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

First Edition— 2004

FOREWORD

The requirements and procedures for the introduction of 300 m (1000 ft) vertical separation between FL290 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 were 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)[1].

In order to ensure that the overall safety objectives for 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*, 7.2.3 b) and Annex 6, Part II — *International General Aviation — Aeroplanes*, 7.2.3 b).

Doc 9574 indicates that there is a need for system performance monitoring during both implementation planning and the post-implementation operational use of RVSM. The principles and procedures for monitoring are described in Chapter 6 of Doc 9574. In all regions where RVSM has been implemented, Regional Monitoring Agencies (RMA) 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;

[1] *This Note applies only to the unedited version being made available via ICAO-Net. State letter AN 13/13.1-04/71 of 30 June 2004 circulated a proposal for amendments to Annex 6, Parts I and II, and Annex 11, relating to aircraft height-keeping performance in RVSM airspace, the need for height monitoring, and the role of RMAs. The new provisions in this amendment proposal already exist as guidance material in Doc 9574, and are in addition to the existing provisions relating to RVSM in these Annexes. The purpose of the amendments is to raise this material to the status of Standards. Because it is expected that the new Standards will be applicable by the time this manual is published, and for completeness, any references to these provisions in the manual refer to the expected new Annex provisions. Readers should bear in mind that their expected applicability date as Standards is 24 November 2005.*

c) monitoring 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.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS

AAD	assigned altitude deviation
ACAS	airborne collision avoidance system
ACC	area control centre
ASE	altimetry system error
ATC	air traffic control
ATS	air traffic services
CARSAMMA	Caribbean/South American Regional Monitoring Agency
CFL	cleared flight level
CMA	Central Monitoring Agency
CRM	collision risk model
FTE	flight technical error
GMS	GPS-based monitoring system
GMU	GPS-based monitoring unit
GPS	global positioning system
HF	high frequency
HMU	height monitoring unit
JAA	Joint Aviation Authorities
MAAR	Monitoring Agency for the Asia Region
MASPS	minimum aircraft system performance specification
MECMA	Middle East Central Monitoring Agency
NAARMO	North Atlantic Approvals Registry and Monitoring Agency
NAT	North Atlantic
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. Those 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.

Airworthiness approval. 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.

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.

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.

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

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 and 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 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 which 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 approval. The process by which the State authority ensures that an operator meets all the requirements for operating aircraft in RVSM airspace.

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 with which aircraft are in longitudinal overlap when traveling in the same or opposite direction on the same route at adjacent flight levels and at the planned vertical separation.

RVSM approval. The term used to describe the successful completion of airworthiness approval and 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 height-keeping performance.

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 purpose of this manual is to provide a set of working principles common to all RMAs. 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 Paragraphs 6.4.4 and 6.4.5 of Doc 9574 provide a detailed list of RMA duties and responsibilities. These are also reproduced in Appendix A of 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 after RVSM implementation; and

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

1.2.3 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.

1.2.4 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 must 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, e.g. the North Atlantic Central Monitoring Agency (NAT CMA), the European Organisation for the Safety of Air Navigation (Eurocontrol) or the Pacific Approvals Registry and Monitoring Organization (PARMO). 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 Section 1.3 of this manual. 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 The experience gained through the introduction of RVSM has shown that the RMA plays an essential role in ensuring safety in a region. It has a significant role in all aspects of the monitoring process. 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 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 solely in that region, 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. Under the designated RMA concept, all States are associated with a particular RMA for the processing of RVSM approvals. Appendix B provides a listing of States and the respective designated RMA for RVSM approvals. RMAs may contact any State to address safety matters without regard to the designated RMA.

2.1.4 It is important to note that, in general, the aircraft operating in airspace where the introduction of RVSM is planned can be divided into two categories. The first category of aircraft either operate solely within the airspace for which the introduction of RVSM is being planned, or if they do operate beyond this, do not operate in areas where RVSM has already been introduced, and therefore would not be expected to have received prior RVSM approval. The second category consists of aircraft that also operate in other airspace where RVSM has already been introduced, and will therefore already have received RVSM approval. It is the responsibility of the RMA supporting introduction of RVSM to gather State approvals for the first category of aircraft from the State authorities issuing those approvals — to do so requires that the RMA establish procedures for communicating with each such authority and providing the authority with a precise description of the information required. 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 Where possible, the RMA should collect State RVSM approvals information for the second category of aircraft — those which already operate in RVSM airspace — from other RMAs. This collection will be facilitated if each RMA maintains, in electronic form, a database of State RVSM approvals containing, as a minimum, a standard set of data, common to all RMAs, for each approval.

2.1.6 Appendix D specifies 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. Data collection forms, database formats for storage of information and sharing with other RMAs, and reporting requirements and formats will be presented for each topic.

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 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 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. 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, under the current operational conditions.

2.2.8 An RMA should work 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 with an existing RMA, the acquisition of 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 N. 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, previous RVSM implementation programmes may provide a useful source of monitoring data for evaluation of technical risk. This should be borne in mind when establishing a technical height-monitoring programme for both pre- and post-implementation monitoring purposes.

Pre-implementation 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. Appendix E lists the aircraft types which are eligible for RVSM approval under the group provisions, and the groups to which they belong.

2.2.14 In assessing the results of technical height monitoring during the pre-implementation phase of an RVSM programme, the following should be taken into account:

a) it must be demonstrated that 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 but the age of the data that may be used will be dependent the outcome of on-going work on ASE stability.

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

Note 3.— Subject to a satisfactory collision risk assessment and other operational considerations, performance verification could be terminated provided that 90 per cent of the flights in the region, or part thereof, would be made by operators that have met the pre-determined minimum monitoring requirements.

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), Appendix E contains the agreed minimum monitoring requirements applicable to operator/aircraft-type combinations. Adjustments to the aircraft type groups and minimum monitoring requirements may be necessary, based on the analysis of monitoring data. Any such changes should be coordinated among the RMAs. Appendix M contains guidance concerning the reduction of minimum monitoring requirements.

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 F 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 G for each observation of aircraft height-keeping performance obtained from the airspace within which it exercises its functions.

Post-implementation technical height monitoring requirements

2.2.20 The PIRG which established an RMA should determine the reporting requirements for that RMA. These requirements would normally include the demonstration, on an annual basis, that the technical TLS of 2.5×10^{-9} fatal accidents per flight hour continues to be met within the airspace for which the RMA has responsibility.

2.2.21 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 mean ASE and 3SD of ASE is not in excess of 75 m (245 ft). No individual measurement should exceed 75 m (245 ft), excluding monitoring system measurement error.

2.2.22 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.

2.2.23 Operator/aircraft-type combinations not previously monitored prior to implementation should be targeted for monitoring.

2.2.24 Aircraft operator/aircraft-type combinations should continue to be monitored to meet a pre-determined level at the frequency prescribed by the RMA.

Note 1.— The specific requirements for post-implementation monitoring, in addition to those listed above, are dependent on the stability of ASE. These requirements, including the frequency and time period required, are still under consideration.

Note 2.— Data from other regions may be used to meet the above objectives. However, the age of the data that may be used will be dependent on the on-going work on ASE stability.

Reporting of aircraft height-keeping performance statistics

2.2.25 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 Appendix E, should be kept. For each group, the magnitude of mean ASE and the magnitude of mean ASE + 3SD of ASE should be compared, respectively, to the limits of (25 m) 80 ft and 75 m (245 ft), noted above, and reported annually to the body which authorized the establishment of the RMA.

2.2.26 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.

2.2.27 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, paragraph 7.2.6, to take immediate corrective action with regard to aircraft which are reported by an RMA as not complying with the height-keeping requirements.[2]

2.2.28 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 these documents. An RMA's actions to achieve this goal should be the following: 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 H;

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

b) 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

[2] See Note to Foreword

c) by means of an official RMA letter, similar in form to that shown in Appendix H, 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

2.2.29 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.

2.2.30 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.

2.2.31 The aircraft 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 due to the remaining causes. 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.

2.2.32 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 surveillance information available to these units, in the form of voice reports, or where available, automatic dependent surveillance (ADS) reports and secondary surveillance radar Mode C returns, 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. 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.

2.2.33 The 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.

A suggested form for these monthly reports is shown in Appendix I.

2.2.34 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. It should also be noted that currently, there is no standard collision risk model (CRM) applicable to all airspace. It will be necessary to adapt existing CRMs to take account of regional variations.

2.3.2 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.

2.3.3 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

2.3.4 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.

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

Establishing the competence necessary to conduct a safety assessment

2.3.6 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.

2.3.7 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.

2.3.8 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

2.3.9 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

2.3.10 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.

2.3.11 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 an 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.

2.3.12 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.

2.3.13 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, with a longer sample period left to the judgment of the RMA.

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

a) date of flight;

b) aircraft identification, in standard ICAO format;

c) aircraft type designator;

d) aircraft registration mark, if available;

e) location indicator for the aerodrome of origin;

f) location indictor for the destination aerodrome;

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

h) time at entry point;

i) flight level at entry point;

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

k) time at exit point;

l) flight level at exit point; and

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

2.3.15 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 J 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.

2.3.16 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

2.3.17 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.

2.3.18 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

2.3.19 "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.

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

2.3.21 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.

2.3.22 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.

2.3.23 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 modelling 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 2.5×10^{-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 5×10^{-9} fatal accidents per flight hour.

The collision risk model used in safety assessment

2.3.24 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*[3], August 1996, available from the ICAO European and North Atlantic Office;

c) *EUR RVSM Mathematical Supplement*, Document RVSM 830, European Organisation 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.

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

2.3.25 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.

2.3.26 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 K presents an overview of the mathematical models used in the North Atlantic safety assessment process.

Readiness assessment

2.3.27 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.

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

2.3.29 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.

2.3.30 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.

2.3.31 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.

2.3.32 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 if 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 L 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. 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) aircraft operating practices resulting in large height deviations; or

c) 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, the RMA should follow the procedures described in this guidance.

2.5.4 As a minimum, RMAs should 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 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:

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

4. recommend, wherever possible, remedial action;

5. analyse 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 2.1 of Doc 9574); and

e) initiate remedial action as required.

8. initiate checks of the “approval status” of aircraft operating in the relevant RVSM airspace (see 4.3.3 to 4.3.6 of Doc 9574), 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 6.2.8 of 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

Responsible RMA	FIR
APARMO	Anchorage Oceanic
APARMO	Auckland Oceanic
APARMO	Brisbane Oceanic
APARMO	Honiara
APARMO	Inchon
APARMO	Melbourne Oceanic
APARMO	Nadi
APARMO	Naha
APARMO	Nauru
APARMO	Oakland Oceanic
APARMO	Port Moresby
APARMO	Tahiti
APARMO	Tokyo
CARSAMMA	Antofagasta
CARSAMMA	Asuncion
CARSAMMA	Barranquilla
CARSAMMA	Belem
CARSAMMA	Bogota
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	Porto Velho
CARSAMMA	Puerto Montt
CARSAMMA	Punta Arenas

Responsible RMA	FIR
CARSAMMA	Recife
CARSAMMA	Resistencia
CARSAMMA	Rouchambeau
CARSAMMA	Santiago
CARSAMMA	Santo Domingo
CMA	Bodo Oceanic
CMA	Gander
CMA	New York Oceanic
CMA	Reyjkvik
CMA	Santa Maria
CMA	Shanwick
EUROCONTROL	Ankara
EUROCONTROL	Athinai
EUROCONTROL	Barcelona
EUROCONTROL	Beograd
EUROCONTROL	Berlin
EUROCONTROL	Bodø
EUROCONTROL	Bratislava
EUROCONTROL	Bremen
EUROCONTROL	Brest
EUROCONTROL	Brindisi
EUROCONTROL	Bruxelles
EUROCONTROL	Bucuresti
EUROCONTROL	Budapest
EUROCONTROL	Chisinau
EUROCONTROL	Düsseldorf
EUROCONTROL	France
EUROCONTROL	Frankfurt
EUROCONTROL	Hannover
EUROCONTROL	Istanbul
EUROCONTROL	Kaliningrad
EUROCONTROL	Kharkiv
EUROCONTROL	København
EUROCONTROL	Kyiv
EUROCONTROL	Lisboa
EUROCONTROL	Ljubljana
EUROCONTROL	London
EUROCONTROL	L'viv
EUROCONTROL	Madrid
EUROCONTROL	Malmö
EUROCONTROL	Malta
EUROCONTROL	Milano
EUROCONTROL	Minsk
EUROCONTROL	München

Responsible RMA	FIR
EUROCONTROL	Nicosia
EUROCONTROL	Odesa
EUROCONTROL	Oslo
EUROCONTROL	Praha
EUROCONTROL	Rhein
EUROCONTROL	Riga
EUROCONTROL	Roma
EUROCONTROL	Rovaniemi
EUROCONTROL	Sarajevo
EUROCONTROL	Scottish
EUROCONTROL	Shannon
EUROCONTROL	Simferopol
EUROCONTROL	Skopje
EUROCONTROL	Sofia
EUROCONTROL	Stavanger
EUROCONTROL	Stockholm
EUROCONTROL	Sundsvall
EUROCONTROL	Switzerland
EUROCONTROL	Tallinn
EUROCONTROL	Tampere
EUROCONTROL	Tirana
EUROCONTROL	Trondheim
EUROCONTROL	Varna
EUROCONTROL	Vilnius
EUROCONTROL	Warszawa
EUROCONTROL	Wien
EUROCONTROL	Zagreb.
EUROCONTROL	Amsterdam
MAAR	Bangkok
MAAR	Calcutta
MAAR	Chennai
MAAR	Colombo
MAAR	Delhi
MAAR	Dhaka
MAAR	Hanoi
MAAR	Ho Chi Minh
MAAR	Hong Kong
MAAR	Jakarta
MAAR	Karachi
MAAR	Kathmandu
MAAR	Kota Kinabalu
MAAR	Kuala Lumpur
MAAR	Lahore
MAAR	Male

Responsible RMA	FIR
MAAR	Manila
MAAR	Mumbai
MAAR	Phnom Penh
MAAR	Sanya AOR
MAAR	Singapore
MAAR	Taibei
MAAR	Ujung Pandang
MAAR	Vientiane
MAAR	Yangon
MECMA	Amman
MECMA	Bahrain
MECMA	Beriut
MECMA	Cario
MECMA	Jeddah
MECMA	Muscat
MECMA	Tehran
MECMA	UAE
NAARMO	Albuquerque
NAARMO	Anchorage
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

Responsible RMA	FIR
NAARMO	Monterrey
NAARMO	Montreal
NAARMO	New York
NAARMO	Oakland
NAARMO	Salt Lake
NAARMO	San Juan
NAARMO	Seattle
NAARMO	Toronto
NAARMO	Vancouver
NAARMO	Washington
NAARMO	Winnipeg
SATMA	Recife
SATMA	Canarias South
SATMA	Dakar Oceanic
SATMA	SAL Oceanic

APPENDIX B

STATES AND DESIGNATED RMA FOR THE REPORTING OF RVSM APPROVALS

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	MAAR
Albania	EUROCONTROL
Algeria	EUROCONTROL
Andorra	EUROCONTROL
Angola	EUROCONTROL
Antigua and Barbuda	CARSAMMA
Argentina	CARSAMMA
Armenia	EUROCONTROL
Australia	APARMO
Austria	EUROCONTROL
Azerbaijan	EUROCONTROL
Bahamas	CARSAMMA
Bahrain	MECMA
Bangladesh	MAAR
Barbados	CARSAMMA
Belarus	EUROCONTROL
Belgium	EUROCONTROL
Belize	CARSAMMA
Benin	EUROCONTROL
Bhutan	MAAR
Bolivia	CARSAMMA
Bosnia and Herzegovina	EUROCONTROL
Botswana	EUROCONTROL
Brazil	CARSAMMA
Brunei Darussalam	APARMO
Bulgaria	EUROCONTROL
Burkina Faso	EUROCONTROL
Burundi	EUROCONTROL
Cambodia	MAAR
Cameroon	EUROCONTROL
Canada	NAARMO
Cape Verde	SATMA
Central African Republic	EUROCONTROL
Chad	EUROCONTROL
Chile	CARSAMMA
China	MAAR
Colombia	CARSAMMA

ICAO Contracting State	**Designated RMA for RVSM Approvals**
Comoros	EUROCONTROL
Congo	EUROCONTROL
Cook Islands	APARMO
Costa Rica	CARSAMMA
Côte d'Ivoire	EUROCONTROL
Croatia	EUROCONTROL
Cuba	CARSAMMA
Cyprus	EUROCONTROL
Czech Republic	EUROCONTROL
Democratic People's Republic of Korea	MAAR
Democratic Republic of the Congo	EUROCONTROL
Denmark	EUROCONTROL
Djibouti	EUROCONTROL
Dominican Republic	CARSAMMA
Ecuador	CARSAMMA
Egypt	MECMA
El Salvador	CARSAMMA
Equatorial Guinea	EUROCONTROL
Eritrea	EUROCONTROL
Estonia	EUROCONTROL
Ethiopia	EUROCONTROL
Fiji	APARMO
Finland	EUROCONTROL
France	EUROCONTROL
Gabon	EUROCONTROL
Gambia	EUROCONTROL
Georgia	EUROCONTROL
Germany	EUROCONTROL
Ghana	EUROCONTROL
Greece	EUROCONTROL
Grenada	CARSAMMA
Guatemala	CARSAMMA
Guinea	EUROCONTROL
Guinea-Bissau	EUROCONTROL
Guyana	CARSAMMA
Haiti	CARSAMMA
Honduras	CARSAMMA
Hungary	EUROCONTROL
Iceland	CMA
India	MAAR
Indonesia	MAAR
Iran (Islamic Republic of)	MECMA
Iraq	MECMA
Ireland	CMA
Israel	EUROCONTROL

ICAO Contracting State	**Designated RMA for RVSM Approvals**
Italy	EUROCONTROL
Jamaica	CARSAMMA
Japan	APARMO
Jordan	MECMA
Kazakhstan	EUROCONTROL
Kenya	EUROCONTROL
Kiribati	APARMO
Kuwait	MECMA
Kyrgyzstan	EUROCONTROL
Lao People’s Democratic Republic	MAAR
Latvia	EUROCONTROL
Lebanon	MECMA
Lesotho	EUROCONTROL
Liberia	EUROCONTROL
Libyan Arab Jamahiriya	MECMA
Lithuania	EUROCONTROL
Luxembourg	EUROCONTROL
Madagascar	EUROCONTROL
Malawi	EUROCONTROL
Malaysia	MAAR
Maldives	MAAR
Mali	EUROCONTROL
Malta	EUROCONTROL
Marshall Islands	APARMO
Mauritania	EUROCONTROL
Mauritius	EUROCONTROL
Mexico	NAARMO
Micronesia (Federated States of)	APARMO
Monaco	EUROCONTROL
Mongolia	MAAR
Morocco	EUROCONTROL
Mozambique	EUROCONTROL
Myanmar	MAAR
Namibia	EUROCONTROL
Nauru	APARMO
Nepal	MAAR
Netherlands, the Kingdom of	EUROCONTROL
New Zealand	APARMO
Nicaragua	CARSAMMA
Niger	EUROCONTROL
Nigeria	EUROCONTROL
Norway	CMA
Oman	MECMA
Pakistan	MECMA
Palau	APARMO

ICAO Contracting State	**Designated RMA for RVSM Approvals**
Panama	CARSAMMA
Papua New Guinea	APARMO
Paraguay	CARSAMMA
Peru	CARSAMMA
Philippines	APARMO
Poland	EUROCONTROL
Portugal	CMA
Qatar	MECMA
Republic of Korea	APARMO
Republic of Moldova	EUROCONTROL
Romania	EUROCONTROL
Russian Federation	EUROCONTROL
Rwanda	EUROCONTROL
Saint Kitts and Nevis	CARSAMMA
Saint Lucia	CARSAMMA
Saint Vincent and the Grenadines	CARSAMMA
Samoa	APARMO
San Marino	EUROCONTROL
Sao Tome and Principe	EUROCONTROL
Saudi Arabia	MECMA
Senegal	SATMA
Serbia and Montenegro	EUROCONTROL
Seychelles	EUROCONTROL
Sierra Leone	EUROCONTROL
Singapore	MAAR
Slovakia	EUROCONTROL
Slovenia	EUROCONTROL
Solomon Islands	APARMO
Somalia	EUROCONTROL
South Africa	EUROCONTROL
Spain	SATMA
Sri Lanka	MAAR
Sudan	MECMA
Suriname	CARSAMMA
Swaziland	EUROCONTROL
Sweden	CMA
Switzerland	EUROCONTROL
Syrian Arab Republic	MECMA
Tajikistan	EUROCONTROL
Thailand	MAAR
The former Yugoslav Republic of Macedonia	EUROCONTROL
Togo	EUROCONTROL
Tonga	APARMO
Trinidad and Tobago	CARSAMMA

ICAO Contracting State	**Designated RMA for RVSM Approvals**
Tunisia	EUROCONTROL
Turkey	EUROCONTROL
Turkmenistan	EUROCONTROL
Uganda	EUROCONTROL
Ukraine	EUROCONTROL
United Arab Emirates	MECMA
United Kingdom	CMA
United Republic of Tanzania	EUROCONTROL
United States	NAARMO
Uruguay	CARSAMMA
Uzbekistan	EUROCONTROL
Vanuatu	APARMO
Venezuela	CARSAMMA
Viet Nam	MAAR
Yemen	MECMA
Zambia	EUROCONTROL
Zimbabwe	EUROCONTROL

APPENDIX C

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

NOTES TO AID COMPLETION OF RMA FORMS F1, F2, AND F3

1. Please read these notes before attempting to complete forms RMA F1, F2, and F3.

2. 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. Recipients are therefore requested to include a completed RMA F1 with their first reply to the RMA. Thereafter, there is no further requirement unless there has been a change to the information provided.

3. If recipients are unable to pass the information requested in the RMA F2 to the RMA through the Internet, by direct electronic transfer, or by data placed on a 3.5" floppy disk, a hard copy RMA F2 must be completed for each aircraft granted RVSM approval. The numbers below refer to the superscript numbers on the blank RMA F2.

(1) Enter the one or two letter nationality identifier for the State as specified in ICAO *Location Indicators* (Doc 7910). In the case of there being more than one identifier designated for the State, use the identifier that appears first.

(2) Enter the operator's 3 letter ICAO designator as contained in *Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services* (Doc 8585). For international general aviation, 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.

(3) Enter the ICAO designator as contained in *Aircraft Type Designators* (Doc 8643): e.g. for Airbus A320-211, enter A320; for Boeing B747-438 enter B744.

(4) Enter series of aircraft type or manufacturer's customer designation, e.g. for Airbus A320-211, enter 211; for Boeing B747-438, enter 400 or 438.

(5) Enter the allocated Mode S aircraft address.

(6) Enter yes or no.

(7) Example: For October 26 1998, write 26/10/1998.

(8) Use a separate sheet of paper if insufficient space available.

4. 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.

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

Enter the nationality identifier as contained in ICAO Doc 7910. In the event that there is more than one identifier for the same State, the one that appears first in the list should be used.

ADDRESS:

CONTACT PERSON FOR MATTERS CONCERNING RVSM APPROVALS:

Full Name:

Title: Surname: 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[1]: ☐☐

Aircraft Type[3]: ☐☐☐☐

Aircraft Series[4]: ☐☐☐☐☐☐

Manufacturers Serial No: ☐☐☐☐☐

Registration Mark: ☐☐☐☐☐☐

Mode S aircraft address[5]: ☐☐☐☐☐☐

Airworthiness Approval[6]: ☐☐☐

Date Issued[7]: ☐☐☐☐☐☐☐☐

RVSM Approval[6]: ☐☐☐

Date Issued[7]: ☐☐☐☐☐☐☐☐

Date of Expiry[7] (If Applicable): ☐☐☐☐☐☐

Method of Compliance (Service Bulletin, STC etc):

Remarks[8]:

When complete, please return to the following address.

(RMA Address)

Telephone: Fax:
E-Mail:

RMA F3
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 RMA airspace, details as requested below must be submitted to the RMA by the most appropriate method.

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[1]: | | |

Aircraft Type[3]: | | | | |

Aircraft Series[4]: | | | | | | |

Manufacturers Serial No: | | | | | |

Registration Mark: | | | | | | |

Mode S aircraft address[5]: | | | | | | |

Date of Withdrawal of RVSM Approval[7]: | | | | | | | | |

Reason for Withdrawal of RVSM Approval[8]:

Remarks:

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 will be defined in document TBA.

Table D-1. Aircraft RVSM Approvals Data

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

Field	***Description***
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?"

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

Table D-2. Approvals Database Record Format

Field	***Description***	***Type***	***Width***	***Valid Range***
1	State of Registry	Alphabetic	2	AA-ZZ
2	Operator	Alphabetic	3	AAA-ZZZ
3	State of the Operator	Alphabetic	2	AA-ZZ
4	Aircraft type	Alphanumeric	4	e.g. MD11
5	Aircraft mark/series	Alphanumeric	6	
6	Manufacturer's serial/construction number	Alphanumeric	12	
7	Aircraft registration mark	Alphanumeric	10	
8	Mode S aircraft address (hexadecimal)	Alphanumeric	6	
9	Airworthiness approved	Alphabetic	1	"Y", "N"
10	Date airworthiness approval issued (dd/mm/yyyy)	Date	8	e.g. 31/12/1999
11	RVSM approved	Alphabetic	1	"Y", "N"
12	State issuing RVSM approval	Alphabetic	2	AA-ZZ
13	Date RVSM operational approval issued (dd/mm/yyyy)	Date	8	e.g. 31/12/1999
14	Date of expiry of RVSM operational approval (if any) (dd/mm/yyyy)	Date	8	e.g. 31/12/1999
15	National remarks	Alphanumeric	60	ASCII text
16	Method of compliance	Alphanumeric	60	ASCII text
17	Date of withdrawal of RVSM airworthiness approval (dd/mm/yyyy)	Date	8	e.g. 31/12/1999
18	Date of withdrawal of RVSM operational approval (dd/mm/yyyy)	Date	8	e.g. 31/12/1999
19	Information provided by State authority	Alphabetic	1	"Y", "N"

2. Aircraft re-registration/operating status change data

2.1. Aircraft frequently change registration information. Re-registration and change of 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 re-registration/operating status change data.

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

Field	***Description***
Reason for change	Reason for change. e.g. aircraft was re-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 operator designator	ICAO designator for previous aircraft operator.
Previous State of the Operator	ICAO nationality identifier for the previous State of the Operator.
New State of the 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 operator designator	ICAO designator for the current aircraft operator.
Aircraft 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	Date new registration/change of status became effective.

3. **Contact data**

3.1. An accurate and up to date list of contacts is essential for an RMA to do business. Table D-4 lists the minimum content for organizational contacts and Table D-5 lists the minimum content for individual points-of-contact.

Table D-4. 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

Field	***Description***
Modification date	Last modification date.
Web Site	Organization's web address.
E-mail	Company e-mail address.
Civil/Mil.	Civil or military.

Table D-5. Individual Point of Contact Data

Field	***Description***
Title contact	Mr., Mrs., Ms., etc.
Surname contact	Surname of point of contact.
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.

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. This minimum sharing data set is a sub-set of the data defined in previous sections of Appendix D.

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 Operator or Authority to the RMA responsible for taking the measurement.

5. **Data exchange procedures**

5.1. The standard mode of exchange shall be e-mail or FTP. Data shall be presented in Microsoft Excel or Access. Because of the size of the data files, any large height-monitoring-data requests shall be made by arrangement between RMAs. RMAs must realize when making a request, that the data is current only to the date of creation of the file.

Table D-6. 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 or HMU and GMS) 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 sending a record to another RMA.

Table D-7. 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

Field	Needed to Share
Date airworthiness approved	Mandatory
RVSM approved	Mandatory
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 authority	Mandatory

7. Aircraft re-registration/operating status change data

7.1. An RMA shall share all re-registration information.

Table D-8. Exchange of aircraft re-registration/operating status change data

Field	Need to Share
Reason for change (ie. re-registered, destroyed, parked)	Mandatory
Previous registration mark	Mandatory
Previous Mode S aircraft address	Desirable
Previous operator name	Desirable
Previous operator – ICAO designator	Mandatory
Previous State of the Operator	Mandatory
New State of the Operator	Mandatory
New registration mark	Mandatory
New State of Registry	Mandatory
New operator name	Desirable
New ICAO designator for operator	Desirable
ICAO aircraft 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 the geometric reliability and the met quality data and quality control checks.

Table D-9. Exchange of height measurement data

Field	Need to Share
Date of measurement	Mandatory
Time of measurement	Mandatory
Measurement instrument*	Mandatory
Mode S aircraft address as recorded by measurement system	Mandatory
Aircraft registration mark	Mandatory
Aircraft serial number.	Mandatory
ICAO aircraft type designator	Mandatory
Operator – ICAO designator	Mandatory
ICAO aircraft type designator	Mandatory
Aircraft series	Mandatory
Mean Mode C altitude during measurement	Mandatory
Assigned altitude at time of measurement	Mandatory
Estimated TVE	Mandatory
Estimated AAD	Mandatory
Estimated ASE	Mandatory
Compliance status **	Mandatory

9. **Exchange of contact data**

9.1. Only State data, manufacturer and design organizations.

Table D-10. Exchange of organizational contact data fields

Field	Need to Share
Type	Mandatory
State	Mandatory
State – ICAO indicator	Desirable
Company/Authority	Mandatory
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-11. Exchange of individual point of 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

10. Monitoring targets

10.1. All data that defines an RMAs 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) Field;
d) Registration mark;
e) Mode S aircraft address;
f) Serial number;
g) ICAO aircraft type designator;
h) State of Registry;
i) Registration date;
j) ICAO designator for the Operator;
k) Operator name;
l) State of the Operator;
m) Date(s) of non-compliant measurement(s);
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) Aircraft type group;
c) Action started (y/n);
d) Specific monitoring data analysis information.

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

MINIMUM MONITORING REQUIREMENTS

Monitoring prior to the issue of RVSM approval is not a requirement. However, operators should be prepared to submit monitoring plans to their State aviation authority to demonstrate how they intend to meet the requirements specified in the table below. Monitoring in accordance with this table may be carried out:

a) pre-RVSM-implementation, once the aircraft has received RVSM airworthiness approval;

b) post-RVSM-implementation, only after the aircraft operator has been approved for RVSM operations.

Table E-1. Minimum monitoring requirements

<table>
<tr><td colspan="4">MONITORING IS REQUIRED IN ACCORDANCE WITH THIS CHART
MONITORING PRIOR TO THE ISSUE OF RVSM APPROVAL IS <u>NOT</u> A REQUIREMENT</td></tr>
<tr><td colspan="2">CATEGORY</td><td>AIRCRAFT TYPE</td><td>MINIMUM OPERATOR MONITORING FOR EACH AIRCRAFT GROUP</td></tr>
<tr><td>1</td><td>GROUP APPROVED: DATA INDICATES COMPLIANCE WITH THE RVSM MASPS</td><td>[A30B, A306], [A312 (GE) A313(GE)], [A312 (PW) A313(PW)], A318, [A319, A320, A321], [A332, A333], [A342, A343], A345, A346

B712, [B721, B722], B732, [B733, B734, B735], B737(Cargo), [B736, B737/BBJ, B738/BBJ, B739], [B741, B742, B743], B74S, B744 (5” Probe), B744 (10” Probe), B752, B753, [B762, B763], B764, B772, B773

CL60(600/601), CL60(604), C560, [CRJ1, CRJ2], CRJ7, DC10, F100, GLF4, GLF5, LJ60, MD10, MD11, MD80 (All series), MD90, T154</td><td>10% or two airframes from each fleet* of an operator to be monitored as soon as possible but not later than 6 months after the issue of RVSM approval and thereafter as directed by the RMA.

* Note.— For the purposes of monitoring, aircraft within parenthesis [ ] may be considered as belonging to the same fleet. For example, an operator with six A332 and four A333 aircraft may monitor one A332 and one A333 or two A332 aircraft or two A333 aircraft.</td></tr>
</table>

	CATEGORY	AIRCRAFT TYPE	MINIMUM OPERATOR MONITORING FOR EACH AIRCRAFT GROUP
2	GROUP APPROVED: INSUFFICIENT DATA ON APPROVED AIRCRAFT	Other group aircraft other than those listed above including: A124, ASTR, B703, B731, BE20,BE40, C500, C25A, C25B, C525, C550**, C56X, C650, C750, CRJ9, [DC86, DC87], DC93, DC95, [E135, E145], F2TH, [FA50 FA50EX], F70, [F900, F900EX], FA20, FA10, GLF2(II), GLF(IIB), GLF3, GALX,, GLEX, H25B(700), H25B(800), H25C, IL62, IL76, IL86, IL96, J328, L101, L29(2), L29(731), LJ31, [LJ35,LJ36], LJ45, LJ55, SBR1, T134, T204, P180, PRM1,YK42	60% of airframes from each fleet of an operator **or** individual monitoring, as soon as possible but not later than 6 months after the issue of RVSM approval and thereafter as directed by the RMA. ** Refer to aircraft group table for detail on C550 monitoring.
3	NON-GROUP	Non-group approved aircraft	100% of aircraft shall be monitored as soon as possible but not later than 6 months after the issue of RVSM approval.

Note.— The above table represents the minimum monitoring requirements, but RMAs may increase these requirements at their discretion.

Table E-2. Aircraft type groups for aircraft certified under group approval provisions

Monitoring Group	**A/C ICAO**	A/C Type	A/C Series
A124	A124	AN-124 RUSLAN	ALL SERIES
A300	A306 A30B	A300 A300	600, 600F, 600R, 620, 620R, 620RF B2-100, B2-200, B4-100, B4-100F, B4-120, B4-200, B4-200F, B4-220, C4-200
A310-GE	A310	A310	200, 200F,300, 300F
A310-PW	A310	A310	220, 220F,320
A318	A318	A318	ALL SERIES
A320	A319 A320 A321	A319 A320 A321	CJ , 110, 130 110, 210, 230 110, 130, 210, 230
A330	A332, A333	A330	200, 220, 240, 300, 320, 340
A340	A342, A343,	A340	210, 310
A345	A345	A340	540
A346	A346	A340	640
A3ST	A3ST	A300	600R ST BELUGA

Monitoring Group	**A/C ICAO**	A/C Type	A/C Series
AN72	AN72	AN-74, AN-72	ALL SERIES
ASTR	ASTR	1125 ASTRA	ALL SERIES
ASTR-SPX	ASTR	ASTR SPX	ALL SERIES
AVRO	RJ1H, RJ70, RJ85	AVRO	RJ70, RJ85, RJ100
B712	B712	B717	200
B727	B721 B722	B727	100, 100C, 100F,100QF, 200, 200F
B732	B732	B737	200, 200C
B737CL	B733 B734 B735	B737	300, 400, 500
B737NX	B736 B737 B738 B739	B737 B737 B737 B737	600 700, 700BBJ 800, BBJ2 900
B737C	B737	B737	700C
B747CL	B741 B742 B743	B747	100, 100B, 100F, 200B, 200C, 200F, 200SF, 300
B74S	B74S	B747	SR, SP
B744-5	B744	B747	400, 400D, 400F (With 5 inch Probes)
B744-10	B744	B747	400, 400D, 400F (With 10 inch Probes)
B752	B752	B757	200, 200PF
B753	B753	B757	300
B767	B762 B763	B767	200, 200EM, 200ER, 200ERM, 300, 300ER, 300ERF
B764	B764	B767	400ER
B772	B772	B777	200, 200ER, 300, 300ER
B773	B773	B777	300, 300ER
BE40	BE40	BEECHJET 400A	ALL SERIES
BE20	BE20	BEECH 200 -KINGAIR	ALL SERIES
C500	C500	500 CITATION, 500 CITATION I, 501 CITATION I SINGLE PILOT	ALL SERIES
C525	C525	525 CITATIONJET, 525 CITATIONJET I	ALL SERIES

Monitoring Group	**A/C ICAO**	A/C Type	A/C Series
C525-II	C25A	525A CITATIONJET II	ALL SERIES
C525 CJ3	C25B	CITATIONJET III	ALL SERIES
C550-552	C550	552 CITATION II	ALL SERIES
C550-B	C550	550 CITATION BRAVO	ALL SERIES
C550-II	C550	550 CITATION II, 551 CITATION II SINGLE PILOT	ALL SERIES
C550-SII	C550	S550 CITATION SUPER II	ALL SERIES
C560	C560	560 CITATION V, 560 CITATION V ULTRA, 560 CITATION V ULTRA ENCORE	ALL SERIES
C56X	C56X	560 CITATION EXCEL	ALL SERIES
C650	C650	650 CITATION III , 650 CITATION VI , 650 CITATION VII	ALL SERIES
C750	C750	750 CITATION X	ALL SERIES
CARJ	CRJ1, CRJ2	REGIONALJET	100, 200, 200ER, 200LR
CRJ-700	CRJ7	REGIONALJET	700
CRJ-900	CRJ9	REGIONALJET	900
CL600	CL60	CL-600 CL-601	CL-600-1A11 CL-600-2A12, CL-600-2B16
CL604	CL60	CL-604	CL-600-2B16
BD100	CL30	CHALLENGER 300	ALL SERIES
BD700	GL5T	GLOBAL 5000	ALL SERIES
CONC	CONC	CONCORDE	ALL SERIES
DC10	DC10	DC-10	10, 10F, 15, 30, 30F, 40, 40F
DC86-7	DC86, DC87	DC-8	62, 62F, 72, 72F
DC93	DC93	DC-9	30, 30F
DC95	DC95	DC-9	SERIES 51
E135-145	E135, E145	EMB-135, EMB-145	ALL SERIES
F100	F100	FOKKER 100	ALL SERIES
F2TH	F2TH	FALCON 2000	ALL SERIES
F70	F70	FOKKER 70	ALL SERIES
F900	F900	FALCON 900, FALCON 900EX	ALL SERIES
FA10	FA10	FALCON 10	ALL SERIES

Monitoring Group	**A/C ICAO**	A/C Type	A/C Series
FA20	FA20	FALCON 20 FALCON 200	ALL SERIES
FA50	FA50	FALCON 50, FALCON 50EX	ALL SERIES
GALX	GALX	1126 GALAXY	ALL SERIES
GLEX	GLEX	BD-700 GLOBAL EXPRESS	ALL SERIES
GLF2	GLF2	GULFSTREAM II (G-1159),	ALL SERIES
GLF2B	GLF2	GULFSTREAM IIB (G-1159B)	ALL SERIES
GLF3	GLF3	GULFSTREAM III (G-1159A)	ALL SERIES
GLF4	GLF4	GULFSTREAM IV (G-1159C)	ALL SERIES
GLF5	GLF5	GULFSTREAM V (G-1159D)	ALL SERIES
H25B-700	H25B	BAE 125 / HS125	700B
H25B-800	H25B	BAE 125 / HAWKER 800XP, BAE 125 / HAWKER 800, BAE 125 / HS125	ALL SERIES/A, B/800
H25C	H25C	BAE 125 / HAWKER 1000	A , B
IL86	IL86	IL-86	NO SERIES
IL96	IL96	IL-96	M , T, 300
J328	J328	328JET	ALL SERIES
L101	L101	L-1011 TRISTAR	1 (385-1), 40 (385-1), 50 (385-1), 100, 150 (385-1-14), 200, 250 (385-1-15), 500 (385-3)
L29B-2	L29B	L-1329 JETSTAR 2	ALL SERIES
L29B-731	L29B	L-1329 JETSTAR 731	ALL SERIES
LJ31	LJ31	LEARJET 31	NO SERIES, A
LJ35/6	LJ35 LJ36	LEARJET 35 LEARJET 36	NO SERIES, A
LJ40	LJ40	LEARJET 40	ALL SERIES
LJ45	LJ45	LEARJET 45	ALL SERIES
LJ55	LJ55	LEARJET 55	NO SERIES B, C
LJ60	LJ60	LEARJET 60	ALL SERIES
MD10	MD10	MD-10	ALL SERIES
MD11	MD11	MD-11	COMBI, ER, FREIGHTER, PASSENGER
MD80	MD81,	MD-80	81, 82, 83, 87, 88

Monitoring Group	**A/C ICAO**	A/C Type	A/C Series
	MD82, MD83, MD87, MD88		
MD90	MD90	MD-90	30, 30ER
P180	P180	P-180 AVANTI	ALL SERIES
PRM1	PRM1	PREMIER 1	ALL SERIES
T134	T134	TU-134	A, B
T154	T154	TU-154	A , B, M, S
T204	T204, T224, T234	TU-204, TU-224, TU-234	100, 100C, 120RR, 200, C
YK42	YK42	YAK-42	ALL SERIES

Note.¾ This list is not considered exhaustive.

APPENDIX F

SAMPLE LETTER TO AN OPERATOR 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 notified as being RVSM MASPS compliant by *(operator)*, 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 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 TGJ6 REV1 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 G

MINIMIM INFORMATION FOR EACH MONITORED AIRCRAFT TO BE MAINTAINED IN ELECTRONI C 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	8	e.g. 01/01/1996
3	Time of Measurement (hh:mm:ss)	Time	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)	Alphanumeric	6	
7	Aircraft Registration Mark	Alphanumeric	10	
8	Flight Call Sign	Alphanumeric	7	
9	Operator	Alphabetic	3	
10	Aircraft Type	Alphanumeric	4	
11	Aircraft Mark/Series	Alphanumeric	6	
12	Flight Origin	Alphabetic	4	
13	Flight Destination	Alphabetic	4	
14	Mean Mode C Altitude During Measurement	Numeric	5	0-99999 This field may be Null for GMS
15	Assigned Altitude at Time of Measurement	Numeric	5	0-99999
16	Mean Estimated Geometric Height of Aircraft	Numeric	5	0-99999
17	SD of Estimated Geometric Height of Aircraft	Numeric	5	0-99999
18	Mean Geometric Height of Assigned Altitude	Numeric	5	0-99999
19	Estimated TVE	Numeric	4	0-9999
20	Minimum Estimated TVE*	Numeric	4	0-9999
21	Maximum Estimated TVE*	Numeric	4	0-9999
22	SD of Estimated TVE*	Numeric	4	0-9999
23	Estimated AAD	Numeric	4	0-9999
24	Minimum Estimated AAD*	Numeric	4	0-9999
25	Maximum Estimated AAD*	Numeric	4	0-9999
26	SD of Estimated AAD*	Numeric	4	0-9999
27	Estimated ASE	Numeric	4	0-9999
28	Minimum Estimated ASE*	Numeric	4	0-9999
29	Maximum Estimated ASE*	Numeric	4	0-9999
30	SD of Estimated ASE*	Numeric	4	0-9999
31	Indicator for Reliability of Geometric Height Measurement	Numeric	3	HMU: 0.0-1.0 GMU: 0.0-9.9
32	Indicator of Reliability of Met Data	Numeric	1	0.1
33	Aircraft Serial/Construction Number	Alphanumeric	12	e.g. 550-0848

** only when more than one data point is available*

APPENDIX H

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 I

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 J

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)	01/05/2000 for 1 May 2000	NECESSARY
Aircraft call sign	MAS704	NECESSARY
Aircraft type	B734	NECESSARY
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	
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 K

DESCRIPTION OF MODELS USED TO ESTIMATE TECHNICAL AND OPERATIONAL RISK

This appendix presents a brief description of the collision risk model forms 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:

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

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

Table K-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 K-2, below.

Table K-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 K-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:

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

and

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

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:

$$N_{az}(cross, technical) = P_z(S_z)\, P_h\, ((2\, v_h / p\ \ l_h) + (½z ½/ 2\ \ l_z)) \qquad (3)$$

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

Table K-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 Organisation 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 K-4.

Table K-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 L

LETTER TO STATE AUTHORITY REQUESTING CLARIFICATION OF THE APPROVAL STATE 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 M

REDUCTION OF 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.

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.

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-

[4] See Footnote to Foreword.

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 N

INFORMATION ON THE MERITS OF HMU AND GMU MONITORING SYSTEMS

1. Height-monitoring systems

1.1 The height-monitoring unit (HMU) is a fixed ground-based system whose technical capability and requirements are discussed in the following section. Its main advantage is the ability to capture a large amount of data which can be made available for analysis rapidly without manual intervention. The main disadvantage is that it requires a flight within range of the HMU.

1.2 The Global Positioning System (GPS) monitoring unit (GMU) is a carry-on system placed on an aircraft for a single flight. Its main advantage 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 GMU is a key element in the GPS-based monitoring system (GMS). The main disadvantages of the GMS are the requirements for cooperation from the target aircraft and significant intervention in operation and data extraction.

1.3 The HMU is used to monitor aircraft height-keeping performance in the North Atlantic and European Regions. The GMS is also used in these regions, as well as in several others.

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

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, for example as shown in Figure 1, 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.

3. The GPS-based monitoring system (GMS)

3.1 The GMS consists of one or more GMUs, and an off-line data processing system. The GMU is a portable unit. Depending upon the supplier, it may consist of one or two GPS receivers, plus a laptop computer for the processing and storage of data, and two separate GPS antennas. 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.

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 will be implemented 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

HMS		GMS
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

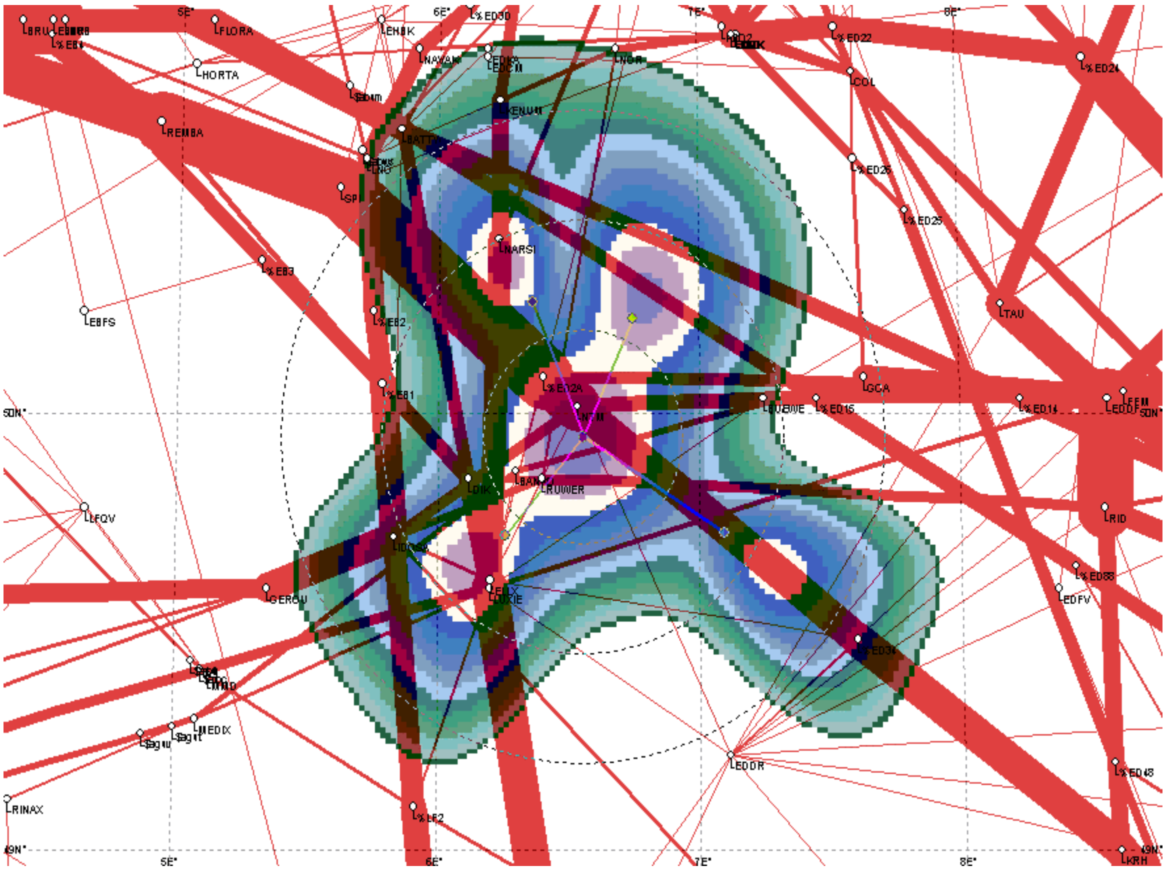

Figure 1. Coverage of Nattenheim HME

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