Regional Seminar on MMEL/MEL and Special Operations

[Airbus Amber]

Organized by ICAO Regional Office for Western and Central Africa (WACAF)

Dakar - Senegal - from 30 June to 5 July 2025

RVSM (Reduced Vertical Separation Minima)

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AIRBUS

Content

Need more FUEL OPTIMUM profiles & increase AIRSPACE CAPACITY

RVSM airspace

RVSM: Background

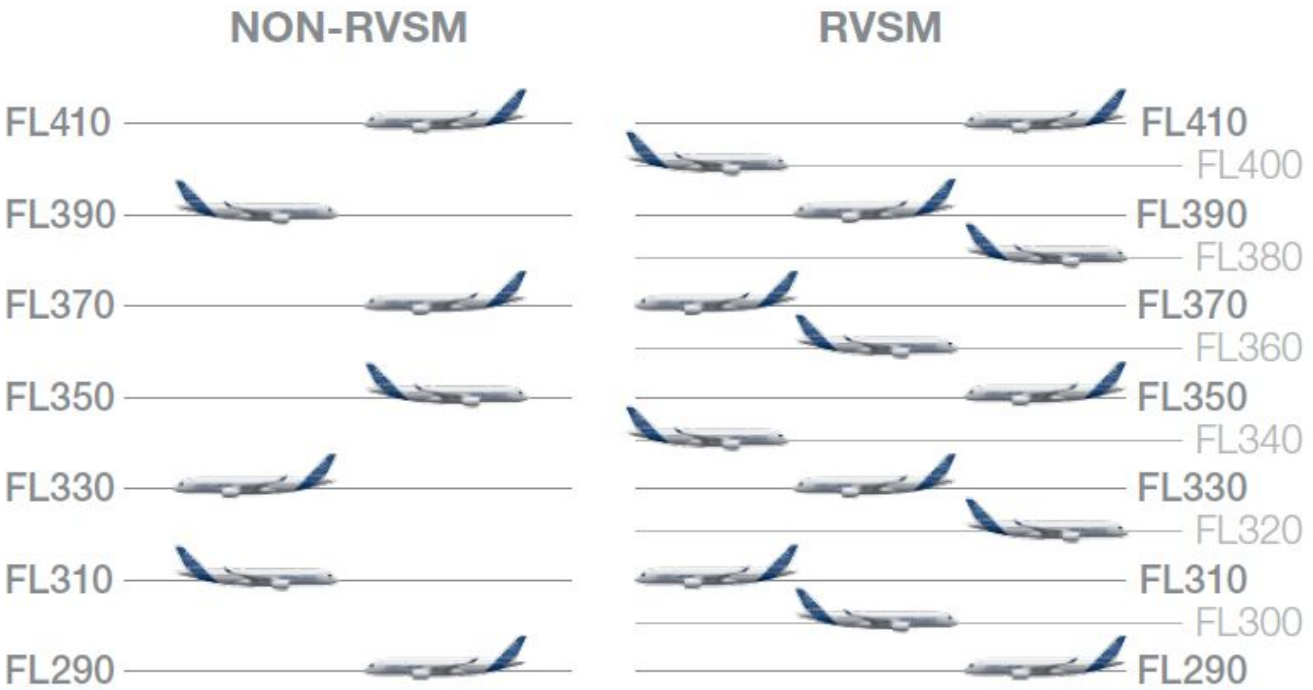
[Airbus Amber]

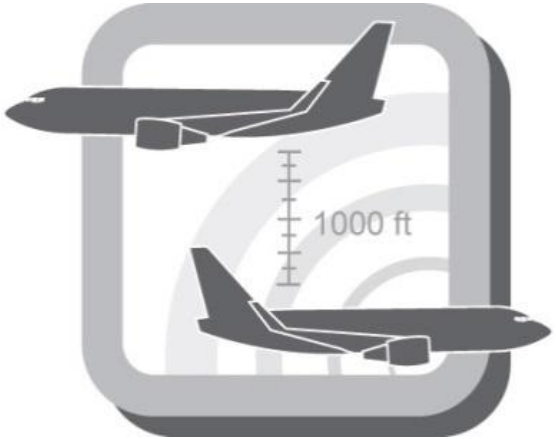
Reduced

Vertical

Separation

Minimum





From To

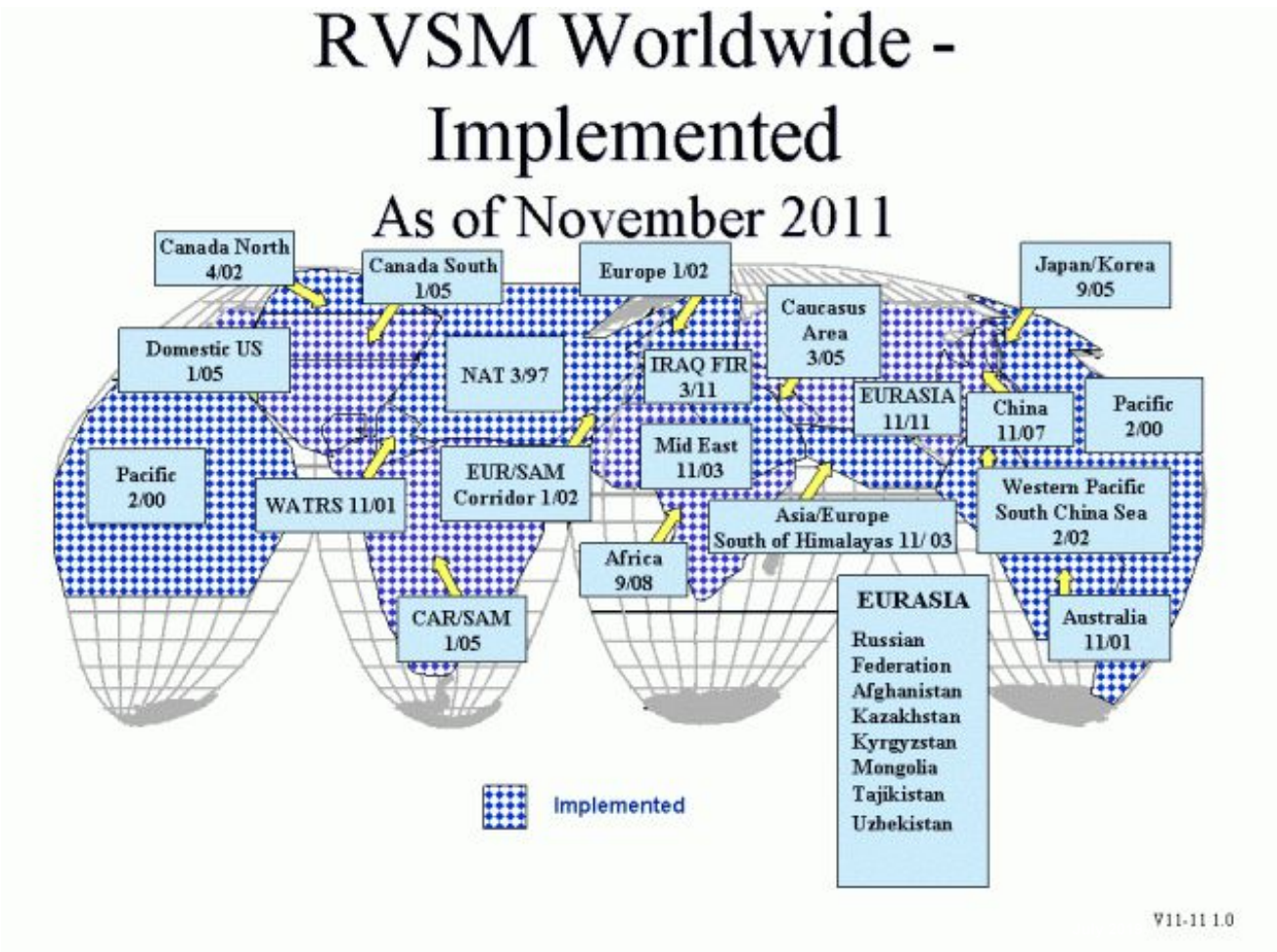
[FL290 - FL410]

Reduced Vertical Separation ⇒ 1000 ft

Instead of 2000 ft in non-RVSM

extension to FL450 under study

Existing Coverage



Content

RVSM

RVSM : Operational approval

RVSM approval based on ability to maintain accurate FL

Ops Approval required

based on

- **A/C A/W certification**
- **Initial Operational Approval**
- **Monitoring program**

RVSM : Operational approval - Regulations

[Airbus Amber]

ICAO Annex 6 (app4 & section 7.2)

JAA TGL 6 Rev1

EASA CS-ACNS.E.RVSM

AIR OPS - Part SPA - RVSM

Federal Aviation Administration

FAA Interim guidelines 91-RVSM

FAA appendix G part 91

APPENDIX 4. ALTIMETRY SYSTEM PERFORMANCE REQUIREMENTS FOR OPERATIONS IN RVSM AIRSPACE

(Chapter 7, 7.2.7, refers)

1. In respect of groups of aeroplanes that are nominally of identical design and build with respect to all details that could influence the accuracy of height-keeping performance, the height-keeping performance capability shall be such that the total vertical error (TVE) for the group of aeroplanes shall have a mean no greater than 25 m (80 ft) in magnitude and shall have a standard deviation no greater than $28 - 0.013z^2$ for $0 \leq z \leq 25$ when z is the magnitude of the mean TVE in metres, or $92 - 0.004z^2$ for $0 \leq z \leq 80$ where z is in feet. In addition, the components of TVE shall have the following characteristics:

a) the mean altimetry system error (ASE) of the group shall not exceed 25 m (80 ft) in magnitude;

b) the sum of the absolute value of the mean ASE and of three standard deviations of ASE shall not exceed 75 m (245 ft); and

c) the differences between cleared flight level and the indicated pressure altitude actually flown shall be symmetric about a mean of 0 m, with a standard deviation no greater than 13.3 m (43.7 ft), and in addition, the decrease in the frequency of differences with increasing difference magnitude shall be at least exponential.

2. In respect of aeroplanes for which the characteristics of the airframe and altimetry system fit are unique and so cannot be classified as belonging to a group of aeroplanes encompassed by paragraph 1, the height-keeping performance capability shall be such that the components of the TVE of the aeroplane have the following characteristics:

a) the ASE of the aeroplane shall not exceed 60 m (200 ft) in magnitude under all flight conditions; and

b) the differences between the cleared flight level and the indicated pressure altitude actually flown shall be symmetric about a mean of 0 m, with a standard deviation no greater than 13.3 m (43.7 ft), and in addition, the decrease in the frequency of differences with increasing difference magnitude shall be at least exponential.

RVSM : Operational approval

[Airbus Amber]

AIR-OPS SPA.RVSM

SUBPART D

OPERATIONS IN AIRSPACE WITH REDUCED VERTICAL SEPARATION MINIMA (RVSM)

SPA.RVSM.100 RVSM operations

Aircraft shall only be operated in designated airspace where a reduced vertical separation minimum of 300 m (1 000 ft) applies between flight level (FL) 290 and FL 410, inclusive, if the operator has been granted an approval by the competent authority to conduct such operations.

SPA.RVSM.105 RVSM operational approval

To obtain an RVSM operational approval from the competent authority, the operator shall provide evidence that:

(a) the RVSM airworthiness approval has been obtained;

(b) procedures for monitoring and reporting height-keeping errors have been established;

(c) a training programme for the flight crew members involved in these operations has been established;

(d) operating procedures have been established specifying:

- (1) the equipment to be carried, including its operating limitations and appropriate entries in the MEL;
- (2) flight crew composition and experience requirements;
- (3) flight planning;
- (4) pre-flight procedures;
- (5) procedures prior to RVSM airspace entry;
- (6) in-flight procedures;
- (7) post-flight procedures;
- (8) incident reporting;
- (9) specific regional operating procedures.

AIR-OPS SPA.RVSM

SPA.RVSM.110 RVSM equipment requirements

Aircraft used for operations in RVSM airspace shall be equipped with:

(a) two independent altitude measurement systems;

(b) an altitude alerting system;

(c) an automatic altitude control system;

(d) a secondary surveillance radar (SSR) transponder with altitude reporting system that can be connected to the altitude measurement system in use for altitude control.

SPA.RVSM.115 RVSM height-keeping errors

(a) The operator shall report recorded or communicated occurrences of height-keeping errors caused by malfunction of aircraft equipment or of operational nature, equal to or greater than:

(1) a total vertical error (TVE) of ± 90 m (± 300 ft);

(2) an altimetry system error (ASE) of ± 75 m (± 245 ft); and

(3) an assigned altitude deviation (AAD) of ± 90 m (± 300 ft).

(b) Reports of such occurrences shall be sent to the competent authority within 72 hours. Reports shall include an initial analysis of causal factors and measures taken to prevent repeat occurrences.

(c) When height-keeping errors are recorded or received, the operator shall take immediate action to rectify the conditions that caused the errors and provide follow-up reports, if requested by the competent authority.

AIR-OPS AMC SPA.RVSM

AMC2 SPA.RVSM.105 RVSM operational approval

OPERATING PROCEDURES

(a) Flight planning

(1) During flight planning the flight crew should pay particular attention to conditions that may affect operation in RVSM airspace. These include, but may not be limited to:

(i) verifying that the airframe is approved for RVSM operations;

(ii) reported and forecast weather on the route of flight;

(iii) minimum equipment requirements pertaining to height-keeping and alerting systems; and

(iv) any airframe or operating restriction related to RVSM operations.

(b) Pre-flight procedures

(1) The following actions should be accomplished during the pre-flight procedure:

(i) 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.

(ii) 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).

(iii) Before take-off, the aircraft altimeters should be set to the QNH (atmospheric pressure at nautical height) 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 (atmospheric pressure at aerodrome elevation/runway threshold) may also be used. The maximum value of acceptable altimeter differences for these checks should not exceed 23 m (75 ft). Any required functioning checks of altitude indicating systems should be performed.

Rules for Aircraft

System Performance:

- Mean ASE deviation **< 245 ft**

- AP keep selected Alt **within 65 ft** under nor turbulent, no gust conditions.

ASE : Altimetry System Error: Difference between actual pressure altitude and the displayed altitude.

PRODUCTION FLIGHT TESTS DEPARTMENT

ANEMOMETRIC RECORDS

	MAIN SYSTEMS			STBY SYSTEMS	
	ADR 1 (CAPT)	ADR 2 (F/O)	ADR 3	ISIS 1 or STBY instruments	ISIS 2 *(if installed)*
ALTITUDE *(ft)*	31000	31005	30965	31140	(*)
AIRSPEED *(kts)*	300	300	300	301	(*)
MACH	0.807	0.807	0.805	0.81 (*)	(*)
ALTITUDE *(ft)*	34995	34995	34970	35010	(*)
AIRSPEED *(kts)*	264	264	263	264	(*)
MACH	0.779	0.779	0.777	0.78 (*)	(*)
ALTITUDE *(ft)*	39000	39000	38960	38940	(*)
AIRSPEED *(kts)*	242	242	241	240	(*)
MACH	0.782	0.782	0.780	0.78 (*)	(*)

Initial demonstration by OEM

Aircraft type certification

+ Production Flight test report

Minimum Equipment:

- 2 independent altitude measurement systems (i.e. 2 ADR and 2 main altitude indications).
- 2 PFD for altitude indication.
- 1 SSR transponder (mini Mode C alt reporting).
- 1 altitude alert system (FWC).
- 1 Autopilot function.
- 1 FCU altitude selection with OPEN CLB/DES engagement.

ADR (Air Data Reference System) / PFD (primary Flight Display) / FCU (Flight Control Unit)
SSR (secondary surveillance Radar) / FWC (Flight Warning Computer)

RVSM : AIRBUS capability

A300/A310/A320/A330/A340

Airworthiness capability demonstrated by dedicated Modification to TC (or SB)

A380/A350

Airworthiness capability demonstrated in TC

Now basic in production on all Airbus aircraft

TC (Type Certificate)

AIRBUS

A350
AIRPLANE FLIGHT MANUAL

Approved

REDUCED VERTICAL SEPARATION MINIMUM (RVSM)

Aircraft have been certified capable to perform RVSM operations according to CS-ACNS subpart E section 2 and FAA 91-RVSM requirements.

Note : Compliance with the standards noted above does not constitute an operational approval. Such authorization must be obtained by the operator from the appropriate authorities.

END

Caution

Aircraft capability statement
DOES NOT constitute an ops approval

⇨ Additional operator requirements

RVSM : Operational approval - AFM

AIRBUS

A350
AIRPLANE FLIGHT MANUAL

Approved

REDUCED VERTICAL SEPARATION MINIMUM (RVSM)

The following table gives the minimum equipment/functions to begin RVSM operation.

Minimum Equipment/Functions Required to Begin RVSM Operation

Required Equipment/Functions	Quantity
ADR	2
ATC transponder	1
FWS (for ALTITUDE ALERT function)	1
Autopilot	1
PFD function (for altitude indication)	2
AFS Control Panel (for altitude target selection and OP CLB/OP DES mode engagement)	1

END

Rules for Operator

A/C Airworthiness approval	AFM A/W compliance statement // Limitations
Flight crew qualification	Training
Operating procedures: Normal, abnormal	OM update based on FCOM
Minumum equipement to start, operating limitations, MEL	MEL update based on MMEL / FCOM
Validation	Validation flights
Monitoring program management	FDA

Pre-flight

- Check MEL

Pre-flight

AIRBUS A350 MASTER MINIMUM EQUIPMENT LIST	MMEL OPERATIONAL PROCEDURES 22 - AUTO FLIGHT 22-10 - AP/FD

22-10-01B	AP (both inoperative)

FLIGHT PREPARATION / LIMITATIONS

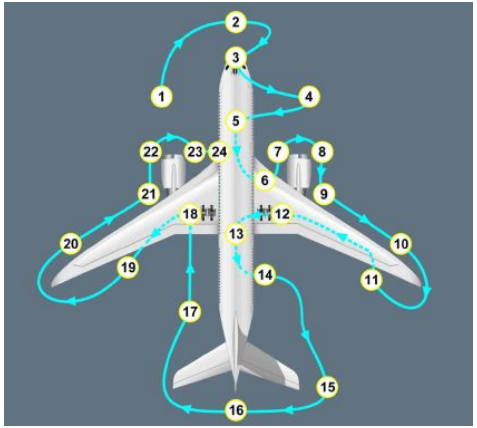
RNP AR operations strictly below 0.3 NM are not permitted.
RVSM operations are not permitted.
The maximum approach and landing capability is APPR1.

Pre-flight

- Check MEL

- External inspection (fuselage skin around static probes)

Pre-flight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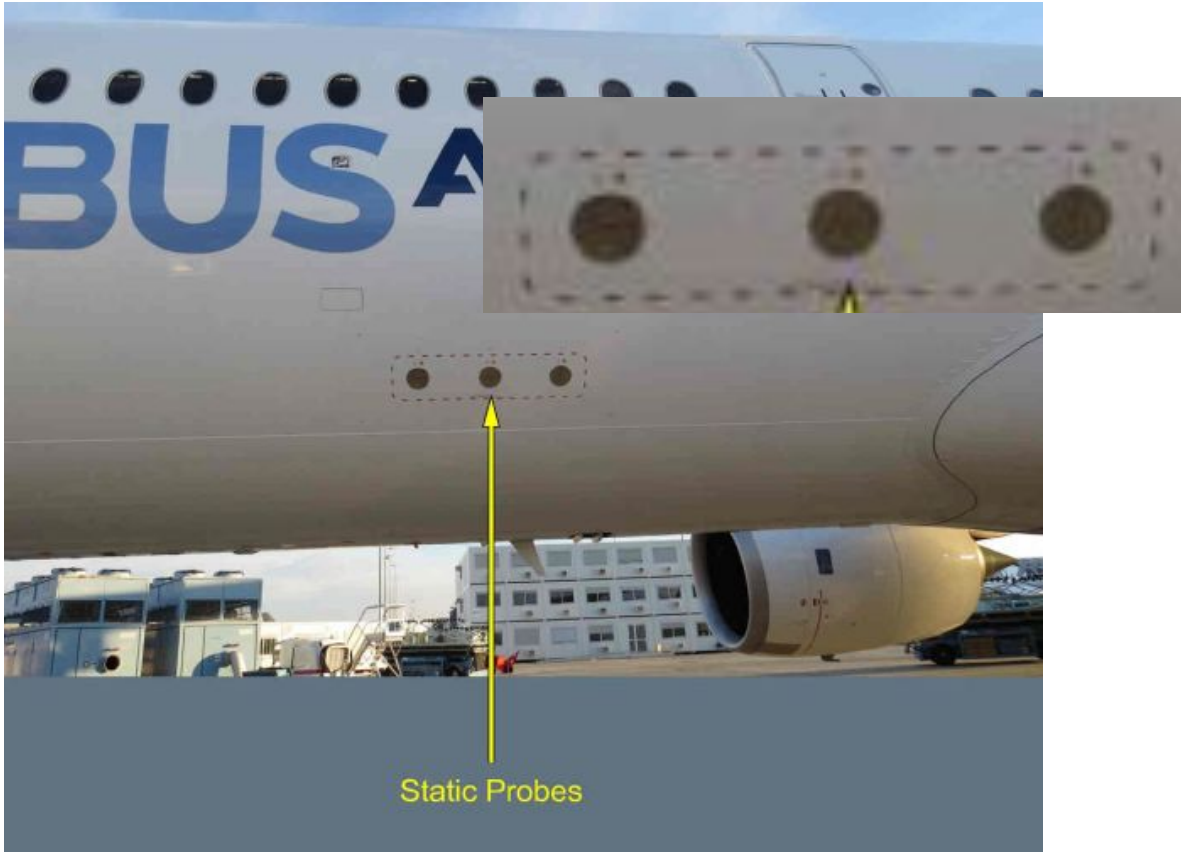
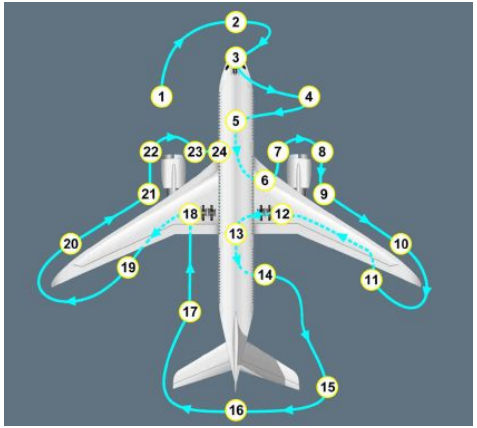

Static Probes

Pre-flight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CAPT
F/O
STATIC PORTS
DO NOT PLUG OR DEFORM HOLES
AREA WITHIN RED LINE MUST BE
SMOOTH AND CLEAN
RVSM - EXTRA CRITICAL AREA
SEE SRM 53-00-11

Pre-flight

- Check MEL
- External inspection (fuselage skin around static probes)
- Compare altimeter sources (difference not exceed specified limits)

Pre-flight

- Check MEL
- External inspection (fuselage skin around static probes)
- Compare altimeter sources (difference not exceed specified limits)
- Check warning messages before Take-off

In Flight

- Check required equipment before entering RVSM
- Compare altimeter sources (difference not exceed specified limits)
- Any issue before entering RVSM: request new clearance to avoid RVSM
- Any issue during RVSM operations: notify ATC

In Flight

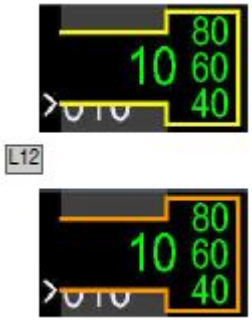
MAXIMUM DIFFERENCES BETWEEN ALTITUDE INDICATIONS

MAXIMUM DIFFERENCES BETWEEN ALTITUDE INDICATIONS

		Comparison of Altitude Indications (ft)	
Flight Level	Speed or Mach Number	Difference between ADRs (on the PFDs)	Difference between ISIS and ADRs (on the PFDs)
FL 50	250 kt	50	100
FL 100	250 kt	50	100
FL 200	320 kt	100	250
FL 290	M 0.85	150	400
FL 350	M 0.85	150	400
FL 430	M 0.85	150	400

--- END ---

In Flight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L12
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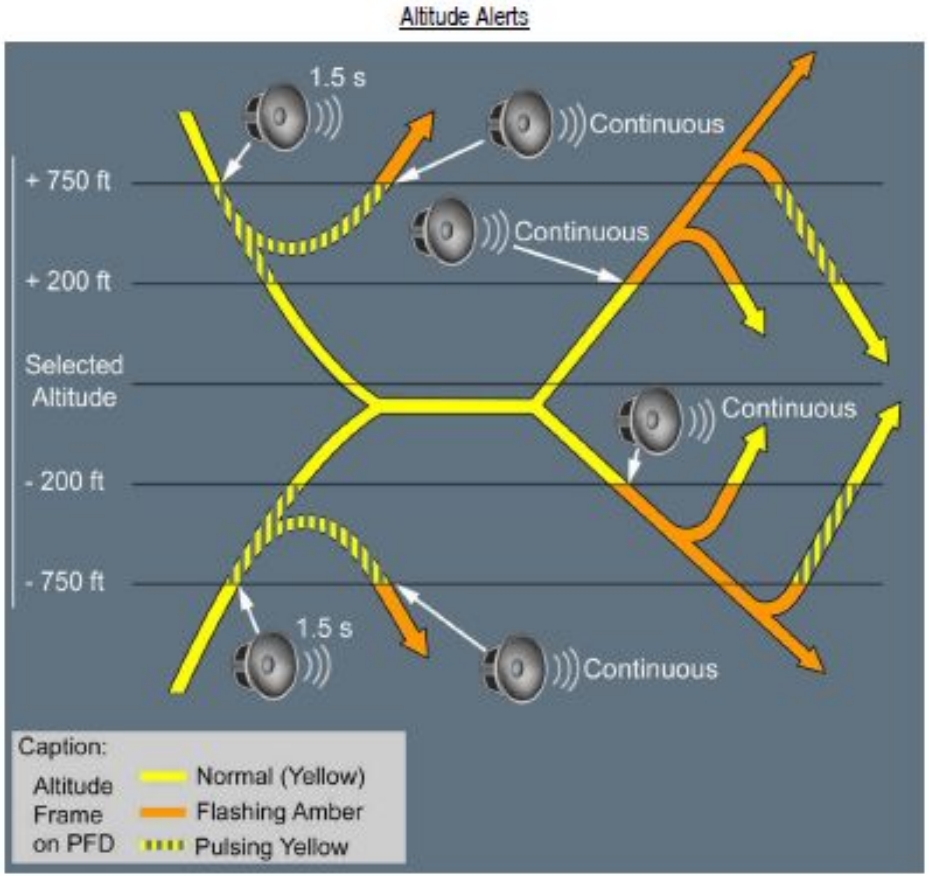

Altitude Alerts
1.5 s
Continuous
+ 750 ft
Continuous
+ 200 ft
Selected
Altitude
Continuous
- 200 ft
- 750 ft
1.5 s
Continuous
Caption:
Altitude
Frame
on PFD
Normal (Yellow)
Flashing Amber
Pulsing Yellow

After Flight FDA analysis

- **Report malfunction** in Height-keeping systems to your authority with plan to recover.
- ASE >245ft
- Total error >300ft

Validation flight

PARMO, European RMA & ARMA maintain worldwide databases for RVSM approved aircraft

Based on Aircraft data & Height Monitoring

PARMO (Pacific Approvals Registry and Monitoring Organization)
RMA (Regional Monitoring Agency) / ARMA (AFI RMA)

Height Monitoring Unit (HMU)

geometric height measurement. Fixed ground stations (ex in europe at LINZ, NATTENHEIM, GENEVA and STRUMBLE)

OR

GPS Monitoring Unit (GMU) portable GPS & computer equipment temporarily on aircraft for height monitoring purposes

⇒ Aircraft capability to maintain requested FL

Every 2 Years OR 1000 flights

GPS Monitoring Unit (GMU) portable GPS & computer equipment temporarily on aircraft for height monitoring purposes

Fleet monitoring

The Operator must perform a monitoring flight at least every **1000 flights or 2 years**.

This flight is initiated by the Operator, on each aircraft or on partial fleet

RVSM Monitoring Group

- A/C built to the same design, have identical avionics, static source error and height keeping performance characteristics
- 3 categories

RVSM : Operational approval - Validation Flight

[Airbus Amber]

MONITORING IS REQUIRED IN ACCORDANCE WITH THIS TABLE

MONITORING PRIOR TO THE ISSUE OF RVSM APPROVAL IS **NOT** A REQUIREMENT

CATEGORY		GROUP DESCRIPTOR	MINIMUM MONITORING REQUIREMENTS
1	GROUP APPROVED: DATA INDICATES COMPLIANCE WITH THE RVSM MASPS	A124, A20N, A30B, A306, A310-GE, A310-PW, A318, A320, A330, A339, A340, A345, A346, A350, A380, A3ST, AVRO, B38M, B39M, B712, B727, B737C, B737CL, B737NX, B747CL, B74S, B744-5, B744-10, B748, B752, B753, B764, B767, B772, B773, B787, B78X, BCS1, BD100, BE40, C25A, C25B, C25C, C510, C525, C550-B, C560, C56X, C650, C680, C750, CARJ, CL600, CL604, CL605, CRJ7, CRJ9, CRJ10, DC10, E135-145, E135BJ1, E135BJ2, E170-190, E290, E295, E545-550, E50P, E55P, F100, F2TH, F900, FA7X, GALX, GLEX, GL5T, GL7T, GLF4, GLF5, GLF6, GLF7, H25B-800, J328, LJ35-36, LJ40, LJ45, LJ60, MD10, MD11, MD80, MD90, PC12, PC24, PRM1, T154, TBM	Operators of aircraft types contained in this category shall have a minimum of 2 airframes monitored every 2 years or 1,000 flight hours, whichever is longer calculated from the date of the last successful height monitoring. Operators with fleets consisting of aircraft from more than one Monitoring Group shall meet this requirement for each group in the fleet. In the event that an operator has a single airframe from a Group, then that aircraft shall be monitored every 2 years or 1,000 flight hours, whichever is longer calculated from the date of the last successful height monitoring.
2	GROUP APPROVED: INSUFFICIENT DATA ON APPROVED AIRCRAFT	Other group aircraft other than those listed above including: A148, A158, A321XLR, A337, AC90, AC95, AJ27, AN72, ASTR, ASTR-SPX, B701, B703, B731, B732, B744-LCF, BE20, BE30, C441, C500, C550-II, C550-SII, C700, C919, D328, DC85, DC86-87, DC91, DC93, DC94, DC95, EPIC, E120, E45X, EA50, F70, FA10, FA20, FA50, G150, G280, GLF2, GLF8, GLF2B, GLF3, H25B-700, H25B-750, H25C, HA4T, HDJT, IL62, IL76, IL86, IL96, L101, L29B-2, L29B-731, LJ23, LJ24, LJ25, LJ28, LJ31, LJ55, MC21, MU30, PA46, P180, P180-II, PAY4, SB20, SBR1, SBR2, SF50, SU95, T134, T204, T334, WW24, YK42	Operators of aircraft types contained in this category shall have a minimum of 60% of airframes monitored every 2 years or 1,000 flight hours, whichever is longer calculated from the date of the last successful height monitoring, (the number of airframes to be monitored shall be rounded up to the nearest whole integer). Operators with fleets consisting of aircraft from more than one Monitoring Group shall meet this requirement for each Group in the fleet.
3	NON-GROUP	Aircraft types for which no generic compliance method exists: A225, AN12, AN26, B190, B462, B463, B74S-SOFIA, BA11, BE9L, FA6X, GSPN, H25A, L29A, PAY3, R721, R722, SJ30, STAR	Operators of aircraft types contained in this category shall have 100% of airframes monitored every 2 years or 1,000 flight hours, whichever is longer calculated from the date of the last successful height monitoring.

Fleet monitoring Category I

Category I consists of all groups which have had a representative sample of airframes monitored and which have demonstrated good and stable ASE characteristics over a minimum of 2 years

- All Airbus A/C are Category 1

- Minimum monitoring 2 airframes each 2 years or 1000 flight hours

Fleet monitoring Category II

This category serves as the initial classification for new aircraft types or for existing types that have undergone significant modifications that could affect their height-keeping performance. Category II also includes aircraft for which there is insufficient monitoring data to confidently place them in Category I.

- not applicable to Airbus A/C

- Minimum monitoring 60% of the fleet each 2 years or 1000 flight hours

Fleet monitoring Category III

Only approved as individual A/C basis

- not applicable to Airbus A/C

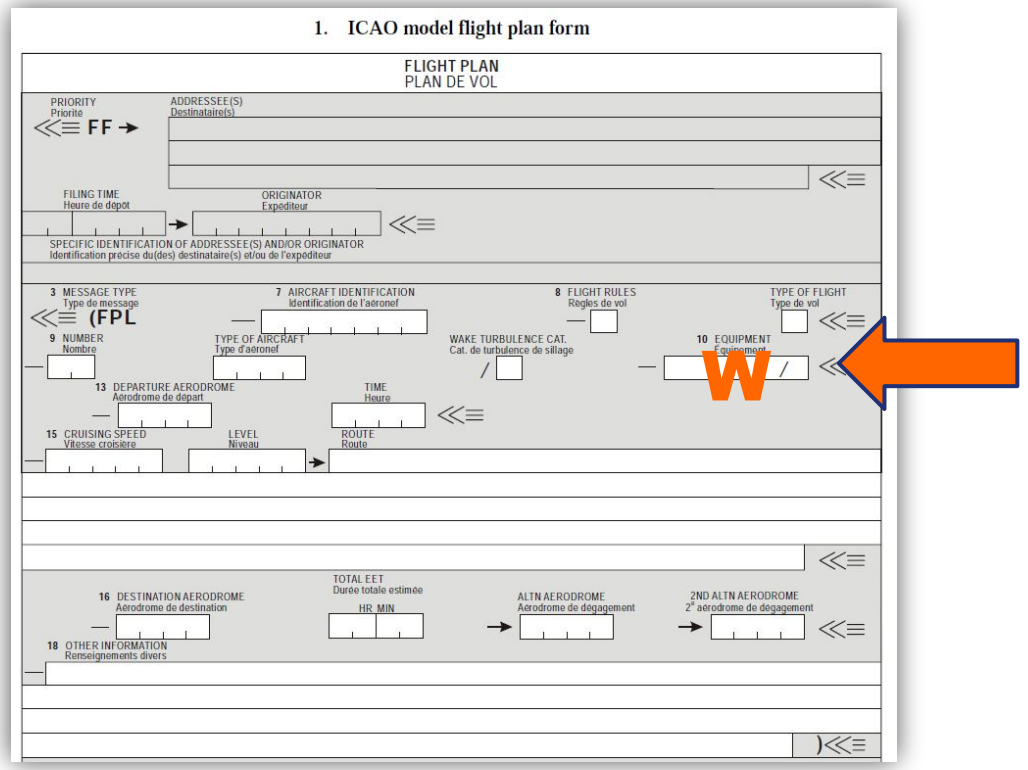
- Minimum monitoring 100% of the fleet each 2 years or 1000 flight hours

Flight Planning

Item 10

Or Item Q

Aircraft capability (see AIP)



AIP (Aeronautical information Publication)

Content

RVSM : supporting material

FAA Inspector Guidance

- New! Job Aid - Altimetry System Error Report (ASE-R) (PDF, 07 Oct 2014)
- New! Job Aid: Part 91 Operator Application to Conduct RVSM Operations (MS Word, 2 April 14)
- New!RVSM Minimum Monitoring Requirements Tables (MMR Chart) for North America (PDF)
- RVSM Monitoring: Situations Where Monitoring Not Completed On Time (MS Word, 25 Feb 2011) This document provides guidance for situations where the operator does not complete RVSM monitoring requirements on time.
- New! Notice Concerning Changes to the Part 91 RVSM Letter of Authorization Template (PDF, 04 Feb 14)
- New! Evaluate Operator's Application to Conduct Flight in RVSM Airspace (See FAA Order 8900.1 Volume 4, Chapter 10, Section 1).
- New! Special Navigation Areas of Operation - RVSM Airspace (See FAA Order 8900.1 Volume 4, Chapter 1, Section 5, Paragraph 4-109).
- New! RVSM Height Monitoring (See FAA Order 8900.1 Volume 4, Chapter 1, Section 5, Paragraph 4-109H).

Back to Top

ICAO

http://www.icao.int/safety/fsix/Library/AppendixG_to_Part-91.pdf

FAA

https://www.faa.gov/air_traffic/separation_standards/rvsm/documentation/#docs_all

EASA

https://www.easa.europa.eu/en/document-library/easy-access-rules/easy-access-rules-air-operations-regulation-eu-no-9652012

Content

RVSM concept relies on

- **Aircraft capability**
  - ability to Maintain FL

    ⇒ Declared Airworthiness capability

- **Operators Ops Approval**
  - Pilots training
  - Customized manuals (maintenance/procedures)
  - Continuous aircraft monitoring (HMU/GMU)

Thank you

AIRBUS

QUIZ

When does flight crew need to consider RVSM capability?

4 Pre-flight

4 In-flight

4 Post-flight

QUIZ

What does pilot need to check during preflight?

4 External inspection

4 Altimeter sources

4 Warning Messages/MEL

Does Airline need to validate/monitor all aircraft of their fleet?

- YES (no group aircraft)
- NO (group aircraft)
- ~~Don’t know…..~~

QUIZ

Does Airline need to monitor all aircraft of their fleet?

ICAO Acft Type	Reg. No.	Operator	Acft Op ICAO	RVSM Yes/No	RVSM Approval Date	Operator Country
BE40	A2WIN	NAC Botswana	NAC	Yes	29/04/2011	Botswana
BE40	A2DBK	FT Meat Packaging Processing	IGA	Yes	13/05/2011	Botswana
GLEX	OK1	Botswana Defence Force	BDF	Yes	21/10/2009	Botswana
C550	A2BCL	BCL	BCL	Yes	06/10/2011	Botswana
H25B	A2MCB	Kalahari Air Services	IGA	Yes	23/01/2013	Botswana
A319	ZSSFJ	South African Airways	SAA	Yes	21/01/2005	South Africa
A319	ZSSFK	South African Airways	SAA	Yes	21/01/2005	South Africa
A319	ZSSFL	South African Airways	SAA	Yes	21/01/2005	South Africa
A319	ZSSFM	South African Airways	SAA	Yes	21/01/2005	South Africa
A319	ZSSFN	South African Airways	SAA	Yes	16/01/2001	South Africa
A320	ZSSZA	South African Airways	SAA	Yes	15/08/2013	South Africa
A320	ZSSZB	South African Airways	SAA	Yes	07/12/2013	South Africa
A322	ZSSZC	South African Airways	SAA	Yes	16/01/2014	South Africa
A322	ZSSZD	South African Airways	SAA	Yes	14/02/2014	South Africa
A320	ZSSZE	South African Airways	SAA	Yes	26/06/2014	South Africa
A320	ZSSZF	South African Airways	SAA	Yes	25/07/2014	South Africa
A320	ZSSZG	South African Airways	SAA	Yes	01/08/2014	South Africa
A320	ZSSZH	South African Airways	SAA	Yes	16/09/2014	South Africa