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

**Tenth Meeting/Workshop of ATM Authorities and Planners
of the CAR/SAM Regions (AP/ATM/10)**

(Lima, Peru, 10 -14 May 2005)

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

c) Safety and Airspace Monitoring Working Group (SAM/WG)

**Examination of Large Height Deviation Reports Received by the
Caribbean and South American Monitoring Agency (CARSAMMA) in
Connection with the Implementation of the Reduced Vertical Separation
Minimum (RVSM) in the CAR/SAM Regions**

(Presented by CARSAMMA)

Summary

This working paper presents a summary of the large height deviation (LHD) reports received by the CARSAMMA associated with the CAR/SAM RVSM implementation.

1. Introduction

1.1. The Caribbean and South American Air Navigation Planning and Implementation Regional Group (GREPECAS) established the Caribbean and South American Monitoring Agency (CARSAMMA) as a safety oversight function to support RVSM implementation and use in the Caribbean and South American Region. The CARSAMMA is a service provided by the Brazilian Air Navigation Management Center.

1.2. The CARSAMMA serves as a regional monitoring agency (RMA) as is called for in ICAO Doc 9574. Along with maintaining a registry of State RVSM approvals of operators and aircraft using RVSM airspace, the CARSAMMA has produced readiness and safety assessments in conjunction with the Safety and Airspace Monitoring (SAM) Working Group of the RVSM Task Force.

1.3. The CARSAMMA has applied the internationally accepted safety assessment process with the introduction of the RVSM into CAR/SAM airspace. The basic collision risk model (CRM) is used to estimate the overall system risk attributable to all causes prior to implementation of the RVSM. To estimate the system risk, the CRM requires many parameters that are derived from data sources supplied to the CARSAMMA. One of the required parameters for the CRM is the total number of annual flying hours spent at incorrect flight levels. To accurately estimate risk the CARSAMMA requests monthly reports, call Large Height Deviation (LHD) reports from the various Flight Information Regions (FIRs) in the target RVSM airspace. The LHD reports contain the information needed to estimate the number of annual flying hours spent at incorrect flight levels in the RVSM airspace.

1.4. At AP/ATM/9 (Lima, November 04), the meeting agreed that States should continue to provide the CARSAMMA with monthly reports of LHDs of 300 ft or more to facilitate the safety oversight of the RVSM airspace. The Large Height Deviation form is presented in **Appendix A**.

1.5. The purpose of this paper is to present a summary of the LHD reports received by the CARSAMMA in connection with the use of the RVSM in the CAR/SAM airspace.

2. **Background**

2.1. This section provides a brief description of how the LHD reports are linked to the ICAO sanctioned CRM that is applied during the safety assessment process.

2.2. The LHD report contains details of events resulting in altitude deviations of 300 ft or more occurring in the RVSM airspace. Events caused by turbulence or other weather related causes, responses to TCAS advisories, deviations due to contingency events, and operational errors are included on the LHD report. The CARSAMMA requests that if no events occur during a month, a report indicating "NIL" LHDs be submitted for completeness.

2.3. Reference 1 provides a description of the CRM used to estimate the system risk attributable to all causes. In the CRM, the estimation of the probability that two aircraft nominally separated by 1,000 ft are in vertical overlap, $P_z(1,000)$, due to large height deviations requires determination of two quantities: (1) the proportion of total flying time spent at incorrect levels, P_i , and (2) the probability that two aircraft nominally flying at the same level are in vertical overlap, $P_z(0)$.

2.4. System risk is directly proportional to the amount of total flight time spent at the wrong flight levels. The estimate of these times are one of the key elements used to determine whether or not the estimated system risk will meet the Target Level of Safety (TLS), using the CRM. The amount of total flight time spent at the wrong flight levels is estimated from the LHD reports received during a specified time interval.

2.5. The proportion of flying time spent at incorrect levels, P_i , is determined as the ratio of the amount of time spent at incorrect levels to the total amount of flying time in CAR/SAM airspace during the period when the wrong-flight-level events occurred.

3. **Discussion**

3.1. Table 1 presents a summary of the LHD reports of 1000ft or more received by the CARSAMMA since February 04 until January 05. The total number of the corresponding number of minutes spent at wrong flight levels are shown for each reporting LHD.

3.2. As part of the safety oversight functions performed by the CARSAMMA, the current 12-month interval of LHD reports is used in the estimation of the system collision risk. For each day - month-year provided in Table 1, the number of minutes spent at wrong flight levels for the corresponding report is provided.

(Follows in next page)

Date	Time	Acft type	AWY	Point of observed LHD	FL	LHD	Time (sec)	Type of Error	Info	FIR	State	Tne opp	Tne same	n ^{lc} _{same}	n ^{lc} _{opp}
03/02/04	21:30	HS25	UW5	-	-	-1000	90	H	Nil	SBCW	SB	90	0	0	0
02/04/04	06:58	B762	UG437	PML	310	4000	0	M	Mode C	MPZL	MP	0	0	0	0
08/04/04	02:05	MD88	UA303	KONRI	310	4000	90	M	Pilot	SCFZ	SC	0	90	0	0
08/04/04	23:36	B752	UG437	DUXUM	330	4000	0	M	Pilot	MPZL	MP	0	0	0	0
29/04/04	02:26	MD88	UA303	KONRI	310	4000	90	M	Pilot	SCFZ	SC	0	90	0	0
06/05/04	23:30	B763	UG437	DUXUM	330	4000	0	M	Pilot	MPZL	MP	0	0	0	0
08/05/04	04:50	-	UW10	RESUS	350	1100	300	B	Mode C	SBRE	SB	300	0	0	0
10/05/04	20:14	MD80	UA317	TBG	350	-4000	0	M	Mode C	MPZL	MP	0	0	0	0
13/05/04	23:30	B737	UZ5	NELSO	310	-1000	90	E	Mode C	SBRE	SB	90	0	0	0
14/06/04	21:09	B763	UL780	BUXOS	310	4000	0	M	Mode C	MPZL	MP	0	0	0	0
16/06/04	18:32	-	UM788/UM792	CGR	370	-2000	90	M	Mode C	SBCW	SB	0	90	0	0
23/06/04	10:44	-	UM540	OSAMU	330	4000	180	A	Mode C	SBCW	SB	0	180	1	2
04/07/04	00:36	A346	UIR SOOO/SBAO	0500S/04000W	330	4000	300	M	Pilot	SOOO	SO	0	300	0	0
12/07/04	16:37	-	UA314	ETANO	310	4000	300	M	Mode C	SBCW	SB	0	300	0	0
14/07/04	07:01	B763	UL302	IREMI	350	4000	1800	M	Pilot	SCFZ	SC	0	1800	0	0
14/07/04	22:25	B737	UM525	BITIX	350	4000	0	M	Mode C	MPZL	MP	0	0	0	0
14/07/04	23:42	B737	UA552	FALLA	330	4000	0	M	Mode C	MPZL	MP	0	0	0	0
20/07/04	15:02	B737	UA317	BUFEO	370	4000	0	M	Pilot	MPZL	MP	0	0	0	0
22/07/04	05:53	-	UA308	MLO	330	-4000	90	M	Mode C	SBCW	SB	0	90	0	0
28/07/04	20:02	B763	UL780	BUXOS	310	4000	0	M	Mode C	MPZL	MP	0	0	0	0
28/08/04	18:08	B757	A636	RETAK	310	4000	60	M	Pilot	MTEG	MT	0	60	0	0
28/08/04	14:08	B757	G444	LENOM	370	2000	60	M	Pilot	MTEG	MT	0	60	0	0
02/10/04	14:59	B737	A315	CRO	280	3000	120	M	Pilot	MTEG	MT	120	0	0	0
03/10/04	-	B757	G444	LENOM	350	-4000	60	M	Pilot	MTEG	MT	0	60	0	0
25/11/04	21:26	B737	A315	CRO	390	-4000	60	M	Pilot	MTEG	MT	0	60	0	0
08/12/04	17:25	DC8	UL305	TERAS	350	4000	900	M	Mode C	SPIM	SP	0	900	0	0
16/12/04	17:25	B737	UV9	TAPIR	290	4000	180	M	Mode C	SPIM	SP	0	180	0	0
26/01/05	03:30	A320	UA303	GELIS	330	2000	0	M	Pilot	SCFZ	SC	0	0	0	0
29/01/05	18:53	B763	UB684	ANKON	380	2000	0	M	Pilot	SCEZ	SC	0	0	0	0
Total												600	4260	1	2

Table 1. Reports of LHD of 1000ft or more received by the CARSAMMA by Month-Year for the CAR/SAM airspace

3.3. Table 3 summarizes the details of the non-“NIL” LHD reports shown in Table 1 including the LHD of less than 1000ft. The cause of each deviation is represented by a letter code for compactness. The letter codes shown in Table 3 are defined in Table 2. Table 2 provides the cause of the LHD by assigned letter code.

Code	Cause of Large Height Deviation
A	Failure to climb/descend as cleared
B	Climb/descend without ATC clearance
C	Entry into airspace at an incorrect flight level
D	Deviation due to turbulence or other weather related cause
E	Deviation due to equipment failure
F	Deviation due to collision avoidance system (TCAS) advisory
G	Deviation due to contingency event
H	Aircraft not approved for operation in RVSM restricted airspace
I	ATC system loop error; (e.g. pilot misunderstands clearance message or ATC issues incorrect clearance)
J	Equipment control error encompassing incorrect operation of fully functional FMS or navigation system (e.g. by mistake the pilot incorrectly operates INS equipment)
K	Incorrect transcription of ATC clearance or re-clearance into the FMS
L	Wrong information faithfully transcribed into the FMS (e.g. flight plan followed rather than ATC clearance or original clearance followed instead of re-clearance)
M	Error in ATC-unit-to-ATC-unit transition message
N	Negative transfer received from transitioning ATC-unit
O	Other

Table 2. Codes Used to Define the Cause of Each Reported LHD

Month- Year	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Feb- 04				2	11			6							
Mar - 04					9			4							
Apr - 04					2	1		3					4		
May - 04		1		1	8	1							2		
Jun -04	1			5	2								1		1
Jul - 04					4								8		
Aug - 04					4			1					3		1
Sep - 04															
Oct - 04													2		
Nov - 04								1					1		1
Dec - 04													2		
Jan - 05													2		

Table 3. Summary of the Total Number of non-“NIL” LHD Reports by Month and Cause of Deviation for the CAR/SAM airspace

3.4. Table 3 demonstrates the frequency of each deviation and its reported cause for all the non-“NIL” LHD reports received by the CARSAMMA. Since February 2004 the most frequent cause of a LHD, save equipment failures, was due to error in ATC-unit to ATC-unit transition message.

(Follows in next page)

3.5. Table 4 presents the LHD reports received by CARSAMMA by month.

FIR	Feb-04	Mar-04	Apr-04	May-04	Jun-04	Jul-04	Aug-04	Sep-04	Oct-04	Nov-04	Dec-04	Jan-05
Curacao - TNCF	-	-	-	-	-	-	-	-	-	-	-	-
Ezeiza – SAEU	-	-	X	X	X	-	X	X	X	X	X	-
Mendoza - SAMV	-	-	X	X	X	X	X	X	X	X	-	-
Resistência - SARU	-	-	X	X	X	X	X	X	X	X	-	-
Comodoro Rivadavia – SAVU	-	-	X	X	X	X	X	X	X	X	-	-
Córdoba - SACU			X	X	X	X	X	X	X	X	-	-
La Paz – SLLF	X	X	X	X	X	X	X	-	-	-	-	-
Curitiba- SBCW	X	X	X	X	X	X	-	X	X	X	X	X
Brasília – SBBS	X	X	X	X	-	-	-	-	-	X	X	X
Recife – SBRE	X	X	X	X	-	-	-	-	X	X	X	X
Amazônica - SBAZ	-	-	-	X	X	X	X	-	-	-	-	-
Punta Arenas - SCCZ	-	-	X	X	X	X	X	-	-	-	-	-
Santiago – SCEZ	X	X	X	X	X	X	X	X	X	X	X	X
Antofagasta - SCFZ	X	X	X	X	X	X	X	X	X	X	X	X
Isla de Pascua - SCIZ	-	X	X	X	X	X	X	X	X	-	-	X
Puerto Montt - SCTZ	-	X	X	X	X	X	X	X	X	X	X	X
Central American - MHTG	X	X	X	X	X	X	X	X	X	X	X	X
Barranquilla - SKEC	-	-	X	X	X	X	X	X	X	-	-	-
Bogota – SKED	-	-	X	X	X	X	X	X	X	-	-	-
Havana – MUFH	X	-	-	-	X	-	X	X	X	X	-	X
Guayaquil – SEGU	-	-	-	-	X	X	X	-	X	X	-	-
Georgetown - SYGC	-	-	-	-	X	X	X	-	X	-	-	-
Rochambeau – SOOO	X	X	X	X	X	X	X	X	X	X	X	X
Port Au Prince – MTEG	-	-	-	-	X	X	-	X	X	X	-	-
Kingston – MKJK	X	X	X	X	X	X	X	X	-	X	-	-
Panama Oceanic – MPZL	X	X	X	X	X	X	X	X	X	-	-	-
Asunción – SGFA	X	X	X	X	X	X	X	X	X	X	X	X
Lima – SPIM	-	X	X	X	X	X	X	X	-	-	X	X
Santo Domingo – MDSD	-	-	-	-	-	-	-	-	-	-	-	-
Paramaribo – SMPM	X	X	X	X	X	X	X	-	-	-	-	-
Piarco – TTZP	-	-	X	X	X	X	X	X	X	X	X	X
Montevideo – SUEO	X	-	X	X	X	X	X	X	X	-	-	X
Maiquetia - SVZM	-	-	-	-	-	-	-	-	-	-	-	-

Table 4 - Large Height Deviations Reports Received by the CARSAMMA by Month

X = Large Height Deviation report has been received for the specified month (including reports indicating "NIL" events)

4. **Summary and Conclusions**

4.1. This paper provides a summary of the LHD reports received by the CARSAMMA in connection with the introduction of the RVSM in CAR/SAM airspace.

4.2. The details of the LHD reports received by the CARSAMMA during the month were presented.

4.3. The total number of minutes spent at incorrect flight levels were presented along with the reported cause of each LHD event.

4.4. Starting in February 2004, the most frequent cause of a reported LHD was due to error in ATC-unit to ATC-unit transition message. For this problem remedial action must take place to reduce the frequency of these errors.

5. **Recommended actions**

5.1 States are requested to take note of the importance of the LHD reports in the safety assessment process.

5.2 States are requested to continue to inform CARSAMMA the LHD reports by the 10th of each month even if no deviation occurs.

5.3 States must remember that aircraft flying in wrong flight levels without ATC clearance or due to mistakes in coordination of traffic must be reported to CARSAMMA so the proportion of flight hours spent at incorrect flight levels can be calculated.

5.4 Controllers must be trained to avoid the errors in ATC-unit to ATC-unit transition message, to reduce the time spent in wrong flight levels.

References

1. The Guidance Material on the Implementation of a 300 M (1000 Ft) Vertical Separation Minimum (VSM) between FL290 and FL410 Inclusive for Application in the Airspace of the Caribbean and South American Regions. Draft CAR/SAM Guidance Version.3, 06-05-2003

APPENDIX A

**CARIBBEAN AND SOUTH AMERICAN
MONITORING AGENCY (CARSAMMA)**

Report of Large Altitude Deviation for aircraft cleared at or above FL290
Report to the Caribbean and South American Monitoring Agency (CARSAMMA) of an altitude deviation
of 300ft or more, including:

- 1) those due to TCAS
- 2) turbulence and contingency events and
- 3) operational errors resulting in operation at flight levels other than cleared by ATC or coordinated
by ATC units.

Name of FIR: _____

Please complete Section I or II as appropriate

SECTION I:

There were no reports of large altitude deviation for the month of _____

SECTION II:

There was/were _____ report(s) of an altitude deviation of 300 ft or more for aircraft cleared at or above
FL290. Details of the altitude deviation are attached (Form A).

(Please use a separate form for each report of altitude deviation).

SECTION III:

When complete please forward the report(s) to:

Management Center Of Air Navigation
Caribbean and South American Monitoring Agency (CARSAMMA)
Av. Brig. Faria Lima, 1941
São José dos Campos, SP
Cep: 12227-000
Brazil
Telephone: (55-12) 3904-5004 or 3904-5010
Fax: (55-12) 3941-7055
E-Mail: carsamma@cgna.gov.br

FORM A

**REPORT OF AN ALTITUDE DEVIATION OF 300 FT OR MORE FOR AIRCRAFT CLEARED
AT OR ABOVE FL 290**

- (1) Reporting unit
- (2) Location of deviation (lat/long or fix)
- (3) Date and time of occurrence (UTC)
- (4) Airway or portion of airspace
- (5) Flight identification (optional) and type of aircraft (mandatory)
- (6) Flight level assigned
- (7) Observed or reported final flight level or altitude

Note : Please provide the source of information - Mode C/Pilot report

- (8) Duration at incorrect flight level or at incorrect altitude reported in (7)
- (9) Cause of deviation
- (10) Other traffic in conflict
- (11) Crew comments, if any, when notified
- (12) Remarks