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**CAR/SAM Planning and Implementation Regional Group (GREPECAS) Twenty Second Scrutiny Working Group Meeting (GTE/22)**

Mexico City, Mexico, 26 to 30 September 2022

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**Agenda Item 3:** **Review of the results of Large Height Deviation (LHD) analysis**
**3.3 Results of the assessment project for safety in RVSM airspace for the CAR and SAM Regions.**

# SAFETY ASSESSMENT IN THE RVSM AIRSPACE OF THE CAR/SAM REGIONS

(Presented by CARSAMMA)


| **EXECUTIVE SUMMARY** | |
|---|---|
| This Paper presents a summary of the reports of Large Height Deviations (LHD) received by CARSAMMA, and the analysis with the SGSO/SMS methodology proposed by ICAO and reaffirmed during the GREPECAS meeting as a recommendation for its application by CARSAMMA in the CAR/SAM Regions. | |
| **Action:** | Suggested actions are included in Section 5. |
| *Strategic Objectives:* | • Safety |
| *References:* | • Doc 9574, Manual on a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive.<br>• Doc 9937, Operating Procedures and Practices for Regional Monitoring Agencies in Relation to the Use of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive.<br>• 2021 Large Altitude Deviations (LHD) Reports. |


## 1. Introduction

1.1 The CAR/SAM Regional Planning and Implementation Group (GREPECAS) delegated to the Caribbean and South American Monitoring Agency (CARSAMMA) the implementation of the role of the SGSO / SMS methodology in the analysis of LHDs.

1.2 The SGSO is used to estimate the Risk Value of the System.

1.3 An extremely important improvement in the use of the methodology in the analysis of SGSO LHD is the risk assessment system and rapid identification of trends, as well as the critical points where they occur, reducing the calculation time of security analysis of the system.

1.4 The objective of this paper is to offer a summary of the safety assessment of RVSM airspace in the FIRs of the CAR/SAM Regions. The safety evaluation was carried out in a period of operation of twelve continuous months.

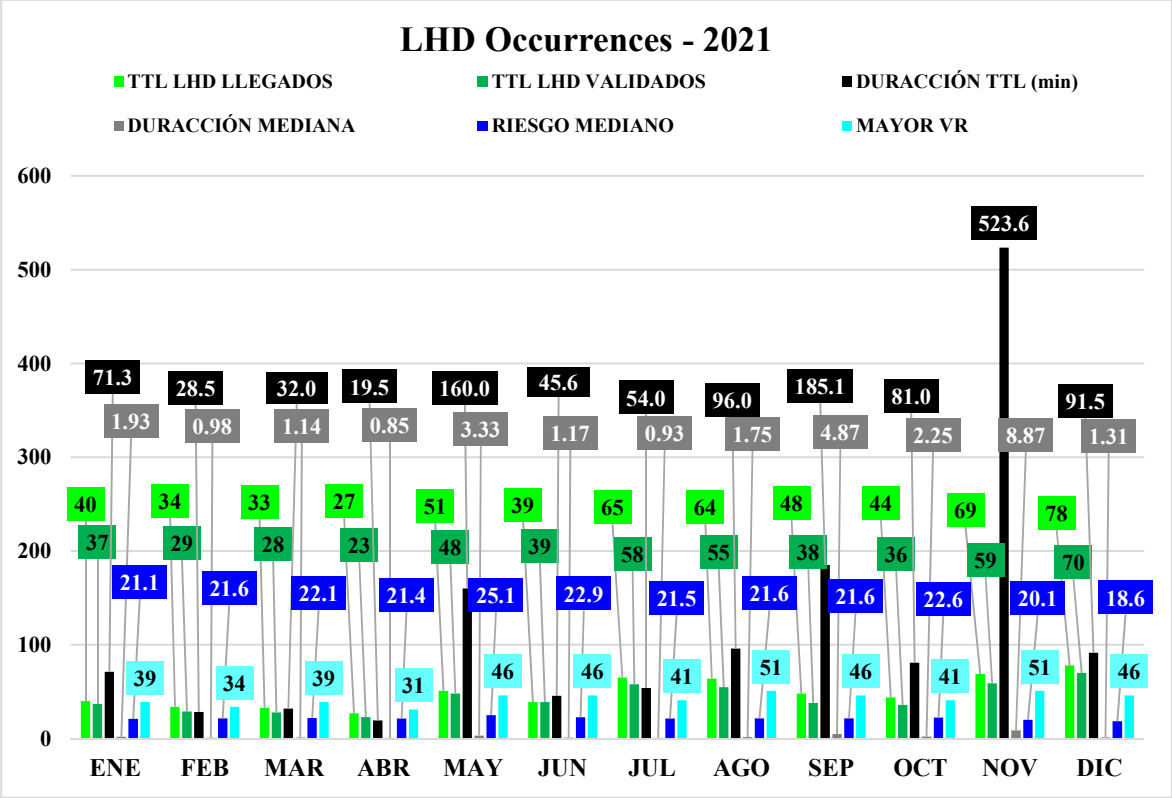
## 2. Context

2.1 A series of LHD reports accumulated for a 12-month period, between January-February 2021, were used for this safety assessment.

2.2 **Table 1 y Graph 1** show the summary of the LHD occurrences validated by CARSAMMA and duration (in minutes) associated with the LHD per month.

| MONTH | LHD RECEIVED | LHD VALIDATED | TOTAL DURATION (min.) | MEDIAN DURATION (min.) | MEDIAN RISK | HIGHER RISK |
|---|---|---|---|---|---|---|
| JANUARY | 40 | 37 | 71,3 | 1,93 | 21,1 | 39 |
| FEBRUARY | 34 | 29 | 28,5 | 0,98 | 21,6 | 34 |
| MARCH | 33 | 28 | 32,0 | 1,14 | 22,1 | 39 |
| APRIL | 27 | 23 | 19,5 | 0,85 | 21,4 | 31 |
| MAY | 51 | 48 | 160,0 | 3,33 | 25,1 | 46 |
| JUNE | 39 | 39 | 45,6 | 1,17 | 22,9 | 46 |
| JULY | 65 | 58 | 54,0 | 0,93 | 21,5 | 41 |
| AUGUST | 64 | 55 | 96,0 | 1,75 | 21,6 | 51 |
| SEPTEMBER | 48 | 38 | 185,1 | 4,87 | 21,6 | 46 |
| OCTOBER | 44 | 36 | 81,0 | 2,25 | 22,6 | 41 |
| NOVEMBER | 69 | 59 | 523,6 | 8,87 | 20,1 | 51 |
| DECEMBER | 78 | 70 | 91,5 | 1,31 | 18,6 | 46 |
| TOTAL | **592** | **520** | **1.388,1** | **2,67** | **21,5** | |

*Table 1. LHD occurrences, with duration, average duration, average risk, and highest risk per month*




*Graph 1. LHD Occurrences, with Average Duration, Average Risk and Highest Risk per Month*

2.3 In November there were two (2) situations that, added together, lasted 440.8 minutes of the total of 523.6 minutes of failures that occurred in this month, that is, 84% of the duration only with these two reports. Both occurred in the Atlantic FIR, report 463, VR = 51, the highest VR of the year and report 464, VR = 21, border position between the SUEO and SBAO FIRs, due to the lack of coordination by the Montevideo ACC and also because the pilot does not make contact at this point since there is an operational agreement between the EGYP ACC and DECEA for the pilot to make contact with SBAO when crossing the 3400W parallel.

2.4 In September there were two (2) situations that, added together, lasted 167.0 minutes of the total of 185.1 minutes of failures that occurred in this month, that is, 90% of the duration only with these 2 reports. The reports occurred between the Maiquetia and San Juan FIRs, SILVA position, due to poor coordination, 120 minutes, report 370, VR = 29 and between the Maiquetia and Amazónica FIRs, VAGAN position, due to poor coordination, 47 minutes, report 382, VR = 29. One more case occurred involving the Maiquetia and Barranquilla FIR, SEMDO position that lasted 3 minutes and a VR = 46.

2.5 In May, twelve (12) situations occurred that, added together, lasted 140.0 minutes of the total of 160.0 minutes of failures that occurred this month, that is, 87% of the duration only with these 12 reports. The reports occurred between the Atlantic and Amazon FIRs, due to the lack of coordination of the Amazon ACC, the aircraft only made contact after 60 minutes already entered the SBAO FIR, report 138 (VR = 46). Due to a coordination failure between the Piarco FIR and the New York FIR, the aircraft flew at a different level for 50 minutes within the New York FIR, report 167, (VR = 34). In this month, ten (10) failures affected the PANAMA FIR. Seven (7) due to failure of the Bogotá FIR (5 E1 and 2 E2), reports 139, VR = 36, ILTUR position, report 143, VR = 34, BUXOS position, report 153, VR = 29, TOKUT position, report 156 , VR = 29, ILTUR position, report 157, VR = 34, DAKMO position, report 169, VR = 41, DAKMO position, report 178, VR = 29, DAKMO position. Two (2) due to failure of the Barranquilla FIR, (2 E2), report 161, VR = 46, position BOGAL and report 163, VR = 46, position BOGAL. One (1) due to failure of the Central America FIR (1 E1), report 166, VR = 34, bufeo position. All those failures with a duration of 3 minutes each, a total of 30 minutes, which represent a total of 19% of the month, only with failures that involve risk for the PANAMA FIR.

2.6 In 2021, there were LHD reports in which the **GUAYAQUIL FIR** is at risk due to failures of the adjacent FIRs. Of a total of **143** reports made, only from the BOGOTÁ FIR were reported 120 failures, due to poor coordination, lack of coordination or transfer problems due to equipment, whose TCP involved are: UGUPI (65), BOKAN (25), PULTU (12), ENSOL (8), ANRAX (6), VAMOS (3) and AKTAB (1). The LIMA FIR committed 16 failures with the GUAYAQUIL FIR and the TCPs involved are: VAKUD (8), TOSES (3), AMERO (2), ARNEL (2) and KABAG (1). The CENTRAL AMERICA FIR committed 7 faults with the GUAYAQUIL FIR and the TCP involved was only LIXAS (7).

*NOTE: Attention is drawn to the TCP UGUPI with 65 reports and BOKAN with 25 reports, points between the GUAYAQUIL and BOGOTÁ FIRs because the largest number of LHD reports occurred in these TCP.*

2.7 The GUAYAQUIL ACC also committed the same failures, in some of these TCP with the BOGOTÁ FIR, namely: UGUPI (5), ENSOL (5), BOKAN (1), a total of 11 failures. With the LIMA FIR, the failures occurred in the TCP: ANPAL (2), PABOB (2), TERA (2), VAKUD (2), LOBOT (1) and MOXOM (1), 10 failures. With the CENTRAL AMERICA FIR, the failures occurred in the TCP: OSELO (2), ARTOM (1), LIXAS (1) and LOGAL (1), a total of 5 failures.

2.8 In Figure 1 below, we can see all the TCPs reported by the GUAYAQUIL FIR and the number of reports that occurred in each of the TCPs. Mitigating measures should be taken mainly where a larger number of failures occurred.

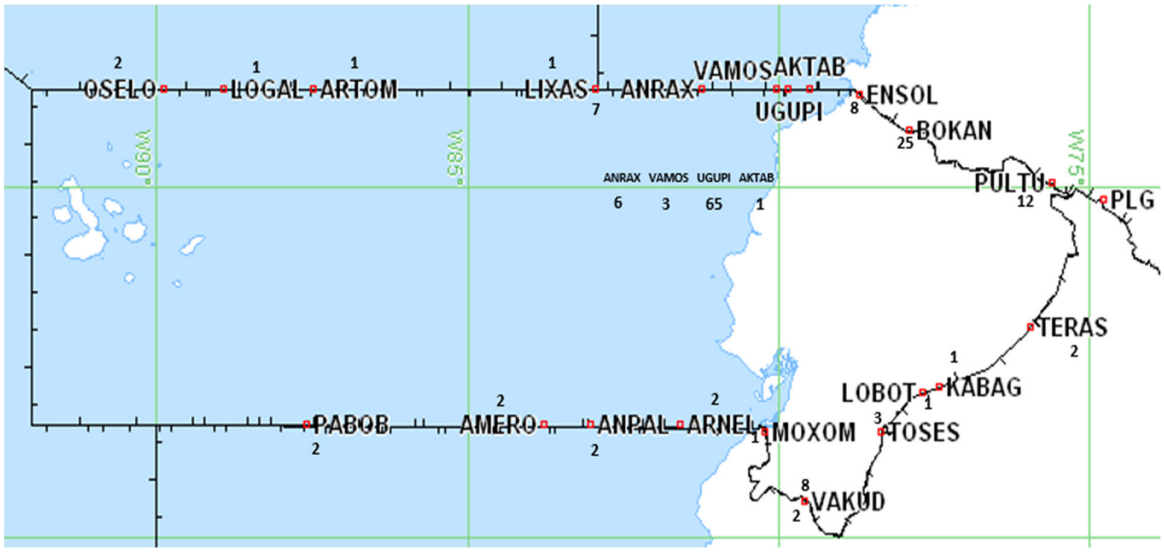



***Figure 1. LHD occurrences at the most reported points between the GUAYAQUIL FIR and neighboring FIRs***

2.9 In 2021, LHD reports occurred in which the PANAMA FIR is at risk due to failures of the adjacent FIRs and a pilot failure, a total of 105 reports made, mainly from the BOGOTÁ FIR, 60 reports, and from the BARRANQUILLA FIR , 35 reports, due to poor coordination, lack of coordination or transfer problems due to equipment, whose TCP involved with the BOGOTÁ FIR are: BUXOS (17), TOKUT (10), DAKMO (8), ARORO (6), BUSMO (6), TINPA (6), ILTUR (4), KAKOL (2) and ASEPI (1) and with the BARRANQUILLA FIR are: BOGAL (11), AGUJA (8), ESEDA (6), ALPON (5), 1228N07225W (1), ISIMO (1), NELUR (1), ROKIN (1) and ROPOL (1). The CENTRAL AMERICA FIR committed 7 failures with the PANAMA FIR and the TCPs involved are: PELRA (3), BUFEO (2), ISEBA (1) and PAPIN (1). The KINGSTON FIR committed 2 failures with the PANAMA FIR and the TCPs involved are: ARNAL (1) and COLBY (1). The PILOT committed 1 fault with the PANAMA FIR at point TBG.

2.10 The PANAMA ACC also committed the same failures, in some TCP with the BOGOTÁ FIR, namely: TOKUT (3), BUXOS (2), ILTUR (2), KAKOL (2), OGLUT (2), BUSMO (1) , IRASO (1) and OGLUT (1), a total of 13 failures. With the BARRANQUILLA FIR there were no failures. With the CENTRAL AMERICA FIR, the failures occurred in the TCP: LESIL (2), ANSON (1) and ISEPA (1), a total of 4 failures. With the KINGSTON FIR no failures occurred.

2.11 In Figure 2 below, we can see all the TCPs reported above and the number of reports that occurred in each of the TCPs. Mitigating measures must be taken.


***Figure 2. LHD occurrences at the most reported points between the PANAMA FIR and neighboring FIRs.***

2.12 In 2021, LHD reports occurred in which the BOGOTÁ FIR is at risk due to failures of the adjacent FIRs and a pilot failure, a total of 40 reports made, mainly from the PANAMA FIR, 13 reports, from the GUAYAQUIL FIR, 11 reports, all already cited above. The LIMA FIR committed 10 failures with the BOGOTÁ FIR and the TCPs involved were: ROLUS (8), and PLG (2). The CENTRAL AMERICA FIR committed 3 failures with the BOGOTÁ FIR and the TCP involved was only BOLDO. The AMAZÓNICA FIR committed 1 failure with the BOGOTÁ FIR and the TCP involved was: ARUXA. The BARRANQUILLA FIR committed 1 fault with the BOGOTÁ FIR and the TCP involved was: BUTAL. The PILOT committed 1 fault with the BOGOTÁ FIR at point UMGOS.

2.13 The BOGOTÁ ACC also committed the same faults, in some TCPs with the GUAYAQUIL FIR and the PANAMA FIR, as we have seen previously. With the LIMA FIR, the failures occurred in the TCP: ILMUX (4) and ROLUS (3), a total of 7 failures. With the CENTRAL AMERICA FIR, the failure occurred only in TCP BOLDO. With the AMAZÓNICA FIR, failures occurred in the TCP: ABIDE (3), BRACO (3), ARUXA (2), LET (2) and ASAPA (1), a total of 11 failures. With the BARRANQUILLA FIR there were no failures.

2.14 In Figure 3 below, we can see all the TCPs reported above and the number of reports that occurred in each of the TCPs. Mitigating measures must be taken.

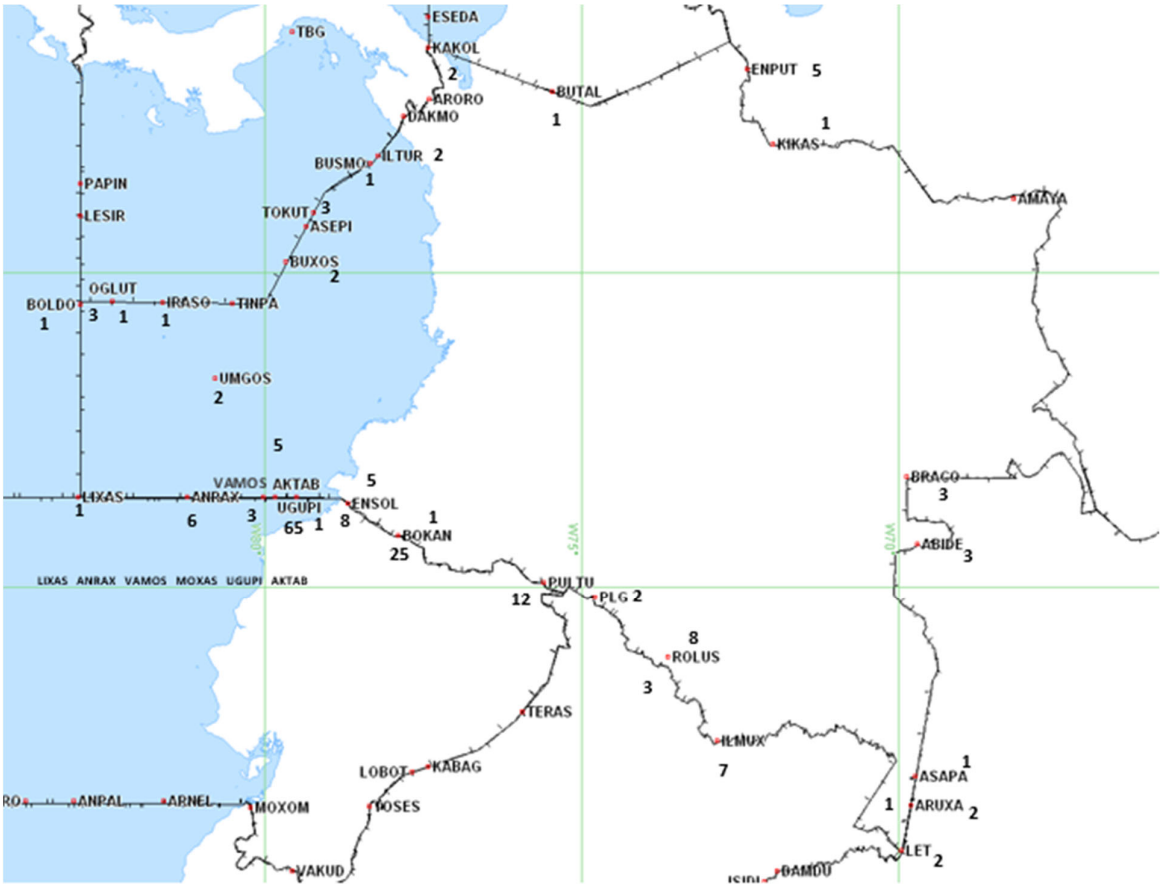



***Figure 3. LHD occurrences at the most reported points between the BOGOTÁ FIR and the neighboring FIRs.***

2.15 In 2021, LHD reports occurred in which the LIMA FIR is at risk due to failures of the adjacent FIRs, a total of 31 reports made. From the GUAYAQUIL FIR, 10 reports, from the AMAZÓNICA FIR, 8 reports, from the BOGOTÁ FIR, 7 reports, from the LA PAZ FIR, 4 reports and from the ANTOFAGASTA FIR, 2 reports. The GUAYAQUIL FIR and the BOGOTÁ FIR made mistakes in the aforementioned TCPs. The AMAZON FIR made mistakes in the TCPs: DAMDU (2), LET (2), ILNAM (1), ISIDI (1), LIMPO (1) and OSORA (1). The LA PAZ FIR made mistakes in the TCPs: ELAKO (1), JUL (1), OBLIR (1) and ORALO (1). The ANTOFAGASTA FIR made a mistake in the TCPs: IREMI (1) and SORTA (1).

2.16 The LIMA ACC also committed the same faults, in some TCPs with the GUAYAQUIL FIR and with the BOGOTÁ FIR, as previously mentioned. With the ANTOFAGASTA FIR, the failures that occurred in the TCP are: IREMI (1) and SORTA (1). No failures occurred with the AMAZÓNICA FIR, with the LA PAZ FIR and with the ISLA DE PASCUA FIR.

2.17 In Figure 4 below, we can see all the TCPs reported above and the number of reports that occurred in each of the TCPs. Mitigating measures must be taken.

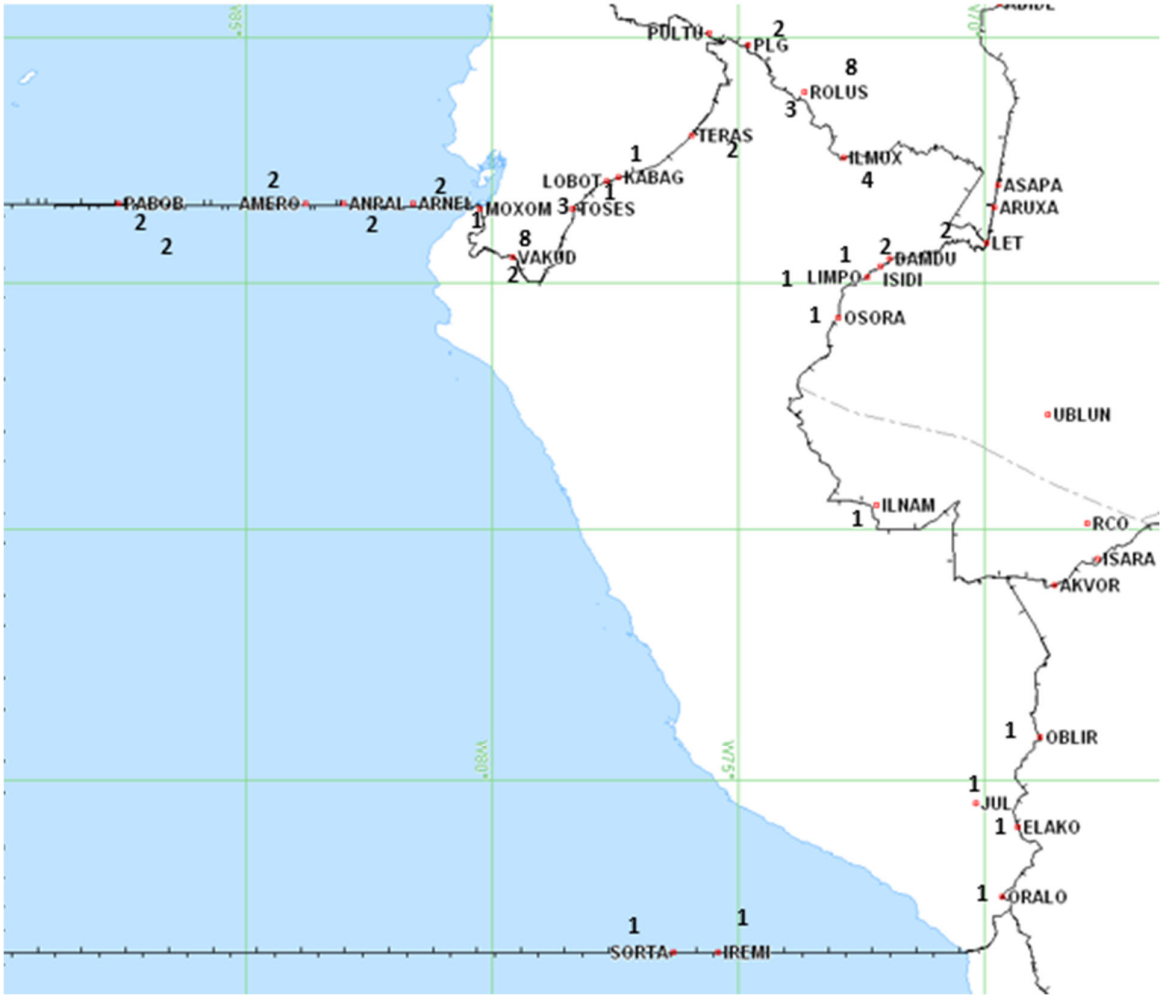



***Figure 4. LHD occurrences at the most reported points between the LIMA FIR and neighboring FIRs.***

2.18 In 2021, there were LHD reports in which the CURAÇAO FIR is at risk due to failures of the adjacent FIRs, a total of 33 reports made. From the BARRANQUILLA FIR, 13 reports, from the SANTO DOMINGO FIR, 12 reports, from the MAIQUETIA FIR, 4 reports, from the KINGSTON FIR, 2 reports and from the PORT AU PRINCE FIR, 2 reports. The BARRANQUILLA FIR committed failures in the TCPs: OROS (6), SELAN (5) and BOTH (2). The SANTO DOMINGO FIR committed failures in the TCPs: VESKA (3), KARUM (2), KISAS (2), PALAS (2), BEROX (1), PIGBI (1), and POKAK (1). The MAIQUETIA FIR committed errors in the TCPs: CHAVES (2), ACORA (1), and VODIN (1). The KINGSTON FIR made an error in the TCPs: AMBIN (1) and DIBOK (1). The PORT AU PRINCE FIR committed errors in the TCP: LENOM (2).

2.19 The CURACAO ACC also committed the same failures, in some TCP with the SANTO DOMINGO FIR in the TCP: PALAS (5), VESKA (5), KARUM (4), BEROX (3), KISAS (3) and POKAK (3 ). With the BARRANQUILLA FIR, with the KINGSTON FIR, with the MAIQUETIA FIR and with the PORT AU PRINCE FIR, no failures occurred.

2.20 In Figure 5 below, we can see all the TCPs reported above and the number of reports that occurred in each of the TCPs. Mitigating measures must be taken.

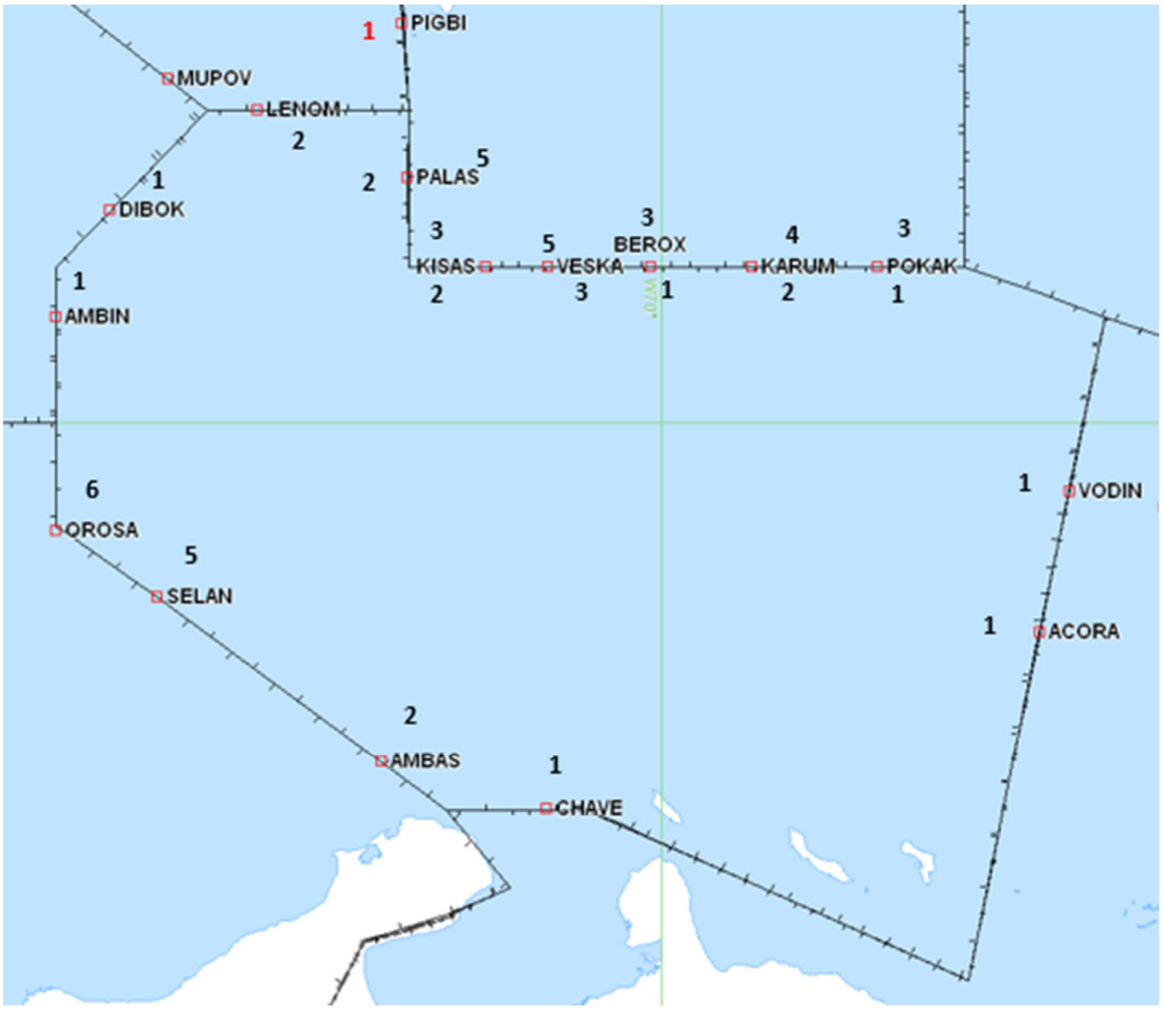



***Figure 5. LHD occurrences at the most reported points between the CURACAO FIR and neighboring FIRs.***

2.21 In 2021, there were LHD reports in which the SANTO DOMINGO FIR is at risk due to failures of the adjacent FIRs, a total of 24 reports made. From the CURACAO FIR, 23 reports, from the PORT AU PRINCE FIR, 1 report. The CURACAO FIR made mistakes in the TCPs already mentioned above. The PORT AU PRINCE FIR committed a fault in the TCP: DCR (1).

2.22 The SANTO DOMINGO ACC also committed the same faults, in some TCP with the CURACAO FIR as already mentioned above. With the PORT AU PRINCE FIR the failures occurred in the TCP: PIGBI (2), ETBOD (1) and RETAK (1).

2.23 In 2021, LHD reports occurred in which the PORT AU PRINCE FIR is at risk due to failures of the adjacent FIRs, a total of 10 reports made. From the MIAMI FIR, (3) reports, from the KINGSTON FIR, (3) reports and from the SANTO DOMINGO FIR, (4) reports. The MIAMI FIR made faults only in the TCP, JOSES (3). The KINGSTON FIR committed failures in the TCPs: MUPOV (1), NOSIS (1) and KEBET (1). The SANTO DOMINGO FIR made mistakes in the TCP already mentioned above.

2.24 The PORT AU PRINCE ACC also committed the same faults, in some TCPs with the SANTO DOMINGO FIR in the TCPs already mentioned above. With the KINGSTON FIR there were no mistakes. With the MIAMI FIR we have no way of knowing since we do not receive the reports.

2.25 In Figure 6 below, we can see all the TCPs reported above in items 2.16 and 2.17 and the number of reports that occurred in each of the TCPs. Mitigating measures must be taken.

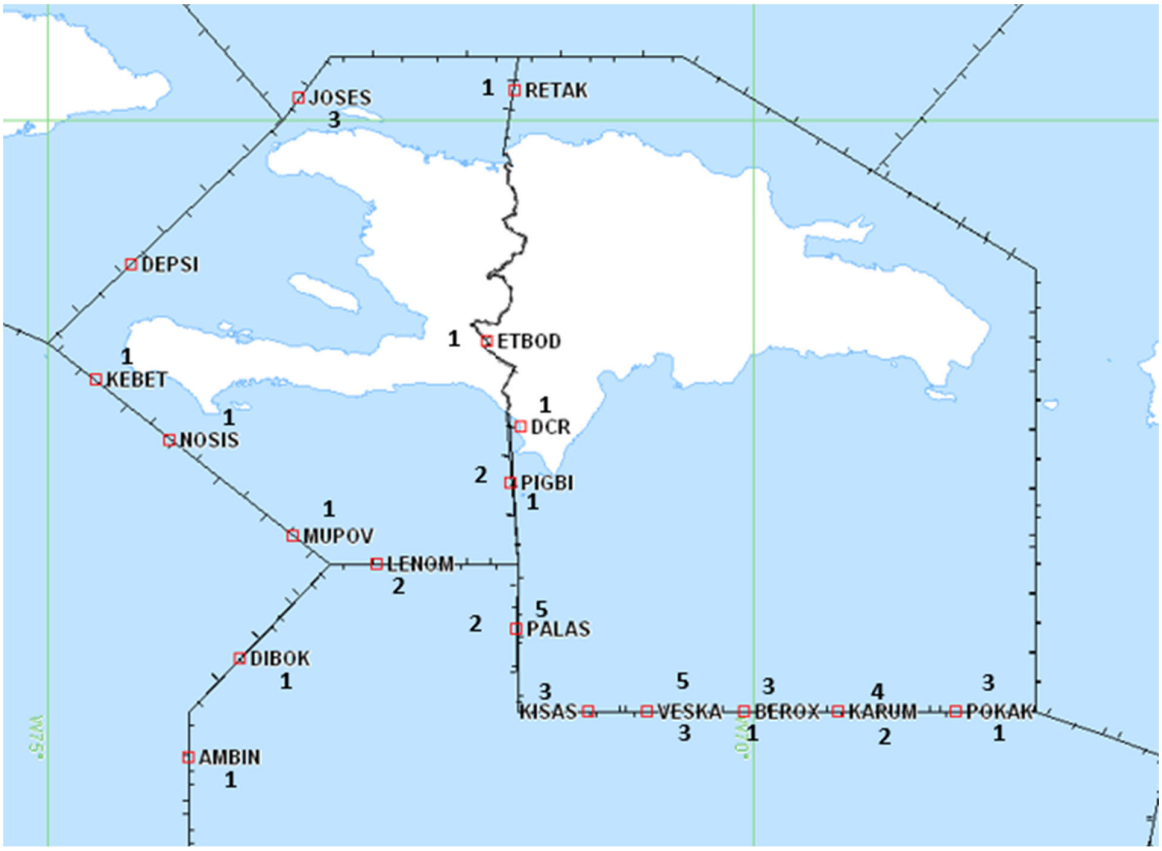



***Figure 6. Occurrences of LHD in the most reported points between the SANTO DOMINGO FIR, PORT AU PRINCE and neighboring FIRs***

2.26 There were LHD reports in 2021 in which the CENTRAL AMERICA FIR is at risk due to failures of the adjacent FIRs, a total of 17 reports made. From the MÉRIDA FIR (5) reports, from the GUAYAQUIL FIR, (5) reports, from the PANAMA FIR (4) reports, from the BOGOTÁ FIR, 1 report and from the KINGSTON FIR 1 report. The MÉRIDA FIR made mistakes in the TCPs: KATIS (3), ALSAL (1), ASOKU (1) and TAKUX (1). The GUAYAQUIL FIR, the PANAMA FIR and the BOGOTÁ FIR, the TCPs were already mentioned above. The KINGSTON FIR committed faults in the TCP MAMBI (1).

2.27 The CENAMER ACC also committed the same faults, in some TCPs with the GUAYAQUIL FIR, with the PANAMA FIR and with the BOGOTÁ FIR, as already mentioned above. With the KINGSTON FIR, the failure occurred in the TCP ULISA (1). With the MÉRIDA FIR, failures occurred in the TCPs: TUGET (2), ASOKU (1), UKORO (1) and VIDNO (1).

2.28 In Figure 7 below, we can see all the TCPs reported above and the number of reports that occurred in each of the TCPs. Mitigating measures must be taken.

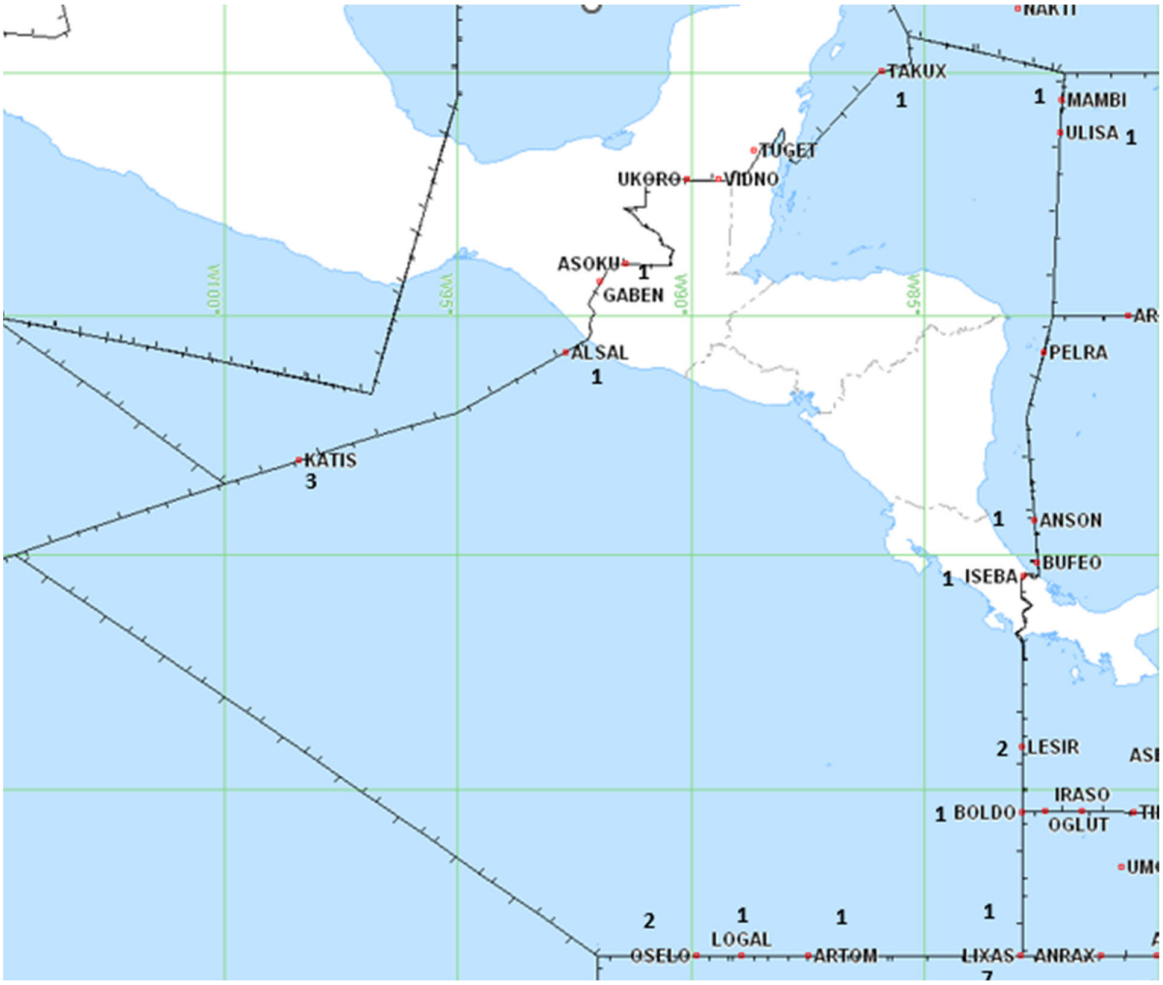



***Figure 7. LHD occurrences at the most reported points between the CENTRAL AMERICA FIR and neighboring FIRs.***

2.29 In 2021, there were LHD reports in which the AMAZÓNICA FIR is at risk due to failures of the adjacent FIRs, a total of 16 reports made. From the BOGOTÁ FIR (11) reports, from the MAIQUETIA FIR, (3) reports, from the BRASILIA FIR, (1) report, PILOT failure, (1) report. The BOGOTA FIR committed the faults in the TCP already mentioned above. The MAIQUETIA FIR committed the faults in the TCP: VUMPI (2) and POVLA (1). The BRASILIA FIR committed an error in the TCP: POPTI (1). The PILOT faulted at point OBLUN (1236S 05940W).

2.30 The AMAZÓNICO ACC also committed the same faults, in some TCPs with the LIMA FIR and with the BOGOTÁ FIR, as already mentioned above. With the CURITIBA FIR, the failures occurred in the TCPs: AKRIL (1) and AMVOP (1). With the ATLANTIC FIR the failure occurred in the TCP: OPVET (1). With the LA PAZ FIR, failures occurred in the TCPs: RCO (4), AKVOR (1) and ISARA (1). With the FIR MAIQUETIA the fault occurred in the TCP: VAGAN (1).

2.31 In Figure 8 below, we can see all the TCPs reported above and the number of reports that occurred in each of the TCPs. Mitigating measures must be taken.

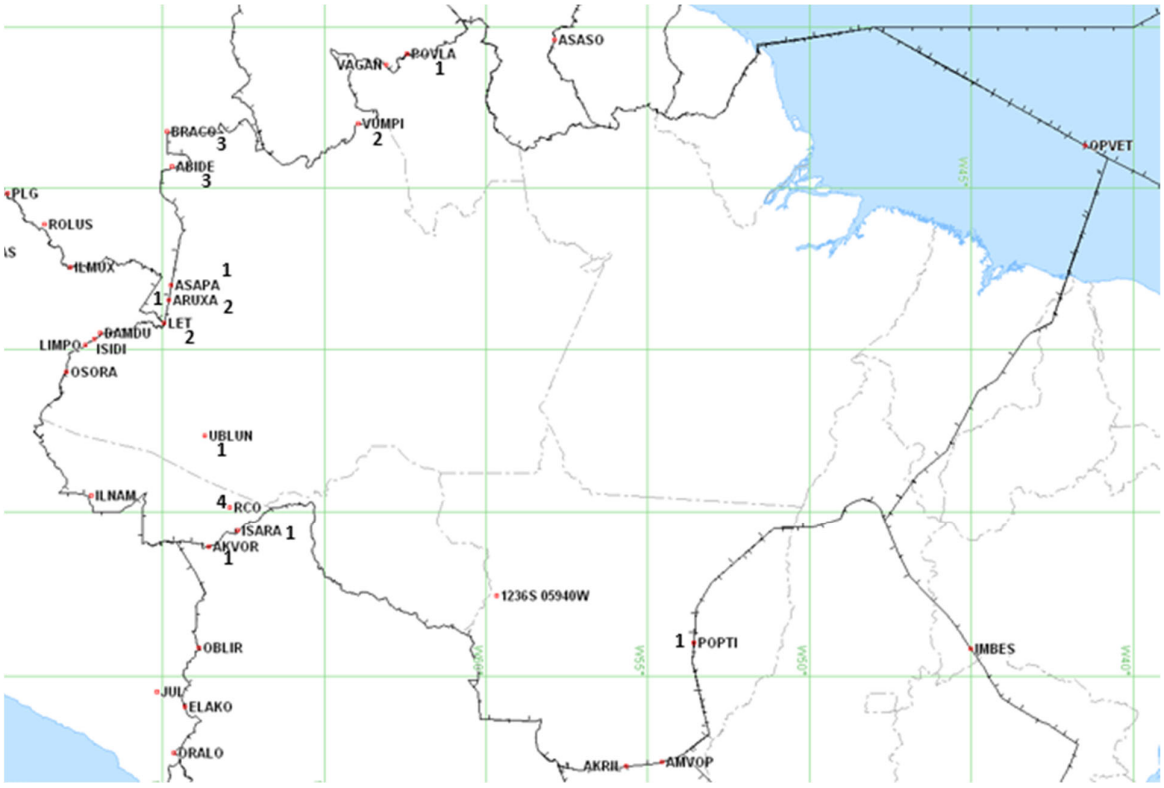



***Figure 8. LHD occurrences in the most reported points between the AMAZÓNICA FIR and neighboring FIRs.***

2.32 In 2021, there were LHD reports in which the LA PAZ FIR is at risk due to failures of the adjacent FIRs, a total of 15 reports made. From the AMAZÓNICA FIR (6) reports, from the CÓRDOBA FIR (3) reports, from the CURITIBA FIR (3) reports, from the ASUNCIÓN FIR (2) reports and from the ANTOFAGASTA FIR (1) report. The AMAZÓNICA FIR committed the faults in the TCP already mentioned above. The CÓRDOBA FIR committed the faults in the TCP: PUBUM (3). The CURITIBA FIR committed the faults in the TCP: SIDAK (2) and CUB (1). The ASUNCION FIR committed the faults in the TCPs: MOMDI (1) and OROMU (1).

2.33 The LA PAZ ACC also committed the same faults, in some TCP with the LIMA FIR, as previously mentioned. With the CURITIBA FIR, the failure occurred in the TCP: SIDAK (1). With the CÓRDOBA FIR the failure occurred in the TCP: PUBUM (1). With the ANTOFAGASTA FIR and with the ASUNCIÓN FIR no failures occurred.

2.34 In Figure 9 below, we can see all the TCPs reported above and the number of reports that occurred in each of the TCPs. Mitigating measures must be taken.

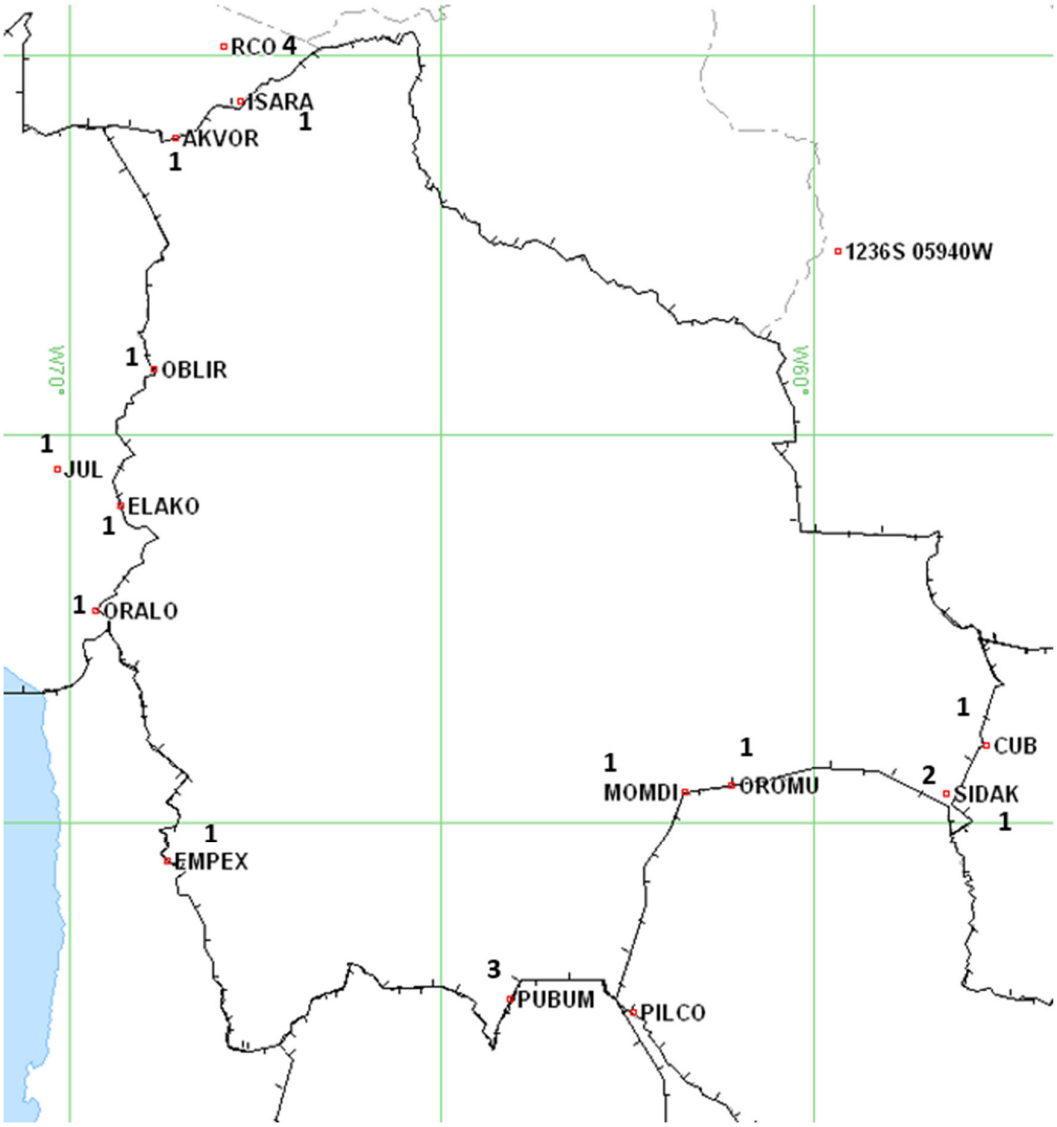



***Figure 9. LHD occurrences at the most reported points between the LA PAZ FIR and neighboring FIRs.***

2.35 In 2021, there were LHD reports in which the MAIQUETIA FIR is at risk due to failures of the adjacent FIRs, a total of 12 reports were made. From the BOGOTÁ FIR, (6) reports, from the BARRANQUILLA FIR, (4) reports, from the AMAZÓNICA FIR, (1) report and from the SAN JUAN FIR (1) report. The AMAZÓNICA FIR committed the faults in the TCP already mentioned above. The BOGOTÁ FIR committed the faults in the TCP: ENPUT (5) and KIKAS (1). The BARRANQUILLA FIR committed the faults in the TCP: SIDAK (2) and CUB (1). The ASUNCION FIR committed the faults in the TCPs: MOMDI (1) and OROMU (1).

2.36 The MAIQUETIA ACC also committed the same faults, in some TCPs with the BOGOTÁ FIR and with the AMAZÓNICA FIR, the TCPs were already mentioned above. With the CURITIBA FIR, the failure occurred in the TCP: SIDAK (1). With the CÓRDOBA FIR the failure occurred in the TCP: PUBUM (1).

2.37 In Figure 10 below, we can see all the TCPs reported above and the number of reports that occurred in each of the TCPs. Mitigating measures must be taken.


***Figure 10. LHD occurrences at the most reported points between the MAIQUETIA FIR and neighboring FIRs.***

2.38 In 2021, there were LHD reports in which the CURITIBA FIR is at risk due to failures of the adjacent FIRs, a total of 12 reports were made. From the AMAZON FIR, (2) reports, from the BRASILIA FIR, (1) report, from the LA PAZ FIR, (3) reports, from AIRCRAFT (3) and from PILOTS, (3) reports. The AMAZÓNICA FIR and the LA PAZ FIR committed the faults in the TCPs already mentioned above. The BRASILIA FIR committed the fault at point: 2245S 04847W (1). The AIRCRAFT committed the faults in the TCP: BOTH (1), OROSA (1) and SELAN (1). The PILOTS committed the faults in the TCP: 2149S 05141W (1), ATIMA (1) and KOVMU (1).

2.39 The CURITIBA ACC also committed the same faults, in some TCPs with the LA PAZ FIR and with the AMAZÓNICA FIR, and the TCPs were already mentioned above. With the BBRASILIA FIR, with the ATLÁNTICO FIR, with the MONTEVIDEO FIR, with the RESISTENCIA FIR and with the ASUNCION FIR, no failures occurred.

2.40 In Figure 11 below, we can see all the TCPs reported above and the number of reports that occurred in each of the TCPs. Mitigating measures must be taken.

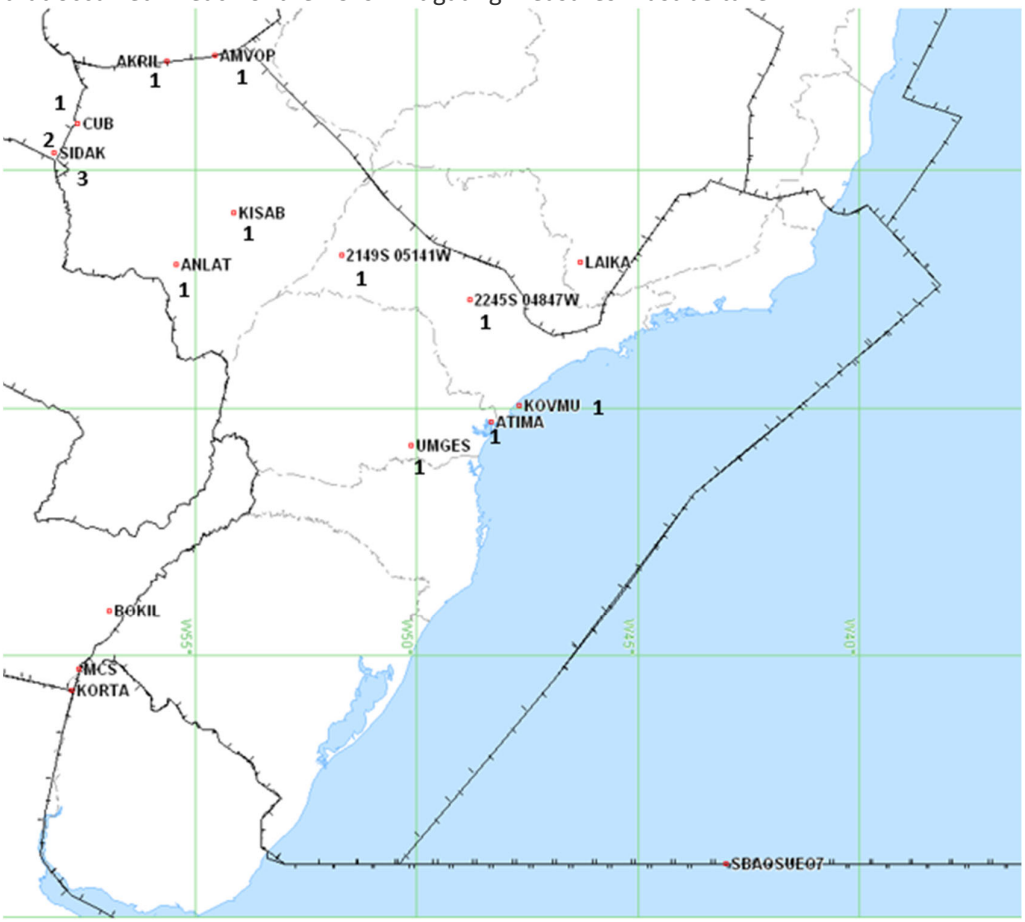



***Figure 11. LHD occurrences at the most reported points between the CURITIBA FIR and neighboring FIRs.***

2.41 LHD reports occurred in the months of the year 2021 in which the other FIRs suffer risk due to failures of the adjacent FIRs, those FIRs will be presented below:

- The KINGSTON FIR made 7 reports, from the BOGOTÁ FIR (5 in KILER and 1 in NEVPA) and from the CENAMER FIR (1 in ULISA).
- The BARRANQUILLA FIR made 2 reports, from the KINGSTON FIR (1 in OTAMO) and from the MAIQUETIA FIR (1 in KONSO).
- The PIARCO FIR made 8 reports, from the DAKAR FIR (1 at 1455N 04448W), from the MAIQUETIA FIR (1 at DAREK and 1 at ONGAL), from the PARAMARIBO FIR (2 at TRAPP) and from PILOTS (1 at 1800N 04547W, 1 at DAREK and 1 at IPSIN).
- The RESISTENCIA FIR made 7 reports, from the ASUNCIÓN FIR (1 in PILCO), from the LA CÓRDOBA FIR (1 in BUPLA and 1 in IREKA), from the MONTEVIDEO FIR (1 in MCS), from the CURITIBA FIR ( 1 in ARULA) and AIRCRAFT (1 in KORTA and 1 in BOKIL).
- The MENDOZA FIR made 5 reports, from the EZEIZA FIR (1 in MOCHO and 2 in TOSOR) and the CÓRDOBA FIR (1 in PAMAL and 1 in SOLER).
- The ANTOFAGASTA FIR made 4 reports, from the CÓRDOBA FIR (2 in KILER) and from the LIMA FIR (1 in IREMI and 1 in SORTA).
- The ATLANTIC FIR made 4 reports, from the AMAZON FIR (1 in OPVET), from the MONTEVIDEO FIR (1 in 3417S 04232W and 1 in 3400S 03300W) and from PILOTS (1 in 3400S 03300W).
- The PARAMARIBO FIR made 3 reports, from the GEORGETOWN FIR (1 in ASASO) and from the PIARCO FIR (1 in DOLRO and 1 in TRAPP).

- The EZEIZA FIR made 3 reports, from the RESISTENCIA FIR (2 in KORTA) and from the MENDOZA FIR (1 in ARVET).
- The HAVANA FIR made 2 reports, from the PORT AU PRINCE FIR (1 in DEPSI) and from PILOTS (1 in NAKTI).
- The MONTEVIDEO FIR made 1 report, from the RESISTENCIA FIR (1 in MOCHO).
- The CÓRDOBA FIR made 1 report, from the LA PAZ FIR (1 in PUBUM).
- The GEORGETOWN FIR made 1 failure report, from the PIARCO FIR (1 in KORTO).
- The RECIFE FIR made 1 failure report, from the BRASILIA FIR (1 in IMBES).

*NOTE: Below we are going to address faults made from FIRs in our region.*

- The SAN JUAN FIR made 5 reports, from the MAIQUETIA FIR (2 in KIKER and 1 in MILOK) and from the PIARCO FIR (1 in LAMKN and 1 in OPAUL).
- The MÉRIDA FIR makes 6 fault reports, from the CENTRAL AMERICA FIR (2 in TUGET, 1 in ASOKU, 1 in UKORO and 1 in VIDNO) and from the PILOT (1 in GABEN).
- The NEW YORK FIR makes 2 failure reports, from the SAN JUAN FIR (1 in KEEKA) and from the PIARCO FIR (1 in ELJEZ).

2.42 In table 2 below, we can better observe what is stated in the items above. We will see all the FIRs involved and the most reported TCPs in 2021.

| FIR THAT RECEIVES THE RISK | FIR THAT MAKES THE FAULT | REPORTS MADE | TCP | CANT. Per FIR | TOTAL GENERAL |
|---|---|---|---|---|---|
| GUAYAQUIL | BOGOTÁ | **65** | **UGUPI** | **120** | **143** |
| | | **25** | **BOKAN** | | |
| | | **12** | **PULTU** | | |
| | | **8** | **ENSOL** | | |
| | | **6** | **ANRAX** | | |
| | | **3** | **VAMOS** | | |
| | | **1** | **AKTAB** | | |
| | LIMA | 8 | VAKUD | 16 | |
| | | 3 | TOSES | | |
| | | 2 | AMERO | | |
| | | 2 | ARNAL | | |
| | | 1 | KABAG | | |
| | CENTRAL AMÉRICA | 7 | LIXAS | 7 | |
| LA PAZ | AMAZÓNICA | 4 | RCO | 6 | 15 |
| | | 1 | AKVOR | | |
| | | 1 | ISARA | | |
| | ASUNCIÓN | 1 | MOMDI | 2 | |
| | | 1 | OROMU | | |
| | CÓRDOBA | 3 | PUBUM | 3 | |
| | CURITIBA | 2 | SIDAK | 3 | |
| | | 1 | CUB | | |
| | ANTOFAGASTA | 1 | EMPEX | 4 | |
| BARRANQUILLA | KINGSTON | **1** | **OTAMO** | **1** | **2** |
| | MAIQUETIA | **1** | **KONSO** | **1** | |

| FIR THAT RECEIVES THE RISK | FIR THAT MAKES THE FAULT | REPORTS MADE | TCP | CANT. Per FIR | TOTAL GENERAL |
|---|---|---|---|---|---|
| BOGOTÁ | GUAYAQUIL | 5 | UGUPI | 11 | 40 |
| | | 5 | ENSOL | | |
| | | 1 | BOKAN | | |
| | PANAMÁ | **3** | **TOKUT** | **13** | |
| | | **2** | **BUXOS** | | |
| | | **2** | **ILTUR** | | |
| | | **2** | **KAKOL** | | |
| | | **1** | **BUSMO** | | |
| | | **1** | **IRASO** | | |
| | | **2** | **OGLUT** | | |
| | CENTRAL AMERICA | **3** | **BOLDO** | **3** | |
| | AMAZÓNICA | **1** | **ARUXA** | **1** | |
| | BARRANQUILLA | **1** | **BUTAL** | **1** | |
| | LIMA | **8** | **ROLUS** | **10** | |
| | | **2** | **PLG** | | |
| | PILOTO | **1** | **UMGOS** | **1** | |
| LIMA | GUAYAQUIL | **2** | **ANPAL** | **10** | **31** |
| | | **2** | **PABOB** | | |
| | | **2** | **TERAS** | | |
| | | **2** | **VAKUD** | | |
| | | **1** | **LOBOT** | | |
| | | **1** | **MOXON** | | |
| | BOGOTÁ | **3** | **ROLUS** | **7** | |
| | | **4** | **ILMUX** | | |
| | ANTOFAGASTA | 1 | IREMI | 2 | |
| | | 1 | SORTA | | |
| | LA PAZ | 1 | ELAKO | 4 | |
| | | 1 | JUL | | |
| | | 1 | OBLIR | | |
| | | 1 | ORALO | | |
| | AMAZÓNICA | 2 | LET | 8 | |
| | | 2 | DAMDU | | |
| | | 1 | ILNAM | | |
| | | 1 | ISIDI | | |
| | | 1 | LIMPO | | |
| | | 1 | OSORA | | |
| KINGSTON | BARRANQUILLA | **1** | **NEVPA** | **6** | 7 |
| | | **5** | **KILER** | | |
| | CENTRAL AMÉRICA | 1 | ULISA | 1 | |

| FIR THAT RECEIVES THE RISK | FIR THAT MAKES THE FAULT | REPORTS MADE | TCP | CANT. Per FIR | TOTAL GENERAL |
|---|---|---|---|---|---|
| AMAZÓNICA | BOGOTÁ | 3 | ABIDE | 11 | 16 |
| | | 2 | LET | | |
| | | 1 | ASAPA | | |
| | | 2 | ARUXA | | |
| | | 3 | BRACO | | |
| | BRASILIA | 1 | POPTI | 1 | |
| | MAIQUETIA | 1 | POVLA | 4 | |
| | | 2 | VUMPI | | |
| | PILOTO | 1 | OBLUM | | |
| PANAMÁ | BOGOTÁ | 17 | BUXOS | 60 | 105 |
| | | 10 | TOKUT | | |
| | | 6 | QRORO | | |
| | | 6 | BUSMO | | |
| | | 6 | TINPA | | |
| | | 2 | KAKOL | | |
| | | 1 | ASEPI | | |
| | | 8 | DAKMO | | |
| | | 4 | ILTUR | | |
| | BARRANQUILLA | 8 | AGUJA | 35 | |
| | | 11 | BOGAL | | |
| | | 6 | ESEDA | | |
| | | 1 | 1228N 07225W | | |
| | | 1 | ISIMO | | |
| | | 1 | NELUR | | |
| | | 1 | ROKIN | | |
| | | 1 | ROPOL | | |
| | | 5 | ALPON | | |
| | CENTRAL AMERICA | 3 | PELRA | 7 | |
| | | 2 | BUFEO | | |
| | | 1 | ISEBA | | |
| | | 1 | PAPIN | | |
| | KINGSTON | 1 | ARNAL | 2 | |
| | | 1 | COLBY | | |
| | PILOTO | 1 | TBG | 1 | |

| FIR THAT RECEIVES THE RISK | FIR THAT MAKES THE FAULT | REPORTS MADE | TCP | CANT. Per FIR | TOTAL GENERAL |
|---|---|---|---|---|---|
| MAIQUETIA | BOGOTÁ | 5 | ENPUT | 6 | 12 |
| | | 1 | KIKAS | | |
| | BARRANQUILLA | 2 | SEMDO | 4 | |
| | | 1 | KONSO | | |
| | | 1 | AKNIL | | |
| | AMAZÓNICA | 1 | VAGAN | 1 | |
| | SAN JUAN | 1 | SILVA | 1 | |
| CURAZAO | BARRANQUILLA | 5 | SELAN | 13 | 33 |
| | | 2 | AMBAS | | |
| | | 6 | OROSA | | |
| | KINGSTON | 1 | AMBIN | 2 | |
| | | 1 | DIBOK | | |
| | PORT AU PRINCE | 2 | LENOM | 2 | |
| | SANTO DOMINGO | 3 | VESKA | 12 | |
| | | 2 | KARUM | | |
| | | 2 | KISAS | | |
| | | 1 | BEROX | | |
| | | 2 | PALAS | | |
| | | 1 | PIGBI | | |
| | | 1 | POKAK | 4 | |
| | MAIQUETIA | 2 | CHAVE | | |
| | | 1 | ACORA | | |
| | | 1 | VODIN | | |
| SANTO DOMINGO | CURAZAO | 4 | KARUM | 23 | 24 |
| | | 5 | PALAS | | |
| | | 3 | BEROX | | |
| | | 3 | KISAS | | |
| | | 3 | POKAK | | |
| | | 5 | VESKA | | |
| | PORT AU PRINCE | 1 | DCR | 1 | |
| PORT AU PRINCE | KINGSTON | 1 | MUPOV | 3 | 10 |
| | | 1 | NOSIS | | |
| | | 1 | KEBET | | |
| | MIAMI | 3 | JOSES | 3 | |
| | SANTO DOMINGO | 2 | PIGBI | 4 | |
| | | 1 | ETBOD | | |
| | | 1 | RETAK | | |

| FIR THAT RECEIVES THE RISK | FIR THAT MAKES THE FAULT | REPORTS MADE | TCP | CANT. Per FIR | TOTAL GENERAL |
|---|---|---|---|---|---|
| CENTRAL AMÉRICA | GUAYAQUIL | 1 | ARTOM | 5 | 17 |
| | | 1 | LIXAS | | |
| | | 1 | LOGAL | | |
| | | 2 | OSELO | | |
| | PANAMÁ | 1 | ANSON | 4 | |
| | | 1 | ISEBA | | |
| | | 2 | LESIR | | |
| | BOGOTÁ | **1** | **BOLDO** | **1** | |
| | KINGSTON | 1 | MAMBI | 1 | |
| | MÉRIDA | 1 | ALSAL | 6 | |
| | | 1 | ASOKU | | |
| | | 3 | KATIS | | |
| | | 1 | TAKUX | | |
| CURITIBA | AMAZONICA | 1 | AKRIL | 2 | 12 |
| | | 1 | AMVOP | | |
| | BRASILIA | 1 | 2245S 04847W | 1 | |
| | LA PAZ | 3 | SIDAK | 3 | |
| | PILOTO | 1 | 2149S 05141W | 3 | |
| | | 1 | ATIMA | | |
| | | 1 | KOVMU | | |
| | AERONAVE | 1 | ANLAT | 3 | |
| | | 1 | UMGES | | |
| | | 1 | KISAB | | |

*NOTE 1: 4 FIRs are almost always involved (GUAYAQUIL, BOGOTÁ, LIMA and - PANAMÁ).*
*NOTE 2: all points related to the FIRs BARRANQUILLA and **BOGOTÁ** are in **BLACK**.*

***Table 2. Points of LHD occurrences, with the indication of the FIRs involved – Points with the most reports***

2.43 In **Table 3** and in **Figure 12** below, we can see the points that were reported which involve the FIRs of Colombia (BARRANQUILLA and BOGOTÁ), with the adjacent FIRs.

| POINTS | TTL | TOTAL, VR FOR EACH POINT | MEDIAN VR | POINTS | TTL | TOTAL VR FOR EACH POINT | MEDIAN VR |
|---|---|---|---|---|---|---|---|
| 1228N 07725W | 1 | 22 | 22,0 | IRASO | 1 | 39 | **39,0** |
| ABIDE | 3 | 54 | 18,0 | ISIMO | 1 | 17 | 17,0 |
| AGUJA | 8 | 144 | 18,0 | KAKOL | 4 | 94 | 23,5 |
| AKNIL | 1 | 46 | **46,0** | KIKAS | 1 | 22 | 22,0 |
| AKTAB | 1 | 22 | 22,0 | KILER | 5 | 96 | 19,2 |
| ALPON | 5 | 86 | 17,2 | KONSO | 2 | 51 | 25,5 |
| AMBAS | 2 | 35 | 17,5 | LET | 4 | 88 | 22,0 |
| ANRAX | 6 | 130 | 21,7 | LIXAS | 8 | 182 | 22,8 |
| ARORO | 6 | 86 | 14,3 | NELUR | 1 | 41 | **41,0** |
| ARUXA | 3 | 62 | 20,7 | NEVPA | 1 | 18 | 18,0 |
| ASAPA | 1 | 17 | 17,0 | OGLUT | 1 | 39 | **39,0** |
| ASEPI | 1 | 22 | 22,0 | OROSA | 6 | 100 | 16,7 |
| BOGAL | 11 | 249 | 22,6 | OTAMO | 1 | 18 | 18,0 |
| BOKAN | 26 | 615 | 23,7 | PLG | 2 | 44 | 22,0 |
| BOLDO | 4 | 151 | **37,8** | PULTU | 12 | 262 | 21,8 |
| BRACO | 3 | 48 | 16,0 | ROKIN | 1 | 17 | 17,0 |
| BUSMO | 7 | 141 | 20,1 | ROLUS | 1 | 251 | 22,8 |
| BUTAL | 1 | 22 | 22,0 | ROPOL | 1 | 26 | 26,0 |
| BUXOS | 19 | 385 | 20,3 | SELAN | 5 | 75 | 15,0 |
| DAKMO | 8 | 201 | 25,1 | SEMDO | 2 | 68 | **34,0** |
| ENPUT | 5 | 85 | 17,0 | TINPA | 6 | 146 | 24,3 |
| ENSOL | 13 | 262 | 20,2 | TOKUT | 13 | 221 | 17,0 |
| ESEDA | 6 | 98 | 16,3 | UGUPI | 70 | 1.570 | 22,4 |
| ILMUX | 4 | 76 | 19,0 | UMGOS | 2 | 72 | 36,0 |
| ILTUR | 6 | 144 | 24,0 | VAMOS | 3 | 76 | 25,3 |
| | | | | **TOTAL** | **315** | **6.836** | **21,7** |

***Table 3. Points of LHD occurrences involving Colombian FIRs with adjacent FIRs***

2.44 We then have a total of 315 reports involving 50 fixes from the BARRANQUILA and BOGOTÁ FIRs with their adjacent FIRs. Of the total of 520 validated reports for the CAR/SAM Region in 2021, these failures in these two FIRs represent 60.6% of all validated reports whose VR added together we obtain a total of 6,836 points and that represents 61.2% of the total VR obtained for the entire CAR/SAM region, which were 11,169 points.

2.45 Only in Figure 12 below, we can see that we then have a total of 400 reports, adding the 85 reports involving 31 fixed FIRs neighboring BARRANQUILA and BOGOTÁ, of the total of 520 reports validated for the CAR/SAM Region in 2021 Those faults in that figure alone represent 76.9% of all validated reports whose VR added together we now obtain a total of 8,460 points and that represents 75.7% of the total VR obtained for the entire CAR/SAM region, which was 11,169 points. .

*NOTE: We must bear in mind that mitigating actions must be implemented in that region as quickly as possible, mainly at points where the number of reports is very high or where the RVs are above RV = 30.*


***Figure 12. Occurrences of LHD in the points common to the FIRs of Colombia and its neighbors***

2.46 In 2021, LHD reports with long duration occurred. We will report only the reports with durations greater than or equal to four (4) minutes and their respective VR.

i. In the PANAMA FIR, in the month of August, report number 303 occurred, position PAPIN, with a duration of 10 minutes, due to the lack of coordination of the ACC CENAMER, whose VR was 51 points.

ii. In the ATLÁNTICO FIR, in the month of November, report number 463 occurred, position 3400S03300W, with a duration of 220.4 minutes, that is, 03 hours and 40 minutes, due to the lack of coordination of the MONTEVIDEO ACC, whose RV was of 51 points.

iii. In the BOGOTÁ FIR, in the month of November, report number 496 occurred, position UMGOS, with a duration of 15 minutes, due to the lack of coordination of the PANAMA ACC, whose VR was 51 points.

*NOTE: In the 3 reports above, the VR was the highest found in the 2021 sample of reports.*

iv. In the LA PAZ FIR, in the month of November, report number 489 occurred, position SIDAK, with a duration of 25 minutes, due to poor coordination of the CURITIBA FIR, whose VR was 49 points.

v. In the ATLANTIC FIR, in the month of May, report number 138 occurred, OPVET position, with a duration of 60 minutes, due to the lack of coordination of the AMAZON ACC, whose VR was 46 points.

vi. In the MAIQUETIA FIR, in the month of August, report number 344 occurred, position AKVIL, with a duration of 5 minutes, due to the lack of coordination of the BARRANQUILLA ACC, whose VR was 46 points.

vii. In the CURITIBA FIR, in the month of November, report number 486 occurred, position AMVOP, with a duration of 5 minutes, due to the lack of coordination of the AMAZÓNICO ACC, whose VR was 46 points.

viii. In the PIARCO FIR, in the month of December, report number 587 occurred, position 1455N 04448W, with a duration of 60 minutes, due to the lack of coordination of the DAKAR ACC, whose VR was 46 points.

ix. In the RESISTENCIA FIR, in the month of August, report number 323 occurred, position KORTA, with a duration of 29 minutes, due to a PILOT fault, whose VR was 41 points.

x. In the MENDOZA FIR, in the month of October, report number 411 occurred, position MOCHO, with a duration of 4 minutes, due to the lack of coordination of the EZEIZA ACC, whose VR was 41 points.

xi. In the PANAMA FIR, in the month of October, report number 442 occurred, position NELUR, with a duration of 16 minutes, due to the absence of coordination of the BARRANQUILLA ACC, whose VR was 41 points.

xii. In the LA PAZ FIR, in the month of March, report number 82 occurred, position RCO, with a duration of 10 minutes, due to poor coordination of the AMAZÓNICO ACC, whose VR was 39 points.

xiii. In the NEW YORK FIR, in the month of February, report number 167 occurred, position ELJEZ, with a duration of 50 minutes, due to poor coordination of the ACC PIARCO, whose VR was 34 points.

xiv. In the MAIQUETIA FIR, in the month of September, report number 370 occurred, position SILVA, with a duration of 120 minutes, due to poor coordination of the SAN JUAN ACC, whose VR was 29 points.

xv. In the MAIQUETIA FIR, in the month of September, report number 382 occurred, position VAGAN, with a duration of 47 minutes, due to poor coordination of the AMAZÓNICO ACC, whose VR was 29 points.

xvi. In the LA PAZ FIR, in the month of October, report number 417 occurred, EMPEX position, with a duration of 35 minutes, due to lack of contact by the PILOT and poor coordination by the ANTOFAGASTA ACC, whose VR was 21 points.

xvii. In the ATLANTIC FIR, in the month of November, report number 464 occurred, position 3400S03300W, with a duration of 220.4 minutes, that is, 03 hours and 40 minutes, due to the absence of contact by the pilot for not complying with the agreement, whose VR was 21 points.

xviii. In the BOGOTÁ FIR, in the month of November, report number 497 occurred, position UMGOS, with a duration of 15 minutes, due to a PILOT failure, whose VR was 21 points.

xix. In the MÉRIDA FIR, in the month of January, report number 1 occurred, position GABEN, with a duration of 35 minutes, due to a PILOT failure, whose VR was 19 points.

xx. In the RESISTENCIA FIR, in the month of November, report number 504 occurred, position BOKIL, with a duration of 4 minutes, due to poor coordination by the ACC CÓRDOBA, whose VR was 19 points.

xxi. In the CURITIBA FIR, in the month of August, report number 310 occurred, position ANLAT, with a duration of 20 minutes, due to a PILOT fault, whose VR was 17 points.

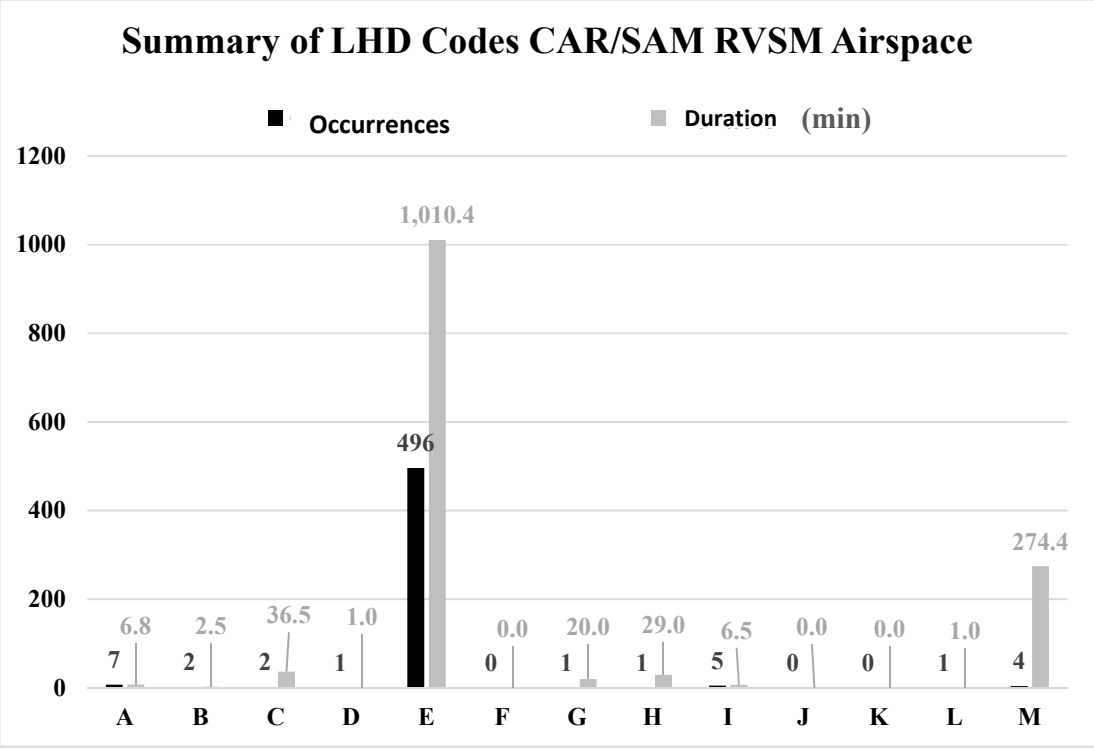
xxii. In the MÉRIDA FIR, in the month of June, report number 197 occurred, position TUGET, with a duration of 4 minutes, due to poor coordination of the ACC CENAMER, whose VR was 16 points.

**2.47** **Table 4 and Graph 2** summarize the number of occurrences of LHD reports, the duration (in minutes) associated with the LHD code, and the number of unauthorized flight levels crossed, from January 1 to December 31, 2021, in airspace RVSM of the CAR/SAM Region.

| LHD Code | LHD Code Description | No. LHD Occurrences LHD | LHD Duration (Min) | FL Crossed with no clearance |
|---|---|---|---|---|
| **A** | The flight crew did not ascend/descend the aircraft as authorized. | 7 | 6,8 | 9 |
| **B** | The flight crew ascended/descended without authorization from the ATC body. | 2 | 2,5 | 3 |
| **C** | Incorrect operation or interpretation of on-board equipment (e.g., malfunction of fully operational FMS, incorrect transcript of ATC clearance or new clearance, flight plan followed instead of ATC clearance, original clearance followed instead of the new authorization, etc.) | 2 | 36,5 | 0 |
| **D** | ATC system loop error (e.g., incorrect ATC clearance delivery or flight crew not understanding clearance message) | 1 | 1,0 | 0 |

| | | | | |
|---|---|---|---|---|
| **E** | Coordination errors between transferring ATC units or control responsibility, as a result of human factors (e.g., late or non-existent coordination; incorrect estimated/actual time; flight level, ATS route, etc. not adjusted to agreed parameters) | 496 | 1.010,4 | 521 |
| **F** | Coordination errors between transfer ATC units or control responsibility, as a result of equipment failure or technical problems. | 0 | 0,0 | 0 |
| **G** | Deviation due to an aircraft contingency event that led to a sudden inability to maintain assigned flight level (eg, pressurization failure, engine failure) | 1 | 20,0 | 2 |
| **H** | Deviation due to airborne equipment failure leading to an unintended or undetected change in flight level | 1 | 29,0 | 0 |
| **I** | Deviation due to turbulence or other cause related to weather conditions. | 5 | 6,5 | 9 |
| **J** | Deviation due to a TCAS resolution notice; flight crew correctly follows a TCAS resolution advisory | 0 | 0,0 | 0 |
| **K** | Deviation due to a TCAS resolution notice; flight crew incorrectly follows a TCAS resolution advisory. | 0 | 0,0 | 0 |
| **L** | A non-RVSM approved aircraft that is provided RVSM separation (e.g., flight plan indicating RVSM approval, but aircraft is not approved; misinterpretation of flight plan by ATC). | 1 | 1,0 | 0 |
| **M** | Others - this includes flights operating (including climb/descent) in airspace in which flight crews are unable to establish normal air-ground communications with the responsible ATS unit. | 4 | 274,4 | 0 |
| **Total** | **(Jan 2021 – Dec 2021)** | **520** | **1.388,1** | **529** |

***Table 4. Summary of LHD Occurrences and Duration by LHD Code***




***Graph 2. Summary of LHD Occurrences by Code***

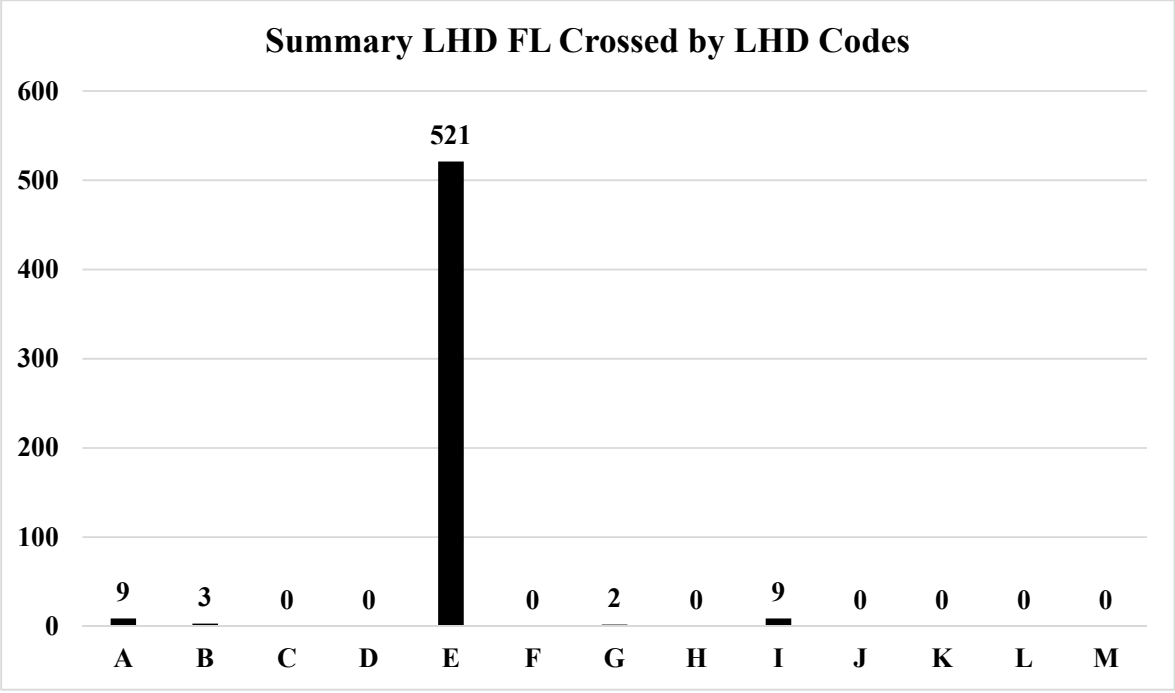
2.48 Once again, LHD reports with Code “E” (coordination error between ATC units) were the most frequent in 2021 with 496 events, representing 95.4% of all errors, followed by Codes “A” ( 7), “I” (5), “M” (4), “B” and “C” (2), “D”, “G”, “H” and “L” (all with 1). The high number of reports with Code “E” demonstrates the need for better coordination between adjacent ATC units, which could be achieved through awareness and coordination training between controllers. It should be noted that in 2020 and 2021 the "F" Codes are not presented as in 2018 and 2019. For this the explanation is simple: On April 14 and later on May 14, 2019, the two teleconferences held with the presence Of almost all the POCs in the region, it was said by the representatives of the FIRs that produced the most these codes that the problem was not in the equipment, but in the ATC personnel who did not know how to handle the equipment perfectly and a review of all was requested. the 2019 reports, being then changed to “E1” and “E2”.

2.49 Just as CARSAMMA for its analyses uses “E1” to define poor coordination failures and “E2” to define lack of coordination, in this paper CARSAMMA requests the use of code “F” to indicate errors by ATC personnel that does not perfectly handle the equipment for the transfers, many times they do not know how to interpret the error codes presented. This request is based on the opinion of the experts as cited in the previous item.

2.50 Likewise, in Graph 2 it can be seen that, in terms of duration, the LHD reports with Code “E” were the ones that most compromised operational safety, with a total duration of 83,286 seconds or 1,388.1 minutes or 23. 1 hours. This is one of the worst incidents in air traffic since the aircraft in question were not expected at that position (E2), or at that level (E1).

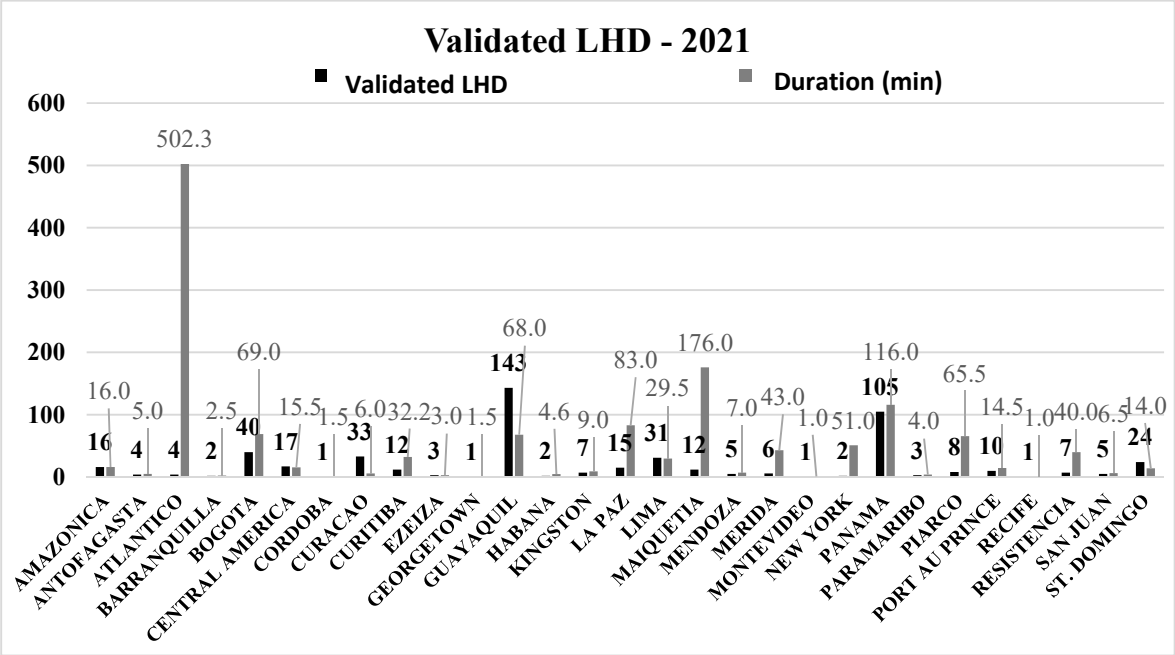
NOTE: Here attention is drawn to the two cases of Code "E". The "E1" for poor coordination, 243 reports and for the "E2" for lack of coordination, 253 reports.

2.51 Graph 3 shows the total number of levels, by code, that have occurred with level crossings without authorization by air traffic control. In this case, the Code “E” LHD reports were the most outstanding, crossing 521 levels.




***Graph 3. Summary of LHD Occurrences by Level Crossing***

2.52 Graph 4 shows the number of all validated LHD reports, separated by FIR. It must be taken into account that the Atlantic, Maiquetia, Panama, La Paz, Bogotá, Guayaquil and Piarco FIRs have the highest absolute number of duration in minutes, leaving the aircraft that use them more exposed to operational risk.




***Graph 4. Summary of LHD Occurrences by FIR***

## 3. Risk Value Assessment (VR)

3.1 This section updates the results of the safety assessment of RVSM airspace in the FIRs of the CAR/SAM Regions. Therefore, the methodology to assess the risk value (SGSO/SMS) was applied to the internationally accepted safety assessment of this airspace.

3.2 Estimates of the parameters of the Risk Value (RV) - The quantity and starting material for the estimation of the values for each parameter inherent to the internationally accepted risk value (RV), which were used to carry out the safety evaluation operational in RVSM space, are summarized in the following formula and described in Table 5.

**VR = (P x D x S) + R + W + T, donde:**

| Parameter | Description | Value |
|---|---|---|
| **VR** | Risk Value | **El to calculate** |
| **P** | Probability of the position | **Varies 1 to 5** |
| **D** | Duration of the Event | **Varies 1 to 3** |
| **S** | Severity of the Event | **Varies 1 to 5** |
| **R** | With or no RADAR/ADS | **With=5 or No=10** |
| **W** | Weather conditions | **VMC=0 or IMC=5** |
| **T** | Other traffic (if any) | **Range varies from 5 (radar)** to **10 (No radar)** |
| | **TOTAL** | **Max of 100** |

***Table 5. Calculation of the Risk Value parameters***

3.3 Safety Assessment - Results of the safety assessment of the RVSM airspace of the FIRs of the CAR/SAM Regions are detailed in Table 6 and Graph 5 (FIR with LHD reports with VR > 30. The limit of LoS was created in GTE 11 - ICAO, held in 2011 (Lima, Peru).

| | LoS | MPZL | SKED | MTEG | SPIM | SLLF | MHTG | SBAO | SVZM | TNCF | SBCW | TTZP | SARU | SAMV | SMPM | KZNY | SKEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ENE | 20 | | | | 39 | | | | | | | | | | | | |
| FEB | 20 | | | | 31 | | | | | 34 | | | | | | | |
| MAR | 20 | | 39 | | | 39 | 39 | | | | | | | | 34 | | |
| ABR | 20 | | | | 31 | | | | | | | | | | | | |
| MAY | 20 | 46 | 39 | 31 | 31 | | | 46 | | | | | | | | 34 | |
| JUN | 20 | 46 | 39 | | | | 34 | | | | | | | | | | |
| JUL | 20 | | | 41 | | | 39 | | | | | | | | | | |
| AGO | 20 | 51 | | | | | | | 46 | 31 | | | 41 | | | | |
| SEP | 20 | | | | | | | | 46 | | | | | | | | |
| OCT | 20 | 41 | 39 | 39 | | 39 | | | | | | | | 41 | | | |
| NOV | 20 | | 51 | | | 49 | | 51 | | | 46 | | | | | | 34 |
| DIC | 20 | | | 34 | | | | | | | | 46 | | | | | |

***Table 6. Estimates of the highest risk values (RV) for LHD, by month.***

3.4 In January, as air traffic is already returning to normal due to the pandemic, we had several reports of high VR. The highest RV (39) occurred in the Lima FIR (SPIM). In February, even with movement returning to normal, the highest VR (34) occurred in the Curacao FIR (TNCF). In March, already with greater movement, we had the highest VR (39) in the Bogotá (SKED), La Paz (SLLF) and Central America (SLLF) FIRs. In April, already with a greater movement, we had in the Lima FIR (SPIM), the highest VR (31) occurred. In May, the highest VR (46) occurred in the Panama (MPZL) and Atlántico (SBAO) FIRs. In June in the Panama FIR (MPZL) the highest VR occurred (46). In July, the highest VR (41) occurred in the Port Au Prince FIR (MTEG). In August, the highest VR (51) occurred in the La Panamá FIR (MPZL). In September in the FIR Maiquetia (SVZM) the highest VR occurred (46). In October in the Panama (MPZL) and Mendoza (SAMV) FIRs, the highest VR occurred (41). In November, the highest VR (51) occurred in the Bogotá (SKED) and Atlántico (SBAO) FIRs. In December in the Piarco FIR (TTZP) the highest VR (46) occurred.

3.5 The LHD 303 report that was presented by the Panama FIR, with a failure by the Central America FIR, in August 2021, contributed 0.88% of the risk assessment for this month, with a VR = 51, which is the largest in the sample.

3.6 The LHD 463 report that was presented by the Atlantic FIR, with a failure by the Montevideo FIR, in November 2021, contributed 0.16% of the risk assessment for this month, with a VR = 51, which is also the largest in the sample.

3.7 The LHD 496 report that was presented by the Bogotá FIR, with a failure by the Panama FIR, in November 2021, contributed 0.16% of the risk assessment for this month, with a VR = 51, which is the highest large sample.

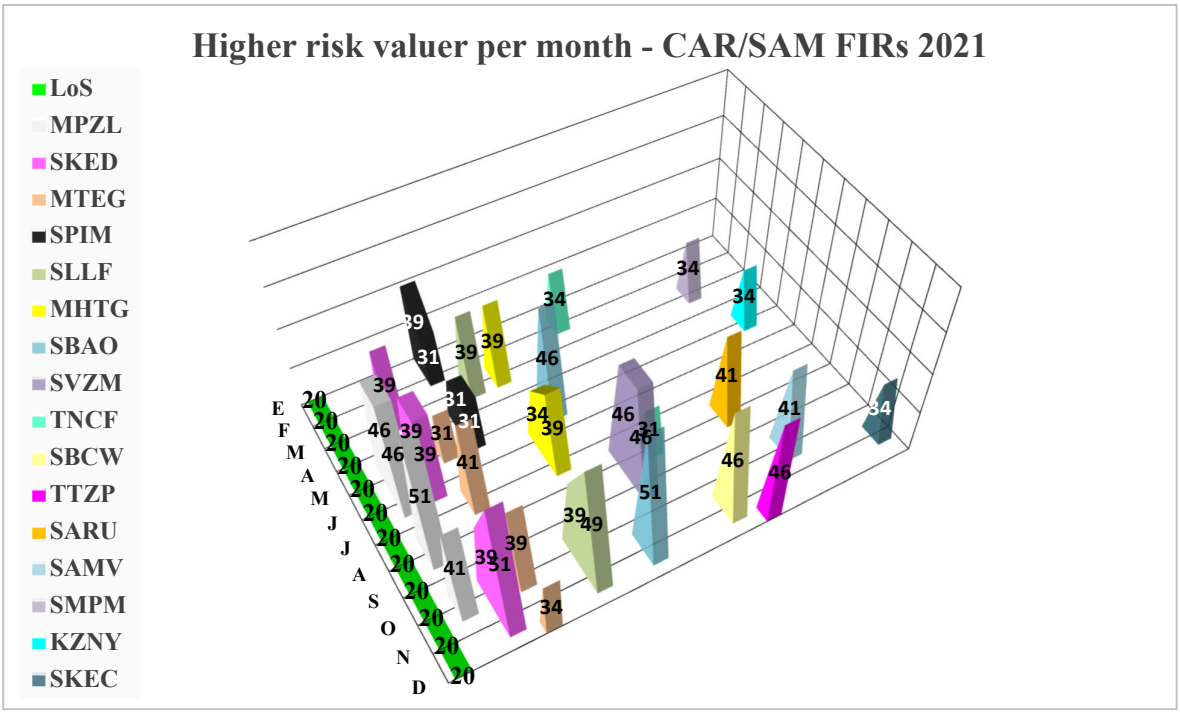
3.8 The LHD 489 report that was presented by the La Paz FIR, with a failure by the Curitiba FIR, in November 2021, contributed 0.16% of the risk assessment for this month, with a VR = 49, which is the second largest in the sample.

3.9 As in our sample we are only analyzing VR greater than 30 points, we have the following scenario:

- In JANUARY we had a VR = 39, report 26 and another VR = 31, report 31, both in the LIMA FIR that contributed 9.0% of the risk assessment for this month.
- In FEBRUARY we had a VR = 34, report 45 and a VR = 31, report 65, from the CURACAO and LIMA FIRs, respectively, which contributed 10.4% of the risk assessment for this month.
- In MARCH we had three VR = 39, reports 82, 97 and 100 and one VR = 34, report 107, from the LA PAZ, BOGOTÁ, CENTRAL AMERICA and PARAMARIBO FIRs, respectively, which contributed 24.4% of the evaluation of risk for this month.
- In APRIL we had only one VR = 31, report 123, from the LIMA FIR, which contributed 6.3% of the risk assessment for this month.
- In MAY we had three VR = 46, reports 138, 161 and 163, one of VR = 41, report 169, one of VR = 39, report 158, four of VR = 34, reports 143, 157, 166 and 167 and two of VR = 31, reports 165 and 175, from the PANAMÁ (7), ATLÁNTICO (1), BOGOTÁ (1), PORT AU PRINCE (1), LIMA (1) and NEW YORK FIRs, which contributed 37.5% of the risk assessment for this month.
- In JUNE we had one VR = 46, reports 195, one VR = 39, report 199, three VR = 34, reports 193, 204 and 207, from the PANAMA (2), BOGOTÁ (2) and CENTRAL AMERICA (1) FIRs. ), which contributed 20.9% of the risk assessment for this month.
- In JULY we had one VR = 41, report 252, two of VR = 39, reports 243 and 271, from the CENTRAL AMERICA (2) and PORT AU PRINCE FIRs, respectively, which contributed 9.5% of the risk assessment for this month.
- In AUGUST we had a VR = 51, report 303, a VR = 46, report 344, a VR = 41, report 323 and a VR = 31, report 329, from the PANAMA, MAIQUETIA, PORT AU PRINCE and CURACAO FIRs , respectively, which contributed 14.2% of the risk assessment for this month.
- In SEPTEMBER we had only one RV = 46, report 396, both in the MAIQUETIA FIR that contributed 5.6% of the risk assessment for this month.
- In OCTOBER we had two VR = 41, reports 411 and 442, four of VR = 39, reports 408, 410, 422 and 425, one of VR = 34, report 445 and one of VR = 31, report 434, from the PANAMA FIR , BOGOTÁ, LA PAZ and PORT AU PRINCE, which contributed 37.3% of the risk assessment for this month.
- In NOVEMBER we had two VR = 51, reports 463 and 496, one of VR = 49, reports 489, one of VR = 46, report 486 and one of VR = 34, report 477, from the FIR ATLÁNTICO, BOGOTÁ, LA PAZ, CURITIBA and BARRANQUILLA, which contributed 19.5% of the risk assessment for this month.
- In DECEMBER we had a VR = 46, reports 587 and a VR = 34, report 564, from the PIARCO and PORT AU PRINCE FIRs, which contributed 6.1% of the risk assessment for this month.

*NOTE: After doing the analyzes with RV > 30 for each month, we saw that the months of MAY, OCTOBER and NOVEMBER contributed a lot to obtain high risk values.*

3.10 In Graph 5, the most important risk values (VR) that occurred in all months are presented based on the LHD reports from January 1 to December 31, 2021.




***Graph 5. Highest monthly risk values for the FIRs of the RVSM CARSAM space. The green line is the VR of the LoS (20).***

## 4. The LHD Safety Analysis (SGSO)

4.1 In Appendix "A", attached, all the LHD reports whose failures or operational errors have been evaluated in teleconferences or by CARSAMMA analysis together with the POCs of the FIRs involved, are detailed, as those that had the highest risk of value (> 20) produced during the 12 months of 2021.

4.2 Table 7 shows the FIRs that suffered and generated risks.

| FIR | Suffers Risk | % | Generates Risk | % |
|---|---|---|---|---|
| AMAZONICA | 16 | | 19 | |
| ANTOFAGASTA | 4 | | 3 | |
| ASUNCION | 0 | | 3 | |
| ATLANTICO | 4 | | 0 | |
| BARRANQUILLA | 2 | | **59** | **12,0** |
| BOGOTA | **40** | **7,9** | **206** | **41,9** |
| BRASILIA | 0 | | 3 | |
| CAYENNE | 0 | | 0 | |
| CENTRAL AMERICA | 17 | | **22** | **4,5** |
| COMODORO RIVADAVIA | 0 | | 0 | |
| CORDOBA | 1 | | 10 | |
| CURAZAO | **33** | **6,5** | **23** | **4,7** |
| CURITIBA | 10 | | 4 | |
| EZEIZA | 3 | | 3 | |
| GEORGETOWN | 1 | | 1 | |
| GUAYAQUIL | **143** | **28,2** | **26** | **5,3** |
| HABANA | 2 | | 0 | |
| ISLA DE PASCUA | 0 | | 0 | |
| KINGSTON | 7 | | 9 | |

| | | | | |
|---|---|---|---|---|
| LA PAZ | 15 | | 8 | |
| LIMA | **31** | **6,1** | **28** | **5,7** |
| MAIQUETIA | 12 | | 13 | |
| MENDOZA | 5 | | 1 | |
| MONTEVIDEO | 1 | | 3 | |
| PANAMA | **105** | **20,7** | 17 | |
| PARAMARIBO | 3 | | 2 | |
| PIARCO | 8 | | 6 | |
| PORT AU PRINCE | 10 | | 4 | |
| PUERTO MONTT | 0 | | 0 | |
| PUNTA ARENAS | 0 | | 0 | |
| RECIFE | 0 | | 0 | |
| RESISTENCIA | 7 | | 3 | |
| SANTIAGO | 0 | | 0 | |
| ST. DOMINGO | **24** | **4,7** | 16 | |
| **TOTAL** | **507** | **74,2** | **492** | **74,0** |

**NOTE 1:** Total reports made/presented by CAR FIR 101, made/presented by SAM FIR 406.

**NOTE 2:** In column 2 - "Suffers the Risk", only those 6 FIRs suffer 74.2% of the risks of the region.

**NOTE 3:** In column 4 - “Generates the Risk”, only those 6 FIRs generate 74.0% of the risks in the region.

| **Adjacent FIRs OTHERS (*) (**)** | **Suffers Risk** | **Generates Risk** |
|---|---|---|
| AERONAVE | 0 | 4 |
| DAKAR | 0 | 1 |
| MERIDA | 6 | 6 |
| MIAMI | 0 | 3 |
| NEW YORK | 2 | 0 |
| PILOTO (**) | 0 | 12 |
| SAN JUAN | 5 | 2 |
| **TOTAL** | **13** | **28** |

***Table 7. FIRs that suffered and generated risks (LHD) in 2020.***

4.3 The FIRs that suffered the most from failures of the adjacent FIRs were: GUAYAQUIL 143 times, PANAMÁ 105 times, BOGOTÁ 40 times, CURACAO 33 times, LIMA 31 times and SANTO DOMINGO 24 times, only those 6 FIRs presented a total of 276 LHD reports which represents 74.2% of all the reports received from the region.

NOTE: FIRs neighboring these FIRs still continue to contribute to risk generation in these RVSM airspaces.

4.4 The FIRs that most contributed to failures for the adjacent FIRs were: BOGOTÁ 206 times, BARRANQUILLA 59 times, LIMA 28 times, GUAYAQUIL 26 times, CURACAO 23 times and CENTRAL AMERICA 22 times, only those 6 FIRs generated a total of 364 LHD reports which represents 74.0% of all the faults observed in the region.

NOTE: Failures of these FIRs are repeating in the last 3 years. Mitigating actions must be taken urgently.

4.5 The BARRANQUILLA FIR has made only two (2) LHD reports from the adjacent FIRs, while generating 59 risk contributions in the neighboring FIRs, mainly to the PANAMA FIR with 35 errors/failures, then to the CURACAO FIR with 13 errors. /failures, then with the KINGSTON FIR with 6 errors/failures, then with the MAIQUETIA FIR with 4 errors/failures and finally with the BOGOTÁ FIR with 1 error/failure.

4.6 Secondly, we have the CÓRDOBA FIR has made only one (1) LHD reporting from the adjacent FIRs, while generating 10 risk contributions in the neighboring FIRs, mainly with the LA PAZ and RESISTENCIA FIRs with 3 errors/failures with each of them and then with the MENDOZA and ANTOFAGASTA FIRs, with 2 errors/failures with each of them.

4.7 Part of the analysis process includes a detailed review of certain operational errors/failures, in order to identify the contributing factors and ensure that the procedures and processes are executed by the CAR/SAM FIR Safety authorities to reduce the probability that the same errors will recur.

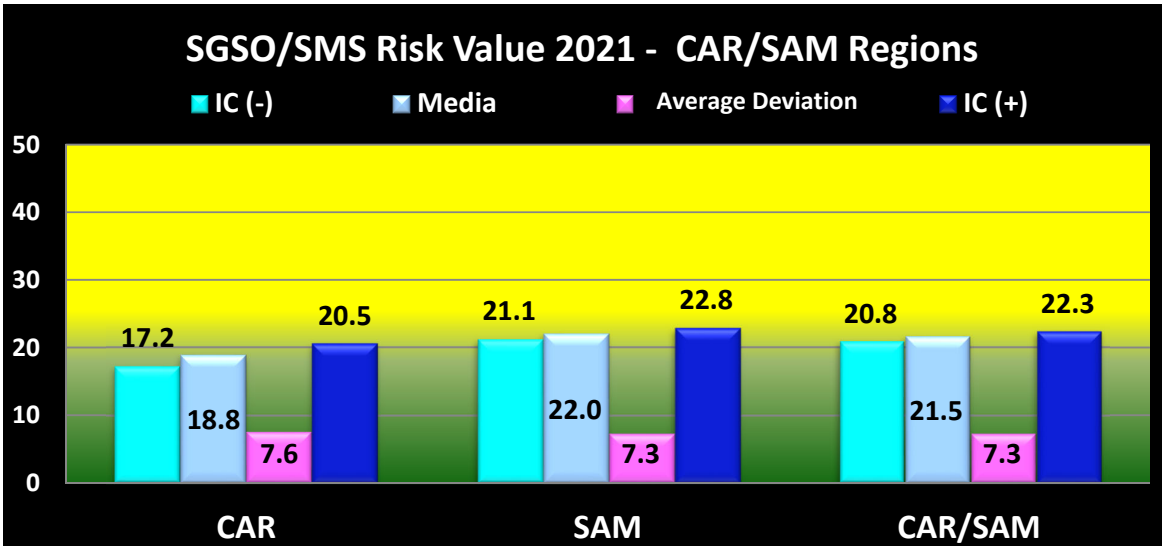
4.8 In the case of RVSM airspace, CARSAMMA evaluated the individual operational errors identified by the LHD reports submitted by the 34 FIRs in its geographic area of coverage, grouping them by FIR and then by State, using the following statistical tools:

Risk Value Averages ⟹ $\bar{x} = \sum VR / n$ ;

Standard Deviations ⟹ $\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x-\bar{x})^2}$ ; y

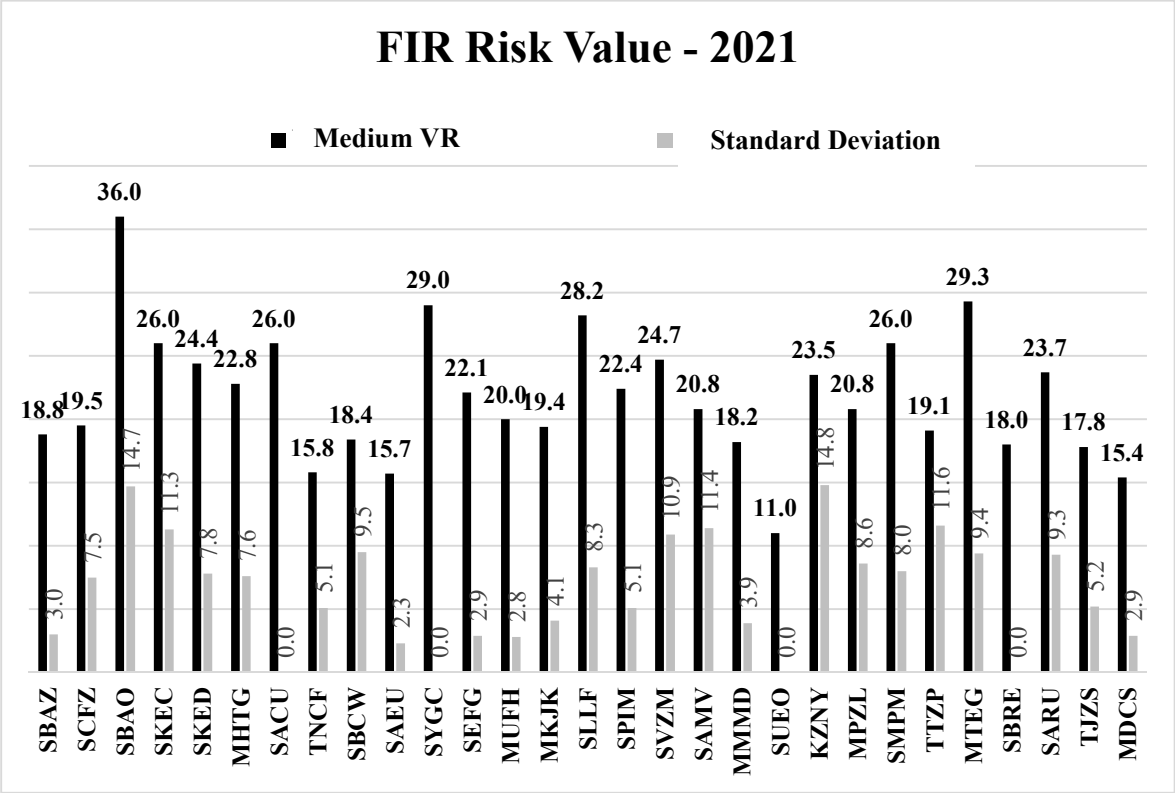
**Mean confidence for the analysis of** 95% (= 1,96).

4.9 Graph 6 shows all these values, the median value, the standard deviation and the intermediate confidence value of the risk values assigned to operational errors reported in the large altitude deviations of all the FIRs involved in the analysis of the data from 2021 LHDs.




***Graph 6. Median value, standard deviation and confidence interval of the Car and SAM Regions.***

4.10 In Figure 7 below, the median values and standard deviations of the results of this analysis are identified with the risk value contribution assigned to the operational errors of the large height deviations by FIR involved in the analysis of the 2021 LHD data.




***Graph 7. Contribution of the means and standard deviation by FIR involved in the risk.***

4.11 Figure 13 provides a visual image of the geographical location of the risk points (VR ≥ 31) of the LHD reports in the dataset of 12 consecutive months in 2021, submitted by the CAR/SAM FIRs. The image is intended to provide a means of identifying specific points of risk related to RVSM operations.

*Note: In table 7 these points will be identified.*

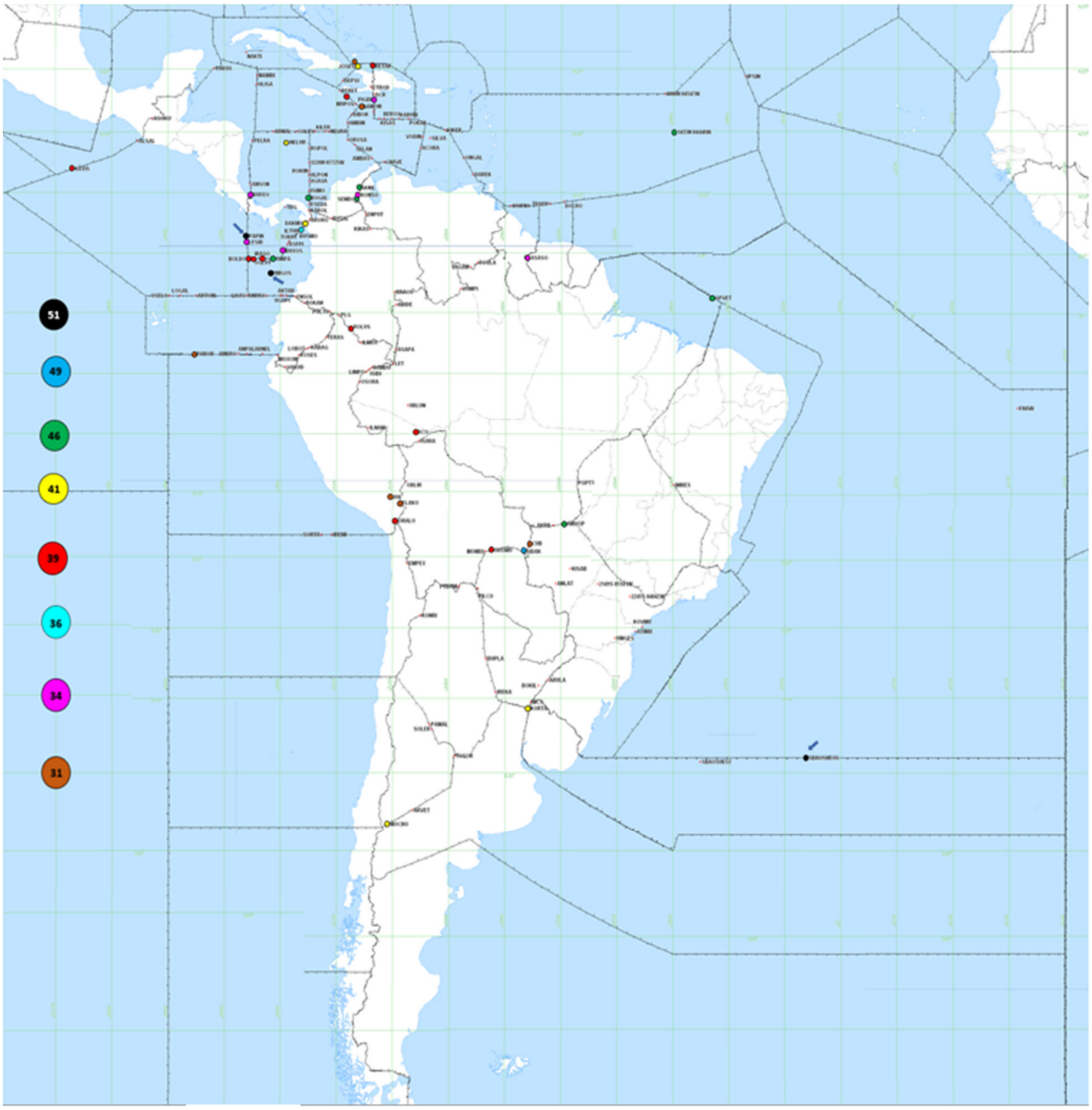



***Figure 13. CAR/SAM FIR - Points of Greater VR Risk in Large Altitude Deviations (LHD)***
*January – December 2021*

4.12 The **black** points, indicated by the arrows, are the points with the highest VR (51), generated by:

1. Lack of coordination between the CENAMER ACC and the PANAMA ACC (#303), in August. Factors that contributed to this value: The aircraft makes a diversion due to weather problems in the CENTRAL AMERICA FIR and there is no coordination by this ACC with the PANAMA ACC and the PANAMA ACC had traffic heading for another traffic that was already in the FIR BOGOTA

2. Lack of coordination between the MONTEVIDEO ACC and the ATLÁNTICO ACC (#463), in November. Factors that contributed to this value: The aircraft does not make a call to the ATLANTIC ACC, as foreseen in the operational agreement between BRAZIL (DECEA) and CAMPO DE MONTE GRADABLE (EGYP). The aircraft, on its route, crossed the entire ATLANTIC FIR without contact. There was no PLN, knowledge of it occurred when the TWR FAWH called the ATLANTIC ACC to inquire about it and minutes later reported its landing.

3. Lack of coordination between the PANAMA ACC and the BOGOTÁ ACC (#496), in November. Factors that contributed to this value: The aircraft made a flight to the SOUTH of the BOGOTÁ FIR and the BOGOTÁ ACC did not have PLN and only became aware of this transit when the PANAMA ACC asked if it had made contact. The BOGOTÁ ACC was only able to observe the aircraft 15 minutes later (900 seconds) in the space of the BOGOTÁ FIR.

4.13 In **table 8**, we can see some points with the number of reports whose VR >30. Number of times that the VR was greater than 30 points by the number of reports at this point, maximum VR and the FIRs involved.

| **POINTS** | **NUMBER OF REPORTS** | **RISK VALUE (MAX)** | **FIR INVOLVED** (Suffers X Generates) |
|---|---|---|---|
| 1455N 04448W | 1 / 1 | 46 | Piarco X Dakar |
| 3400S 03300W | 1 / 1 | 51 | Atlántico x Montevideo |
| AKNIL | 1 / 1 | 46 | Maiquetía x Barranquilla |
| ANVOP | 1 / 1 | 46 | Curitiba x Amazónica |
| ASASO | 1 / 1 | 34 | Paramaribo x Georgetown |
| BOGAL | 2 / 11 | (2) 46 | Panamá x Barranquilla |
| BOLDO | 1 / 1 | 39 | Central América x Bogotá |
| BOLDO | 3 / 3 | 34 y (2) 39 | Bogotá X Central América |
| BUFEO | 1 / 2 | 34 | Panamá x Central América |
| BUXOS | 3 / 17 | (3) 34 | Panamá x Bogotá |
| BUXOS | 0 / 2 | - | Bogotá x Panamá |
| CUB | 1 / 1 | 34 | La Paz X Curitiba |
| DAKMO | 2 / 8 | 34 y (1) 41 | Panamá x Bogotá |
| ELAKO | 1 / 1 | 31 | Lima x La Paz |
| ELJEZ | 1 / 1 | 34 | New York x Piarco |
| ILTUR | 1 / 4 | 36 | Panamá x Bogotá |
| ILTUR | 0 / 2 | - | Bogotá X Panamá |
| IRASO | 1 / 1 | 39 | Bogotá X Panamá |
| JOSES | 2 / 3 | 31 y 41 | Port Au Prince x Miami |
| JUL | 1 / 1 | 31 | Lima x La Paz |
| KATIS | 1 / 3 | 39 | Central América x Mérida |
| KONSO | 1 / 1 | 34 | Barranquilla x Maiquetía |
| KONSO | 0 / 1 | - | Maiquetía X Barranquilla |
| KORTA | 0 / 2 | 31 | Ezeiza x Resistencia |
| KORTA | 1 / 1 | 41 | Resistencia X Piloto |
| LENOM | 1 / 2 | 31 | Curacao X Port Au Prince |
| LESIR | 1 / 2 | 34 | Central América X Panamá |
| MOCHO | 1 / 1 | 41 | Mendoza X Ezeiza |
| NELUR | 1 / 1 | 41 | Panamá x Barranquilla |
| NOSIS | 1 / 1 | 39 | Port Au Prince X Kingston |
| OGLUT | 1 / 1 | 39 | Bogotá X Panamá |
| OPVET | 1 / 1 | 46 | Atlántico X Amazónica |
| ORALO | 1 / 1 | 39 | Lima x La Paz |
| OROMU | 1 / 1 | 39 | La Paz X Asunción |
| PABOB | 2 / 2 | (2) 31 | Lima x Guayaquil |
| PAPIN | 1 / 1 | 51 | Panamá x Central América |
| PIGBI | 1 / 3 | (3) 34 | Port Au Prince x St. Domingo |
| RCO | 1 / 4 | 39 | La Paz X Amazónica |

| | | | |
|---|---|---|---|
| RETAK | 1 / 1 | 39 | Port Au Prince x St. Domingo |
| ROLUS | 0 / 3 | - | Lima x Bogotá |
| ROLUS | 1 / 8 | 39 | Bogotá X Lima |
| SEMDO | 1 / 2 | 46 | Maiquetía X Barranquilla |
| SIDAK | 0 / 3 | - | Curitiba X La Paz |
| SIDAK | 1 / 2 | 49 | La Paz X Curitiba |
| TINPA | 1 / 6 | 46 | Panamá X Bogotá |
| UMGOS | 1 / 2 | 51 | Bogotá x Panamá |

***Table 8. CAR/SAM FIR - RVSM Risk Points of Large Altitude Deviations (LHD)***
*January – December 2021*

4.14 We can observe in 2021 there were three (3) reports with VR = 51, between the ATLÁNTICO FIR and the MONTEVIDEO FIR, between the PANAMA FIR and the CENTRAL AMERICA FIR and between the BOGOTÁ FIR and the PANAMA FIR.

4.15 We can observe in 2021 one report with VR = 49 between the LA PAZ FIR and the CURITIBA FIR.

4.16 We can observe in 2021, there were eight (8) reports with VR = 46, between the PIARCO FIR and the DAKAR FIR, between the MAIQUETÍA FIR and the BARRANQUILLA FIR (twice), between the CURITIBA FIR and the AMAZÓNICA FIR, between the PANAMA FIR and the BARRANQUILLA FIR (twice), between the ATLANTIC FIR and the AMAZON FIR, and between the PANAMA FIR and the BOGOTÁ FIR.

4.17 We can observe in 2021, there were five (5) reports with VR = 41, between the MENDOZA FIR and the EZEIZA FIR, between the PANAMA FIR and the BARRANQUILLA FIR, between the PANAMA FIR and the BOGOTÁ FIR, between the FIR PORT AU PRINCE and the MIAMI FIR AND between the RESISTANCE FIR and an AIRCRAFT.

4.19 We can observe in 2021, there were twelve (12) reports with VR = 39, between the LIMA FIR and the LA PAZ FIR, between the LA PAZ FIR and the AMAZÓNICA FIR, between the BOGOTÁ FIR and the CENTRAL AMERICA FIR (TWICE) , between the CENTRAL AMERICA FIR and the MÉRIDA FIR, between the BOGOTÁ FIR and the LIMA FIR, between the CENTRAL AMERICA FIR and the BOGOTÁ FIR, between the PORT AU PRINCE FIR and the SANTO DOMINGO FIR, between the BOGOTÁ FIR and the PANAMA FIR (TWICE), between the LA PAZ FIR and the ASUNCION FIR and between the PORT AU PRINCE and the KINGSTON FIR.

4.20 We can observe in 2021 one report with VR = 36, between the PANAMA FIR and the BOGOTÁ FIR.

4.21 We can observe in 2021 there were twelve (12) reports with VR = 34, between the CURACAO FIR and the SANTO DOMINGO FIR, between the PANAMA FIR and the CENTRAL AMERICA FIR, between the NEW YORK FIR and the PIARCO FIR, between the PORT FIR AU PRINCE and the SANTO DOMINGO FIR, between the PARAMARIBO FIR and the GEORGETOWN FIR, between the PANAMA FIR and the BOGOTÁ FIR (4 times), between the BOGOTÁ FIR and the CENTRAL AMERICA FIR, between the CENTRAL AMERICA FIR and the PANAMA FIR and between the BARRANQUILLA FIR and the MAIQUETIA FIR.

4.22 We can observe in 2021 there were seven (7) reports with VR = 31, between the LIMA FIR and the GUAYAQUIL FIR (twice), between the LIMA FIR and the LA PAZ FIR (twice), between the LA PAZ FIR and the CURITIBA FIR, between the PORT AU PRINCE FIR and the MIAMI FIR and between the CURACAO FIR and the PORT AU PRINCE FIR.

4.23 From the information in item 4.14 to item 4.21, we have the following scenario:

1. The FIRs that suffered the most very high risks only with these reports with VR > 30 were: ATLÁNTICO with 67.4%, BARRANQUILLA with 65.4%, PORT AU PRINCE with 62.8%, PARAMARIBO with 43.6%, MENDOZA with 39.4%, LA PAZ with 37.4%, MAIQUETIA with 31.1%, PIARCO with 29.5%, CENTRAL AMERICA with 28.9%, RESISTENCIA with 24.7%, LIMA with 23.5% , PANAMA with 21.8%, CURITIBA with 20.8%, BPGOTÁ with 20.0% and CURACAO with 12.5%, of the total risk for their FIRs.

2. Another factor that we can observe is that the FIRs that generated the most very large risks only with these VR > 30 were: DAKAR and GEORGETOWN with 100%, MIAMI with 76%, CURITIBA with 61%, MONTEVIDEO with 57%, EZEIZA with 55 %, AERONAVE with 48%, LA PAZ with 49%, ASUNCIÓN with 42%, PORT AU PRINCE with 41%, PANAMÁ with 39%, CENTRAL AMERICA and SANTO DOMINGO with 36.0%, AMAZÓNICA and MÉRIDA with 27%, PIARCO with 26%, BARRANQUILLA with 19%, MAIQUETÍA with 14%, GUAYAQUIL with 11%, LIMA and BOGOTÁ with 7%.

4.24 TCP that had already been reported in 2019 and 2020 with high VR and are reported again in 2021 as: BOLDO, DAKMO, ELAKO, PABOB and SIDAK. Adjacent FIRs that contain these TCPs must urgently take mitigating measures so that the VR comes down.

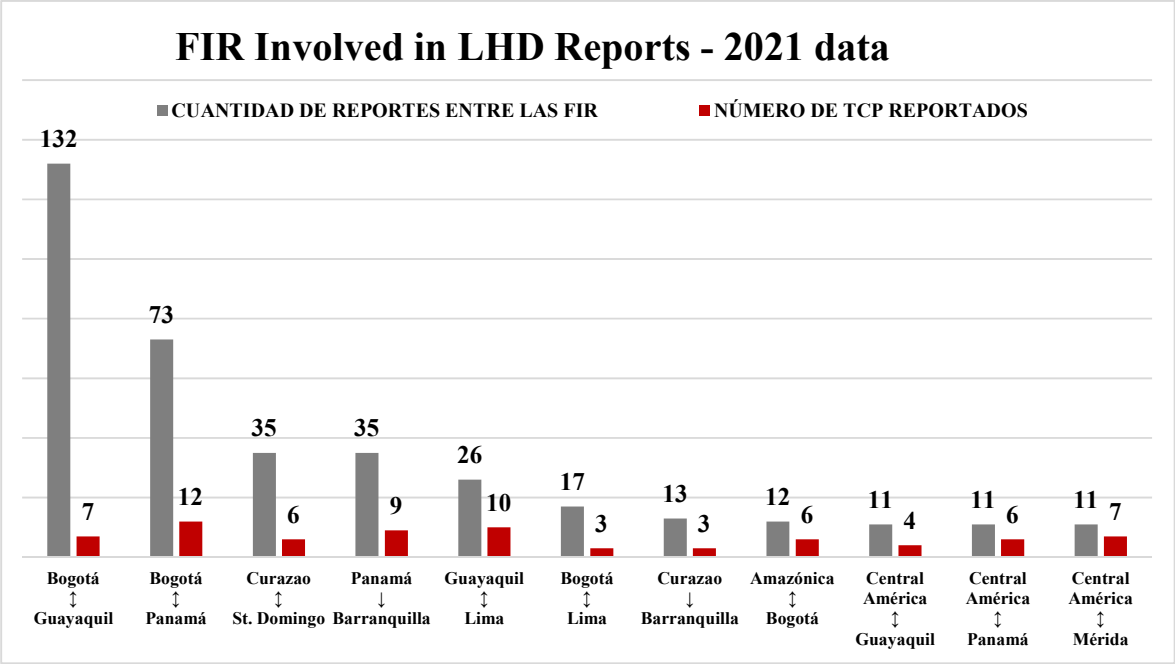
4.25 In table 9 we can see the top 30 pairs of FIRs that presented the most reports. All of them with the total number of reports between them and the total points/fixes reported.

| FIR INVOLVED | NUMBER OF REPORTS | NUMBER OF POINTS INVOLVED |
|---|---|---|
| Bogotá ↔ Guayaquil | 132 | 7 |
| Bogotá ↔ Panamá | 73 | 12 |
| Curazao ↔ St. Domingo | 35 | 6 |
| Panamá → Barranquilla | 35 | 9 |
| Guayaquil ↔ Lima | 26 | 10 |
| Bogotá ↔ Lima | 17 | 3 |
| Curazao → Barranquilla | 13 | 3 |
| Amazónica ↔ Bogotá | 12 | 6 |
| Central América ↔ Guayaquil | 11 | 4 |
| Central América ↔ Panamá | 11 | 6 |
| Central América ↔ Mérida | 11 | 7 |
| Lima → Amazónica | 8 | 6 |
| Barranquilla ← Kingston | 7 | 3 |
| Maiquetia → Bogotá | 6 | 2 |
| La Paz → Amazónica | 6 | 3 |
| Port Au Prince ↔ St. Domingo | 5 | 4 |
| Maiquetía ↔ Barranquilla | 5 | 3 |
| Amazónica ↔ Maiquetía | 4 | 3 |
| Bogotá ↔ Central América | 4 | 1 |
| Lima → La Paz | 4 | 4 |
| Córdoba ↔ La Paz | 4 | 1 |
| Paramaribo ↔ Piarco | 4 | 2 |
| Antofagasta ↔ Lima | 4 | 2 |
| La Paz ↔ Curitiba | 4 | 2 |
| La Paz ↔ Córdoba | 4 | 1 |
| Curacao → Maiquetia | 4 | 3 |

| | | |
|---|---|---|
| Maiquetía ↔ San Juan | 4 | 3 |
| Mendoza ↔ Ezeiza | 4 | 3 |
| Port Au Prince → Miami | 3 | 1 |
| Curitiba → Aeronave | 3 | 3 |
| Curitiba → Piloto | 3 | 3 |
| Port Au Prince → Kingston | 3 | 3 |
| Piarco → Piloto | 3 | 3 |
| Resistencia → Córdoba | 3 | 3 |
| Ezeiza → Resistencia | 2 | 1 |
| Antofagasta → Córdoba | 2 | 1 |
| La Paz → Asunción | 2 | 2 |
| Atlántico → Montevideo | 2 | 2 |
| Panamá → Kingston | 2 | 2 |
| Kingston ↔ Central América | 2 | 2 |
| Curitiba → Amazónica | 2 | 2 |
| Curacao → Kingston | 2 | 2 |
| Curacao → Port Au Prince | 2 | 1 |
| Mendoza → Córdoba | 2 | 2 |
| Montevideo ↔ Resistencia | 2 | 1 |
| Piarco → Maiquetia | 2 | 2 |
| San Juan → Piarco | 2 | 2 |
| Habana → Port Au Prince | 1 | 1 |
| Amazónica → Brasilia | 1 | 1 |
| Bogotá → Barranquilla | 1 | 1 |
| Georgetown → Piarco | 1 | 1 |
| Panamá → Piloto | 1 | 1 |
| Paramaribo → Georgetown | 1 | 1 |
| Curitiba → Brasilia | 1 | 1 |
| Habana → Piloto | 1 | 1 |
| La Paz → Antofagasta | 1 | 1 |
| Bogotá → Piloto | 1 | 1 |
| Resistencia → Curitiba | 1 | 1 |
| Resistencia → Asunción | 1 | 1 |
| Resistencia → Aeronave | 1 | 1 |
| Piarco → Dakar | 1 | 1 |
| New York → Piarco | 1 | 1 |
| Atlántico → Amazónica | 1 | 1 |
| Atlántico → Piloto | 1 | 1 |
| Amazónica → Piloto | 1 | 1 |

***Table 9 - CAR/SAM FIR-Number of reports between them and Total Points reported***

4.26 In graph 8 below, we can see the top 11 FIR pairs that reported the most and the number of points where failures occurred.




***Graph 8. CAR/SAM FIR-Number of reports between them and Number of points reported***

4.27 In table 10 we can see the first 30 pairs of FIRs that presented the most reports now with the respective points/fixes reported.

| FIR INVOLVED | POINTS /FIXES REPORTED |
|---|---|
| Bogotá ↔ Guayaquil | UGUPI – BOKAN – PULTU – ENSOL – ANRAX – VAMOS – AKTAB – GAVUT |
| Bogotá ↔ Panamá | ARORO – ASEPI - BUSMO – BUXOS – DAKMO – ILTUR – IRASO – KAKOL – OGLUT - TINPA – TOKUT - UMGOS |
| Curazao ↔ St. Domingo | BEROX – KISAS - KARUM - PALAS – POKAK - VESKA |
| Panamá → Barranquilla | 1228N 07725W – AGUJA – ALPON – BOGAL – ESEDA – ISIMO – NELUR – ROKIN - ROPOL |
| Guayaquil ↔ Lima | VAKUD – ARNEL – TERAS – PABOB – TOSES – ANPAL – LOBOT – AMERO – KABAG - MOXOM |
| Bogotá ↔ Lima | ILMUX – PLG - ROLUS |
| Curazao → Barranquilla | AMBAS – OROSA - SELAN |
| Amazónica ↔ Bogotá | ABIDE – ARUXA – ASAPA – BRACO – LET - VUMPI |
| Central América ↔ Guayaquil | ARTOM – LOGAL - LIXAS - OSELO |
| Central América ↔ Panamá | ANSON – BUFEO – ISEBA - LESIR – PAPIN - PELRA |
| Central América ↔ Mérida | ALSAL – ASOKU – KATIS – TAKUX – TUGET – UKOMO - VIDNO |
| Lima → Amazónica | DAMDU – ILNAM - ISIDI – LET – LIMPO - OROSA |
| Barranquilla ← Kingston | KIKER – OTAMO - NEVPA |
| Maiquetia → Bogotá | ENPUT - KIKAS |
| La Paz → Amazónica | AKVOR – ISARA - RCO |
| Port Au Prince ↔ St. Domingo | DCR – ETBOD – PIGBI - RETAK |
| Maiquetía ↔ Barranquilla | AKNIL – KONSO - SEMDO |
| Amazónica ↔ Maiquetía | POVLA – VAGAN – VUMPI |
| Bogotá ↔ Central América | BOLDO |
| Lima → La Paz | ELAKO – JUL - OBLIR – ORALO |
| Córdoba ↔ La Paz | PUBUM |
| Paramaribo ↔ Piarco | DORLO - TRAPP |
| Antofagasta ↔ Lima | IREMI - SORTA |

| | |
|---|---|
| La Paz ↔ Curitiba | CUB - SIDAK |
| La Paz ↔ Córdoba | PUBUM |
| Curacao → Maiquetia | ACORA – CHAVE - VODIN |
| Maiquetía ↔ San Juan | KIKER – MILOK – SILVA |
| Mendoza ↔ Ezeiza | ARVET – MOCHO - TOSOR |
| Port Au Prince → Miami | JOSES |
| Curitiba → Aeronave | ANLAT – KISAS - UMGES |
| Curitiba → Piloto | 2149S 05141W – ATIMA – KOVMU |
| Port Au Prince → Kingston | MUPOV - NOSIS – KEBET |
| Piarco → Piloto | 1800N 04547W – DAREK – IPSIN |
| Resistencia → Córdoba | BOKIL – BUPLA - IREKA |
| Ezeiza → Resistencia | KORTA |
| Antofagasta → Córdoba | KONRI |
| La Paz → Asunción | MOMDI - OROMU |
| Atlántico → Montevideo | 3417S 04232W – 3400S 03300W |
| Panamá → Kingston | ARNAL - COLBY |
| Kingston ↔ Central América | MAMBI - ULISA |
| Curitiba → Amazónica | AKRIL - AMVOP |
| Curacao → Kingston | AMBIN - DIBOK |
| Curacao → Port Au Prince | LENOM |
| Mendoza → Córdoba | PAMAL - SOLER |
| Montevideo ↔ Resistencia | MCS |
| Piarco → Maiquetia | DAREK - ONGAL |
| San Juan → Piarco | OPAUL - LAMKN |
| Habana → Port Au Prince | DEPSI |
| Amazónica → Brasilia | POPTI |
| Bogotá → Barranquilla | BUTAL |
| Georgetown → Piarco | KORTO |
| Panamá → Piloto | TBG |
| Paramaribo → Georgetown | ASASO |
| Curitiba → Brasilia | 2245S 04847W |
| Habana → Piloto | NAKTI |
| La Paz → Antofagasta | EMPEX |
| Bogotá → Piloto | UMGOS |
| Resistencia → Curitiba | ARULA |
| Resistencia → Asunción | PILCO |
| Resistencia → Aeronave | KORTA |
| Piarco → Dakar | 1445N 04448W |
| New York → Piarco | ELJEZ |
| Atlántico → Amazónica | OPVET |
| Atlántico → Piloto | 3400S 03300W |
| Amazónica → Piloto | OBLUN |

***Table 10 - CAR/SAM FIR-Names of the Points reported between the FIRs***

4.28 All fixes and/or coordinates reported in item 4.26, above, are in Figures 14 and 15, below.

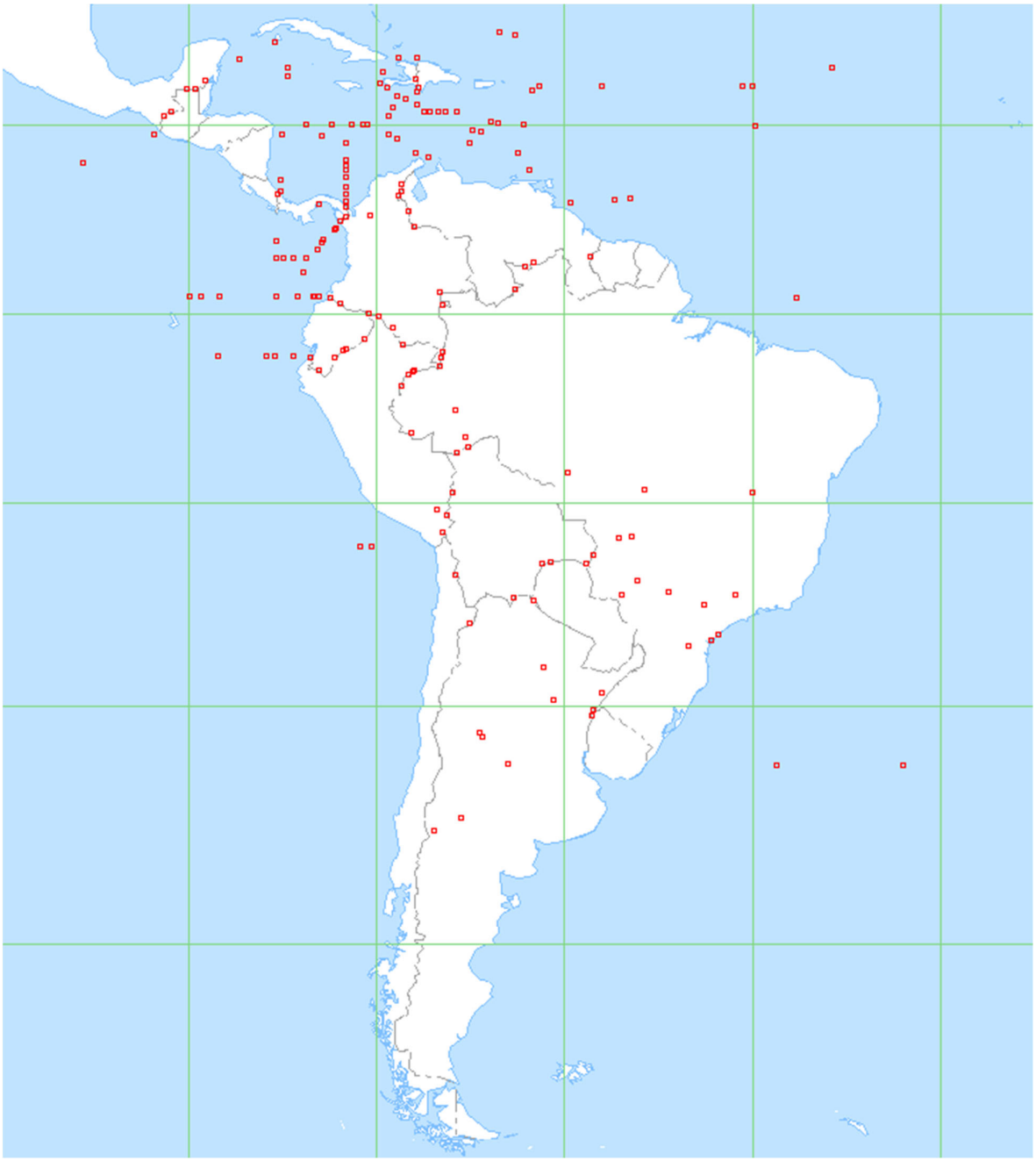


***Figure 14. CAR/SAM FIR - Points of Risk reported in Large Altitude Deviations (LHD) without FIRs***
*January – December 2021*

***Figure 15. CAR/SAM FIR - Points of Risk reported in the Large Altitude Deviations (LHD) with the FIRs***
*January – December 2021*

## 5. Suggested actions

5.1 The Meeting is invited to:

a) Take note of the information in this Working Paper and suggest States to use the information presented as a reference for the mitigation of their LHDs; and

b) Present to the members of the GTE for approval and submission to GREPECAS.

—END—