EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

ATC Manual for a

Reduced Vertical Separation Minimum (RVSM)

in Europe

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Abstract

This manual represents an operational reference document intended for the use of ATS personnel involved in the planning, implementation and application of a Reduced Vertical Separation Minimum (RVSM) in Europe.

Keywords

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List of Abbreviations:

ACAS	Airborne Collision Avoidance System
ACC	Area Control Centre
ACH	ATC Flight Plan Change Message (IFPS)
ACI	Area of Common Interest
ACT	Activation Message (OLDI)
ADEP	Aerodrome of Departure
ADES	Aerodrome of Destination
AFIL	Flight Plan Filed in the Air
AFP	ATC Flight Plan Proposal Message (IFPS)
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publication
AMC	Airspace Management Cell
ANT	Airspace and Navigation Team
APDSG	ATM Procedures Development Sub-Group
APL	ATC Flight Plan Message (IFPS)
ASE	Altimetry System Error
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Service
CDB	Central Data Base
CFL	Cleared Flight Level
CFMU	Central Flow Management Unit
CHG	Modification Message (IFPS)
CMA	Central Monitoring Agency (NAT)
CVSM	Conventional Vertical Separation Minimum
EANPG	European Air Navigation Planning Group
EATCHIP	European Air Traffic Control Harmonisation and Integration Programme
ECAC	European Civil Aviation Conference
FAA	Federal Aviation Administration (USA)
FDPS	Flight Data Processing System
FIR	Flight Information Region
FL	Flight Level
FLAS	Flight Level Allocation Scheme
FMP	Flow Management Position (ACC)
FPL	Flight Plan
GAT	General Air Traffic
GMU	GPS Height Monitoring Unit
GPS	Global Positioning System
HMU	Height Monitoring Unit
ICAO	International Civil Aviation Organization
IFPS	Integrated Initial Flight Plan Processing System
IFPZ	IFPS Zone
IFR	Instrument Flight Rules
JAA	Joint Aviation Authorities
JAA AMC	JAA Acceptable Means of Compliance
JAR	Joint Aviation Requirements
LoA	Letter of Agreement
MASPS	Minimum Aircraft System Performance Specification
MNPS	Minimum Navigation Performance Specification
MTCD	Medium Term Conflict Detection
NAT	North Atlantic
NAT CMA	North Atlantic Region Central Monitoring Agency
NATSPG	North Atlantic Systems Planning Group
NOTAM	Notice to Airmen
OAT	Operational Air Traffic
OLDI	On-Line Data Interchange
RA	Resolution Advisory (ACAS)
REJ	Reject message (IFPS)
RFL	Requested Flight Level
RGCSP	Review of the General Concept of Separation Panel
RNAV	Area Navigation
RNP	Required Navigation Performance
RPL	Repetitive Flight Plan
RTF	Radiotelephony
RVSM	Reduced Vertical Separation Minimum of 300 m /1 000 ft Between FL 290 and FL 410 Inclusive
SARPs	Standards and Recommended Practices
SDB	State Data Base
SSEC	Static Source Error Correction
SSR	Secondary Surveillance Radar
STCA	Short Term Conflict Alert
TA	Traffic Advisory (ACAS)
TGL	Temporary Guidance Leaflet (JAA)
TLS	Target Level of Safety
TSA	Temporary Segregated Area
TSE	Total System Error
TVE	Total Vertical Error
UAC	Upper Area Control Centre
UIR	Upper Flight Information Region
VFR	Visual Flight Rules
VSM	Vertical Separation Minimum

DEFINITIONS

Flight Level Allocation Scheme (FLAS):

The scheme whereby specific flight levels may be assigned to specific route segments within the route network.

General Air Traffic (GAT)

Flights conducted in accordance with the rules and provisions of ICAO.

Operational Air Traffic (OAT)

Flights which do not comply with the provisions stated for GAT and for which rules and procedures have been specified by appropriate authorities.

RVSM Approval:

The approval that is issued by the appropriate authority of the State in which the Operator is based or of the State in which the aircraft is registered. To obtain such RVSM approval, Operators shall satisfy the said State:

1) that aircraft for which the RVSM Approval is sought have the vertical navigation performance capability required for RVSM operations through compliance with the criteria of the RVSM Minimum Aircraft Systems Performance Specification (MASPS).
2) that they have instituted procedures in respect of continued airworthiness (maintenance and repair) practices and programmes.
3) that they have instituted flight crew procedures for operations in the EUR RVSM airspace.

*Note: For the purposes of the application of RVSM, the term: **"RVSM APPROVED**" shall be used to indicate that an aircraft has been granted RVSM Approval.*

RVSM Entry Point

The first reporting point over which an aircraft passes or is expected to pass immediately before, upon, or immediately after initial entry into European RVSM airspace, normally the first reference point for applying a reduced vertical separation minimum.

RVSM Exit Point

The last reporting point over which an aircraft passes or is expected to pass immediately before, upon, or immediately after leaving European RVSM airspace, normally the last reference point for applying a reduced vertical separation minimum.

State Aircraft

Aircraft used in military, customs and police services shall be deemed to be State aircraft.

Ref: ICAO, Convention on International Civil Aviation, Article 3 (b.

Strategic Flight Level:

A flight level which is flight-plannable in accordance with the Table of Cruising Levels of ICAO Annex 2, Appendix 3 and the FLAS, as specified in the relevant Aeronautical Information Publications (AIPs).

Tactical Flight Level:

A flight level which is not flight-plannable and which is reserved for tactical use by ATC.

EXECUTIVE SUMMARY

The application of a reduced vertical separation minimum in the airspace of the European Civil Aviation Conference (ECAC) Member States and other States participating in the European RVSM Programme, represents a change of major significance to the operational environments of those ACCs/UACs involved. Careful planning in advance of the implementation of RVSM will ensure that benefits in terms of capacity and operating efficiency are optimised, and that controllers will be able to successfully cope with the magnitude of the change to their operational environments, thereby ensuring continued levels of safety.

Text within this manual, highlighted through the use of a shaded box, describe ATC procedures and system support requirements as dictated by identified operational requirements and as endorsed by the EATCHIP Airspace and Navigation Team. In support of these ATC procedures and system support requirements, the manual serves as a guidance and reference document for those operational and management ATS personnel involved with the planning for the implementation of RVSM. As well, it will serve as a reference document for those personnel involved with the continuing ATC operations of ACCs/UACs in an RVSM environment.

The manual will address those elements of the European ATM system which are impacted directly by, or have an impact on, RVSM implementation and application.

While the document describes the European RVSM airspace, ATC procedures, ATC phraseologies and relevant flight crew procedures associated with the application of RVSM, it does not supersede the relevant ICAO and national documents.

Throughout this document the use of the term: “European RVSM airspace” has been incorporated to reflect the application of RVSM within the airspace not only of Member States of ECAC, but also within certain States adjacent to ECAC, which have decided to participate in the RVSM Programme. Although originally intended for implementation only within the ECAC Member States as a capacity enhancing element of the European Air Traffic Control Harmonisation and Integration Programme (EATCHIP), additional States bordering the ECAC area will as well implement RVSM in their airspace, in order to

achieve a homogeneous European RVSM airspace and to share in the expected benefits of RVSM.

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1. INTRODUCTION

1.1 Background

The implementation of a reduced vertical separation minimum represents a major capacity enhancing objective of the European Air Traffic Control Harmonisation and Integration Programme (EATCHIP) Work Programme. Effectively, the introduction of RVSM will permit the application of a 1 000 ft vertical separation minimum (VSM) between suitably equipped aircraft in the level band FL 290-FL 410 inclusive, thereby making available six additional usable flight levels. The purpose of the implementation of RVSM is to increase capacity, through the provision of these six additional flight levels, to reduce controller workload, while maintaining, or improving upon, current levels of safety, and to provide the airspace user community with an improved operating environment for optimising flight profiles.

The making available of these additional levels is one of the means which will enable controllers:

- to efficiently handle both the current and future levels of traffic within their areas of responsibility,
- to de-conflict strategically traffic over the major crossing points of the European ATS route network more effectively, and
- to accommodate pilot requests for optimal cruising levels.

As described below, and as a pre-requisite to the introduction of RVSM in the ECAC airspace, implementation of RVSM requires that levels of safety of operations within the European RVSM airspace, when compared to current levels of safety, be either maintained or improved. Work undertaken by EUROCONTROL in the form of real-time simulations and safety studies have confirmed the feasibility of implementing RVSM, both technically and operationally, within required levels of safety. Experience gained through the application of RVSM within the ICAO North Atlantic (NAT) Region has been used in the development of the relevant associated aspects of the implementation of RVSM in the European airspace. In this way, consistency in flight operations across the two operational ATC environments was maintained to the maximum extent possible. Furthermore, the

EATCHIP RVSM Programme has been undertaken in close co-ordination with the European Air Navigation Planning Group (EANPG) of ICAO. The material developed as a result of the EATCHIP RVSM Programme is in accordance with all relevant ICAO Standards and Recommended Practices (SARPs) and associated ICAO Guidance Material on both RVSM and ATS. Thus, the implementation of RVSM in the European airspace is undertaken with due consideration for consistency with applications of the concept, both existing and planned, in other regions.

1.2 The Need for RVSM

Over the last five years, improvements brought about by EATCHIP have contributed to containing the duration, and frequency of occurrence, of ATC delays despite annual increases of between 3 to 10%. However, current forecasts indicate that air traffic movements will continue to rise, and will more than double by the year 2015 compared to 1996 figures. The anticipated trends are illustrated at Figure 1.

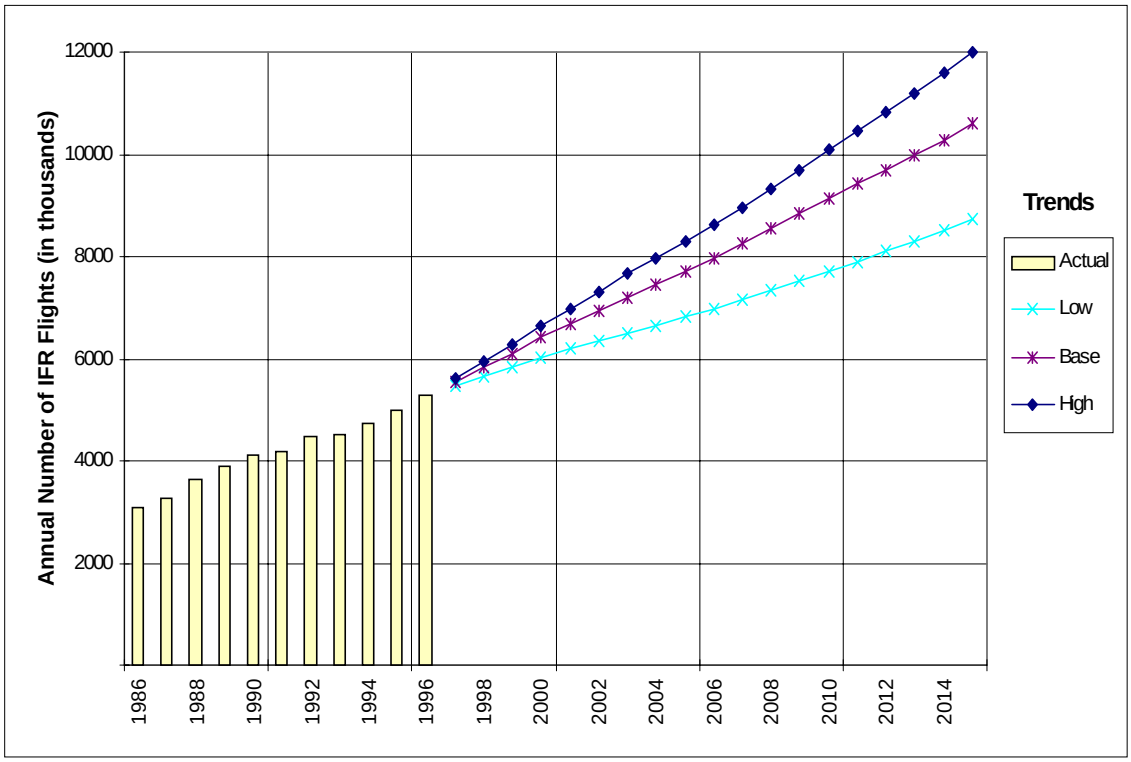

Figure 1. Traffic Statistics and Forecasts

It is accepted that major changes to the ATM systems will be necessary in order to cope with this continued traffic growth. Of the various measures under consideration, the

implementation of RVSM is considered to be the most cost effective means of meeting this need through the provision of six additional flight levels for use in the highly congested airspace from FL 290 to FL 410 inclusive. The RVSM Programme will result in the following benefits:

- Optimum Route Profiles.

  The availability of the additional flight levels in the busiest level band, will allow operators to plan for, and operate at or closer to, the optimum vertical route profile for the particular aircraft type. This will provide fuel economies in terms of both the fuel carried, and the fuel burn, for the flight. The economies are estimated at between 0.5% and 1% of the total fuel burn which has been translated to overall savings of 155 million ECU over the 20 year period following RVSM implementation[1].

- Increased ATC Capacity

  A series of ATC Real Time Simulations carried out at the EUROCONTROL Experimental Centre (EEC) at Bretigny, France, have provided evidence that RVSM can reduce controller workload. The simulations demonstrated that the capacity of those sectors simulated could be increased by approximately 20% when compared to a conventional vertical separation minimum (CVSM) environment[2]. There is also potential for further growth, through a revised airspace structure including, for example, resectorisation and/or the introduction of additional sectors.

  However, the presence of non-RVSM approved State aircraft, which have been exempted[3] from having to meet the RVSM Minimum Aircraft System Performance Specification (MASPS) requirements for operations in European RVSM airspace (see Part 3), and which are required to operate regularly as GAT along the ATS route network, will decrease the expected capacity gains. Evidence from the continuing operation of RVSM in the NAT region indicates that a large proportion of

[1] PA Consulting Group: Cost Benefit Assessment of RVSM Implementation
[2] 3rd Continental RVSM Real-Time Simulation, S08, (Conclusions)
[3] certain military tactical aircraft cannot, due to physical limitations, be adapted to meet RVSM MASPS

State aircraft operating as GAT are nevertheless RVSM approved. This trend is expected to continue.

1.3 History

In the late 1950s it was recognised that, as a result of the reduction in accuracy of pressure-sensing of barometric altimeters with increasing altitude, there was a need above a certain flight level to increase the prescribed vertical separation minimum (VSM) of 1 000 ft. In 1960, an increased VSM of 2 000 ft was established for use between aircraft operating above FL 290 except where, on the basis of regional air navigation agreement, a lower flight level was prescribed for the increase. The selection of FL 290 was not so much an empirically-based decision but rather a function of the operational ceiling of aircraft at that time. In 1966, this change-over level was established at FL 290 on a global basis. At the same time, it was considered that the application of a reduced VSM above FL 290, on a regional basis and in carefully prescribed circumstances, was a distinct possibility in the not too distant future. Accordingly, ICAO provisions stated that such a reduced VSM could be applied under specified conditions within designated portions of airspace on the basis of regional air navigation agreements.

In the late 1970s, faced with rising fuel costs and growing demands for a more efficient utilisation of the available airspace, ICAO initiated a comprehensive programme of studies to examine the feasibility of reducing the 2 000 ft VSM applied above FL 290, to the same 1 000 ft VSM which is applied below FL 290. Throughout the 1980s, various studies were conducted, under the auspices of ICAO and in Europe, Canada, Japan, and the United States. The underlying approach of the programmes was to:

- determine the height keeping accuracy of the altimetry systems of the then current aircraft population.
- establish the causes of observed height keeping errors.
- determine the required safety levels for the implementation and use of a Reduced Vertical Separation Minimum (RVSM) of 1 000 ft in the level band FL 290 - FL 410 inclusive.
- define a MASPS, for aircraft altimetry and associated height keeping equipment, which would improve height keeping accuracy to a standard compatible with the agreed safety requirements for RVSM.
- determine whether the global implementation and use of RVSM was :

1. technically feasible, subject to the over-riding need to satisfy the agreed safety standards, and
2. cost beneficial.

The results of these exhaustive studies demonstrated that the reduction of vertical separation was safe, cost beneficial and feasible, - without the imposition of unduly demanding technical requirements.

The studies also showed that the types of aircraft and the essentially unidirectional flow of traffic in the North Atlantic Minimum Navigation Performance Specifications (MNPS) airspace, made the NAT Region an ideal candidate for the first implementation of RVSM.

Planning for RVSM in the NAT Region commenced in 1990. The first stage of the Operational Evaluation phase, using the 1 000 ft RVSM, began on the 27th March 1997 in the level band FL 330 and FL 370 inclusive. The application of RVSM was extended in a second stage to encompass FL 310, FL 320, FL 380 and FL 390 in October 1998.

From the outset it was clear that the complex nature of the European ATS route structure, the wide variety of aircraft types, high traffic density and the high percentage of climbing and descending aircraft, would be a more complex ATM environment than the North Atlantic Region for the implementation of RVSM. Thus, safety considerations were given a high priority in the initial ECAC RVSM feasibility studies which were conducted under the auspices of the EUROCONTROL Airspace and Navigation Team (ANT). These studies indicated that, subject to aircraft meeting the altimetry MASPS, RVSM could be introduced into the European Region without compromising required safety levels, and also that it would provide a positive benefit to cost ratio over a wide range of assumptions regarding future developments within the European aviation environment.

1.4 The EATCHIP RVSM Implementation Programme

The Programme consists of a series of co-ordinated activities, performed within the EUROCONTROL Agency, ICAO, Joint Aviation Authorities (JAA), Participating States and User Organisations.

The programme has followed the general strategy set out in the ICAO Doc. 9574 (First Edition) - "Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive" which proposed a multi-step approach within four distinct phases :

Phase 1: Initial Planning

- Step 1: Assessment of Operational System Safety
- Step 2: Assessment of Costs and Benefits from RVSM
- Step 3: Elaboration of programme plans and production of technical specifications.

This phase was completed in June 1997. The EATCHIP Project Board reviewed the progress made on the RVSM Programme and recommended that work should continue so that full implementation can be achieved on the target date of November 2001. This programme was endorsed by the ICAO European Air Navigation Planning Group (EANPG) in December 1997.

Phase 2: Advanced Planning and Preparation

In this phase the emphasis of the work programme moved from the theory and initial design of the total system to the practical application and introduction of the system requirements. The objectives of this phase were:

1. to prepare the aircraft for RVSM operations
2. to prepare a monitoring environment to allow confirmation of the technical performance of aircraft
3. to commence the preparation of the ATS environment for RVSM operation.

Note: Points 1 and 2 will allow Phase 3 to start, point 3 is pre-requisite to Phase 4.

Phase 3 : Verification of Aircraft Performance

The purpose of the Verification Phase, is to confirm, in a 2 000 ft vertical separation environment:

- the effectiveness of the RVSM approval process;
- the effectiveness of the MASPS, by measuring the height keeping performance accuracy of the maximum possible number of aircraft which have obtained RVSM airworthiness approval;
- that the safety levels of the proposed RVSM system will remain at, or be better than, those established by the Target Level of Safety (TLS).

This phase will continue until all aspects of the work programme necessary to the successful completion of the verification process have been completed. This is expected to take approximately one year.

Phase 4 : Introduction of RVSM

The introduction of RVSM does not mark the end to the Programme. This phase of the programme will be used to confirm that:

- all elements of the total system are operating satisfactorily,
- the level of “vertical risk” in the system is below that tolerated by the TLS.

This phase will support the resolution of any operational issues which might be revealed following the implementation of 1 000 ft VSM.

Phase 4 will continue until it is possible to confirm that the long term safety of 1 000 VSM can be assured without further monitoring.

1.5 Supporting Documentation

The following reference documents will be amended to incorporate the changes necessitated by the introduction of RVSM in European airspace:

- ICAO Doc. 7030 - European (EUR) Regional Supplementary Procedures
- ICAO Doc. 9574 - Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum between FL 290 and FL 410 Inclusive.

The following documents are in the course of preparation and will provide the detailed procedures and requirements necessary for the implementation of RVSM in the European RVSM airspace:

- ICAO Guidance Material on the Implementation and Application of a 300 m (1 000ft) Vertical Separation Minimum in the European RVSM Airspace.
- JAA Temporary Guidance Leaflet on Approval of Aircraft and Operators for Flight in RVSM Airspace - TGL No.6.
- National AICs and/or. AIPs

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2. DESCRIPTION OF THE EUROPEAN RVSM AIRSPACE

2.1 The European RVSM airspace

2.1.1 RVSM shall be applicable in that volume of airspace between FL 290 and FL 410 inclusive in the following FIRs/UIRs:

Amsterdam, Ankara, Athinai, Barcelona, Beograd, Berlin, Bodo, Bratislava, Bremen, Brindisi, Brussels, Bucuresti, Budapest, Canaries (ICAO AFI Region), Dusseldorf, France, Frankfurt, Hannover, Istanbul, Kaliningrad, Kobenhavn, Kishinev, Lisboa, Ljubljana, London, Madrid, Malmo, Malta, Milano, Munchen, Nicosia, Oslo, Praha, Rhein, Riga. Roma, Rovaniemi, Sarajevo, Scottish, Shannon, Skopje, Sofia, Stavanger, Stockholm, Sundsvall, Switzerland, Tallinn, Tampere, Tirana, Trondheim, Varna, Vilnius, Warszawa, Wien, Zagreb.

RVSM shall as well be applicable, between FL 290 and FL 410 inclusive, in all, or part of, the following FIRs/UIRs:

Casablanca, Simferopol, Odesa, L'viv

2.2 The European RVSM Transition airspace

Transition tasks, associated with the application of RVSM within the European RVSM airspace, shall be carried out in the following peripheral FIRs/UIRs:

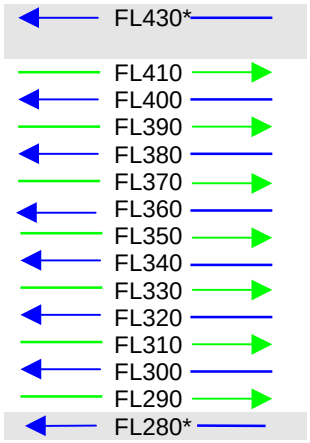
Ankara, Athinai, Barcelona, Bodo, Canaries (ICAO AFI Region), Casablanca, France, L'viv, Madrid, Malta, Nicosia, Odesa, Riga, Roma, Rovaniemi, Simferopol, Tallinn, Tampere, Vilnius, Warszawa

Figure 2: Depiction of European and NAT RVSM areas with list of 39 States participating in the European RVSM Programme.

Albania	Luxembourg
Austria	Malta
Belgium	Moldova
Bosnia and Herzegovina	Monaco
Bulgaria	Morocco
Croatia	The Netherlands
Cyprus	Norway
Czech Republic	Poland
Denmark	Portugal
Estonia	Romania
Federal Republic of Yugoslavia	Slovak Republic
Finland	Slovenia
France	Spain
Germany	Sweden
Greece	Switzerland
Hungary	The Former Yugoslav Republic of Macedonia
Ireland	Turkey
Italy	Ukraine
Latvia	United Kingdom
Lithuania	

2.3 Table of Cruising Levels applicable to the European RVSM Airspace

Flight levels within the European RVSM airspace will be organised on the basis of their intended use in regards to direction of flight, in accordance with ICAO Annex 2, Appendix 3, para. a), Table of Cruising Levels. Graphically, such an organisation is described as follows:



*	non-RVSM level
→	Tracks 000° - 179° (or 090° - 269° in the FIRs/UIRs of Italy, France, Portugal and Spain)
←	Tracks 180° - 359° (or 270° - 089° in the FIRs/UIRs of Italy, France, Portugal and Spain)

It is to be noted from the above that the application of RVSM, has the effect of reversing the assignment of FLs 310, 350 and 390 with respect to their use in regards to direction of flight, as compared to airspace where RVSM is not applied.

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3. PROVISION OF SERVICE TO NON-RVSM APPROVED STATE AIRCRAFT

3.1 In consideration of the physical inability (due to limitations in aircraft design) of adapting the large majority of military tactical aircraft to the defined RVSM MASPS, discussions took place within the relevant EATCHIP Working Groups which included the means by which the requirements of military flight operations, within RVSM airspace, could be met. As an outcome of the discussions, State aircraft were exempted from having to meet the RVSM MASPS. However, EUROCONTROL has urged States to adapt their State aircraft, operating as GAT along ATS routes, to the RVSM MASPS, to the maximum extent possible. Nonetheless, certain types of State aircraft cannot feasibly be adapted to the point where they would be RVSM MASPS compliant. These aircraft will nevertheless be permitted to operate as either OAT or GAT in the RVSM airspace.

When operating in the European RVSM airspace, such non-RVSM approved State aircraft operating as GAT, will be provided with a minimum vertical separation of 2 000 ft from all other IFR aircraft. Although the number of non-RVSM approved State aircraft operating as GAT within the RVSM airspace is expected to be very small, the impact which the handling of such flights will have on controller workload is not to be underestimated.

3.2 The requirement for ATC to accommodate non-RVSM approved State aircraft within the RVSM airspace imposes operational considerations of a very high order. Several real time simulations carried out by EUROCONTROL in support of the RVSM Work Programme have confirmed that significant increases in controller workload result from the requirement of having to selectively apply two distinct vertical separation minima (VSM) within the same volume of airspace, namely:

1 000 ft: between any two aircraft operating as GAT where both aircraft are RVSM approved, or

2 000 ft: between any two aircraft operating as GAT where either:

- one of the aircraft involved is non-RVSM approved, or
- both of the aircraft involved are non-RVSM approved

3.3 Of prime operational importance, therefore, is the requirement that controllers be continually aware of the RVSM approval status of all aircraft operating within or in close proximity to RVSM airspace situated within the ACC's/UAC's areas of responsibility. To support this requirement, operational system requirements and ATC procedures have been developed.

3.4 Specific ATC and flight planning procedures in this regard are described in Part 5 while the automated systems adaptations necessary to support the requirements mentioned above, are detailed in Part 8.

note: see para. 5.6 in regards to the provision of service to non-RVSM approved civil aircraft within the RVSM transition airspace

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4. FLIGHT OPERATIONS WITHIN THE EUROPEAN RVSM AIRSPACE

4.1 Except for State aircraft and as provided for in para. 5.6 (Transition Procedures) only RVSM approved aircraft shall be permitted to operate within the RVSM airspace.

4.2 Except for State aircraft operating as OAT, only flight operations conducted under IFR shall be permitted in the RVSM airspace.

Reference ICAO Annex 2, Chapter 4, Para. 4.5:

"Authorization for VFR flights to operate above FL 290 shall not be granted in areas where a vertical separation minimum of 300 m (1 000 ft) is applied above FL 290."

Note: The provisions of ICAO Annex 2 described above, also preclude VFR flight operations above FL 410, in areas where RVSM is implemented between FL 290 and FL 410 inclusive.

4.3 The organisation of flight levels within the RVSM airspace, as described in para. 2.3, does not preclude the establishment of uni-directional ATS Routes where deemed necessary.

Furthermore, it is noteworthy, that the assigning of a particular level, by ATC to a particular aircraft within the RVSM airspace, is not a function of that aircraft's RVSM approval status. All levels are therefore equally assignable to either RVSM approved or non-RVSM approved aircraft, provided that the applicable VSM is applied.

5. PROCEDURES

Note: Text within shaded areas represent approved ATC procedures.

The ATC procedures related to RVSM include the following:

- General Procedures
- Procedures for non-RVSM approved State aircraft operating as General Air Traffic (GAT) within the RVSM airspace
- Procedures for State aircraft operating as Operational Air Traffic (OAT), Crossing ATS Routes, within the RVSM Airspace
- Flight planning procedures
- Inter-centre co-ordination procedures
- Contingency procedures
- Transition procedures
- Phraseology

5.1 General Procedures

5.1.1 ATC shall only clear RVSM approved aircraft into the RVSM airspace, except for State aircraft and except as provided for in para. 5.6 (transition procedures).

Except for State aircraft, operations within the RVSM airspace are restricted to RVSM approved aircraft. Flight planning provisions in relation to RVSM will make possible the display of the RVSM related flight plan information to enable controllers to be systematically aware of any particular aircraft's RVSM approval status.

5.1.2 ATC shall provide a minimum of 1 000 ft vertical separation between RVSM approved aircraft operating within the RVSM airspace.

Within the RVSM airspace, a reduced vertical separation minimum of 1 000 ft may only be applied between two aircraft where both aircraft are RVSM approved.

Within the RVSM transition airspace (see para. 2.2), and supplemental to the conditions specified in para. 5.1.1 above, non-RVSM approved civil aircraft proceeding from non-RVSM airspace to RVSM airspace will be accommodated, for the purpose of clearing such aircraft to levels appropriate to adjacent FIRs/UIRs situated within the lateral limits of the RVSM airspace. Such aircraft shall be provided with a VSM of 2 000 ft from all other aircraft while operating within RVSM airspace where transition tasks are carried out.

5.1.3 ATC shall provide a minimum of 2 000 ft vertical separation between any non-RVSM approved State aircraft and any other aircraft operating within the RVSM airspace.

See 5.1.4 below.

5.1.4 In airspace where transition tasks are carried out (see para. 2.2), ATC shall provide a minimum of 2 000 ft vertical separation between any non-RVSM approved aircraft (Civil or State) and any other aircraft.

For all cases where an aircraft operating within the RVSM airspace is non-RVSM approved, it shall be provided with a minimum vertical separation of 2 000 ft.

5.1.5 Except as provided for in para. 5.6 (Transition Procedures), ATC shall withhold clearance into the RVSM airspace to all formation flights of civil aircraft.

ICAO Annex 2, Ch. 3, provides that aircraft participating in formation flights are permitted to operate within 100 ft above or below the flight leader. Consequently, the operation of the formation as a whole, could compound the allowable variation for total vertical error (Appendix E refers) for the flight leader within RVSM airspace, and as such the formation would not comply with the required RVSM MASPS. Formation flights shall therefore be considered as being non-RVSM approved. Nonetheless, such formation flights of civil aircraft will be permitted to operate within RVSM airspace where transition tasks are carried out, as described in para. 5.6.

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

5.1.6 ATC shall provide a minimum of 2 000 ft vertical separation between all formation flights of State aircraft and any other aircraft operating within the RVSM airspace.

For the reasons discussed in Para. 5.1.5 above, formation flights of State aircraft shall be considered as being non-RVSM approved, regardless of the RVSM approval status of the individual aircraft concerned. Inasmuch as State aircraft have been exempted from having to meet the requirements of the RVSM MASPS for the RVSM airspace, such formation flights of State aircraft will be accommodated within the RVSM airspace and shall be provided with a minimum vertical separation of 2 000 ft from any other aircraft.

5.1.7 ATC shall assign flight levels to non-RVSM approved aircraft, other than State aircraft, in accordance with the table below:

	ADES within lateral limits of RVSM airspace	*ADES outside lateral limits of RVSM airspace*
ADEP within lateral limits of RVSM airspace	Assign level **below** RVSM airspace	Assign level **below** RVSM airspace
ADEP outside lateral limits of RVSM airspace	Assign level **below** RVSM airspace	Assign level **below or above** RVSM airspace

Note: Controllers should review the description of the RVSM airspace in Para. 2 in regards to the lateral limits of the RVSM airspace.

Non-RVSM approved aircraft, departing from and landing at an aerodrome situated outside the lateral limits of the RVSM airspace, could operate at flight levels above the RVSM airspace, since ATC would, as a consequence, not be required to subsequently descend such aircraft through the RVSM airspace.

5.2 Procedures for State Aircraft operating as Operational Air Traffic (OAT), Crossing ATS Routes, within the RVSM Airspace

5.2.1 The majority of State aircraft operating as OAT will be non-RVSM MASPS compliant. Therefore, as a basic principle, and unless otherwise notified, State aircraft operating as OAT shall be considered as being non-RVSM approved.

As previously mentioned, it is not possible, for physical reasons resulting from limitations in design, to adapt the large majority of tactical military aircraft to meeting the RVSM MASPS defined for the RVSM airspace.

5.2.2 The minimum vertical separation required between (a) State aircraft operating as OAT, crossing ATS routes, and (an) aircraft operating as GAT, where both are operating within the RVSM airspace, shall be 2 000 ft.

5.2.2.1 However, in an airspace environment where both the civil and military ATC units are fully aware as to the RVSM approval status of all traffic involved, a reduced vertical separation of 1 000 ft may be applied between an RVSM approved State aircraft operating as OAT, and RVSM approved GAT.

Provision is made for the application of a reduced vertical separation minimum of 1 000 ft between OAT and GAT aircraft where either advanced civil-military co-ordination systems, which systematically display the RVSM approval status of all aircraft involved to the respective controllers, are in use or where verbal co-ordination, including RVSM approval information of the individual aircraft, is accomplished.

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5.3 Flight Planning

5.3.1 The flight plan submitted for a flight intending to operate across the lateral limits of the RVSM airspace shall include:

- the entry point at the lateral limits of the RVSM airspace and the specific requested flight level (RFL) for that portion of the route commencing immediately after the entry point;
- the exit point at the lateral limits of the RVSM airspace and the specific requested flight level (RFL) for that portion of the route commencing immediately after the exit point.

Note: See defintions, RVSM Entry/Exit Points

For all ATS routes crossing the lateral limits of the RVSM airspace, compulsory reporting points will be established on/near the boundaries with the non-RVSM airspace. Communication failure procedures require the description of these points for the purpose of defining the beginning of the time parameter specified in ICAO communication failure procedures. Specifically, operations extending across the lateral limits of the RVSM airspace require that precise information regarding the aircraft's requested flight level (RFL) for that portion of flight before, within and after, as applicable, the lateral limits of the RVSM airspace be available to support the requirements of ICAO communication failure procedures. Due to the incompatibility of flight levels in RVSM airspace with those flight levels in non-RVSM airspace, with regard to their intended use in relation to direction of flight (para. 2.3 refers), ATC will require precise information as to the RFL for those portions of flight immediately after entry and/or exit to/from RVSM airspace.

Information regarding the specific RFL of an aircraft for that portion of flight before/after the compulsory reporting point, will ensure the eventual operation of the aircraft at a level appropriate to the operating environment of the accepting ACC/UAC, in the event of a communication failure in flight.

See para. 7, Communications Failure in Flight.

5.3.2 All operators of RVSM approved aircraft, shall insert the letter "**W"** in Item 10 of the ICAO Flight Plan, regardless of the requested flight level.

The letter "W" has been adopted to indicate RVSM approval status. It is consistent with flight planning provisions for the ICAO North Atlantic Region (NAT). Operators are required to indicate their RVSM approval status regardless of RFL, since ATC must additionally be aware of an aircraft's RVSM approval status when operating in close vertical proximity to the RVSM airspace. ATC shall have an unambiguos indication of an aircraft's RVSM approval status when intending to clear an aircraft into the RVSM airspace. In absence of such an indication, the controller shall solicit such information.

Note: See para. 5.7.1.1 and 5.7.1.2 for relevant RTF Phraseology.
See Definitions: RVSM Approval.

5.3.3 All operators of non-RVSM approved State aircraft with a requested flight level (RFL) of FL 290 or above, shall insert the phrase "**STS/NONRVSM"** in Item 18 of the ICAO Flight Plan.

"STS/NONRVSM" will indicate the request for "special handling" by ATS, namely, a requirement for ATC to provide a minimum vertical separation of 2 000 ft between such flights and other aircraft operating within the RVSM airspace. Non-RVSM approved State aircraft, even though filing an RFL above FL410, a level at which no special handling would be required in terms of providing the minimum vertical separation, will nevertheless be required to indicate this request, since special handling by ATC will be required for that portion of the flight consisting of the vertical transit through the RVSM airspace.

5.3.4 In addition to operators of military aircraft, operators of customs or police aircraft shall insert the letter "**M**" in Item 8 of the ICAO Flight Plan if non-RVSM approved and intending to operate within the RVSM airspace.

Aircraft used in military, customs, or police service are deemed to be State aircraft. ICAO flight planning provisions currently only permit the identification of those flights in military service (ICAO Flight Plan Item 8) through the use of the letter

"M". The application of this letter has been expanded to permit the identification of flights in customs or police services as State aircraft to ATC. The Initial Integrated Flight Planning System (IFPS) shall disseminate this information to the flight data processing systems (FDPS) concerned for the purpose of providing ATC with the required clear indication that such non-RVSM approved flights, are in fact "State aircraft" and as such are permitted to operate within the RVSM airspace.

5.3.5 All operators filing Repetitive Flight Plans (RPLs) shall include in Item Q of the RPL equipment information in regards to the RVSM approval status in the format **"EQPT/W",** for flights operated by RVSM approved aircraft and **"EQPT/ ",** for flights operated by non-RVSM approved aircraft, with operational service ceilings corresponding to FL 280 or above, regardless of the requested flight level.

ICAO flight planning provisions in regards to the filing of RPLs do not provide for the ability to indicate ICAO Flight Plan Item 10 information (e.g.: RVSM approved, Letter "W") as an element of an RPL. Nevertheless, ATC must be in possession of this information for each individual flight on day of operation. For this reason, ICAO European regional flight planning provisions will require the relevant ICAO Flight Plan Item 10 information, in regards to a flight's RVSM approval status, to be filed as an element of RPLs in the above-mentioned format. For each individual flight on day of operation, IFPS shall generate and distribute flight plans, from stored RPL information, containing the relevant RVSM approval status.

(Ref.: CFMU Handbook, "IFPS Users Manual", Ed. 4.0, Para. 9.5)

5.3.6 If a change of aircraft operated in accordance with a repetitive flight plan results in a modification of the RVSM approval status as stated in Item Q, a modification message (CHG) shall be submitted by the operator.

5.3.7 Operators of non-RVSM approved State aircraft, filing RPLs including an RFL of FL 290 or above, shall include **"STS/NONRVSM"** in Item Q.

see para. 5.3.3 above.

5.3.8 Regardless of the RVSM approval status of the individual aircraft concerned, the letter "**W**" shall never be inserted in Item 10 of flight plans related to formation flights of State aircraft.

See para. 5.1.6 above.

5.3.9 Operators of formation flights of State aircraft intending to operate as GAT in RVSM airspace shall include **"STS/NONRVSM"** in Item 18 of the ICAO Flight Plan.

Formation flights of State aircraft will be accommodated within the RVSM airspace and will be considered as being non-RVSM approved, regardless of the RVSM approval status of the individual aircraft involved. As such, they shall request special handling by ATC and be provided with a minimum vertical separation of 2 000 ft from all other aircraft operating within the RVSM airspace.

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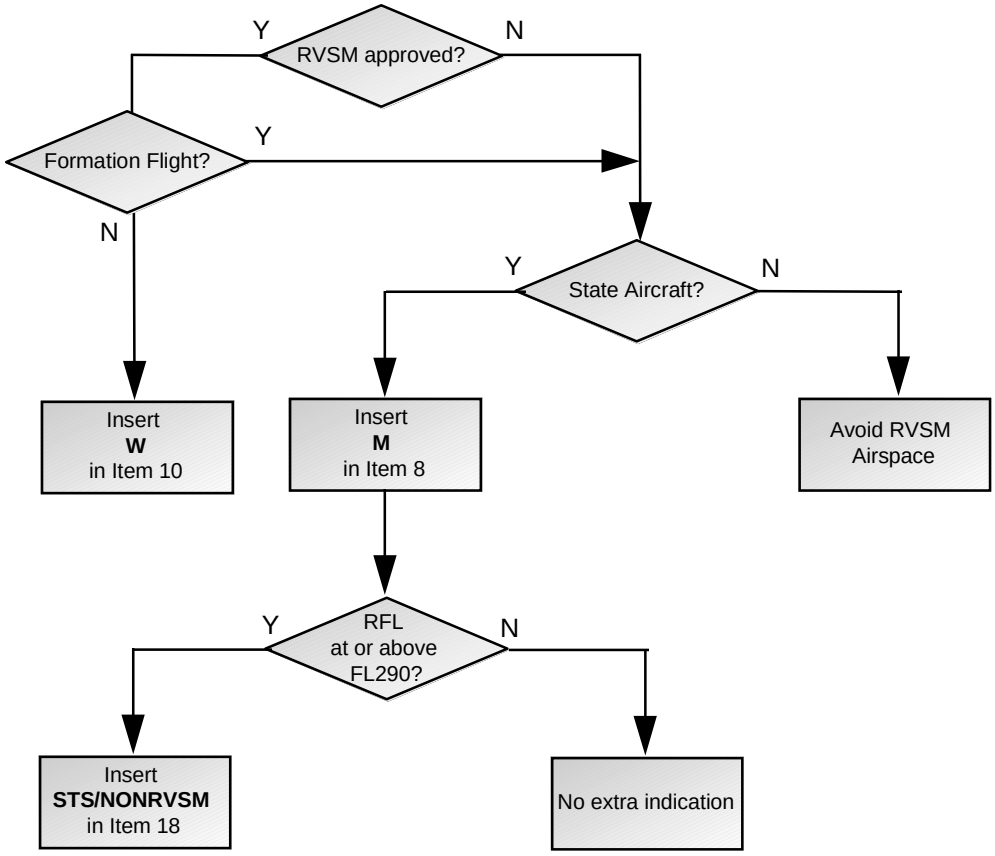

Figure 3 : Overview of RVSM Flight Planning Requirements for Operators

5.4 Inter-Centre Co-ordination

5.4.1 Computer-assisted co-ordination of estimate messages:

The On-Line Data Interchange (OLDI) System should support the co-ordination of requests for special handling (i.e.: STS) as filed in Item 18 of the ICAO Flight Plan.

Since the Activation (ACT) Message replaces the verbal estimate message, and notwithstanding the fact that the information should be contained within the local FDPS, a clear indication as to an aircraft's non-RVSM approval status and its request for special handling, should be included as an integral part of the automated estimate message:

- as confirmation of the data filed in the flight plan, as it is very safety critical

- to cover the case where degradation of capability in the performance of flight planning systems has occurred for a particular flight, and
- to cover the case where, for whatever reason, the accepting unit has not received the flight plan.

5.4.1.1 In the case of automated messages not containing the information provided in Item 18 of the flight plan relating to RVSM operations, the sending air traffic control unit shall inform the receiving air traffic control unit of that information by supplementing the ACT message verbally.

The term **"NEGATIVE RVSM"** or **"NEGATIVE RVSM STATE AIRCRAFT"**, as applicable, shall be used to verbally supplement such automated estimate messages.

5.4.2 Verbal Co-ordination of Estimate Messages

When a verbal co-ordination process is being used, the sending air traffic control unit shall include the information filed in Item 18 of the ICAO flight plan, relevant to RVSM operations, at the end of the verbal estimate message.

The term **"NEGATIVE RVSM"** or **"NEGATIVE RVSM STATE AIRCRAFT"**, as applicable, shall be included at the end of the verbal estimate message.

5.4.3 For the case of a single aircraft experiencing an in flight contingency, the associated co-ordination messages shall be supplemented verbally by a description of the cause of the contingency.

The associated co-ordination messages shall incorporate either the term:

- **UNABLE RVSM DUE EQUIPMENT,** or
- **UNABLE RVSM DUE TURBULENCE**, as appropriate.

5.5 Contingency Procedures

Note: Para. 5.7 below contains the phraseologies associated with contingency events.

In respect to RVSM operations, a contingency event refers to a set of unforeseen circumstances, which directly impact on the ability of a single aircraft, or a group of aircraft, to operate in accordance with the height keeping requirements of the RVSM airspace. ATC, once advised of the occurrence of such an event, shall provide the concerned aircraft with a Vertical Separation Minimum (VSM) of 2 000 ft. from all other aircraft operating in the RVSM airspace while the concerned aircraft operates in RVSM airspace.

Such contingency events relate to either:

- degradation of aircraft equipment associated with height keeping or
- occurrence of weather phenomenon resulting in turbulent atmospheric conditions which directly affect the ability of aircraft to maintain their CFLs,

and are further discussed below.

Para. 5.7.1 describes precise pilot RTF Phraseology which shall be used to convey to ATC the precise nature of the contingency. Pilots shall inform ATC, on a timely basis, of circumstances which prevent them from maintaining CFL within tolerances required for RVSM airspace.

Controllers must react to these contingency events, but their actions cannot be specified as they will be dynamically affected by the real-time situation.

5.5.1 Procedures applicable to individual aircraft, equipment related:

The RVSM MASPS required for operation within the RVSM airspace require, as a minimum, that aircraft be equipped with, at the least:

- two fully serviceable independent primary altitude measurement systems
- one automatic altitude-control system

- one altitude-alerting device
- one Mode C SSR Transponder, where so prescribed by the appropriate ATS Authority for the airspace of intended operation.

Failure in flight, of any component of the above minimum equipment fit required for RVSM operations, shall render the aircraft non-RVSM approved. Pilots experiencing such in-flight failures shall report this contingency event as soon as practicable to ATC. Additionally, pilots shall inform ATC of other equipment failures which affect the aircraft's ability to maintain the CFL.

5.5.1.1 Where an aircraft's Mode C displayed level differs from the CFL by 300 ft or more, the controller shall inform the pilot accordingly and the pilot shall be requested to both check the pressure setting and confirm the aircraft's level.

If after confirmation of the aircraft's level, the Mode C readout continues to differ from the CFL by 300 ft or more, ATC will follow the existing ICAO procedures prescribed for the failure of Mode C in flight.

The allowable tolerance for Mode C readout of 300 ft remains applicable within RVSM airspace. Such 300 ft parameter relates solely to SSR transponder operation. It does not relate to the height keeping accuracy required by the RVSM MASPS.

5.5.1.2 When informed by the pilot that the aircraft's equipment has degraded to below RVSM MASPS compliance levels while operating within the RVSM airspace, the controller shall either provide for a minimum vertical separation of 2 000 ft or an appropriate horizontal separation. Controllers shall normally clear the aircraft below FL 290 (or, alternatively, above FL 410 if the destination aerodrome is outside the lateral limits of the RVSM airspace) before the next inter-centre transfer of control point, unless otherwise co-ordinated.

Such aircraft shall be considered as being non-RVSM approved and, as a consequence, require a minimum 2 000 ft vertical separation. ATC shall immediately upon receipt of information indicating an equipment related contingency event which causes the aircraft to become non-RVSM approved, take

action to ensure the application of either a minimum 2 000 ft vertical separation or an appropriate horizontal separation from other aircraft operating as GAT in the RVSM airspace. ATC shall subsequently, to the extent the radar display system makes possible, manually manipulate the display of the concerned aircraft's associated radar label and/or radar position symbol, for the purpose of clearly distinguishing such radar label and/or radar position symbols in accordance with established local radar display features applicable to non-RVSM approved aircraft.

Note: See also para. 8.4, Radar Display Systems

Although actual circumstances will dictate the relative priority which ATC can assign to the task of clearing the aircraft in question out of the RVSM airspace, the continued operation of aircraft, rendered non-RVSM approved as a result of an equipment related contingency event, within the RVSM airspace is highly discouraged. The ability to accurately distinguish such aircraft in accordance with locally established procedures regarding automated systems, in contradiction to the RVSM approval information originally filed by the operator in the flight plan, may render the practice unsafe.

ATC shall normally clear RVSM approved State aircraft experiencing a similar equipment related contingency resulting in non-MASPS compliance, to a level outside the RVSM airspace as soon as practicable.

Although non-RVSM approved State aircraft, are under normal circumstances permitted to operate within the RVSM airspace, the ability to accurately co-ordinate the non-RVSM approval status, contrary to information which had originally been disseminated by IFPS and/or OLDI, would be compromised and render inadvisable the continued operation of such aircraft in the RVSM airspace.

It is imperative that ATC accurately co-ordinate the specifics related to the contingency event through the use of the appropriate associated co-ordination messages:

"UNABLE RVSM DUE EQUIPMENT" or **"UNABLE RVSM DUE TURBULENCE"**, (*as applicable)*

Pilots will inform ATC as soon as practicable of any eventual restoration of the proper functioning of those equipment related elements required for operation in RVSM airspace. ATC will as a result, be in a position to consider clearing the aircraft into the RVSM airspace applying a 1 000 ft vertical separation minimum. As well, ATC would manually remove the application of the locally adapted distinguishing feature, associated with such aircraft, from the radar display.

5.5.2 Procedures applicable to individual aircraft, weather related:

5.5.2.1 For the case of an individual aircraft reporting severe turbulence preventing the aircraft from maintaining its CFL, the controller shall establish either an appropriate horizontal separation, or an increased minimum vertical separation.

The specific actions to be taken by ATC will be dictated by the actual weather-related circumstances and the traffic situation existing at the time. ATC is expected to use best judgement to safeguard separation between aircraft in these circumstances and to accommodate, to the extent possible, pilot requests for level changes.

ATC shall co-ordinate the circumstances of the weather related contingency by verbally supplementing the estimate message with: **“UNABLE RVSM DUE TURBULENCE”.**

ATC shall manually apply the distinguishing feature of the radar label to such aircraft until such time as the pilot reports to be in a position to resume operations in accordance with RVSM.

Aircraft experiencing severe turbulence need not be cleared out of the RVSM airspace. Such flights continue to be RVSM approved and as such, comply with the basic requirements for operation within the RVSM airspace.

5.5.2.2 If informed of the existence of severe turbulence, the controller shall solicit other relevant turbulence reports to determine, in co-ordination with the Supervisor, whether RVSM operations should be suspended entirely or within a specific level band and/or area.

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5.5.3 Procedures for multiple aircraft, weather related, non-predicted:

5.5.3.1 For the case of immediate requirements where a controller has received no advance warning of impending meteorological conditions that could create severe turbulence, the controller shall provide for an increased minimum vertical separation or an appropriate horizontal separation, and the following action(s), although not exhaustive, should be considered:

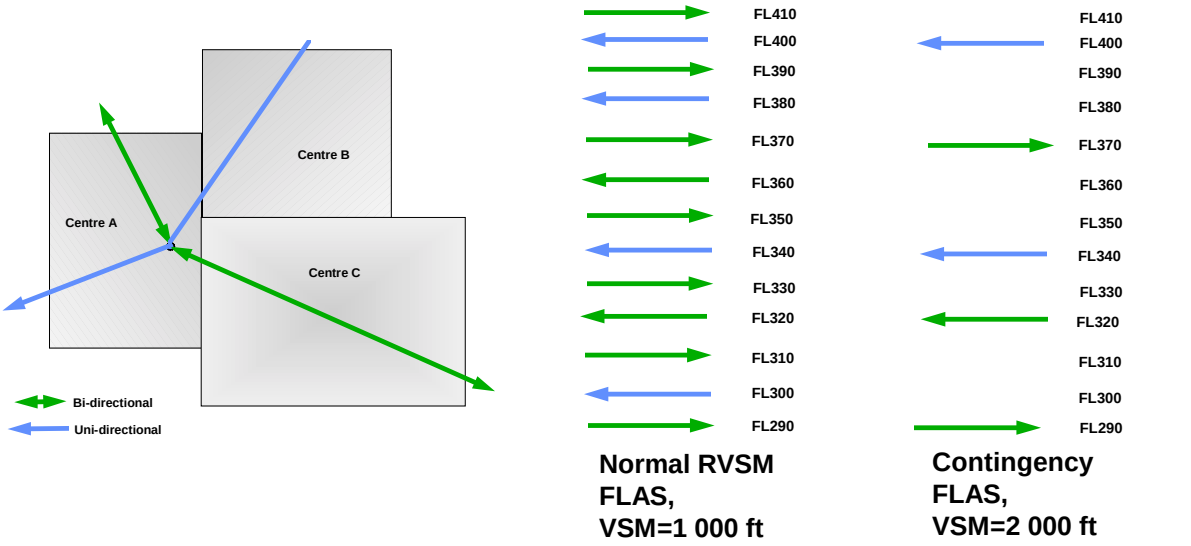
- since each real time situation will demand very specific, distinct actions, the controller should use his/her best judgement to ensure the safety of the aircraft under his/her responsibility.
- the controller should pass traffic information to the extent possible
- the controller will co-ordinate with the Supervisor for the purpose of determining whether RVSM operations will be suspended entirely or within a specific level band and/or area.
- if a reversion to a 2 000 ft vertical separation minimum is deemed necessary, co-ordination with adjacent ACCs/UACs shall be accomplished to ensure an orderly progression to the transfer of traffic using a 2 000 ft vertical separation as the minimum
- Supervisors may co-ordinate, to the extent deemed necessary, a request for the deactivation of any airspace restrictions and/or reservations required to provide additional radar vectoring airspace necessary to facilitate the transition to a 2 000 ft vertical separation minimum
- the Supervisor should co-ordinate with the parent Flight Management Position (FMP) to adjust the applicable sector capacities

5.5.4 Procedures for multiple aircraft, weather related, predicted

For the case of meteorological conditions causing severe turbulence, predicted by Meteorological Services, the procedures required will of consequence be of a strategic nature. A meteorological forecast, predicting severe turbulence, received by an ACC, will demand of the ACC/UAC Supervisor a decision as to whether RVSM operations are to be interrupted, for what period of time, and for what specific level(s) and/or area. Should an increased vertical separation be necessary, the Supervisor will co-ordinate with the adjacent ACCs/UACs concerned as to the flight levels appropriate for the transfer of traffic, unless a contingency flight level allocation scheme (FLAS) has been determined in the Letter of Agreement. The Supervisor should co-ordinate with the parent Flight Management Position (FMP) to establish the applicable sector capacities. The issuance of a NOTAM should be considered as circumstances require.

Consideration should be given to the development of contingency FLASs to supplement existing FLASs between ACCs/UACs. Such contingency FLASs should be described in Letters of Agreement for the purpose of being applied, after the necessary inter-centre co-ordination, during times of weather related contingency events, be they predicted or non-predicted. The development of such contingency FLASs would greatly facilitate the transition to a 2 000 ft vertical separation minimum within the RVSM airspace

The application of a contingency FLAS will be facilitated through the designation of levels within the contingency FLAS that are consistent with their designations in the corresponding normal RVSM FLAS, with regard to their intended use for direction of flight.



The application of the contingency FLAS, when required, is facilitated by virtue of the fact that the use of the levels within the "Contingency FLAS" is consistent with their use in the "Normal RVSM FLAS".

Example: When informed by Centre A that the Contingency FLAS is to be applied, Centre C would be required to discontinue the use of FL 360 for traffic to be transferred to Centre A, however Centre B would not be required to alter the use of FL 320. In this way, the operational impact upon Centre B is mitigated and Centre B's ability to establish aircraft at levels appropriate for Centre A is greatly facilitated.

Figure 4 - Example description of a Contingency FLAS

In regards to facilitating the co-ordination and establishment of new capacity figures for the ACC/UAC, during contingency events requiring the reversion to a 2,000 ft VSM within the RVSM airspace, ACCs/UACs should consider predetermining such capacity figures for the purpose of permitting rapid co-ordination with the local FMP.

The importance of obtaining timely accurate forecasts of severe turbulence should be stressed within agreements with the appropriate meteorological services office responsible for the dissemination of such information for the area concerned.

5.6 Transition Procedures

Within the RVSM transition airspace (para. 2.2 refers), and supplemental to the conditions specified in para. 5.1, non-RVSM approved civil aircraft and formation flights of civil aircraft will be accommodated within the RVSM airspace where transition tasks are carried out, for those cases where such aircraft are proceeding from non-RVSM airspace to RVSM airspace.

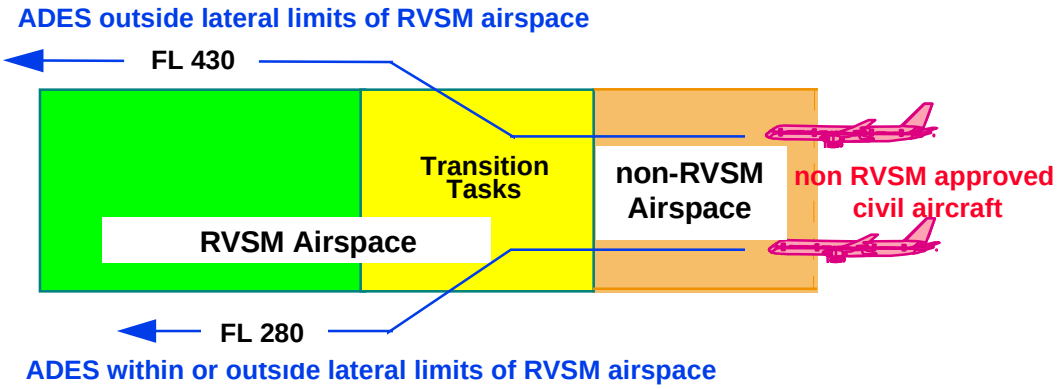


Figure 5 : Transition task for non-RVSM approved **civil** aircraft, proceeding *from non-RVSM to RVSM airspace.*

Those ACCs/UACs responsible for transition tasks may, if traffic volumes permit, consider accommodating, within RVSM airspace, non-RVSM approved civil aircraft proceeding into adjacent FIRs/UIRs where RVSM is not applied, so as to permit such aircraft to reach an RFL of FL 290 or higher, prior to the transfer of control point to the ACC not applying RVSM.

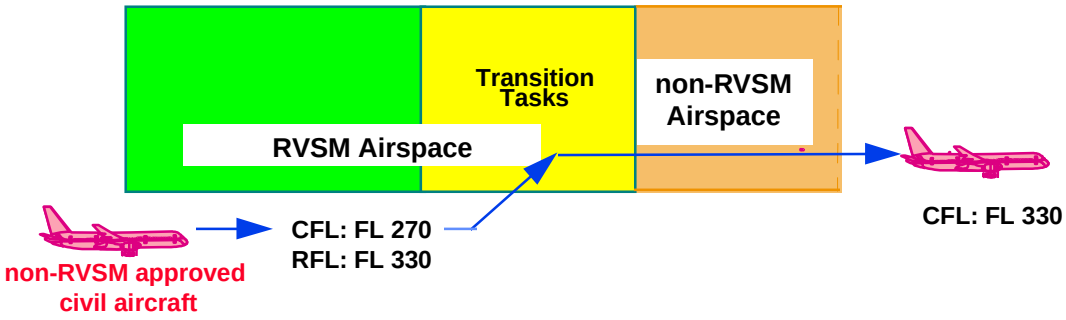


Figure 6 : Transition task for non-RVSM approved **civil** aircraft, proceeding *from RVSM to non-RVSM airspace.*

5.6.1 For aircraft to be transferred from RVSM airspace to non-RVSM airspace, the last ACC/UAC providing air traffic control service to such aircraft within the RVSM airspace shall establish a minimum of 2 000 ft vertical separation before the aircraft passes the transfer of control point to the adjacent non-RVSM ACC established at a flight level

- in accordance with the ICAO Table of Cruising Levels as published in ICAO Annex 2, Appendix 3, table b), and/or
- in accordance with the FLAS, if applicable, and/or
- as specified in the inter-centre Letter of Agreement.

ICAO Annex 2, Appendix 3, table b), describes the assignment of flight levels according to direction of flight for a non-RVSM environment.

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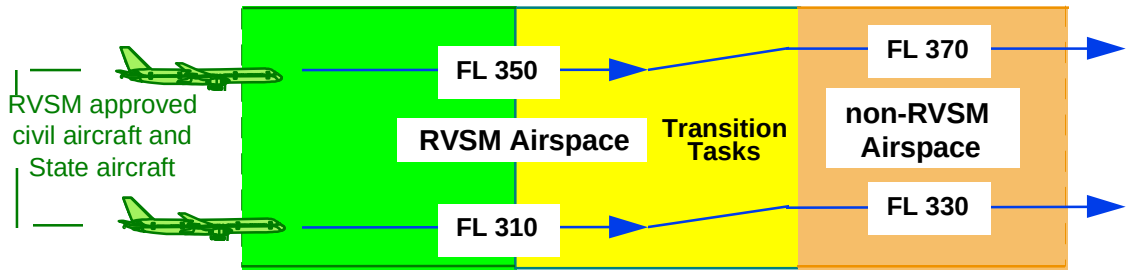
*RVSM Airspace **west** of non-RVSM Airspace:*



*RVSM Airspace **east** of non-RVSM Airspace:*

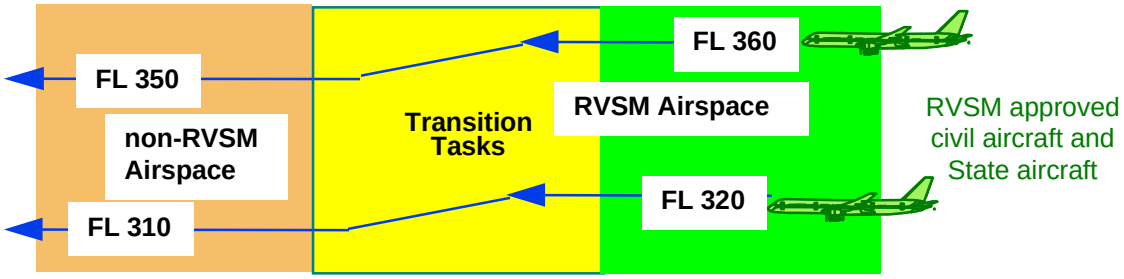


Figure 7 : Example Transition Task, *from RVSM to non-RVSM airspace*

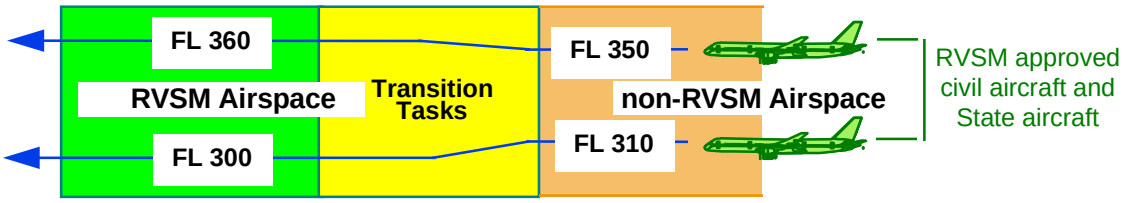
5.6.2 For aircraft transferred from non-RVSM airspace to RVSM airspace, the first ACC providing air traffic control service to such aircraft within the RVSM airspace shall ensure that RVSM approved aircraft and non-RVSM approved State aircraft are cleared so as to be established at a flight level

- in accordance with the ICAO Table of Cruising Levels as published in ICAO Annex 2, Appendix 3, table a), and/or
- in accordance with the FLAS, if applicable and/or
- as specified in the inter-centre Letter of Agreement,

before the aircraft passes the transfer of control point to the adjacent ACC.

ICAO Annex 2, Appendix 3, table a), describes the assignment of flight levels according to direction of flight for an RVSM environment.

*RVSM Airspace **west** of non-RVSM Airspace:*



*RVSM Airspace **east** of non-RVSM Airspace:*

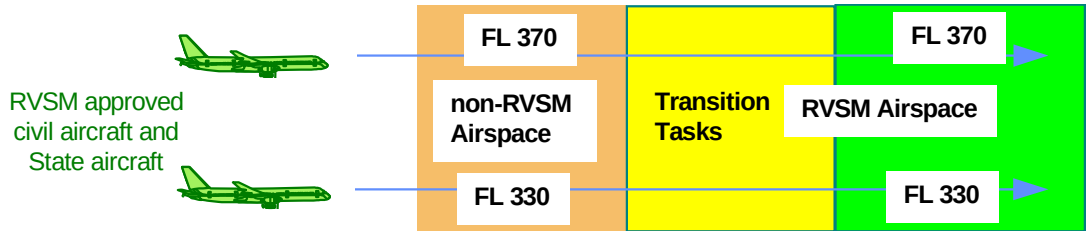


Figure 8 : Transition Tasks, *from non-RVSM to RVSM airspace*

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5.6.3 For aircraft landing at an aerodrome within the lateral limits of the RVSM airspace, the first ACC providing air traffic control service within RVSM airspace to aircraft transferred from non-RVSM airspace to RVSM airspace shall ensure that non-RVSM approved aircraft, except State aircraft, are cleared so as to be established at a flight level below FL 290

- in accordance with the FLAS, if applicable and/or
- as specified in the inter-centre Letter of Agreement,

before the aircraft passes the transfer of control point to the adjacent ACC within the lateral limits of the RVSM airspace.

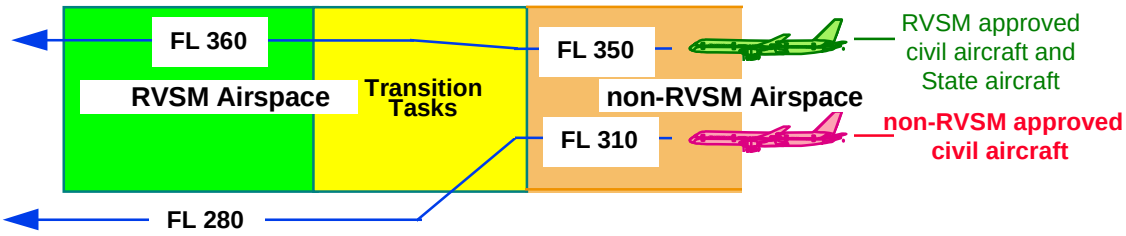


Figure 9: Transition Task, *from non-RVSM airspace to RVSM airspace*

5.6.4 For aircraft landing at an aerodrome outside, and transiting the lateral limits of, the RVSM airspace, the first ACC providing air traffic control service to aircraft within the RVSM airspace, transferred from non-RVSM airspace to RVSM airspace, shall ensure that non-RVSM approved aircraft, except State aircraft, are cleared so as to be established at a flight level below FL 290 or above FL 410 before the aircraft passes the transfer of control point to the adjacent ACC

- in accordance with the FLAS, if applicable, and/or
- as specified in the inter-centre Letter of Agreement.

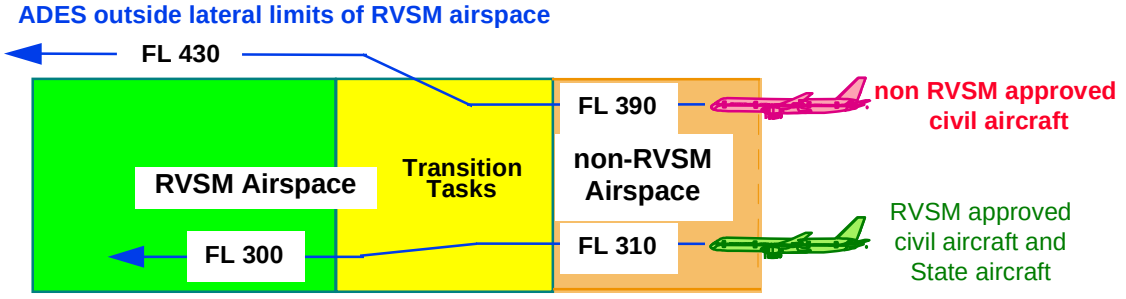


Figure 10: Transition Task, *from non-RVSM to RVSM airspace*

5.7 Phraseology

5.7.1 Controller-pilot RTF Phraseology:

(* *indicates a pilot transmission)*

Para	Message	Phraseology
5.7.1.1	To ascertain the RVSM approval status of a flight:	*(callsign)* **CONFIRM RVSM APPROVED**
5.7.1.2	Pilot indication of non-RVSM approval status: To be stated: I. in the initial call on any frequency within the RVSM airspace (*controllers shall provide a readback with this same phrase)*, and II. in all requests for flight level changes pertaining to flight levels within the RVSM airspace III. in all readbacks to flight level clearances pertaining to flight levels within the RVSM airspace As well, pilots of aircraft, other than State aircraft, shall respond to level clearances involving the vertical transit through either FL 290 or FL 410 with this phrase. *See examples below.* Pilot indication of RVSM approval status:	**NEGATIVE RVSM *** **AFFIRM RVSM***
5.7.1.3	State aircraft, non-RVSM approved, shall indicate their status as being that of a State aircraft, in conjunction with a negative response to the RTF	

	indicated in Para. 5.7.1.1, with the phrase:	**NEGATIVE RVSM STATE AIRCRAFT***
5.7.1.4	Denial of clearance into the RVSM airspace:	*(callsign)* **UNABLE CLEARANCE INTO RVSM AIRSPACE, MAINTAIN [***or* **DESCEND TO,** *or* **CLIMB TO] FLIGHT LEVEL** *(number)*
5.7.1.5	For the case of an individual aircraft reporting severe turbulence or other severe weather related phenomenon, the pilot phraseology shall be:	**UNABLE RVSM DUE TURBULENCE***
5.7.1.6	The phraseology required of a pilot to communicate those circumstances which would cause an aircraft's equipment to degrade to below altimetry MASPS compliance levels shall be: The phrase is to be used to convey both the initial indication of the non-altimetry MASPS compliance and, henceforth, on initial contact on all frequencies within the lateral limits of the RVSM airspace until such time as the problem ceases to exist.	**UNABLE RVSM DUE EQUIPMENT***
5.7.1.7	The pilot shall communicate his/her ability to resume operation within the RVSM airspace after an equipment related contingency, or his/her ability to resume RVSM operations after a weather related contingency with the phrase:	**READY TO RESUME RVSM***
5.7.1.8	Controllers wishing to solicit this information shall use the phrase:	**REPORT ABLE TO RESUME RVSM**

Example 1: A non-RVSM approved State aircraft operating as GAT, maintaining FL 260, subsequently requests a climb to FL 320.

Pilot RTF: (*callsign*) REQUEST FL 320, NEGATIVE RVSM

Controller RTF:(*callsign*) CLIMB TO FL 320

Pilot RTF: (*callsign*) CLIMB TO FL 320, NEGATIVE RVSM

Example 2: A non-RVSM approved State aircraft operating as GAT, maintaining FL 260, subsequently requests a climb to FL 430.

Pilot RTF: (*callsign*) REQUEST FL430, NEGATIVE RVSM

Controller RTF:(*callsign*) CLIMB TO FL 430

Pilot RTF: (*callsign*) CLIMB TO FL 430, NEGATIVE RVSM

Example 3: A non-RVSM approved State aircraft operating as GAT, maintaining FL 360, subsequently requests a climb to FL 380.

Pilot RTF: (*callsign*) REQUEST FL 380, NEGATIVE RVSM

Controller RTF:(*callsign*) CLIMB TO FL 380

Pilot RTF: (*callsign*) CLIMB TO FL 380, NEGATIVE RVSM

Example 4: A non-RVSM approved civil aircraft maintaining FL 280 subsequently requests a climb to FL 320.

Pilot RTF: (*callsign*) REQUEST FL 320, NEGATIVE RVSM

Controller RTF:(*callsign*) UNABLE CLEARANCE INTO RVSM AIRSPACE, MAINTAIN FL 280

5.7.2 Co-ordination between ATS units:

Para	Message	Phraseology
5.7.2.1	To verbally supplement an automated estimate message exchange which does not automatically transfer Item 18 information:	**NEGATIVE RVSM** *or* **NEGATIVE RVSM STATE AIRCRAFT** **[***as applicable***]**
5.7.2.2	To verbally supplement estimate messages of non-RVSM approved aircraft:	**NEGATIVE RVSM** *or* **NEGATIVE RVSM STATE AIRCRAFT** **[***as applicable***]**
5.7.2.3	To communicate the cause of a single aircraft contingency:	**UNABLE RVSM DUE TURBULENCE [***or* **EQUIPMENT,** *as applicable***]**

6. VERTICAL SPACING FROM TSAs, PROHIBITED, RESTRICTED AND DANGER AREAS

All activities occurring within airspace restrictions and/or reservations are to be considered as being non-RVSM approved.

Consequently, the minimum vertical spacing required between the vertical limits of the activities contained within such airspace restrictions and/or reservations and non-participating aircraft operating within the RVSM airspace is:

- 2 000 ft, above the upper limit of such activities, for upper limits of FL 290 or above, and
- 2 000 ft, below the lower limit of such activities, for lower limits of FL 300 or above.

Therefore, the application of RVSM will continue to require that the same minimum vertical spacing be applied between activities occurring within airspace restrictions and/or reservations and non-participating aircraft, as were being applied prior to RVSM implementation.

States will, as stipulated in the ASM Handbook, promulgate the first usable flight levels above/below airspace restrictions and/or reservations, in the definition of the associated ATS routes. Depending on the methodology used to delineate and promulgate such airspace restrictions and/or reservations, the first usable flight levels will be situated either 1 000 ft or 2 000 ft above/below the *published* vertical limits of the airspace restrictions and/or reservations. Nevertheless, operation by non-participating aircraft at such first usable flight levels, defined as a function of one of the two delineation methodologies, will guarantee the application of the required minimum 2 000 ft vertical spacing from the activities occurring within airspace restrictions and/or reservations.

However, in an airspace environment where the responsible ATS units are fully aware as to the RVSM approval status of all traffic involved, a reduced vertical separation of 1 000 ft may be applied between RVSM approved aircraft.

7. COMMUNICATIONS FAILURE IN FLIGHT

7.1 TRANSITION AIRSPACE

The existing ICAO Communication Failure Procedures do not lend themselves satisfactorily to application in that European RVSM airspace where transition tasks are carried out. Specifically, the length of time to elapse (twenty minutes) before an aircraft will adjust level and speed in accordance with the filed flight plan, could be excessive for those instances where the aircraft is flight planned to cross the lateral limits of the RVSM airspace. Such aircraft could operate over large distances at a flight level inappropriate to an adjacent RVSM or non-RVSM operating environment.

Consequently, the application by aircraft of the ICAO provisions regarding aircraft experiencing communications failure in flight could cause operational problems both to those ACCs/UACs controlling RVSM airspace and to those ACCs/UACs controlling adjacent non-RVSM airspace.

7.1.2 A requirement that aircraft report over a compulsory reporting point in the vicinity of the boundary between RVSM and non-RVSM FIRs/UIRs is recognised, since such reports would provide the means of establishing for both the pilot and the controller that a communication failure exists, and thus to determine the time from which the period of 20 minutes starts.

7.1.3 It is recalled that the filed flight plan will contain the specific entry point for RVSM airspace and the requested flight level for operating within RVSM airspace, as well as the specific exit point from RVSM airspace and the requested flight level for the subsequent non-RVSM airspace (reference para. 5.3.1).

7.1.4 Two scenarios are representative of the operational issues associated with communications failure in the transition airspace, namely where RVSM airspace is west of non-RVSM airspace and where RVSM airspace is east of non-RVSM airspace[4].

[4] or north and south where predominate traffic flows prescribe the use of flight levels, with regard to direction of flight, on this basis.

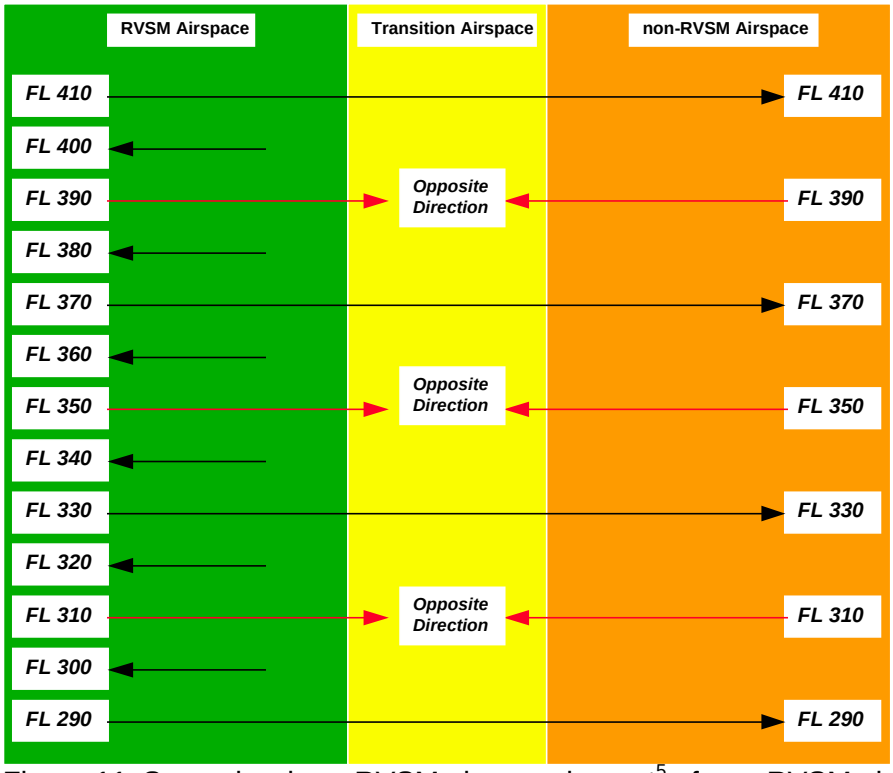


Figure 11: Scenario where RVSM airspace is west[5] of non-RVSM airspace.

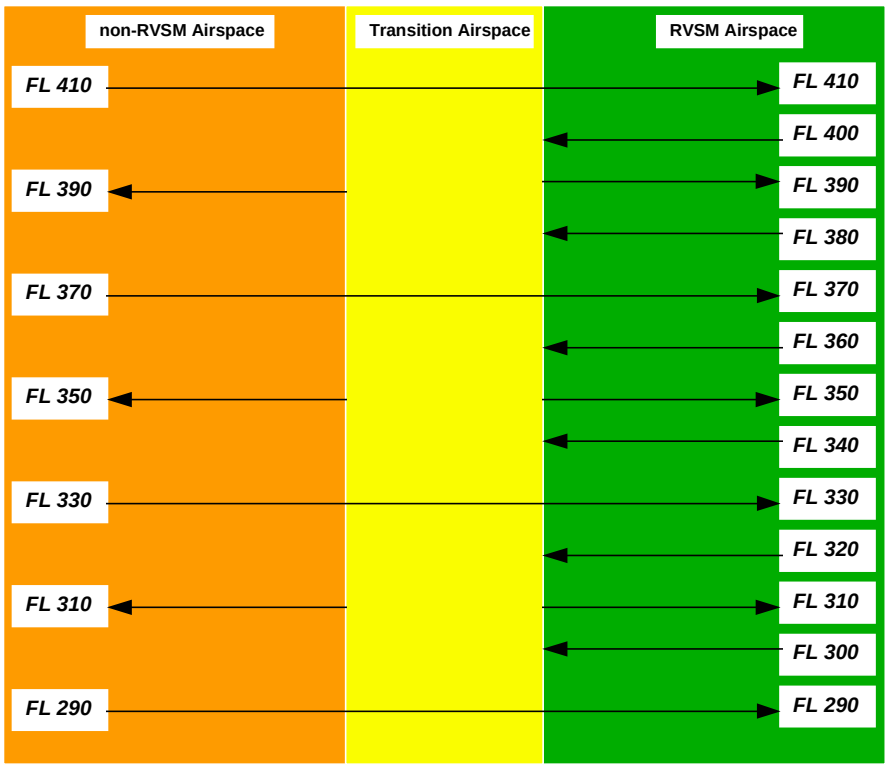


Figure 12: Scenario where RVSM airspace is east[6] of non-RVSM airspace

[5] or north, where predominate traffic flows prescribe the use of flight levels, with regard to direction of flight, on a north/south basis.

[6] or south, where predominate traffic flows prescribe the use of flight levels, with regard to direction of flight, on a north/south basis.

7.1.4 As is apparent from the two scenarios described above, there is a significant difference regarding the impact of a communication failure, depending on whether the RVSM airspace is located to the west or to the east of the non-RVSM airspace, namely:

7.1.4.1 **West**

- In Figure 11, the RVSM airspace is located to the west of the non-RVSM airspace. FLs 290, 330, 370 and 410 are "same-direction" flight levels (eastbound) in both RVSM and non-RVSM airspace.
- Aircraft at FLs 310, 350 and 390 are however "*opposite-direction*" flight levels. Therefore, specific revised communication failure procedures need to be developed for this case.

7.1.4.2 **East**

- In Figure 12, the RVSM airspace is located to the east of the non-RVSM airspace. FLs 290, 330, 370 and 410 are "same-direction" flight levels (eastbound) in both RVSM and non-RVSM airspace.
- There are no flight levels which would have aircraft as opposite traffic if operating on the same ATS route, thus, no specific revised communication failure procedures need to be developed for this case.

7.1.5 The ICAO Communication Failure procedures do not, therefore, lend themselves for application in that European RVSM transition airspace where RVSM airspace is situated west of the non-RVSM airspace unless a process of adaptation of route structures and/or the adaptation of ATS local/regional agreements were to be undertaken, that would mitigate the impact of opposite-direction traffic operating at the same flight levels on the same ATS routes described above.

7.1.5.1 Adaptation of Route Structures

7.1.5.1.1 Implementation, unless an already existing unidirectional route structure makes it unnecessary, of unidirectional laterally spaced parallel routes, as described in Figure 13 below, would resolve the separation of opposite-direction aircraft operating at the same flight levels.

7.1.5.1.2 Introduction of compulsory reporting points prior to leaving and prior to entering RVSM airspace, as follows:

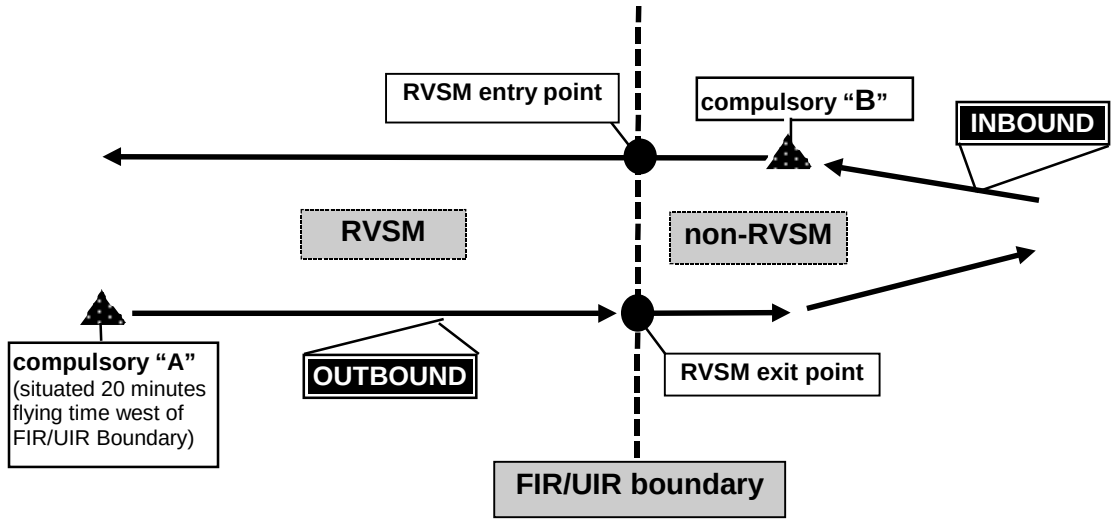


Figure 13: Unidirectional laterally spaced parallel routes

7.1.5.1.3 RVSM Outbound

a. The aircraft will report to the applicable RVSM ATS unit passing *compulsory "A".* The ATS unit will issue a clearance to an appropriate non-RVSM flight level, to cross the RVSM exit point maintaining that level.

b. If radio contact cannot be established with the applicable ATS unit passing compulsory "A", the pilot will continue to attempt to establish radio contact. If these attempts fail, the pilot can be expected to commence the *adjustment of level* to the non-RVSM flight level, as filed in the flight plan, at a point *twenty (20) minutes* after passing *compulsory "A".*

7.1.5.1.4 RVSM Inbound

a. The pilot will report *compulsory "B"* to the applicable non-RVSM ATS unit.

b. If radio contact cannot be established with the applicable non-RVSM ATS unit, the pilot will continue to attempt to establish radio contact. If these attempts fail, the aircraft will commence the *adjustment of level* to the RVSM flight level, as filed in the flight plan, at a point *twenty (20)* minutes after passing *compulsory "B***"**. This means that the level adjustment will take place well within RVSM airspace.

7.1.5.1.5 Airspace Requirements Observations:

The introduction of the above described laterally spaced routing at <u>all</u> entry and exit points could require extensive re-structuring of the ATS route network in adjoining non-RVSM FIRs/UIRs and in the RVSM FIRs/UIRs in whose airspace transition tasks are carried out, as well as, possibly, in adjacent RVSM FIRs/UIRs, when the first RVSM FIR/UIR is of insufficient width.

The magnitude of this task would increase when, after RVSM implementation, non-RVSM airspace is added to the European RVSM area.

7.1.5.2 <u>Adaptation of ATS Local/Regional Agreements</u>

7.1.5.2.1 Apart from the above described route structure method, there exists a possible 'in-house' solution where RVSM airspace is located <u>west</u> of non-RVSM airspace:

7.1.5.2.2 The last RVSM ACC/UAC ensures that the flight levels where an opposite traffic situation exists with traffic coming from non-RVSM airspace, i.e. FL 310, FL 350, and FL 390 will <u>not</u> be used in a defined RVSM "<buffer>" airspace immediately adjoining non-RVSM airspace.

7.1.5.2.3 This would require the issuance of ACC/UAC-internal directives to ensure that these three flight levels will not be used within a given distance, i.e. the "<buffer>" (in time or units of distance) from the boundary with non-RVSM airspace, and/or the publication of a relevant FLAS.

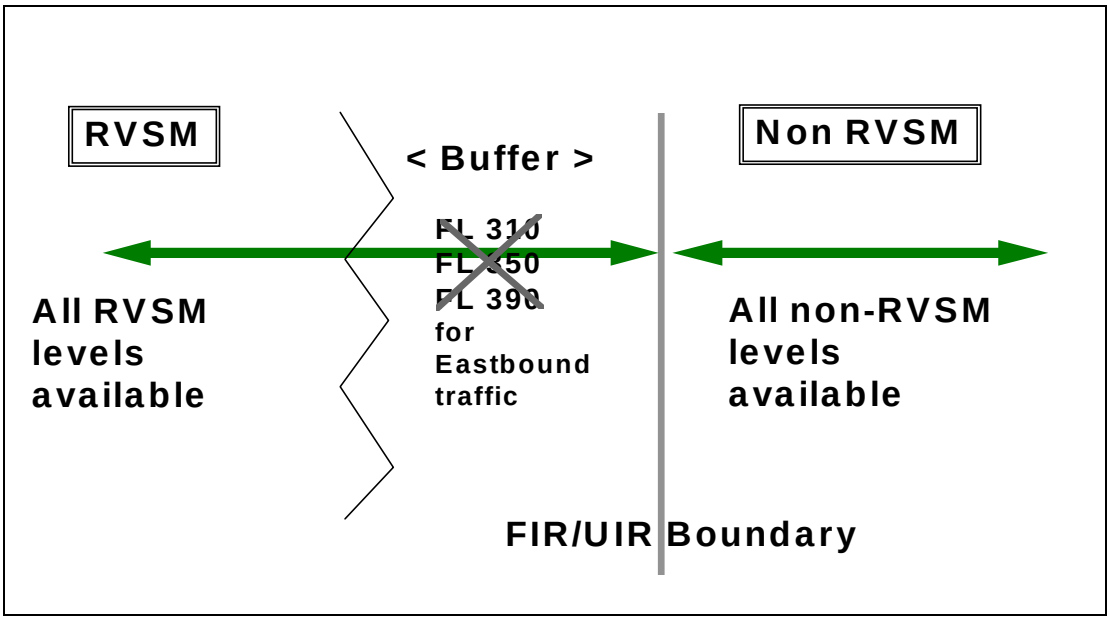


Figure 14: Adaptation of ATS Local/Regional Agreements to create a "buffer zone".

7.1.5.2.4 It may require that certain Letters of Agreement between adjacent RVSM FIRs/UIRs be adjusted to reflect this requirement where flight distances/times to non-RVSM airspace so dictate.

7.1.5.2.5 The loss of use of three flight levels within a given distance from non-RVSM airspace should not cause a significant hardship since transition tasks require, in any event, that aircraft outbound from RVSM airspace be established at a non-RVSM flight level prior to the boundary with non-RVSM airspace. Thus, it would mean only that this particular transition task would be carried out well in advance of the traffic entering non-RVSM airspace.

7.1.5.3 Combination

The foregoing method in para. 7.1.5.1 of laterally spaced routes and the "in-house" solution in para. 7.1.5.2 could as well be combined in certain airspace where traffic volumes warrant. This would, in addition, assist in the transition related tasks.

7.1.5.4 General

7.1.5.4.1 In all cases, the existing requirement in Doc 4444, Note to para. 8.3.1.1 remains intact, namely:

"*Transponder equipped aircraft experiencing radio-communication failure will operate the transponder on Mode A Code 7600."*

7.1.5.4.2 Also intact remains the direction to controllers in Doc 4444, Part VI:

"8.3.1.1 If two-way communication is lost with an aircraft, the radar controller should determine whether or not the aircraft's receiver is functioning by instructing the aircraft on the frequency so far used to acknowledge by making a specified manoeuvre and by observing the aircraft's track, or by instructing the aircraft to operate IDENT or to make code changes." and

"8.3.1.2 If the action prescribed in 8.3.1.1 is unsuccessful, it shall be repeated on any other available frequency on which it is believed that the aircraft may be listening."

7.1.5.5 Those ACCs/UACs which will undertake the tasks associated with RVSM/non-RVSM transition, within the framework of the flight level organisation depicted in figure 11 above, should undertake early planning to determine the optimal means by which operational issues associated both with aircraft experiencng communications failure in flight and with RVSM/non-RVSM transition can be mitigated.

7.2 OTHER RVSM AIRSPACE

No specific provisions for aircraft experiencing communications failure in flight within the remaining European RVSM airspace have been developed. The existing ICAO provisions are therefore fully applicable.

8. ATS SYSTEMS SUPPORT

Text in shaded boxes describe specific systems requirements.

8.1 General

8.1.1 Given the requirement for ATC to accommodate non-RVSM approved State aircraft as GAT within the European RVSM airspace, it is essential that ATC be systematically aware as to the RVSM approval status of all flights operating, not only within the RVSM airspace, but also outside and in close proximity to the RVSM airspace. The ATS systems adaptations described in this section have been developed to support this safety critical operational requirement.

8.1.2 Also significant is the operational requirement for ATC to be aware of a flight's status as being that of a State aircraft where such a flight is requesting operation within the RVSM airspace and has not indicated that it is RVSM approved.

8.1.3 The requirement for ATC to selectively apply two vertical separation minima within the same volume of airspace, as a result of the requirement to accommodate non-RVSM approved State aircraft, within the RVSM airspace, renders flight-planning provisions, associated with the application of RVSM, safety critical.

8.1.4 The ATS systems adaptations will be applied as a function of the RVSM related flight plan information filed.

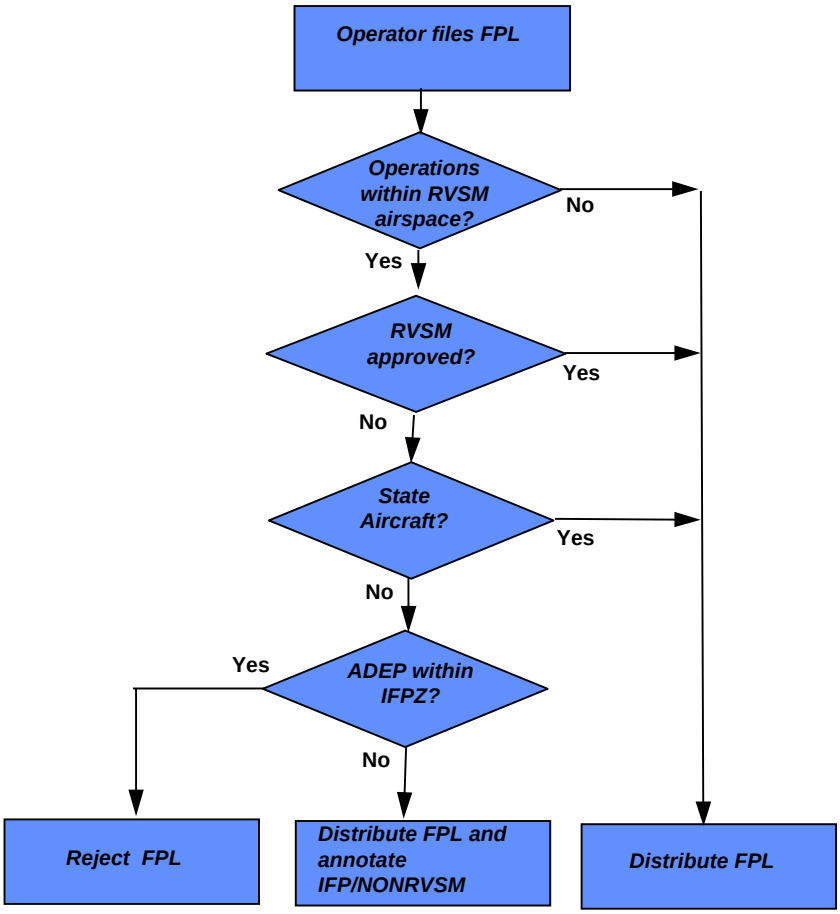
8.2 Flight Data Processing Systems

8.2.1 Given the safety essential nature of ensuring the application of a reduced vertical separation minimum to RVSM approved aircraft only, it is critical that ACCs/UACs receive the support of IFPS for the purpose of:

- rejecting, those flight plans, filed with a ADEP within the IFPS Zone (IFPZ), which do not qualify for operation within the RVSM airspace on the basis of the information filed, and

- annotating, those flight plans, filed with a ADEP outside the IFPS Zone (IFPZ), which do not qualify for operation within the RVSM airspace on the basis of the information filed,and
- ensuring the timely and accurate distribution of the relevant RVSM associated flight plan information.

8.2.2 IFPS will reject or distribute flight plans submitted by operators on the basis of the following decision scheme:



8.2.3 In support of these requirements, IFPS will distribute all relevant flight plan information, including the RVSM approval status (ICAO Flight Plan Items 10 or Item Q of the RPL format), filed in accordance with the ATC procedures described in Part 5, to the Flight Data Processing Systems (FDPS) of those ACCs/UACs, situated within the IFPZ, concerned for a particular flight.

8.2.4 Controllers, having received an estimate message for which no flight plan was available, shall be aware as to the high likelihood of no flight plan being available in adjacent ACCs/UACs. As a consequence, the sending controller shall use a verbal co-ordination as a means of ensuring that the receiving controller is aware of the aircraft's non-RVSM approval status.

8.2.5 AFIL - Flight Plan Filed In the Air:

In support of flight plans filed in the air (AFILs), all ATC Flight Plan Proposals (AFP) forwarded to IFPS, should include the relevant ICAO Item 8, 10 and 18 information (all currently optional) to the extent possible. ATC Flight Plans (APL) or ATC Flight Plan Change Messages (ACH) distributed by IFPS on the basis of AFPs for which no relevant RVSM information was forwarded (Item 10), shall contain the indicator: "**IFP/RVSMUNKNOWN**". For all flight plans so annotated, controllers shall ensure that the relevant RVSM approval information is forwarded to the adjacent control sectors concerned.

8.2.6 States situated within the IFPZ, extracting their own RPLs, shall ensure that the flight plan (FPL) created by their local FDPS, is in conformance with the provisions associated with the filing of RPLs, in regards to RVSM, within IFPS.

8.2.7 Controllers are reminded that for flight plans filed with a ADEP located outside the IFPS Zone, IFPS cannot reject the flight plan. Consequently, such FPLs generated by IFPS, which would have been rejected on the basis of the RVSM flight plan information filed, shall contain the indicator "**IFP/NONRVSM**".

8.2.8 FDPSs shall be able to process and make available for display all flight levels in RVSM airspace.

8.3 Radar Display Systems

8.3.1 The specific approval requirements for operations within the RVSM airspace, together with the requirement to simultaneously accommodate both RVSM approved and non-RVSM approved aircraft, impose upon ATC operational considerations of a very high order:

- the requirement for ATC to accommodate both RVSM approved and non-RVSM approved aircraft in airspace where transition tasks are carried out with the resultant requirement to selectively apply both a 1 000 ft and a 2 000 ft vertical separation minimum;
- the operational requirement for ATC to exclude non-RVSM aircraft (other than State aircraft and, as provided for in para. 5.6 in regards to non-RVSM approved civil aircraft) from operations within the RVSM airspace;
- the requirement for ATC to selectively apply, in all RVSM airspace, both a 1 000 ft vertical separation minimum between aircraft RVSM approved and a 2 000 ft vertical separation minimum between non-RVSM approved State aircraft and other traffic.

8.3.2 The operational requirements regarding radar display systems are applicable to those radar display systems associated with ACCs/UACs whose areas of responsibility include RVSM airspace.

8.3.3 Furthermore they shall apply, at a minimum, to the radar position symbols and/or radar labels associated with GAT.

8.3.4 The operational requirements associated with radar display systems are essential to ATC being able to maintain a continuous, systematic and unambiguous level of awareness as to the RVSM approval status of *all* flights under its responsibility.

8.3.5 In a radar environment, the radar position symbols and/or radar labels associated with aircraft operating within the RVSM airspace, shall provide a clear indication of the current non-RVSM approval status.

Note: Non-RVSM approved aircraft operating in RVSM airspace could include State aircraft operating as GAT and/or civil aircraft operating within that RVSM airspace where transition tasks are carried out.

Note: Controllers shall be aware that the RVSM approval status, as reflected in the current flight plan, may be downgraded from RVSM approved to non-RVSM approved, based on information received directly from the pilot.. Controllers shall be aware that only for those circumstances associated with equipment related contingency events, may such RVSM approval status be upgraded.

8.3.6 Where radar is used as the primary tool for applying separation, the radar position symbols and/or radar labels should provide a clear indication of the current non-RVSM approval status of flights operating within such level bands above and below the RVSM airspace as defined by the local ATS authority.

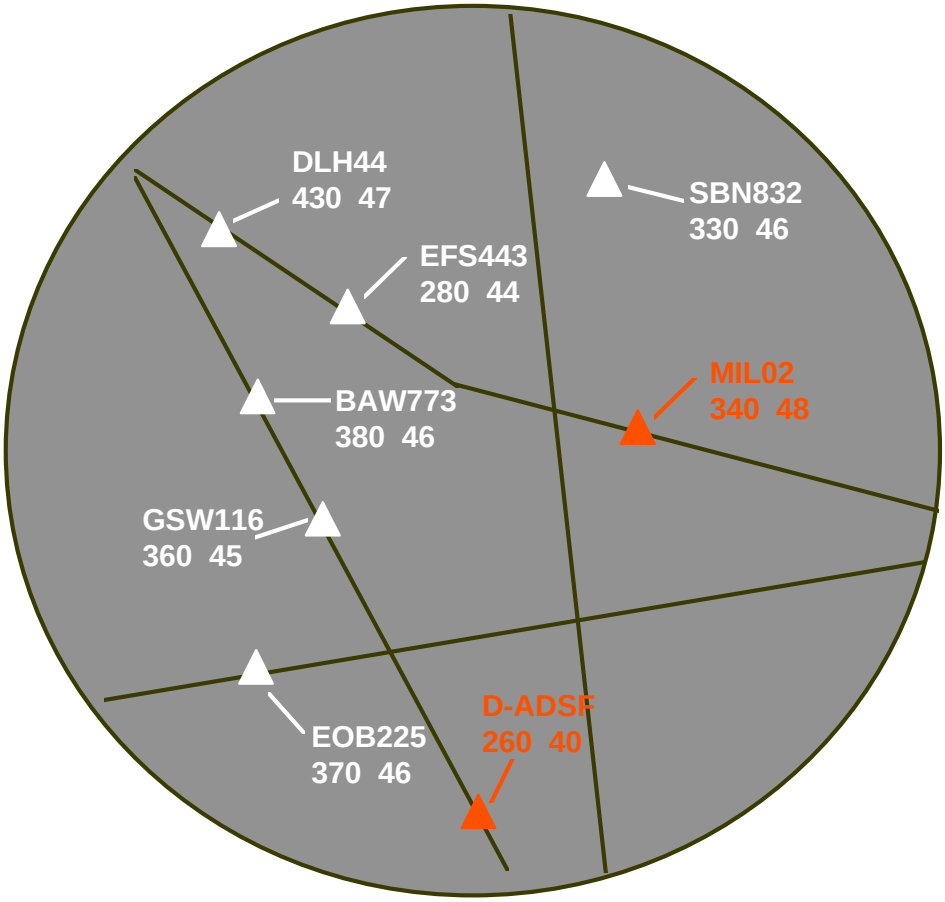
Note: The vertical extent of the level bands will have been determined locally as a function of specific local operational requirements in terms of sectorisation, etc.

8.3.7 The means by which the distinguishing feature is applied to the radar position symbols and/or radar labels of the aircraft concerned shall be automatic.

Note: It is understood that, during the initial period of RVSM implementation, for certain radar display systems, it may be required to accomplish the application of this distinguishing feature manually, provided clear and validated procedures are in place to ensure that this safety critical information is available to the relevant radar control positions.

8.3.8 The possibility for the manual manipulation of the radar position symbols and/or radar labels of aircraft shall be available.

Note: This manual manipulation will be used as a means of updating the radar position symbols and/or radar labels of aircraft experiencing in-flight equipment related contingencies which result in the loss of RVSM approval status.



Radar Position Symbols and Radar Labels, orange colour: *non-RVSM approved*

Radar Position Symbols and Radar Labels, white colour: *RVSM approved*

Figure 15: Example of Radar Display which uses colour to distinguish radar labels of non-RVSM approved aircraft

8.4 Flight Strips (Paper or Electronic)

Note: If there are no paper or electronic strips, these requirements shall be applied to the "extended label".

8.4.1 These operational requirements are applicable to those flight progress strips generated within ACCs/UACs whose areas of responsibility include RVSM airspace.

8.4.2 Local FDPS shall indicate on all flight strips (paper, electronic or, in the absence of either, extended label) associated with flights by non-RVSM approved aircraft, the

information filed by operators in respect of both their RVSM approval status and their status as that of a State aircraft (if applicable) as follows:

8.4.3 Information regarding a State or civil aircraft's current non-RVSM approval status shall be displayed on the flight strip. (Message example: **NONRVSM**).

PH-XXX 5713 LR23 400 LIRP EBBR R260 NONRVSM			260 260	IXILU 1558	DANAR 1601	EPL 1603			DIK 1618 REIMS	UE 27 133.22

Relevant RVSM Approval information Fields

8.4.4 Where applicable, the indication that a non-RVSM approved aircraft is a State aircraft shall be displayed on the flight strip. (Message example: **STATE AIRCRAFT**)

STEEL82 5713 BA46 380 LIRP EBBR R260 NONRVSM STATE			260 260	IXILU 1558	DANAR 1601	EPL 1603			DIK 1618 REIMS	UE 27 133.22

Relevant RVSM Approval information Fields

8.4.5 For all RVSM approved aircraft, no indication is required:

STEEL82 5713 BA46 380 LIRP EBBR R280 			280 280	IXILU 1558	DANAR 1601	EPL 1603			DIK 1618 REIMS	UE 27 133.22

Relevant RVSM Approval information Fields

8.4.6 ACCs/UACs are also advised to consider the adoption of additional visual cues that could support the requirement of remaining continually aware of the RVSM approval status of all flights within its area of responsibility. Such methods might include assigning a dedicated colour to strip holders for such flights where paper

flight strips are used or to assigning a dedicated colour to the electronic strips associated with such flights.

8.5 OLDI

8.5.1 OLDI should include the current RVSM approval status of a flight as well as the information regarding an aircraft's status as being a "State" aircraft, where applicable.

Note: This will facilitate the current practice in some ACCs/UACs of complimenting missing or erroneous flight plan date.

8.5.2 OLDI should support the systematic transfer of information related to requests for "Special Handling" in the RVSM airspace, in Item 18 of the ICAO Flight Plan (Item 18 message: **STS/NONRVSM**).

Since the automated OLDI message replaces the verbal estimate message, information regarding the request for special handling (STS/NONRVSM) as indicated by Item 18 should be transmitted to emulate the information which would have been passed as Item "e" at the end of the verbal estimate message.

8.5.3 The support of OLDI in the forwarding of RVSM related information will be beneficial:

- as confirmation of the data filed in the flight plan, as it is very safety critical
- to cover the case where degradation of capability has occurred for a particular flight
- to cover the case where, for whatever reason, the accepting unit does not have the flight plan.

8.5.4 In consideration of the significant operational impact posed by the accommodation of non-RVSM approved State aircraft within RVSM airspace, and where automated co-ordination dialogue facilities are in use (SYSCO), such flights could be the subject of a referral to the controller in the receiving unit for his/her explicit acceptance, and as such, co-ordination procedures to this effect could be agreed and included in inter-centre Letters of Agreement.

8.6 ATS Systems Overview

The following matrix provides an overview of the automated systems adaptations required to support the application of RVSM: *(see next page)*

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red non-italics: mandatory ***Blue italics: highly desirable***		Flight Strip (Electronic, Paper or Extended Label[1]), indicate:	OLDI Message (Item 22)	Radar Position Symbols and/or Radar Labels
RVSM approved aircraft	All Levels	no requirements		
non-RVSM approved State aircraft (operating as GAT)	FL430 and above	• non-RVSM approval status (e.g.: **NONRVSM)** • Indicate state aircraft status (e.g.: **STATE A/C)**	*transmit:* • ***STS/NONRVSM*** • ***current RVSM approval and "State" status***	*apply distinguishing feature*[2]
	FL290-410	• non-RVSM approval (e.g.: **NONRVSM)** • Indicate state aircraft status (e.g.: **STATE A/C)**	*transmit:* • ***STS/NONRVSM*** • ***current RVSM approval and "State" status***	apply distinguishing feature
	FL280 and below	• non-RVSM approval status (e.g.: **NONRVSM)** • Indicate state aircraft status (e.g.: **STATE A/C)**	*transmit:* • ***current RVSM approval and "State" status***	*apply distinguishing feature*[2]
All formation flights of State aircraft[3] (operating as GAT)	FL430 and above	• non-RVSM approval status (e.g.: **NONRVSM)** • Indicate state aircraft status (e.g.: **STATE A/C)**	*transmit:* • ***STS/NONRVSM*** • ***current RVSM approval and "State" status***	*apply distinguishing feature*[2]
	FL290-410	• non-RVSM approval status (e.g.: **NONRVSM)** • Indicate state aircraft status (e.g.: **STATE A/C)**	*transmit:* • ***STS/NONRVSM*** • ***current RVSM approval and "State" status***	apply distinguishing feature
	FL280 and below	• non-RVSM approval status (e.g.: **NONRVSM)** • Indicate state aircraft status (e.g.: **STATE A/C)**	*transmit:* • ***current RVSM approval and "State" status***	*apply distinguishing feature*[2]
non-RVSM approved civil aircraft	FL430 and above	• non-RVSM approval status (e.g.: **NONRVSM)**	*transmit:* • ***current RVSM approval status***	*apply distinguishing feature*[2]
	FL290-410 (in airspace responsible for transition tasks)	• non-RVSM approval status (e.g.: **NONRVSM)**	*transmit:* • ***current RVSM approval status***	apply distinguishing feature
	FL280 and below	• non-RVSM approval status (e.g.: **NONRVSM)**	*transmit:* • ***current RVSM approval status***	*apply distinguishing feature*[2]

Note [1]: -this information may be included in an extended label if no paper or electronic strips exist,

Note [2]: -to be applied between level bands above and/or below RVSM airspace according to individual ACC/UAC specified vertical limits based on a national system policy decision.

Note [3]: -only formation flights of State aircraft shall be accommodated within the RVSM airspace. (See para. 5.1.5)

8.7 STCA/MTCD

Short Term Conflict Alert - STCA

8.7.1 STCA systems of ACCs/UACs applying RVSM should be able to selectively assess the applicable VSM of either 1 000 ft or 2 000 ft, as determined by the current RVSM approval or non-approval status of the aircraft concerned, operating in the level band FL 290 - FL 410 inclusive.

8.7.2 Where the STCA system of a ACC/UAC applying RVSM does not meet the requirements of para. 4.1, it shall be able to assess a VSM of 1 000 ft up to and including FL 410.

The serious disruptions to those operational environments applying RVSM, caused by STCA systems generating alerts based on an assessment of a VSM of 2 000 ft in the level band FL 290 - FL 410 inclusive, would be too numerous to be sustainable.

ACCs/UACs will be aware, for those STCA systems not adapted to meet the requirement described in para. 8.7.1 above, that alerts for those encounters involving at least one non-RVSM approved aircraft, operating in the level band FL 290 - FL 410 inclusive, would be based on a VSM which would not be applicable to the encounter in question. Nevertheless, in keeping with the concept of STCA as a safety net, alerts would however be generated as a function of a VSM assessment sufficient to assist in the prevention of collision avoidance.

Medium Term Conflict Detection - MTCD

8.7.3 MTCD systems of the ACCs/UACs applying RVSM shall be able to assess the selective application of a VSM of either 1 000 ft or 2 000 ft, as determined by the current RVSM approval or non-approval status of the aircraft concerned, operating in the level band FL 290 - FL 410 inclusive.

8.7.4 Individual ACCs/UACs should undertake early planning to ensure that the necessary software adaptations are accomplished within the defined timeframes for the initial implementation of RVSM. Implementation of RVSM prior to the completion of the necessary adaptations to STCA/MTCD systems would result in nuisance alerts to be generated to an extent that severe operational disruptions could result.

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9. ATC CONSIDERATIONS

The introduction of RVSM will require that individual ACCs/UACs undertake a critical evaluation of operating practises so as to identify areas where adjustments or changes are required.

Individual ACCs/UACs may well wish to take the opportunity to maximise the operational benefits to be gained from the introduction of RVSM by undertaking an extensive critical operational analysis of the following:

9.1 Inter-Centre Letters of Agreement

9.1.1 The introduction of RVSM will require that individual ACCs/UACs re-evaluate their existing letters of agreement for the purpose of optimising transfer of control agreements through the stipulation of new optimal levels to be used for the transfer of control of aircraft between ACCs/UACs (EUROCONTROL Common Format Letter of Agreement, Annex D refers).

9.1.2 ACCs/UACs are advised to consider the incorporation into their letters of agreement with adjacent ACCs/UACs descriptions of “contingency FLAS” which could be applied during periods of meteorological conditions requiring a reversion to a 2 000 ft vertical separation minimum. In this way, co-ordination of levels appropriate to the transfer of traffic requiring a minimum 2 000 ft vertical separation minimum from adjacent ACCs/UACs can be facilitated. (*See para. 5.5.4, Contingency procedures)*

9.1.3 Individual ACCs/UACs may consider the requirement for stipulating increased pre-notification time parameters for the passing of estimate messages involving non-RVSM approved aircraft intending to operate within the RVSM airspace, as a means of facilitating planning for the integration of such traffic in accordance with a 2 000 ft VSM.

9.1.4 ACCs/UACs should consider stipulating precise co-ordination procedures related to RVSM within their LoAs with those ACCs/UACs which do not receive flight plan information from IFPS, so as to ensure that the individual RVSM approval status of each individual flight is accurately communicated.

9.2 Flight Level Allocation Schemes

The introduction of RVSM will permit an optimisation of existing agreed FLAS through the designation of new flight levels for specified ATS route segments. Strategic de-confliction of major crossing points will as well be facilitated through the availability of additional flight levels available for use within newly defined agreed FLAS. Also, FLAS for and adjacent to airspace where transition tasks are carried out could be considered.

9.3 Sectorisation

9.3.1 The implementation of RVSM may require an analysis of the optimal levels to be used for delineating the vertical limits of control sectors within ACCs/UACs. Operational experts concerned should evaluate the requirement to re-define such vertical limits as a function of adaptations to FLAS or predicted changes in the vertical profiles of major traffic flows expected from the introduction of RVSM.

9.3.2 Consideration should as well be given to the impact on inter-sector co-ordination workload resulting from the requirement for ATC to provide a 2 000 ft vertical separation minimum to non-RVSM approved State aircraft operating as GAT within the RVSM airspace at levels situated immediately above or below those vertical sector boundaries defined by levels situated within the RVSM airspace. For this situation, all sectors vertically adjacent will require continuous awareness of the presence of such a flight through inter-sector co-ordination so as to ensure the required vertical separation. As an example, consideration could be given to adjusting the lower limit of a sector from FL 300 to FL 285 with the implementation of RVSM, so as to mitigate the impact on co-ordination requirements for flights of non-RVSM approved State aircraft operating within the RVSM airspace.

9.3.3 The implementation of RVSM will render those flight levels, in the level band FL 290-FL 410 inclusive, which were designated as representing the vertical limits of sectors prior to RVSM implementation, as usable flight levels. As a

consequence ACCs/UACs will be required to designate vertical sector limits based on 500 ft interval situated between two usable flight levels.

e.g.: *Prior* RVSM implementation, upper limit of sector: FL300
After RVSM implementation, upper limit of sector: FL295

9.3.4 ACCs/UACs may wish to consider the designation of FL 275 as a suitable division flight level between two sectors. Such designation would make available, to the sector responsible for RVSM airspace, a “non-RVSM level” (FL 280) for use by an aircraft experiencing an equipment related contingency.

9.3.5 As a consequence of having defined new vertical sector limits in response to the implementation of RVSM, Areas of Common Interest (ACIs) described in letters of agreement must be amended.

9.4 Optimisation of the ATS Route Structure

9.4.1 It is expected that the optimisation of the existing route network, after the implementation of RVSM, will be realised through a combination of FLAS, sectorisation and to a lesser extent changes to the en-route structure. In general, it is expected that after the implementation of RVSM there will be a vertical redistribution of traffic with more flights reaching a Flight Level close to their optimum. The redistribution of flights in the airspace above FL 290 may well require changes to the boundaries of sectors to balance workload, particularly in areas where there are a number of horizontal sector boundaries above FL 290. It is also expected that the application of a FLAS at the confluence of major routes or at heavily loaded crossing points could have a beneficial affect on capacity. For optimal benefit, such FLASs will need to be coordinated on a Europe wide basis. These changes will, by and large, be accommodated within the Version 3 route network. However, there may be instances where due to traffic levels or specific local demands, changes to the route network will be required.

9.4.2 On bi-directional routes, traffic climbing or descending to/from cruise will need to cross more Flight Levels than is currently the case. Therefore, consideration should be given to the potential benefit of extending the uni-directional route

system. Local needs (e.g. availability of airspace, sectorisation, crossing points) will dictate whether or not this is practicable but on those segments where the majority of the traffic is in the evolutionary stages of flight, the creation of specialised one way routes, ideally permitting climb/descent to/from cruise, could decrease controller workload and maximise capacity.

9.4.3 States on the periphery of the proposed RVSM area are faced with different ATC tasks to States within the RVSM core area. These States may wish to evaluate the potential increase in controller workload on busy uni-directional routes that cross the proposed RVSM/non-RVSM boundary. Controllers will need to adjust the Flight Level on most aircraft entering and exiting the RVSM area. This task is complicated by the disparity between the two VSMs (Conventional outside the RVSM area and RVSM within) which results in the situation where traffic operating at three FLs, FL 310, 350 and 390 will be in opposite direction, same level at the eastern RVSM boundary. States may wish to consider the option of creating a uni-directional route network at the RVSM/non-RVSM boundary if the traffic levels or complexity of tasks are sufficiently high to warrant a structural solution. This could be achieved either cross border after co-ordination with neighbouring non-RVSM States or if necessary within the FIR of an individual State.

10. ACAS

The provisions of ICAO Doc. 7030, European (EUR) Regional Supplementary Procedures, Chapter 16: “Use of Airborne Collision Avoidance System (ACAS)”, will render mandatory the carriage and operation of ACAS II in the EUR Region (including FIR Canarias) for specified aircraft from 01-January-2000.

It is relevant to note that the current state of ACAS operations, globally, is represented, for the most part, by the operation of TCAS II, Version 6.04A, on an either mandatory or voluntary basis. Equally relevant, is the fact that the aforementioned Version 6.04A of TCAS II is not ICAO ACAS SARPs compliant. The operation of such a version of a TCAS II system would not, therefore, satisfy those EUR ACAS provisions described above.

The TCAS II Version 6.04A thresholds, for issuing Traffic Advisories (TAs) and Resolution Advisories (RAs), were designed for an environment with standard vertical separation, above FL 290, of 2 000 ft. Analysis of TCAS II Version 6.04A performance has revealed that, in an RVSM environment, the system would be operationally incompatible - this is not to suggest that it is unsafe. Operational experience in the North Atlantic Region has confirmed that TCAS II Version 6.04A poses some significant operational issues. The upgrade of TCAS II Version 6.04A to Version 7 includes modifications to address operational issues and to improve the compatibility in RVSM (other modifications are expected to improve TCAS II operations in other respects).

The ECAC RVSM traffic environment will be more complex and dense than that on the North Atlantic. Comprehensive work is underway to confirm TCAS II Version 7 performance in the ECAC RVSM environment. Initial analysis indicates that the modifications introduced are effective, and it is considered important that TCAS II Version 7 should be in widespread use before the ECAC RVSM system is implemented.

The implementation of RVSM will not bring about changes to ATC procedures relating to ACAS (PANS-RAC, Part II). Nevertheless, controllers are to be aware,

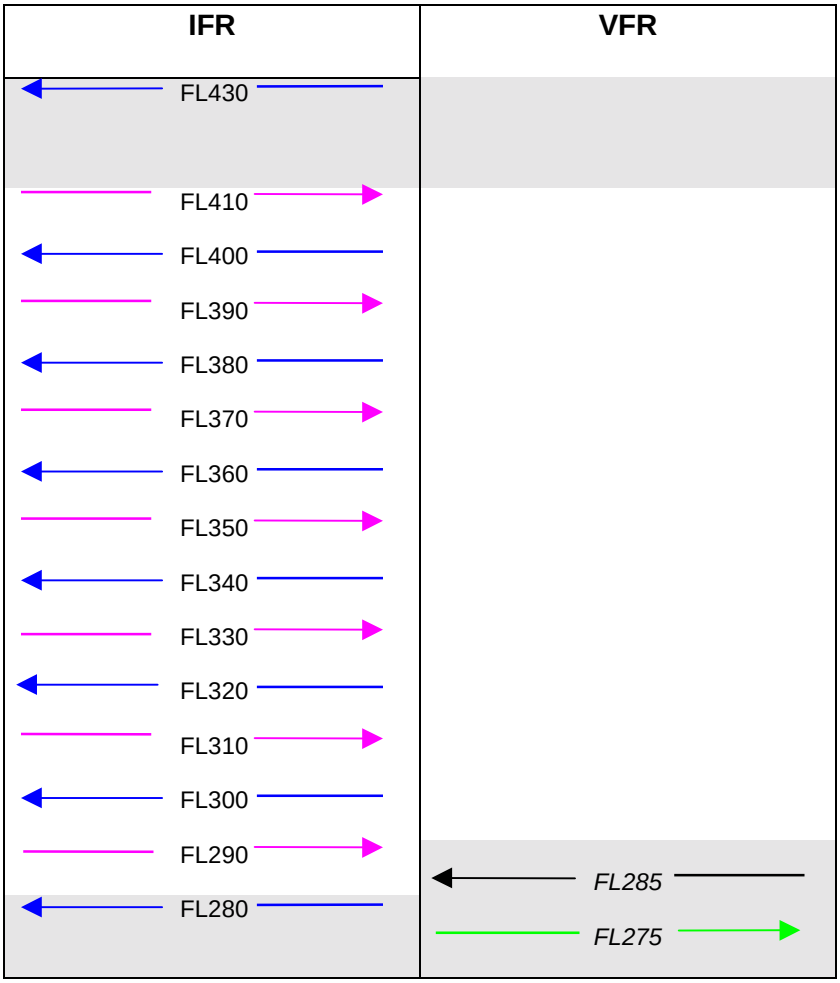
that notwithstanding the EUR ACAS provisions referred to above, there shall remain a probability that a small population of aircraft may continue to operate in the European RVSM airspace while operating either TCAS II, Version 6.04A or no ACAS system, by virtue of the fact that they are not included in the aircraft selection criteria of the EUR ACAS Provisions, i.e.: civil, fixed-wing turbine aircraft of more than 15 000 kg or maximum passenger load of more than 30. Safety studies initiated by EUROCONTROL are currently underway which will seek to define, among other issues, the impact which aircraft so equipped will pose to the RVSM operational environment. The implementation of RVSM is being undertaken with due regard for the for the operational performance of ACAS II. As indicated in the EUR ACAS Provisions, the mandatory use of ACAS II in Europe precedes the implementation of RVSM in Europe.

---***END***---

Appendix A

RVSM Table of Cruising Levels

(Reference: ICAO Annex 2, Appendix 3, Paragraph a))



IFR Cruising Level for Tracks 000° - 179° (or 090° - 269°in the FIRs/UIRs of Italy, France, Portugal and Spain)

IFR Cruising Level for Tracks 180° - 359° (or 270° - 089° in the FIRs/UIRs of Italy, France, Portugal and Spain)

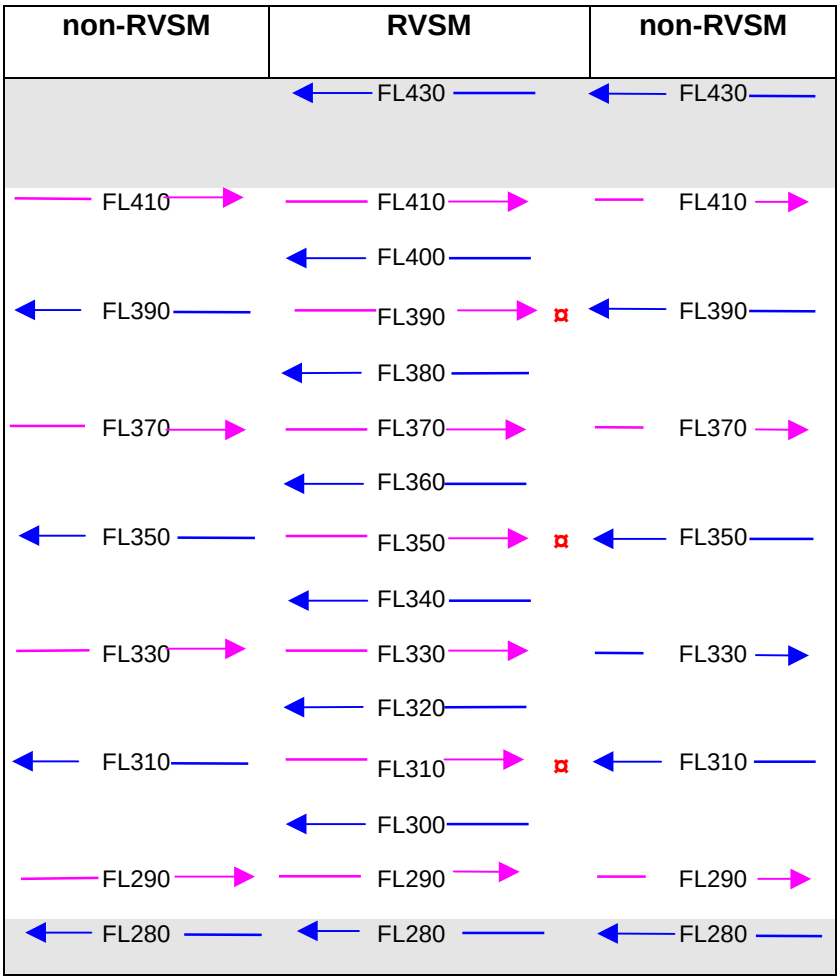
VFR Cruising Level for Tracks 000° - 179° (or 090° - 269° in the FIRs/UIRs of Italy, France, Portugal and Spain)

VFR Cruising Level for Tracks 180° - 359° (or 270° - 089° in the FIRs/UIRs of Italy, France, Portugal and Spain)

note: The provisions of ICAO Annex 2 preclude VFR flight above FL 290. Accordingly, attention is drawn to the absence of VFR cruising levels above FL410, where the VSM reverts to 2 000 ft.

Appendix B

RVSM/non-RVSM Transition



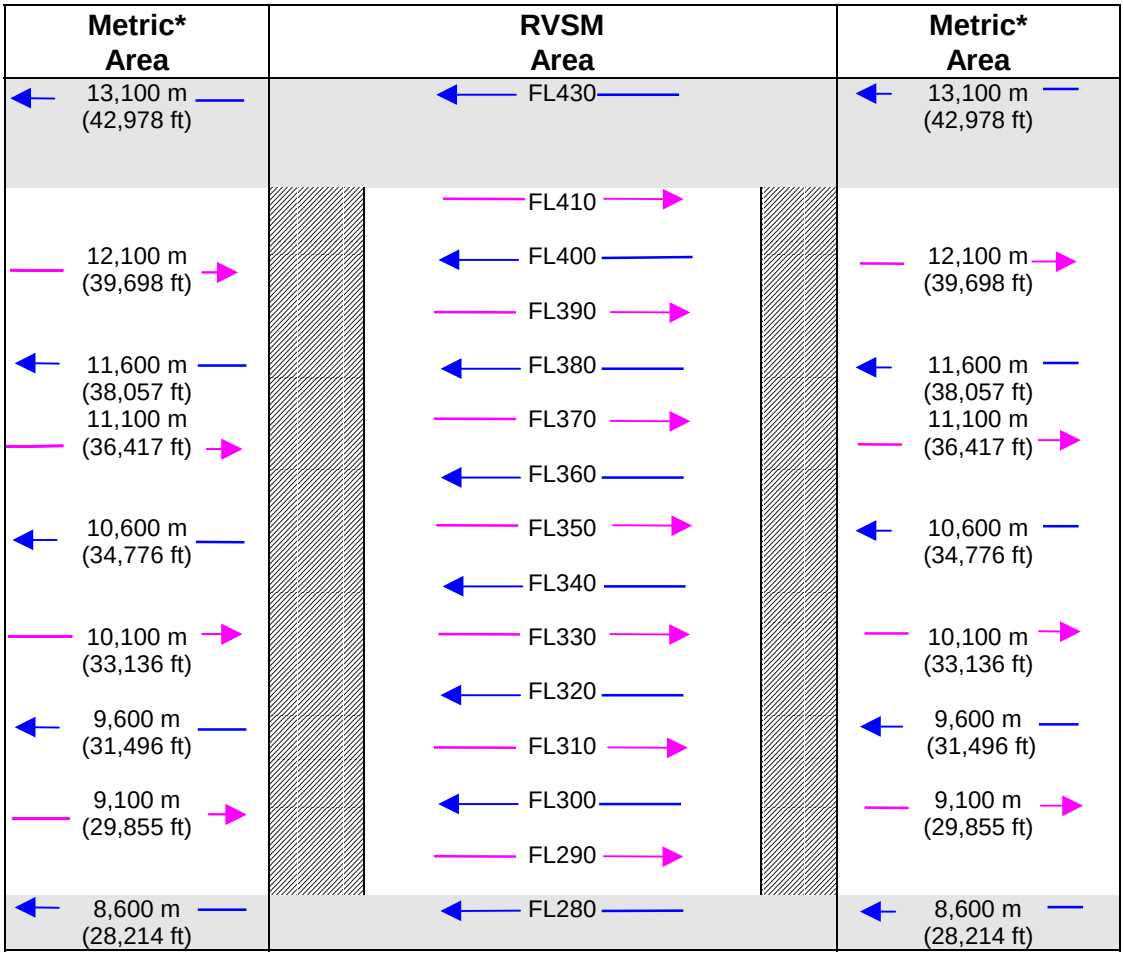
¤ conflict to be resolved during transition

→ Tracks 000° - 179° (or 090° - 269° in the FIRs/UIRs of Italy, France, Portugal and Spain)

← Tracks 180° - 359° (or 270° - 089° in the FIRs/UIRs of Italy, France, Portugal and Spain)

Appendix C

Feet - Metric Transition



* system of metric cruising levels as applied, for instance, in the Russian Federation

Tracks 000° - 179° (or 090° - 269° in the FIRs/UIRs of Italy, France, Portugal and Spain)

Tracks 180° - 359° (or 270° - 089° in the FIRs/UIRs of Italy, France, Portugal and Spain)

Airspace where Transition Tasks are carried out

Appendix D

*Following is an extract of the relevant section (Part 3) of the ICAO Document "*Guidance Material on the Implementation of a 300m (1000ft) Vertical Separation Minimum in the European RVSM Airspace"*: Airworthiness*

It is intended as a means of providing background material of sufficient detail to allow operational ATC personnel to gain an appreciation of the subject. The contents of this appendix, therefore should not be considered as authoritative.

AIRWORTHINESS

Introduction

This material has been prepared in conjunction with the Joint Airworthiness Authority (JAA) and it provides an overview of the development, and content, of JAA Temporary Guidance Leaflet (TGL) No.6. which is the authoritative document on all issues relating to the European MASPS and on the approval of aircraft and operators for flight in designated RVSM airspace.

Background

1 The initial MASPS, for the height keeping accuracy necessary for RVSM operations, was established by the ICAO RGCSP. It was further refined by the NAT SPG by means of a group of technical specialists from State authorities, aircraft and avionics manufacturers, and airline and pilot associations. This group developed material which was then published by the Federal Aviation Administration (FAA) as FAA Document 91 - RVSM : Interim Guidance for Approval of Operators/Aircraft for RVSM Operations, and by the JAA as Information Leaflet No. 23 (I.L.No. 23). These documents detailed the airworthiness, continuing airworthiness, and operations programmes necessary to approve operators and aircraft for RVSM operations in the NAT RVSM airspace.

2 JAA TGL No.6

2.1 JAA TGL No.6 was published in mid 1998. It extends the area of applicability of the requirements of I.L. No. 23, to any region in which RVSM operations are introduced. Regional differences (e.g. ATC Procedures) are addressed in separate Annexes to the main body of TGL No.6, which will ultimately be re-issued as a JAA Acceptable Means of Compliance (AMC) with Joint Aviation Requirements (JAR Ops 1 Subpart L). The requirements detailed in the main body of TGL No.6 are unchanged from those set out in IL No. 23. which were developed in accordance with the conclusions of the RGCSP/6 Meeting (Doc 9536).

TGL No.6 provides detailed guidance on :

- the process for the approval of Aircraft and Operators, for RVSM operations.
- RVSM performance requirements
- Aircraft System requirements
- Airworthiness Approval
- Continued Airworthiness (Maintenance Requirements)
- Operational Approval (ATC and Flight Crew) aspects.

together with the following Appendices :

Appendix 1 - Explanation of W/δ
Appendix 2 - Altimetry System Error (ASE) Components
Appendix 3 - Establishing and Monitoring Static Source Errors
Appendix 4 - Training Programmes and Operating Practices and Procedures
Appendix 5 - Review of ICAO Doc.9574 - Height Keeping Errors
Appendix 6 - Specific Procedures [ATC] for European RVSM Airspace
Appendix 7 - Specific Procedures for the North Atlantic Airspace

TGL No.6 Para 8 details the following minimum equipment fit for aircraft seeking airworthiness approval for RVSM operations :

a) Two independent altitude measurement systems. Each system will need to be composed 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 the 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 needed to meet the performance criteria.

- Signals referenced to a pilot selected altitude for automatic control and alerting. These signals should be derived from an altitude measurement system meeting the criteria of this document [TGL No. 6], and, in all cases, enabling the criteria relating to Altitude Control Output and Altitude Alerting to be met.

b) One Secondary Surveillance Radar (SSR) transponder with an altitude reporting system that can be connected to the altitude measurement system in use for altitude for height keeping.

c) An altitude alerting system

d) An automatic altitude control system.

Appendix E

*Following is an extract of the relevant section (Part 4), State Approval of Aircraft for RVSM Operations, of the ICAO Document: "*Guidance Material on the Implementation of a 300m (1000ft) Vertical Separation Minimum in the European RVSM Airspace".

It is intended as a means of providing background material, of sufficient detail, to allow operational ATC personnel to gain an appreciation of the subject. The contents of this appendix, therefore should not be considered as authoritative.

STATE APPROVAL OF AIRCRAFT FOR RVSM OPERATIONS

1 The State Approval Process

1.1. With effect from the agreed date of the implementation of RVSM in European airspace, Operators intending to conduct flights within the notified RVSM airspace shall require an RVSM Approval either from the State in which the aircraft is registered, or from the State in which the Operator is based. Whilst the primary responsibility for gaining the necessary approval must rest with the aircraft operator, State aviation authorities will be expected to initiate such procedures as necessary to publicise the requirement for, and the means of obtaining, such approvals. In addition, State aviation authorities should maintain regular checks and records of the approvals which they have granted, and ensure that the relevant data is passed to the designated central data base.

2 RVSM Approvals. An RVSM approval will encompass the following elements:

2.1 Airworthiness Requirements (including continuous airworthiness)

2.1.1 The European RVSM Airworthiness requirements are detailed in the JAA TGL No 6. Para. 9. This provides guidance for the approval of newly built aircraft and for aircraft that have already in service. Aircraft may be granted an airworthiness approval against these requirements, or those of equivalent State documentation.

2.1.2 State Airworthiness authorities should also confirm that aircraft altimetry and height-keeping equipment will be maintained in accordance with approved procedures and servicing schedules as detailed in TGL No 6 Para 10.

2.1.3 Whilst meeting the airworthiness requirements of an RVSM approval is, by itself, not sufficient to authorise flight in RVSM airspace, it will qualify the aircraft to enter the Airspace User Preparation & Performance Verification Phase (P1) of the monitoring programme. It is important therefore that the appropriate State Authority should advise the designated monitoring cell accordingly.

2.2 Operational Requirements

2.2.1 To meet the operational requirements of an RVSM approval, the operator will need to satisfy the appropriate authority that that they have instituted flight crew procedures for operations in the European RVSM airspace.

3. Content of Operator RVSM Application

3.1 The required content of an Operator's application for RVSM approval is detailed in TGL No.6 Para 11.3, and summarised below. The application should be submitted in sufficient time to permit evaluation before the intended start of RVSM operations and should include :

- Airworthiness Documents - to show that the aircraft holds an RVSM airworthiness approval

- Description of Aircraft Equipment - appropriate to RVSM operations

- Training Programmes and Operating Practices and Procedures - holders of Air Operators Certificates (AOC) should submit training syllabi and other appropriate material to the responsible authority to show that the operating practices, procedures and training items related to RVSM operations are incorporated in initial, and where appropriate, recurrent training programmes. Other operators will need to comply with local procedures to satisfy the responsible authority that their knowledge of RVSM

operating procedures and practices is equivalent to that set for AOC Holders, sufficient to hold approval to conduct RVSM operations. Guidance on the content of Flight Crew training programmes and operating practices and procedures is given in Section 5 of this document. This material is identical to Appendix 4 of TGL No.6. The European RVSM ATC Procedures which are set out in Section 6 of this document are copied in Appendix 6 to TGL No.6.

- Operations Manuals and Checklists - the appropriate manuals and checklists should be revised to include information/guidance on standard operating procedures for RVSM operations.

- Past Performance - relevant operating history, where available, should be included in the application. The applicant should show that changes needed in training, operating or maintenance practices to improve poor height keeping performance, have been made.

- Minimum Equipment List (MEL) - where applicable, an MEL, adapted from the Master Minimum Equipment List (MMEL) and relevant operational regulations, should include items pertinent to operating in RVSM airspace.

- Maintenance - when application is made for operational approval, the operator should establish a maintenance programme acceptable to the responsible authority.

- Plan for participation in the Performance Verification/Monitoring Programmes - this plan will need to include, as a minimum, a check on a sample of the operators fleet by an independent height monitoring system.

3 The application of the RVSM approval process and the monitoring programmes may be sufficient to verify the height keeping performance of an aircraft. However, the final step of the approval process may require a demonstration flight. The responsible authority may appoint an inspector for a flight in RVSM airspace to verify that all procedures are applied effectively. If the performance is satisfactory, the operator will be eligible for RVSM approval.

4 Issue of RVSM Approval.

- For AOC Holders - approvals will be issued by the appropriate authority in accordance with Joint Airworthiness Requirements (JAR OPS 1). Each aircraft group for which the operator is granted approval will be listed in the Approval.

- For Non AOC Holders - these operators will be issued with an Approval as required by national regulations or with JAR OPS 2 when this is published. These approvals will be valid for a period specified in National Regulations, typically 2 years, and may require renewal.

5 Suspension or Revocation of Approval for RVSM Operations.

5.1 The incidence of height keeping errors that can be tolerated in an RVSM environment is small. Thus Operators will be expected to take immediate action to rectify the conditions which cause an error. The operator should report an occurrence involving poor height keeping to the responsible authority within 72 hours. The report should include an initial analysis of causal factors and measures taken to prevent any reoccurrence. The need for follow up reports will be determined by the responsible authority.

5.2 Occurrences that should be reported and investigated are height keeping errors which display a :

- TVE equal to or greater than 300 ft (90m)
- ASE equal to or greater than 245 ft (75m)
- AAD equal to or greater than 300 ft (90m)

5.3 An Operator that consistently experiences height keeping errors, whether they are due to technical or operational causes, will have approval for RVSM operations revoked. If a problem is related to one specific aircraft type, then RVSM operational approval may be revoked for that specific type within the Operator's fleet. If an Operator's response to a notification of an height keeping error is not timely or effective, then the relevant authority may consider suspending or revoking RVSM approval.

6 Provision for the monitoring of aircraft:

6.1 A programme to monitor or verify aircraft height-keeping performance is considered a necessary element of European RVSM implementation. Verification and monitoring programmes have the basic objective of observing and evaluating the height-keeping performance of MASPS equipped aircraft to :

a) confirm the efficacy of the RVSM MASPS
b) monitor the effectiveness of the approval process.
c) confirm that required safety levels will be achieved when RVSM is implemented.

7 Data base of State approvals

7.1 State aviation authorities will be expected to maintain a State Data Base (SDB) of all approvals which they have granted for operations in RVSM airspace. The details of the compilation and formatting of the data and the system operating parameters are under development. Ideally, the SDBs will provide data to one or more Central Data Bases (CDBs), including the NAT Central Monitoring Agency (CMA). This would facilitate the tactical monitoring of the approval status of those aircraft which have flight planned to operate in RVSM airspace, should such monitoring be considered necessary.

Appendix F

*Following is an extract of the relevant section (Parts 5) of the ICAO Document "*Guidance Material on the Implementation of a 300m (1000ft) Vertical Separation Minimum in the European RVSM Airspace": *Flight Crew Training Programmes and Operating Practices and Procedures*

It is intended as a means of providing background material of sufficient detail to allow operational ATC personnel to gain an appreciation of the subject. The contents of this appendix, therefore should not be considered as authoritative.

FLIGHT CREW TRAINING PROGRAMMES AND OPERATING PRACTICES AND PROCEDURES

1. Introduction

1.1 Flight crews will need to have an awareness of the criteria for operating in RVSM airspace and be trained accordingly. The items detailed in paragraphs 2 to 6 should be standardised and incorporated into training programmes and operating practices and procedures. Certain items may already be adequately standardised in existing procedures. New technology may also remove the need for certain actions required of the flight crew. If this is so, then the intent of this guidance can be considered to be met.

Note: *This guidance material has been developed for all users of RVSM airspace, and as such is designed to present all required actions. It is recognised that some material may not be necessary for larger public transport operators.*

2. Flight Planning

2.1 During flight planning the flight crew should pay particular attention to conditions that may affect operation in RVSM airspace.

2.1.1 These include, but may not be limited to:

- verifying that the airframe is approved for RVSM operations;
- reported and forecast weather on the route of flight;
- minimum equipment requirements pertaining to height keeping and alerting systems; and
- any airframe or operating restriction related to RVSM approval.

3. Pre-flight procedures at the aircraft for each flight

3.1 The following actions should be accomplished during the pre-flight procedure:

- review technical logs and forms to determine the condition of equipment required for flight in the RVSM airspace. Ensure that maintenance action has been taken to correct defects to required equipment;
- during the external inspection of aircraft, particular attention should be paid to the condition of static sources and the condition of the fuselage skin near each static source and any other component that affects altimetry system accuracy. This check may be accomplished by a qualified and authorised person other than the pilot (e.g. a flight engineer or ground engineer);
- before takeoff, the aircraft altimeters should be set to the QNH of the airfield and should display a known altitude, within the limits specified in the aircraft operating manuals. The two primary altimeters should also agree within limits specified by the aircraft operating manual. An alternative procedure using QFE may also be used. Any required functioning checks of altitude indicating systems should be performed.
- Note. *The maximum value for these checks cited in operating manuals should not exceed 23m (75 ft).*
- before take-off, equipment required for flight in RVSM airspace should be operative, and any indications of malfunction should be resolved.

4. Procedures prior to RVSM airspace entry

4.1 The following equipment should be operating normally at entry into RVSM airspace:

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

Note: *Dual equipment requirements for altitude-control systems will 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.*

- Operating Transponder. An operating transponder may not be required for entry into all designated RVSM airspace. The operator should determine the requirement for an operational transponder in each RVSM area where operations are intended. The operator should also determine the transponder requirements for transition areas next to RVSM airspace.

    Note: *Should any of the required equipment fail prior to the aircraft entering RVSM airspace, the pilot should request a new clearance to avoid entering this airspace;*

5 In-Flight Procedures

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

- Flight crews will need to comply with any aircraft operating restrictions, if required for the specific aircraft group, e.g. limits on indicated Mach number, given in the RVSM airworthiness approval.

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

- In level cruise it is essential that the aircraft is flown at the cleared flight level. This requires that particular care is taken to ensure that ATC clearances are fully understood and followed. The aircraft should not intentionally depart from cleared flight level without a positive clearance from ATC unless the crew are conducting contingency or emergency manoeuvres;

- When changing levels, the aircraft should not be allowed to overshoot or undershoot the cleared flight level by more than 45 m (150 ft);

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

- An automatic altitude-control system should be operative and engaged during level cruise, except when circumstances such as the need to re-trim the aircraft or turbulence require disengagement. In any event, adherence to cruise altitude should be done by reference to one of the two primary altimeters. Following loss of the automatic height keeping function, any consequential restrictions will need to be observed.

- Ensure that the altitude-alerting system is operative;

- At intervals of approximately one hour, cross-checks between the primary altimeters should be made. A minimum of two must agree within ±200 ft (±60 m). Failure to meet this condition will require that the altimetry system be reported as defective and notified to ATC;

  the usual scan of flight deck instruments should suffice for altimeter cross-checking on most flights.

- In normal operations, the altimetry system being used to control the aircraft should be selected for the input to the altitude reporting transponder transmitting information to ATC.

- If the pilot is advised in real time that the aircraft has been identified by a height-monitoring system as exhibiting a TVE greater than ±300 ft (±90 m) and/or an ASE greater than ±245 ft (±75 m) then the pilot should follow established regional procedures to protect the safe operation of the aircraft. This assumes that the monitoring system will identify the TVE or ASE within the set limits for accuracy.

- If the pilot is notified by ATC of an assigned altitude deviation of 300 ft (90 m) or more then the pilot should take action to return to cleared flight level as quickly as possible.

5.2 Contingency procedures after entering RVSM airspace are:

5.2.1 The pilot should notify ATC of contingencies (equipment failures, weather) which affect the ability to maintain the cleared flight level, and co-ordinate an appropriate plan of action.

5.2.2 Examples of equipment failures which should lead to notification to ATC:

- failure of all automatic altitude-control systems aboard the aircraft;
- loss of redundancy of altimetry systems,
- loss of thrust on an engine necessitating descent; or
- any other equipment failure affecting the ability to maintain cleared flight level

5.2.3 The pilot should notify ATC when encountering greater than moderate turbulence.

5.2.4 If unable to notify ATC and obtain an ATC clearance prior to deviating from the assigned cleared flight level, the pilot should follow the established contingency procedures and obtain ATC clearance as soon as possible.

6. Post Flight

6.1 In making technical log 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.

6.2 The following information should be recorded when appropriate:

- Primary and standby altimeter readings.

- Altitude selector setting.

- Sub-scale setting on altimeter.

- Auto-pilot used to control the aeroplane and any differences when an alternative auto-pilot system was selected.

- Differences in altimeter readings, if alternate static ports selected.

- Use of air data computer selector for fault diagnosis procedure.

- The transponder selected to provide altitude information to ATC and any difference noted when an alternative transponder was selected.

7 Special Emphasis Items: Flight Crew Training

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

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

- importance of crew members cross checking to ensure that ATC clearances are promptly and correctly complied with;

- use and limitations in terms of accuracy of standby altimeters in contingencies. Where applicable, the pilot should review the application of static source error correction/ position error correction through the use of correction cards;

  Note: Such correction data will need to be readily available on the flight deck.

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

- characteristics of aircraft altitude capture systems which may lead to overshoots.

- relationship between the aircraft's altimetry, automatic altitude control and transponder systems in normal and abnormal conditions.

- any airframe operating restrictions, if required for the specific aircraft group, related to RVSM airworthiness approval.

Appendix G

*Following is an extract of the relevant section (Parts 7) of the ICAO Document "*Guidance Material on the Implementation of a 300m (1000ft) Vertical Separation Minimum in the European RVSM Airspace": *System Performance Monitoring*

It is intended as a means of providing background material of sufficient detail to allow operational ATC personnel to gain an appreciation of the subject. The contents of this appendix, therefore should not be considered as authoritative.

SYSTEM PERFORMANCE MONITORING

1 Introduction

1.1 This Part provides guidance on the monitoring of operations in European RVSM airspace. The objectives of the monitoring programme are to ensure that the level of collision risk does not exceed the TLS and to assess the compliance of aircraft with the global height keeping performance specification (paragraph 2.2 refers). This information will be taken into account by decision makers in judging whether overall safety goals applicable to the European RVSM airspace are being achieved.

1.2 The overall criterion for safety in the European RVSM area is that the TLS of 5×10^{-9} fatal accidents per flight hour (representing the risk due solely to the loss of vertical separation from any cause) is not exceeded. The agreed method of assessing actual collision risk is by the use of a variant of the Reich collision risk model (CRM) suitable to the area.

1.3 The height-keeping errors which will contribute to collision risk in the European RVSM area can be divided into two categories; technical errors and operational errors. Technical errors, i.e. Altimetry System Errors (ASE) are caused by inaccuracies in the height-keeping equipment of aircraft, whereas, operational errors, i.e. Assigned Altitude Deviation (AAD), are caused by mistakes, by ATC or Flight Crew, which result in aircraft being flown at incorrect flight levels. ASE and AAD are

the main constituents of Total Vertical Error (TVE). As aircraft operations in the European area are, for the larger part, conducted under tactical radar control together with some procedural separation, the frequency of occurrence, size and duration of operational errors can be greatly reduced. Nevertheless, operational errors can, and do, occur and may make a significant contribution to the overall collision risk. The TLS has been chosen to take account of the risk from both technical errors and operational errors.

1.4 In order to ensure that the TLS is not being exceeded, it is necessary to monitor both the occurrence of vertical errors and the CRM parameter values on a continuing basis. Many of the parameter values used in the CRM are based on a planning horizon of approximately 10 years and require periodic monitoring.

1.5 The CRM parameters fall into two groups from the stand-point of monitoring requirements. The first group consists of two important parameters which are critical for safety assessment, in the sense that the actual risk in the airspace changes in proportion to changes in their values. The first of these parameters is an estimate of the proportion of flight time spent by aircraft, nominally separated by 1 000 ft, in vertical overlap. This parameter is a function of the height-keeping performance of the overall aircraft population. It is termed the "vertical overlap probability" and denoted by the term “Pz(1000)”. The second of these parameters is an estimate of the number of aircraft plan overlap events per aircraft flight hour.

1.6 The second group of CRM parameters is less demanding either because the CRM is relatively insensitive to their values, or because they are not expected to change substantially over the planning horizon of this document. They should be re-assessed periodically to ensure that their values reflect the current European RVSM airspace system.

1.7 It must be emphasised that the monitoring requirements, in particular the measurement of TVE, have been established at a stringent level appropriate to the first application of RVSM in a complex, high density continental airspace. As a result of initial work done in the NAT, and the additional data and operational experience which will be gained in Europe, it may be possible in the future to relax some of the monitoring requirements in the European area and in other regions where the RVSM is introduced as a part of the global implementation process.

1.8 All of the measures which combine to constitute, or to verify, the height-keeping performance of an aircraft play a part in the concept of monitoring which is expected to make a significant contribution to risk reduction. The measures include:

- the requirement for aircraft to carry and use the equipment defined in the MASPS;
- the initial installation procedures, tests and, where necessary, flight checks of aircraft altimetry equipment;
- the compliance with State airworthiness approval procedures;
- the compliance with continued airworthiness requirements;
- the adherence to ATC procedures; and
- the completion of in-flight operating drills by crews.

1.9 All of the foregoing measures are addressed in the relevant parts of this guidance material. However, these measures do not give a direct indication that the overall criterion for safety is met. This can be achieved only through independent system performance monitoring.

2 The Collision Risk Model

2.1 The risk of a mid-air collision due to a loss of vertical separation, from any cause, will be estimated using a CRM which is currently being adapted to meet the specific requirements of European airspace. The model brings together factors of the operational system, through probabilistic and deterministic elements, to produce an estimate of the long-term average system risk of aircraft collision.

2.2 The TLS for the European RVSM airspace, of 5 $x10^{-9}$ fatal accidents per flight hour, embodies the collision risk due to the loss of vertical separation from all causes. This represents the upper limit for the value of N_{az} which results when the collision risk equation is evaluated. That is, the N_{az} can not be larger than the TLS.

3 Monitoring the Parameters of the CRM specification

In order to ensure that the collision risk with European RVSM operations does not exceed the TLS, the parameters of the CRM must be monitored and assessed on a continuing basis.

3.1 MONITORING OF PZ(1 000)

3.1.1 Monitoring of height keeping performance in the European RVSM airspace

3.1.1.1 The agreed TLS of 5×10^{-9} fatal accidents per flight hour requires that an assessment of total system vertical overlap probability (Pz(1000)) be performed. This requires that the duration of all large errors in the vertical plane be reported and assessed. Thus, in addition to errors detected through the height monitoring system, all operational errors which occur in European RVSM airspace and which result in aircraft flying at or close to a flight level other than the one to which they were assigned, or were assigned to in error, must be reported.

3.1.1.2 The contribution of operational errors to the overall risk is not yet known but could be high in the European area. However, because the majority of aircraft in the region are controlled tactically using radar surveillance, it is anticipated that controller intervention will limit or reduce the size and duration of operational errors. Nonetheless, it is vital that reports of all operational errors should be sent by provider States to the designated monitoring agency.

3.1.1.3 System risk is directly proportional to the amount of total flight time spent by aircraft at an incorrect flight level. The estimates of such times will be one of the key elements to be used in determining whether or not the system is in compliance with the TLS, using appropriate mathematical and statistical methods.

3.1.1.4 Data sources for estimating time spent by aircraft at incorrect flight levels will include reports to the designated monitoring agency by ATC authorities and airlines, as well as the results of special data gathering exercises using HMUs and other suitable systems.

3.1.2 Monitoring of Compliance with the Global System Performance Specification

3.1.2.1 In addition to the requirement that total system performance meets the overall TLS, the monitoring process will be used to ensure that the fleet of aircraft flying in the European RVSM airspace meets the global system performance specification from which the RVSM MASPS was derived (paragraph 2.2.3 above also refers).

3.1.2.2 Because the global system performance specification, and in particular the Pz(1000) of 1.7×10^{-8}, was used to derive aircraft height keeping performance specifications, only errors resulting from incorrectly operating equipment are included in this aspect of the monitoring programme.

3.1.2.3 An assessment of TVE is critical to an assessment of Pz(1 000). As a result, the accuracy with which TVE can be measured is an important concern. TVE can be measured by comparing the geometric height of an aircraft, as measured by an HMU, or any other suitable system, to the geometric height of its assigned flight level. The accuracy of the measurement should be such that the mean error is 0 ft and the SD of the error does not exceed 50 ft.

3.1.2.4 These measured TVE data are fundamental to the monitoring process. Large amounts of such TVE data are needed to draw inference from the monitoring process with a high level of confidence.

3.1.2.5 Given a measured TVE and a simultaneous difference between automatically reported Mode C altitude and assigned flight level (i.e. the AAD), it is possible to estimate the aircraft's ASE, i.e., the difference between its TVE and AAD. Thus it is important to obtain as much measured TVE data as possible, in order to calculate typical ASE values for airframes and for aircraft types, before and during initial applications of the RVSM, to determine whether these ASE values are constant and repeatable. If this can be shown it will become possible to estimate an aircraft’s TVE from a knowledge of the Mode C (or Mode S or ADS) altitude.

3.2 MONITORING AIRCRAFT PASSING EVENTS INVOLVING PLAN OVERLAP

3.2.1 In addition to an upper bound for Pz(1000), the original form of the global system performance specification provided upper bounds for aircraft passing frequency and

the probability of lateral overlap. These values were derived for opposite direction traffic.

3.2.2 However, because the majority of traffic in European RVSM airspace will fly on crossing routes and because a growing proportion of traffic is expected to be flying direct routes in the future, the global system performance specification has been reformulated in terms of passing events involving plan overlap.

3.2.3 The aircraft passing frequency involving plan overlap in the European area will be assessed on a monthly basis by the designated monitoring agency using traffic data supplied by the ATC authorities. It is anticipated that the level of this parameter may be close to that used to derive the aircraft height-keeping performance in the global system performance specification.

3.3 MONITORING OTHER CRM PARAMETERS

3.3.1 The remaining CRM parameters are average aircraft speed, relative speed between aircraft, and the average length, width and height of the aircraft operating in the European airspace. As stated previously, the risk of a mid-air collision is either relatively insensitive to these parameter values, or the values are not expected to change substantially over the planning horizon of this document. Intensive monitoring of the values of these parameters should not be necessary. The designated monitoring agency should be aware of the relative importance of these parameters in the overall process of ensuring that system safety is maintained, and should assess their likely values, on a periodic basis, using whatever means are deemed appropriate.

4 Assessment of the safety of European RVSM operations

4.1 The airspace parameters which are derived from the monitoring procedures outlined above allow the collision risk, in the vertical plane, in the airspace system to be assessed against the TLS. The height-keeping performance of aircraft can also be assessed and compared to the requirements of the global height-keeping performance specification outlined in paragraph 2.2.2 above.

4.2 Prior to implementation of RVSM in the European area, mathematical and statistical techniques will be used to provide detailed information on the forecast performance of the system in terms of collision risk and aircraft height-keeping performance. After implementation of RVSM the monitoring of the CRM parameters and the assessment of the system performance will continue so that any adverse trends may be quickly identified and corrected.

4.3 During the performance verification programme, and after implementation of RVSM, periodic reports will be issued to provide an analysis of the information obtained from routine monitoring procedures (HMU and GMU), mandatory occurrence reports, air-miss data, near mid-air collision reports or any other similar source of information on aircraft height-keeping performance. The appropriate European body should take action as necessary to ensure that the level of collision risk is maintained below the TLS.

5 Responsibilities of the designated monitoring agency

5.1 The designated monitoring agency will be responsible for the efficient and effective performance of the above monitoring tasks. To this end it will be necessary to :

- ensure the availability of all data required for the monitoring system,
- ensure the availability of monitoring system output,
- process the monitoring system output,
- take follow-up action after the detection of large height deviations,
- perform safety assessment.
- make recommendations to improve height keeping performance.
- issue periodic reports

6 Objectives of the Height Monitoring System

6.1 In order to recommend a monitoring system, it was necessary first to define overall monitoring targets. Following a review of information and data collected in the vertical studies programme and the monitoring activities in the NAT Region, it was assumed that ASE for individual airframes would be stable for a period of two years. Two important objectives of the Performance Verification programme (P1) were therefore

to establish the ASE performance of the airframes which will operate the European RVSM airspace and to confirm the assumptions concerning the stability of ASE.

6.2 On the basis of the above assumption, it was possible to establish the objectives of the monitoring programme and to consider how these objectives could be met. Firstly, the ultimate objective was to carry out a complete census of airframes. The monitoring system should therefore be designed to be capable, in principle, of performing such a census over a period of one year. Because a complete census may prove to be an impractical target during the performance verification programme, the minimum targets, listed below, were agreed. These should enable the monitoring cell to collect sufficient information on the height keeping performance of aircraft operating in the European Region:

6.2.1 Monitoring Targets

6.2.1.1 Monitoring targets for the Performance Verification programme for those aircraft considered to be members of an Aircraft Group.[1]

6.2.1.1.1 A minimum target of 60%* of the airworthiness approved airframes of each aircraft group from each operator is required in order to generate sufficient monitoring data to confirm whether a particular group is compliant with the MASPS.

* Note :Alternatively, this percentage may be reduced (to a minimum of 10% or 2 aircraft whichever is greater) if it can be shown, based on the ASE results, that a sufficient number of aircraft of the same group have been sampled to satisfy the requirement that the aircraft group meets the MASPS with a high level of confidence.

6.2.1.1.2 The method to determine whether a group[1] is compliant with the MASPS, and the organisational aspects of the application of that method, will have to be defined, taking into account the need for a strong coherence with NAT practices.

6.2.1.1.3 Any airworthiness approved group aircraft failing individual requirements (i.e. the absolute value of ASE > 245ft) would be deemed non-compliant. In making this decision allowance would have to be made for the measurement error of the height monitoring system.

6.2.1.2 Monitoring targets for the Performance Verification programme for aircraft which do not qualify as members of an aircraft group[2.]

6.2.1.2.1 All airworthiness approved aircraft need to be monitored on an individual basis unless flight test evidence can be provided to show that each airframe is compliant with ASE targets.

6.2.1.2.2 Any airworthiness approved aircraft failing individual requirements (i.e., the absolute value of ASE > 200ft) would be deemed non-compliant. In making this decision allowance would have to be made for the measurement error of the height monitoring system.

6.2.1.3 Use of NAT experience - After consideration of the data and experience gained in the monitoring of the NAT RVSM operations, the following principles were adopted for the European Region : :

- the European RVSM monitoring programme will not be part of the European RVSM approval process for airframes. The monitoring output will only be used to determine the go-ahead for the introduction of RVSM (P2.6).
- the number of aircraft of a particular operator which were monitored in the NAT programme should be taken into account in determining how many aircraft of that operator should be monitored in the European monitoring programme;
- in general, any operator-group pairings, or non-group aircraft, already satisfying the monitoring requirements through participation in the NAT RVSM programme would not require any further monitoring; and
- those aircraft groups, for which the reduced “10% or minimum of 2” rule is applied in the NAT monitoring programme, will satisfy the European RVSM monitoring requirements with that same rule.

6.2.1.4 Conclusion of Performance Verification programme - Subject to a satisfactory collision risk assessment and other operational considerations, the introduction of RVSM could be made provided that 90% of the flights in the area of interest would be made by operator-aircraft group pairings or non-group aircraft that have satisfied the monitoring requirements during the verification programme.

Notes :

(1) Group aircraft are those of nominally identical design and build with respect to all details that could influence the accuracy of height keeping performance. A detailed explanation is given in JAA TGL No.6 Para 9.3.1.

(2) Non group aircraft are those aircraft not falling under the definition of group aircraft.

6.3 These targets are considered to be the minimum necessary to ensure that a representative sample of MASPS approved aircraft will be obtained. The data obtained from a monitoring programme that meets these targets will be sufficient to provide:

- further evidence of the stability of ASE;
- guidance on the efficacy of the MASPS and on the effectiveness of altimetry system modifications; and
- confidence that the TLS will be met.

6.4 It is important to note that these minimum targets have been agreed on the assumption that the observed aircraft height keeping performance would meet the global requirements and consequently that the collision risk due to technical errors would be less than the technical aspect of the TLS. If the observed performance proved to be significantly worse than the global height keeping requirements, then the minimum sampling requirements might have to be increased to determine both the cause of the errors and whether or not the regional TLS would be threatened.

7 Description of the Height Monitoring System

1 Currently there are two accepted methods of measuring aircraft height keeping performance. These are :

- Height Monitoring Unit (HMU). This is a fixed ground based system which employs a network of a Master and 4 Slave Stations to receive aircraft SSR Mode A/C signals to establish the three dimensional position of the aircraft. The geometric height of the

aircraft is measured to an accuracy of 50 ft (1 Standard Deviation (SD)). This is compared, in near real time, with meteorological input data on the geometric height of the assigned Flight (Pressure) Level to obtain a measurement of the Total Vertical Error (TVE) of the target aircraft. The aircraft SSR Mode C data is also recorded to determine the extent of any Assigned Altitude Deviation (AAD) and for subsequent aircraft identification, when the SSR Mode S response is not available.

- GPS Monitoring Unit (GMU). A GMU is a portable "box" (contained in a carry case approximately 45 x 40 x 30 cm^3) which contains a GPS receiver, a device for recording and storing the GPS three dimensional position data, and two separate GPS receiver antenna's which need to be attached to aircraft windows using suction pads. The GMU is positioned on board the candidate aircraft and, being battery powered, functions independently of the aircraft systems. Following the flight the recorded GPS data are sent back to a central site where, using differential post processing, aircraft geometric height is determined. A network of not more than 25 GMUs will make up the GPS Monitoring System (GMS).

2 It is intended that the European Height Monitoring System should be a hybrid system of HMUs and GMUs which makes optimum use of the advantages offered by each. Thus the strategic and inflexible characteristics of the HMUs, which can provide a large and predictable rate of collection of high quality data at relatively high installation and low maintenance/ongoing operating costs, can be blended with the tactical flexibility of the GMU which permits the targeting of specific aircraft at a low initial purchase price, but with relatively high operating costs in both manpower and logistics. The resultant system will be capable of acquiring a representative sample of the height keeping performance of the aircraft population by operator, type or airframe. or if required, a complete census of RVSM approved aircraft.

3 Over a period of time the HMUs will provide repeat samples of the height keeping performance of individual aircraft. These data will establish the typical ASE range for a variety of aircraft types and will be the basis of the studies to determine whether the assumptions regarding the stability and repeatability of ASE are valid.

4 Those aircraft which normally operate on routes which do not pass within the effective range of one of HMUs will be candidates for monitoring by the GMS. The

GMS can also be used to obtain repeat measurements of airframes and aircraft types which have been shown to be poor performers.

4 A combination of HMUs and a GMS is expected to provide the most efficient means of achieving the verification and monitoring objectives. Furthermore, because of the complementary nature of the systems, both elements (HMU/GMS) are equally critical to the composition of the hybrid system.

5 It is currently planned that the height monitoring system for the European RVSM airspace will consist of four HMUs, of which one (Strumble, United Kingdom) also belongs to the NAT height monitoring system. The other three HMUs with an extended coverage area, will be placed near Nattenheim (Germany), Geneva (Switzerland) and Linz or Sollenau (Austria). The GMS will consist of not more than 25 GMUs, together with GPS reference stations, post-flight processing facilities and adequate logistic support.

Appendix H

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