



Agenda Item 3: Air navigation activities at global, intra-regional and inter-regional level

3.3 Inter-regional air navigation activities

**New methodology for the analysis and assessment of
Large Height Deviations in the CAR/SAM Region**

(Presented by the Rapporteur of the Scrutiny Working Group - GTE)

SUMMARY	
This working paper presents new methodology used by CARSAMMA and the Scrutiny Working Group (GTE) for the analysis and assessment of Large Height Deviations in the CAR/SAM Region.	
References: <ul style="list-style-type: none">• Final Report of the GTE/11 Meeting• Final Report of the GTE/12 Meeting• Final Report of the GTE/13 Meeting• ICAO Document 9574	
ICAO strategic objectives	<i>A - Safety C - Environmental protection and sustainable development of air transport</i>

1. Introduction

1.1 Since the implementation of the Reduced Vertical Separation Minima (RVSM) in the CAR/SAM Regions, the Caribbean and South American Monitoring Agency (CARSAMMA) and the Scrutiny Working Group (GTE) have made an analysis of Large-Height Deviations (LHD) to assess the Target Level of Safety (TLS), as established in ICAO Doc 9574.

1.2 After the analysis of all reports, CARSAMMA and the GTE noticed that 94% of the LHD's reported are due to coordination errors in the ATC-to-ATC transfer or control responsibility as a result of Human Factors. Also there was noticed that even with the increasing amount of LHD reports, (645 in 2010, 687 in 2011, 1065 in 2012 and 1332 in 2013) the TLS, both technical and overall, as established in ICAO Doc 9574, were met.

1.3 The GTE/11 Meeting held in Lima, Peru, approved the implementation of a SMS based approach for the analysis and assessment of LHD. This methodology allows a quantitative calculation of the level of risk for each individual report.

1.4 Since 2011, CARSAMMA and the GTE have been working using both, the new methodology and the Collision Risk Model (CRM) in the SMS Methodology to analyze LHD reports.

2. **Analysis**

2.1 Using this new methodology for calculating the risk level, it has been noted that a great number of LHD went from 49% in 2012, to 54% in 2013 and require mitigation actions by the States/Territories. This information gives a valuable tool to States to require the implementation of specific plans for these purposes. The Manual-Guide on the Assessment of Large Height Deviations (LHDs) based on an ATS Safety Management System (SMS), included in **Appendix A**, contains all the details of this methodology.

2.2 This methodology provides a qualitative approach for the analysis of LHD's, and even if the TLS established in ICAO Doc 9574 is met, States/Territories are required to take the mitigation action if a particular LHD Level of Risk is above of the target level of safety (TLS).

2.3 The main goal is that CARSAMMA and GTE continue with the RVSM airspace safety assessment using both methodologies to recommend required mitigation actions to reduce the amount of LHD reports in the CAR/SAM Regions.

3. **Suggested actions:**

3.1 The Meeting is invited to:

- a) Take note of the information contained in this working paper;
- b) Revise and approve the new methodology for the analysis and assessment for LHD reports;
- c) Encourage States/Territories and International Organizations to use this methodology in the analysis of their LHD reports; and
- e) Recommend other actions that are considered necessary.

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**Manual on the Assessment of Large
Height Deviations (LHDs) based on an
ATS Safety Management System (SMS)
for the CAR/SAM Regions**

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1. INTRODUCTION

The Scrutiny Task Force (GTE) and the CAR/SAM Monitoring Agency (CARSAMMA) have developed a methodology for the analysis and assessment of Large Height Deviations (LHDs), based on a Safety Management System (SMS), with the purpose of increasing the level of safety in CAR/SAM RVSM airspace.

This methodology is used for assessing the level of risk of each occurrence individually, and helps to identify trends and critical points of occurrence.

CARSAMMA will continue calculating the Risk Value using the Collision Risk Model (CRM) established in ICAO Doc 9574 (Manual on implementation of a 300m vertical separation minimum between FL290 and FL410 inclusive), using a TLS of 5×10^{-9} fatal accidents per hour of flight as reference parameter. The objective is to conduct a quantitative (CRM) and qualitative (SMS) assessment of operations in RVSM airspace and increase the level of safety in the CAR/SAM Regions.

2. Background

The GTE recognised the need to analyse LHDs applying a safety management system (SMS) approach, since the Collision Risk Model uses a mathematical formula to calculate the level of risk of the Regions without giving details of the occurrences analysed.

The GTE has been using the SMS methodology to analyse and assess LHDs since 2011. This methodology allows CAR/SAM States and international organisations to analyse, adopt and implement measures to mitigate LHDs in their respective FIRs.

3. LHD Analysis and Assessment

During the analysis, the cause of the occurrence is identified using the LHD code table, which is contained in appendix B to this manual.

Following the identification of the causes (LHD code) by CARSAMMA, the GTE must analyse the risks associated to each LHD code that has been identified, assessing their severity and likelihood of occurrence.

For the **Severity Analysis**, the GTE team, based on its experience, applies the Severity Table as follows:

Effects	Severity of Hazard (LHD)
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	Catastrophic 5	Hazardous 4	Major 3	Minor 2	Insignificant 1
ATC	Collision with aircraft, ground or obstacle. TCAS (RA) warning	Significant reduction of separation or total loss of capacity (ATC zero)	Significant reduction of separation or ATC capacity	Slight reduction of ATC capacity or significant increase of ATC workload	Slight increase of ATC workload

Table 1

Each code is associated to an LHD severity based on the impact on safety:

5	4	3	2	1
J, K	B, D, F, G, H, I	A, C, E, L	E	M

Table 2

After determining the severity, the **Likelihood** is established based on statistical data showing the points with higher rates of occurrence in the CAR/SAM Regions, bearing in mind the worst-case scenario. To this end, the following table is used:

Likelihood	Level of ATC service/system	Operational
Frequent 5	Continuously occurring in the system	Expected to occur every 1-2 days
Occasional 4	Expected to occur frequently in the system	Expected to occur several times a month
Remote 3	Expected to occur several times during the lifetime of the system	Occur approximately once every few months
Unlikely 2	Unlikely, but may be reasonably expected to occur during the lifetime of the system	Expected to occur approximately once every three years
Extremely unlikely 1	One of them is unlikely but possible in the lifetime of the system	Expected to occur approximately every 30 years

Table 3

After determining the likelihood, the duration of the occurrence is established based on the following table:

1 Short	$d \leq 1$ minutes
2 Medium	$1 < d \leq 2$ minutes
3 Long	$d > 3$ minutes

Table 4

Thus, the following expression may be used:

Likelihood (P)	Duration (D)	Severity (G)
5 Frequent		5 Catastrophic
4 Occasional		4 Hazardous
3 Remote	3 Long	3 Major
2 Unlikely	2 Medium	2 Minor
1 Extremely unlikely	1 Short	1 Insignificant

Table 5

Once the aforementioned values have been obtained, it is determined whether the FIR that is subject to the risk has an ATS surveillance system, if meteorological conditions were VMC or IMC, and whether there was other conflicting traffic, based on which the following values are assigned:

Surveillance system	Meteorological conditions	Other traffic
YES = 5	VMC = 0	With surveillance = 10
NO = 10	IMC = 5	Without surveillance = 10

Table 6

4. Risk Value Calculation

Once the aforementioned data is obtained, the following formula is applied for calculating the risk value:

$$VR = (Px Dx G) + R + W + T, \text{ where:}$$

Parameter	Description	Value
VR	Risk value	To be calculated
P	Probability of the position	Varies from 1 to 5
D	Duration of the occurrence	Varies from 1 to 3
G	Severity of the occurrence	Varies from 1 to 5
R	With or without ATS surveillance	With=5 or Without=10
W	Meteorological conditions	VMC=0 or IMC=5
T	Other traffic (if any)	10
	TOTAL	Maximum 100 points

Table 7

5. Target level of safety (TLS)

Once the LHD analysis and assessment process has been completed, the resulting Risk Value for each LHD is inserted in the risk matrix, which is designed to show if the level of risk of each occurrence is above or below the TLS that has been defined as the acceptable level for the CAR/SAM Regions, *i.e.*, 20 points.

RV	Risk Level	Control
76-100	HIGH	Unacceptable risk, RVSM airspace must be cancelled until the hazard is mitigated and the risk is reduced to the medium or low level
21-75	MEDIUM	Acceptable risk, but monitoring and management are mandatory.
01-20	LOW	Acceptable without restriction or limitation, hazards do not require active management, but must be documented.

Table 8

After defining the level of risk for each LHD, the States and international organisations shall develop and implement mitigation plans, as needed, which shall be presented at face-to-face GTE meetings. The analyses conducted by CARSAMMA and the GTE at the virtual and face-to-face meetings will be presented in a final report to the ICAO Mexico City and Lima Regional Offices and at GREPECAS meetings.

6. Terms of Reference (TOR) of the CAR/SAM Regional RVSM Scrutiny Group (GTE)

The Terms of Reference (TOR) of the CAR/SAM Regional RVSM Scrutiny Group (RVSM/SG), known as the GTE, were established with a view to analysing issues affecting the TLS, based on LHD information provided by the States and international organisations.

Terms of reference

- a) To assemble safety management subject matter experts in air traffic control, aircraft flight operations, regulation and certification, data analysis, and risk modelling;
- b) To analyse and evaluate large height deviations of 300 ft or greater as defined in ICAO Doc 9574, Manual on the implementation of a 300 m (1 000 ft) vertical separation minimum between FL 290 and FL 410 inclusive;
- c) To coordinate the collection and review of large height deviation data with the CARSAMMA;
- d) To determine and validate an estimate of the flight time away from the cleared flight level to be used to estimate the Collision Risk Model (CRM) made by CARSAMMA;
- e) To identify safety trends based on the analysis of large height deviations (LHD) reports, recommend mitigation actions in accordance with ICAO SMS provisions, and submit annual reports on safety assessment results to GREPECAS so as to improve safety in the RVSM airspace of the CAR/SAM Regions; and
- f) To accomplish other tasks as directed by GREPECAS.

Composition:

CAR and SAM States, CARSAMMA, COCESNA, IATA, IFALPA, IFATCA, and the Rapporteur.

7. Terms of Reference (TOR) of CARSAMMA

Duties of CARSAMMA:

- a) Maintain a central registry of RVSM-approved operators and aircraft of each State/Territory that use CAR/SAM RVSM airspace;
- b) Facilitate the transfer of approved data to and from other RVSM Regional Monitoring Agencies (RMAs);
- c) Establish and maintain a database containing the height-keeping errors and height deviations of 300 ft or more within CAR/SAM RVSM airspace;
- d) Submit timely information for State civil aviation authorities (CAAs) on changes or monitoring status of aircraft type classifications;
- e) Submit the results of the monitoring flight using the GPS global monitoring system (GMS);
- f) Provide the means for identifying aircraft non-RVSM approved operating in the CAR/SAM RVSM airspace, and notify the appropriate State civil aviation authority (CAA) accordingly;
- g) Develop the means for summarising and communicating the content of relevant databases to the RVSM Scrutiny Group (GTE) for the corresponding safety assessment; and
- h) Conduct the assessment of the collision risk level (CRM) in the RVSM airspace of the CAR/SAM Regions, in accordance with ICAO Doc 9574 and Doc 9937.

Acronyms:

GTE:	Scrutiny Group/ Grupo de Tarea de Escrutinio
LHD:	Large Height Deviation / Grande Desviación de Altitud
CAR:	Caribbean / Caribe
SAM:	South América / Sur América
RVSM:	Reduced Vertical Separation Minimum / Separación Vertical Mínima Reducida
CARSAMMA:	Caribbean and South American Monitoring Agency / Agencia de Monitoreo del Caribe y Sur América
SMS:	Safety Management System / Sistema de Gestión de la Seguridad Operacional
CRM:	Collision Risk Model / Modelo de Riesgo de Colisión
FIR:	Flight Information Region / Región de Información de Vuelo
VMC:	Visual Meteorological Conditions / Condiciones meteorológicas de vuelo visual
IMC:	Instrument Meteorological Conditions / Condiciones meteorológicas de vuelo por instrumentos
TLS:	Target Level of Safety / Nivel de Seguridad Operacional
ICAO / OACI:	International Civil Aviation Organization / Organización de Aviación Civil Internacional
GREPECAS:	CAR/SAM Regional Planning and Implementation Group
TOR:	Terms of Reference / Términos de Referencia

Appendix B

LHD Code Table

LHD CODE	LHD Code Description
A	Fail to climb/descend the aircraft as cleared.
B	Climb/descent without ATC clearance.
C	Incorrect operation or interpretation of airborne equipment (<i>e.g.</i> , incorrect operation of fully functional FMS, incorrect transcription of ATC clearance or re-clearance, flight plan followed rather than ATC clearance, original clearance followed instead of re-clearance, etc.)
D	ATC system loop error (<i>e.g.</i> , ATC issues incorrect clearance or flight crew misunderstands clearance messages)
E	Coordination errors in the ATC to ATC transfer or control responsibility as a result of human factors issues (<i>e.g.</i> , late or non-existent coordination, incorrect time estimate/actual, flight level, ATS route, etc., not in accordance with agreed parameters)
F	Coordination errors in the ATC to ATC transfer or control responsibility as a result of equipment outage or technical issues.
G	Deviation due to aircraft contingency event leading to sudden inability to maintain assigned flight level (<i>e.g.</i> , pressurisation failure, engine failure)
H	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level
I	Deviation due to turbulence or other weather related cause
J	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory
K	Deviation due to TCAS resolution advisory, flight crew incorrectly following the resolution advisory.
L	An aircraft being provided with RVSM separation is not RVSM approved (<i>e.g.</i> , flight plan indicating RVSM approval but aircraft not approved, ATC misinterpretation of flight plan)
M	Other – this includes situations of flights operating (including climbing/descending) in airspace where flight crews are unable to establish normal air-ground communications with the responsible ATS unit.