



ICAO

Doc 9937

Operating Procedures and Practices for Regional
Monitoring Agencies in Relation to the Use
of a 300 m (1 000 ft) Vertical Separation Minimum
Between FL 290 and FL 410 Inclusive

Second Edition, 2019



Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION **Documents**



Document Sharing Hub



| ICAO

Doc 9937

Operating Procedures and Practices for Regional
Monitoring Agencies in Relation to the Use
of a 300 m (1 000 ft) Vertical Separation Minimum
Between FL 290 and FL 410 Inclusive

Second Edition, 2019

Approved by and published under the authority of the Secretary General

INTERNATIONAL CIVIL AVIATION ORGANIZATION



Documents
Document Sharing Hub

Published in separate English, Arabic, Chinese, French, Russian
and Spanish editions by the
INTERNATIONAL CIVIL AVIATION ORGANIZATION
999 Robert-Bourassa Boulevard, Montréal, Quebec, Canada H3C 5H7

For ordering information and for a complete listing of sales agents
and booksellers, please go to the ICAO website at www.icao.int

Second Edition, 2019

**Doc 9937, *Operating Procedures and Practices for Regional
Monitoring Agencies in Relation to the Use of a 300 m (1 000 ft)
Vertical Separation Minimum Between FL 290 and FL 410 Inclusive***
Order Number: 9937
ISBN 978-92-9258-644-7

© ICAO 2019

All rights reserved. No part of this publication may be reproduced, stored in a
retrieval system or transmitted in any form or by any means, without prior
permission in writing from the International Civil Aviation Organization.

AMENDMENTS

Amendments are announced in the supplements to the *Products and Services Catalogue*; the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

[illegible][illegible]

FOREWORD

The requirements and procedures for the introduction of a 300 m (1 000 ft) vertical separation between FL 290 and FL 410, generally referred to as the reduced vertical separation minimum (RVSM), were developed by the Review of the General Concept of Separation Panel (RGCSF), which has since been renamed the Separation and Airspace Safety Panel (SASP). The provisions necessary for the application of RVSM have been incorporated into 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 is provided in the *Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive* (Doc 9574).

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

Doc 9574 states that there is a need for system performance monitoring for the operational use of RVSM. The requirement for and technical performance criteria of monitoring are described in Chapter 5 of Doc 9574. Regional monitoring agencies (RMAs) have been established by the appropriate planning and implementation regional groups (PIRGs) to undertake these functions. The objectives of the RVSM monitoring programme include, inter alia:

- a) verification that the RVSM approval process remains effective;
- b) verification that the target level of safety will be met upon implementation of RVSM and will continue to be met thereafter;
- c) monitoring of the effectiveness of the altimetry system modifications which have been implemented to enable aircraft to meet the required height-keeping performance criteria; and
- d) evaluation of the stability of altimetry system error (ASE).

TABLE OF CONTENTS

	<i>Page</i>
Glossary	(ix)
Definitions	(ix)
Abbreviations and acronyms.....	(xi)
Publications	(xiii)
Chapter 1. Introduction	1-1
1.1 Purpose of the manual	1-1
1.2 General description of RMA functions	1-1
1.3 Requirements for the establishment and operation of an RMA	1-2
Chapter 2. Working principles common to all regional monitoring agencies.....	2-1
2.1 Establishment and maintenance of an RVSM approvals database	2-1
2.2 Monitoring and reporting aircraft height-keeping performance and the occurrence of large height deviations	2-2
2.3 Conducting safety assessments	2-7
2.4 Safety reporting and monitoring operator compliance with State approval requirements after RVMS implementation	2-12
2.5 Remedial actions.....	2-12
Appendix A. Duties and responsibilities of a regional monitoring agency.....	App A-1
Appendix B. RMA forms for use in obtaining records of RVSM approvals from a State authority.....	App B-1
Appendix C. Content and format of an RVSM approvals database and procedures for exchanging data.....	App C-1
Appendix D. Merits and requirements of height-monitoring systems.....	App D-1
Appendix E. Guidance on reducing minimum monitoring requirements.....	App E-1
Appendix F. Action to be taken when an individual airframe is assessed as being non-compliant with altimetry system error performance requirements.....	App F-1
Appendix G. Recommended height-keeping performance monitoring data to be maintained in electronic form by an RMA for each monitored aircraft.....	App G-1

Appendix H. Action to be taken when a monitoring group is assessed as being non-compliant with altimetry system error performance requirements.....	App H-1
Appendix I. Large height deviation reporting form	App I-1
Appendix J. Scrutiny group composition, objectives and methodology	App J-1
Appendix K. Suggested form for ATC unit monthly reporting of large height deviations	App K-1
Appendix L. Sample content and format for collection of sample traffic movements	App L-1

GLOSSARY

DEFINITIONS

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

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

Aircraft-type group. Aircraft are considered to be members of the same group if they are designed and assembled by one manufacturer and are of nominally identical design and build with respect to all details that could influence the accuracy of height-keeping performance.

Altimetry system error (ASE). The difference between the altitude indicated by the altimeter display, assuming a correct altimeter barometric setting, and the pressure altitude corresponding to the undisturbed ambient pressure.

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

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

Altitude-keeping device. Any equipment which is designed to automatically control the aircraft to a referenced pressure altitude.

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

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

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

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

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

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

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

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

Large height deviation (LHD). A vertical deviation of 300 ft or more from an altitude assigned or coordinated by ATC. The deviation may be the result of human error, equipment malfunction or environmental factors such as turbulence, and should be reported in accordance with the LHD codes in Attachment B to Appendix J.

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) of 75 m (245 ft) or more.

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

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

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

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

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

RVSM airworthiness 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's service bulletin for the aircraft and having the State authority verify the successful completion of this work.

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

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

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

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

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

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

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

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

ABBREVIATIONS AND ACRONYMS

AAD	Assigned altitude deviation
ACAS	Airborne collision avoidance system
ADS-B	Automatic dependent surveillance — broadcast
ADS-C	Automatic dependent surveillance — contract
AGHME	Aircraft geometric height measurement element
AHMS	ADS-B height monitoring system
ARD	Altitude recording device
ASE	Altimetry system error
ATC	Air traffic control
ATS	Air traffic services
CRM	Collision risk model
FAA	Federal Aviation Administration
FIR	Flight information region
GMS	GPS-based monitoring system
GMU	GPS-based monitoring unit
GPS	Global positioning system
HME	Height-monitoring equipment
HMU	Height-monitoring unit
JAA	Joint Aviation Authorities
KSN	Knowledge sharing network
LHD	Large height deviation
MASPS	Minimum aircraft system performance specification
MLAT	Multilateration
MMR	Minimum monitoring requirements
NAT	North Atlantic
NOAA	National Oceanic and Atmospheric Administration
PIRGs	Planning and implementation regional groups
RA	Resolution advisory
RGCSPP	Review of the General Concept of Separation Panel
RMA	Regional monitoring agency
RVSM	Reduced vertical separation minimum
SASP	Separation and Airspace Safety Panel
SD	Standard deviation
SSR	Secondary surveillance radar
STC	Supplementary type certificate
TCAS	Traffic alert and collision avoidance system
TGL	Temporary guidance leaflet
TLS	Target level of safety
TMU	Total vertical error monitoring unit
TVE	Total vertical error
VSM	Vertical separation minimum



PUBLICATIONS

(referred to in this manual)

Annexes to the Convention on International Civil Aviation

Annex 2 — *Rules of the Air*

Annex 6 — *Operation of Aircraft*

Part I — *International Commercial Air Transport — Aeroplanes*

Part II — *International General Aviation — Aeroplanes*

Part III — *International Operations — Helicopters*

Annex 10 — *Aeronautical Telecommunications*

Volume II — *Communication Procedures including those with PANS status*

Annex 11 — *Air Traffic Services*

Procedures for Air Navigation Services

ATM — *Air Traffic Management* (Doc 4444)

Manuals

Aircraft Type Designators (Doc 8643)

Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services (Doc 8585)

Location Indicators (Doc 7910)

Manual on a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive (Doc 9574)

Reports of Meetings

Report of the Sixth Meeting of the Review of the General Concept of Separation Panel (RGCSP/6) (Doc 9536)¹

1. This document is permanently out of print.

Chapter 1

INTRODUCTION

1.1 PURPOSE OF THE MANUAL

The intent of this manual is to provide guidance on RMA operating procedures, in order to achieve a standardized approach to the way in which RMAs carry out these functions and the associated detailed duties and responsibilities of Doc 9574. It is not intended to provide exhaustive guidance on how to operate an RMA. Information on what is required of an RMA will be found in the *Manual on 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 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.

1.2.2 RMA duties and responsibilities are described in Doc 9574, 5.4.4 and 5.4.5, as well as in Appendix A to this manual. For the purposes of this overview, the functions of an RMA can be summarized as:

- a) establish and maintain a database of RVSM approvals;
- b) monitor aircraft height-keeping performance and the occurrence of LHDs and report the results appropriately;
- c) conduct safety assessments and report the results appropriately;
- d) monitor operator compliance with State approval requirements and report non-approved aircraft to the appropriate authority or RMA; and
- e) initiate necessary remedial actions if RVSM requirements are not met.

1.2.3 A list of the RMAs responsible for the provision of monitoring and safety assessment activities related to RVSM in each FIR and a list of the States and respective designated RMAs for RVSM approvals are available on the ICAO portal and the websites of individual RMAs.

1.3 REQUIREMENTS FOR THE 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 receives authority from a PIRG to act as an RMA as the result of a decision by a State, a group of States or a 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 the 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 an established RMA. For an organization with no prior experience in RVSM monitoring, such a programme could take as long as one year and should include both formal and on-the-job training.

Chapter 2

WORKING PRINCIPLES COMMON TO ALL REGIONAL MONITORING AGENCIES

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

2.1 ESTABLISHMENT AND MAINTENANCE OF AN RVSM APPROVALS DATABASE

2.1.1 One of the functions of an RMA is to establish a database of aircraft approved by its State authority for operations in RVSM airspace in the region for which the RMA has responsibility. This information is necessary for two reasons:

- a) the RMA is responsible for verifying the approval status of all aircraft operating within its region; and
- b) height-keeping performance data must be correlated to an approved airframe.

This information is of vital importance if the height-keeping performance data collected by the height-monitoring systems are 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 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 will need its own RMA to act as a focal point for the collection and collation of RVSM approvals for aircraft operating under its jurisdiction, it may not need to maintain a complete database of all aircraft in the world that are RVSM-approved. It will, however, need to establish links with other RMAs in order to determine the RVSM status of aircraft it has monitored, or intends to monitor, so that a valid assessment of the technical height-keeping risk can be made.

2.1.3 To avoid duplication by States in registering approvals with RMAs, the concept of a designated RMA for the processing of approval data has been established in this guidance material. Under the designated RMA concept, all States are associated with a particular RMA for the processing of RVSM approvals. A list of States and their respective designated RMAs should be endorsed by PIRGs and/or bilateral agreements detailing the respective responsibilities, and should be maintained on ICAO's portal and the websites of individual RMAs. RMAs may contact any State to address safety matters without regard to the list of designated RMAs. The correspondence between the RMA and each particular State should be coordinated with the respective designated RMA.

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

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

2.1.6 Appendix C suggests the minimum database content and the format in which it should be maintained by an RMA. Appendix C also describes the data to be shared by RMAs and procedures for sharing such data.

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 monitoring responsibility. In addition, it must establish procedures for the collection of information concerning large deviations from the cleared flight level and operational errors caused by non-compliance with ATC instructions or loop errors within the ATC system.

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

Monitoring of aircraft height-keeping performance

2.2.3 Monitoring of aircraft height-keeping performance is a demanding enterprise, particularly as regards the 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 in an airspace. Guidance on monitoring requirements for RVSM-approved aircraft is also provided along with suggested formats for storing monitoring data to facilitate data exchange with other RMAs.

Establishment of a technical height-monitoring function

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

- a) evidence of the effectiveness of the RVSM MASPS, and altimetry system modifications made in order to comply with the MASPS, in achieving the desired height-keeping performance;
- b) confidence that the technical TLS will continue to be met thereafter; and
- c) evidence of ASE stability.

2.2.5 To achieve these objectives, a technical height-monitoring function must be established. To date, regions have used either ground-based HMUs, AHMSs, or air portable 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 whether height-monitoring data from whatever sources they use can be combined for the purposes of the data analysis. The combination of data for collision risk evaluation should be avoided unless the error characteristics of the two monitoring systems have been determined to be identical. This is especially important in any work to establish ASE stability because the different measurement errors in individual systems can 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 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, AHMS and the GMS, which employs GMUs, should indicate that each system satisfies these requirements.

2.2.8 An RMA should coordinate with its region's PIRG to ensure that a suitable monitoring infrastructure is available to meet the region's requirements. A suitable monitoring infrastructure can be established through an arrangement to share GMU facilities with an existing RMA, through the establishment of fixed ground-based monitoring facilities or an AHMS within the region, or by engaging a suitable contractor to operate the monitoring programme. If the latter option is selected, the choice of support contractors 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 height-monitoring systems, see Appendix D. If a new method of monitoring is proposed, the new system should, in addition to meeting the requirements of 2.2.7, be evaluated against existing systems to ensure that the results are comparable.

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

Technical height-monitoring requirements

2.2.11 The three objectives of aircraft height-keeping performance monitoring are stated in Doc 9574 and noted in 2.2.4 above.

2.2.12 The majority of current aircraft types are eligible for RVSM airworthiness approval under group approval provisions. These provisions make it possible to define aircraft-type groups consisting of aircraft types that are designed and assembled by one manufacturer and are of nominally identical design and build with respect to all details that could influence the accuracy of height-keeping performance. It is not normally necessary to monitor all airframes within a monitoring group providing an adequate sample is available and the performance of the group is within the parameters specified below.

2.2.13 The minimum monitoring requirements (MMR) document serves as guidance for RMAs in evaluating airworthiness issues within their RVSM airspace of responsibility. It is also required to check the long-term stability of ASE on an ongoing basis. It lists the aircraft types that are eligible for RVSM approval under group provisions and the groups to which they belong, and suggests the level of monitoring that should be expected for each operator. As data are collected over time, the monitoring requirements for specific aircraft types may change and, as a result, the MMR should be updated periodically. The MMR table is available on RMAs' websites and guidance on how to reduce MMR is provided in Appendix E.

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

- a) the technical TLS of 2.5×10^{-9} fatal accidents per flight hour has been met;
- b) the number of aircraft monitored for each operator/aircraft-type combination meets a predetermined level;

- c) aircraft-type groups 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 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 exceeds 49 m (160 ft) in magnitude, excluding monitoring system measurement error.

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

Note 2.— With reference to 2.2.14 b), the minimum number of aircraft in a particular group to be monitored is normally expressed as a percentage of the operator's fleet of that group, with a further provision that the number of aircraft must not be less than two unless the operator has only a single airframe in the group.

Note 3.— With reference to 2.2.14 a), the technical TLS is normally evaluated on an annual basis, as determined by the PIRG, or on a more frequent basis as determined by an individual RMA. The other activities may be continuous.

2.2.15 Guidance on 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), the MMR should be reviewed at regular intervals and coordinated with all RMAs. The reviewed version should be available on the RMA's website. An RMA in conjunction with its PIRG may require a higher level of monitoring than defined in the MMR. The MMR itself should be subject to periodic review, either in collaboration with other RMAs or through ICAO. This review should be based on the quality and quantity of available data.

2.2.17 It is especially important that an RMA take 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 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 It is also necessary to establish procedures 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 the exchange of height measurement data table in Appendix G for each observation of aircraft height-keeping performance obtained from the airspace within which it exercises its functions.

Reporting of aircraft height-keeping performance statistics

2.2.20 If an RMA is employing a height-keeping performance monitoring system that produces substantial estimates of aircraft ASE, then tabulations of ASE by aircraft-type groups, as identified in the MMR, should be kept. For each group, the magnitude of mean ASE and the magnitude of mean ASE + 3 SD of ASE should be calculated and compared to the group performance limits, which are 25 m (80 ft) and 75 m (245 ft), as noted above. Groups exceeding

the performance requirements must be investigated and reported annually, or more frequently as required, to the body which authorized the establishment of the RMA. Note that a minimum data set of results is required before the group results can be considered valid.

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

2.2.22 It is the RMA's responsibility to bring performance issues that have 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 that approved the RVSM airworthiness documents for the aircraft-type group has such authority. However, the State is required, under the provisions of Annex 6, Parts I and II, to take immediate corrective action with regard to aircraft that are reported by an RMA as not complying with the height-keeping requirements.

2.2.23 RVSM airworthiness approval documents in the form of an approved service bulletin, supplementary type certificate (STC) or similar State-approved material provide directions to operators regarding the steps needed to bring an aircraft type into compliance with RVSM requirements. If there is a flaw in the ASE performance of an aircraft type, the ultimate goal of the RMA is to influence appropriate corrections to the compliance method, which would then be incorporated into the applicable RVSM airworthiness approval documents. An RMA's actions to achieve this goal should be the following:

- a) assemble all ASE monitoring data for the aircraft type from the airspace for which the RMA is responsible in accordance with the approach shown in Appendix H;
- b) assemble the measurement error characteristics of the monitoring system or systems used to produce the results in a);
- c) as deemed relevant by the RMA, assemble all summary monitoring data (consisting of mean ASE, ASE SD, minimum ASE, maximum ASE, and details of any flights found to be non-compliant with ASE requirements) from other regions or airspace where the aircraft type has been monitored; and
- d) by means of an official RMA letter, similar in form to that shown in Appendix H, inform the State authority that 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 3 SD of ASE be no greater than 75 m (245 ft);
 - 2) the data described in a) and b) and, as necessary, c), which will be provided on request;
 - 3) the need for compliance with these requirements in order to support safe RVSM operations; and

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

Monitoring the occurrence of large height deviations

2.2.24 Experience has shown that LHDs — deviations of 90 m (300 ft) or more in magnitude — have significantly influenced the outcome of safety assessments of RVSM. RMAs play a key role in the collection and processing of reports of such occurrences.

2.2.25 The causes of such deviations 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) the crew not following established contingency procedures during an emergency descent by an aircraft;
- d) the 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) coordination errors between adjacent ATC units in the transfer of control responsibility for an aircraft, resulting in flight at an incorrect flight level.

2.2.26 The aircraft technical height-keeping performance monitoring programme administered by an RMA addresses the first of these causes. There is, however, a need to establish, at a regional level, the means to detect and report the occurrence of LHDs due to the remaining causes. A sample LHD reporting form is included in Appendix I. While the RMA will be the recipient and archivist for reports of LHDs, 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 LHDs. This needs to be addressed through the appropriate PIRG and its subsidiary bodies as part of an overall regional safety management programme.

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

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

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

- a) reporting unit;
- b) location of deviation, either as latitude/longitude or a bearing and distance from a significant point;
- c) date and time of the LHD;
- 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 the ATC unit making the report.

2.2.30 Other sources of LHD reports 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 LHD incidents in the airspace for which the RMA is responsible.

2.3 CONDUCTING SAFETY ASSESSMENTS

Safety assessment

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 must acquire in-depth knowledge on the use of RVSM within a particular airspace. Experience has shown that such knowledge can be gained, in part, by reviewing charts and other materials describing the airspace and by periodically collecting samples of traffic movements within the airspace. It is also important that RMA personnel sufficiently understand the way in which an ATC system operates in order for them to correctly interpret the information from these sources.

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