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South American Office
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Agenda Item 2: Large Height Deviation (LHD) Analysis

Study for the Implementation of the Safety Management System (SMS) Methodology for the Collection, Drafting and Analysis of Large Height Deviation (LHD) Reports

(Presented by CARSAMMA)

Summary

This paper presents a summary of the large height deviation (LHD) reports received by CARSAMMA, associated to the SMS methodology advocated by ICAO and recommended by the GREPECAS meeting for use by CARSAMMA in the CAR / SAM Regions.

References

- ICAO SMS Manual
- Report of large height deviations (LHDs) occurred in 2010

ICAO Strategic Objectives:	**A** - Safety

1. Background

1.1. The CAR/SAM Regional Planning and Implementation Group (GREPECAS) delegated to the Caribbean and South American Monitoring Agency (CARSAMMA) the task of implementing the SMS methodology for the analysis of LHDs. CARSAMMA is an administrative agency that reports to the International Air Navigation Study Commission (CERNAI), an entity that is part of the Airspace Control System of Brazil (SISCEAB).

1.2. In order to use the SMS methodology for analysing LHDs, CARSAMMA has prepared an "SMS LHD Guide", shown in **Appendix A** to this working paper, which describes, step by step, the stages involved in this analysis. The SMS is used for estimating the system risk value.

1.3. An important addition to the methodology for analysing SMS LHDs is the system for risk assessment and quick identification of trends and critical points of occurrence, which reduces the time required for system safety analysis.

1.4. The objective of this paper is to present a summary of the study on the use of the SMS analysis on the LHDs received by CARSAMMA, and to document and present safety management as a valid tool for assessing safety in RVSM airspace.

2. Context

2.1. This section provides a brief description of how information is analysed in the SMS LHD model approved by ICAO during the risk assessment process.

2.2. Following the analysis and assessment of LHDs by the GTE (telecon), the SMS risk matrix shows risks classified at three levels: high, medium, and low, as shown in Figure 1.

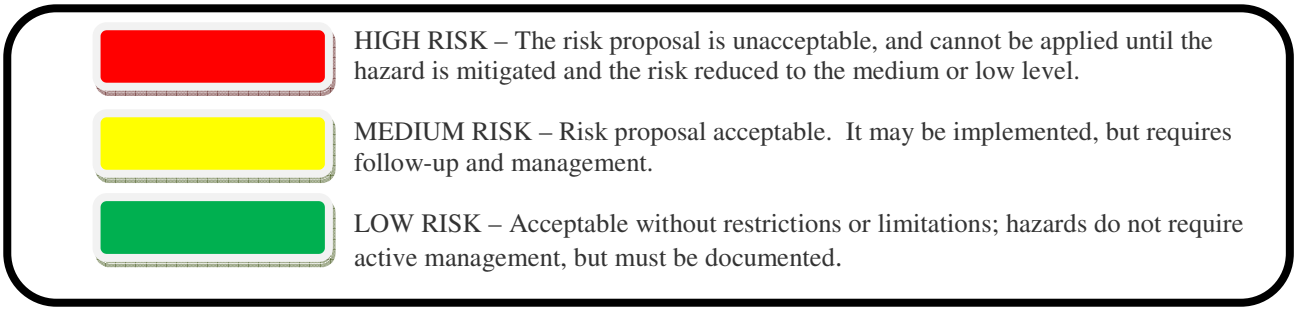

Figure 1 – Risk acceptance criteria

3. Discussion

3.1. For analysing the SMS LHD methodology, some parameters must be taken into account, such as the duration of the event, CPDLC or radar display, weather conditions during the event, and whether other traffic was involved.

3.2. To this end, the following expression is used:

VR= risk value

VR=(PxDxG)+R+W+T, where:

P= likelihood
D= duration
G= severity

R= with/without RADAR/CPDLC coverage
W= weather conditions (VMC or IMC)
T= other traffic

3.3. CARSAMMA used its database to identify LHDs from 2004 to 2010 inclusive, LHD reporting frequency, and based on this information, built a consolidated table with levels from one (1) to five (5) to be used in the LHD likelihood analysis.

3.4. The values calculated based on the LHD analysis were classified as follows:

Low risk - 1 to 25
Medium risk - 26 to 75
High risk - 76 to 100

4. Summary and conclusions

4.1. Based on risk identification and analysis, LHDs were classified as of low, medium or high risk to generate an ICAO/CARSAMMA Safety Management Document (LHD-SMD) containing the number, description, cause, severity, likelihood and initial risk value of LHDs.

Notes:

1. The implementation of the Safety Management System is the responsibility of the States, and the GTE / CARSAMMA act as facilitators in this process.

2. *The LHD-SMD will be sent to the ICAO Lima and Mexico Offices so that it may be forwarded to each State (FIR) involved in the analysed LHDs for the adoption of the corresponding mitigation measures.*

4.2. Based on the 2010 LHD safety analysis, CARSAMMA draws the attention of CAR/SAM States to the following events that had the highest risk value, with the only intention of enhancing safety in RVSM airspace:

a) Event of longest **duration**
- LHD 485 – 300min - Code N - VR = 19

b) Event of highest **severity**
- LHD 692 - TCAS (4 Nm) - Code F - VR = 30

c) Event with a **risk level=5** and **likelihood=40**
- LHD 152, 226, 273-1, 541, 562, 563 – Code N
- LHD 273 - Code C

d) Events of highest **risk value** (46)
- LHD 50, 433, 538, 746, 747 – Code N

5. Suggested action

5.1. The Meeting is invited to:

a) take note of the information provided in this working paper, which may be used by States as a reference for mitigating their LHDs;

b) approve the proposed method for application in LHD safety analyses and as a guide for member States in their activities concerning the collection, processing, analysis, delivery and publication of data on the topic; and

c) submit such decision to GTE members for their information and approval.

APPENDIX A

Risk Management Guide for Analysing Large Height Deviations (LHDs) in the CAR/SAM Regions Using the SMS methodology

FOREWORD

This guide must be used when conducting SMS safety analyses applying the ICAO methodology recommended by GREPECAS for use by CARSAMMA in the CAR/SAM Regions. CARSAMMA experts, in conjunction with members of the Scrutiny Group (ICAO GTE) analysed the large height deviation (LHD) forms generated in the CAR/SAM Regions.

Since safety management is to be applied in various areas of civil aviation, the first part of this guide contains the principles of the SMS methodology, and the second part applies this methodology to LHD analysis, adjusting the tables and documents to the specific characteristics of RVSM airspace.

PART 1

SAFETY MANAGEMENT PROCESS

In general, the risk management process has five phases:

- System description;
- Hazard identification and coding - CARSAMMA;
- Risk analysis - GTE (teleconference);
- Risk assessment – GTE; and
- Risk management (mitigation) - State.

DESCRIPTION OF THE SMS SYSTEM

The manual defines a system as "an integrated set of combining components, or the support to an operational environment to achieve a given objective. These components include people, culture, equipment, information, procedures, facilities, services and others".

Not all system states have the same weight *vis-a-vis* an identified threat (*e.g.,* loss of power in one engine). For example, the loss of one engine (for aircraft with several engines), at a given speed and altitude, not always translates into a catastrophic accident. Many aircraft have multiple engines and are designed to fly with a single engine in a restricted flight. However, the loss of an engine system in some states (low speed, low altitude, gross weight in altitude) has the potential of causing loss of control or support. In this state of the system, the hazard can be catastrophic. The manual requires that the SMS consider the worst reasonable state of the system. If so desired, other states of the system may be considered, but only as a supplement to the worst-case scenario.

RISK ASSESSMENT

Risk assessment must be done in accordance with the ICAO SMS Manual.

The SMS risk matrix classifies risk into three levels: high, medium and low. These levels define the risk mitigation measures to be applied for each hazard identified, according to Figure 1.

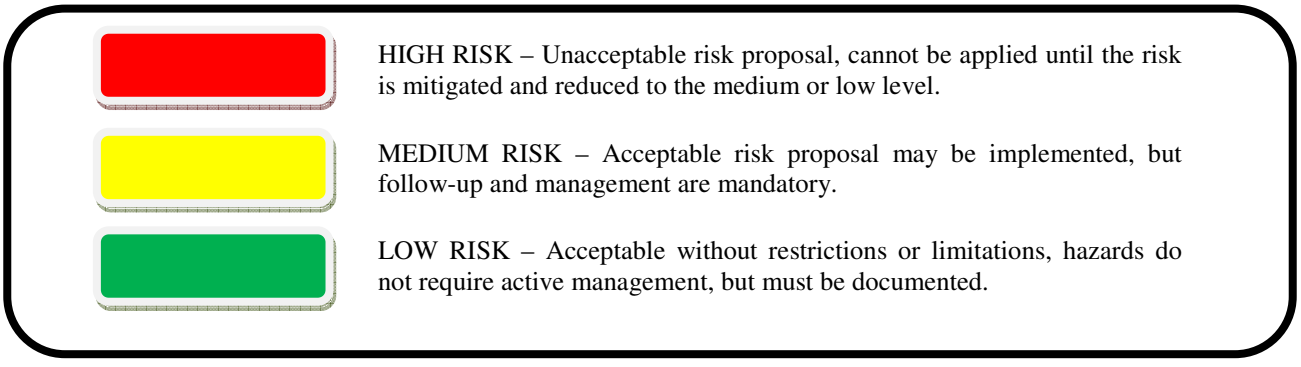

Figure 1 – Risk acceptance criteria

PART 2

LHD FLOW ANALYSIS (SMS)

Application of SMS Methodology to Risk Identification

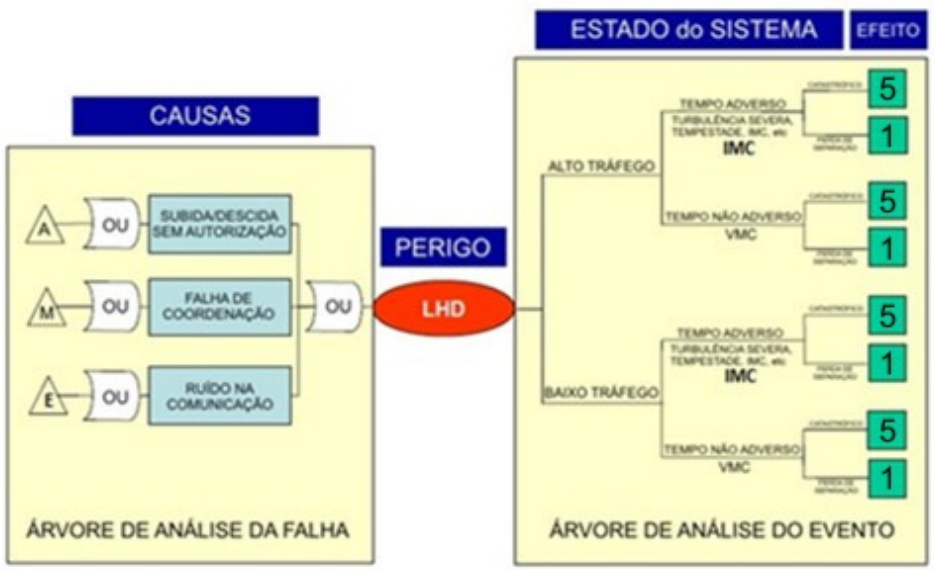

Figure 2 – LHD SMS flow analysis

In this example, the hazard identified is a large height deviation (LHD) that will be numbered and coded by CARSAMMA.

Some causes of LHDs are identified on the left side of the above figure. Following the coding process, the GTE starts working (teleconference). Figure 3 shows, to the right of the hazard, the state of the system, initially identified as high or low traffic; this state was later divided into adverse or non-adverse meteorological conditions.

Each of these states results in one of the described effects (air collision or loss of separation). These effects are classified according to the severity, number 5 representing a catastrophic event and number 1 representing an insignificant effect on safety. The worst case is when the LHD occurs under adverse meteorological conditions, with both low and high traffic.

Analysis by the GTE (teleconference)

a) The GTE Risk Management Team (teleconference) met to identify the hazards/causes (LHD code)/ system status. We are currently using, with satisfactory results, the internet-based **GO-TO-MEETING** tool for analysing the risks identified.

b) As a result, a hazard analysis table has been adopted, where fields 1 and 2 describe the LHD, fields 3 and 4 are coded by CARSAMMA, fields 5 and 6 will be the outcome of the analysis by the GTE (teleconference), field 7 is for the State of the FIR involved, and field 8 is completed subsequently at the GTE meeting.

LHD N° (1)	Description (2)	Causes LHD Code (3)	Severity (4)	Likelihood (5)	Level of risk (6)	Mitigation measures (7)	Residual risk foreseen (8)

Table 1 – Hazard analysis

LHD RISK ANALYSIS AND ASSESSMENT

Once CARSAMMA has identified the causes (LHD code), the GTE must analyse the risks associated to each of the LHD codes identified, assessing the severity and likelihood of the occurrence.

Each code must have an associated LHD severity, for example:

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

The **Severity Analysis** is performed based on the experience of the GRSO/GTE team members, using the severity table as follows:

Effects	Severity of the Hazard (LHD)				
	Catastrophic 5	**Hazardous 4**	**Major 3**	**Minor 2**	**Insignificant 1**
ATC	Collision with aircraft, ground, or obstacle TCAS advisory (TA/RA)	Reduction of separation or total loss of ATC capability (zero ATC)	Significant reduction of separation or ATC capability	Slight reduction of ATC capability or significant increase of ATC workload	Slight increase of ATC workload

Once the severity has been defined, the **Likelihood** of occurrence of a hazard is established, taking into account the worst-case scenario.

Once again, based on the knowledge and experience of the GRSO/GTE personnel, the qualitative likelihood classification method must be taken into account, using the following table:

Likelihood	Level of ATC services/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 3 years
Extremely unlikely 1	Unlikely but possible during the lifetime of the system	Expected to occur at least once every 30 years

To this end, Table 2 below may be used:

LIKELIHOOD	DURATION	SEVERITY
5 FREQUENT		5 CATASTROPHIC
4 LIKELY		4 HAZARDOUS
3 OCCASIONAL	3 CONTINUOUSLY (>6 min)	3 MAJOR
2 UNLIKELY	2 MORE THAN NORMAL (2-6 min)	2 MINOR
1 EXTREMELY UNLIKELY	1 NORMAL (1-2 min)	1 INSIGNIFICANT

Table 2 – Analysis of parameters

VR = value of risk

VR=(PxDxG)+R+W+T, where:

P = likelihood
D =duration
G =severity

R=with/without radar coverage / CPDLC (0 or 5)
W = weather conditions (IMC=5 ó VMC=0)
T = other traffic (from 0 to 15)

Once the GTE has assigned a VR to each LHD, use Table 3 to classify the level of risk, to be reported to the SMD.

VR	LEVEL OF RISK	CONTROL
76-100	**HIGH**	Unacceptable risk, RVSM airspace must be cancelled until the hazard is mitigated and the risk reduced to medium or low
26-75	**MEDIUM**	Acceptable risk, but follow-up and management are mandatory
01-25	**LOW**	Acceptable without restriction or limitation, hazards do not require active management, but must be documented

Table 3 – Level of Risk

SUMMARY:

Responsibility	Issuance phase	Assessment phase	Analysis phase I	Mitigation phase	Analysis phase II
FIRs involved					
ICAO Office					
CARSAMMA					
TELECON team					
States					
GTE					

Notes:

1. The implementation of the safety management system is the responsibility of the States, and the GTE/CARSAMMA act as facilitators in this process.

2. The LHD-SMD will be sent to the ICAO Lima and Mexico Offices, as well as to each State (FIR) involved in the analysed LHD for the adoption of the applicable mitigation measures.

To demonstrate the LHD analysis methodology (SMS), CARSAMMA followed all the steps of this process in 2010, resulting in a qualitative safety assessment in RVSM airspace.