

Headquarters U.S. Air Force

Integrity - Service - Excellence

Domestic Reduced Vertical Separation Minimum (DRVSM) Aircrew Training



Part I: All Aircraft

Air Force Flight Standards Agency

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DRVSM Aircrew Training

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- **Part I Contents:**
 - **What is RVSM?**
 - **Domestic RVSM Mandate**
 - **RVSM Equipage Requirements**
 - **Formation Operations**
 - **Flight Planning – Equipment Suffixes**
 - **Preflight actions**
 - **In flight actions**
 - **Post flight Actions**
 - **Terminology**
 - **Contingencies**

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What is RVSM?

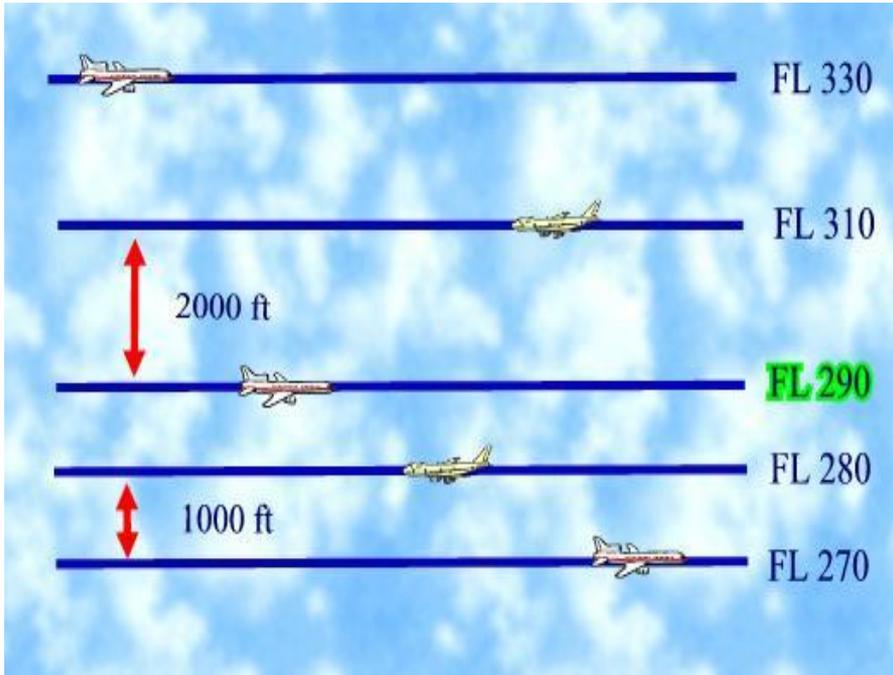
- **The Reduced Vertical Separation Minimum (RVSM) program enables vertical separation between properly equipped aircraft to be reduced from 2,000 ft. to 1,000 ft. between FL 290-410 (inclusive)**

- **RVSM makes six additional flight levels available for operations. It has been shown to:**
 - **Enhance aircraft operating efficiency by making more fuel/time efficient flight levels available**
 - **Enhance air traffic control flexibility**
 - **Provide the potential for enhanced enroute airspace capacity.**

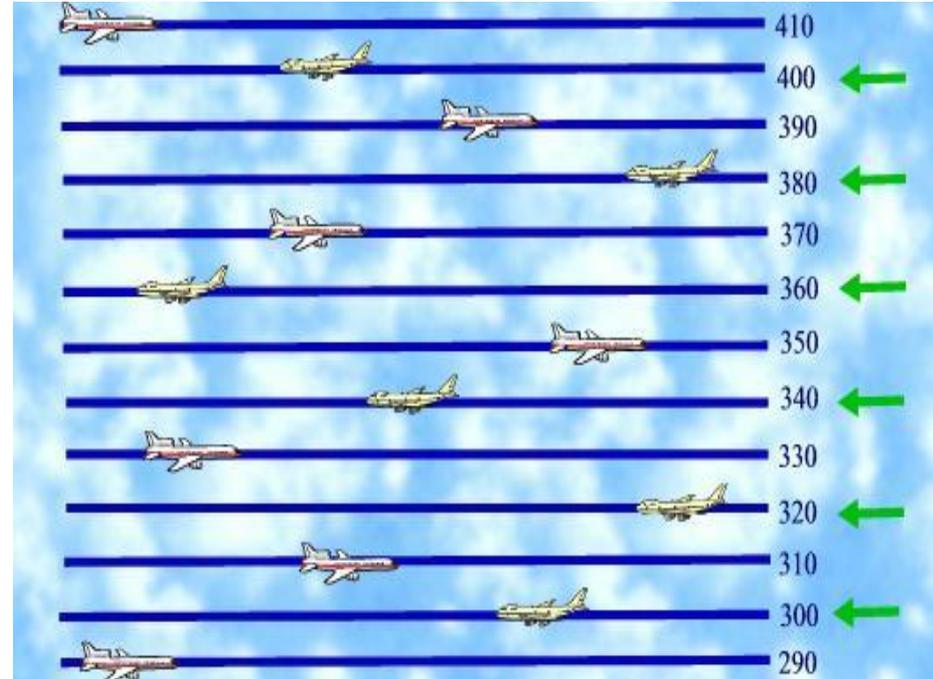


What is RVSM?

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Non-RVSM



RVSM

- Reduces vertical separation between FL 290-410 from 2000-ft to 1000-ft
- Promotes optimum flight profiles, fuel savings, increase ATC flexibility, airspace capacity



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Worldwide RVSM Implementation

- First implemented in North Atlantic – 1997
- Continued in Atlantic, Pacific, Asian, European, and Australian Airspace
- Caribbean and South America implemented Jan 2005
- Japan and Korea planning for 2005

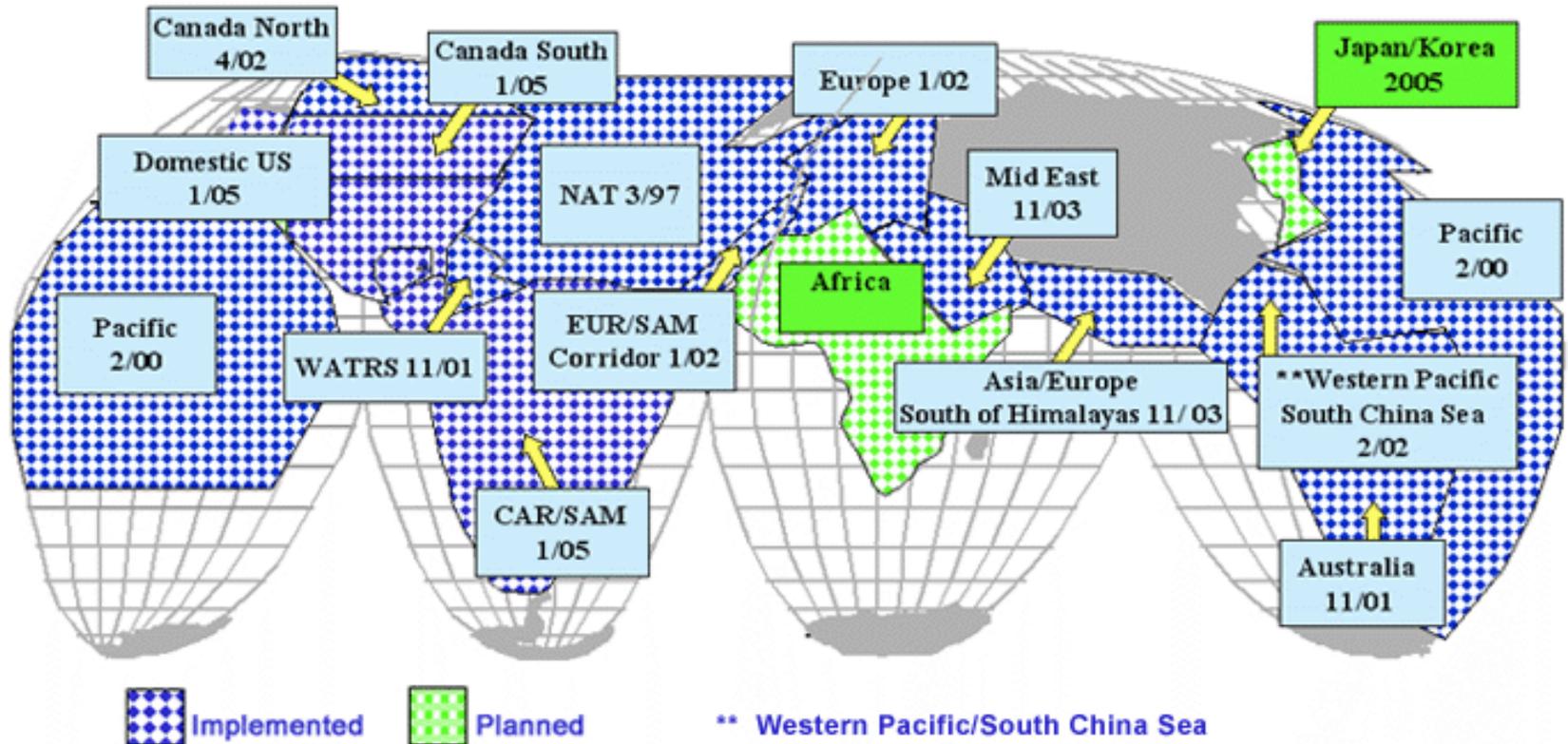
RVSM Status Americas - Europe		
North Atlantic:	March 1997	FL 330-370
	October 1998	FL 310-390
	Jan 24, 2002	FL 290-410
West Atlantic Route System (WATRS):	Nov 1, 2001	FL 310-390
	Jan 24, 2002	FL 290-410
Europe Tactical (UK, Ireland, Germany, Austria)	April 2001	FL 290-410
Europe-wide	Jan 24, 2002	FL 290-410
South Atlantic:	Jan 24 2002	FL 290-410
Canada Northern Domestic	April 2002	FL 290-410
Canada Southern Domestic	Coordinate with US domestic	
Domestic US	January 20, 2005	FL 290-410
Caribbean/South America	January 20, 2005	Consult AIPs

RVSM Status Asia/Pacific		
Pacific:	February 2000	FL 290-390
*FL 410 is available for non-RVSM approved flights	Tactical Use	FL 400-410
Australia:	November 2001	FL 290-410
Western Pacific/South China Sea	Feb 21, 2002	Consult AIPs
Mid East:	11/2003	Consult AIPs
Asia-Europe/South of Himalayas:	11/2003	Consult AIPs



RVSM Implemented & Planned

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** Western Pacific/South China Sea

February 2002 Implementation
Bangkok, Ho Chi Minh, Kota Kinabalu, Kuala Lumpur, Manila, Phnom Penh, Sanya, Singapore, Taipei

October 2002 Implementation
Hanoi, Hong Kong, Jakarta, Ujung Pandang, Vientiane



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RVSM Flight Level Orientation Scheme

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RVSM Airspace		Non-RVSM Airspace	
FL 410	→	→	FL 410
FL 400	←		FL 400
FL 390	→	←	FL 390
FL 380	←		FL 380
FL 370	→	→	FL 370
FL 360	←		FL 360
FL 350	→	←	FL 350
FL 340	←		FL 340
FL 330	→	→	FL 330
FL 320	←		FL 320
FL 310	→	←	FL 310
FL 300	←		FL 300
FL 290	→	→	FL 290



Domestic US RVSM Mandate

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- **On 20 Jan 05, the FAA implemented Reduced Vertical Separation Minimum (RVSM) between flight level (FL) 290-410 (inclusive) in the following airspace: the airspace of the lower 48 states of the United States, Alaska, Atlantic and Gulf of Mexico High Offshore Airspace and the San Juan Flight Information Region (FIR)**
 - **Includes – Houston and Miami Oceanic FIRs**
 - **Coincided with RVSM implementation in Southern Canada, Mexico, Caribbean States and South America**



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Gulf of Mexico High Offshore Airspace

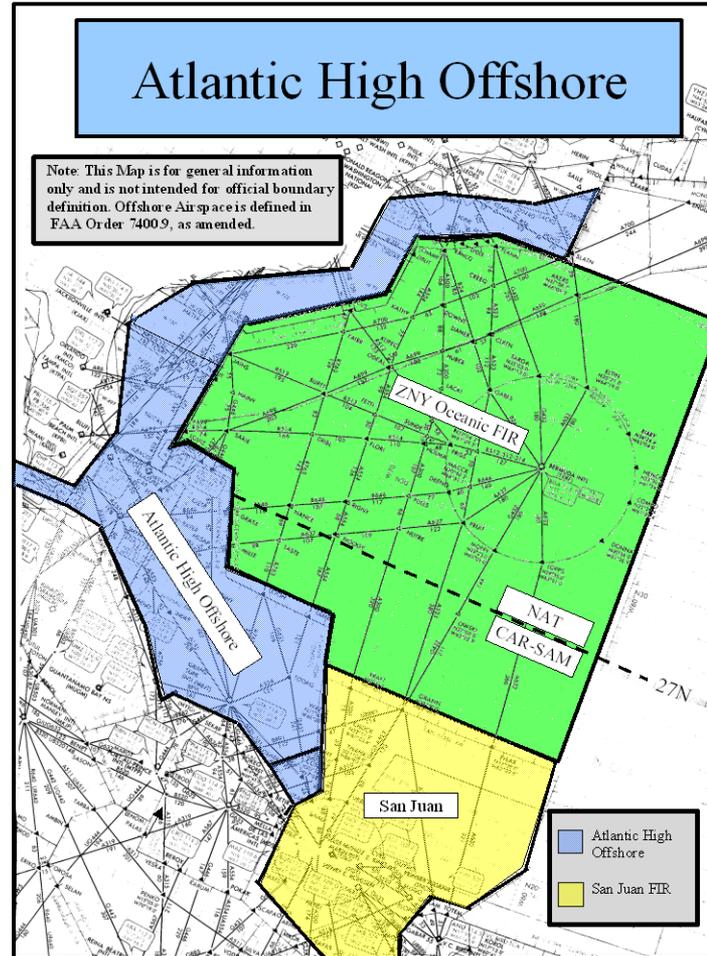




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Atlantic High Offshore Airspace and San Juan FIR





Domestic US RVSM Mandate

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- **RVSM authority is required for operation in DRVSM Airspace with limited exceptions:**
 - **Non-RVSM DoD, lifeguard, foreign state (government) and certification/development aircraft can be accommodated by providing 2,000 ft vertical/appropriate horizontal separation**
 - **Provisions made for non-RVSM compliant aircraft to climb to and descend from flight levels above RVSM airspace**
 - **ALL non-RVSM aircraft operations are conducted based upon workload and traffic conditions**



RVSM Authority

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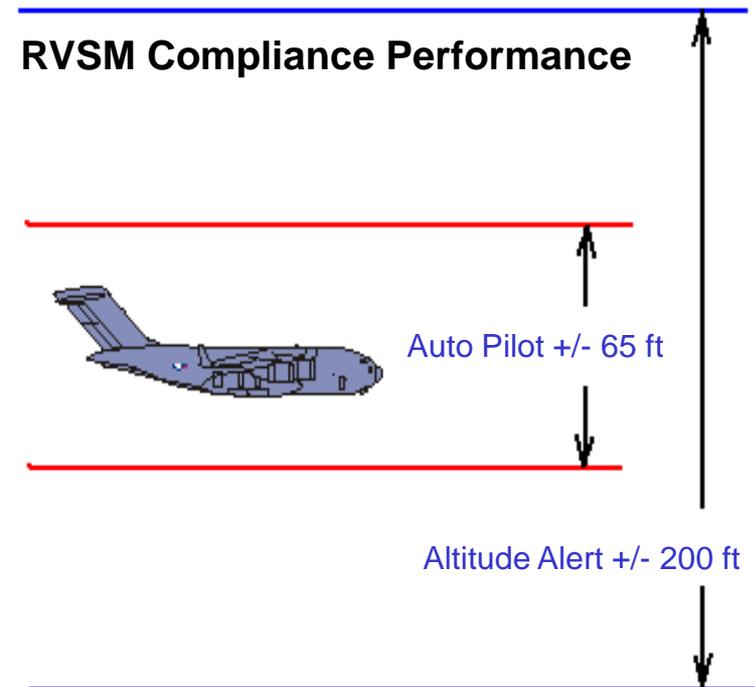
- **USAF Major Commands grant RVSM Authority/ Operational Approval to aircraft based on:**
 - **RVSM Airworthiness Certification from Aircraft Program Office based on equipage/performance**
 - **Implementation of proper training, logistics, maintenance and operational procedures**
 - **Aircraft RVSM authority should be documented in Flight Manual (Dash-1), MDS-Specific AFI Vol. 3, or equivalent document**
 - **For aircraft-specific questions, ask your MAJCOM**
- **Aircraft which have not been granted MAJCOM authority for RVSM operations will be referred to as “non-RVSM” aircraft**



Aircraft Equipage

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- **Two operational independent altitude measurement systems that meet RVSM altimeter system error criteria:**
 - Cross coupled static source/system
 - Static pressure equipment
 - Digitally encoded signal for automatic reporting
 - Static source error correction
 - Reference signals for control and alerting
- **One secondary surveillance radar transponder (Mode C)**
- **An altitude alerting systems**
 - +/- 200 ft: off altitude alert
- **An automatic altitude control system**
 - Tolerance band of +/- 65 ft





Aircraft Equipage - TCAS

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- **RVSM does not require aircraft to be equipped with the Traffic Alert and Collision Avoidance System (TCAS), but...**
 - **If an aircraft already equipped with TCAS II is flown in RVSM airspace, it must be modified to incorporate TCAS II version 7.0 or a later version**
 - **Exception: Non-RVSM aircraft equipped with TCAS II which are accommodated in RVSM airspace (receiving 2,000 altitude separation) do not need to be modified with version 7.0 or later**



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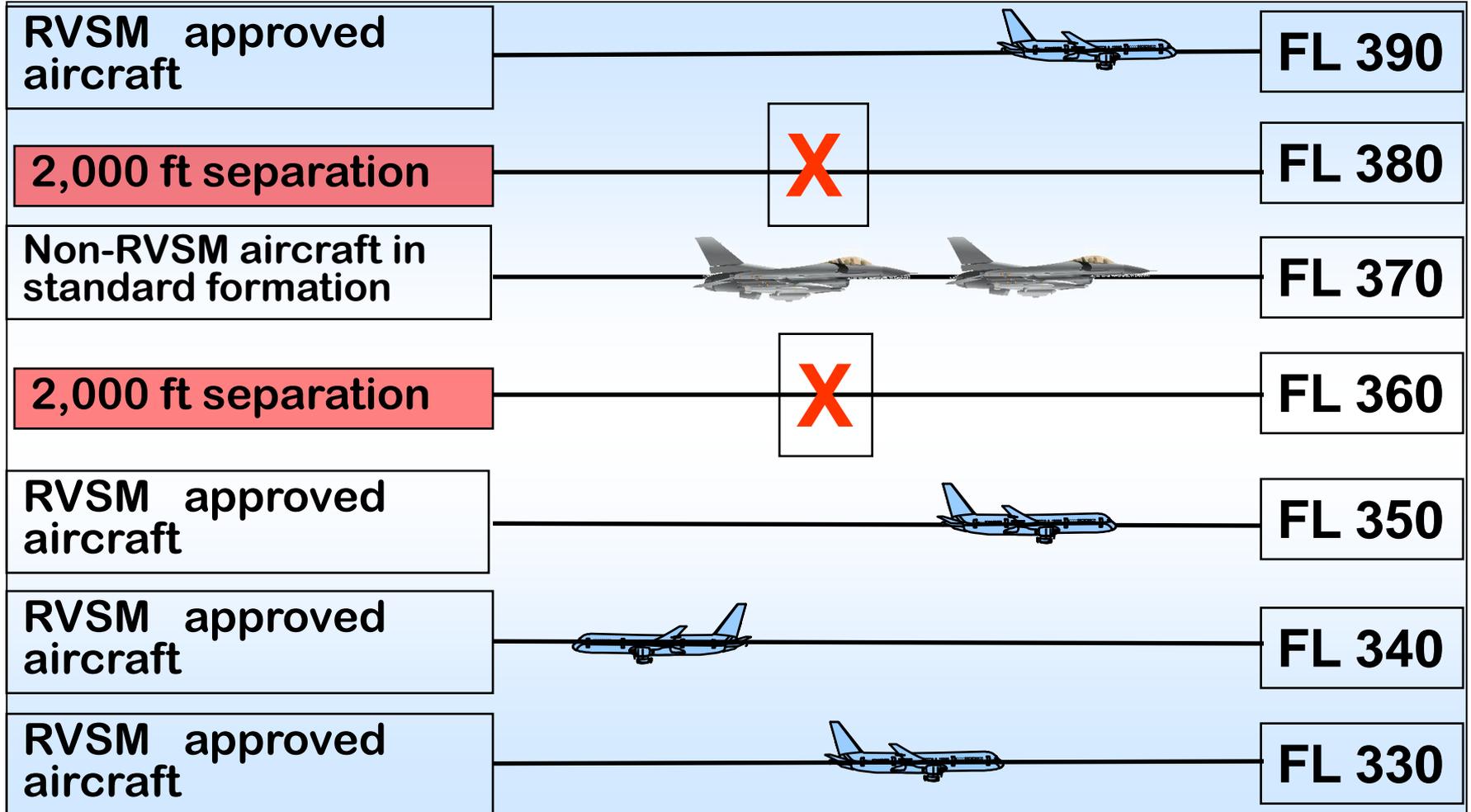
Formation Operations

- **Aircraft operating in a formation (standard or non-standard) are currently considered non-RVSM compliant, regardless of their single-ship RVSM status**
 - **A formation must request accommodation into RVSM airspace as a single non-RVSM aircraft would**
 - **If accommodated, will be given 2,000 ft. altitude separation**
 - **DoD and FAA are working to develop procedures for RVSM formation operations**



Standard Formation

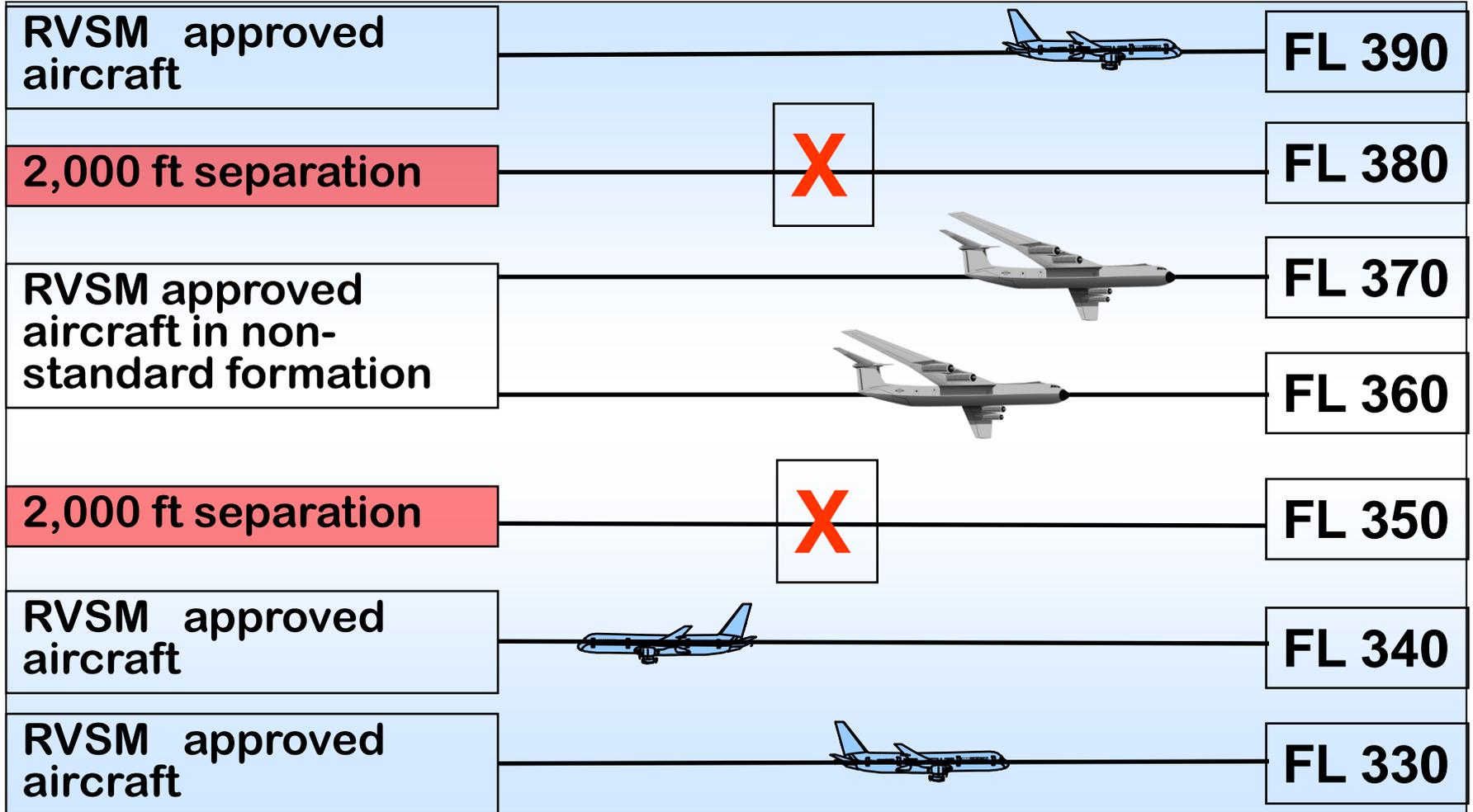
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Non-Standard Formation

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UNCLASSIFIED *Flight Planning – Equipment Suffixes*

- **RVSM Equipment Suffixes for DD Form 175 Military Flight Plan or FAA Flight Plan:**
 - **“/Q” – Indicates aircraft has both RVSM and advanced RNAV capabilities**
 - **For RVSM compliant aircraft with /E, /F, /G or /R navigation capability**
 - **“/W” – Indicates RVSM without advanced RNAV capability**
 - **Operators can still only file one equipment suffix on DD Form 175 or FAA flight plan**



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Flight Planning – UNCLASSIFIED *Equipment Suffixes*

- **RVSM Equipment Suffixes for DD Form 1801 International Flight Plan:**
 - **RVSM compliant aircraft continue to file “/W” in Block 10 (Equipment) plus appropriate suffixes for navigation and communication capabilities**
 - **“/Q” suffix is not authorized for DD Form 1801 Flight Plan**



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Flight Planning – *Equipment Suffixes*

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- **ATC uses RVSM suffix (or lack of) to:**
 - Issue or deny clearance into RVSM airspace
 - Apply 2,000 ft vertical separation to non-RVSM aircraft
- **Non-RVSM aircraft must not use RVSM suffix, even if intending to operate in RVSM airspace**

**OPERATORS MUST FILE APPROPRIATE
EQUIPMENT SUFFIX FOR RVSM OPERATIONS**



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The following guidance on pre-flight, in-flight, and post-flight procedures is derived from AFI 11-202 Vol. 3 and FAA Guidance 91-RVSM Appendix 4. This information is general in nature. MAJCOMs and units should supplement with MAJCOM or MDS-specific guidance as necessary. See FAA Guidance 91-RVSM for more information.



Preflight Procedures

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- **Prior to flight in RVSM airspace, pilots should:**
 - **Verify the aircraft is approved for RVSM operations**
 - **Pay particular attention to:**
 - **Reported/forecast weather conditions on the route of flight – especially turbulence/mountain wave activity**
 - **Minimum equipment requirements pertaining to height-keeping systems**
 - **Review maintenance forms to ascertain the condition of equipment required for flight in the RVSM airspace**



Preflight Procedures, Cont'd

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■ Before takeoff:

- The aircraft altimeters should be set to the local altimeter setting and should display a known elevation (e.g., field elevation) within the limits specified in aircraft operating manuals
 - The difference between the known elevation and the elevation displayed on the altimeters should not exceed 75 ft.
 - The two primary altimeters should also agree within limits specified by the aircraft operating manual



In Flight Procedures

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- **Prior to entry into RVSM airspace the following equipment shall be operating normally:**
 - **Two primary altitude measurement systems**
 - **One automatic altitude-control system (autopilot)**
 - **One altitude-alerting device**
 - **An operational transponder**

- **Should any required equipment fail, or be suspect, prior to entering RVSM airspace, the pilot should request a new clearance to avoid flight in this airspace**



In Flight Procedures, Cont'd

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- **Emphasis should be placed on promptly setting all primary and standby altimeters to 29.92 in. when passing the transition altitude and rechecking for proper altimeter setting when reaching the initial cleared flight level (CFL)**

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



In Flight Procedures, Cont'd

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- **During cleared transition between levels, the aircraft should not be allowed to overshoot or undershoot the cleared flight level by more than 150 ft**
 - **Recommend level offs 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 retrim the aircraft or turbulence require disengagement. In any event, adherence to cruise altitude should be done by reference to one of the two primary altimeters**



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In Flight Procedures, Cont'd

- At intervals of approximately one hour, cross-checks between the primary altimeters and the stand-by altimeter should be made. A minimum of two primary altimeters should agree within 200 ft or a lesser value if specified in the aircraft operating manual. The difference between the primary and stand-by altimeters should be noted for use in contingency situations
 - The normal pilot scan of cockpit instruments should suffice for altimeter crosschecking on most flights



In Flight Procedures, Cont'd

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

- If the pilot detects (or is notified by ATC of) an altitude error which exceeds 300 ft then the pilot should take action to return to CFL as quickly as possible



Post Flight Procedures

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- In making maintenance write-ups against malfunctions in height-keeping systems, the following should be noted when appropriate:
 - Primary and standby altimeter readings
 - Altitude selector setting
 - Subscale setting on altimeter
 - Autopilot used to control the airplane and any differences when the alternate system was selected
 - Differences in altimeter readings if alternate static ports selected
 - Use of air data computer selector for fault diagnosis
 - Transponder selected to provide altitude information to ATC and any difference if alternate transponder or altitude source is manually selected.
-



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Pilot/Controller Phraseology

Tables on the following pages show standard phraseology for domestic RVSM operations:

Proper pilot/controller phraseology is critical for safe RVSM operations



Pilot/Controller Phraseology

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Message	Phraseology
<p>For a controller to ascertain the RVSM approval status of an aircraft (MAJCOM RVSM authority granted):</p>	<p><u>Controller:</u> “(call sign) confirm RVSM approved”</p>
<p>Pilot indication that flight is RVSM approved (MAJCOM RVSM authority granted)</p>	<p><u>Pilot:</u> “Affirm RVSM”</p>
<p>For non-RVSM aircraft, pilot will report lack of RVSM approval:</p> <ul style="list-style-type: none"> a. On the initial call on any frequency in the RVSM airspace and... b. In all requests for flight level changes pertaining to flight levels within the RVSM airspace and... c. In all read-backs to flight level clearances pertaining to flight levels within the RVSM airspace and... d. In read back of flight level clearances involving climb and descent through RVSM airspace (FL290-410) 	<p><u>Pilot:</u> “Negative RVSM (supplementary information)” (e.g., “military”)</p>



Pilot/Controller Phraseology

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Message	Phraseology
<p>Pilot report of one of the following after entry into RVSM airspace: all primary altimeters, automatic altitude control systems or altitude alerters have failed</p> <p>(See contingency information)</p> <p><i>(This phrase is to be used to convey both the initial indication of RVSM aircraft system failure and on initial contact on all frequencies in RVSM airspace until the problem ceases to exist or the aircraft has exited RVSM airspace)</i></p>	<p><u>Pilot:</u> “Unable RVSM Due Equipment”</p>
<p>ATC denial of clearance into RVSM airspace</p>	<p><u>Controller:</u> “Unable issue clearance into RVSM airspace, maintain FL ____”.</p>



Pilot/Controller Phraseology

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Message	Phraseology
Pilot reporting inability to maintain cleared flight level due to weather encounter (See contingency information)	<u>Pilot:</u> “Unable RVSM due (state reason)” (e.g., “turbulence”, “mountain wave”)
ATC requesting pilot to confirm that an aircraft has regained RVSM-approved status or a pilot is ready to resume RVSM	<u>Controller:</u> “Confirm able to resume RVSM ”
Pilot ready to resume RVSM after aircraft system or weather contingency	<u>Pilot:</u> “Ready to resume RVSM”



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Contingencies

Tables on the following pages provide pilot guidance on actions to take under certain conditions of aircraft system failure and weather encounters. It also describes the expected ATC controller actions in these situations.

Pilots and controllers must use judgment to determine the action most appropriate to any given situation.



Contingencies - General

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Initial Pilot Actions when unable to maintain flight level or unsure of aircraft altitude-keeping capability:

- Notify ATC and request assistance
- Maintain cleared flight level, to the extent possible, while evaluating the situation
- Watch for conflicting traffic both visually and by reference to TCAS, if equipped
- Alert nearby aircraft by illuminating exterior lights (commensurate with aircraft limitations)



Contingencies - Equipment

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Failure of Automatic Altitude Control System, Altitude Alerter or All Primary Altimeters

Pilot will:	Controller will:
<ul style="list-style-type: none"> ■ Contact ATC and state “Unable RVSM Due Equipment” ■ Request clearance out of RVSM airspace unless operational situation dictates otherwise 	<ul style="list-style-type: none"> ■ Provide 2,000 ft. vertical separation or appropriate horizontal separation ■ Clear aircraft out of RVSM airspace unless operational situation dictates otherwise



Contingencies - Equipment

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One Primary Altimeter Remains Operational

Pilot will:	Controller will:
<ul style="list-style-type: none"> ■ Cross check stand-by altimeter ■ Notify ATC of operation with single primary altimeter ■ If unable to confirm primary altimeter accuracy, follow actions for failure of all primary altimeters 	<ul style="list-style-type: none"> ■ Acknowledge operation with single primary altimeter



Contingencies - Equipment

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Transponder Failure

Pilot will:	Controller will:
<ul style="list-style-type: none">■ Contact ATC and request authority to continue to operate at cleared flight level■ Comply with revised ATC clearance, if issued	<ul style="list-style-type: none">■ Consider request to continue to operate at cleared flight level■ Issue revised clearance, if necessary



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UNCLASSIFIED *Contingencies – Severe Weather*

- **Pilots must take appropriate action in RVSM airspace when aircraft experience severe turbulence and/or mountain wave activity (MWA) that is of sufficient magnitude to significantly affect altitude-keeping**
 - **An additional concern is the sensitivity of collision avoidance systems when one or both aircraft operating in close proximity receive TCAS advisories in response to disruptions in altitude hold capability**



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Contingencies – Severe Weather

Severe Turbulence and/or Mountain Wave Activity (MWA) Induced Altitude Deviations of Approximately 200 feet

Pilot will:	Controller will:
<ul style="list-style-type: none">■ Contact ATC and state “Unable RVSM Due (state reason)” (e.g., turbulence, mountain wave)■ If not issued by the controller, request vector clear of traffic at adjacent flight levels■ If desired, request flight level change or re-route■ Report location and magnitude of turbulence or MWA to ATC	<ul style="list-style-type: none">■ Vector aircraft to avoid merging target with traffic at adjacent flight levels, traffic permitting■ Advise pilot of conflicting traffic■ Issue flight level change or re-route, traffic permitting■ Issue PIREP to other aircraft



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Contingencies – Severe Weather

Less significant MWA encounters which do not result in altitude deviations of 200 feet.

Pilot will:	Controller will:
<ul style="list-style-type: none">■ Contact ATC and report experiencing MWA■ If so desired, pilot may request a flight level change or re-route■ Report location and magnitude of MWA to ATC	<ul style="list-style-type: none">■ Advise pilot of conflicting traffic at adjacent flight level■ If pilot requests, vector aircraft to avoid merging target with traffic at adjacent RVSM flight levels, traffic permitting■ Issue flight level change or re-route, traffic permitting■ Issue PIREP to other aircraft



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Contingencies - Wake Turbulence

- **Pilots should be aware of the potential for wake turbulence encounters following DRVSM implementation**
 - **Encounters are generally moderate or less in magnitude**
- **It is anticipated that wake turbulence in DRVSM airspace will mirror European RVSM experience gained since January 2002**
 - **European reports of wake turbulence encounters have not increased significantly since RVSM implementation**
 - **Reported wake turbulence was generally similar to moderate clear air turbulence**



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Contingencies - Wake Turbulence

- **Pilots should be alert for wake turbulence when operating:**
 - **In the vicinity of aircraft climbing or descending through their altitude**
 - **Approximately 12-15 miles after passing 1,000 feet below opposite direction traffic**
 - **Approximately 12-15 miles behind and 1,000 below same-direction traffic**



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Contingencies - Wake Turbulence

- **Pilot Action To Mitigate Wake Turbulence Encounters**
 - **Pilots encountering or anticipating wake turbulence in DRVSM airspace have the option of requesting a vector, flight level change or if capable, a lateral offset**
 - **Offsets of approximately a wing span upwind generally can move the aircraft out of the immediate vicinity of another aircraft's wake vortex**
 - **In domestic U.S. airspace, pilots must request clearance to fly a lateral offset. Strategic lateral offsets flown in oceanic airspace do not apply.**



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Contingencies - Wake Turbulence

Wake Turbulence Encounters

Pilot should:	Controller should:
<ul style="list-style-type: none">■ Contact ATC and request vector, flight level change or, if capable, a lateral offset	<ul style="list-style-type: none">■ Issue vector, flight level change or lateral offset clearance, traffic permitting



DRVSM Aircrew Training

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- **This concludes Part I of DRVSM Aircrew Training**

- **Part II contains information specific to non-RVSM aircraft**

- **For more information:**
 - **FAA DRVSM Website:**
<http://www.faa.gov/ats/ato/drvsm/Default.asp>
 - **HQ AFFSA Website:**
<https://private.andrews.amc.af.mil/AFFSA/affsa.htm>
 - **DINS NOTAMs Website:**
<https://www.notams.jcs.mil/>



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