GTE/18 — IP/02
14/09/18

CAR/SAM Planning and Implementation Regional Group (GREPECAS) Eighteenth Scrutiny Working Group Meeting (GTE/18)

Mexico City, Mexico, 22 – 26 October 2018

Agenda Item 5: Other Business

VERTICAL SAFETY MONITORING REPORT FOR MEXICO AIRSPACE

(Presented by North American Approvals and Registry Monitoring Organization (NAARMO))

EXECUTIVE SUMMARY

The NAARMO, an ICAO endorsed Regional Monitoring Agency (RMA) administered by the U.S. Federal Aviation Administration at the William J. Hughes Technical Center (WJHTC), serves as a RMA for United States, Canadian and Mexican airspace. This information paper contains the 2017 vertical safety monitoring report for Mexico airspace.

There were a total of 38 reported large height deviations during calendar year 2017. This report contains a summary of the reported deviations and an estimate of the vertical collision risk. The vertical collision risk estimate for Mexico airspace meets the target level of safety value of 5 x 10^{-9} fatal accidents per flight hour.

Strategic Objectives:	• Safety • Air Navigation Capacity and Efficiency
References:	• ICAO Doc 9574 - *Manual on a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive*, 3rd Edition, 2012 • ICAO 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 FL290 and FL 410 Inclusive*, 1st Edition, 2010

1. Introduction

1.1 The purpose of this information paper is to provide the GTE/18 meeting with an update on the progress of Conclusion GTE/16-5 (see below).

Conclusion	Title	Text	Responsible
GTE/16-5	AGREEMENT BETWEEN MEXICO AND THE NORTH AMERICAN APPROVALS REGISTRY AND MONITORING ORGANIZATION (NAARMO) FOR DATA EXCHANGE REGARDING SAFETY ASSESSMENT IN THE RVSM AIRSPACE	That, Mexico and the NAARMO exchange data information regarding aircraft movement, Large Height Deviations (LHD) reports in the RVSM airspace, as well as register of aircraft with RVSM approval, according to the information of Appendix F to GTE/16 report, and present this activities progress to the next GTE/17 meeting.	Mexico and NAARMO

2. Discussion

2.1. **Appendix** to this information paper contains the 2017 vertical safety monitoring report for Mexico airspace.

2.2. There was an increase in the number of reports involving communication failure. During calendar year 2016, there were 15 such reports. In calendar year 2017, there were 27 reported communication failures. In all of these cases, the proper procedures for radio failure (NORDO) were followed; therefore there is no contribution towards the estimate of collision risk. However, because of the numerous reported cases of NORDO, the scrutiny team agreed there should be further study on these reports. The scrutiny team consists of DGAC Mexico, SENEAM and NAARMO.

2.3. The review of the reported LHDs for 2017 took place several months after the end of the calendar year. This time lapse did not permit the scrutiny team to obtain responses from the aircraft operators. In the future, in order to solicit an operator response for a NORDO event, the scrutiny team will reach out to the operators as soon as practical after receiving the reports.

2.4. There were fewer reports of ATC coordination errors during calendar year 2017 compared to calendar year 2016. In 2017 there were six reported ATC coordination errors, and in 2016 there were 15 reports.

2.5. There was an increase in the observed annual flying hours from 0.8 million to 0.95 million per year. These estimates are determined from the December traffic sample obtained through the Traffic Flow Management System (TFMS), and are evaluated every year. The estimate of vertical collision risk is very sensitive to the estimated flying hours because the duration associated with reported events is averaged over the estimated annual flying hours. Therefore, a larger value of annual flying hours reduces the collision risk estimate.

2.6 The 2017 vertical risk estimate is 3.217×10^{-9} fatal accidents per flight hour (fapfh) or about 30 percent below the overall safety goal of 5.0×10^{-9} fapfh.

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APPENDIX

MEXICO AIRSPACE VERTICAL SAFETY MONITORING REPORT ~ 2017

September 2018

Vertical Safety Monitoring Report for Mexico Airspace

(Prepared by North American Approvals Registry and Monitoring Organization (NAARMO))

Summary

This paper provides the vertical safety monitoring report for the continued-safe use of the Reduced Vertical Separation Minimum (RVSM) in Mexico Airspace. The safety assessment has been conducted according to the methodology endorsed by the International Civil Aviation Organization (ICAO). This work makes use of large height deviation (LHD) reports and traffic sample data (TSD) provided by Mexico to the NAARMO for calendar year 2017.

The purpose of this report is to compare actual performance to safety goals related to continued use of the RVSM in Mexico airspace. This report contains a summary of large height deviation reports received by the NAARMO for the calendar year 2017. There are a total of 38 reported large height deviations that occurred during this period in Mexico airspace. This report also contains an estimate of the vertical collision risk. The vertical collision risk estimate for Mexico airspace meets the target level of safety (TLS) value of 5.0 x 10^{-9} fatal accidents per flight hour.

1. Introduction

1.1. The Dirección General de Aeronáutica Civil (DGAC Mexico) implemented the Reduced Vertical Separation Minimum (RVSM) between flight level 290 and flight level 410, inclusive, in all sovereign and delegated Mexican airspace on January 20, 2005. By mutual agreement, along with Mexico, Canada, and the United States, the North American Aviation Trilateral States, implemented the RVSM simultaneously on the same date in all North American airspace.

1.2. The North American Approvals Registry and Monitoring Organization (NAARMO), a service provided by the FAA Technical Center, fulfills the role of regional monitoring agency (RMA) for the continued-safe use of the RVSM in North American airspace.

1.3. This report covers the calendar year 2017. Within this report, the reader will find a summary of the large height deviation (LHD) reports received by the NAARMO and the corresponding vertical collision risk estimate. There were a total of 38 such reports submitted to the NAARMO for calendar year 2017.

2. Traffic Sample Data

2.1. The NAARMO received a December 2017 traffic sample data (TSD) for Mexico airspace. These data included flight observations from four area control centers (ACCs) – Mexico (MMEX), Monterrey (MMTY), Mazatlan (MMZT), and Merida (MMID). The information provided for each flight operation includes the date, aircraft call sign, aircraft registration mark, aircraft type, origin airport, destination airport, and aircraft position information.

2.2. In addition to the TSD received from the four ACCs, the NAARMO has access to the Federal Aviation Administration's (FAA's) Traffic Flow Management System (TFMS), which includes aircraft observations in Mexico airspace. Each traffic movement record within the TFMS data sample contains the date, time, latitude, longitude, flight level, aircraft flight identification, aircraft type, origin airport and the destination airport. The TFMS data contain frequent position estimates for each flight – a position estimate is provided approximately once a minute. **Figure 2-1** presents the aircraft positions provided in the TFMS data for 10 December 2017.

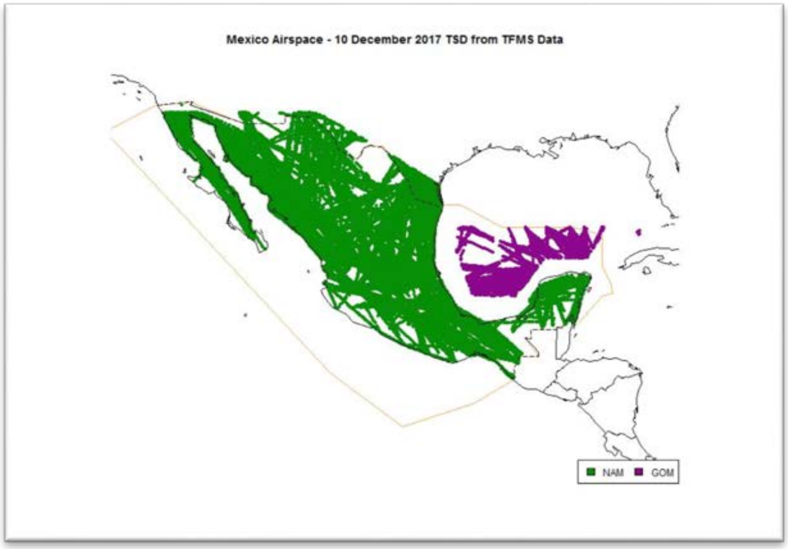

Figure 2-1. Aircraft Position Data Provided in TFMS – 10 December 2017

2.3. **Figure 2-2** shows the number of flights by day in the TFMS data for December 2017. The horizontal blue line represents the average number of flight operations per day observed in the data sample. The average number of flight operations per day observed in the TFMS data is 2,732 flights per day. This value is slightly higher than observed in previous data; in 2016 there were 2,508 flights per day and in 2015 there were 2,378 flights per day.

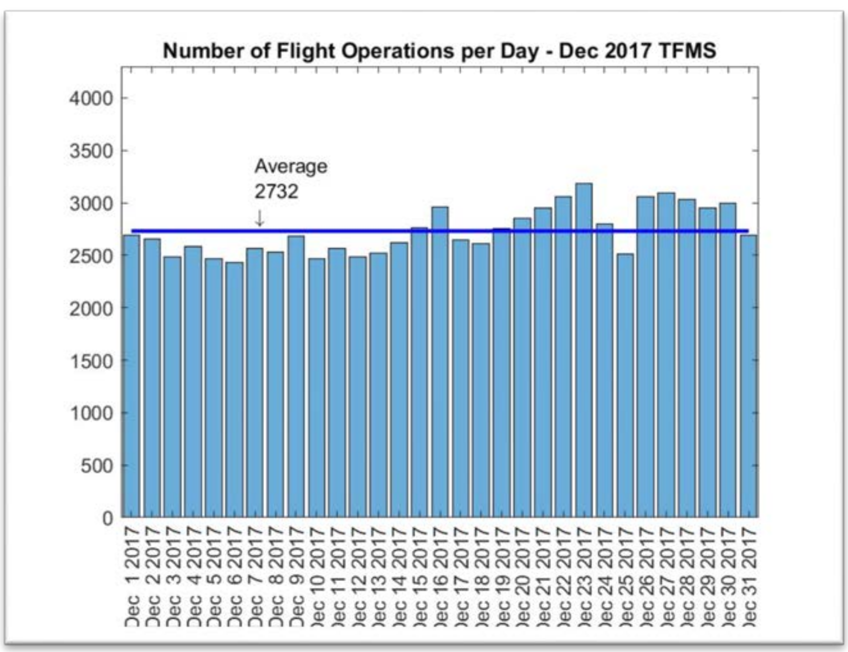

Figure 2-2. Number of Flight Operations Observed by Day - TFMS December 2017

3. RVSM Airspace Audit

3.1. The December 2017 TSD received from Mexico for the MMEX, MMTY, MMZT, and MMID ACCs are used to identify the operations operating within RVSM airspace. These data total approximately 143,000 operations in the month of December 2017.

3.2. The December 2017 TSD for Mexico airspace was compared with the collective approvals database as of 30 August 2018 to determine the approval status of each observed operation. The operations for which no approval or an expired approval is found are identified for further verification. **Table 3-1** provides a summary of the results of the Mexico RVSM Airspace Audit following the initial verification process. The results are listed alphabetically by the State of the Operator/Registry. This list contains 58 civilian non-approved operations from six different States observed within RVSM airspace in Mexico.

Table 3-1. Mexico RVSM Airspace Audit – 2017

STATE OF OPERATOR/REGISTRY	AIRCRAFT REGISTRATION	RMA
BRAZIL	PPSGM	CARSAMMA
BRAZIL	PTMVF	CARSAMMA
BRAZIL	PTMVG	CARSAMMA
BRAZIL	PTMVL	CARSAMMA
GUATEMALA	TGDAE	CARSAMMA
GUATEMALA	TGTAJ	CARSAMMA
LITHUANIA	LYCOM	EUR RMA
LITHUANIA	LYVEQ	EUR RMA
LITHUANIA	LYVET	EUR RMA
LITHUANIA	LYVEV	EUR RMA
MEXICO	XAAJE	NAARMO
MEXICO	XAALV	NAARMO
MEXICO	XAASS	NAARMO
MEXICO	XAAVO	NAARMO
MEXICO	XABDK	NAARMO
MEXICO	XABFK	NAARMO
MEXICO	XACIN	NAARMO
MEXICO	XADHM	NAARMO
MEXICO	XAEGU	NAARMO
MEXICO	XAGDQ	NAARMO
MEXICO	XAGPS	NAARMO
MEXICO	XAHEL	NAARMO
MEXICO	XAJAO	NAARMO

STATE OF OPERATOR/REGISTRY	AIRCRAFT REGISTRATION	RMA
MEXICO	XALAU	NAARMO
MEXICO	XAMJS	NAARMO
MEXICO	XAMMN	NAARMO
MEXICO	XAOFM	NAARMO
MEXICO	XARED	NAARMO
MEXICO	XARSA	NAARMO
MEXICO	XASEX	NAARMO
MEXICO	XATFR	NAARMO
MEXICO	XATVA	NAARMO
MEXICO	XAUFF	NAARMO
MEXICO	XAUTY	NAARMO
MEXICO	XAUVC	NAARMO
MEXICO	XAUZD	NAARMO
MEXICO	XAUZF	NAARMO
MEXICO	XAXTR	NAARMO
MEXICO	XAXXX	NAARMO
MEXICO	XBCAR	NAARMO
MEXICO	XBELJ	NAARMO
MEXICO	XBMBP	NAARMO
MEXICO	XBMTG	NAARMO
MEXICO	XBNVE	NAARMO
MEXICO	XBOJA	NAARMO
MEXICO	XBOSP	NAARMO
MEXICO	XBOXP	NAARMO
MEXICO	XBSGT	NAARMO
MEXICO	XBVFJ	NAARMO
PANAMA	HP1377	CARSAMMA
PANAMA	HP1524	CARSAMMA
PANAMA	HP1525	CARSAMMA
UNITED STATES	N379LG	NAARMO
UNITED STATES	N38VC	NAARMO
UNITED STATES	N538CC	NAARMO
UNITED STATES	N826EP	NAARMO
UNITED STATES	N875HB	NAARMO
UNITED STATES	N961AA	NAARMO

4. Reported Large Height Deviations (LHDs)

4.1. The NAARMO receives monthly LHD reports for Mexico airspace. There were 38 reported LHDs during calendar year 2017. After scrutiny group review, seven of the 38 reported LHDs were determined to be risk-bearing. **Table 4-1** contains a summary of all the qualifying reported LHDs by month.

Table 4-1. Qualifying Reported LHDs for Mexico Airspace - 2017

Month	Count	Duration at Uncleared FL	Number of Uncleared FLs Crossed
Jan-17	0	0.0	0
Feb-17	0	0.0	0
Mar-17	0	0.0	0
Apr-17	1	2.5	0
May-17	0	0.0	0
Jun-17	1	0.0	4
Jul-17	1	10.0	0
Aug-17	2	2.0	0
Sep-17	1	1.0	0
Oct-17	1	1.0	0
Nov-17	0	0.0	0
Dec-17	0	0.0	0
TOTAL	**7**	**16.5**	**4**

4.2. There were 27 reported LHDs determined to be non-qualifying involved aircraft's failure to communicate with ATC for a period of time. In all these cases, the proper procedures for radio failure (NORDO) were followed, therefore there is no contribution towards the estimate of collision risk. During the previous calendar year 2016, there were 15 reported LHDs involving an aircraft's failure to communicate with ATC or NORDO. Due to the numerous reported cases of NORDO, DGAC Mexico, SENEAM and NAARMO agreed there should be some further study on these data.

4.3. In calendar year 2017, the 27 reported NORDO events accounted for 805 minutes of time in which ATC could not communicate with an aircraft. There were 7 reports of NORDO near the fix ELURA, accounting for 202 minutes of ATC unable to communicate with an aircraft. There were 3 NORDO reports located near AXOMU, which is close to the ELURA fix, AXOMU, accounting for 143 minutes. **Figure 4-1** provides the general location for all the reported NORDO events. The fix ELURA and AXOMU are marked in blue and orange, the remaining NORDO locations are marked in green.

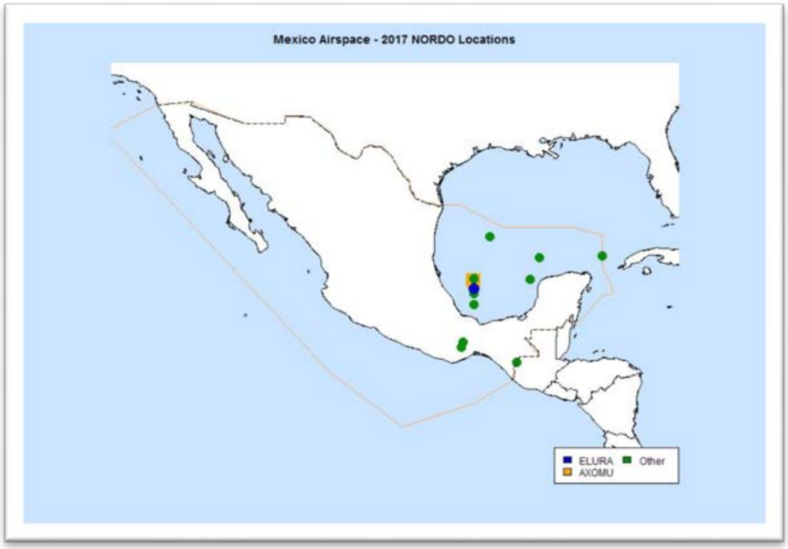

Figure 4-1. Reported NORDO Locations - 2017

4.4. The aircraft operators involved in the NORDO reports are contained in **Table 4-2**. Volaris had six NORDO reports accounting for 117 minutes. Aeromexico were involved in 4 NORDO reports accounting for 175 minutes. **Table 4-2** contains the operator details for the 2017 NORDO reports.

Table 4-2. Operators involved in the NORDO reports - 2017

ICAO Code	Operator Name	State of Operator	Number of NORDO Reports	Total NORDO Duration
VOI	Volaris	Mexico	6	117
AIJ	ABC Aerolineas	Mexico	5	140
AMX	Aeromexico - Aerovias de Mexico	Mexico	4	175
IGA	IGA individual operators	Mexico/United States	3	130
SLI	AeroMexico Connect	Mexico	3	90
AAL	American Airlines	United States	2	27
CMP	Compania Panamena de Aviacion	Panama	1	27
JBU	JETBlue Airways	United States	1	50
UAL	United Air Lines	United States	1	26
VIV	Aeroenlaces Nacionales	Mexico	1	23
		TOTALS	**27**	**805**

4.5. The scrutiny review of the reported LHDs for 2017 took place several months after the end of the calendar year. This time lapse did not permit the scrutiny team to obtain responses from the aircraft operators. In the future, in order to solicit an operator response for a NORDO event, the scrutiny team will reach out to the operators as soon as practical after receiving the reports.

4.6. The scrutiny review determined the cause for each of the seven qualifying LHD reports in 2017. Six of the qualifying LHD reports involve coordination errors in the ATC transfer, and one of the reports involve an ATC loop error. **Table 4-3** summarizes the qualifying LHD reports by cause.

Table 4-3. Qualifying LHD Reports by Cause – 2017

LHD Category Code	LHD Category Description	Number of LHD	Duration at Uncleared FL	Number of Uncleared FLs Crossed
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	1	0	4
E	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues	6	16.5	0
Totals		**7**	**16.5**	**4**

4.7. **Figure 4-2** shows the aircraft locations for the seven qualifying reported LHD in 2017. Four of the qualifying events classified as category E, coordination errors in the ATC-unit-to-ATC-unit transfer of control, occurred for control of aircraft transferring from Houston Center to Merida Center. In three of these four cases, the coordination was not updated with new flight level information. In one of these cases, Houston ATC did not climb an aircraft to the expected flight level prior to boundary crossing.

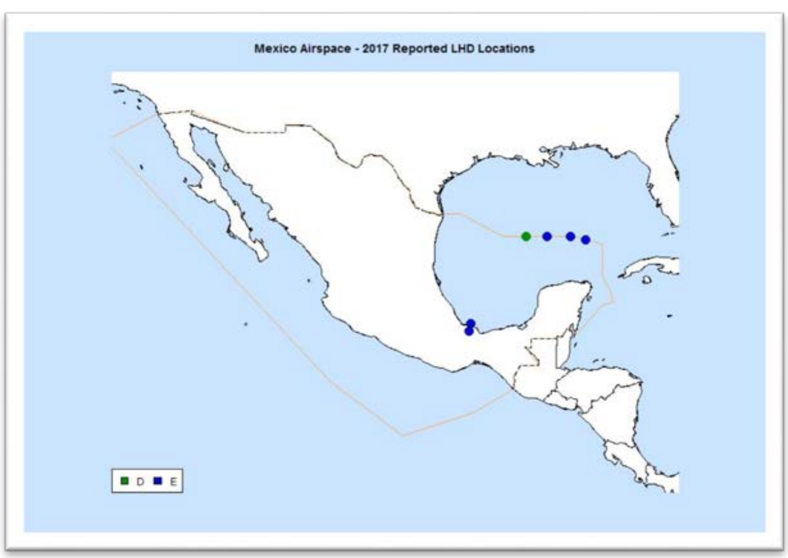

Figure 4-2. Qualifying LHD Reports - 2017

4.8. The NAARMO organized scrutiny group teleconferences between Mexico ATC and Houston ATC to review the events reported during 2017. However, the scrutiny review took place several months after the end of the calendar year. This time lapse did not permit the scrutiny team to obtain responses from the aircraft operators and limited any additional information from ANSPs. In the future, in order to solicit as much information as possible, the NAARMO will arrange for scrutiny meetings earlier in the calendar year.

5. Vertical Collision Risk Estimation

5.1. This section of the paper provides the parameter estimates used in the ICAO vertical risk model. The collision risk methodology consists of a mathematical model to estimate risk for comparison to the safety criterion, the target level of safety (TLS). The section also provides information on the sources of data used to estimate risk model parameters.

5.2. The internationally agreed TLS for the 1 000-ft vertical separation standard is specified for technical and operational risk separately. The vertical technical risk provides the risk associated the effects of turbulence, loss of altitude hold and crew response to airborne collision-avoidance system alerts in addition to errors arising from aircraft altimetry and altitude height-keeping system performance. The vertical operational risk estimate provides the risk associated with operational errors. The risk due to all causes is the sum of the vertical operational and technical risk estimates. The TLS for the 1 000-ft vertical separation standard is specified as:

a) collision risk due to all causes does not exceed 5 fatal accidents in 10^9 flying hours, and, simultaneously,
b) collision risk due to aircraft height-keeping systems does not exceed 2.5 fatal accidents in 10^9 flying hours

5.3. Based on the December 2017 TFMS data, the NAARMO estimates approximately 945,396 annual flying hours for 2017 in Mexico airspace where the RVSM is applied. Since a collision due to the loss of 1,000-ft vertical separation is assumed to result in two fatal accidents, the TLS can be expressed as 2.5 fatal midair collisions due to all causes in 10^9 flying hours. Thus, an interpretation of the TLS value associated with RVSM in Mexico Airspace where the RVSM is applied will be safe if the expected number of collisions does not exceed an average of 1 every 423 years need to update, where the number of flying hours in a year is roughly 0.9 million.

5.4. Mexico airspace consists of a combination of parallel and crossing routes; therefore the total risk is expressed as the sum of three basic types of collision risk as follows:

$$N_{az}=N_{az}(same)+N_{az}(opp)+N_{az}(cross) \quad (1)$$

The terms on the right hand side of the equation represent the expected number of accidents per aircraft flight hour resulting from collisions of aircraft-pairs on the same, opposite and crossing routes, respectively due to the loss of vertical separation between aircraft at adjacent flight levels.

5.5. The models for the three different types of collision risk - opposite-direction, same-direction, and crossing-routes - have basically the same structure. The estimate of vertical operational risk for same and opposite direction traffic is composed of two parts: that due to time spent at incorrect levels and that due to levels transitioned without clearance.

5.6. Aircraft Types Observed in Mexico Airspace

5.6.1 **Figure 5-1** provides the top 25 aircraft types observed in the December 2017 TFMS Mexico traffic data by flying hours. These aircraft types account for more than 90 percent of total flying hours observed in Mexico airspace. The flying hours associated with the Airbus A320 aircraft type represent 28 percent of all the flying hours observed in the traffic sample. The percentage of flying hours observed for the Airbus A320 family; including the A319, A320, and A321, account for 39 percent of all the flying hours observed in the traffic data. The Boeing 737-800 is the second most observed aircraft in Mexico airspace. The percentage of flying hours observed for the Boeing 737 NGX family; including B737, B738, and B739, is 27 percent of all the flying hours observed in the traffic data.

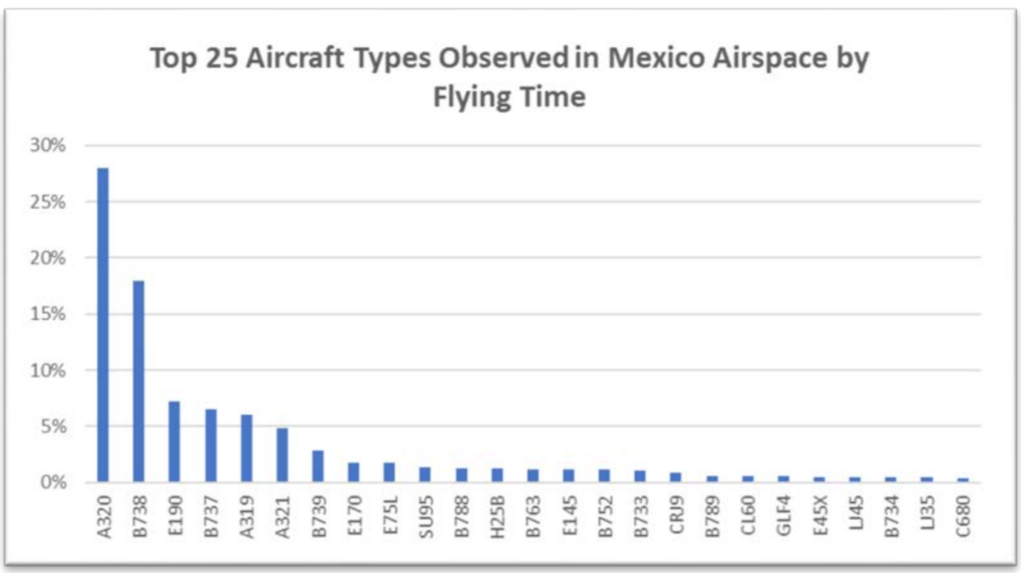

Figure 5-1. Observed Aircraft Types in Terms of Flying Hours in Mexico Airspace

5.7. Aircraft Size

5.7.1 The collision risk model parameters related to the aircraft size are: length, wingspan, and height. These parameters are estimated directly from the Mexico December 2017 TFMS data and related aircraft specifications. The weighted dimensions are calculated using the actual dimensions of the aircraft type multiplied by the proportion of total flying time observed for the type in the traffic sample. The resulting CRM parameters for the aircraft length, wingspan, and height are presented in **Table 5-1**.

Table 5-1. CRM Parameter Estimates for Aircraft Size

Length λ_x (NM)	Wingspan λ_y (NM)	Height λ_z (NM)
0.0201	0.0184	0.0063

5.8. Same-Direction, Opposite-Direction, and Crossing-Route Vertical Passing Frequencies

5.8.1 The TFMS data is used to estimate the number of vertical aircraft passings per hour. The same and opposite direction vertical occupancy estimates are 0.049 and 0.057, respectively.

5.8.2 Crossing route vertical occupancy is estimated by the number of vertically proximate aircraft pairs on routes that cross at a specific angle, θ. Both mathematical considerations and experience in previous safety assessments have established that the vertical occupancy estimated for pairs of aircraft at intersections of routes is generally less by an order of magnitude than that for pairs of aircraft on the same route at adjacent flight levels. Thus it is expected that the collision risk estimate for crossing routes will be below the risk for same route adjacent flight levels. The number of crossing-route aircraft pairs observed in the December 2017 TFMS data was 14,379. This value, prorated from the 31-sample days for the calendar year 2017 is 169,301 aircraft pairs.

5.9. Probability of Vertical Overlap Attributable to Technical Height-Keeping Performance and Reported LHDs

5.9.1 RVSM technical risk is considered to arise from the effects of turbulence, loss of altitude hold and crew response to airborne collision avoidance system alerts as well as from errors in aircraft altimetry and altitude-keeping system performance. Hence, estimation of the probability of vertical overlap must account for contributions to vertical error arising from all of these sources.

5.9.2 Currently, the U.S. Aircraft Geometric Height Monitoring Element (AGHME) and the GPS Monitoring Unit (GMU) systems provide the NAARMO with estimates of aircraft altimetry system error (ASE), an important contributor to estimated risk. Control of ASE is one of the principal objectives of the State RVSM approval process, which must be held by operators in airspace where the RVSM is applied.

5.9.3 The NAARMO estimate for the probability of vertical overlap for aircraft pairs operating on adjacent flight levels, $P_z(1\ 000)$, used in the estimate of vertical technical risk is 1.64 x 10^{-9}. The NAARMO estimate for the probability of vertical overlap for aircraft pairs operating on the same flight level, $P_z(0)$,used in the estimation of vertical operational risk is 0.48.

5.10. Time spent at Uncleared FL

5.10.1 The proportion of flying time spent at incorrect levels, P_i, is determined as the ratio of the amount of time spent at incorrect levels to the total amount of flying time in the Mexico airspace during the period when the wrong-flight-level events occurred. The qualifying LHDs for calendar year 2017 contain 16.5 minutes of flying time spend at uncleared flight level. The proportion of total flight time spent at uncleared flight levels is 2.91 x 10^{-7}.

5.11. Collision Risk Model Parameters

5.11.1 The individual parameters of the models, their definitions, estimates, and sources are given in **Table 5-2**.

Table 5-2. Vertical Collision Risk Model Parameter Estimates

Term	Definition	Estimate	Source
$P_z(S_z)$	Probability that two aircraft nominally separated by the vertical separation minimum S_z are in vertical overlap.	1.93 x 10^{-9}	Value used in the US CONUS vertical risk estimate
$P_y(0)$	Probability that two aircraft on the same track are in lateral overlap.	0.1	Value used in the vertical risk estimates for Pacific airspace
λ_x	Average aircraft length.	0.0201 NM	Estimated using December 2017 Mexico TFMS sample
λ_y	Average aircraft wingspan.	0.0184 NM	Estimated using December 2017 Mexico TFMS sample
λ_z	Average aircraft height with undercarriage retracted.	0.0063 NM	Estimated using December 2017 Mexico TFMS sample
$E_z(same)$	Same-direction vertical occupancy for a pair of aircraft at adjacent flight levels on same route.	0.049	Estimated using December 2017 Mexico TFMS sample
$E_z(opp)$	Opposite-direction vertical occupancy for a pair of aircraft at adjacent flight levels on same route.	0.057	Estimated using December 2017 Mexico TFMS sample
$\overline{\lvert\Delta V\rvert}$	Average absolute relative along-track speed between aircraft on same-direction routes.	13 knots	Value used in the North Atlantic, Pacific, and US Domestic airspace vertical risk estimates
$\overline{\lvert V\rvert}$	Average absolute aircraft ground speed.	480 knots	Value used in the North Atlantic, Pacific, and US Domestic airspace vertical risk estimates
$\overline{\lvert\dot{y}\rvert}$	Average absolute relative cross-track speed for an aircraft pair nominally on the	5 knots	Value used in the North Atlantic, Pacific, and US Domestic airspace vertical

Term	Definition	Estimate	Source
	same route.		risk estimates
$\lvert\dot{z}\rvert$	Average absolute relative vertical speed of an aircraft pair that have lost all vertical separation	1.5 knots	Value used in the North Atlantic, Pacific, and US Domestic airspace vertical risk estimates

6. Results and Conclusions

6.1. **Table 6-1** provides 2017 estimates of technical and operational vertical risk for Mexico airspace.

Table 6-1. 2017 Vertical Risk Estimates for Mexico RVSM Airspace

Description	Risk Estimate ($x10^{-9}$ fapfh)
Estimate of Technical Risk	**0.047**
Estimate of Risk Due to Operation at Incorrect Flight Levels	**3.170**
Estimate of Overall Risk	**3.217**

6.2. The estimated technical risk in the Mexico RVSM airspace is 0.047 x 10^{-9} fatal accidents per flight hour (fapfh). This estimate is significantly below 2.5 x 10^{-9} fapfh, which is the portion of the TLS set as the safety goal for technical height-keeping performance.

6.3. The operational risk estimate for Mexico RVSM airspace 3.170 x 10^{-9} fapfh. The sum of this value and the technical risk estimate for Mexico airspace is 3.217 x 10^{-9} fapfh, or about 30 percent below the overall safety goal of 5.0 x 10^{-9} fapfh.

6.4. Table 6-2 provides the overall vertical risk estimates for calendar years 2015 – 2017 for Mexico RVSM airspace. The decrease in the vertical risk estimate for calendar year 2017 occurs because of a significantly higher estimate for the annual flying, hours 945,000 hours in 2017 versus 800,000 hours in 2016, and smaller durations associated with the reported LHDs.

Table 6-2. Overall Vertical Risk Estimates for Mexico RVSM Airspace

Calendar Year	Vertical Collision Risk Estimate ($x10^{-9}$ fapfh)
2015	**4.8**
2016	**4.8**
2017	**3.2**