

# RVSM

**Reduced Vertical Separation Minimum**

FAA GUIDANCE  
REGULATION INFORMATION



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# **Table of Contents**

## **Section A**

❖ <b>RVSM Regulation Information</b>	<b>A-1</b>
➤ Regulation Table of Contents	A-2
➤ TCAS II Regulation Information	A-3
➤ RVSM New to the Operator	A-4
➤ Interim Guidance Material FAA No. 91-RVSM	A-8
➤ PL-84 Master Minimum Equipment List for RVSM	A-70
➤ Proposed Rule for RVSM in Domestic US Airspace	A-72
➤ Correction of Proposed Rule	A-83
❖ <b>References</b>	<b>A-84</b>

# Regulation Information

**For more information concerning TCAS Operation in RVSM Airspace visit the FAA web address:**

- **Training Considerations for Using TCAS Version 6.04 and Version 7 in RVSM Airspace (19 Mar 02)**

**[www.faa.gov/ats/ato/150\\_docs/tcas\\_5.doc](http://www.faa.gov/ats/ato/150_docs/tcas_5.doc)**

- **TCAS II, Change 7 Modifications (21 Mar 02) - Provides explanation of modifications to TCAS II when Change 7 is incorporated. Recommends that aircraft operating practices recommended for TCAS Version 6.04 be continued**

**[www.faa.gov/ats/ato/150\\_docs/chng7mod.doc](http://www.faa.gov/ats/ato/150_docs/chng7mod.doc)**



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### **RVSM AREA NEW TO THE OPERATOR:**

1. **PURPOSE.** It is the objective of this paper to highlight policy and procedures that an operator that has been previously approved for RVSM in one area of operations (such as the North Atlantic or Pacific) must address when starting RVSM operations in a different area of operations.
2. **RVSM WEBSITE:** see paragraphs below for addresses for the FAA RVSM websites and access to FAA Safety Inspector Handbook Bulletins related to RVSM approval.
3. **WORLD-WIDE AIRCRAFT RVSM APPROVAL.** Please note, an **aircraft** that has been approved for RVSM operations is eligible to conduct RVSM operations in continental and oceanic airspace any where in the world. See FAA Interim Guidance 91-RVSM (Change 1) paragraph 11b(3). However, as discussed below, operators must address operational policy and procedures unique to individual areas of operation prior to flying in those areas.
4. **US OPERATOR REQUIREMENTS FOR OPERATION OUTSIDE THE US.** The Federal Aviation Regulations (FAR) hold operators responsible for knowledge of and conformance with regulations, policies and procedures in force in the countries in which the aircraft is operated and over the high seas (including those related to RVSM). Part 91, Section 91.703 (a)(1), (a) (2), (a)(3) and (a) (4); Section 91.706 (Operations in RVSM Airspace) and Part 91 Appendix G, Section 3 (Operator authorization) are applicable. Part 91 Section 91.703(a)(1) states that operators, when over the high seas, will comply with ICAO Annex 2 (Rules of the Air). Annex 2 paragraph 2.3.2 (Pre-flight action) calls for the pilot to be “familiar with all available information appropriate to the intended operation”.
5. **NEW AREA APPROVAL FOR PART 121, 125, AND 135 OPERATORS.** Interim Guidance (IG) 91-RVSM, paragraph 11d shows the content of an application for RVSM approval and states that it can be modified to only address those subjects that apply to a new area of operations. IG 91-RVSM, paragraph 11g states that Part 121, 125 and 135 operators are authorized to conduct RVSM in an area of operations that is new to them when Operations Specification (OpSpecs) paragraph B046 (Operations in RVSM Airspace) is added to the appropriate area of operations in OpSpecs paragraph B050 (Authorized Areas of En Route Operation. Limitations and Provisions). The list provided below is intended to show those subjects that an operator must address prior to flying in a new RVSM area of operations.
6. **PART 91 OPERATORS STARTING RVSM OPERATIONS IN A NEW AREA OF OPERATIONS.** IG 91-RVSM, paragraph 11d is also applicable to Part 91 operators. Part 91 operators must also address those subjects that are unique to a new RVSM area of operations prior to flying in that area. Part 91 operators that have previously received a Letter

of Authorization (LOA) to conduct RVSM operations are NOT required to obtain a separate LOA to fly in an RVSM area of operations that is new to them. As noted above, however, part 91 operators must comply with the regulations, policies and procedures applicable to each area of operations. The list provided below is intended to show those subjects on which an operator must be informed prior to conducting flight in a new area of operations. (Joint Flight Standards Handbook Bulletin for Air Transportation and General Aviation (HBAT 99-11A/HBGA 99-17A), paragraph 5C details this policy ).

7. OPERATIONAL ISSUES FOR AN OPERATOR TO ADDRESS FOR NEW AREAS OF OPERATION. See the paragraphs below for reference documents that contain information on area unique policies and procedures. The following issues may be unique to individual areas of operations where RVSM is implemented:

A. FLOOR, CEILING AND HORIZONTAL BOUNDARIES OF RVSM AIRSPACE. (In Pacific oceanic airspace, RVSM approval is required except by special arrangement between FL 290-390. In the North Atlantic, RVSM approval is currently required except by special arrangement between FL 290-410 (inclusive),. On January 24, 2002, RVSM was implemented in European airspace from FL 290-410 (inclusive).

B. POLICY ON EXCLUSION OF AIRCRAFT NOT RVSM APPROVED.  
Note: Area specific policy on climbing and descending through RVSM airspace

C. FLIGHT PLANNING POLICY.

D. PILOT PROCEDURES.

- (1) ICAO Special Procedures for In-flight Contingencies
- (2) Updated Weather Deviation Procedures
- (3) Track Offset Procedures for wake turbulence and nuisance aircraft system alerts
- (4) Pilot Level off call

E. PROCEDURES FOR FLIGHT OF NON-RVSM COMPLIANT AIRCRAFT FOR MAINTENANCE, HUMANITARIAN AND DELIVERY FLIGHTS.

F. CONTINUED AIRWORTHINESS PROCEDURES. If not previously established, RVSM procedures must be established at destination/departure airports new to the operator.

G. MONITORING REQUIREMENTS. Operators must show that they have completed or plan to complete the monitoring requirements for the new area of operations. If they have not already completed monitoring requirements by participating in the monitoring program for another area, operators must show their plan for completing monitoring for the new area.

Monitoring Requirements Charts for individual areas of operation are published on the FAA RVSM website.

8. REFERENCE DOCUMENTS FOR AREA UNIQUE POLICY/PROCEDURES

A. PACIFIC UNIQUE POLICY/PROCEDURES. A paper entitled “**Pacific RVSM: Operational Policy/Procedures**” addresses items 4A-4E above. It is published on the **FAA RVSM website “RVSM Documentation, Pacific” section**. The paper discusses the content of an FAA NOTAM on the subject, as well as, Pacific State AIP’s providing policy/procedures. (The FAA NOTAM is also published in the FAA Domestic/International NOTAMS book.

B. NORTH ATLANTIC UNIQUE POLICY/PROCEDURES. See the following:

(1) North Atlantic MNPS Airspace Operations Manual. (Can be down linked through ATP-130 website. See below for address).

(2) FAA Domestic/International NOTAM BOOK. Can be down loaded from:

<http://www.faa.gov/NTAP>

(3) Individual North Atlantic ATS Provider State AIP’s and AIC’s.

C. WEST ATLANTIC ROUTE SYSTEM (WATRS) UNIQUE POLICY/PROCEDURES.

D. EUROPEAN POLICIES/PROCEDURES. The FAA RVSM provides a link to the European RVSM website. It can also be accessed at: [eur-rvsm.com](http://eur-rvsm.com).

9. FAA RVSM WEBSITE ADDRESSES.

A. ATP-130 (Oceanic Operations and Procedures). Use Quick Jump Menu to link to RVSM, RNP, (Aviation) Flight Standards and other websites:

<http://www.faa.gov/ats/ato/130.htm>

B. FAA RVSM Website:

<http://www.faa.gov/ats/ato/rvsm1.htm>.

The website contains documents related to RVSM aircraft and operator approval.

10. FAA HANDBOOK BULLETINS. The Joint Flight Standards Handbook Bulletin for Air Transportation (HBAT) and General Aviation (HBAT 99-11A/HBGA 99-17A) containing guidance to FAA inspectors on the approval of aircraft and operators for RVSM can be obtained by accessing the ATP-130 website...

- Then use Quick Jump Menu to Go to (Aviation) Flight Standards website
- Click on FAA Safety Inspector Handbooks and Bulletins, then...
- Bulletins, then...
- HBAT, HBGA or FSAW

# INTERIM GUIDANCE MATERIAL ON THE APPROVAL OF OPERATORS/AIRCRAFT FOR RVSM OPERATIONS

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**Subject:** APPROVAL OF AIRCRAFT  
AND OPERATORS FOR FLIGHT  
IN AIRSPACE ABOVE FLIGHT  
LEVEL (FL) 290 WHERE A  
1,000 FOOT VERTICAL  
SEPARATION MINIMUM IS APPLIED

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**Date:** 6/30/99  
**Initiated by:** AIR-100  
AFS-400

**No.:** 91-RVSM  
**Change:** 1

\*1. PURPOSE. This document is intended to provide interim guidance. It establishes an acceptable means, but not the only means, that can be used in the approval of aircraft and operators to conduct flight in airspace or on routes where Reduced Vertical Separation Minimum (RVSM) is applied. It contains guidance on airworthiness, continuing airworthiness, and operations programs for RVSM operations. (Appendix 7 contains a table of contents which lists where these issues are addressed in the document.) (RVSM airspace is any airspace or route between FL 290 and FL 410 inclusive where aircraft are separated vertically by 1,000 ft (300 m)).

\* a. Paragraphs containing new or amended material are preceded by an asterisk.

2. RELATED FAR SECTIONS. FAR Section 91.705, FAR Section 91.411, FAR Part 145, FAR Part 121, FAR Part 135, FAR Part 43.

3. RELATED READING MATERIAL.

\* a. International Civil Aviation Organization (ICAO) Doc. 9574, *Manual on the Implementation of a 300 m (1,000 ft) Vertical Separation Minimum Between FL 290 - FL 410 Inclusive*. Copies may be obtained from ICAO, Document Sales Unit, 999 University Street, Montreal, Quebec H3C 5H7, Canada; Tel.: (514) 954-8022; Fax: (514) 954-6769; E-mail: sales\_unit@icao.org

b. ICAO Doc. 9536, Review of the General Concept of Separation Panel (RGCSP), Sixth Meeting, Montreal, 28 November - 15 December 1988. Copies may be obtained from address above.

c. ICAO Doc. 9572, RGCSP, Seventh Meeting, Montreal, 30 October - 20 November 1990. Copies may be obtained from address above.

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#### 4. BACKGROUND.

a. In mid-1981, the FAA established a Vertical Studies program with the objective of collecting data on aircraft height-keeping performance, developing program requirements for the reduction of vertical separation, and providing technical and operational representation on the working groups studying the subject. In early 1982, the FAA hosted a Public meeting on vertical separation. This meeting recommended that the Radio Technical Commission for Aeronautics (RTCA) should be the forum for the development of the minimum system performance standards (MSPS) for RVSM. RTCA Special Committee (SC) 150 was formed in March 1982 for this purpose.

b. In the international arena, the FAA committed resources to the ICAO RGCSP which was tasked in 1974 to add the study of vertical separation to its work program.

c. The data and analysis developed in the FAA Vertical Studies Program was reviewed by the national and international working groups studying RVSM. The major results and conclusions of this program are contained in the "Summary Report of United States Studies on 1,000 foot Vertical Separation Above Flight Level 290" which was completed in July 1988. (This report was incorporated in its entirety into Volume II of the RGCSP/6 report. Volume II is a compilation of reports from EUROCONTROL and four individual states on vertical studies).

d. RTCA SC 150 was established with the purpose of developing minimum system performance requirements, identifying required aircraft equipment improvements and operational procedure changes and assessing the impact of RVSM implementation on the aviation community. SC 150 served as the focal point for the study and development of RVSM criteria and programs in the U.S. from 1982 to 1987. SC 150 completed its "Initial Report on Minimum System Performance Standards for Vertical Separation Above Flight Level 290 in November 1984. This report contains information on the methodology for evaluating safety, factors influencing vertical separation, and strawman system performance standards. RTCA also developed a draft "Minimum System Performance Standard for 1,000-Foot Vertical Separation Above Flight Level 290." The draft MSPS continued to develop over a period of years. Draft 7 of the material was developed in August 1990.

e. In 1987, the FAA concentrated its resources for the development of RVSM programs in the ICAO RGCSP. The U.S. delegation to RGCSP used the material developed by SC 150 in developing U.S. positions and proposals on RVSM criteria and programs.

f. The ICAO RGCSP published two major reports which have provided the basis for the development of RVSM implementation documents. The Report of RGCSP/6 (Montreal, 28 November-15 December 1988) was published in two volumes. Volume 1

summarized the major conclusions reached by the panel and by individual states. Volume 2 presented the complete RVSM study reports of EUROCONTROL, the U.S., Japan, Canada, and the USSR. The major conclusions of this report are that:

(1) RVSM is "technically feasible without imposing unreasonably demanding technical requirements on the equipment"

(2) RVSM would provide "significant benefits in terms of economy and en route airspace capacity."

g. The second major report published by RGCSP was the Report of RGCSP/7 (Montreal, 30 October - 20 November 1990). This report contains the draft "Manual on Implementation of a 300 M (1,000 ft) Vertical Separation Minimum (VSM) Between FL 290 and 410 Inclusive." This material was approved by the ICAO Air Navigation Commission in February 1991 and published as ICAO Document 9574. This manual provides guidance for RVSM implementation planning, airworthiness requirements, flight crew procedures, ATC considerations, and system performance monitoring.

h. Appendix 6 provides a discussion of certain major conclusions detailed in Doc. 9574 which have served as the foundation for the development of the specific aircraft and operator approval criteria and programs contained in the Interim Guidance.

5. DEFINITIONS. The following definitions are intended to clarify certain specialized terms used in this advisory material:

a. Aircraft Group. A group of aircraft that are of nominally identical design and build with respect to all details that could influence the accuracy of height keeping performance (see paragraph 9b(2)).

b. Altimetry System Error (ASE). The difference between the pressure altitude displayed to the flightcrew when referenced to ISA standard ground pressure setting (29.92 in. Hg/1013.25 hPa) and free stream pressure altitude.

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

d. Automatic Altitude Control System. Any system which is designed to automatically control the aircraft to a referenced pressure altitude.

e. Avionics Error (AVE). The error in the processes of converting the sensed pressure into an electrical output, of applying any static source error correction (SSEC) as appropriate, and of displaying the corresponding altitude.

f. Basic RVSM Envelope. The range of Mach numbers and gross weights within the altitude ranges FL290 to FL410 (or max available altitude) where an aircraft can reasonably be expected to operate most frequently. (See paragraph 9b(4)(ii)).

g. Full RVSM Envelope. The entire range of operational Mach numbers,  $w/\delta$ , and altitude values over which the aircraft can be operated within RVSM airspace. (See paragraph 9b(4)(i)).

h. Height-Keeping Capability. Aircraft height-keeping performance which can be expected under nominal environmental operating conditions with proper aircraft operating practices and maintenance.

i. Height-Keeping Performance. The observed performance of an aircraft with respect to adherence to a flight level.

j. Non-Group Aircraft. An aircraft for which the operator applies for approval on the characteristics of the unique airframe rather than on a group basis. (see paragraph 9b(3)).

k. Residual Static Source Error. The amount by which static source error (SSE) remains undercorrected or overcorrected after the application of SSEC.

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

m. Static Source Error Correction (SSEC). A correction for static source error.

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

o.  $W/\delta$ . Aircraft weight,  $W$ , divided by the atmospheric pressure ratio,  $\delta$ .

## 6. THE APPROVAL PROCESS.

a. General. Airspace where RVSM is applied should be considered special qualification airspace. Both the individual operator and the specific aircraft type or types which the operator intends to use should be approved by the appropriate FAA offices before the operator conducts flight in RVSM airspace. This document provides guidance for the approval of aircraft types and operators for flight in airspace where RVSM is applied.

b. Approval of Aircraft. Each aircraft type that an operator intends to use in RVSM airspace should have received FAA approval in accordance with paragraph 9 prior to the operational approval being granted. Paragraph 9 provides guidance for the approval of aircraft which have already entered service and for new build aircraft.

(1) In-service Aircraft: FAR Parts 121, 125, and 135 Operations. Aircraft manufacturers should coordinate with the appropriate Aircraft Certification Office (ACO) to determine the process and procedures for RVSM airworthiness approval. An individual operator seeking approval for its aircraft should contact the manufacturer of the specific aircraft type and their assigned Certificate Management Office (CMO) or the Flight Standards District Office (FSDO) which holds their operating certificate to determine/coordinate the process for RVSM approval. Final approval will require coordination between the operator, the CMO or FSDO, the ACO, and the aircraft manufacturer or design organization.

(2) In-service Aircraft: FAR Part 91 Operations. An aircraft manufacturer should contact their assigned ACO to determine the process and procedures for RVSM airworthiness approval. An individual operator seeking approval for its aircraft should contact the manufacturer of the specific aircraft type and their local FSDO to determine/coordinate the process for RVSM approval.

(3) New Build Aircraft. A manufacturer which desires to have a specific aircraft type approved for the RVSM operations should contact the appropriate ACO within its assigned geographical area. Manufacturers will be able to receive airworthiness approval only.

(4) Other Aircraft. For RVSM operations conducted within the United States under FAR Part 129, aircraft should be approved by the state of the operator or registry. Experimental aircraft should be approved through special flight authorizations.

c. Operator Approval. Paragraph 10 contains guidance on the continuous airworthiness (maintenance) programs for RVSM operations. Paragraph 11 contains guidance on the operational procedures and programs which an operator should adopt for RVSM operation. Each individual operator should plan on presenting these programs to the FAA at least 60 days prior to proposed operation. Paragraph 11 discusses the timing, process, and maintenance and operations material which the operator should submit for FAA review and evaluation. The appropriate FAA offices which should be contacted to start the process are as follows:

(1) FAR Parts 121, 125, and 135 Operators. The operator should notify the CMO or FSDO which holds its operating certificate of its intent to obtain approval for RVSM operations. The operator can expect the CMO or FSDO to consult the Air Transportation Operations Inspector's Handbook, FAA Order 8400.10, and Airworthiness

the Inspector's Handbook, FAA Order 8300.10, for guidance on RVSM approval and for sources of technical assistance.

(2) FAR Part 91 Operators. FAR Part 91 operators should contact their local FSDO to start the process to receive a letter of authorization (LOA) which will grant authorization for RVSM operations. The operator can expect the FSDO to consult FAA General Aviation Operations Inspector's Handbook, FAA Order 8700.1, and the Airworthiness Inspector's Handbook, FAA Order 8300.10, as necessary for guidance on RVSM approval and for sources of technical assistance.

## 7. RVSM PERFORMANCE.

a. General. The statistical performance statements of ICAO Doc. 9574 for a population of aircraft (see Appendix 6) have been translated into airworthiness standards by assessment of the characteristics of ASE and altitude control. The following standards differ in some respects from that document, but they are consistent with the requirements of RVSM.

b. RVSM Flight Envelopes. For the purposes of RVSM approval, the aircraft flight envelope may be considered in two parts: the Basic RVSM Envelope and the Full RVSM Envelope. (The parameters for these envelopes are detailed in paragraph 9b(4)). The Basic RVSM Envelope is the part of the flight envelope where aircraft operate the majority of time. The Full RVSM Envelope includes parts of the flight envelope where the aircraft operates less frequently and where a larger ASE tolerance is allowed (See paragraphs 7c(3) and 7c(4)).

### c. Altimetry System Error.

(1) In order to evaluate a system against the ASE performance statements established by RGCSP (see Appendix 6, paragraph 3), it is necessary to quantify the mean and three standard deviation values for ASE, expressed as  $ASE_{\text{mean}}$  and  $ASE_{3SD}$ . In order to do this, it is necessary to take into account the different ways in which variations in ASE can arise. The factors which affect ASE are as follows:

- (i) Unit to unit variability of avionics.
- (ii) Effect of environmental operating conditions on avionics.
- (iii) Airframe to airframe variability of static source error.
- (iv) Effect of flight operating condition on static source error.

(2) Assessment of ASE, whether based on measured or predicted data, must, therefore, cover paragraphs 7c(1)(i), 7c(1)(ii), 7c(1)(iii) and 7c(1)(iv). The effect of item (iv) as a variable can be eliminated by evaluating ASE at the most adverse flight condition in an RVSM flight envelope.

(3) The requirements in the Basic RVSM Envelope are as follows:

(i) At the point in the Basic RVSM Envelope where mean ASE reaches its largest absolute value, the absolute value should not exceed 80 ft (25m).

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

(4) The requirements in the Full RVSM Envelope are as follows:

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

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

(iii) If necessary, for the purpose of achieving RVSM approval for an aircraft group, an operating restriction may be established to restrict aircraft from conducting RVSM operations in areas of the Full RVSM Envelope where the absolute value of mean ASE exceeds 120 ft (37m) and/or the absolute value of mean ASE plus three standard deviations of ASE exceed 245 ft (75m). When such a restriction is established, it should be identified in the data package and documented in appropriate aircraft operating manuals; however, visual or aural warning/indication systems should not be required to be installed on the aircraft.

(5) Aircraft types for which application for type certification or major change in type design is made after January 1, 1997 should meet the criteria established for the Basic Envelope in the Full RVSM Envelope. (See paragraph 7c(3)). The FAA will consider factors that provide an equivalent level of safety in the application of this criteria as stated in FAR section 21.21b(1).

(6) The requirement of ICAO Doc. 9574 that each individual aircraft in the group should be built to have ASE contained within  $\pm 200$  ft ( $\pm 60$  m) is discussed in paragraph 9b(5)(iv)(F).

(7) The standards of paragraphs 7c(3), 7c(4) and 7c(5) cannot be applied to nongroup aircraft approval because there can be no group data with which to develop airframe to airframe variability. Therefore, a single ASE value has been established that controls the simple sum of the altimetry system errors. In order to control the overall population distribution, this limit has been set at a value less than that for group approval.

(8) Accordingly the standard for aircraft submitted for approval as nongroup aircraft, as defined in paragraph 9b(3) is as follows:

(i) For all conditions in the Basic RVSM Envelope:

$$| \text{Residual static source error} + \text{worst case avionics} | \leq 160 \text{ ft (50 m)}$$

(ii) For all conditions in the Full RVSM Envelope:

$$| \text{Residual static source error} + \text{worst case avionics} | \leq 200 \text{ ft (60 m)}$$

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

d. Altitude Keeping. An automatic altitude control system should be required and it should be capable of controlling altitude within  $\pm 65$  ft ( $\pm 20$  m) about the acquired altitude when operated in straight and level flight under nonturbulent, nongust conditions.

*Note.* Aircraft types for which application for type certification or major change in type design is made prior to January 1, 1997 which are equipped with automatic altitude control systems with flight management system/performance management system inputs allowing variations up to  $\pm 130$  ft ( $\pm 40$  m) under nonturbulent, nongust conditions do not require retrofit or design alteration.

## 8. AIRCRAFT SYSTEMS.

a. Equipment for RVSM Operations. The minimum equipment fit should be as follows:

(1) Two independent altitude measurement systems. Each system should be composed of the following elements:

(i) Crosscoupled static source/system, provided with ice protection if located in areas subject to ice accretion;

(ii) Equipment for measuring static pressure sensed by the static source, converting it to pressure altitude and displaying the pressure altitude to the flightcrew;

(iii) Equipment for providing a digitally coded signal corresponding to the displayed pressure altitude, for automatic altitude reporting purposes;

(iv) Static source error correction (SSEC), if needed to meet the performance requirements of paragraphs 7c(3) and 7c(4), or 7c(8), as appropriate; and

(v) The equipment fit should provide reference signals for automatic control and alerting at selected altitude. These signals should preferably be derived from an altitude measurement system meeting the full requirements of this document, but must in all cases enable the requirements of paragraphs 8b(6) and 8c to be met.

(2) One SSR altitude reporting transponder. If only one is fitted, it should have the capability for switching to operate from either altitude measurement system.

(3) An altitude alert system.

(4) An automatic altitude control system.

b. Altimetry.

(1) System Definition. The altimetry system of an aircraft comprises all those elements involved in the process of sampling free stream static pressure and converting it to a pressure altitude output. The elements of the altimetry system fall into two main groups:

(i) Airframe plus static sources.

(ii) Avionics and/or instruments.

(2) Altimetry System Outputs. The following altimetry system outputs are significant for RVSM operations:

(i) Pressure altitude (Baro Corrected) display.

(ii) Pressure altitude reporting data.

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

(3) Altimetry System Accuracy. The total system accuracy should satisfy the requirements of paragraphs 7c(3) and 7c(4), or 7c(8), as appropriate.

(4) SSEC. If the design and characteristics of the aircraft and altimetry system are such that the standards of paragraphs 7c(3) and 7c(4), or 7c(8), are not satisfied by the location and geometry of the static sources alone, then suitable SSEC should be applied automatically within the avionic part of the altimetry system. The design aim for static source error correction, whether aerodynamic/geometric or avionic, should be to produce a minimum residual static source error, but in all cases it should lead to satisfaction of the standards of paragraphs 7c(3) and 7c(4), or 7c(8), as appropriate.

(5) Altitude Reporting Capability. The aircraft altimetry system should provide an output to the aircraft transponder in accordance with regulations of the approving authority.

(6) Altitude Control Output.

(i) The altimetry system shall provide an output which can be used by an automatic altitude control system to control the aircraft at a commanded altitude. The output may be used either directly or combined with other sensor signals. If SSEC is necessary in order to satisfy the requirements of paragraphs 7c(3) and 7c(4), or 7c(8) of this document, then an equivalent SSEC must be applied to the altitude control output. The output may be an altitude deviation signal, relative to the selected altitude, or a suitable absolute altitude output.

(ii) Whatever the system architecture and SSEC system the difference between the output to the altitude control system and the altitude displayed must be kept to the minimum .

(7) Altimetry System Integrity. During the RVSM approval process it must be verified analytically that the predicted rate of occurrence of undetected altimetry system failures does not exceed  $1 \times 10^{-5}$  per flight hour. All failures and failure combinations whose occurrence would not be evident from cross cockpit checks, and which would lead to altitude measurement/display errors outside the specified limits, need to be assessed against this budget. No other failures or failure combinations need to be considered.

c. Altitude Alert. The altitude deviation warning system should signal an alert when the altitude displayed to the flightcrew deviates from selected altitude by more than a nominal value. For aircraft for which application for type certification or major change in type design is made prior to January 1, 1997, the nominal value shall not be greater than  $\pm 300$  ft ( $\pm 90$  m). For aircraft for which application for type certification or major change in type design is made after January 1, 1997, the nominal value should not be greater than

$\pm 200$  ft ( $\pm 60$  m). The overall equipment tolerance in implementing these nominal threshold values should not exceed  $\pm 50$  ft ( $\pm 15$  m).

d. Automatic Altitude Control System

(1) As a minimum, a single automatic altitude control system should be installed which is capable of controlling aircraft height within a tolerance band of  $\pm 65$  ft ( $\pm 20$  m) about the acquired altitude when the aircraft is operated in straight and level flight under nonturbulent, nongust conditions.

*Note. Aircraft types for which application for Type Certification is made prior to January 1, 1997, which are equipped with automatic altitude control system with flight management system/performance management system inputs which allow variations up to  $\pm 130$  ft ( $\pm 40$  m) under nonturbulent, nongust conditions do not require retrofit or design alteration.*

(2) Where an altitude select/acquire function is provided, the altitude select/acquire control panel must be configured such that an error of no more than  $\pm 25$  ft ( $\pm 8$  m) exists between the display selected by the flightcrew and the corresponding output to the control system.

9. AIRWORTHINESS APPROVAL.

a. General. Obtaining RVSM airworthiness approval is a 2 step process. First, the manufacturer or design organization develops the data package through which airworthiness approval should be sought, and submits the package to the appropriate Aircraft Certification Office (ACO) for approval. Once the ACO approves the data package, the operator applies the procedures defined in the package to obtain approval from the FSDO or CMO (as appropriate) to utilize its aircraft to conduct flight in RVSM airspace. Paragraph 9b specifically addresses the data package requirements.

b. Contents of the Data Package.

(1) Scope. As a minimum, the data package should consist of the following items:

(i) A definition of the aircraft group or non-group aircraft to which the data package applies.

(ii) A definition of the flight envelope(s) applicable to the subject aircraft.

(iii) The data needed to show compliance with the requirements of paragraphs 7 and 8.

(iv) The compliance procedures to be used to ensure that all aircraft submitted for airworthiness approval meet RVSM requirements.

(v) The engineering data to be used to ensure continued in-service RVSM approval integrity.

(2) Definition of Aircraft Group. For aircraft to be considered as members of a group for purposes of RVSM approval, they should satisfy all of the following conditions:

(i) Aircraft should have been manufactured to a nominally identical design and be approved by the same Type Certificate (TC), TC amendment, or supplemental TC, as applicable.

*Note. For derivative aircraft it may be possible to utilize the database from the parent configuration to minimize the amount of additional data required to show compliance. The extent of additional data required will depend on the nature of the changes between the parent aircraft and the derivative aircraft.*

(ii) The static system of each aircraft should be installed in a nominally identical manner and position. The same SSE corrections should be incorporated in all aircraft of the group.

(iii) The avionics units installed on each aircraft to meet the minimum RVSM equipment requirements of paragraph 8a should be manufactured to the manufacturer's same specification and have the same part number.

*Note. Aircraft which have avionic units which are of a different manufacturer or part number may be considered part of the group, if it is demonstrated that this standard of avionic equipment provides equivalent system performance.*

(iv) The RVSM data package should have been produced or provided by the airframe manufacturer or design organization.

(3) Definition of Nongroup Aircraft. If an airframe does not meet the conditions of paragraphs 9b(2)(i), 9b(2)(ii), 9b(2)(iii), and 9b(2)(iv) to qualify as a member of a group or is presented as an individual airframe for approval, then it must be considered as a non-group aircraft for the purposes of RVSM approval.

(4) Definition of Flight Envelopes. The RVSM flight envelope is defined as the Mach number,  $W/\delta$ , and altitude ranges over which an aircraft can be operated in cruising flight within the RVSM airspace (see Appendix 1 for an explanation of  $W/\delta$ ). As noted in

paragraph 7b, the RVSM operational flight envelope for any aircraft may be divided into two zones as defined below:

(i) Full RVSM Envelope:

(A) The Full RVSM Envelope will comprise the entire range of operational Mach number,  $W/\delta$ , and altitude values over which the aircraft can be operated within RVSM airspace. Table 1 establishes the parameters which should be considered.

Table 1. Full RVSM Envelope Boundaries.

	Lower Boundary is defined by:	Upper Boundary is defined by:
Altitude	<ul style="list-style-type: none"> <li>• FL 290</li> </ul>	The lower of the following <ul style="list-style-type: none"> <li>• FL 410</li> <li>• Airplane maximum certified altitude</li> <li>• Altitude limited by: cruise thrust; buffet; other aircraft flight limitations</li> </ul>
Mach or Speed	The lower of the following: <ul style="list-style-type: none"> <li>• Maximum endurance (holding) speed</li> <li>• Maneuver speed</li> </ul>	The lower of the following <ul style="list-style-type: none"> <li>• Mmo/Vmo</li> <li>• Speed limited by: Cruise thrust; buffet; other aircraft flight limitations</li> </ul>
Gross Weight	<ul style="list-style-type: none"> <li>• The lowest gross weight compatible with operation in RVSM airspace</li> </ul>	<ul style="list-style-type: none"> <li>• The highest gross weight compatible with operation in RVSM airspace</li> </ul>

(ii) Basic RVSM Envelope:

(A) The boundaries for the Basic RVSM Envelope are the same as those for the Full RVSM Envelope except in regard to the upper Mach boundary.

(B) For the Basic RVSM Envelope, the upper Mach boundary may be limited to a range of airspeeds over which the aircraft group can reasonably be expected to operate most frequently. This boundary should be declared for each aircraft group by the manufacturer or design organization. It may be defined as equal to the upper Mach/airspeed boundary defined for the Full RVSM Envelope or a specified lower value. This lower value

should not be less than the Long Range Cruise Mach Number plus .04 Mach unless limited by available cruise thrust, buffet, or other aircraft flight limitations:

*Note: Long Range Cruise Mach Number is the Mach for 99% of best fuel mileage at the particular W/d under consideration.*

(5) Data Requirements. The data package should contain data sufficient to substantiate that the accuracy standards of paragraph 7 are met.

(i) General.

(A) ASE will generally vary with flight condition. The data package should provide coverage of the RVSM envelope sufficient to define the largest errors in the Basic and Full RVSM envelopes. Note that in the case of group approval the worst flight condition may be different for each of the requirements of paragraph 7c(3) and 7c(4), and each should be evaluated.

(B) Where precision flight calibrations are used to quantify or verify altimetry system performance they may be accomplished by any of the following methods. Flight calibrations should only be performed once appropriate ground checks have been completed. Uncertainties in application of the method must be assessed and taken into account in the data package.

(1) Precision tracking radar in conjunction with pressure calibration of atmosphere at test altitude.

(2) Trailing cone.

(3) Pacer aircraft.

(4) Any other method acceptable to the FAA or approving authority.

*Note. When using pacer aircraft it should be understood that the pacer aircraft must have been directly calibrated to a known standard. It is not acceptable to calibrate a pacer aircraft by another pacer aircraft.*

(ii) Altimetry System Error Budget. It is implicit in the intent of paragraph 7c, for group approvals and for non-group approvals, that a trade may be made between the various error sources which contribute to ASE (as noted in Appendix 2). This document does not specify separate limits for the various error sources which contribute to the mean and variable components of ASE as long as the overall ASE accuracy requirements of paragraph 7c are met. For example, in the case of group approval, the smaller the mean of

the group and the more stringent the avionics standard, the larger the available allowance for SSE variations. In all cases the trade-off adopted should be presented in the data package in the form of an error budget which includes all significant error sources. This is discussed in more detail in the following sections and the discussion of altimetry system error sources provided in Appendix 2.

(iii) Avionics. Avionics equipment should be identified by function and part number. It must be demonstrated that the avionics equipment can meet the requirements established according to the error budget when the equipment is operated in the environmental conditions expected to be met during RVSM operations.

(iv) Groups of Aircraft. Where approval is sought for an aircraft group, the data package must be sufficient to show that the requirements of paragraph 7c(3) and 7c(4) are met. Because of the statistical nature of these requirements, the content of the data package may vary considerably from group to group.

(A) The mean and airframe-to-airframe variability of ASE should be established based on precision flight test calibration of a number of aircraft. Where analytical methods are available, it may be possible to enhance the flight test data base and to track subsequent change in the mean and variability based on geometric inspections and bench test or any other method acceptable to the approving authority. In the case of derivative aircraft it may be possible to utilize data from the parent as part of the data base. (An example would be the case of a fuselage stretch where the only difference in mean ASE between groups could be reliably accounted for by analytical means.)

(B) An assessment of the aircraft-to-aircraft variability of each error source should be made. The error assessment may take various forms as appropriate to the nature and magnitude of the source and the type of data available. For example, for some error sources (especially small ones) it may be acceptable to use specification values to represent 3SD. For other error sources (especially larger ones) a more comprehensive assessment may be required; this is especially true for airframe error sources where "specification" values of ASE contribution may not have been previously established.

(C) In many cases one or more of the major ASE error sources will be aerodynamic in nature (such as variations in the aircraft surface contour in the vicinity of the static pressure source). If evaluation of these errors is based on geometric measurements, substantiation should be provided that the methodology used is adequate to ensure compliance. An example of the type of data which could be used to provide this substantiation is provided in figure 3-2 of Appendix 3.

(D) An error budget should be established to ensure that the standards of paragraphs 7c(3) and 7c(4) are met. As noted in 9b(5)(i)(A), the worst flight condition may be different for each of these standards and therefore the component error values may also be different.

(E) In showing compliance with the overall requirements, the component error sources should be combined in an appropriate manner. In most cases this will involve the algebraic summation of the mean components of the errors, root-sum-square (rss) combination of the variable components of the errors, and summation of the rss value with the absolute value of the overall mean. (Care should be taken that only variable component error sources which are independent of each other are combined by rss.)

(F) The methodology described above for group approval is statistical in nature. This is the result of the statistical nature of the risk analysis and the resulting statistical statements of Appendix 6, paragraphs 5a and 5b. In the context of a statistical method, the statements of Appendix 6, paragraph 5c required reassessment. This item states that "each individual aircraft in the group shall be built to have ASE contained within  $\pm 200$  feet". This statement has not been taken to mean that every airframe should be calibrated with a trailing cone or equivalent to demonstrate that ASE is within 200 ft. Such an interpretation would be unduly onerous considering that the risk analysis allows for a small proportion of aircraft to exceed 200 ft. However, it is accepted that if any aircraft is identified as having an error exceeding  $\pm 200$  ft then it should receive corrective action.

(v) Nongroup Aircraft. Where an aircraft is submitted for approval as a nongroup aircraft, the data should be sufficient to show that the requirements of paragraph 7c(8) are met. The data package should specify how the ASE budget has been allocated between residual SSE and avionics error. The operator and the FAA should agree on what data is needed to satisfy approval requirements. The following data should be established:

(A) Precision flight test calibration of the aircraft to establish its ASE or SSE over the RVSM envelope should be required. Flight calibration should be performed at points in the flight envelope(s) as agreed by the certifying authority. One of the methods prescribed in paragraph 9b(5)(i)(B) should be used.

(B) Calibration of the avionics used in the flight test as required to establish residual SSE. The number of test points should be agreed by the certifying authority. Since the purpose of the flight test is to determine the residual SSE, specially calibrated altimetry equipment may be used.

(C) Specifications for the installed altimetry avionics equipment indicating the largest allowable errors will be presented.

(D) Using paragraphs 9b(5)(v)(A), 9b(5)(v)(B), and 9b(5)(v)(C) demonstrate that the requirements of paragraph 7c(8) are met. If subsequent to aircraft approval for RVSM operation avionic units which are of a different manufacturer or part number are fitted, it should be demonstrated that the standard of avionic equipment provides equivalent altimetry system performance.

(6) Compliance Procedures. The data package must include a definition of the procedures, inspections/tests and limits which will be used to insure that all aircraft approved against the data package "conform to type," that is all future approvals, whether of new build or in-service aircraft, meet the budget allowances developed according to paragraph 9b(5)(ii). The budget allowances will be established by the data package and include a methodology that allows for tracking the mean and SD for new build aircraft. Compliance requirements must be defined for each potential source of error. A discussion of error sources is provided in Appendix 2. Examples of compliance procedures are presented in Appendix 3.

(7) Where an operating restriction has been adopted (see paragraph 7c(4)(iii)), the package should contain the data and information necessary to document and establish that restriction.

(8) Continued Airworthiness.

(i) The following items should be reviewed and updated as appropriate to include the effects of RVSM implementation:

(A) The Structural Repair Manual with special attention to the areas around the static source, angle of attack sensors and doors if their rigging can affect airflow around the previously mentioned sensors.

(B) The MMEL.

(ii) The data package should include descriptions of any special procedures which are not covered in paragraph 9b(8)(i) but may be needed to insure continued compliance with RVSM requirements as follows:

(A) For nongroup aircraft where airworthiness approval has been based on flight test, the continuing integrity and accuracy of the altimetry system shall be demonstrated by periodic ground and flight tests of the aircraft and its altimetry system at periods to be agreed with the approving authority. However, alleviation of the flight test requirement may be given if it can be adequately demonstrated that the relationship between any subsequent airframe/system degradation and its effects on altimetry system accuracy is understood and adequately compensated/corrected for.

(B) To the extent possible, in-flight defect reporting procedures should be defined to facilitate identification of altimetry system error sources. Such procedures could cover acceptable differences between primary and alternate static sources, and others as appropriate.

(C) For groups of aircraft where approval is based on geometric inspection, there may be a need for periodic re-inspection, and the interval required should be specified.

c. Data Package Approval. All necessary data should be submitted to the appropriate ACO for action.

d. RVSM Airworthiness Approval. The approved data package should be used by the operator to demonstrate compliance with RVSM performance standards.

e. Post Approval Modification. Any variation/modification from the initial installation that affects RVSM approval should require clearance by the airframe manufacturer or approved design organization and be cleared with the FAA to show that RVSM compliance has not been impaired.

#### 10. CONTINUED AIRWORTHINESS (MAINTENANCE REQUIREMENTS).

##### a. General.

(1) The integrity of the design features necessary to ensure that altimetry systems continue to meet RVSM standards should be verified by scheduled tests and/or inspections in conjunction with an approved maintenance program. The operator should review its maintenance procedures and address all aspects of continuing airworthiness which are affected by RVSM requirements.

(2) Each person or operator should demonstrate that adequate maintenance facilities are available to ensure continued compliance with the RVSM maintenance requirements.

b. Maintenance Program Approval Requirements. Each operator requesting RVSM operational approval should submit a maintenance and inspection program which includes any maintenance requirements defined in the approved data package (paragraph 9) as part of a continuous airworthiness maintenance program approval or an equivalent program approved by the FAA. Although air carriers operating aircraft subject to a continuous airworthiness maintenance program do not have to comply with the provisions of FAR Section 91.411 pertaining to altimeter system and altitude reporting equipment test and

inspections, an effective maintenance and inspection program will, typically, incorporate these provisions as a requirement for maintenance program approval.

c. Maintenance Documents Requirements. The following items should be reviewed as appropriate for RVSM maintenance approval:

- (1) Maintenance Manuals.
- (2) Structural Repair Manuals.
- (3) Standards Practices Manuals.
- (4) Illustrated Parts Catalogs.
- (5) Maintenance Schedule.
- (6) MMEL/MEL.

d. Maintenance Practices.

(1) If the operator is subject to an ongoing approved maintenance program, that program should contain the maintenance practices outlined in the applicable aircraft and component manufacturer's maintenance manuals for each aircraft type. The following items should be reviewed for compliance for RVSM approval and if the operator is not subject to an approved maintenance program the following items should be followed:

(i) All RVSM equipment should be maintained in accordance with the component manufacturer's maintenance requirements and the performance requirements outlined in the approved data package.

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

(iii) Any maintenance practices which may affect the continuing RVSM approval integrity, e.g., the alignment of pitot/static probes, dents, or deformation around static plates, should be referred to the approving authority or persons delegated by the authority.

(iv) Built-in Test Equipment (BITE) testing is not an acceptable basis for system calibrations, (unless it is shown to be acceptable by the airframe manufacturer with the approval authorities agreement) and should only be used for fault isolation and troubleshooting purposes.

(v) Some aircraft manufacturers have determined that the removal and replacement of components utilizing quick disconnects and associated fittings, when properly connected, will not require a leak check. While this approach may allow the aircraft to meet static system certification standards when properly connected, it does not always ensure the integrity of the fittings and connectors, nor does it confirm system integrity during component replacement and reconnections. Therefore, a system leak check or visual inspection should be accomplished any time a quick disconnect static line is broken.

(vi) Airframe and static systems should be maintained in accordance with the airframe manufacturer's inspection standards and procedures.

(vii) To ensure the proper maintenance of airframe geometry for proper surface contours and the mitigation of altimetry system error, surface measurements or skin waviness checks should be made if needed to ensure adherence to the airframe manufacturer's RVSM tolerances. These tests and inspections should be performed as established by the airframe manufacturer. These checks should also be performed following repairs, or alterations having an effect of airframe surface and airflow.

(viii) The maintenance and inspection program for the autopilot should ensure continued accuracy and integrity of the automatic altitude control system to meet the height-keeping standards for RVSM operations. This requirement will typically be satisfied with equipment inspections and serviceability checks.

(ix) Where the performance of existing equipment is demonstrated as being satisfactory for RVSM approval, it should be verified that the existing maintenance practices are also consistent with continued RVSM approval integrity. Examples of these are:

- (A) Altitude alert.
- (B) Automatic altitude control system
- (C) ATC altitude reporting equipment (transponders FAR 91.215)
- (D) Altimetry systems.

e. Maintenance Practices for Noncompliant Aircraft. Those aircraft positively identified as exhibiting height-keeping performance errors which require investigation as specified in paragraph 11i(1) should not be operated in airspace where RVSM is applied until the following actions have been taken:

(1) The failure or malfunction is confirmed and isolated by maintenance action and,

(2) Corrective action is carried out as required to comply with paragraph 9b(5)(iv)(F) and verified to ensure RVSM approval integrity.

f. Maintenance Training Requirements. It is expected that new training requirements will be introduced by the RVSM approval processes. Areas that may need to be highlighted for initial and recurrent training of shop and line personnel are:

- (1) Aircraft geometric inspection techniques.
- (2) Test equipment calibration/usage techniques.
- (3) Any special documentation or procedures introduced by RVSM approval.

g. Test Equipment.

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

(2) Standards. Test equipment should be calibrated utilizing reference standards whose calibration is certified as being traceable to the national standard approved. It should be calibrated at periodic intervals as agreed by the approving authority. The approved maintenance program should encompass an effective quality control program which includes the following:

- (i) Definition of required test equipment accuracy.
- (ii) Regular calibrations of test equipment traceable to a master inhouse standard. Determination of calibration interval should be a function of the stability of the test equipment. The calibration interval should be established on the basis of historical data so that degradation is small in relation to the required accuracy.
- (iii) Regular audits of calibration facilities both inhouse and outside.
- (iv) Adherence to acceptable shop and line maintenance practices.
- (v) Procedures for controlling operator errors and unusual environmental conditions which may affect calibration accuracy.

## 11. OPERATIONAL APPROVAL.

a. Purpose and Organization. Paragraph 6 describes in general the administrative process which an operator should follow to receive approval to operate an aircraft in RVSM airspace. Paragraph 11 is intended to provide detailed guidance on the content of operational programs, practices, and procedures. It also describes specifically the steps in the operational approval process: application for authority, FAA evaluation of this application, and granting of approval to operate. Appendices 4 and 5 are related to this paragraph and contain essential information for operational programs.

\* b. General. The FAA should ensure that each operator can maintain high levels of height-keeping performance.

(1) The FAA should be satisfied that operational programs are adequate. Flightcrew training as well as operations manuals should be evaluated. Approval should be granted for each individual operator.

(2) Approval should be granted for each individual aircraft group and each individual aircraft to be used by the operator in RVSM operations. Each aircraft should receive airworthiness approval in accordance with paragraph 9 prior to being approved for use by the operator. (Aircraft group is defined in paragraph 9b(2)).

\* (3) Aircraft Approval for Worldwide RVSM Operations. Aircraft that have been approved for RVSM can be used in RVSM operations worldwide. This includes RVSM operation in continental areas such as Europe and the U.S. when RVSM is implemented in those areas. Aircraft equipage and altitude-keeping performance requirements were developed using the highest density traffic counts in the world so that aircraft could receive one-time approval for worldwide operations.

\* (4) Operational Approval for New RVSM Areas of operation. Operators that are starting RVSM operations in an RVSM area of operations that is new to them should ensure that their RVSM programs incorporate any operations or continued airworthiness requirements unique to the new area of operations. (See Paragraph 11g for information on the form of RVSM authority for new areas of operations).

c. Pre-application Meeting. A pre-application meeting should be scheduled between the operator and the CMO or FSDO. The intent of this meeting is to inform the operator of FAA expectations in regard to approval to operate in a RVSM environment. The content of the operator RVSM application, FAA review and evaluation of the application, validation flight requirements, and conditions for removal of RVSM authority should be basic items of discussion.

\* d. Content of Operator RVSM Application. The following paragraphs describe the material which an operator applying for RVSM authority should provide to the FAA for review and evaluation at least 60 days prior to the intended start of RVSM operations. Part 121, 125, and 135 operators applying for authority to conduct operations in an RVSM area

of operations that is new to them may modify the application content to address those items unique to the new area of operations. Part 91 operators, and Part 125 operators holding a deviation that allows operation under Part 91 that have obtained an LOA for RVSM operations in the North Atlantic should contact the appropriate FSDO to determine the LOA requirements (if any) for a new RVSM area of operations. (See Paragraph 11g).

(1) Airworthiness Documents. Sufficient documentation should be available to show that the aircraft has been approved by appropriate airworthiness authorities.

\* (i) In-service aircraft. Documents that contain the inspections and/or modifications that are required to make an in-service aircraft RVSM compliant can take the form of approved Service Bulletins, Aircraft Service Changes, Supplemental Type Certificates or any other format the FAA finds acceptable.

\* (ii) In-production or New-production aircraft. For such aircraft, statements of eligibility to conduct RVSM operations can be included in the Airplane Flight Manual. Also, Type Certification Data Sheets can be used to show RVSM eligibility by describing RVSM related avionics configurations and continued airworthiness criteria or providing reference to FAA approved documentation in the form of a report. Eligibility can be shown in any other format found acceptable to the FAA.

(2) Description of Aircraft Equipment. The applicant should provide a configuration list which details all components and equipment relevant to RVSM operations. (Paragraph 8 discusses equipment for RVSM operations).

\* (3) Operations Training Programs and Operating Practices and Procedures. Practices and procedures in the following areas should be standardized using the guidelines of Appendix 4: flight planning, preflight procedures at the aircraft for each flight, procedures prior to RVSM airspace entry, inflight procedures, and flightcrew training procedures. Appendix 4, paragraph 7 contains special emphasis items for flightcrew training. Also, pilots and, where applicable, dispatchers should be knowledgeable on contingency and other procedures unique to specific areas of operation. (See the appendices for guidance on such procedures. Appendix 5, for example, contains guidance on oceanic contingency procedures).

\* (i) FAR Part 121, 125 and 135 Operators. Such operators should submit training syllabi and other appropriate material to the FAA to show that the operating practices and procedures and training items related to RVSM operations are incorporated in initial and, where warranted, recurrent training programs. (Training for dispatchers should be included, where appropriate).

\* (ii) FAR Part 91 Operators and Part 125 Operators holding a deviation that allows operation under Part 91. These operators should show the FAA that pilot knowledge of RVSM operating practices and procedures will be adequate to warrant granting of approval to conduct RVSM operations. The following are acceptable means for the operator to show the FAA that its pilots will have adequate knowledge of the RVSM operating

practices and procedures contained in Appendices 4 and 5: the FAA may accept training center certificates without further evaluation; may evaluate a training course prior to accepting a training certificate; may accept a statement in the operator's application that the operator will ensure that its pilots will be knowledgeable on RVSM procedures contained in Appendices 4 and 5; or may accept a statement by the operator that it has or will conduct an in-house training program.

\* (4) Operations Manuals and Checklists. The appropriate manuals and checklists should be revised to include information/guidance on standard operating procedures detailed in Appendix 4 and in the appendices that address area of operations unique procedures (e.g., Appendix 5). Appropriate manuals should include a statement of the airspeeds, altitudes and weights considered in RVSM aircraft approval to include identification of any operations restrictions established for that aircraft group (see paragraph 7c(4)(iii)). Manuals and checklists should be submitted for FAA review as part of the application process.

(5) Past Performance. An operating history should be included in the application. The applicant should show any events or incidents related to poor height keeping performance which may indicate weaknesses in training, procedures, maintenance, or the aircraft group intended to be used.

(6) Minimum Equipment List. A minimum equipment list (MEL), adopted from the master minimum equipment list (MMEL), should include items pertinent to operating in RVSM airspace.

(7) Maintenance. The operator should submit a maintenance program for approval in accordance with paragraph 10 at the time the operator applies for operational approval.

\* (8) Plan for participation in Verifications/Monitoring Programs. The operator should provide a plan for participation in the verification/monitoring program. This program should normally entail a check of at least a portion of the operator's aircraft by an independent height-monitoring system. Guidance on monitoring programs for specific areas of operation can be found on the FAA RVSM website. It can be accessed by typing [www.faa.gov](http://www.faa.gov) and clicking on RVSM and Go in the Quick Jump menu. (See paragraph 11h for further discussion of verification/monitoring programs).

e. FAA Review and Evaluation of Applications.

(1) Once the application has been submitted, the FAA will begin the process of review and evaluation. If the content of the application is insufficient, the FAA will request additional information from the operator.

(2) When all the airworthiness and operational requirements of the application are met, the authority will proceed with the approval process.

f. Validation Flight(s) for Part 121 and 135 operators. In some cases, the review of the RVSM application and programs may suffice for validation purposes. However, the final step of the approval process may be the completion of a validation flight. The FAA may accompany the operator on a flight through airspace where RVSM is applied to verify that operations and maintenance procedures and practices are applied effectively. If the performance is adequate, operational approval for RVSM airspace should be granted. If performance is not adequate, then approval should be delayed.

g. Form of Authorizing Documents.

\* (1) FAR Part 121, Part 125, and Part 135 Operators. Approval to operate in RVSM airspace should be granted through the issuance of an operations specifications paragraph from Part B (En route Authorizations, Limitation, and Procedures) and Part D (Aircraft Maintenance). Each aircraft type group for which the operator is granted authority should be listed in OpSpecs. Approval to conduct RVSM operations in an RVSM area of operations that is new to the operator should be granted by adding the part B RVSM OpSpecs paragraph number to the appropriate area of operations in the Part B paragraph: Authorized Areas of En Route Operation. Limitations and Provisions.

(2) FAR Part 91 Operators and Part 125 operators holding a deviation to operate under Part 91. These operators should be issued a letter of authorization (LOA) when the approval process has been completed. This LOA should be reissued on a biennial basis. Operators that have obtained an LOA for RVSM operations in the North Atlantic should contact the appropriate FSDO to determine the LOA requirements (if any) for an RVSM area of operation that is new to them.

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

*Note: A height-monitoring system based on Global Positioning Satellites or an earth-based system may fulfill this function.*

i. Conditions for Removal of RVSM Authority.

(1) The incidence of height-keeping errors which can be tolerated in an RVSM environment is very small. It is incumbent upon each operator to take immediate action to rectify the conditions which caused the error. The operator should also report the event to the FAA within 72 hours with initial analysis of causal factors and measures to prevent further events. The requirement for follow up reports should be determined by the FAA. Errors which should be reported and investigated are: TVE equal to or greater than  $\pm 300$  ft

( $\pm 90$  m), ASE equal to or greater than  $\pm 245$  ft ( $\pm 75$  m), and AAD equal to or greater than  $\pm 300$  ft ( $\pm 90$  m).

(2) Height-keeping errors fall into two broad categories: errors caused by malfunction of aircraft equipment and operational errors. An operator which consistently commits errors of either variety may be required to forfeit authority for RVSM operations. If a problem is identified which is related to one specific aircraft type, then RVSM authority may be removed for the operator for that specific type.

(3) The operator should make an effective, timely response to each height-keeping error. The FAA may consider removing RVSM operational approval if the operator response to a height-keeping error is not effective or timely. The FAA should also consider the operator's past performance record in determining the action to be taken. If an operator shows a history of operational and/or airworthiness errors, then approval may be removed until the root causes of these errors are shown to be eliminated and RVSM programs and procedures are shown to be effective. The FAA will review each situation on a case-by-case basis.

APPENDIX 1. EXPLANATION OF  $W/\delta$ 

1. Paragraph 9(b)(4) describes the range of flight conditions over which conformity to the ASE rules must be shown. The description includes reference to the parameter  $W/\delta$ . The following discussion is provided for the benefit of readers who may not be familiar with the use of this parameter.
2. It would be difficult to show all of the gross weight, altitude, and speed conditions which constitute the RVSM envelope(s) on a single plot. This is because most of the speed boundaries of the envelopes are a function of both altitude and gross weight. As a result, a separate chart of altitude vs. Mach would be required for each aircraft gross weight. Aircraft performance engineers commonly use the following technique to solve this problem.
3. For most jet transports the required flight envelope can be collapsed to a single chart, with good approximation, by use of the parameter  $W/\delta$  (weight divided by atmospheric pressure ratio). This fact is due to the relationship between  $W/\delta$  and the fundamental aerodynamic variables  $M$  and lift coefficient as shown below.

$$W/\delta = 1481.4 C_L M^2 S_{\text{Ref}}, \text{ where:}$$

$\delta$  = ambient pressure at flight altitude divided by sea level standard pressure of 29.92126 inches Hg

$W/\delta$  = Weight over Atmospheric Pressure Ratio

$C_L$  = Lift Coefficient

$M$  = Mach Number

$S_{\text{REF}}$  = Reference Wing Area

4. As a result, the flight envelope may be collapsed into one chart by simply plotting  $W/\delta$ , rather than altitude, versus Mach Number. Since  $\delta$  is a fixed value for a given altitude, weight can be obtained for a given condition by simply multiplying the  $W/\delta$  value by  $\delta$ .
5. Over the RVSM altitude range, it is a good approximation to assume that position error is uniquely related to Mach Number and  $W/\delta$  for a given aircraft.



## APPENDIX 2. ALTIMETRY SYSTEM ERROR COMPONENTS

1. INTRODUCTION. Paragraph 9b(5)(ii) states that an error budget must be established and presented in the approval data package. The requirements for this error budget are discussed in some detail in paragraph 9b(5)(iii) through 9b(5)(v) for group and non-group aircraft. The purpose of this appendix is to provide guidance to help ensure that all of the potential error sources are identified and included in the error budget for each particular model.

2. OBJECTIVE OF ASE BUDGET.

a. The purpose of the ASE budget is to demonstrate that the allocation of tolerances amongst the various parts of the altimetry system is, for the particular data package, consistent with the overall statistical ASE requirements. These individual tolerances within the ASE budget also form the basis of the procedures, defined in the airworthiness approval data package, which will be used to demonstrate that aircraft satisfy the RVSM requirements.

b. It is necessary to ensure that the budget takes account of all contributory components of ASE.

c. For group approval it is necessary to ensure either that the budget assesses the combined effect of the component errors in a way that is statistically realistic, or that the worst case specification values are used.

3. ALTIMETRY SYSTEM ERROR.

a. Breakdown. Figure 2-1 shows the breakdown of total ASE into its main components, with each error block representing the error associated with one of the functions needed to generate a display of pressure altitude. This breakdown encompasses all altimetry system errors which can occur, although different system architectures may combine the components in slightly different ways.

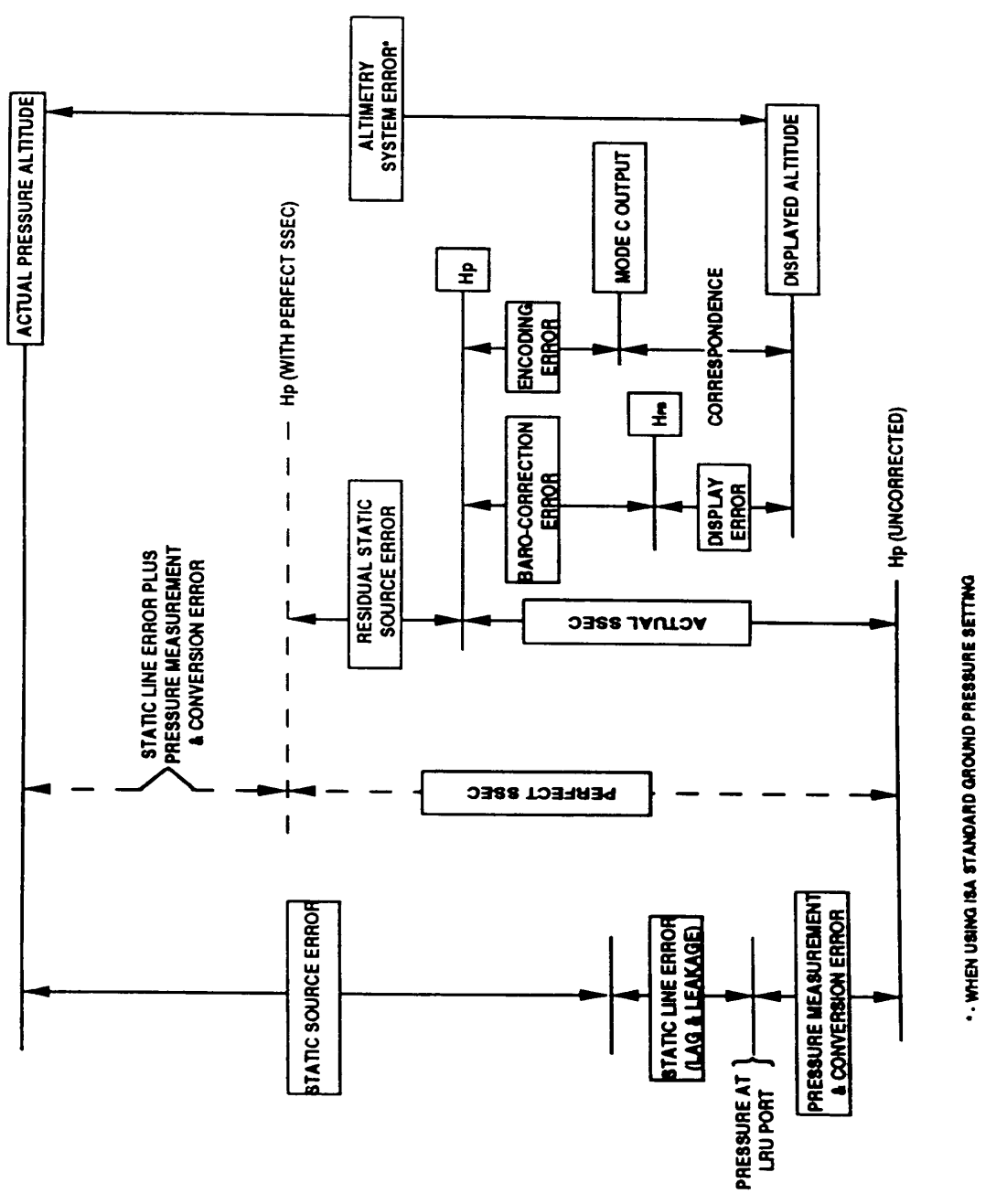
(1) The "Actual Altitude" is the pressure altitude corresponding to the undisturbed ambient pressure.

(2) "Static Source Error" is the difference between the undisturbed ambient pressure and the pressure within the static port at the input end of the static pressure line.

(3) "Static Line Error" is any difference in pressure along the length of the line.

APPENDIX 2. ALTIMETRY SYSTEM ERROR COMPONENTS

Figure 2-1 ASE and Its Components



## APPENDIX 2. ALTIMETRY SYSTEM ERROR COMPONENTS

(4) "Pressure Measurement and Conversion Error" is the error associated with the processes of transducing the pneumatic input seen by the avionics, and converting the resulting pressure signal into altitude. As drawn, figure 2-1 represents a self-sensing altimeter system in which the pressure measurement and altitude conversion functions would not normally be separable. In an air data computer system the two functions would be separate, and SSEC would probably then be applied before pressure altitude (Hp) was calculated.

(5) "Perfect SSEC" would be that correction which compensated exactly for the SSE actually present at any time. If such a correction could be applied, then the resulting value of Hp calculated by the system would differ from the actual altitude only by the static line error plus the pressure measurement and conversion error. In general this cannot be achieved, so although the "Actual SSEC" can be expected to reduce the effect of SSE, it will do so imperfectly.

(6) "Residual Static Source Error" is applicable only in systems applying an avionic SSEC. It is the difference between the SSE and the correction actually applied. The corrected value of Hp will therefore differ from actual pressure altitude by the sum of static line error, pressure measurement and conversion error, and residual SSE.

(7) Between Hp and displayed altitude occur the baro-correction error and the display error. Figure 2-1 represents their sequence for a self-sensing altimeter system. Air data computer systems can implement baro-correction in a number of ways which would modify slightly this part of the block diagram, but the errors would still be associated with either the baro-correction function or the display function. The only exception is that those systems which can be switched to operate the display directly from the Hp signal can eliminate baro-correction error where standard ground pressure setting is used, as in RVSM operations.

b. Components. The altimetry system errors presented in table 2-1 and described in paragraph 3a are discussed below in greater detail.

(1) Static Source Error. The component parts of SSE are presented in table 2-1, with the factors which control their magnitude.

(i) The reference SSE is the best estimate of actual SSE, for a single aircraft or an aircraft group, obtained from flight calibration measurements. It is variable with operating condition, characteristically reducing to a family of  $W/\delta$  curves which are functions of Mach. It includes the effect of any aerodynamic compensation which may have been incorporated in the design once it has been determined, the reference SSE is fixed for the single aircraft or group, although it may be revised in the light of subsequent data.

## APPENDIX 2. ALTIMETRY SYSTEM ERROR COMPONENTS

(ii) The test techniques used to derive the reference SSE will have some measurement uncertainty associated with them, even though known instrumentation errors will normally be eliminated from the data. For trailing-cone measurements the uncertainty arises from limitations on pressure measurement accuracy, calibration of the trailing-cone installation, and variability in installations where more than one are used. Once the reference SSE has been determined, the actual measurement error is fixed, but as it is unknown it can only be handled within the ASE budget as an estimated uncertainty.

(iii) The airframe variability and probe/port variability components arise from differences between the individual airframe and probe/port, and the example(s) of airframe and probe port used to derive the reference SSE.

(2) Residual Static Source Error.

(i) The components and factors are presented in Table 2-2. Residual SSE is made up of those error components which make actual SSE different from the reference value, components 2, 3, and 4 from Table 2-1, plus the amount by which the actual SSEC differs from the value which would correct the reference value exactly, components 2(a), (b) and (c) from Table 2-2.

(ii) There will generally be a difference between the SSEC which would exactly compensate the reference SSE, and the SSEC which the avionics is designed to apply. This arises from practical avionics design limitations. The resulting error component 2(a) will therefore be fixed, for a particular flight condition, for the single aircraft or group. Additional variable errors 2(b) and 2(c) arise from those factors which cause a particular set of avionics to apply an actual SSEC which differs from its design value.

(iii) The relationship between perfect SSEC, reference SSEC, design SSEC and actual SSEC is illustrated in Figure 2-2, for the case where static line errors and pressure measurements and conversion errors are taken as zero.

APPENDIX 2. ALTIMETRY SYSTEM ERROR COMPONENTS

**Table 2-1. Static Source Error  
(Cause: Aerodynamic Disturbance to Free-Stream Conditions)**

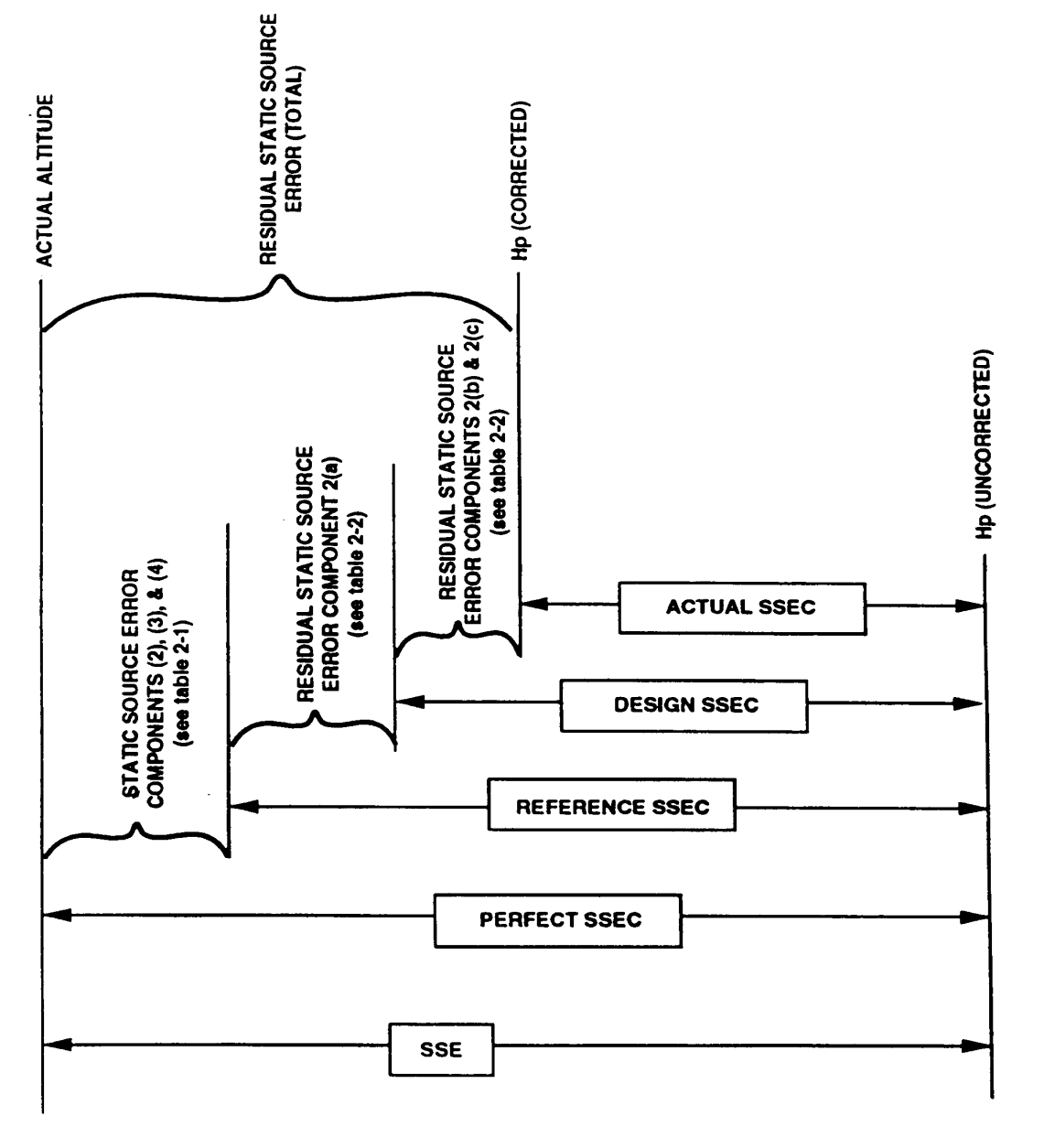
Factors		Error Components
Airframe Effects		1) Reference SSE values from flight calibration measurements. 2) Uncertainty of flight calibration measurements. 3) Airframe to Airframe variability 4) Probe/Port to Probe/Port variability
Operating Condition	(M, Hp, $\infty$ , $\beta$ )	
Geometry:	shape of airframe location of static sources variations of surface contour near the sources variations in fit of nearby doors, skin panels or other items	
Probe/Port Effects		
Operating Condition	(M, Hp, $\infty$ , $\beta$ )	
Geometry:	shape of probe/port manufacturing variations installation variations	

**Table 2-2. Residual Static Source Error (Aircraft with Avionic SSEC)  
(Cause: Difference between the SSEC actually applied and the actual SSE)**

Factors	Error Components
1) As for Static Source Error  <p style="text-align: center;"><u>PLUS</u></p> 2) Source of input data for SSEC function a) Where SSEC is a function of Mach: i) $P_s$ sensing: difference in SSEC from reference SSE. ii) $P_s$ measurement: pressure transduction error iii) $P_T$ errors: mainly pressure transduction error  b) Where SSEC is a function of Angle of Attack: i) geometric effects on alpha - sensor tolerances - installation tolerances - local surface variations  ii) measurement error - angle transducer accuracy  3) Implementation of SSEC function a) Calculation of SSEC from input data b) Combination of SSEC with uncorrected height	1) Static Source Error Components (2), (3), and (4) from table 2-1  <p style="text-align: center;"><u>PLUS</u></p> 2a) Approximation in fitting design SSEC to flight calibration reference SSE. 2b) Effect of production variability (sensors and avionics) on achieving design SSEC. 2c) Effect of operating environment (sensors and avionics) on achieving design SSEC.

APPENDIX 2. ALTIMETRY SYSTEM ERROR COMPONENTS

Figure 2-2 SSE/SSEC Relationships for ASE where Static Line, Pressure Measurement and Conversion Errors are Zero



## APPENDIX 2. ALTIMETRY SYSTEM ERROR COMPONENTS

(iv) Factors which create variability of SSE relative to the reference characteristic must be accounted for in two ways. Firstly, as noted for the SSE itself in table 2-1, and secondly for its effect on the application of SSEC as in factor 2(a)(i) of table 2-2. Similarly the static pressure measurement error must be accounted for in two separate ways. The main effect will be via the "pressure measurement and conversion" component, but a secondary effect will be via Factor 2(a)(ii) Table 2-2.

(3) Static Line Error. Static line errors arise from leaks and pneumatic lags. In level cruise these can be made negligible for a system which is correctly designed and correctly installed.

(4) Pressure Measurement and Conversion Error.

(i) The functional elements are static pressure transduction, which may be mechanical, electromechanical or solid-state, and the conversion of pressure signal to pressure altitude.

(ii) The error components are:

- (A) calibration uncertainty;
- (B) nominal design performance;
- (C) unit to unit manufacturing variations; and
- (D) effect of operating environment.

(iii) The equipment specification is normally taken to cover the combined effect of the error components. If the value of pressure measurements and conversion error used in the error budget is the worst case specification value, then it is not necessary to assess the above components separately. However, calibration uncertainty, nominal design performance and effect of operating environment can all contribute to bias errors within the equipment tolerance. Therefore if it is desired to take statistical account of the likely spread of errors within the tolerance band, then it will be necessary to assess their likely interaction for the particular hardware design under consideration.

(iv) It is particularly important to ensure that the specified environmental performance is adequate for the intended application.

## APPENDIX 2. ALTIMETRY SYSTEM ERROR COMPONENTS

(5) Baro-Setting Error. This is defined as the difference between the value displayed and the value applied within the system. For RVSM operation the value displayed should always be ISA standard ground pressure, but setting mistakes, although part of TVE, are not components of ASE.

(i) The components of Baro-Setting Error are:

- (A) resolution of setting knob/display ("Setability");
- (B) transduction of displayed value; and
- (C) application of transduced value.

(ii) The applicability of these factors and the way that they combine depends on the particular system architecture.

(iii) For systems in which the display is remote from the pressure measurement function there may be elements of the transduction and/or application or transduced value error components which arise from the need to transmit and receive the setting between the two locations

(6) Display Error. The cause is imperfect conversion from altitude signal to display. The components are:

- (i) conversion of display input signal;
- (ii) graticule/format accuracy, and
- (iii) readability.

(7) In self-sensing altimeters the first of these would normally be separate from the pressure measurement and conversion error

## APPENDIX 3: ESTABLISHING AND MONITORING STATIC SOURCE ERRORS

1. The requirements for the data package are discussed in general terms in paragraph 9b. It is stated, in paragraph 9b(5)(iv)(C) that the methodology used to establish the static source error must be substantiated. It is further stated in paragraph 9b(6) that procedures be established to ensure conformity of newly manufactured airplanes. There may be many ways of satisfying these requirements; two examples are discussed below.

2. Example 1.

a. One process for showing compliance with RVSM requirements is shown in Figure 3-1. Figure 3-1 illustrates that flight test calibrations and geometric inspections will be performed on a given number of aircraft. The flight calibrations and inspections will continue until a correlation between the two is established. Geometric tolerances and SSEC will be established to satisfy RVSM requirements. For aircraft being manufactured, every Nth aircraft will be inspected in detail and every Mth aircraft will be flight test calibrated, where N and M are determined by the manufacturer and agreed to by the approving authority. The data generated by N inspections and M flight calibrations shall be used to track the mean and 3 SD values to insure continued compliance of the model with the requirements of paragraph 7. As additional data are acquired, they should be reviewed to determine if it is appropriate to change the values of N and M as indicated by the quality of the results obtained.

b. There are various ways in which the flight test and inspection data might be used to establish the correlation. The example shown in Figure 3-2 is a process in which each of the error sources for several airplanes is evaluated based on bench tests, inspections and analysis. Correlation between these evaluations and the actual flight test results would be used to substantiate the method.

c. The method illustrated in Figures 3-1 and 3-2 is appropriate for new models since it does not rely on any pre-existing data base for the group.

3. Example 2.

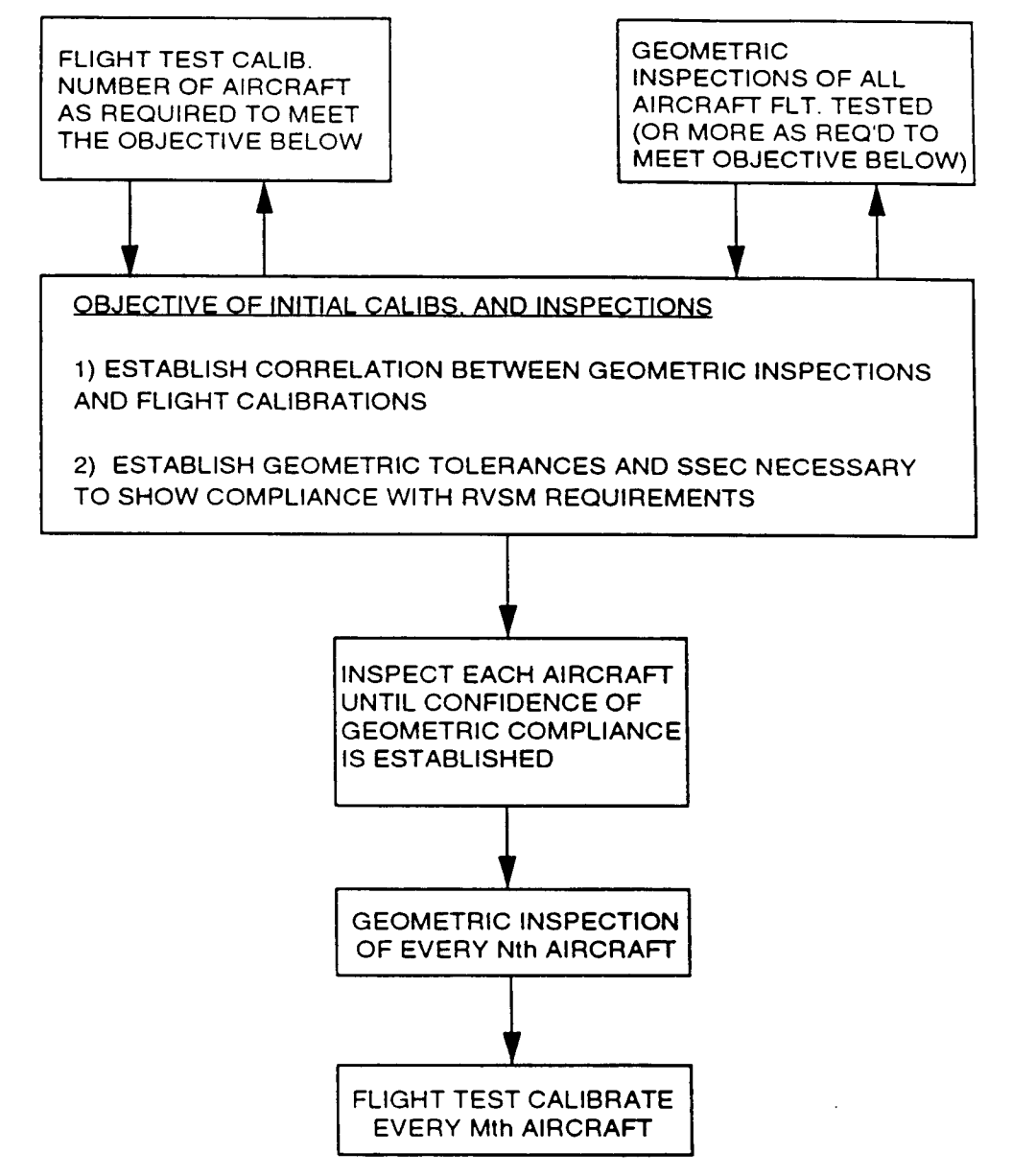
a. Figure 3-3 illustrates that flight test calibrations should be performed on a given number of aircraft and consistency rules for air data information between all concerned systems verified. Geometric tolerances and SSEC should be established to satisfy the requirements. A correlation should be established between the design tolerances and the consistency rules. For aircraft being manufactured, air data information for all aircraft should be checked in term of consistency in cruise conditions and every Mth aircraft should be calibrated, where M is determined by the manufacture and agreed to by the approving authority. The data generated by the M flight calibrations should be used to

APPENDIX 3: ESTABLISHING AND MONITORING STATIC SOURCE ERRORS

track the mean and 3SD values to ensure continued compliance of the group with the requirements of paragraph 7.

APPENDIX 3: ESTABLISHING AND MONITORING STATIC SOURCE ERRORS

Figure 3-1 Process for Showing Initial and Continues Compliance of Airframe Static Pressure System



APPENDIX 3: ESTABLISHING AND MONITORING STATIC SOURCE ERRORS

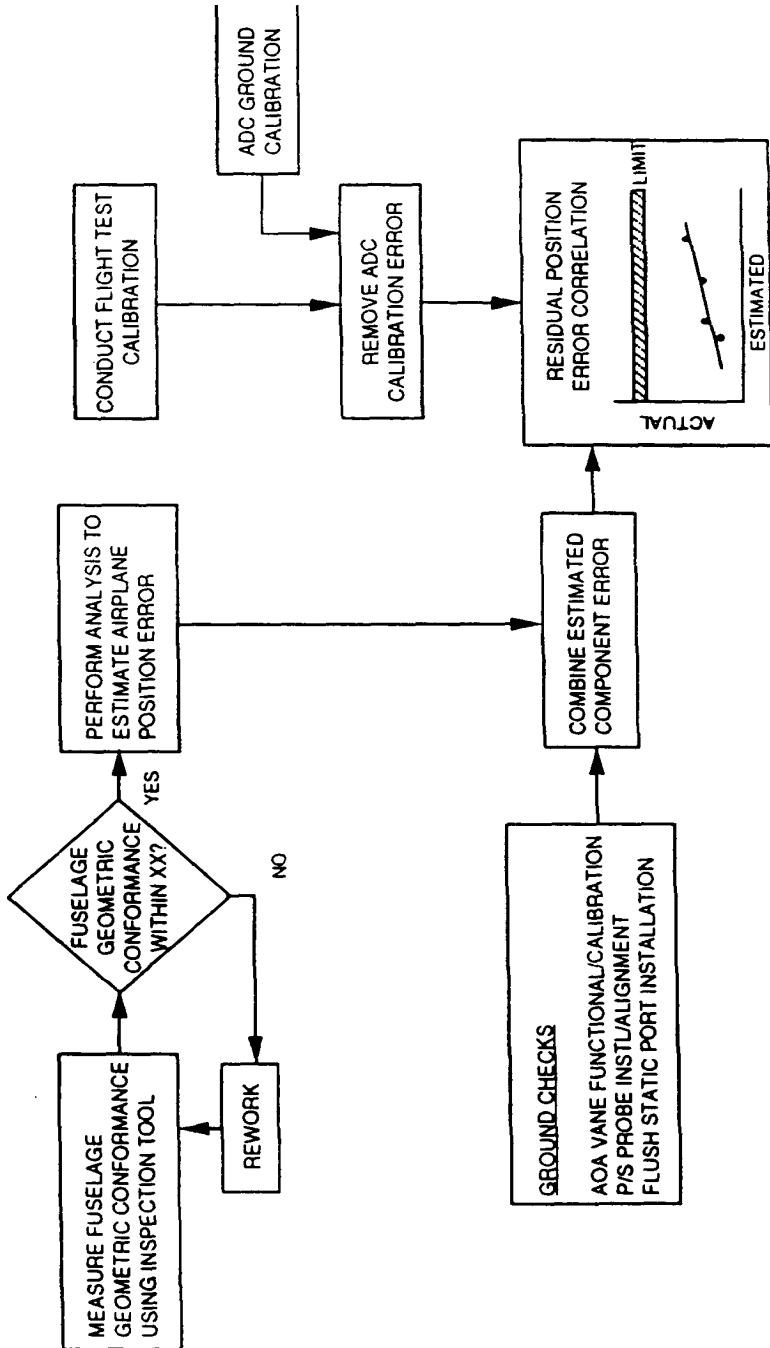
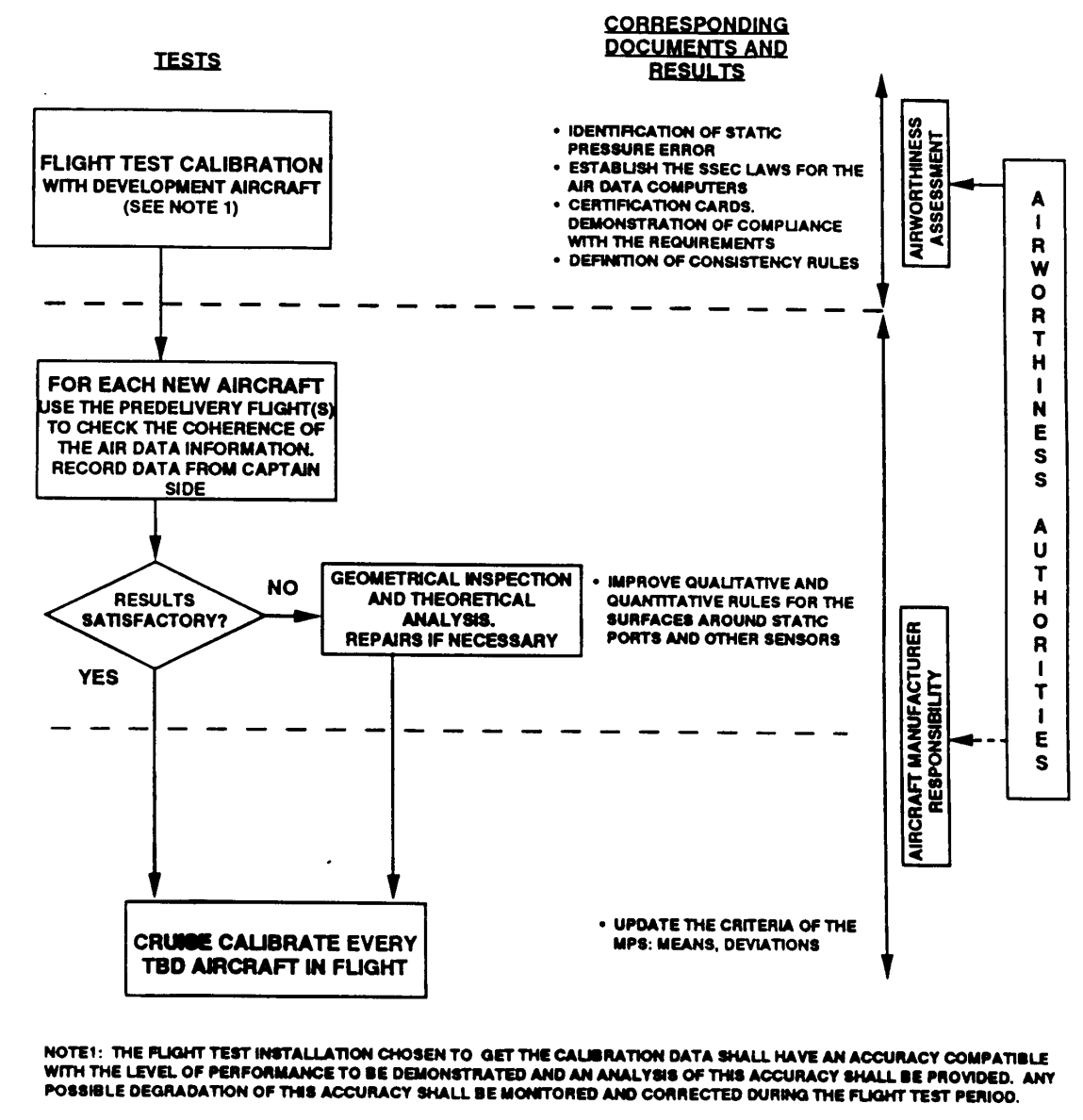


Figure 3-2. Compliance Demonstration Ground-to-flight Test Correlation Process Example.

APPENDIX 3: ESTABLISHING AND MONITORING STATIC SOURCE ERRORS

Figure 3-3 Process for Showing Initial and Continued Compliance of Airframe Static Pressure Systems for In-Service and New Model Aircraft





## APPENDIX 4. TRAINING PROGRAMS AND OPERATING PRACTICES AND PROCEDURES

1. Introduction. The following items (detailed in paragraphs 2 through 7) should be standardized and incorporated into training programs and operating practices and procedures. Certain items may already be adequately standardized in existing operator programs and procedures. New technologies may also eliminate the need for certain crew actions. If this is the case, then the intent of this guidance can be considered to be met.

Note. The document has been written for use by a wide variety of operator types (FAA Part 91 to Part 121) and therefore, certain items have been included for purposes of clarity and completeness.

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

a. verifying that the aircraft is approved for RVSM operations.

\* b. annotating the flight plan to be filed with the Air Traffic Service Provider to show that the aircraft and operator are approved for RVSM operations. (In North Atlantic Minimum Navigation Performance (NAT MNPS) and Pacific oceanic airspace, block 10 (Equipment) of the ICAO flight plan should be annotated with the letter "W" to show RVSM approval).

c. reported and forecast weather conditions on the route of flight;

d. minimum equipment requirements pertaining to height-keeping systems; and

e. If required for the specific aircraft group; accounting for any aircraft operating restrictions related to RVSM airworthiness approval. (See paragraph 7c(4)(iii)).

3. Preflight procedures at the aircraft for each flight. The following actions should be accomplished during preflight:

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

b. During the external inspection of aircraft, particular attention should be paid to the condition of static sources and the condition of the fuselage skin in the vicinity of each static source and any other component that affects altimetry system accuracy (this check may be accomplished by a qualified and authorized person other than the pilot, e.g., a flight engineer or maintenance personnel);

#### APPENDIX 4. TRAINING PROGRAMS AND OPERATING PRACTICES AND PROCEDURES

\* c. Before takeoff, the aircraft altimeters should be set to the local altimeter (QNH) setting and should display a known elevation (e.g., field elevation) within the limits specified in aircraft operating manuals. The difference between the known elevation and the elevation displayed on the altimeters should not exceed 75 ft. The two primary altimeters should also agree within limits specified by the aircraft operating manual. An alternative procedure using QFE may also be used;

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

4. Procedures prior to RVSM airspace entry. The following equipment should be operating normally at entry into RVSM airspace:

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

*Note. Dual equipment requirements for altitude-control systems may be established by regional agreement after an evaluation of criteria such as mean time between failures, length of flight segments and availability of direct pilot-controller communications and radar surveillance.*

d. Should any of the required equipment fail prior to the aircraft entering RVSM airspace, the pilot should request a new clearance so as to avoid flight in this airspace;

*Note. Operating Transponder. The operator should ascertain the requirement for an operational transponder in each RVSM area where operations are intended. The operator should also ascertain the transponder requirements for transition areas adjacent to RVSM airspace. Appendix 5, paragraph 9 discusses transponder failure for RVSM transition areas.*

## APPENDIX 4. TRAINING PROGRAMS AND OPERATING PRACTICES AND PROCEDURES

5. In-flight Procedures. The following policies should be incorporated into flight crew training and procedures:

a. Flight crews should comply with aircraft operating restrictions (if required for the specific aircraft group) related to RVSM airworthiness approval. (See paragraph 7c(4)(iii)).

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

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

d. During cleared transition between levels, the aircraft should not be allowed to overshoot or undershoot the cleared flight level by more than 150 ft (45 m);

*Note. It is recommended that the level off be accomplished using the altitude capture feature of the automatic altitude-control system, if installed.*

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

f. The altitude-alerting system should be operational;

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

(1) The normal pilot scan of cockpit instruments should suffice for altimeter crosschecking on most flights.

(2) At least the initial altimeter cross-check in the vicinity of the point where Class II navigation is begun should be recorded (e.g., on coast out). The readings of the

#### APPENDIX 4. TRAINING PROGRAMS AND OPERATING PRACTICES AND PROCEDURES

primary and standby altimeters should be recorded and available for use in contingency situations. (Class II navigation is defined in FAA Order 8400.10).

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

h. Normally, the altimetry system being used to control the aircraft should be selected to provide the input to the altitude-reporting transponder transmitting information to ATC.

i. If the pilot is notified by ATC of an AAD error which exceeds 300 ft (90 m) then the pilot should take action to return to CFL as quickly as possible.

\* j. Contingency procedures after entering RVSM airspace. The pilot should notify ATC of contingencies (aircraft system failures, weather conditions) which affect the ability to maintain the CFL and co-ordinate a plan of action. Appendix 5 contains detailed guidance for contingency procedures for oceanic airspace. (Other appendices may be added as necessary to address additional areas of operation.)

#### 6 Post Flight.

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

- (1) Primary and standby altimeter readings.
- (2) Altitude selector setting.
- (3) Subscale setting on altimeter.
- (4) Autopilot used to control the airplane and any differences when the alternate system was selected.
- (5) Differences in altimeter readings if alternate static ports selected.
- (6) Use of air data computer selector for fault diagnosis procedure.

## APPENDIX 4. TRAINING PROGRAMS AND OPERATING PRACTICES AND PROCEDURES

(7) Transponder selected to provide altitude information to ATC and any difference if alternate transponder or altitude source is manually selected.

7. Special Emphasis Items: Flightcrew Training. The following items should also be included in flightcrew training programs:

a. knowledge and understanding of standard ATC phraseology used in each area of operations;

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

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

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

e. characteristics of aircraft altitude capture systems which may lead to the occurrence of overshoots;

\* f. operational procedures and operating characteristics related to TCAS (ACAS) operation in an RVSM operation;

g. relationship between the altimetry, automatic altitude control, and transponder systems in normal and abnormal situations;

h. Aircraft operating restrictions (if required for the specific aircraft group) related to RVSM airworthiness approval. (See paragraph 7c(4)(iii)); and

\* i. Use of track offset procedures to mitigate the effect of wake turbulence.



## APPENDIX 5. SPECIFIC PROCEDURES FOR OCEANIC AIRSPACE

1. INTRODUCTION

\* a. RVSM was initially implemented in North Atlantic Minimum Navigation Performance Specification (NAT MNPS) airspace in March 1997. The guidance which follows has been applied in the NAT region since that time. It will be applied to RVSM operations in Pacific oceanic airspace and can be adapted to RVSM operations in other oceanic airspaces.

\* b. This appendix contains information on procedures which are unique to oceanic RVSM airspace. Contingency procedures contained in regional supplementary procedures and guidance which is specifically related to RVSM are presented in this appendix. Contingencies which relate to lateral as well as vertical navigation are also discussed.

2. GENERAL INFORMATION: AIRSPACE DIMENSIONS

## a. NAT MNPS AIRSPACE.

\* (1) When RVSM was implemented in NAT MNPS airspace, NAT MNPS approval expanded to encompass demonstration of special qualification for both lateral navigation and height-keeping performance.

\* (2) NAT MNPS airspace now has a ceiling of FL 420 and a floor of FL 285. As of October 1998, 1,000 ft (300 m) vertical separation is applied between aircraft operating between FL 310 and FL 390 (inclusive). At a future date, planning calls for RVSM to be expanded to apply in NAT MNPS between FL 290 and FL 410 (inclusive).

\* b. PACIFIC OCEANIC AIRSPACE. RVSM is planned to be implemented in the Pacific oceanic Flight Information Regions (FIRs) between FL 290 and FL 390 (inclusive). NOTAMS and State Aeronautical Information Publications (AIPs) should be consulted for current implementation plans and schedules in specific FIRs.

3. INTENDED USE OF THIS MATERIAL.

a. Paragraph 4, Basic Concepts For Contingencies. This paragraph is intended to provide an overview of contingency procedures. It is intended to orient the pilot's thinking to the concepts involved and aid in understanding the specific guidance detailed in paragraph 5 and 6. This material should be included in training programs and appropriate flight crew manuals.

\* b. Paragraph 5, Guidance To The Pilot In the Event of Equipment Failures or Encounters With Turbulence After Entering RVSM Airspace. This paragraph details summary guidance on specific actions for the pilot to take to mitigate the potential for

## APPENDIX 5. SPECIFIC PROCEDURES FOR OCEANIC AIRSPACE

conflict with other aircraft in the situations listed. It should be reviewed in conjunction with Paragraph 6 which provides additional technical and operational detail. The pilot actions in Paragraph 5 should be considered **required pilot knowledge** and should be included in training/qualification programs and appropriate flight crew manuals.

\* c. Paragraph 6, Expanded RVSM Equipment Failure and Turbulence Scenarios. This paragraph reviews the situations discussed in Paragraph 5 in greater detail. The material may be used in training programs as an operator deems appropriate.

\* d. Paragraph 7, Contingency Procedures published in ICAO Document 7030, Regional Supplementary Procedures. This paragraph lists the “Special Procedures for In-flight Contingencies” published for various ICAO regions in the Doc 7030. These procedures should be considered **required pilot knowledge**. The material may be condensed for ease of presentation and should be included in training/qualification programs and appropriate flight crew manuals.

\* e. Paragraph 8, Wake Turbulence Procedures. Paragraph 8 discusses published procedures for the pilot to follow in the event that wake turbulence is encountered. These procedures should be considered **required pilot knowledge**.

f. Paragraph 9, RVSM Transition Areas. Paragraph 9 highlights the necessity for pilots to be informed on policy and procedures established for operation in RVSM transition areas. This information should be addressed in training programs and manuals.

### 4. BASIC CONCEPTS FOR CONTINGENCIES.

\* a. General. The in-flight contingency procedures for the NAT, published in Doc 7030, were revised to provide for RVSM implementation in NAT MNPS airspace. Specifically, NAT Regional Supplementary Procedures, Paragraph 5.0 was revised to account for RVSM operations. NATSPG developed draft Paragraph 5.0 revisions which were endorsed by the Limited NAT Regional Air Navigation Meeting in November 1992. They were made effective at the start of operational trials in March 1997. (Aircraft were separated vertically above FL 290 by 1,000 ft (300 m) in the NAT for the first time when operational trials were begun). The NAT Operations Manual was also revised with this material prior to the start of operational trials.

b. The basic concepts for contingencies described in this paragraph have been developed from the specific guidance contained in Doc 7030 paragraphs published for individual ICAO regions entitled “Special Procedures for In-flight Contingencies”. Contingency procedures become complicated when specific situations are detailed. However, if the details are examined in the context of certain basic concepts, then they are more easily understood. Reviewing these concepts should serve to aid pilots' understanding of the specific contingency procedures detailed in the Doc 7030 paragraphs.

## APPENDIX 5. SPECIFIC PROCEDURES FOR OCEANIC AIRSPACE

c. The basic concepts for contingencies are:

(1). Guidance for contingency procedures should not be interpreted in any way which prejudices the final authority and responsibility of the pilot in command for the safe operation of the aircraft.

(2). If the pilot is unsure of the vertical or lateral position of the aircraft or the aircraft deviates from its assigned altitude or track for cause without prior ATC clearance, then the pilot must take action to mitigate the potential for collision with aircraft on adjacent routes or flight levels.

\* (i) In this situation, the pilot should alert adjacent aircraft by making maximum use of aircraft lighting and broadcasting position, flight level, and intentions on 121.5 MHz (as a back-up, the appropriate VHF inter-pilot air-to-air frequency may be used);

(3) Unless the nature of the contingency dictates otherwise, the pilot should advise ATC as soon as possible of a contingency situation and if possible, request an ATC clearance before deviating from the assigned route or flight level.

(4) If a revised ATC clearance cannot be obtained in a timely manner and action is required to avoid potential conflict with other aircraft, then the aircraft should be flown at an altitude and/or on a track where other aircraft are least likely to be encountered:

(i) This can be accomplished by offsetting from routes or altitudes normally flown in the airspace. The Doc 7030 paragraphs entitled "Special Procedures for In-flight Contingencies" provide recommendations on the order of preference for the following pilot actions:

(A) The pilot may offset half the lateral distance between routes or tracks.

(B) The pilot may offset half the vertical distance between altitudes normally flown.

(C) The pilot may also consider descending below FL 285 or climbing above FL 410. (The vast majority of oceanic traffic has been found to operate between FL 290 and 410. Flight above FL 410 or below FL 285 may limit exposure to conflict with other aircraft).

(5). When executing a contingency maneuver the pilot should:

(i) Watch for conflicting traffic both visually and by reference to ACAS, if equipped.

## APPENDIX 5. SPECIFIC PROCEDURES FOR OCEANIC AIRSPACE

- \* (ii) Continue to alert other aircraft using 121.5 MHz (as a back-up, the VHF inter-pilot air-to-air frequency may be used) and aircraft lights.
- (iii) Continue to fly offset tracks or altitudes until an ATC clearance is obtained.
- (iv) Obtain an ATC clearance as soon as possible.

5. GUIDANCE TO THE PILOT (INCLUDING EXPECTED ATC ACTIONS) IN THE EVENT OF EQUIPMENT FAILURES OR ENCOUNTERS WITH TURBULENCE AFTER ENTRY INTO RVSM AIRSPACE. In addition to emergency conditions that require immediate descent, such as loss of thrust or pressurization, ATC should be made aware of the less explicit conditions that may make it impossible for an aircraft to maintain its CFL appropriate to RVSM. Controllers should react to such conditions but these actions cannot be specified, as they will be dynamically affected by the real-time situation.

\* a. Objective of the Guidance Material. The following material is provided with the purpose of giving the pilot guidance on actions to take under certain conditions of equipment failure and encounters with turbulence. It also describes the expected ATC controller actions in these situations. It is recognized that the pilot and controller will use judgment to determine the action most appropriate to any given situation. The guidance material recognizes that for certain equipment failures, the safest course of action may be for the aircraft to maintain the assigned FL and route while the pilot and controller take precautionary action to protect separation. For extreme cases of equipment failure, however, the guidance recognizes that the safest course of action may be for the aircraft to depart from the cleared FL or route by obtaining a revised ATC clearance or if unable to obtain prior ATC clearance, executing the established Doc 7030 contingency maneuvers for the area of operation.

*Note: Paragraph 6 provides an expanded description of the scenarios detailed below.*

\* b. CONTINGENCY SCENARIOS. The following paragraphs summarize pilot actions to mitigate the potential for conflict with other aircraft in certain contingency situations. They should be reviewed in conjunction with the expanded contingency scenarios detailed in Paragraph 6 which contain additional technical and operational detail.

## APPENDIX 5. SPECIFIC PROCEDURES FOR OCEANIC AIRSPACE

**\*Scenario 1:** The pilot is: 1) unsure of the vertical position of the aircraft due to the loss or degradation of all primary altimetry systems, or 2) unsure of the capability to maintain CFL due to turbulence or loss of all automatic altitude control systems.

<b>The Pilot should:</b>	<b>ATC can be expected to:</b>
Maintain CFL while evaluating the situation;	
Watch for conflicting traffic both visually and by reference to ACAS, if equipped;	
If considered necessary, alert nearby aircraft by <ol style="list-style-type: none"> <li>1) making maximum use of exterior lights;</li> <li>2) broadcasting position, FL, and intentions on 121.5 MHz (as a back-up, the VHF inter-pilot air-to-air frequency may be used).</li> </ol>	
Notify ATC of the situation and intended course of action. Possible courses of action include:	Obtain the pilot's intentions and pass essential traffic information.
<ol style="list-style-type: none"> <li>1) maintaining the CFL and route provided that ATC can provide lateral, longitudinal or conventional vertical separation.</li> </ol>	<ol style="list-style-type: none"> <li>1) If the pilot intends to continue in RVSM airspace, assess traffic situation to determine if the aircraft can be accommodated through the provision of lateral, longitudinal, or conventional vertical separation, and if so, apply the appropriate minimum.</li> </ol>
<ol style="list-style-type: none"> <li>2) requesting ATC clearance to climb above or descend below RVSM airspace if the aircraft cannot maintain CFL and ATC cannot establish adequate separation from other aircraft.</li> </ol>	<ol style="list-style-type: none"> <li>2) If the pilot requests clearance to exit RVSM airspace, accommodate expeditiously, if possible.</li> </ol>
<ol style="list-style-type: none"> <li>3) executing the Doc 7030 contingency maneuver to offset from the assigned track and FL, if ATC clearance cannot be obtained and the aircraft cannot maintain CFL.</li> </ol>	<ol style="list-style-type: none"> <li>3) If adequate separation cannot be established and it is not possible to comply with the pilot's request for clearance to exit RVSM airspace, advise the pilot of essential traffic information, notify other aircraft in the vicinity and continue to monitor the situation.</li> </ol>
	<ol style="list-style-type: none"> <li>4) Notify adjoining ATC facilities/sectors of the situation.</li> </ol>

**\*Scenario 2:** There is a failure or loss of accuracy of one primary altimetry system (e.g., greater than 200 foot difference between primary altimeters)

<b>The Pilot should</b>
Cross check standby altimeter, confirm the accuracy of a primary altimeter system and notify ATC of the loss of redundancy. If unable to confirm primary altimeter system accuracy, follow pilot actions listed in the preceding scenario.

APPENDIX 5. SPECIFIC PROCEDURES FOR OCEANIC AIRSPACE

\*6. EXPANDED EQUIPMENT FAILURE AND TURBULENCE ENCOUNTER SCENARIOS.

Operators may consider this material for use in training programs.

**\*Scenario 1: All automatic altitude control systems fail (e.g., Automatic Altitude Hold).**

<b>The Pilot should</b>	<b>ATC can be expected to</b>
<b>Initially</b>	
Maintain CFL	
Evaluate the aircraft's capability to maintain altitude through manual control.	
<b>Subsequently</b>	
Watch for conflicting traffic both visually and by reference to TCAS, if equipped.	
If considered necessary, alert nearby aircraft by 1) making maximum use of exterior lights; 2) broadcasting position, FL, and intentions on 121.5 MHz (as a back-up, the VHF inter-pilot air-to-air frequency may be used.)	
Notify ATC of the failure and intended course of action. Possible courses of action include:	
1) maintaining the CFL and route, provided that the aircraft can maintain level.	1) If the pilot intends to continue in RVSM airspace, assess traffic situation to determine if the aircraft can be accommodated through the provision of lateral, longitudinal, or conventional vertical separation, and if so, apply the appropriate minimum.
2) requesting ATC clearance to climb above or descend below RVSM airspace if the aircraft cannot maintain CFL and ATC cannot establish lateral, longitudinal or conventional vertical separation.	2) If the pilot requests clearance to exit RVSM airspace, accommodate expeditiously, if possible.
3) executing the Doc 7030 contingency maneuver to offset from the assigned track and FL, if ATC clearance cannot be obtained and the aircraft cannot maintain CFL.	3) If adequate separation cannot be established and it is not possible to comply with the pilot's request for clearance to exit RVSM airspace, advise the pilot of essential traffic information, notify other aircraft in the vicinity and continue to monitor the situation.
	4) Notify adjoining ATC facilities/sectors of the situation.

## APPENDIX 5. SPECIFIC PROCEDURES FOR OCEANIC AIRSPACE

**\*Scenario 2: Loss of redundancy in primary altimetry systems**

<b>The Pilot should</b>	<b>ATC can be expected to</b>
If the remaining altimetry system is functioning normally, couple that system to the automatic altitude control system, notify ATC of the loss of redundancy and maintain vigilance of altitude keeping.	Acknowledge the situation and continue to monitor progress

**\*Scenario 3: All primary altimetry systems are considered unreliable or fail**

<b>The Pilot should</b>	<b>ATC can be expected to</b>
Maintain CFL by reference to the standby altimeter (if the aircraft is so equipped).	
Alert nearby aircraft by <ol style="list-style-type: none"> <li>1) making maximum use of exterior lights;</li> <li>2) broadcasting position, FL, and intentions on 121.5 MHz (as a back-up, the VHF inter-pilot air-to-air frequency may be used).</li> </ol>	
Consider declaring an emergency. Notify ATC of the failure and intended course of action. Possible courses of action include:	Obtain pilot's intentions, and pass essential traffic information.
1) maintaining CFL and route provided that ATC can provide lateral, longitudinal or conventional vertical separation.	1) If the pilot intends to continue in RVSM airspace, assess traffic situation to determine if the aircraft can be accommodated through the provision of lateral, longitudinal, or conventional vertical separation, and if so, apply the appropriate minimum.
2) requesting ATC clearance to climb above or descend below RVSM airspace if ATC cannot establish adequate separation from other aircraft.	2) If the pilot requests clearance to exit RVSM airspace, accommodate expeditiously, if possible.
3) executing the Doc 7030 contingency maneuver to offset from the assigned track and FL, if ATC clearance cannot be obtained.	3) If adequate separation cannot be established and it is not possible to comply with the pilot's request for clearance to exit RVSM airspace, advise the pilot of essential traffic information, notify other aircraft in the vicinity and continue to monitor the situation.
	4) Notify adjoining ATC facilities/sectors of the situation.

APPENDIX 5. SPECIFIC PROCEDURES FOR OCEANIC AIRSPACE

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

<b>The Pilot should</b>
Attempt to determine the defective system through established trouble-shooting procedures and/or comparing the primary altimeter display to the standby altimeter (as corrected by the correction cards, if required).
If the defective system can be determined, couple the functioning altimeter system to the altitude keeping device.
If the defective system cannot be determined, follow the guidance in Scenario 3 for failure or unreliable altimeter indications of all primary altimeters.

**\*Scenario 5: Turbulence (greater than moderate) which the pilot believes will impact the aircraft's capability to maintain flight level.**

<b>The Pilot should</b>	<b>ATC can be expected to</b>
Watch for conflicting traffic both visually and by reference to TCAS, if equipped.	
If considered necessary, alert nearby aircraft by: <ul style="list-style-type: none"> <li>1) making maximum use of exterior lights;</li> <li>2) broadcasting position, FL, and intentions on 121.5 MHz (as a back-up, the VHF inter-pilot air-to-air frequency may be used).</li> </ul>	
Notify ATC of intended course of action as soon as possible. Possible courses of action include:	
1) maintaining CFL and route provided ATC can provide lateral, longitudinal or conventional vertical separation.	1) Assess traffic situation to determine if the aircraft can be accommodated through the provision of lateral, longitudinal, or conventional vertical separation, and if so, apply the appropriate minimum.
2) requesting flight level change, if necessary.	2) If unable to provide adequate separation, advise the pilot of essential traffic information and request pilot's intentions.
3) executing the Doc 7030 contingency maneuver to offset from the assigned track and FL, if ATC clearance cannot be obtained and the aircraft cannot maintain CFL.	3) Notify other aircraft in the vicinity and monitor the situation
	4) Notify adjoining ATC facilities/sectors of the situation.

## APPENDIX 5. SPECIFIC PROCEDURES FOR OCEANIC AIRSPACE

\*7. SPECIAL PROCEDURES FOR IN-FLIGHT CONTINGENCIES PUBLISHED FOR INDIVIDUAL ICAO REGIONS IN DOC 7030.

\* a. The Doc 7030 should be considered the source document for specific contingency procedures applicable to individual ICAO regions. Doc 7030 should always be consulted before training material or manuals are developed.

\* b. In-flight contingency procedures applicable to Pacific oceanic operations are published in paragraph 4.0 of the Regional Supplementary Procedures for the Pacific and the Middle East/Asia (Mid/Asia).

\* c) In-flight contingency procedures applicable to NAT oceanic operations are published in paragraph 5.0 of NAT Regional Supplementary Procedures.

\*8. WAKE TURBULENCE PROCEDURES. The ATS authorities developed pilot and ATC procedures for aircraft experiencing wake turbulence. These procedures provide for the contingency use of a 2 NM lateral offset to avoid exposure to wake turbulence. The procedures have been published in State NOTAMS and AIPs and are planned for publication in Regional Supplementary Procedures. These procedures should be incorporated in pilot training programs and manuals.

9. TRANSPONDER FAILURE AND RVSM TRANSITION AREAS. The specific actions that ATC will take in the event of transponder failure in RVSM transition areas will be determined by the provider States. (Transition areas are planned to be established between airspaces where different vertical separation standards are applied).



APPENDIX 6. REVIEW OF ICAO DOCUMENT 9574  
HEIGHT-KEEPING PARAMETERS

1. ICAO Doc. 9574, Manual on the Implementation of a 300m (1,000 ft) Vertical Separation Minimum Between FL 290 - FL 410 Inclusive, covers the overall analysis of factors for achieving an acceptable level of safety in a given airspace system. The major factors are: passing frequency, lateral navigation accuracy, and vertical overlap probability. Vertical overlap probability is a consequence of errors in adhering accurately to assigned flight level, and this is the only factor addressed in the present document.

2. In ICAO Doc. 9574, Section 2.1.1.3, the vertical overlap probability requirement was restated as the aggregate of height keeping errors of individual aircraft, which must lie within the total vertical error (TVE) distribution expressed as the simultaneous satisfaction of the following four requirements:

a. the proportion of height keeping errors beyond 300 feet (90 m) in magnitude must be less than  $2.0 \times 10^{-3}$ ;

b. the proportion of height keeping errors beyond 500 feet (150 m) in magnitude must be less than  $3.5 \times 10^{-6}$ ;

c. the proportion of height keeping errors beyond 650 feet (200 m) in magnitude must be less than  $1.6 \times 10^{-7}$ ; and

d. the proportion of height keeping errors between 950 feet (290 m) and 1,050 feet (320 m) in magnitude must be less than  $1.7 \times 10^{-8}$ .

3. The following characteristics presented in ICAO Doc. 9574 were developed in accordance with the conclusions of ICAO Doc. 9536, to satisfy the distributional limits in paragraph 2a, and to result in aircraft airworthiness having negligible effect on meeting the requirements in paragraphs 2b, 2c, and 2d. They are applicable statistically to individual groups of nominally identical aircraft operating in the airspace. These characteristics describe the performance which the groups need to be capable of achieving in service, exclusive of human factors errors and extreme environmental influences, if the airspace system TVE requirements are to be satisfied. The following characteristics are the basis for development of this document:

a. "The mean altimetry system error (ASE) of the group shall not exceed  $\pm 80$  feet ( $\pm 25$  m);

b. The sum of the absolute value of the mean ASE for the group and three standard deviations of ASE within the group shall not exceed 245 feet (75 m); and

c. Errors in altitude keeping shall be symmetric about a mean of 0 feet (0 m) and shall have a standard deviation not greater than 43 feet (13 m) and should be such that the

APPENDIX 6. REVIEW OF ICAO DOCUMENT 9574  
HEIGHT-KEEPING PARAMETERS

error frequency decreases with increasing error magnitude at a rate which is at least exponential."

4. ICAO Doc. 9574 recognized that specialist study groups would develop the detailed specifications to ensure that the TVE objectives can be met over the full operational envelope in RVSM airspace for each aircraft group. In determining the breakdown of tolerances between the elements of the system, it was considered to be necessary to set system tolerances at levels which recognize that the overall objectives must be met operationally by aircraft and equipment subject to normal production variability, including that of the airframe static source error, and normal in-service degradation. It was also recognized that it would be necessary to develop specifications and procedures covering the means for ensuring that in-service degradation is controlled at an acceptable level.

5. On the basis of studies reported in ICAO Doc. 9536, Volume 2; ICAO Doc. 9574 recommended that the required margin between operational performance and design capability should be achieved by ensuring that the performance requirements are developed to fulfill the following requirements, where the narrower tolerance in paragraph 5b is specifically intended to allow for some degradation with increasing age:

a. "the mean uncorrected residual position error (static source error) of the group shall not exceed  $\pm 80$  feet ( $\pm 25$  m);

b. the sum of the absolute value of the mean ASE for the group and three standard deviations of ASE within the group, shall not exceed 200 feet (60 m);

c. each individual aircraft in the group shall be built to have ASE contained within  $\pm 200$  feet ( $\pm 60$  m); and

d. an automatic altitude control system shall be required and will be capable of controlling altitude within a tolerance band of  $\pm 50$  feet ( $\pm 15$  m) about commanded altitude when operated in the altitude hold mode in straight and level flight under nonturbulent, nongust conditions."

6. These standards provide the basis for the separate performance aspects of airframe, altimetry, altimetry equipment and automatic altitude control system. It is important to recognize that the limits are based on studies (Doc. 9536, Volume 2) which showed that ASE tends to follow a normal distribution about a characteristic mean value for the aircraft group. The document should, therefore, provide controls which will preclude the possibility that individual aircraft approvals could create clusters operating with a mean significantly beyond 80 ft (25 m) in magnitude, such as could arise where elements of the altimetry system generate bias errors additional to the mean corrected static source error.

## APPENDIX 7. CONTENTS

<i>Paragraph</i>	<i>Page</i>
1. Purpose.....	1
2. Related FAR Sections.....	1
3. Related Reading Material.....	1
4. Background.....	2
5. Definitions.....	3
6. The Approval Process.....	4
a. General.....	4
b. Approval of Aircraft.....	5
c. Operator Approval.....	5
7. RVSM Performance.....	6
a. General.....	6
b. RVSM Flight Envelopes.....	6
c. Altimetry System Error.....	6
d. Altitude Keeping.....	6
8. Aircraft Systems.....	8
a. Equipment for RVSM Operations.....	8
b. Altimetry.....	9
c. Altitude Alert.....	10
d. Automatic Altitude Control System.....	11
9. Airworthiness Approval.....	11
a. General.....	11
b. Contents of the Data Package.....	11
c. Data Package Approval.....	18
d. RVSM Airworthiness Approval.....	18
e. Post Approval Modification.....	18
10. Continued Airworthiness (Maintenance Requirements).....	18
a. General.....	18
b. Maintenance Program Approval Requirements.....	18
c. Maintenance Document Requirements.....	19
d. Maintenance Practices.....	19
e. Maintenance Practices for Noncompliant Aircraft.....	20
f. Maintenance Training Requirements.....	21
g. Test Equipment.....	21

APPENDIX 7. CONTENTS

<i>Paragraph</i>	<i>Page</i>
11. Operational Approval.....	22
a. Purpose and Organization.....	22
b. General.....	22
c. Pre-application Meeting .....	22
d. Content of Operator RVSM Application.....	22
e. FAA Review and Evaluation of Applications .....	24
f. Validation Flight(s) .....	25
g. Form of Authorizing Documents .....	25
h. Verification/Monitoring Programs.....	25
i. Conditions for Removal of RVSM Authority.....	25

**Appendices**

Appendix 1:	Explanation of W/ $\delta$ (1 page)
Appendix 2:	Altimetry System Error Components (8 pages)
Appendix 3:	Establishing and Monitoring Static Source Errors (5 pages)
Appendix 4:	Training Programs and Operating Practices and Procedures (5 pages)
Appendix 5:	Specific Procedures for Oceanic Airspace (9 pages)
Appendix 6:	Review of ICAO Document 9574 Height-Keeping Parameters (2 pages)
Appendix 7:	Contents (2 pages)



POLICY:

The FOPB has determined that the MMEL's for aircraft approved to operate in RVSM airspace should reflect dispatch requirements for certain aircraft systems that provide altitude-keeping capability. Accordingly, the following requirements must be addressed:

- ◆ Two (2) independent altitude measurement systems comprised of the following elements:
  - Cross coupled static source system provided with ice protection if located in areas subject to ice accretion
  - Equipment for measuring static pressure sensed by the static source, converting it to pressure altitude, and displaying pressure altitude to the flight crew
  - Equipment for providing a digitally coded signal corresponding to the displayed pressure altitude, for automatic altitude reporting purposes
  - Static source error correction (SSEC), if required to meet RVSM altimetry system error requirements
  - Equipment to provide reference signals for automatic altitude control and alerting systems
- ◆ One (1) SSR altitude reporting transponder
- ◆ One (1) altitude alert system
- ◆ One (1) automatic altitude control system capable of automatically controlling the aircraft to a referenced pressure altitude

Above guidance and generic equipment requirements, reflect the operational environment as it currently exists, and are applicable to all aircraft dispatching into airspace where RVSM is applied. FOEB chairmen may need to assess specific aircraft and systems independently where unique design features and/or service history identify the need to address "other" unspecified equipment requirements, e.g., operational limitations on the B-747 classic that may mandate the use of autothrottles to preclude unacceptable mach excursions which can induce altimetry system errors.

EXAMPLE:

Altitude Alerting A - 0 (0)Except where enroute

System operations require its use, may be inoperative provided:

- a) Autopilot with altitude hold is operative, and
- b) Repairs are made within three flight days.



# Federal Register

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**Friday,  
May 10, 2002**

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**Part V**

## **Department of Transportation**

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**Federal Aviation Administration**

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**14 CFR Part 91**

**Reduced Vertical Separation Minimum in  
Domestic United States Airspace;  
Proposed Rule**

**DEPARTMENT OF TRANSPORTATION****Federal Aviation Administration****14 CFR Part 91**

[Docket No. FAA-2002-12261; Notice No. 02-09]

RIN 2120-AH63

**Reduced Vertical Separation Minimum in Domestic United States Airspace****AGENCY:** Federal Aviation Administration (FAA), DOT.**ACTION:** Notice of proposed rulemaking (NPRM).

**SUMMARY:** This action proposes to permit Reduced Vertical Separation Minimum (RVSM) flights in the airspace over the contiguous 48 States of the United States (U.S.) and Alaska and that portion of the Gulf of Mexico where the FAA provides air traffic services. The RVSM program would allow the use of reduced vertical separation between aircraft at certain altitudes. This reduction of vertical separation minima would only be applied between those aircraft that meet stringent altimeter and auto-pilot performance requirements. This proposed rule would also require any aircraft that is equipped with Traffic Alert and Collision Avoidance System version II (TCAS II) and flown in RVSM airspace to incorporate a version of TCAS II that is compatible with RVSM operations. The FAA is proposing this action to enhance airspace capacity and to assist aircraft operators to save fuel and time.

**DATES:** Comments must be submitted on or before August 8, 2002.

**ADDRESSES:** Address your comments to the Docket Management System, U.S. Department of Transportation, Room Plaza 401, 400 Seventh Street, SW., Washington, DC 20590-0001. You must identify the docket number FAA-2002-XXXXX at the beginning of your comments, and you should submit two copies of your comments. If you wish to receive confirmation that FAA received your comments, include a self-addressed, stamped postcard.

You may also submit comments through the Internet to <http://dms.dot.gov>. You may review the public docket containing comments to these proposed regulations in person in the Docket Office between 9 a.m. to 5 p.m., Monday through Friday, except Federal holidays. The Dockets Office is on the plaza level of the NASSIF Building at the Department of Transportation at the above address. Also, you may review public dockets on the Internet at <http://dms.dot.gov>.

**FOR FURTHER INFORMATION CONTACT:** Roy Grimes, Flight Technologies and Procedures Division, Flight Standards Service, AFS-400, Federal Aviation Administration, 600 Independence Avenue, SW., Washington, DC 20591, telephone (202) 267-3734.

**SUPPLEMENTARY INFORMATION:****Comments Invited**

The FAA invites interested persons to participate in this proposed rulemaking by submitting written comments, data, or views. We also invite comments relating to the economic, environmental, energy or federalism impacts that might result from adopting the proposals in this document. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, and include supporting data. We ask that you send us two copies of written comments.

We will file in the docket all comments we receive, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking. The docket is available for public inspection before and after the comment closing date. If you wish to review the docket in person, go to the address in the **ADDRESSES** section of this preamble between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays. You may also review the docket using the Internet at the web address in the **ADDRESSES** section.

Before acting on this proposal, we will consider all comments we receive on or before the closing date for comments. We will consider comments filed late if it is possible to do so without incurring expense or delay. We may change this proposal in light of the comments we receive.

If you want the FAA to acknowledge receipt of your comments on this proposal, include with your comments a pre-addressed, stamped postcard on which the docket number appears. We will stamp the date on the postcard and mail it to you.

**Availability of Rulemaking Documents**

You can get an electronic copy of this copy through in Internet by taking the following steps:

- (1) Go to the search function of the Department of Transportation's electronic Docket Management System (DMS) web page (<http://dms.dot.gov/search>).
- (2) On the search page type in the last four digits of the Docket number shown at the beginning of this notice. Click on "search."
- (3) On the next page, which contains the Docket summary information for the

Docket you selected, click on the document number of the item you wish to view.

You can also get an electronic copy using the Internet through the Office of Rulemaking's web page at <http://www.faa.gov/avr/armhome.htm> or the Federal Register's web page at [http://www.access.gpo.gov/su\\_docs/aces/aces140.html](http://www.access.gpo.gov/su_docs/aces/aces140.html).

You can also get a copy by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue SW., Washington, DC 20591, or by calling (202) 267-9680. Make sure to identify the docket number, notice number, or amendment number of this rulemaking.

**Why RVSM Implementation in US and Gulf of Mexico Airspace Is Warranted: Benefits, Proven Safety, Existing Aircraft Eligibility***Statement of the Problem*

Air traffic levels were reduced following the events of September 11, 2001. The FAA anticipates, however, that over the next 12-18 months, air traffic will resume the steady increase that has been exhibited in past years. Air traffic at FAA air route traffic control centers is projected to increase over the next ten years at an average annual rate of 1.5 percent. By 2012, FAA air route traffic control centers are projected to be required to manage approximately 9 million more instrument flight rule (IFR) flights than they did in 2000 (55.0 million versus 46.0 million).

As air traffic increases, the opportunity for aircraft to fly the desired time and fuel-efficient flight levels and routes will be significantly diminished. In addition, traffic increases will diminish the capability of the FAA to move aircraft through and around areas affected by significant weather systems. In areas characterized by high-density traffic, the FAA may be required to invoke restrictions that can result in traffic delays and fuel penalties.

*National Airspace System Operational Evolution Plan (NAS OEP) Initiatives*

In 2001, the FAA began a focused study of initiatives to enhance the efficiency and reliability of air traffic operations in the NAS. This study and inputs from the airspace user community has led the FAA to pursue a variety of options and initiatives to enhance airport capacity and arrival, approach, and enroute operations. The initiatives and FAA plans to pursue them are published in the NAS OEP.

The website address for this document is: [www.faa.gov/programs/oep](http://www.faa.gov/programs/oep).

The FAA believes that the option to implement RVSM in the NAS should be a high priority initiative because RVSM has proven over the past several years to provide significant enhancements to enroute operations in other areas. The RVSM implementation project is listed in the Enroute Congestion Solutions section of the NAS OEP.

#### *Advocacy by User Groups*

Organizations and representatives from the aviation community have advocated the implementation of RVSM in U.S. and Gulf of Mexico airspace. The U.S. operators view RVSM as a proven operational program that can mitigate some of the problems encountered in U.S. domestic operations.

#### *RVSM Mitigation of Air Traffic Management Problems*

The explanation of the term "flight levels (FL)" in this paragraph is provided to introduce the discussion of RVSM benefits below. Flight levels are stated in three digits that represent thousands of feet. The term flight level is used to describe a surface of constant atmospheric pressure related to a reference datum of 29.92 inches of mercury. Flight levels are separated by specific pressure intervals. Rather than adjusting altimeters for changes in atmospheric pressure, pilots base altitude readings above the transition altitude (18,000 feet in the United States) on this standard reference. Thus FL 290 represents the pressure surface equivalent to 29,000 feet based on the 29.92" Hg datum; FL 310 represents 31,000 feet, and so on.

With air traffic levels increasing annually, FAA airspace planners and their international counterparts have established programs to implement RVSM as a primary measure to enhance air traffic management and operating efficiency. RVSM has been successfully implemented in both oceanic and continental airspace. The RVSM program has been implemented in oceanic airspace in the North and South Atlantic, the Pacific, the South China Sea, and in the portion of the West Atlantic Route System (WATRS) that is in the New York Oceanic Flight Information Region (FIR). The RVSM program has also been implemented in the continental airspace of Australia and Europe.

The RVSM program allows the vertical separation standard that is applied below FL 290 to be applied between FL 290 and 410. Below FL 290 (29,000 feet), air traffic controllers can assign Instrument Flight Rules (IFR)

aircraft to flight levels that are separated by 1,000 feet. Above FL 290, however, the Conventional Vertical Separation Minimum (CVSM) is 2,000 feet and IFR aircraft must be assigned to FL's separated by 2,000 feet.

The 2,000-foot minimum vertical separation restricts the number of flight levels available. Flight levels 310, 330, 350, 370, and 390 are flight levels at which aircraft operate most economically. During peak periods, these FL's can become congested. When all RVSM FL's (FL 290–410) are utilized, six additional flight levels are available: FL's 300, 320, 340, 360, 380, and 400. Increasing the number of FL's available in the U.S. domestic airspace is projected to provide enhancements to aircraft operations similar to those gained in the North Atlantic (NAT) and Pacific (PAC) (i.e., mitigation of fuel penalties attributed to the inability to fly optimum altitudes and tracks and enhanced controller flexibility for air traffic management).

#### *Benefits and Enhancements*

Implementation of a 1,000-foot vertical separation standard above FL 290 offers substantial operational benefits to operators, including:

- Greater availability of the most fuel-efficient altitudes. In the RVSM environment, aircraft are more likely to receive their requested altitude enabling them to consistently fly closer to their most fuel efficient FL.

- Greater availability of the most time and fuel-efficient routes (and an increased probability of obtaining these routes). Operators may not be cleared on the route that was filed due to demand for the optimum routes and resultant traffic congestion on those routes. The RVSM program allows the FAA to accommodate a greater number of aircraft on a given track or route. More time and fuel-efficient tracks or routes would therefore be available to more aircraft.

- Increased air traffic controller flexibility. The RVSM program gives the FAA greater flexibility to manage traffic by increasing the number of flight levels available on each track or route. This enhanced flexibility is especially desirable in situations where the FAA must re-route traffic around weather.

- Reduction of air traffic controller workload. The enhanced flexibility described above will reduce controller workload and allow them to work more efficiently.

- Enhanced flexibility to allow aircraft to cross intersecting routes. The RVSM program makes more flight levels available to enable aircraft to cross

intersecting flight paths above or below conflicting traffic.

- Enhanced safety in the application of separation standards. Studies show that the RVSM program produces a wider distribution of aircraft among different routes and altitudes.

#### *Example of RVSM Benefits to NAT Operations*

Over the past five years, the FAA and the other NAT Air Traffic Service Providers have observed significant benefits provided by RVSM implementation in NAT airspace. Prior to the introduction of RVSM, 27 percent of flights in NAT airspace were issued clearances on tracks and at altitudes other than the optimum tracks and altitudes requested by the operators in their filed flight plans. These flights were, therefore, generally subject to time and fuel penalties.

The NAT Implementation Management Group (IMG) (of which the FAA is a member) observed the following improvements in NAT operations due to the introduction of RVSM:

1. Fifty percent of the fuel penalty attributed to NAT system operation was eliminated. The total NAT system fuel penalty is estimated based on track design, meteorological forecast, cruise level, and traffic congestion penalties.

2. Twenty five percent fewer fixed tracks were required to be published. This allows more airspace for operators to fly preferred tracks.

3. There was a five percent increase in flights cleared to fly at both the altitude and on the track that the operator requested.

#### *Aircraft Operating in U.S. Airspace Already Approved for RVSM*

Approximately twenty-two percent of flights in U.S. airspace are already conducted by aircraft that have been approved for RVSM operations. Approximately 2,600 aircraft of U.S. registry have already been FAA-approved for RVSM operations under the existing RVSM regulation. Many U.S. operators have obtained RVSM approval for these aircraft so they can be flown in airspace outside the U.S. where RVSM has been implemented. Aircraft that have been approved for RVSM are currently approved for RVSM operations in any area of the world where RVSM is applied.

#### *Developing of RVSM Programs*

Rising traffic volume and fuel costs, which made flight at fuel-efficient altitudes a priority for operators, sparked an interest in the early 1970's in implementing RVSM above FL 290.

In April 1973, the Air Transport Association of America (ATA) petitioned the FAA for a rule change to reduce the vertical separation minimum to 1,000 feet for aircraft operating above FL 290. The petition was denied in 1977 in part because (1) aircraft altimeters had not been improved sufficiently, (2) improved maintenance and operational standards had not been developed, and (3) altitude correction was not available in all aircraft. In addition, the cost of modifying nonconforming aircraft was prohibitive. The FAA concluded that granting the ATA petition at that time would have adversely affect safety.

#### *Forums for Development of RVSM Policy and Procedures*

The FAA recognized, however, the potential benefits of RVSM and in the 1980's, focused its efforts and resources on establishing the criteria and policies that would allow RVSM to be implemented safely. In conjunction with this effort, the FAA also considered the economic feasibility of RVSM. These efforts were considered in the following national and international forums.

1. *FAA Vertical Studies Program.* This program began in mid-1981, with the objectives of collecting and analyzing data on aircraft performance in maintaining assigned altitude, developing program requirements to reduce vertical separation, and providing technical and operational representation on the various working groups studying the issue outside the FAA.

2. *RTCA Special Committee (SC)-150.* RTCA, Inc., (formerly Radio Technical Commission for Aeronautics) is an industry organization in Washington, D.C., that addresses aviation technical requirements and concepts and produces recommended standards. When the FAA hosted a public meeting in early 1982 on vertical separation, it was recommended that RTCA be the forum for development of minimum system performance standards for RVSM. RTCA SC-150 served as the focal point for the study and development of RVSM criteria and programs in the United States from 1982 to 1987, including analysis of the results of the FAA Vertical Studies Program.

3. *International Civil Aviation Organization (ICAO) Review of the General Concept of Separation Panel (RGCS).* In 1987, the FAA concentrated its resources for the development of RVSM programs in the ICAO RGCS. The U.S. delegation to the ICAO RGCS used the material developed by RTCA SC-150 as the foundation for U.S. positions and plans on RVSM criteria

and programs. The panel's major conclusions were:

- RVSM is technically feasible without imposing unreasonably demanding technical requirements on the equipment.
- RVSM provides significant benefits in terms of economy and enroute airspace capacity.
- Implementation of RVSM on either a regional or global basis requires sound operational judgment supported by an assessment of system performance based on: Aircraft altitude-keeping capability, operational considerations, system performance monitoring, and risk assessment.

The RGCS developed the ICAO Manual on Implementation of a 300-meter (1,000-foot) Vertical Separation Minimum Between FL 290 and FL 410 (inclusive) (ICAO Document 9574) that was published in 1992. This document provided the FAA with the basis for: The development of detailed aircraft and operator approval documents, planning for required RVSM implementation tasks, and developing programs to monitor aircraft performance and system safety.

4. *North Atlantic System Planning Group (NATSPG) and the NATSPG Vertical Separation Implementation Group (VSIG).*

After developing and reviewing cost/benefit studies, the NATSPG (of which the FAA is a member) concluded in 1991 that RVSM should be implemented in North Atlantic Minimum Navigation Performance Specification airspace and that working groups and programs should be established to implement it in 1996-1997. The NATSPG, thus, became the first ICAO regional group to develop the technical and operational programs to implement RVSM.

To pursue implementation, the NATSPG established the VSIG in June 1991 to take the necessary actions to implement RVSM in the NAT. These actions included:

- Aircraft and Operator Approval. The Operations and Airworthiness Group (chaired by the FAA) developed a detailed document containing the criteria and process to approve aircraft and operators for RVSM operations. The document addressed issues related to aircraft airworthiness, maintenance, and operations. The ICAO regional implementation groups and civil aviation authorities world-wide have adopted this document as the basis for aircraft airworthiness and operations programs.

- Safety Analysis and Monitoring Aircraft Altitude-keeping performance. The VSIG provided the forum to develop criteria and process for safety

analysis and for the development and use of two different, but complementary, monitoring systems to assess aircraft altitude-keeping in-service performance. These systems are the ground-based Height Monitoring Unit (HMU) and the Global Position System Monitoring System (GMS). The NATSPG used these systems to observe the performance of individual airframes and groups of aircraft with the objective of confirming that the approval process was uniformly effective and that the airspace system was safe.

- Air Traffic Policy and Procedures. The NATSPG Air Traffic Management Group developed ATC procedures for RVSM, conducted simulation studies to assess the effect of RVSM on ATC, and developed documents to address ATC issues.

Policy, procedures and documents developed in the NATSPG forum are used as the basis for RVSM program implementation worldwide.

#### **Safety Observed in RVSM Operations**

*Application of 1,000-foot Vertical Separation Below FL 290.* Before discussing the safety observed in the application, over the past several years, of 1,000-foot vertical separation at and above FL 290, it is important to note that 1,000-foot vertical has been applied safety below FL 290 for over 40 years. The 1,000-foot vertical separation of aircraft below FL 290 is an ICAO separation standard and since the 1960's, it has been applied below FL 290 worldwide, including in the U.S. The RVSM program enables the use of 1,000-foot vertical separation to be expanded above FL 290 to FL 410.

#### *Existing and Proposed Regulations: Criteria for Aircraft and Operator Approval*

Part 91, § 91.706 (Operations within airspace designated as Reduced Vertical Separation Minimum Airspace) and part 91, Appendix G (Operations in Reduced Vertical Separation Minimum (RVSM) Airspace) contain the FAA requirements for aircraft and operator approval for RVSM operations outside the U.S. They have been applied to operations outside the U.S. since they were published in April of 1997. A major objective of the proposed part 91 amendment is to add § 91.180 (Operations Within Reduced Vertical Separation Minimum Airspace in the United States) to make the standards of Appendix G applicable to RVSM operations within the U.S.

The aircraft and operator approval requirements published in part 91, Appendix G, and European Joint Airworthiness Authorities (JAA) RVSM documents was developed in a joint

FAA/JAA working group. In that group, technical and operational experts from the FAA, the European Joint Airworthiness Authorities (JAA), the aircraft manufacturers, and pilot associations developed detailed criteria and procedures for RVSM approval using the ICAO RVSM Manual (Doc 9574) as the starting point. These FAA and JAA regulations and standards have been used worldwide for RVSM aircraft and operator approval.

Section 91.706 requires that aircraft and operators meet the standards of Appendix G and receive authorization from the Administrator prior to flying in airspace where RVSM is applied. Appendix G contains requirements in eight sections:

1. Definitions
2. Aircraft Approval
3. Operator Authorization
4. RVSM operations (flight planning into RVSM airspace)
5. Deviation Authority Approval
6. Reporting Altitude-keeping Errors
7. Removal or Amendment of Authority
8. Airspace Designation

The criteria and procedures published in FAA Appendix G and in JAA and ICAO documents have produced aircraft performance that is significantly better than the minimum required for safety in the ICAO RVSM Manual.

#### *Observed Altitude-Keeping Performance*

For the past several years, the FAA, in conjunction with the NATSPG, has evaluated (or monitored) the altitude-keeping performance of RVSM approved aircraft. The GMS and the ground-based HMU have been used to observe aircraft performance in both oceanic and continental airspace.

Altitude system error (ASE) is the major component of aircraft altitude-keeping performance. The ASE is the difference between the pressure altitude displayed on the altimeter (assuming a correct altitude barometric setting) and the true pressure altitude.

Measurements have shown that the altitude-keeping performance of the population of aircraft approved for RVSM operations is significantly better than the minimum requirement established by the ICAO RGCSP in the ICAO RVSM Manual. The ICAO RVSM Manual calls for average or mean ASE for groups of aircraft not to exceed 80 feet and 99.9% of ASE measurements not to exceed 245 feet. To date, over 120,000 measurements of ASE taken for approximately 6,000 airframes has shown that the observed average ASE is -4.69 feet and 99.9% of ASE is within approximately 165 feet.

#### **RVSM Safety Analysis**

Over the past several years, the ongoing assessment of RVSM risk in various areas worldwide has shown that operational safety is maintained. All sources of aircraft, pilot, and controller error in RVSM operations have been assessed using safety analysis processes. The FAA and other civil aviation authorities have concluded that RVSM operations are safe.

#### **Proposed Implementation Plans and Schedules**

##### *Domestic RVSM (DRVSM) Implementation Team*

The FAA has established a Domestic RVSM Implementation Team to develop U.S. Domestic RVSM implementation plans and programs. It is the objective of the FAA team to develop and coordinate the DRVSM program and to complete the necessary tasks to implement RVSM in U.S. and Gulf of Mexico airspace.

#### **Proposed DRVSM Implementation Plan**

The FAA proposes to implement DRVSM in the airspace of the contiguous 48 states, Alaska and Gulf of Mexico airspace where the FAA provides air traffic service in December of 2004 between FL 290-410 (inclusive). When DRVSM is implemented, with limited exceptions described below, to fly in that airspace, civil operators and aircraft must comply with the standards of part 91 Appendix G and the operator must be authorized by the Administrator or, if a foreign operator, the country of registry to conduct RVSM operations. Implementing DRVSM in this manner enhances safety by requiring the aircraft/operator population to be approved to common standards, thus, enabling controllers to apply, in normal operations, a single vertical separation standard. It also enables a significant majority of operators to consistently flight plan, fuel plan and fly RVSM FL's and, therefore to maximize RVSM benefits.

In accordance with Appendix G, Section 5 (Deviation Authority Approval), the FAA proposes to allow the following exceptions to RVSM standards for civil aircraft operating in DRVSM airspace:

- The FAA will accommodate unapproved aircraft conducting air ambulance flights using a Lifeguard call sign as described in the Aeronautical Information Manual.
- Unapproved aircraft may be allowed to climb through RVSM FL's to operate above RVSM airspace at FL 430 and above, traffic permitting.

When such aircraft operate in RVSM aircraft, their lack of RVSM approval status will be displayed to FAA controllers and 2,000-foot vertical or the appropriate lateral or longitudinal separation standard will be applied to them.

#### *Factors Considered in Developing the Implementation Plan*

In proposing a FL stratum and implementation date, the FAA has considered the following factors:

- Feasibility of phased implementation
- Timeframe for significant majority of flights to be conducted by approved aircraft
- Justification to avoid further delay of RVSM benefits
- Capability and timeframe for the majority of operators and aircraft to obtain approval
- Options for unapproved aircraft to continue to operate

These implementation factors are discussed below:

*Phased implementation.* The FAA does not consider phased implementation to be feasible. Prior to reaching this conclusion, the FAA conducted real-time simulations at the William J. Hughes Technical Center to assess the feasibility of implementing RVSM initially between FL 350-390 or between 330-390. In the simulations of these implementation scenarios, the FAA analyzed controller workload, the potential for controller error and the impact on airspace complexity. Observations were made of qualified FAA controllers managing representative air traffic flows in three RVSM airspace scenarios: FL 350-390, FL 350-390, and FL 290-410. The FAA concluded that the FL 290-410 implementation scenario offered significant advantages in that it provided reductions in controller workload, airspace complexity and potential for error. Controllers were required to vector aircraft significantly less frequently and required coordination between air route centers was significantly reduced.

*Timeframe for a significant majority of flights to be conducted by RVSM approved aircraft.* In preparation for RVSM implementation, the FAA has worked with U.S. operators to establish a timeframe when a significant majority of flights would be conducted by RVSM approved aircraft. The FAA conducted a survey of U.S. operators to determine their plans to schedule and complete RVSM aircraft engineering tasks. The FAA found that many U.S. aircraft and operators have already obtained RVSM approval in order to operate in RVSM

airspace outside the U.S. In addition, anticipating DRVSM implementation, many operators are planning for completion of RVSM engineering work in late 2004. A significant motivation noted was the desire to accomplish RVSM aircraft work during scheduled maintenance checks to avoid costs associated with special inspections outside the normal maintenance cycle.

The FAA used the operator survey information in combination with data obtained from the Enhanced Traffic Management System (ETMS) to project the percentage of flights to be conducted in domestic airspace in December of 2004 by individual aircraft types. The FAA has projected that by December of 2004 over 90% of flights conducted between FL 290–410 will be conducted by RVSM approved aircraft.

*Justification to avoid further delay.* The FAA believes that further delay beyond December 2004 would result in an unwarranted loss of benefits. Based on the enhanced capability for aircraft to operate at more fuel-efficient altitudes, the FAA has projected \$388 million dollars in fuel savings for the period from December 2004 through calendar year 2005, assuming DRVSM is implemented in December 2004. In addition, as noted previously, the FAA has projected that the addition of six FL's between FL 290–410 would significantly enhance controller flexibility to manage traffic in situations such as weather re-routes and increase the number of aircraft that can traverse a sector. These benefits would be lost if implementation were delayed.

*Capability for operators to obtain aircraft approval.* First, aircraft certification authorities have approved RVSM aircraft engineering packages for all major aircraft types used in either airline or general aviation operations. Second, Appendix G provides operators with the option of obtaining approval for their aircraft in a non-group or individual airframe status. Third, the FAA is working with Aircraft Service Centers and other organizations that provide RVSM engineering service, as well as operator organizations, to standardize and clarify the aircraft approval process, as necessary. In addition, the FAA will conduct RVSM seminars and enhance the FAA RVSM information network to ensure that operators have ready access to information on the RVSM approval process.

*Options for unapproved aircraft to continue to operate.* Operators unable or unwilling to obtain RVSM approval for their aircraft by the proposed December 2004 implementation date would still be able to operate at and below FL 280. The

FAA recognizes that aircraft operating at and below FL 280 would not be operating at fuel-efficient altitudes. In addition, aircraft that can operate at and above FL 430 would be allowed to climb through to operate above RVSM airspace, traffic permitting. Finally, the FAA will plan to accommodate civilian air ambulance flights conducted by unapproved aircraft operating under a "Lifeguard" call sign. (Guidance on Lifeguard flights is published in the Aeronautical Information Manual).

#### *Specific Airspace Issues*

*Coordination with Mexico and Canada.* The FAA has established contact with representatives from the civil aviation authorities of Canada and Mexico and is coordinating RVSM implementation plans with them. Canadian representatives have informed the FAA that RVSM will be implemented in Northern Canadian Domestic airspace in April 2002, and Canada is planning to implement RVSM implementation in Canadian Southern Domestic airspace at the time that it is implemented in the U.S.

*Gulf of Mexico Airspace.* The airspace in the Gulf of Mexico for which the FAA provides air traffic services has been included in this proposal. The regulations, at 14 CFR 71.33(c), already designate portions of Houston and Miami Oceanic and Jacksonville Offshore Airspace as Class A airspace "within which domestic ATC procedures are applied." The offshore airspace is treated in the regulations as an extension of the Class A airspace of the continental U.S. In addition, certain routes where RVSM is proposed begin in continental U.S. airspace, cross the Gulf of Mexico and then re-enter continental airspace on the other side. Inclusion of Gulf of Mexico airspace in the proposal will mitigate unwarranted air traffic management complexity and contribute to maximizing benefits to the operators.

*Hawaiian Airspace.* The airspace of the Hawaiian Islands is surrounded by Pacific Oceanic RVSM airspace. RVSM approved aircraft operate to and from Hawaiian airspace, however, there is currently no plan to require RVSM approval for all aircraft to operate within that airspace. Instead, 1,000-foot vertical separation is applied between FL 290–410 when two passing aircraft are both RVSM approved and 2,000-foot vertical or horizontal separation is applied if either of the passing aircraft is not RVSM approved.

#### *Exploration of Tactical RVSM*

The FAA is exploring allowing controllers to apply "tactical RVSM"

prior to the proposed DRVSM implementation date of December 2004. Prior to December 2004, RVSM approval would not be mandatory for operation in U.S. domestic airspace. Application of tactical RVSM would allow controllers to use 1,000-foot vertical separation between FL 290–410, at controller's discretion, if both passing aircraft are RVSM approved. In this situation, the approval status would be displayed to the controller. This provision has been used successfully in Europe since April 2001.

#### *DRVSM Aircraft and Operator Approval Factors*

The intent of this rulemaking is to expand the application of the RVSM aircraft and operator approval requirements to all aircraft operating in the U.S. and Gulf of Mexico airspace. Currently, 14 CFR 91.706 addresses RVSM operations for U.S. registered civil aircraft outside of the U.S. The FAA proposes to locate new RVSM § 91.180 in part 91, subpart B (Flight Rules). Section 91.180 would, therefore, apply to RVSM operations conducted in the NAS. The new section instructs domestic operators and their aircraft to comply with part 91, Appendix G and obtain an authorization from the Administrator prior to conducting RVSM operations. In addition, proposed § 91.180 would provide that foreign operators and their aircraft would comply with appendix G and be authorized by the country of registry prior to conducting flight in RVSM airspace of the U.S.

*Eligibility of Aircraft Approved for RVSM Operations Outside the U.S.* Aircraft that have already received RVSM airworthiness approval in accordance with Appendix G that have been used in RVSM operations outside the U.S. are eligible for RVSM operations within the NAS. Prior to conducting NAS RVSM operations, however, operators will be required to adopt RVSM operational policies and procedures unique to the U.S. for pilots and, if applicable, dispatchers.

*TCAS II Version 7.0 Requirement.* A significant majority of the aircraft that operate in the domestic U.S. at and above flight level 290 area already required to be equipped with TCAS II, Version 6.04a. Requirements for aircraft TCAS equipage are published in 14 CFR parts 121, 125, 129 and 135. Approximately 85% of domestic operations above FL 290 are conducted by large jet aircraft operating under parts 121 or 129. These parts call for aircraft equipage with an approved TCAS II if the aircraft has seating capacity of more than 30 seats. FAA

Airworthiness Directives published in 1994 mandate TCAS II, Version 6.04a for TCAS II installations.

Part 91, appendix G, section 2, paragraph (g) states that “after March 31, 2002, unless otherwise authorized by the Administrator, if you operate an aircraft that is equipped with TCAS II in RVSM airspace, it must be a TCAS II that meets TSO C-119b (Version 7.0), or a later version.” This provision was adopted because Version 7.0 incorporates Traffic Alert and Resolution Advisory thresholds that mitigate unnecessary alerts when 1,000-foot vertical separation is applied above FL 290. Version 7.0 generally requires a software modification that is not a major system modification. The cost for this modification has been accounted for in the cost-benefit analysis. Operators of aircraft equipped with TCAS II must consider this provision when planning for the proposed DRVSM implementation date of December 2004.

*Eligibility of turbo-propeller Aircraft Operated Under Part 91 and Equipped with a single RVSM Compliant Altimeter.* In the proposed amendment, the FAA proposes operational and airworthiness criteria for turbo-propeller aircraft operated under part 91 to conduct RVSM operations when equipped with a single RVSM compliant altimeter. The FAA believes that aircraft can be used in RVSM operations conducted under part 91 in US operations for the following reasons:

*Frequency of Single Altimeter Operations.* General aviation (part 91) operations account for approximately ten percent of the total flights in the U.S. between FL 290-410. Of these flights, only a small percentage of flights operating above FL 290 would be conducted by turbo-propeller aircraft equipped with a single RVSM compliant altimeter.

*NAS Communications/Navigation/Surveillance (CNS) capabilities.* Direct pilot-controller communications, a robust navigation aid structure, and ATC radar surveillance are available in US domestic airspace. ATC will have the CNS tools to aid a pilot experiencing a failure or malfunction of the primary altimeter in exiting RVSM airspace, to apply the appropriate separation to the aircraft, and to aid the pilot in diverting to an alternate airport, if necessary.

*Continued Airworthiness.* Aircraft approved for RVSM operations must be maintained under the Continued airworthiness requirements of appendix G, section 3 (Operator Authorization).

*Altitude-keeping Performance Monitoring.* Part 91 aircraft have participated in the altitude-keeping performance monitoring program

established for RVSM implementation in oceanic operations and have demonstrated satisfactory RVSM performance. Aircraft equipped with a single RVSM compliant altimeter will participate in the monitoring program for domestic RVSM.

*Loss of function and integrity.* The single RVSM compliant altimeter/second or stand by altimeter installation detailed in the proposed Appendix G amendment would meet airworthiness requirements for availability and integrity of the RVSM altitude function.

#### **Air Traffic Control Factors Related to RVSM Operations**

RVSM implementation will require that certain air traffic policies and procedures be implemented to address issues related to the introduction of a reduced vertical separation standard. Policies and procedures will be established for the following:

- As discussed previously, unapproved aircraft will be allowed to climb or descend through RVSM airspace to operate above or below it, traffic permitting.
- Limited accommodation will be made for unapproved aircraft conducting air ambulance flights under a “Lifeguard” call sign.
- In areas when and where mountain wave is active, ATC will establish policies for the use of appropriate separation.

Wake turbulence events experienced in the past five years of RVSM operations have shown wake turbulence at RVSM FL's to be generally moderate or less than moderate. FL changes or aircraft lateral path offsets have been shown to mitigate the effect of wake turbulence.

*Proposed Amendment to Part 91, Appendix G, Section 5 (Deviation Authority Approval).* First, the FAA would only grant authority to deviate from the requirements of part 91 § 91.706 or the proposed § 91.180 in limited circumstances. The FAA may choose not to grant a deviation if the operator has elected not to equip its aircraft for RVSM operations because the presence of an unapproved aircraft could affect traffic flow and increase controller workload. Second, the FAA proposes to require the operator to submit an appropriate request in a time and manner acceptable to the Administrator, as published in the Aeronautical Information Manual and appropriate FAA orders. Section 5 currently calls for the operator to submit a request at least 48 hours in advance. However, several years of RVSM experience has shown that air traffic has been able, in certain circumstances, to

accommodate the operation of unapproved aircraft with less lead-time. The proposed wording would allow the FAA to prescribe more appropriate policy when warranted by operational circumstances.

*Proposed Amendment to VFR and IFR Cruising Altitudes At and Above FL 290.* The FAA proposes to revise part 91, § 91.159 (VFR cruising altitude or flight level) and § 91.179 (IFR cruising altitude or flight level). The proposed revision to § 91.159 would eliminate reference to VFR FL's above FL 180. Airspace above FL 180 is established as Positive Control Airspace where aircraft must maintain the altitude or flight level assigned by ATC.

The proposed revision to § 91.179 would revise the altitudes or FL's that are considered to be appropriate for IFR flight in uncontrolled airspace above FL 290 in airspace where RVSM is implemented. In accordance with RVSM policy, this revision would provide FL's that are separated by 1,000 feet vertically based on the direction of flight.

#### **Factors Related to Safety Analysis and Monitoring of Altitude-keeping Performance in the Pre-and Post Implementation Phases**

*Necessity for Monitoring Programs.* DRVSM implementation would require RVSM standards to be applied to the thousands of aircraft and operators that operate above FL 290 in domestic airspace. In order to assess the uniform effectiveness of aircraft and operator actions and identify adverse trends that may arise, the FAA would establish a DRVSM monitoring program similar to those established for oceanic RVSM implementation.

*Monitoring Experience.* The altitude-keeping performance of RVSM approved aircraft has generally been significantly better than the minimum required by RVSM standards, however, in the past five years of RVSM operations, a few individual airframes and aircraft groups have demonstrated altitude-keeping that has not met RVSM standards. A major purpose of monitoring is to identify performance that does not meet RVSM standards and, when necessary, to ensure that operators and/or manufacturers take appropriate corrective actions.

*Justification for Sampling Process and Monitoring After Approval Granted.* Altitude-keeping performance monitoring began in 1996. Since that time, the FAA and other authorities responsible for monitoring have obtained approximately 120,000 measurements for appropriately 6,000 individual airframes and 80 individual

aircraft types. To date only seven airframes have been observed exhibiting performance that exceeded RVSM standards. In addition, altimetry system error for the aircraft population as a whole has been demonstrated to be significantly better than the minimum standards. These results have given the FAA and other authorities confidence in RVSM aircraft engineering processes. Based on the monitoring results, authorities have adopted the position that monitoring may take the form of a sampling of newly approved airframes and, for most aircraft, it was not necessary for operators to complete monitoring prior to RVSM operating authority being granted.

*Systems Developed to Monitor Aircraft Performance.* Two systems have been deployed to perform monitoring for RVSM purposes. One is the ground-based Height Monitoring Unit (HMU). The other is the GPS-based Monitoring Unit (GMU). HMU's are now placed in strategic locations in Canada, the UK and Europe so that a large percentage of flights will be observed. At least three FAA HMU's will be deployed by the FAA in the U.S. for the same purpose. Only aircraft that fly in close proximity to the HMU location can be observed.

To obtain performance measurements with the GMU system, a GMU unit is temporarily installed, in accordance with appropriate certification documents, on an aircraft for a flight. The unit contain a GPS to obtain the geometric height of the aircraft in flight. This data is processed after the flight by the FAA Technical Center to obtain measurement of ASE, Total Vertical Error (TVE) and Assigned Altitude Deviation (AAD).

Operators have had and will have for DRVSM, the options of overflying an HMU at no cost or contracting for service to have the GMU installed on the aircraft and data processed.

Operators have been notified of monitoring program processes and procedures in the following formats: letters to State authorities issued by ICAO Regional Offices, NOTAMS, FAA and JAA guidance and the FAA RVSM website.

#### *Pre-Implementation Programs*

In the 2–3 year period leading to RVSM implementation, operators will begin to obtain RVSM airworthiness approval for aircraft that have not already been approved for RVSM. During this period, the FAA will review aircraft operations with the overall objections of:

1. Confirming that operators are conducting RVSM operations safely.

2. Confirming through observation (monitoring) that aircraft approved for RVSM operation demonstrate altitude-keeping performance that meets RVSM standards. This will be achieved by:

- Identifying and eliminating any causes of out-of-tolerance altitude-keeping performance, in general or for specific aircraft groups; and
- Monitoring a sample of RVSM-approved aircraft and operators that is representative of the total population.

3. Verifying that operational procedures adopted for RVSM are effective and appropriate.

4. Confirming that the altitude-monitoring program is effective.

#### *Post Implementation Programs*

After DRVSM is implemented, the FAA will continue to:

1. Collect altitude-keeping performance data relying primarily on the ground-based HMU.
2. Monitor to confirm that safety goals are being met.
3. Monitor to establish that there are no unresolved adverse trends in DRVSM operations.

#### *Conclusion*

The FAA has examined the success of existing RVSM programs, the costs and benefits for DRVSM implementation, the measures to be taken to protect operational safety, the factors bearing on the implementation schedule and implementation scenario and the factors related to aircraft and operator approval and air traffic programs. The FAA proposes that RVSM should be implemented between FL 290–410 (inclusive) in December 2004.

#### **Regulatory Impact Analysis Summary**

Executive Order 12866 directs federal agencies to promulgate new regulations or modify existing regulations after consideration of the expected benefits to society and the expected costs. Each federal agency shall assess both the costs and the benefits of proposed regulations while recognizing that some costs and benefits are difficult to quantify. A proposed rule is promulgated only upon a reasoned determination that the benefits of the proposed rule justify its costs.

The order also requires federal agencies to assess whether a proposed rule is considered a “significant regulatory action”. The Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of regulatory changes on small entities. The Office of Management and Budget directs agencies to assess the effect of regulatory changes on international trade. Finally, Public Law 104–4

requires federal agencies to assess the impact of any federal mandates on state, local, tribal governments, and the private sector.

In conducting these analyses, the FAA has determined that this rule: (1) Generates benefits that justify its costs for the significant majority of U.S. operators and is “a significant regulatory action” as defined in the Executive Order; (2) is significant as defined in Department of Transportation’s Regulatory Policies and Procedures; (3) does not have a significant impact on a substantial number of small entities; and (4) does not constitute a barrier to international trade. These analyses, available in the docket, are summarized below.

This proposal expands Reduced Vertical Separation Minimum (RVSM) operations to aircraft operating between FL 290–410 (inclusive) in the airspace of the 48 contiguous States of the U.S., Alaska and the FIR’s in the Gulf of Mexico where the FAA provides air traffic services. The benefits of this proposed rulemaking are: (1) An increase in the number of available flight levels; (2) enhanced airspace capacity; (3) permits operators to operate more fuel/time efficient routes and altitudes; and (4) enhanced air traffic controller flexibility by increasing the number of available flight levels, while maintaining an equivalent level of safety.

The FAA estimates that this proposed rule would cost U.S. operators \$634.0 million for the fifteen-year period 2002–2016 or \$539.9 million, discounted. For the purposes of this cost analysis, the FAA assumed that operators would choose to upgrade all of their aircraft to meet RVSM standards. Operators of non-RVSM approved aircraft would, however, retain the option of flying above or below RVSM airspace. Benefits would begin accruing in December 2004. Estimated benefits, based on fuel savings for the commercial aircraft fleet over the years 2004 to 2018, would be \$5.8 billion or discounted at \$2.9 billion.

In addition to fuel savings, many non-quantifiable or value-added benefits would result from the implementation of RVSM in domestic U.S. airspace. Input from air traffic managers, controllers, and operators has identified numerous additional benefits.

Through implementation of RVSM in the NAT and PAC regions, operators and controllers have realized some additional benefits. The major additional benefits as identified by air traffic managers and controllers are:

- Enhanced capacity

- Decreased operational errors in these regions
- Reduction of user-requested off course climbs for altitude changes
- Improved flexibility for peak traffic demands
- More options in deviating aircraft during period of adverse weather.

The benefits outlined above for RVSM in the NAT and PAC regions are anticipated in domestic U. S. airspace. There should be expected efficiencies through reduced airspace complexity, increased flight levels, and fewer altitude changes with crossing traffic.

Operators can also expect enhanced operating efficiency and the potential for decreased departure delays due to improved airspace efficiency. Specific benefits cited by aircraft operators are:

- Decreased flight delays
- Improved access to desired flight levels
- Reduced average flight times
- Increased likelihood of receiving a clearance for weather deviations
- Seamless, transparent, and harmonious operations between the NAT and WATRS regions

- Consistent procedural environment throughout the entire flight
- Reduced impact of adverse weather by permitting aircraft deviations to other airways without any efficiency loss.

Implementation of RVSM in U.S. domestic airspace should increase user satisfaction. The benefits described in this section are compelling in number and operational impact. These benefits are also important in that they are enjoyed both by air traffic and aircraft operators.

#### Analysis of Alternatives

This NPRM is a “significant regulatory action” as defined by Executive Order (E.O.) 12866 (Regulatory Planning and Review) because this NPRM would impose costs exceeding \$100 million annually. The E.O. requires that agencies promulgating economically significant rules provide an assessment of feasible alternatives to their respective rulemaking actions. In addition, the E.O. requires that an explanation of why the final rule, which is significant, is preferable to the identified potential alternatives. The FAA identified and considered three alternatives to the proposed rule.

#### Alternative One—The Status Quo

The alternative would maintain the 2,000-foot separation above FL 290 and would avoid the equipment and testing requirements of this NPRM, which impose a cost of \$634.0 million (\$539.9 million, discounted) from 2002 to 2004 on the aviation industry and the FAA.

But maintaining the status quo also means that aviation industry would not receive any of the cost-savings afforded by Domestic RVSM.

As mentioned earlier, the cost-savings afforded by this NPRM are estimated to be \$5.8 billion (\$2.9 billion, discounted) in fuel savings over the same period. Since the foregone cost-savings of the alternative greatly exceed the avoided NPRM costs, the FAA rejects this alternative in favor of the proposed rule.

#### Alternative Two—Implement Domestic RVSM Without the Equipment and Testing Requirements

This alternative would allow RVSM between FL 290 and FL 410 without requiring aircraft system engineering to 14 CFR part 91, appendix G. This alternative would allow the aviation industry to receive the estimated \$5.8 billion (\$2.9 billion, discounted) in fuel savings while the aviation industry and the FAA avoids the NPRM costs of \$634.0 million (\$539.9 million, discounted). Unfortunately, this is not a viable alternative due to safety considerations.

Studies by the FAA and European civil aviation authorities have shown that many aircraft that have not been calibrated to the proposed RVSM standards exhibit altitude-keeping errors that exceed the Standards established for RVSM safety. In these studies, non-RVSM calibrated aircraft were observed with errors of up to 700 feet. Under RVSM aircraft are allowed to operate with only 1,000 feet vertical separation. If non-RVSM calibrated aircraft were allowed to operate with only 1,000 feet vertical separation, there could be a 400 foot altitude overlap in altitude-keeping errors for two non-RVSM calibrated aircraft operating in close proximity to each other. Thus, there is an increase risk of midair collisions if non-RVSM calibrated aircraft are allowed to operate under RVSM. Since there are some aviation safety concerns with this alternative, this alternative is also rejected in favor of the proposed rule.

#### Alternative Three—Delay Implementation of the RVSM by Seven or Eight Years

This alternative would delay implementation of the proposed rule by seven or eight years. This would allow the costs to be spread over a longer period of time so that costs in any one-year would be below \$100 million. This would make the proposed rule no longer economically significant under E.O. 12866. The cost of this alternative would still be the same as the cost of the proposed rule, although the discounted costs would be lower than the

discounted costs of the proposed rule. However, if implementation of the rule is delayed by seven or eight years, the estimated cost-savings would be reduced by \$2.0 billion or \$2.4 billion, respectively (\$1.5 billion, discounted or \$1.8 billion, discounted, respectively). This is a considerable amount of cost-savings to forego in order for the FAA to avoid issuing an economically significant rule. For this reason, this alternative is rejected in favor of the proposed rule.

#### Initial Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 establishes as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and applicable status, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation. To achieve that principle, the Act requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The Act covers a wide-range of small entities including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule will have a significant economic impact on a substantial number of small entities. If the determination is that it will, the agency must prepare a regulatory flexibility analysis (RFA) as described in the Act.

However, if an agency determines that a proposed or final rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the 1980 Act provides that the head of the agency may so certify and an RFA is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear.

Only two small operators were found to have significant costs of compliance. This is not a substantial number of small entities that would be significantly affected by this proposed rulemaking. Therefore, the FAA certifies that this proposed rulemaking does not have a significant impact on a substantial number of small entities. The FAA requests comments from small operators affected by this rulemaking concerning the findings of this regulatory flexibility determination.

#### International Trade Impact Statement

The FAA has assessed the potential effect of this rulemaking and has determined that it would impose the

same costs on domestic and international entities and thus has a neutral trade impact.

### Federalism Implications

The regulations proposed herein would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this proposal would not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

### Paperwork Reduction Act of 1995

This proposal contains the following new information collection requirements. As required by the Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)), the Department of Transportation has submitted the information requirements associated with this proposal to the Office of Management and Budget for its review.

*Title:* Reduced Vertical Separation Minimum.

*Summary:* This proposal requires aircraft operators seeking operational approval to conduct RVSM operations within the 48 contiguous States of the United States (U.S.), Alaska and that portion of the Gulf of Mexico where the FAA provides air traffic services to submit application to their Certificate-Holding District Office (CHDO).

*Use of:* This proposal would support the information needs of the operator's CHDO as they register RVSM approved airframes in the FAA RVSM Approvals Database. When operators complete airworthiness, continued airworthiness and operations program requirements, the CHDO grants operational approval.

*Respondents:* The 2,275 likely respondents to this proposed information requirement are scheduled and non-scheduled commercial air carriers, and corporations or individuals operating RVSM-capable aircraft.

*Frequency:* The FAA estimates that this proposed information requirement would be a one-time submission of application for operational approval. Thus, the frequency of an annual requirement is zero.

*Annual Burden Estimate:* This proposal would result in a one-time recordkeeping and reporting burden. The proposed rule, while imposing additional reporting and recordkeeping requirements on those operators, would have the following impacts:

- The estimated preparation time for an operator to complete and submit an

application for operational approval to their CHDO would be 16 hours.

- All pilots would need to be trained to ensure familiarity with RVSM operations. Each organization would have a navigation specialist prepare a document. The FAA anticipates that it would take this specialist approximately 14 hours to prepare the document; and
- Each pilot would have to receive a copy of the 4-page training document. To be conservative, the FAA is assuming that each pilot's document has been photostated. Each organization would need to spend 30 hours on paperwork at a cost of approximately \$950 each. The total hours and costs sum to 68,250 hours and \$2,147,052.40.

The FAA estimates that aircraft upgrade costs for this proposed rule would cost U.S. operators \$578.3 million. While it is impossible to accurately isolate the equipment costs associated with these upgrade costs, the FAA estimates that approximately 50% or \$289.2 million of the upgrade costs will be due to equipment costs. In addition, all aircraft equipped with TCAS version 6.04 would be required to upgrade to TCAS II Version 7.0 at a cost of \$45.6 million. The total equipment costs for this proposed rule are estimated at \$334.8 million.

The regulation will increase paperwork for the Federal government:

The FAA assumes that it would take either an avionics inspector or an operations inspector 8 hours to process each applicant submission. The time and cost to the Federal government for processing 2,275 application packages is 18,200 and \$981,162.00.

The FAA is soliciting comments to—

- (1) Evaluate whether the proposed information requirement is necessary for the proper performance of the functions of the agency, including whether the information will have practical utility;
- (2) evaluate the accuracy of the agency's estimate of the burden;
- (3) enhance the quality, utility, and clarity of the information to be collected; and
- (4) minimize the burden of the collection of information on those who are to respond, including through the use of appropriate automated, electronic, mechanical, or other technological collection techniques or other forms of information technology.

Individuals and organizations may submit comments on the information collection requirement by July 9, 2002, and should direct them to the address listed in the **ADDRESSES** section of this document.

According to the regulations implementing the Paperwork Reduction Act of 1995, (5 CFR 1320.8(b)(2)(vi)), an agency may not conduct or sponsor, and

a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control number for this information collection will be published in the **Federal Register**, after the Office of Management and Budget approves it.

### Unfunded Mandates Reform Act of 1995 Assessment

The Unfunded Mandates Reform Act of 1995 (the Act), enacted as Public Law 104-4 on March 22, 1995, is intended, among other things, to curb the practice of imposing unfunded Federal mandates on State, local, and tribal governments.

Title II of the Act requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in a \$100 million or more expenditure (adjusted annually for inflation) in any one year by State, local, and tribal governments in the aggregate, or by the private sector; such as a mandate is deemed to be a "significant regulatory action."

This proposed rule does not contain such a mandate. Therefore, the requirements of Title II of the Unfunded Mandates Reform Act of 1995 do not apply.

### International Civil Aviation Organization and Joint Aviation Requirements

In keeping with U.S. obligations under the Convention on ICAO, it is FAA policy to comply with ICAO Standards and Recommended Practices (SARP) to maximum extent practicable. The operator and aircraft approval process was developed jointly by the FAA and the JAA under the auspices of NATSPG. The FAA has determined that this amendment does not present any difference.

### Environmental Analysis

FAA Order 1050.1D defines FAA actions that may be categorically excluded from preparation of a National Environmental Policy Act (NEPA) environmental assessment or environmental impact statement. In accordance with FAA Order 1050.1D, appendix 4, paragraph 4(j), regulations, standards, and exemptions (excluding those, which if implemented may cause a significant impact on the human environment) qualify for a categorical exclusion. The FAA proposes that this rule qualifies for a categorical exclusion because no significant impacts to the environment are expected to result from its finalization or implementation.

Energy Impact

The energy impact of this proposed rule has been assessed in accordance with the Energy Policy and Conservation Act (EPCA) and Public Law 94-163, as amended (42 U.S.C. 6362). It has been determined that this proposed rule is not a major regulatory action under the provisions of the EPCA.

List of Subjects in 14 CFR Part 91

Air-traffic control, Aircraft, Airmen, Airports, Aviation safety. Reporting and record-keeping requirements.

The Proposed Amendment

For the reasons discussed in the preamble, the Federal Aviation Administration proposes to amend part 91 of Title 14 of the Code of Federal Regulations (14 CFR Part 91) as follows:

PART 91—GENERAL OPERATING AND FLIGHT RULES

1. The authority citation for part 91 continues to read as follows:

Authority: 49 U.S.C. 106(g), 1155, 40103, 40113, 40120, 44101, 44111, 44701, 44709, 44711, 44712, 44715, 44716, 44717, 44722, 46306, 46315, 46316, 46504, 46506-46507, 47122, 47508, 47528, -47531, articles 12 and 29 of the Convention on International Civil Aviation (61 stat. 1180).

Subpart B—Flight Rules

1. Amend § 91.159 by revising paragraph (b) to read as follows and by removing paragraph (c):

§ 91.159 VFR cruising altitude or flight level.

(b) When operating above 18,000 feet MSL, maintain the altitude or flight level assigned by ATC.

2. Amend § 91.179 by revising paragraph (b)(3), introductory text, and adding a new paragraph (b)(4) to read as follows:

§ 91.179 IFR cruising altitude or flight level.

(b) In uncontrolled airspace. (3) When operating at flight level 290 and above in non-RVSM airspace, and—

(4) When operating at flight level 290 and above in airspace designated as

Reduced Vertical Separate Minimum (RVSM) airspace and—

(i) On a magnetic course of zero degrees through 179 degrees, any odd flight level, at 2,000-foot intervals beginning at and including flight level 290 (such as flight level 290, 310, 330, 350, 370, 390, 410); or

(ii) On a magnetic course of 180 degrees through 359 degrees, any even flight level, at 2000-foot intervals beginning at and including flight level 300 (such as 300, 320, 340, 360, 380 or 400).

3. Add section 91.180 to subpart B to read as follows:

\* \* \* \* \*

§ 91.180 Operations within airspace designated as Reduced Vertical Separation Minimum airspace.

(a) Except as provided in paragraph (b) of this section, no person may operate a civil aircraft in airspace designated as Reduced Vertical Separation Minimum (RVSM) airspace unless:

(1) The operator and the operator's aircraft comply with the minimum standards of appendix G of this part; and

(2) The operator is authorized by the Administrator of the country of registry to conduct such operations.

(b) The Administrator may authorize a deviation from the requirements of this section.

4. Amend Appendix G as follows:

a. Amend Section 2 by revising paragraph (c)(1) and paragraph (h) and adding a new paragraph (i).

b. Amend Section 5 by revising the introductory text; redesignating paragraph (2) as paragraph (a) and by revising newly redesignated (a);

c. Amend Section 8 by adding new paragraphs (d) and (e).

The revisions and additions read as follows:

Appendix G To Part 91—Operations in Reduced Vertical Separation Minimum (RVSM) Airspace

Section 2. Aircraft Approval

\* \* \* \* \*

(c) Altitude-keeping equipment: All aircraft. \* \* \*

(1) The aircraft must be equipped with two operational independent altitude measurement systems that meet the requirements of paragraphs (d), (e) or (f), as appropriate, unless the aircraft is approved and operated in accordance with the provisions of paragraph (h) of this section.

\* \* \* \* \*

(h) Turbo-propeller Aircraft Operated Under Part 91 Equipped With a Single RVSM

Compliant Altitude Measurement System. Such aircraft will be considered eligible for RVSM operations conducted under part 91 within the airspace of the U.S. and within the airspace of foreign countries that authorize such a provision, provided that:

(1) Altimeters are installed in the aircraft in accordance with the provisions of part 23 or part 25, as appropriate; and

(2) The Administrator finds that at least one of the installed altitude measurement systems meets the standards for altimetry system error containment detailed in paragraphs (d), (e), or (f), as appropriate, of this section; and

(3) A second altitude measurement system is installed and the pilot provided with a means (such as correction cards) to correct for the inaccuracy in that altimeter when operating in RVSM airspace; and

(4) Procedures are established for pilots to:

(1) Use the appropriate means (e.g., correction cards), after initial level off, to compare the accuracy of the RVSM compliant altitude measurement system to the second system; and

(ii) Report as soon as practical to ATC any malfunction of the installed RVSM compliant altimeter occurring in flight that would prevent the aircraft from maintaining altitude to the degree of accuracy required for RVSM operations.

(i) If the Administrator finds that the applicant's aircraft complies with this section, the Administrator will notify the applicant in writing.

\* \* \* \* \*

Section 5. Deviation Authority Approval

The Administrator may authorize an aircraft operator to deviate from the requirements of § 91.180 or 91.706 for a specific flight in RVSM airspace if that operator has not been approved in accordance with Section 3 of this appendix if:

(a) The operator submits a request in a time and manner acceptable to the Administrator; and

\* \* \* \* \*

Section 8. Airspace Designation

\* \* \* \* \*

(d) RVSM in the United States. (1) RVSM may be applied in the airspace of the 48 contiguous states and Alaska, including that airspace overlying the waters within 12 nautical miles of the coast.

(e) RVSM in the Gulf of Mexico. (1) RVSM may be applied in the Gulf of Mexico in the following areas: Houston Oceanic ICAO FIR, Miami Oceanic ICAO FIR, and the Jacksonville Offshore Airspace.

Issued in Washington, DC, on May 6, 2002.

James J. Ballough,

Director, Flight Standards Service.

[FR Doc. 02-11704 Filed 5-7-02; 12:00 pm]

BILLING CODE 4910-13-M

altered, or repaired in the area subject to the requirements of this AD. For airplanes that have been modified, altered, or repaired so that the performance of the requirements of this AD is affected, the owner/operator must request approval for an alternative method of compliance in accordance with paragraph (e) of this AD. The request should include an assessment of the effect of the modification, alteration, or repair on the unsafe condition addressed by this AD; and, if you have not eliminated the unsafe condition, specific actions you propose to address it.

(f) *Where can I get information about any already-approved alternative methods of compliance?* Contact Doug Rudolph, Aerospace Engineer, FAA, Small Airplane Directorate, 901 Locust, Room 301, Kansas City, Missouri 64106; telephone: (816) 329-4059; facsimile: (816) 329-4090.

(g) *What if I need to fly the airplane to another location to comply with this AD?* The FAA can issue a special flight permit under sections 21.197 and 21.199 of the Federal Aviation Regulations (14 CFR 21.197 and 21.199) to operate your airplane to a location where you can accomplish the requirements of this AD.

(h) *How do I get copies of the documents referenced in this AD?* You may get copies of the documents referenced in this AD from British Aerospace Regional Aircraft, Prestwick International Airport, Ayrshire, KA9 2RW, Scotland; telephone: (01292) 672345; facsimile: (01292) 671625. You may view these documents at FAA, Central Region, Office of the Regional Counsel, 901 Locust, Room 506, Kansas City, Missouri 64106.

**Note 3:** The subject of this AD is addressed in British Aerospace Jetstream Service Bulletin 55-JA010941, Original Issue: January 25, 2002. This service bulletin is classified as mandatory by the United Kingdom Civil Aviation Authority (CAA).

Issued in Kansas City, Missouri, on July 23, 2002.

**Michael Gallagher,**  
Manager, Small Airplane Directorate, Aircraft Certification Service.

[FR Doc. 02-19255 Filed 7-30-02; 8:45 am]

**BILLING CODE 4910-13-P**

## DEPARTMENT OF TRANSPORTATION

### Federal Aviation Administration

#### 14 CFR Part 91

[Docket No. FAA-2002-12261; Notice No. 02-09]

RIN 2120-AH68

#### Reduced Vertical Separation Minimum in Domestic United States Airspace; Correction

**AGENCY:** Federal Aviation Administration (FAA), DOT.

**ACTION:** Notice of proposed rulemaking; correction.

**SUMMARY:** This document contains a correction to the notice of proposed rulemaking, published in the **Federal Register** on May 10, 2002 (67 FR 31920). That document proposed to permit Reduced Vertical Separation Minimum (RVSM) flights in the airspace over the contiguous 48 States of the United States and Alaska and that portion of the Gulf of Mexico where the FAA provides air traffic services. The RVSM program would allow the use of reduced vertical separation between aircraft at certain altitudes.

**FOR FURTHER INFORMATION CONTACT:** Roy Grimes, (202) 267-3734.

#### Correction of Publication

In the notice FR Doc. 02-11704, beginning on page 31920 in the **Federal Register** issue of May 10, 2002, make the following correction:

1. On page 31920, in column 1, in the heading section, beginning on line 6, correct "RIN 2120-AH63" to read "RIN 2120-AH68".

Issued in Washington, DC on July 25, 2002.

**Donald P. Byrne,**  
Assistant Chief Counsel, Regulations Division.

[FR Doc. 02-19365 Filed 7-30-02; 8:45 am]

**BILLING CODE 4910-13-M**

## DEPARTMENT OF THE TREASURY

### 17 CFR Part 420

RIN 1505-AA88

#### Government Securities Act Regulations: Large Position Rules

**AGENCY:** Office of the Assistant Secretary for Financial Markets, Treasury.

**ACTION:** Proposed rule.

**SUMMARY:** The Department of the Treasury ("Treasury," "We," or "Us") is publishing for comment proposed amendments to the reporting requirements pertaining to very large positions in certain Treasury securities. The regulations are issued under the Government Securities Act Amendments of 1993 ("GSAA"). The purpose of the rules is to provide Treasury with information to better understand the causes of market shortages in certain Treasury securities. We are proposing changes to improve the information available to Treasury. Specifically, we are proposing to modify the report to require separate reporting of certain components of the "net trading position" and the "gross financing position." We are also proposing to revise the current

"memorandum" item to require that the par amount of securities delivered through repurchase agreements be separated by maturity classification. In addition, we are proposing to add a new memorandum item to the large position report that would report the gross par amount of "fails to deliver." Finally, we are proposing to modify the definition of "gross financing position" to eliminate the optional exclusion in the calculation of the amount of securities received through certain financing transactions.

**DATES:** Submit comments on or before September 16, 2002.

**ADDRESSES:** You may send hard copy comments to: Government Securities Regulations Staff, Bureau of the Public Debt, 999 E Street N.W., Room 315, Washington, D.C. 20239-0001. You may also send us comments by e-mail at [govsecreg@bpd.treas.gov](mailto:govsecreg@bpd.treas.gov). When sending comments by e-mail, please use an ASCII file format and provide your full name and mailing address. You may download this proposed rule, and review the comments we receive, from the Bureau of the Public Debt's website at [www.publicdebt.treas.gov](http://www.publicdebt.treas.gov). The proposed rule and comments will also be available for public inspection and copying at the Treasury Department Library, Room 1428, Main Treasury Building, 1500 Pennsylvania Avenue, N.W., Washington, D.C. 20220. To visit the library, call (202) 622-0990 for an appointment.

**FOR FURTHER INFORMATION CONTACT:** Lori Santamorenna (Executive Director), Lee Grandy (Associate Director), or Nadir Isfahani (Government Securities Advisor), Bureau of the Public Debt, Government Securities Regulations Staff, (202) 691-3632 or e-mail us at [govsecreg@bpd.treas.gov](mailto:govsecreg@bpd.treas.gov).

**SUPPLEMENTARY INFORMATION:** Treasury published final rules<sup>1</sup> in 1996 that established Part 420 providing recordkeeping and reporting requirements related to very large positions in certain Treasury securities.<sup>2</sup> We are re-examining the "large position rules" and proposing modifications to improve the information available to better understand the causes of market shortages in certain Treasury securities. In this notice, we first provide background on the rules and then describe the proposed changes.

<sup>1</sup> 61 FR 48338 (September 12, 1996).

<sup>2</sup> 17 CFR Part 420.

# RVSM

## Reduced Vertical Separation Minimum

### REFERENCES:

#### Web-sites:

<http://www.faa.gov>

<http://www.tc.faa.gov/act-500/niaab/drvsm/Default.asp>

<http://www1.faa.gov/fsdo/orl/files/pp/rvsm.ppt>

<http://dms.dot.gov/search/document.cfm?documentid=168451&docketid=12261>

#### Other:

Barfield, Inc.

Tel-Instruments

Nav-aids, Ltd.



**Aero Express, Inc.**

[www.aeroexpress.com](http://www.aeroexpress.com)