please use a separate form for each report of height deviation).

SECTION III:

When complete please forward the report(s) to:

(Regional Monitoring Agency Name)
(Postal address)

Telephone:
Fax:
E-Mail:

APPENDIX K

SAMPLE CONTENT AND FORMAT FOR COLLECTION OF SAMPLE OF TRAFFIC MOVEMENTS

The following table lists the information required for each flight in a sample of traffic movements.

INFORMATION FOR EACH FLIGHT IN THE SAMPLE

The information requested for a flight in the sample is listed in the following table with an indication as to whether the information is necessary or is optional:

ITEM	EXAMPLE	NECESSARY OR OPTIONAL
Date (dd/mm/yyyy) or (dd/mm/yyyy)	01/05/2000 for 1 May 2000	NECESSARY
Flight identification or Aircraft call sign	MAS704	NECESSARY
Aircraft type	B734	NECESSARY
Aircraft Registration Number	N500DX	OPTIONAL
Does Item 10 of Flight Plan Indicate that the Operator and Aircraft are RVSM approved? (Does a “W” appear in item 10 of Flight Plan?)	“YES” ; “NO”	OPTIONAL (Highly Desirable)
Origin aerodrome	WMKK	NECESSARY
Destination aerodrome	RPLL	NECESSARY
Entry fix into RVSM airspace	MESOK	NECESSARY
Time at entry fix	0225	NECESSARY
Flight level at entry fix	330	NECESSARY
Exit fix from RVSM airspace	NISOR	NECESSARY
Time at exit fix	0401	NECESSARY
Flight level at exit fix	330	NECESSARY
First fix within RVSM airspace OR first airway within RVSM airspace	MESOK or G582	OPTIONAL
Time at first fix	0225	OPTIONAL
Flight level at first fix	330	OPTIONAL
Second fix within RVSM airspace OR second airway within RVSM airspace	MEVAS OR G577	OPTIONAL
Time at second fix	0250	OPTIONAL
Flight level at second fix	330	OPTIONAL
(Continue with as many fix/time/flight-level entries as are required to describe the flight’s movement within RVSM airspace)		OPTIONAL

Information Required for a Flight in Traffic Sample

APPENDIX L

DESCRIPTION OF MODELS USED TO ESTIMATE TECHNICAL AND OPERATIONAL RISK

This appendix presents a brief description of the collision risk model used to estimate technical and operational risk. The notation used in this appendix is that of *Risk Assessment and System Monitoring*[3], published by the ICAO European and North Atlantic Office, August 1996. The same notation is employed in the collision risk model development of Appendix B to *Guidance Material on the Implementation of a 300 (1 000 ft) Vertical Separation Minimum (VSM) for Application in the Airspace of the Asia Pacific Region*, ICAO Asia and Pacific Office, Bangkok, October 2000. *EUR RVSM Mathematical Supplement*, (Document RVSM 830), European Organization for the Safety of Air Navigation (Eurocontrol), August 2001, describes the collision risk model for RVSM in continental airspace.

Model for estimation of technical risk

The model for the total technical risk, N_{az}, expressed as the sum of three basic types of collision risk, is:

$$N_{az}\text{ (technical)} = N_{az}\text{ (same, technical)} + N_{az}\text{ (opposite, technical)} + N_{az}\text{ (cross, technical)} \tag{1}$$

where the terms on the right side of (1) are defined in Table L-1.

Table L-1. Technical risk model parameter definitions

Parameter	Description
N_{az} (technical)	Expected number of accidents per aircraft flight hour resulting from collisions due to the loss of planned vertical separation of 300 m (1 000 ft) between aircraft pairs at adjacent flight levels.
N_{az} (same, technical)	Expected number of accidents per aircraft flight hour resulting from collisions due to the loss of planned vertical separation of 300 m (1 000 ft) between aircraft pairs flying on the same route in the same direction at adjacent flight levels.
N_{az} (opposite, technical)	Expected number of accidents per aircraft flight hour resulting from collisions due to the loss of planned vertical separation of 300 m (1 000 ft) between aircraft pairs flying on the same route in opposite directions at adjacent flight levels.
N_{az} (cross, technical)	Expected number of accidents per aircraft flight hour resulting from collisions due to the loss of planned vertical separation of 300 m (1 000 ft) between aircraft pairs flying on crossing routes at adjacent flight levels.

[3] This material was originally published in NAT Doc 002, which is no longer in print; however, the Supplement is still available.

Same-route technical risk

The model form appropriate for the estimation of same-route technical risk for same- and opposite-direction traffic at adjacent flight levels is:

N_{az}*(same-route, technical) =* N_{az}*(same, technical) +* N_{az} *(opposite, technical) =*

$$P_z(S_z)P_y(0)\frac{\lambda_x}{S_x}\left\{E_z(same)\left[\frac{\overline{|\Delta V|}}{2\lambda_x}+\frac{\overline{|\dot{y}|}}{2\lambda_y}+\frac{\overline{|\dot{z}|}}{2\lambda_z}\right]+E_z(opp)\left[\frac{2\overline{|V|}}{2\lambda_x}+\frac{\overline{|\dot{y}|}}{2\lambda_y}+\frac{\overline{|\dot{z}|}}{2\lambda_z}\right]\right\} \tag{2}$$

where the parameters of the model presented in (2) are defined in Table L-2, below.

Table L-2. Same-route technical risk model parameter definitions

CRM Parameter	Description
S_z	Vertical separation minimum.
$P_z(S_z)$	Probability that two aircraft nominally separated by the vertical separation minimum S_z are in vertical overlap.
$P_y(0)$	Probability that two aircraft on the same track are in lateral overlap.
λ_x	Average aircraft length.
λ_y	Average aircraft wingspan.
λ_z	Average aircraft height with undercarriage retracted.
S_x	Length of longitudinal window used to calculate occupancy.
$E_z(same)$	Same-direction vertical occupancy for a pair of aircraft at adjacent flight levels on same route.
$E_z(opp)$	Opposite-direction vertical occupancy for a pair of aircraft at adjacent flight levels on same route.
$\overline{\lvert\Delta V\rvert}$	Average relative along-track speed between aircraft on same direction routes.
$\overline{\lvert V\rvert}$	Average absolute aircraft ground speed.
$\overline{\lvert\dot{y}\rvert}$	Average absolute relative cross track speed for an aircraft pair nominally on the same track.
$\overline{\lvert\dot{z}\rvert}$	Average absolute relative vertical speed of an aircraft pair that have lost all vertical separation

The term “overlap” used in Table L-2 means that the centres of mass of a pair of aircraft in a given dimension are at least as close as the extent (length, wingspan or height) of the average aircraft in that dimension.

The occupancy parameters, E_z(same) and $E_z(opp)$, in (2) are measures of the relative packing of aircraft at adjacent flight levels on the same route. An alternative measure of such packing is passing frequency, or the number of aircraft per flight hour at an adjacent flight level which pass a typical aircraft. As with occupancies, passing frequencies are defined for traffic at adjacent flight levels operating in the same and opposite directions and represented symbolically as $N_x(same)$ and $N_x(opp)$. The relation between passing frequency and occupancy is shown below:

$$N_x(same) = \frac{\lambda_x}{\hat{S}_x} E_z(same) \frac{\overline{|\Delta V|}}{2\lambda_x}$$

and

$$N_x(opp) = \frac{\lambda_x}{\hat{S}_x} E_z(opp) \frac{|\overline{V}|}{\lambda_x}$$

Estimation of technical risk for pairs of aircraft on crossing routes

The general form for the model to estimate the collision risk between aircraft at adjacent flight levels on routes which cross, as presented in Volume 2 of RGCSP/6, is:

$$N_{az}(cross, technical) = P_z(S_z)\, P_h\, ((2\, v_h / \pi\, \lambda_h) \qquad (3)$$

$$+ (/z // 2\, \lambda_z))$$

where the parameters of the model are defined in table L-3.

Table L-3. Crossing-route technical risk model parameter definitions

CRM Parameter	Description
N_{az}(cross, technical)	Number of fatal accidents per flight hour due to loss of vertical separation between aircraft at adjacent flight levels on crossing routes.
S_Z	Vertical separation minimum.
$P_z(S_Z)$	Probability that two aircraft nominally separated by the vertical separation minimum S_Z are in vertical overlap.
P_h	Probability that two aircraft at adjacent flight levels on crossing routes are in horizontal overlap.
v_h	Average relative speed in horizontal plane of a pair of aircraft at adjacent flight levels on crossing routes while they are in horizontal overlap.
λ_h	Average diameter of a disk used to represent aircraft horizontal-plane shape.

It is important to note that this general form assumes that an RMA has accounted properly for angles of route intersection. A more detailed and complete form of the technical risk model for crossing routes can be found in Appendix A of “EUR RVSM Mathematical Supplement,” Document RVSM 830, European Organization for the Safety of Air Navigation (Eurocontrol), August 2001.

Model for estimation of risk due to operational errors

The model for estimation of the risk due to operational errors has the same form as (2), above, with one exception. The probability of vertical overlap for aircraft with planned vertical separation S_z, $P_z(S_z)$, is replaced by the following:

$$P_z\,(n\ x\ S_z) = P_z\,(0)\ Pi \qquad (4)$$

where the parameters are defined in table L-4.

Table L-4. Definitions of parameters required for operational risk model

CRM Parameter	Description
$P_z\,(n\ x\ S_z)$	Probability of vertical overlap arising from errors resulting in deviations of integral multiples of the vertical separation standard, S_Z
$P_z\,(0)$	Probability that two aircraft nominally flying at the same level are in vertical overlap
P_i	Proportion of total system flying time spent at incorrect levels

The proportion of total flying time spent at incorrect levels, P_i, is commonly estimated based on the latest 12 months of operational error data available.

APPENDIX M

LETTER TO STATE AUTHORITY REQUESTING CLARIFICATION OF THE RVSM APPROVAL STATUS OF AN OPERATOR

Note.— When the RVSM approval status shown in a filed flight plan cannot be confirmed from an RMA's database of State approvals, a letter similar to the following should be sent to the relevant State authority.

(State authority address)

1. The *(RMA name)* has been established by the *(body authorizing RMA establishment)* to support safe implementation and use of the reduced vertical separation minimum (RVSM) in *(airspace where the RMA has responsibility)* in accordance with guidance published by the International Civil Aviation Organization.

2. Among other activities, the *(RMA name)* conducts a comparison of the State RVSM approval status notified by an operator to an air traffic control unit to the records of State RVSM approvals available to us. This comparison is considered vital to ensuring the continued integrity of RVSM operations.

3. This letter is to advise that an operator for which we believe you are the State of *(Registry or Operator, as appropriate)* provided notice of State RVSM approval which is not confirmed by our records. The details of the occurrence are as follows:

Date:
Operator name:
Aircraft flight identification:
Aircraft type:
Registration mark:
ATC unit receiving notification:

4 We request that you advise this office of the RVSM approval status of this operator. In the event that you have not granted RVSM approval to this operator, we request that you advise this office of any action which you propose to take.

Sincerely,

(RMA official)

APPENDIX N

GUIDANCE TO REDUCE MINIMUM MONITORING REQUIREMENTS

The following material describes the process used by Eurocontrol, in its role as operator of the European RMA, to determine whether minimum monitoring requirements for particular aircraft type groups may be reduced. It is provided as an example which may be used by other RMAs to assist in the development of criteria for the reduction of minimum monitoring requirements in their own areas of responsibility.

The four criteria used to determine initial monitoring requirements or targets are:

1. The value of the |mean ASE| + 3 SD of ASE < 60 m (200 ft)

JAA TGL 6 and FAA 91-RVSM state that the ASE for an aircraft type group, when the aircraft are operating in the basic flight envelope, should meet the criterion of |mean ASE| + 3SD of ASE ≤ 60 m (200 ft). This performance standard is more strict than that set for aircraft in the total flight envelope (|mean ASE| + 3 SD of ASE ≤ 75 m (245 ft)). It should be noted that the latter is also the group requirement specified in Annex 6, Part I, Chapter 7, Appendix 3 and Annex 6, Part II, Chapter 7, Appendix 2.[4]

It is assumed that all monitoring data is collected while aircraft were flying within the basic flight envelope. It is also assumed that if the observed ASE monitoring data showed that an aircraft type group is meeting the standard for the basic flight envelope, then it is likely to satisfy |mean ASE| + 3 SD of ASE ≤ 75 m (245 ft) when operating in the total flight envelope. Therefore, when deciding whether or not the monitoring requirements for the group could be reduced, the stricter criterion for the basic flight envelope is applied.

To fully satisfy this criterion, the upper limit of a two-sided 95 per cent confidence interval for the standard deviation must also fall within the upper bound of the criteria for the basic flight envelope.

2. Percentage of operator population with at least one measurement

In addition to the first criterion, it is necessary to ensure that the monitoring data is representative of the total population. It is assumed that it is necessary for at least 75 per cent of the total operators to have at least one of their aircraft monitored to provide a good representation of the entire operator population.

3. Individual aircraft performance must be consistent with that of the group

For each aircraft type group, the individual aircraft means are compared to the classification mean ±1.96 times the between airframe standard deviation with a correction factor. The correction factor is dependent on the number of repeated samples, and corrects for any bias in the estimation of standard deviation. The individual aircraft means should fall within these upper and lower bounds in 95 per cent of the cases.

[4] See Footnote to Foreword.

An additional examination should be made of the plots of individual aircraft standard deviations against the pooled estimate of the within airframe standard deviation with a 95 per cent two-sided confidence interval. This is based on the assumption that the within airframe variation of ASE is the same for all the aircraft of an aircraft type group.

4. Each operator has a fleet that is meeting individual measurement requirements

JAA TGL 6 and FAA 91-RVSM state that the absolute ASE of any measure for a non-group aircraft must not exceed 49 m (160 ft) for worst-case avionics. On the assumption that a group aircraft should perform equal to or better than a non-group aircraft, the absolute maximum ASE value was examined for all operator/aircraft type group combinations. To account for any measurement system error, an additional 9 m (30 ft) was considered when examining the measurements.

It was accepted that some of the fleet would be outside of these limits. However, if this were to grow to greater than 10 per cent of the fleet, then it would not be considered appropriate to reduce the monitoring requirement to as low at 10 per cent. To cater for small fleets, an operator that has at least two aircraft showing performance worse than 58 m (190 ft), and these constitute at least 10 per cent of the operator's measured fleet, is considered to have failed this criterion.

APPENDIX O

HEIGHT MONITORING SYSTEMS

1. Introduction

1.1 The primary function of a Height Monitoring System (HMS) is to estimate the ASE of an aircraft by comparing the actual height of the aircraft to the height of the Flight Level as indicated by the aircraft's own altimetry system. The Flight Level is actually a pressure level that changes in height over time and space due to variations in meteorological conditions. It is therefore important that any HMS is capable of modeling the variations in meteorological conditions normally by reference to actual or forecast meteorological data.

1.2 An HMS must determine the ASE to a very high precision (in the order of tens of feet). HMS systems typically produce a stream of 3 dimensional plot data. This data stream is then combined into a single track which is smoothed and compared to the height of the pressure level over the course of the track. An HMS therefore consists of 2 elements; a detection and plot extraction system to provide the data stream followed by a processing system to calculate the value of ASE.

1.3 At the present time there are 2 generic types of HMS. These are fixed ground based systems that monitor all aircraft that enter the coverage area, and portable onboard monitoring systems that measure the aircraft on which they are carried. The ground-based systems are used to monitor aircraft height-keeping performance of traffic in the North Atlantic, North American and European Regions. The portable systems are also used in these regions, as well as in several others. There are advantages and disadvantages to both systems which are discussed below.

2. Ground-based height-monitoring units (HMUs and AGHMEs)

2.1 An HMU is a network of ground-based receiver stations which receive secondary surveillance radar (SSR) transponder signals from aircraft replying to interrogations from one (or more) radar stations, together with associated signal processing equipment. An HMU operates in a passive manner, in the sense that the system does not interrogate aircraft in the manner of a secondary surveillance radar. It receives random replies from aircraft as a result of uncorrelated interrogations. The replies have to be sorted, the form of reply which has been received (Mode A or C) has to be established, and those from the same aircraft chained to allow the smoothed value of the geometric height to be compared with the geometric height of the assigned flight levels and the reported flight level (Mode C). The elements of the system which are involved in the measurement of an aircraft's geometric height together comprise the height monitoring equipment (HME). Those elements of the system which perform the estimation of TVE comprise the total vertical error monitoring unit (TMU).

2.2 The HME determines the geometric height of each aircraft by comparing the time of reception of its SSR signals at each of the different receiver stations. The HME outputs the 3D position and associated identification (Mode A, C or S as appropriate) once per second. To evaluate TVE, the TMU requires meteorological data provided by MET offices. These data are further refined by evaluating the trends in the performance of the ensemble of aircraft being monitored during a particular time interval.

2.3 The size of the HMU coverage area and the number of HMUs needed depends upon the airspace route structure and the number of aircraft required to be monitored. For example, the NAT environment has gateway locations ensuring a large proportion of the aircraft will fly over a single HMU during their normal operations. No such gateway locations which would allow such a high coverage from a single HMU exist for European operations.

2.4 To provide cover over a number of air routes and to avoid the need to inhibit ATC freedom, the HMUs necessary for the European RVSM programme need an operational radius of approximately 45 NM. To maintain the system accuracy over this area the HMU requires a five-site system with a distance of approximately 25 NM between the central station and the remaining 4 receiver stations arranged in a square around the central site.

2.5 The preferred sites identified for the European HMU were airfields and other installations owned by the ATS providers. The use of such sites simplifies procurement procedures and reduces the risk associated with application for planning permission. The second set of sites identified were sites where line-of-sight can be physically obtained. These are mainly communication towers.

2.6 The Aircraft Geometric Height Measurement Element (AGHME) is the US version of the HMU, developed by the FAA at the William J. Hughes Technical Center in Atlantic City, NJ. It calculates aircraft height similar to its HMU counterpart where mode S signals are accurately time-stamped within a network of five receiver stations and later processed to determine aircraft position in the form of (latitude, longitude, height, time). Multiple estimates of position are possible within one second measurements. Aircraft identification is derived from the mode S address and mode S altitude is directly recorded and used to determine flight level and assigned altitude deviation (AAD). Meteorological data is gathered from the National Oceanic and Atmospheric Administration (NOAA) for the calculation of aircraft TVE and ASE.

2.7 AGHME site locations support the monitoring program of North American operations and is under the jurisdiction of the NAARMO. Two AGHME sites are installed and operational in Lethbridge and Ottawa, Canada. Four additional sites are installed and operational in the US cities of Atlantic City, NJ, Wichita, KS, Cleveland, OH, and Phoenix, AZ. A fifth AGHME site is in the planning stages for Eugene, OR. Site locations were determined based on North American, Atlantic and Pacific operations. Test flights are an ongoing measure of system accuracy and development for all North American AGHME sites and thus far have demonstrated AGHME post processing accuracies in the neighborhood of 30 NM.

2.8 Further activity with ground-based monitoring systems is now being undertaken through a formal research project between the FAA and Airservices Australia represented by the Australian Airspace Monitoring Agency (AAMA). This research is aimed at post-processing large ADS-B data sets obtained from the extensive Australian automatic dependent surveillance-broadcast (ADS-B) network, using programs developed by the FAA Technical Center that currently process data from AGHME and GMS (see paragraph 3 .) monitoring systems to calculate ASE. To date the results have been very encouraging. Establishing the validity of using ADS-B geometric height for estimating ASE may provide a highly efficient, wide area monitoring system at minimal cost and with little operational impact to aircraft operators or flight crews.

2.9 The main advantage of ground-based systems is their ability to capture a large amount of data which can be made available for analysis rapidly without copious manual intervention. The main disadvantage is that it requires a flight within range of the system.

3. The GPS-based monitoring system (GMS)

3.1 The GMS consists of one or more portable GMUs, and an off-line data processing system. Depending upon the supplier, a GMU may consist of one or two GPS receivers, an Altitude Recording Device (ARD), a laptop computer for the processing and storage of data, an integrated computer with an embedded Windows operating system, and two separate GPS antennas. Units with the ARD and integrated computer system are an updated version of the original GMU with one antenna. These units are called Enhanced GMUs (EGMU). The ability to collect mode C data in real time with ARD portion of the unit in conjunction with the GPS receiver and integrated operating system make this unit preferable over older monitoring technology. The antennas are attached to aircraft windows using suction pads. The GMU may be either battery powered, or have a power input to allow connection to the aircraft's power supply. After completion of the flight, the recorded GPS data is transferred to a central site where, using differential GPS post-processing, the aircraft geometric height is determined. The height data are then compared with the geometric height of the assigned flight levels as estimated from data provided by the MET offices. It is important to note that the MET data cannot be refined in the manner described for the HMU operation. SSR Mode C data, as recorded by the GMU or obtained from ATC providers as radar data output, are then combined with the height data and flight level heights to determine the aircraft altimetry system errors.

3.2 The analysis of the GMU data can be made available within a few days but this can extend up to a few weeks, dependent upon the logistics of the use of the GMU and the retrieval of the data.

3.3 To monitor a specific airframe, the GMU may be installed on the aircraft flight deck or within the cabin. It may require a power input and the antennas will need to be temporarily attached to the aircraft windows. This process may require appropriate certification of the GMU for the aircraft types in which it has to be installed. It also requires appropriate expertise for the installation and operation and active support from operators and pilots.

3.4 The main advantage of a portable system is the ability to target an individual aircraft for monitoring during normal operations without requiring that the aircraft fly in a particular portion of airspace. The main disadvantages of the GMS are the requirements for cooperation from the target aircraft and significant labor costs in operation and in data extraction and post-processing.

4. Advantages and disadvantages

4.1 In developing a monitoring system, an RMA is advised to consider carefully the goals of the monitoring programme, the flows of traffic within the airspace where the RVSM exists and the availability of applicable monitoring data from other Regions. With this information, an RMA can then examine the merits of HMUs and GMUs as discussed above, which can be summarized as follows:

HMS		GMS
Measures all aircraft in the coverage area	←→	Aircraft individually targetable
Refinement of FL geometric height possible	←→	Refinement not possible
Large data set captured per day	←→	Small data set captured per day
Expensive to buy and deploy	←→	Inexpensive to buy
Inexpensive to operate	←→	Expensive to operate
Operation is transparent to aircraft	←→	Possible difficulties to install on flight deck
Trend detection of height-keeping performance for a/c type groups	←→	Uncertain trend detection

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