



**CAR/SAM Planning and Implementation Regional Group (GREPECAS) Twenty Third Scrutiny  
 Working Group Meeting (GTE/23)**

Lima, Peru, 11 – 15 September 2023

**Agenda Item 2: Review of the results of Large Height Deviation (LHD) analysis**

**VERTICAL SAFETY MONITORING REPORT FOR MIAMI OCEANIC, NEW YORK WEST, AND SAN JUAN  
 AIRSPACE – 2022**

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

**EXECUTIVE SUMMARY**

This paper provides the vertical safety monitoring report for the continued safe use of the Reduced Vertical Separation Minimum (RVSM) in Miami Oceanic, New York West, and San Juan 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) for calendar year 2022.

The purpose of this report is to compare actual performance to safety goals related to continued use of the RVSM. This report contains a summary of LHD reports received by the NAARMO for the calendar year 2022. There are 34 reported occurrences accounting for 91 minutes spent at an unexpected/incorrect Flight Level (FL) during calendar year 2022. This report also contains an estimate of the vertical collision risk. The vertical collision risk estimate for the airspace exceeds the Target Level of Safety (TLS) value of  $5.0 \times 10^{-9}$  fatal accidents per flight hour.

|                              |   |
|------------------------------|---|
| <b>Action:</b>               | Suggested actions are included in Section 4   |
| <i>Strategic Objectives:</i> | <ul style="list-style-type: none"> <li>• Safety</li> <li>• Air Navigation Capacity and Efficiency</li> </ul>  |
| <i>References:</i>           | <ul style="list-style-type: none"> <li>• ICAO Doc 9574 – <i>Manual on a 300m (1000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive</i></li> <li>• ICAO Doc 9937- <i>Operating Procedures &amp; 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</i></li> </ul> |

## **1. Introduction**

1.1 The North American Approvals Registry and Monitoring Organization (NAARMO), a service delegated to the WJH Technical Center, fulfills the role of Regional Monitoring Agency (RMA) for the continued-safe use of the RVSM in the Miami Oceanic, New York West, and San Juan airspace.

1.2 This airspace primarily contains operations travelling between North America and the Caribbean. The U.S. FAA is the Air Traffic Service (ATS) provider for the Miami Oceanic, New York and San Juan Flight Information Regions (FIRs). The RVSM was introduced in November 2001 into this airspace. The NAARMO conducts the on-going airspace safety monitoring activities to help ensure the continued safe use of the RVSM.

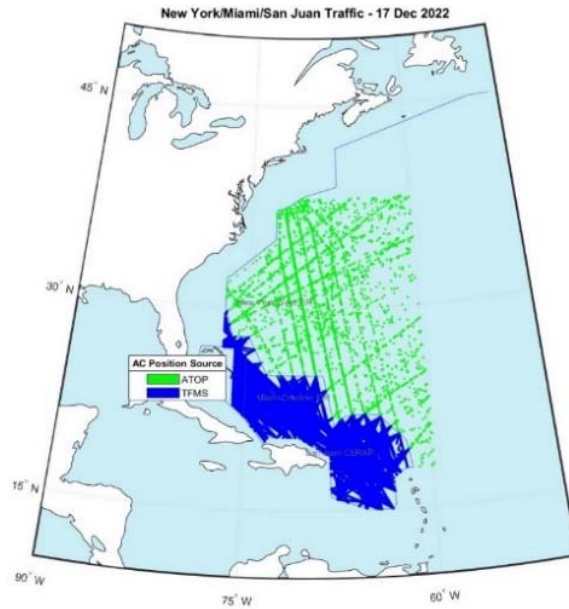
1.3 This report covers the calendar year 2022. Within this report, the reader will find a summary of the LHD reports received by the NAARMO and the corresponding vertical collision risk estimate. There were 34 such reports submitted to the NAARMO for calendar year 2022.

## **2. Discussion**

### **2.1 Traffic Sample Data**

2.1.1 The NAARMO has access to the Federal Aviation Administration's (FAA's) Traffic Flow Management System (TFMS), which includes aircraft observations in Miami Oceanic and San Juan airspace. Each traffic movement record within the TFMS data sample contains the date, time, latitude, longitude, flight level (FL), 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.

2.1.2 The source of traffic data for the New York West FIR is the FAA Advanced Technologies and Oceanic Procedures (ATOP) oceanic automation system data reduction and archives (DR&A). These data contain all the reported aircraft positions, as well as the pilot-ATC High Frequency (HF) radio communications and Controller Pilot Data Link Communications (CPDLC) messages. Figure 2-1 shows the aircraft position locations within the New York West FIR and the TFMS data for the Miami Oceanic and San Juan FIRs for 17 December 2022. The Miami Oceanic and San Juan traffic observed in the TFMS data are combined with the New York West traffic observed in the ATOP DR&A.Ff



**Figure 2-1.** Miami Oceanic, New York West, San Juan FIRs Air Traffic Operations – 17 Dec 2022

2.1.3 Figure 2-2 shows the number of flight operations per month for the New York West FIR for calendar year 2020 through May 2023. Seasonal variations in traffic volume are expected in the airspace. Typically, the high traffic period for Miami Oceanic, New York West, and San Juan airspace begins in November and ends in April/May. Figure 2-2 shows that by the end of calendar year 2021, traffic levels are increasing and a sustained recovery in the number of operations is observed in the current data plotted through May 2023.

2.1.4 Figure 2-3 shows the numbers of flight operations per day for calendar year 2022. The average number of flights per day for calendar year 2022 was 571 flights, which is an increase over the 448 average number of flights per day observed in 2021.

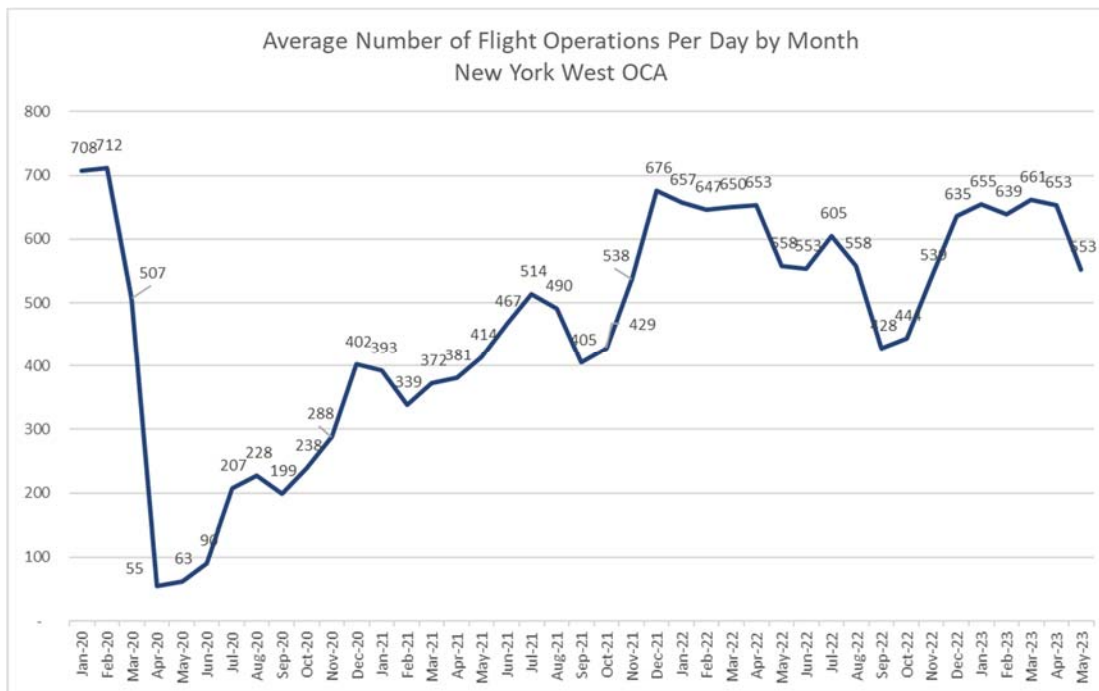
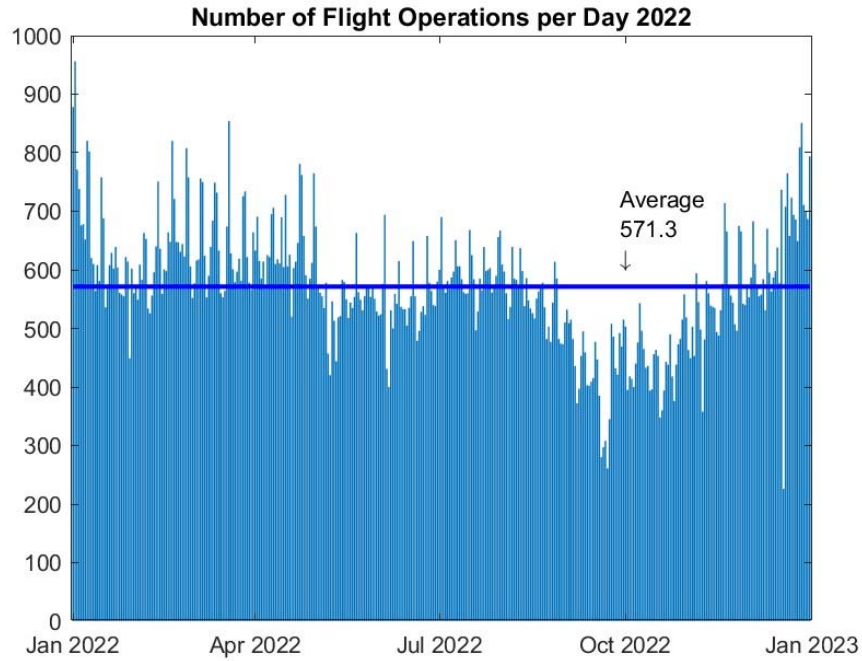


Figure 2-2. New York West FIR, average number of flight operations per day by month – calendar year 2020 through May 2023

## 2.2 Reported Large Height Deviations (LHDs)

2.2.1 The NAARMO utilizes the FAA’s Comprehensive Electronic Data Analysis and Reporting (CEDAR) database, which contains all reports of potentially safety-related events from several internal FAA sources. There were 46 reported occurrences reviewed by the scrutiny group for the Miami Oceanic, New York West, and San Juan airspace. The scrutiny group consists of operational experts from each air traffic control facility, representatives from FAA Flight Standards and Airspace Safety, and safety analyses experts from the NAARMO. The scrutiny group met virtually several times and reviewed all forty-six reported occurrences from calendar year 2022. The scrutiny group determined there were thirty-four validated LHD occurrences during calendar year 2022. Table 2-1 contains a summary of all the validated LHDs by month.

2.2.2 The 34 validated LHD reports are tabulated by month and shown in Table 2-1. Table 2-1 includes the number of reports, LHD duration and the flight levels crossed without clearance by month. The scrutiny group review determined a general cause for each of the 34 validated LHD reports. Table 2-2 summarizes the reported LHDs categorized by general cause. One of the thirty-four reported LHDs listed in Table 2-2 is a technical risk event. The technical risk LHD is a category J, flight crew correctly following the TCAS RA. The associated duration and/or flight levels crossed for the technical risk LHDs are not included in calculation of operational vertical risk and are not shown in Table 2-2. Only the reported LHDs classified as operational risk and their associated duration at incorrect FL and number of incorrect FLs crossed without ATC clearance contribute to the operational vertical collision risk estimate.



**Figure 2-3.** New York West FIR, Number of flight operations per day – calendar year 2022

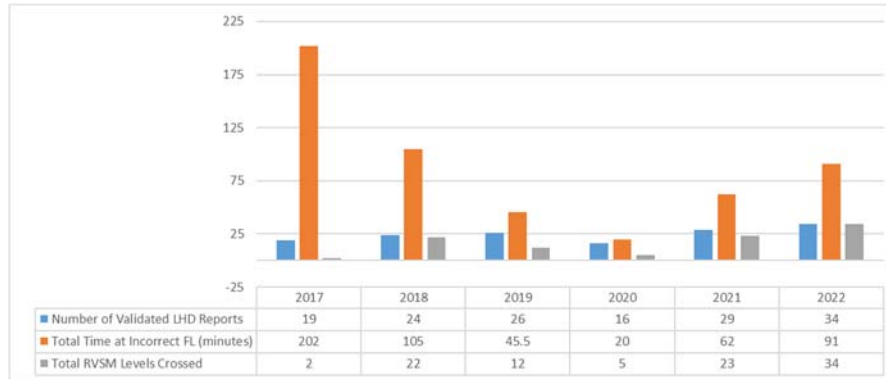
**Table 2-1.** Validated LHDs – 2022

| Month        | Count     | Duration at Unexpected FL (mins) | Number of Unexpected FLs Crossed |
|--------------|-----------|----------------------------------|----------------------------------|
| Jan-22       | 7         | 3                                | 27                               |
| Feb-22       | 3         | 0                                | 0                                |
| Mar-22       | 1         | 0                                | 0                                |
| Apr-22       | 5         | 3                                | 2                                |
| May-22       | 1         | 0                                | 0                                |
| Jun-22       | 2         | 67                               | 0                                |
| Jul-22       | 1         | 0                                | 0                                |
| Aug-22       | 1         | 0                                | 0                                |
| Sep-22       | 4         | 4                                | 1                                |
| Oct-22       | 2         | 0.5                              | 0                                |
| Nov-22       | 5         | 13.5                             | 2                                |
| Dec-22       | 2         | 0                                | 2                                |
| <b>TOTAL</b> | <b>34</b> | <b>91</b>                        | <b>34</b>                        |

**Table 2-2.** Validated LHD Reports by Cause – 2022

| LHD Category Code | LHD Category Description   | Number of LHD | Duration at Incorrect FL (minutes) | Number of Incorrect FLs Crossed |
|-------------------|--|---------------|------------------------------------|---------------------------------|
| <b>A</b>          | Flight crew failing to climb / descend the aircraft as cleared   | 3             | 0                                  | 2                               |
| <b>B</b>          | Flight crew climbing /descending without ATC clearance   | 9             | 67                                 | 17                              |
| <b>C</b>          | Incorrect operation of airborne equipment  | 1             | 0                                  | 0                               |
| <b>D</b>          | ATC system loop error; (e.g., ATC issues incorrect clearance or flight crew misunderstands clearance message)  | 7             | 3.5                                | 3                               |
| <b>E1</b>         | Coordination errors (wrong FL, time, route) in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues                                   | 9             | 17.5                               | 0                               |
| <b>E2</b>         | Negative Coordination in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues   | 1             | 3                                  | 0                               |
| <b>F</b>          | Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of equipment outage or technical issues   | 0             | 0                                  | 0                               |
| <b>G</b>          | Aircraft contingency event leading to sudden inability to maintain assigned flight level   | 1             | 0                                  | 12                              |
| <b>H</b>          | Airborne equipment failure leading to unintentional or undetected change of flight level   | 0             | 0                                  | 0                               |
| <b>I</b>          | Turbulence or other weather related causes – <i>contributes towards technical risk</i>   | 1             | 0                                  | 0                               |
| <b>J</b>          | TCAS resolution advisory; flight crew correctly following the resolution advisory  | 1             | 0                                  | 0                               |
| <b>K</b>          | TCAS resolution advisory; flight crew incorrectly following the resolution advisory  | 0             | 0                                  | 0                               |
| <b>L</b>          | An aircraft being provided with RVSM separation is not RVSM approved (e.g. flight plan indicating RVSM approval but aircraft not approved, ATC misinterpretation of flight plan) | 0             | 0                                  | 0                               |
| <b>M</b>          | Other  | 1             | 0                                  | 0                               |
| <b>TOTAL</b>      |  | <b>34</b>     | <b>91</b>                          | <b>34</b>                       |

2.2.3 An increase in both the number of reported LHDs and duration spent at the unexpected/incorrect FL was observed in 2022 compared to the previous years. This result was expected due to the ongoing recovery from the COVID-19 pandemic and associated increase in flight activity. Figure 2-4 shows the comparison in the numbers of validated LHDs, duration and flight levels crossed without ATC Clearance for calendar years 2017 through 2022. The numbers of reported LHDs and associated duration in 2022 is comparable to the number of reported LHDs during pre-COVID years.



**Figure 2-4.** Validated LHD Reports, calendar years 2017 through 2022

## 2.2.4 Significant LHD reports

2.2.4.1 The largest contribution towards vertical risk was a long duration event, greater than 20 minutes, within the New York West OCA. The aircraft involved did not have a High Frequency (HF) radio on the aircraft. Aircraft are required to have a working HF radio in oceanic airspace. At some point during the oceanic portion of the flight, the pilot climbed to an uncleared flight level (FL). The incorrect FL was discovered when the aircraft entered radar surveillance airspace. The total flying time within oceanic airspace for this flight was 67 minutes. The type of aircraft operation involved with this occurrence was International General Aviation (IGA). The appropriate State Regulator was notified. New York ARTCC personnel indicated an increase in the number of IGA aircraft entering oceanic airspace without the proper radio equipment. The assigned LHD category for this occurrence is category B with a secondary category of “communication failure”.

2.2.4.2 The reported occurrences in calendar year 2022 included many instances of communication failure. The 67-minute reported LHD described above was the only such report that involved a deviation from cleared flight level or route. There were forty communication failure reports received by NAARMO for the New York West OCA and Miami/San Juan airspace involving communication failures, the numbers by airspace are listed in Table 2-3.

**Table 2-3.** Communication Failure Reports – 2022

| Airspace                    | Number of Communication Failure Reports - 2022 |
|-----------------------------|--|
| Miami Oceanic/San Juan FIRs | 29   |
| New York West FIR           | 11   |
| <b>Total</b>                | <b>40</b>                                      |

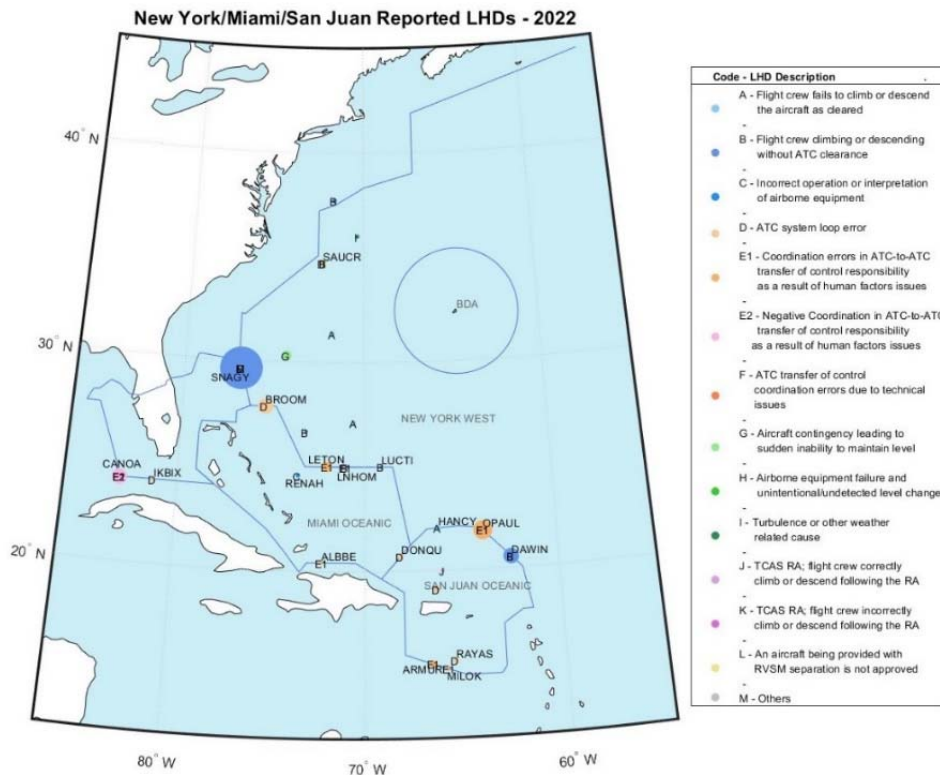
2.2.4.3 The second largest contribution towards vertical risk came from an occurrence with a duration of 13 minutes. For this reported LHD, the coordination between the two ATC-units was successful, however the transferring ATC-unit did not provide the clearance to the aircraft for the coordinated FL. The aircraft entered the airspace of the receiving ATC-unit at a different FL than coordinated and was in conflict with a nearby aircraft. It took 13 minutes for the receiving ATC-unit to

identify the error and provide clearances to the affected aircraft. This occurrence was assigned to category E1 with a secondary category D.

2.2.4.4 The operational risk-bearing LHD events are separated into two areas; those occurring within New York West airspace and those occurring within the Miami Oceanic/San Juan Flight Information Regions (FIRs) and New York West boundary. Table 2-4 contains the breakdown of operational LHD events and associated durations for each area. Figure 2-5 shows the approximate locations of the operational LHDs in 2022. The locations of the category E events occur on an ATC boundary.

**Table 2-4.** Validated operational LHDs by area – 2022

| Airspace                    | Number of LHD | Duration at unexpected FL (min) | Number of unexpected FLs crossed |
|-----------------------------|---------------|---------------------------------|----------------------------------|
| Miami Oceanic/San Juan FIRs | 20            | 7.5                             | 17                               |
| New York West FIR           | 14            | 83.5                            | 17                               |
| <b>Total</b>                | <b>34</b>     | <b>91</b>                       | <b>34</b>                        |



**Figure 2-5.** Approximate Location of the Risk-bearing LHDs – 2022

## 2.2.5 Vertical Collision Risk Estimate

2.2.5.1 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.

2.2.5.2 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 with 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:

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

2.2.5.3 Based on the December 2022 traffic data, the NAARMO estimates approximately 692,857 annual flying hours for 2022 in Miami Oceanic, New York West, and San Juan airspace where the RVSM is applied. This represents an average 12 percent increase in flying hours compared to 2021.

2.2.5.4 The methodology applied in the collision risk calculation for the airspace splits the airspace into two areas. The New York West airspace is considered separately from Miami Oceanic and San Juan airspace. Although the aircraft operations are similar within both areas, the available ATC surveillance and communications differ. In addition, there are differences in the available traffic data source for the two areas. The individual risk estimates for each area are combined to provide an estimate of the airspace using the observed annual flying hours within each area.

2.2.5.5 The 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:

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

2.2.5.6 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 assigned to adjacent flight levels due to the loss of planned vertical separation. The three terms on the right hand side are estimated from aircraft operating on adjacent flight levels that are flying in the same direction on the same route,  $N_{az}(same)$ , opposite direction on the same route,  $N_{az}(opp)$ , and on crossing routes regardless of relative headings,  $N_{az}(cross)$ .

2.2.5.7 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.

2.2.6 Aircraft Types Observed in Miami Oceanic, New York West, and San Juan FIRs

2.2.6.1 Figure 2-6 provides the top aircraft types observed in the December 2022 traffic data by flying hours. The two traffic data sources are maintained in the figure; Miami Oceanic and San Juan traffic data are sourced from the TFMS and the New York West data are sourced from the ATOP DR&A. The aircraft types in Figure 2-6 account for more than 75 percent of total flying hours observed in the airspace. The Airbus A320 is the most frequently observed aircraft in the New York West airspace. The Boeing B738 is the most frequently observed aircraft in the Miami Oceanic and San Juan airspace.

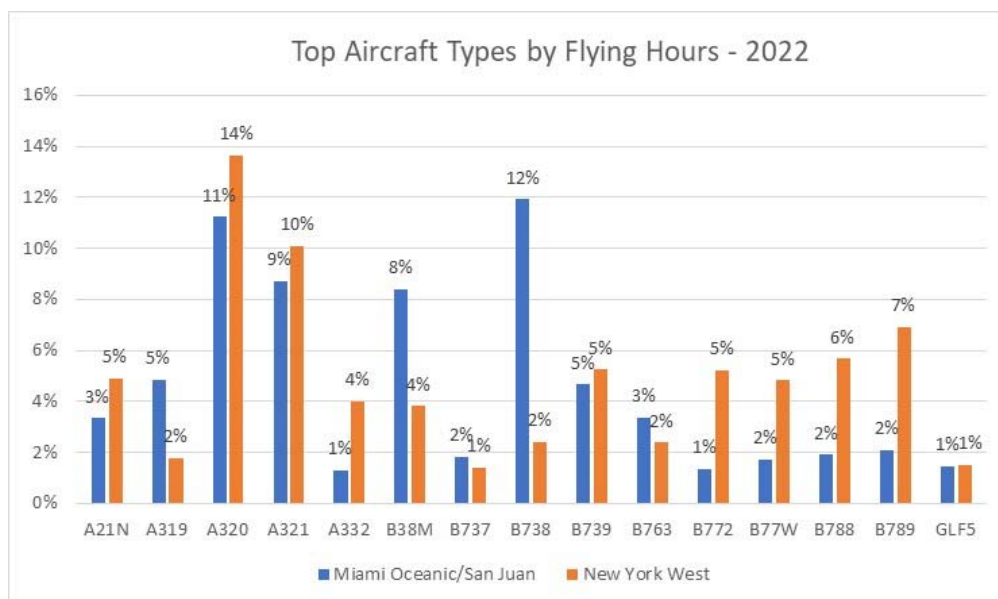


Figure 2-6. Observed Aircraft Types in Terms of Flying Hours in Miami Oceanic/San Juan and New York West Airspace - 2022

2.2.7 Aircraft Size

2.2.7.1 The collision risk model (CRM) parameters related to the aircraft size are: length, wingspan, and height. These parameters are estimated directly from the TFMS and ATOP DR&A December 2022 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 2-5.

Table 2-5. CRM Parameter Estimates for Aircraft Size

| Airspace               | Length $\lambda_x$ (NM)   | Wingspan $\lambda_y$ (NM) | Height $\lambda_z$ (NM)  |
|------------------------|---------------------------|---------------------------|--------------------------|
| Miami Oceanic/San Juan | 0.0223<br><i>(135 ft)</i> | 0.0199<br><i>(121 ft)</i> | 0.0066<br><i>(40 ft)</i> |
| New York West          | 0.0270<br><i>(164 ft)</i> | 0.0249<br><i>(151 ft)</i> | 0.0076<br><i>(46 ft)</i> |

## 2.2.8 Same-Direction, Opposite-Direction, and Crossing-Route Vertical Passing Frequencies

2.2.8.1 The traffic data are used to estimate the vertical occupancy values for the airspace. Table 2-6 shows the same and opposite direction vertical occupancy estimates for the Miami Oceanic/San Juan and New York West airspace in calendar year 2022. The data show similar vertical occupancy values in 2022 compared to 2021.

**Table 2-6.** Same and opposite direction vertical occupancy estimates

| Airspace                   | Same Direction Vertical Occupancy Value | Opposite Direction Vertical Occupancy Value |
|----------------------------|---|---|
| Miami Oceanic and San Juan | 0.0372                                  | 0.0905                                      |
| New York West              | 0.0419                                  | 0.1044                                      |

## 2.2.9 Probability of Vertical Overlap Attributable to Technical Height-Keeping Performance and Reported LHDs

2.2.9.1 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.

2.2.9.2 Estimates of aircraft Altimetry System Error (ASE) and Assigned Altitude Deviation (AAD) are obtained from aircraft height monitoring processes developed by NAARMO. These processes require several data sets, including meteorological and aircraft geometric height data. Aircraft geometric data is obtained from either the U.S. Aircraft Geometric Height Monitoring Element (AGHME), ADS-B data, or the GPS Monitoring Unit (GMU) system. Control of aircraft 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.

2.2.9.3 The NAARMO estimate for the probability of vertical overlap for aircraft pairs operating on adjacent flight levels,  $P_z(1000)$ , used in the estimate of vertical technical risk is  $1.93 \times 10^{-9}$ . 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 0.42.

## 2.2.10 Time spent at Unexpected/Incorrect FL

2.2.10.1 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 airspace during the period when the wrong-flight-level events occurred. The risk-bearing LHDs for calendar year 2022 contain 91 minutes of flying time spent at unexpected flight level.

2.2.10.2 Table 2-3, provided earlier in this paper, gives the duration at unexpected/incorrect flight level for both areas. The proportion of flying time spent at unexpected flight level is estimated for each area using the values in the table and dividing by the estimated flying hours for each area. The estimated annual flying hours for New York West airspace obtained from the ATOP DR&A data are 310,102 hours.

The estimated annual flying hours for Miami Oceanic and San Juan airspace obtained from the combined TFMS data are 382,754 flying hours. The ratios of time spent at unexpected flight level are  $2.7 \times 10^{-4}$  and  $1.9 \times 10^{-5}$  for New York West and Miami Oceanic/San Juan airspace, respectively.

### 2.2.11 Collision Risk Model Parameters

2.2.11.1 The individual parameters of the models, their definitions, estimates, and sources are given in Table 2-7.

**Table 2-7.** Vertical Collision Risk Model Parameter Estimates - 2021

| 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. | $1.93 \times 10^{-9}$   | Value used in the US CONUS vertical risk estimate   |
| $P_z(0)$                | Probability that two aircraft operating on the same flight level are in vertical overlap                            | 0.42                    | Value used in the vertical risk estimates for Pacific airspace                              |
| $P_y(0)$                | Probability that two aircraft on the same track are in lateral overlap.   | 0.1                     | Value used in the vertical risk estimates for Pacific airspace                              |
| $\lambda_x$             | Average aircraft length.  | 0.0223 NM and 0.0270 NM | Estimated from Miami Oceanic/San Juan and New York West traffic data                        |
| $\lambda_y$             | Average aircraft wingspan.  | 0.0199 NM and 0.0249 NM | Estimated from Miami Oceanic/San Juan and New York West traffic data                        |
| $\lambda_z$             | Average aircraft height with undercarriage retracted.   | 0.0066 NM and 0.0076 NM | Estimated from Miami Oceanic/San Juan and New York West traffic data                        |
| $E_z(\text{same})$      | Same-direction vertical occupancy for a pair of aircraft at adjacent flight levels on same route.                   | 0.0372 and 0.0419       | Estimated from Miami Oceanic/San Juan and New York West traffic data                        |
| $E_z(\text{opp})$       | Opposite-direction vertical occupancy for a pair of aircraft at adjacent flight levels on same route.               | 0.0905 and 0.1044       | Estimated from Miami Oceanic/San Juan and New York West traffic data                        |
| $ \overline{\Delta V} $ | 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{V} $        | Average absolute aircraft ground speed.   | 480 knots               | Value used in the North Atlantic, Pacific, and US Domestic airspace vertical risk estimates |
| $ \overline{y} $        | Average absolute relative cross-track speed for an aircraft pair nominally on the same route.                       | 5 knots                 | Value used in the North Atlantic, Pacific, and US Domestic airspace vertical risk estimates |

|                  |   |           |   |
|------------------|---|-----------|---|
| $\overline{ z }$ | 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 |
| $F(NY)$          | Estimated flying hours within New York West FIR   | 310,102   | Estimated from FAA ATOP DR&A for New York West airspace                                     |
| $F(MS)$          | Estimated flying hours within Miami Oceanic and San Juan FIRs                                       | 382,754   | Estimated from TFMS data for Miami Oceanic and San Juan airspace                            |

### 3. Results and Conclusions

3.1 The risk-bearing LHDs are separated based on the location of the event. The risk-bearing LHDs within New York West airspace are applied to the estimated flying hours and vertical occupancy values for New York West airspace. The same method is applied to the data for Miami Oceanic and San Juan airspace. Table 2-8 provides the weighted 2022 estimates of technical and operational vertical risk for Miami Oceanic, New York West and San Juan airspace. The last row in Table 2-7 contains the weighted sum of the risk from the two areas.

Table 2-8. 2022 Vertical Risk Estimates for Miami Oceanic, New York West and San Juan Airspace ( $\times 10^{-9}$  fatal accidents per flight hour (fapfh))

| Airspace                   | Technical   | Operational  | Overall      |
|----------------------------|-------------|--------------|--------------|
| New York West              | 0.03        | 12.53        | 12.56        |
| Miami Oceanic and San Juan | 0.04        | 5.39         | 5.43         |
| <b>Total</b>               | <b>0.07</b> | <b>17.92</b> | <b>17.99</b> |

3.2 The estimated technical risk in the RVSM airspace is  $0.07 \times 10^{-9}$  fatal accidents per flight hour (fapfh). This estimate is significantly below  $2.5 \times 10^{-9}$  fapfh, which is the portion of the TLS set as the safety goal for technical height-keeping performance.

3.3 The operational vertical risk estimate for RVSM airspace  $17.92 \times 10^{-9}$  fapfh. The sum of this value and the technical risk estimate for airspace is  $17.99 \times 10^{-9}$  fapfh, which is larger than the overall safety goal of  $5.0 \times 10^{-9}$  fapfh.

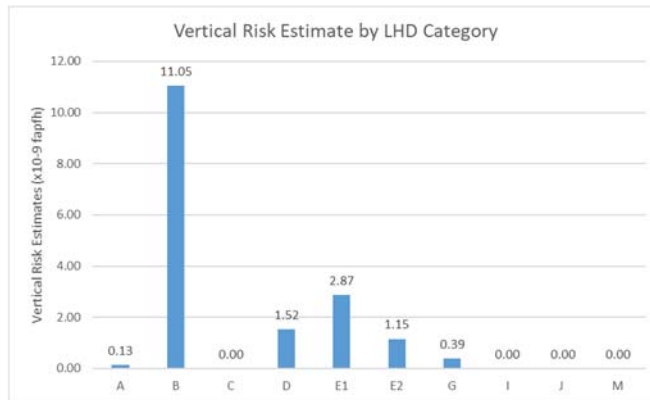
#### 3.4 Reported LHDs and Corresponding Vertical Risk

3.4.1 The largest contribution towards the estimate of vertical risk comes from a reported category B LHD with a duration of 67 minutes. The risk estimate associated with this occurrence is  $9.6 \times 10^{-9}$  fapfh, a value that is more than half of the overall vertical risk estimate.

3.4.2 The second largest contribution towards the vertical risk estimate comes from a reported category E1 LHD with a duration of 13 minutes. The risk estimate associated with this occurrence is  $1.86 \times 10^{-9}$  fapfh.

3.4.3 Figure 2-7 shows the estimates of vertical risk by LHD category. The vertical risk estimate associated with Category B LHD reports is  $11.05 \times 10^{-9}$  fapfh, most of this vertical risk value is attributed to

the 67-minute occurrence. The next largest category in terms of contribution towards vertical risk is category E1.

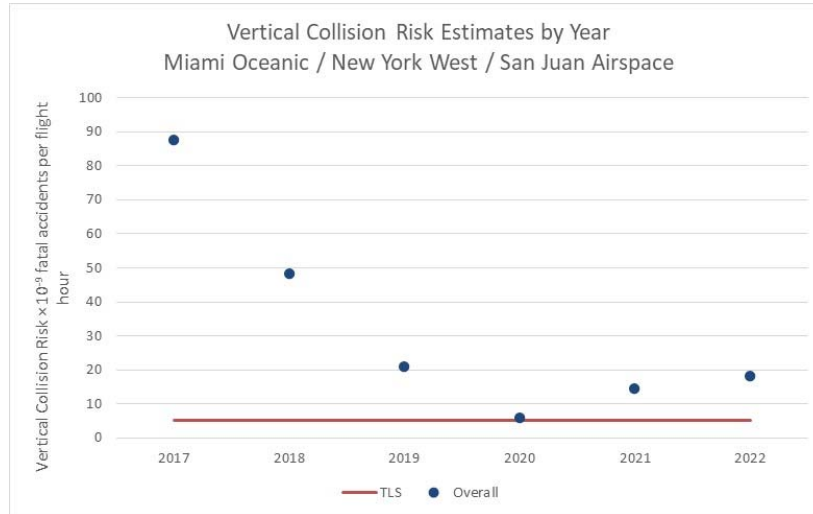


**Figure 2-7.** Vertical Risk Estimates by LHD Category (× 10<sup>-9</sup> fatal accidents per flight hour (fapfh))

3.4.4 The estimated vertical risk estimate for 2022, shown in Table 2-8, is an increase from that estimated for calendar year 2021 but is comparable to the risk estimates from the pre-COVID period (e.g. 2017 – 2019). The increase in the vertical risk estimate is directly related to the increase in the time spent at unexpected flight levels as shown in Figure 2-4. For comparison, Table 2-9 and Figure 2-7 provide the vertical risk estimates for calendar years 2017 through 2022.

**Table 2-9.** Vertical Risk Estimates for Miami Oceanic, New York West and San Juan Airspace (× 10<sup>-9</sup> fatal accidents per flight hour (fapfh))

| Calendar Year | Technical Risk | Operational Risk | Overall Vertical Risk | TLS |
|---------------|----------------|------------------|-----------------------|-----|
| 2017          | 0.05           | 87.44            | 87.50                 | 5   |
| 2018          | 0.07           | 48.04            | 48.11                 | 5   |
| 2019          | 0.07           | 20.67            | 20.75                 | 5   |
| 2020          | 0.07           | 5.61             | 5.68                  | 5   |
| 2021          | 0.08           | 14.28            | 14.36                 | 5   |
| 2022          | 0.07           | 17.92            | 17.99                 | 5   |



**Figure 2-8.** Vertical Risk Estimates for Miami Oceanic, New York West and San Juan Airspace ( $\times 10^{-9}$  fatal accidents per flight hour (fapfh))

#### 4. Action by the meeting

##### 4.1 The GTE is invited to:

- a) Note and discuss the information provided;
- b) request both ATC-units involved in category E LHD occurrences continue to share information to improve validation results, and
- c) encourage States to remind operators of the necessary radio equipment for operations in oceanic and remote airspace.