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International Civil Aviation Organization
UNDP/ICAO Regional Project RLA/98/003
Transition to the CNS/ATM Systems in the CAR and SAM Regions

Sixth Meeting/Workshop of ATM authorities and planners in the CAR/SAM Regions for RVSM, RNAV routes and RNP Implementation (AP/ATM/6 RVSM-RNAV-RNP)

(San Jose, Costa Rica, 29 September to 3 October 2003)

Agenda Item 3: Review of the issues related with RVSM Implementation in the CAR/SAM Regions

RVSM Cost and Engineering Reference Data

(Presented by the United States of America)

SUMMARY

The data presented in this paper has been researched and compiled in support of U.S. Domestic RVSM planning. This data is provided by the Federal Aviation Administration (FAA) to assist States and operators in assessing their individual benefits.

1. Introduction

1.1 In the June AP/ATM/6 Meeting held in Panama City, Panama, the United States presented the paper, *Summary of the Preliminary Cost-Benefit Analysis for the Implementation of RVSM in the CAR/SAM*. This paper contained the results of fuel-burn modeling and analysis activities to determine the potential fuel savings through implementing RVSM in the CAR/SAM Regions.

1.2 The results of this study found that the average per-flight fuel savings was 104.43 lbs. per flight, or 1.63%. The total yearly fuel savings was calculated at $30.4 million per annum. The estimated potential 15-year benefits of $538.0 million from the implementation of CAR/SAM RVSM exceed aircraft upgrade costs of $141.2 million by a margin of 3.81 to 1.

1.3 The Safety and Airspace Monitoring Group noted that statistics and techniques utilized in the study did not account for the economic conditions of CAR/SAM States. The members stated that the 7% cost of capital utilized in the discounting technique was not representative of current rates in the CAR/SAM Region States.

2. **Discussion**

2.1 This paper contains data to aid individual States and operators in estimating their potential upgrade costs. **Appendix A** presents the estimated costs to bring aircraft into RVSM airworthiness compliance. These cost estimates were obtained from aircraft manufacturers, engineering design organizations, and operators. RVSM upgrade costs are largely dependent on aircraft equipage and range from $0.00 U.S. to $175,000.00 U.S. While some aircraft types require only a visual inspection, other aircraft types require extensive avionics upgrades to achieve RVSM compliance.

2.2 **Appendix B** presents the availability of RVSM engineering packages for large transport aircraft. This listing reference the applicable service bulletin by aircraft type along with any required operational changes. This listing also gives air data computer and skin waviness check requirements if applicable. Pitot-static system requirements are included in this listing along with probe life information.

2.3 **Appendix C** presents the availability of RVSM engineering packages for small commercial and general aviation aircraft types. This listing is grouped by manufacturer and contains the current or forecasted availability of an engineering package for the various aircraft types. In addition to the original equipment manufacturer (OEM) solutions, this listing also tracks the known available and projected engineering packages offered by third party providers.

2.4 The Meeting is invited to consider the information presented in this paper for use by States and operators in conducting their specific analyses.

APPENDIX A

Aircraft Engineering Costs		
Type	**Estimate**	**Source**
A300	****	Manufacturer (Visual inspection only)
A320	****	Manufacturer (Visual inspection only)
A330	****	Manufacturer (Visual inspection only)
A340	****	Manufacturer (Visual inspection only)
B701,B703	$175,000.00	Engineering design organization
B712	****	Manufacturer (Visual inspection only)
B721, B722	$130,000.00	Engineering design organization
B731	$130,000.00	Engineering design organization
B732	$130,000.00	Engineering design organization
B733-B735	$17,500.00	Operator Survey 1/01
B736-B739	****	Manufacturer (Visual inspection only)
B741, B742, B743	$58,400.00	FAA Survey 12/97 and OWG Survey 6/97
B744	$33,300.00	OWG Survey 6/97
B752, B753	$50,700.00	FAA Survey 12/97 and OWG Survey 6/97
B762, B763, B764	****	Manufacturer (Visual inspection only)
B772, B773	****	Manufacturer (Visual inspection only)
F100	$8,000.00	Operator Survey 6/01
DC8	$150,000.00	Engineering design organization
DC9	$150,000.00	Engineering design organization
DC10	$2,200.00	OWG Survey 6/97
MD11	$2,200.00	Engineering analysis, similar to DC10
MD80	$33,300.00	Engineering analysis, similar to B744
MD90	$33,300.00	Engineering analysis, similar to B744
L101	$25,000.00	Manufacturer, 1/01
ASTR	$110,000.00	Manufacturer
BE40	$25,000.00	Manufacturer
CL60 (1A)	$62,500.00	Manufacturer
CL60 (3A/3R)	$17,500.00	Manufacturer
CL60 (604)	****	Manufacturer
CRJ1	****	Manufacturer
CRJ2	****	Manufacturer
CRJ7	****	Manufacturer
C500	$101,259.00	Manufacturer, 11/02
C501	$101,259.00	Manufacturer, 11/02
C525	$58,000.00	Manufacturer, 11/02
C525A	$22,647.00	Manufacturer, 11/02
C550	$111,500.00	Manufacturer, 11/02
C551	$111,500.00	Manufacturer, 11/02
C560	$42,953.00	Manufacturer, 11/02
C56X	****	Manufacturer, 11/02
C650	$74,918.00	Manufacturer, 11/02
C750	$7,680.00	Manufacturer, 11/02

Aircraft Engineering Costs		
E135	$17,500.00	Manufacturer
E145	$17,500.00	Manufacturer
F2TH	$15,000.00	Manufacturer
F900	$15,000.00	Manufacturer
FA50	$15,000.00	Manufacturer
FA10	$150,000.00	Engineering design organization
FA20	$15,000.00	Manufacturer
GALX	****	Manufacturer
GLEX	****	Manufacturer
GLF2	$235,000.00	Manufacturer, 11/02
GLF3 (S/N 426 and lower)	$226,200.00	Manufacturer, 11/02
GLF3 (S/N 427 and higher)	$14,000.00	Manufacturer, 11/02
GLF4	$14,000.00	Manufacturer, 11/02
GLF5	****	Manufacturer, 11/02
H25A	$150,000.00	Engineering design organization
H25B	$32,500.00	Manufacturer, 3/01
H25C	$32,500.00	Manufacturer, 3/01
L29B	$150,000.00	Engineering design organization
LJ20 Series	$149,000.00	Engineering design organization
LJ31	$46,000.00	Manufacturer, 11/02
LJ35	$145,000.00	Manufacturer, 11/02
LJ45	****	Manufacturer, 11/02
LJ55	$155,000.00	Manufacturer, 11/02
LJ60	$20,000.00	Manufacturer, 11/02
MU30	$110,000.00	Engineering design organization
PRM1	****	Manufacturer, 11/02
SBR1	$139,000.00	Engineering design organization
SBR2	$175,000.00	Engineering design organization
WW23	$140,000.00	Engineering design organization
WW24	$140,000.00	Engineering design organization

****** Costs anticipated to be less than $100 per aircraft**

APPENDIX B

Large Transport Aircraft Engineering Packages

Model	Service Bulletin	Operational Changes	Air Data Computer	Skin Check	Pitot Static Probe Life
737-300/400/ 500	737-53-1180 (2/96) IN-03	No Change	No Change	Visual	Unplated, no limit
737-600/700/ 800/900/BBJ	N/R	Service letter: 737-SL-02-017 (1/98)			
737-600	Service letter: 737-SL-02-017 (1/98)	Factory RVSM ready s/n 28259 and subsequent (delivered Sep 98)			
737-700	Service letter: 737-SL-02-017 (1/98)	Factory RVSM ready s/n 27835 and subsequent (delivered Dec 97)			
737-800	Service letter: 737-SL-02-017 (1/98)	Factory RVSM ready s/n 27977 and subsequent (delivered Apr 98)			
737-900	Service letter: 737-SL-02-017 (1/98)	Factory RVSM ready s/n 29599 and subsequent (delivered Jun 00)			
737-BBJ	Service letter: 737-SL-02-017 (1/98)	Factory RVSM ready s/n 29102 and subsequent (delivered Dec 98)			
747-400 5" Probes	747-53-2394 IN-03 (7/95) 747-53-2398 (11/95)	Mach $\leq$ 0.90 in RVSM airspace	No Change	Detailed Measurement	Unplated: 3 years Plated: no limit
747-400, 10" Probes	747-53-2393 (11/95)	Mach $\leq$ 0.90 in RVSM airspace	No Change	Visual	Plated: no limit
757-200	757-34-0132 IN-02 (12/95) 757-53-0074 (10/95)	No Change	ADC Upgrade & new SSEC	Visual	N/A
757-300	Service letter 757-SL-02-016C (3/99)	Factory RVSM ready s/n 29012 and subsequent (delivered Mar 99)			
767-200/300	767-34-0237 IN-02 (1/95) 767-53-0068 (7/95) Rev 2 - 5/97	No Change	Use 767-300 SSEC on all models	Visual	Unplated: 3 years Plated: no limit
767-400	Service Letter 767-02-011-B 8/2000	Factory RVSM ready s/n 29446 and subsequent (delivered Aug 00)			
777-200/300	777-53-0007 (4/97)	No Change	No Change	Visual	N/A
707	STC group approval is under development by AeroMech, Inc. and is expected 2nd Quarter of 2003.				
727-100/200	727-53-0220 (Contact Boeing for AFM update)	No Change	New ADC and SSEC	Visual	N/A
727-100/200	ST01011SE (11/01) (Aeromech)	No Change	New ADC	Visual	N/A
737-200	737-53-1191 IN-01 (7/96)	No Change	New ADC	Visual	Unplated: no limit
737-200/200 Advanced	ST00894SE (3/01) (Aeromech)	No Change	New ADC	Visual	Unplated: no limit
747-100/200/ 300/SP	747-53-2405 (5/96) 747-53-2394 (7/95) 747-34-2135 (11/80)	Mach $\leq$ 0.90 or 0.87 @ low weight in RVSM airspace	Specific SSEC	Detailed Measurement	Unplated: 4 years Plated: no limit

Model	Service Bulletin	Operational Changes	Air Data Computer	Skin Check	Pitot Static Probe Life
MD-81/82/83/ 87/88	MD-80 34-289 (2/97) Rev 2 – 5/98	No Change	No Change	Detailed Measurement (Static Plate)	N/A
MD-90-10/30/40	MD-90 34-006 (5/97)	No Change	No Change	Detailed Measurement (Static Plate)	N/A
717	N/R	N/R			
MD-11 Combi, Freighter, Passenger	MD-11 34-065 (3/96) Rev 2 – 2/97	No Change	No Change	Detailed Measurement (Static Plate)	N/A
DC-10	DC-10 34-134 (3/96) Rev 7 – 6/99	No Change	No Change	Detailed Measurement (Static Plate)	N/A
DC-9	ST01136LA (3/01) -30,-40,-50 series aircraft in conjunction with Boeing-Douglas Corporation (Aeromech)	No Change	New ADC	Detailed Measurement (Static Plate)	N/A
DC-8	ST01073LA (9/00) -61,-62,-63,-71,-72,-73 series aircraft both passenger and freighter models (Aeromech)	No Change	New ADC	Detailed Measurement (Static Plate)	N/A
A319	A320-34-1137		No Change	Visual	
A320	A320-34-1137		MSN <621 : Pitot 1 relocation A320-34-1122	Visual	
	or A320-34-1115	MMEL/FCOM restriction: ADR1 and 2 operative	No Change	Visual	
A321	A320-34-1137		MSN < 621 Pitot 1 relocation A320-34-1122 ADIRU 3 modification A320-34-1129(Hwl) A320-34-1129(Lit)	Visual	
	or A320-34-1115	MMEL/FCOM restriction: ADR1 and 2 operative	No Change	Visual	
A340	A340-34-4034		No Change	Visual	
A330	A330-34-3031		No Change	Visual	
A300-600	A300-34-6101		No Change	Visual	

Model	Service Bulletin	Operational Changes	Air Data Computer	Skin Check	Pitot Static Probe Life
A310 GE	A310-34-2112		No Change	Visual	
A310 PW	A310-34-2112		MSN < 698 DADC-914 required A310-34-2114	Visual	
A300 B2/B4	A300-34-0139		No Change	Visual	
L-1011	L1011-093-34-204	No Change	No Change	Detailed Measurement	6 years or 10 years
F100	FBF100-34-072		Functional test	Visual	
Non-Group RVSM Programs	Each STC is serial number specific **(Aeromech)**				
707-300					
727-100					
DC-8-60/-70					
DC-9-10					
DC-9-30					
KC-135A (USAF)		J-57 engines			
KC-135E (USAF)		Turbofans			

APPENDIX C

SMALL COMMERCIAL AND GENERAL AVIATION AIRCRAFT ENGINEERING PACKAGE STATUS

Aircraft Type	ICAO Type Designator	Aircraft Engineering Status
Canadair		
Global Express	GLEX	Released SB-700-34-014
Challenger 604	CL60	Released SB-604-34-012
Challenger 601	CL60	Released SB-601-0484
Challenger 600	CL60	Released SB-600-0673
CL-601R C-RJ	CRJ2	Released SB-601R-34-080
CL-601R SE	CRJ2	Released SB-601R-34-080
Cessna		
Citation I (S/N 500-0275 thru –0689)	C500	Released SB-500-34-65
Citation ISP	C501	Released SB-500-34-60
CitationJet	C525	Released SB-525-34-41
CitationJet CJ2	C525A	Released SB-525A-34-01
CitationJet I	C525	Released SB-525-34-40
CitationJet II	C525A	Released SB-525A-34-01 (factory option)
Citation SII	CSII	Released SB-550-34-36
Citation II (S/N 550-0002 thru –0733)	C550	Released SB-550-34-79
Citation IISP	C551	Released SB-550-34-79
Citation II Bravo	C550	Released SB-550-34-70
Citation V (S/N 560-001 thru –0259)	C560	Released SB-560-34-97
Citation V Ultra	C560	Released SB-560-34-79
Citation V Encore	C560	Factory RVSM-ready
Citation Excel	C56X	Released SL-560XL-34-02
Citation III	C650	Released SB-650-34-107
Citation VI	C650	Released SB-650-34-105
Citation VII	C650	Released SB-650-34-97
Citation X	C750	Released SB-750-34-05
Conquest	C441	TBD
****Cessna** - Other Known RVSM Solutions*		
Citation I	C500	Released ST01636CH (Garrett SPZ-500 A/P only)
Citation I	C500	Released ST01149WI (Columbia Avionics)
Citation ISP	C501	Released SA01156WI (Columbia Avionics)
Citation ISP	C501	Released ST01637CH (Garrett SPZ-500 A/P only)
Citation II	C550	Released ST01149WI (Columbia Avionics)
Citation II	C550	Released ST01636CH (Garrett SPZ-500 A/P only)
Citation IISP	C551	Released SA01156WI (Columbia Avionics)
Citation IISP	C551	Released ST01637CH (Garrett SPZ-500 A/P only)
Citation V	C560	Released ST01149WI (Columbia Avionics)
Citation V	C560	Released ST01636CH (Garrett SPZ-500 A/P only up to s/n 259)
Dassault Falcon Jet		
2000	F2TH	Released SB-063
900	F900	Released SB-186

Aircraft Type	ICAO Type Designator	Aircraft Engineering Status
900EX	F900	Released SB-004
50	FA50	Released SB-246
50EX	FA50	Released SB-246
200	FA20	Released SB-104
20	FA20	Released SB-743
10	FA10	Released SB-289 (Available only in France on non-group, individual aircraft basis)
***Falcon** - *Other Known RVSM Solutions*		
10	FA10	Released ST01625CH-D (Garrett AP-105, APS-80 and SPZ-600)
10	FA10	Released ST01187SE (Aeromech)
20	FA20	Expected 3Q 2003 (Aeromech)
20	FA20	Released ST01262CH-D (Garrett Proline 21 equipped only)
50	FA50	Released ST01047CH-D (Garrett Proline 21 equipped only)
Embraer		
ERJ 135	E135	SB-145-35-0032/SB 145-34-0064
ERJ 145	E145	SB-145-35-0032/SB 145-34-0064
Israel Aircraft Industries / Galaxy		
Astra SP	ASTR	SB-1125-34-193 and 194 (s/n 30, 42 to 72)
Astra SPX	ASTR	SB-1125-34-168 (s/n 73 and subsequent)
Westwind 1124	WW24	STC Expected 3Q 2003
Westwind 1124A	WW24	STC Expected 3Q 2003
***Israel Aircraft Industries** - *Other Known RVSM Solutions*		
Astra /Astra SP	ASTRA	ST01141SE (Aeromech, s/n 01 to 29, 31 to 41)
Westwind 1124 / 1124A	WW24	ST01116SE (Aeromech)
Gulfstream		
G2	GLF2	Released ASC499 (aircraft equipped with SPZ-800)
G2	GLF2	Released ASC498 (aircraft equipped with SP50)
G2B	GLF2	Released ASC505 (aircraft equipped with SPZ-800)
G2B	GLF2	Released ASC504 (aircraft equipped with SP50)
G3	GLF3	Released ASC308
G4	GLF4	Released ASC380
G5	GLF5	Released ASC13
G-100 (Formerly Astra SPX)	G100	Released SB-1125-34-168 (Rev. 2)
G-200 (Formerly Galaxy)	G200	Released SB-GALAXY-34-022
***Gulfstream** - *Other Known RVSM Solutions*		
G2 *(aircraft equipped with SP50)*	GLF2	Released ST01090LA (Garrett Aviation Services)
G2B *(aircraft equipped with SP50)*	GLF2	Released ST01635CH (Garrett Aviation Services)
Learjet		
20 Series	LJ23,LJ24,LJ25	None planned
31	LJ31	Expected 1Q 2004
31A	LJ31	Released SB-31-34-11
35/36 (FC200)	LJ35	Released ST00952SE

Aircraft Type	ICAO Type Designator	Aircraft Engineering Status
35/36 (FC530)	LJ35	Released ST00952SE
45	LJ45	Factory RVSM-ready
55	LJ55	Released ST01050SE
55 BC	LJ55	Released ST01050SE
60	LJ60	Released SB-60-34-06
***Learjet** - Other Known RVSM Solutions In Development		
20 Series	LJ24,LJ25	Expected 2Q 2003 - Bizjet International/ Avcon Industries
20 Series	LJ24,LJ25	Expected 2Q 2003 - LJSC
20 Series	LJ24,LJ25	TBD - Spirit Wing
35/35A/36/36A	LJ35	Released ST00952SE (Aeromech)
55/55B/55C	LJ55	Released ST01050SE (Aeromech
Lockheed		
Jetstar 731	L29B	TBD
Jetstar 2	L29B	TBD
***Lockheed** – Other Known RVSM Solutions In Development		
Jetstar 731	L29B	Expected 4Q 2003 (Aeromech)
Jetstar 2	L29B	Released ST01082SE (Aeromech)
Piaggio		
Avanti P180	P180	Expected 3Q 2003 (U.S.)
Pilatus		
PC-12	PC12	TBD
Piper		
PA-42-1000 Cheyenne 400	PAY4	TBD
Raytheon		
Beech King Air 200	BE20	Released SB-34-3506, Rev. 2 (ADC-85/APS-65H equipped a/c)
Beech King Air 350	B350	Released SB-34-3507, Rev. 4 (ADC-85/APS-65J equipped a/c)
Beechjet 400	BE40	Raytheon Aircraft Services STC expected 4Q 2003
Beechjet 400A	BE40	Released SB-34-343 (except 2-Tube AMS-850 equipped a/c)
Diamond MU-300	MU30	Raytheon Aircraft Services STC expected 4Q 2003
HS 125 Series 1 through 600	H25A	None planned
HS 125 Series 700 A	H25B	Raytheon Aircraft Services STC available for ADC-80/ non-ADC(Atlanta/Chester)
HS 125 Series 700 B	H25B	Raytheon Aircraft Services STC available for ADC-80/ non-ADC(Atlanta/Chester)
HS 125 Series 800	H25B	Released SB-34-3381 Rev. 4 (Collins ADC-82A)
HS 125 Series 800	H25B	Contact Raytheon Aircraft Services - Chester Single A/C approvals
HS 125 Series 800 and 800XP	H25B	Released SB-34-3110, Rev. 8 (Honeywell)
HS 125 Series 800 and 800XP	H25B	Released SB-34-3166, Rev. 5 (Collins ADC-86A)
HS 125 Series 1000	H25C	Released SB-34-3216, Rev. 2 (Honeywell)
Premier I	PRM1	Completed - Installed by factory kit
Beech Starship 2000	STAR	TBD
***Raytheon** - Other Known RVSM Solutions In Development		
HS 125 Series 700 A	H25B	Released ST01124WI (Midcoast Aviation)

Aircraft Type	ICAO Type Designator	Aircraft Engineering Status
HS 125 Series 700 B	H25B	Released ST01124WI (Midcoast Aviation)
HS 125 Series 800	H25B	Expected 4Q 2003 (Midcoast Aviation)
Beech King Air 200/ 200C/ B300/ 300C	BE20/ 30	Released ST01070SE (Aeromech)
Beechjet 400A	BE40	Released ST00821SE (Aeromech)
Sabreliner		
NA-265	SBR2	Aircraft to be modified in accordance with FAA-Approved Drawing 65E-011-0012
***Sabreliner** - *Other Known RVSM Solutions*		
NA-265	SBR2	ST01134SE (Aeromech)
NA-265	SBR2	TCA2WE (Midcoast Aviation)
NA-265-80	SBR2	Expected 4Q 2004 (Midcoast Aviation)

Non-Group RVSM Programs

Aircraft Type	ICAO Type Designator	Aircraft Engineering Status
Bombardier CL-600-1A11	CNTL	**Each RVSM STC is serial-number specific/ several exist for each airframe**
British Aerospace BAE.125-800A	H25B	**Aircraft listed below had STCs developed by Aeromech**
Cessna Citation 501	C501	
Dassault-Breguet Falcon 10	FA10	
Dassault-Breguet Falcon 20F	FA20	
Hawker Siddeley HS.125-700	H25B	
IAI Westwind 1124	WW24	
IAI Westwind 1124A	WW24	
IAI Astra 1125	ASTR	
Learjet Inc. Model 31	LJ31	
Learjet Inc. Model 55	LJ55	
Lockheed Martin 1329-25 Jetstar II	L29B	
Lockheed Martin 1329-23 Jetstar 731	L29B	
Rockwell/ Sabreliner Model 265-65	SBR1	