International Civil Aviation Organization

Twenty-Eighth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/28)

Bangkok, Thailand, 21 – 24 August 2023

Agenda Item 3: Reports from Asia/Pacific RMAs and EMAs

PARMO HORIZONTAL SAFETY MONITORING REPORT 2022

(Presented by United States/PARMO)

SUMMARY

This paper presents the horizontal safety monitoring report from the Pacific Approvals Registry and Monitoring Organization (PARMO) for the period 1 January to 31 December 2022. This report contains a summary of large longitudinal errors and large lateral deviations received by the PARMO for that period and the related performance monitoring activities for the Anchorage, Auckland, Nadi, Oakland, and Tahiti Flight Information Regions (FIRs).

1. INTRODUCTION

1.1 The Pacific Approvals Registry and Monitoring Organization (PARMO), serves as the En-route Monitoring Agency (EMA) for the Anchorage, Auckland, Nadi, Oakland, and Tahiti Flight Information Regions (FIRs). The report presented in this paper fulfills the ICAO emphasis on safety management systems; such reporting for international airspace is a component of safety management systems.

1.2 This working paper contains the PARMO horizontal safety monitoring report for the time period 1 January to 31 December 2022. This paper contains a summary of large lateral deviation (LLD) and large longitudinal error (LLE) reports received by the PARMO during the reporting period.

2. DISCUSSION

Attachment A contains the PARMO Horizontal Safety Monitoring Report for January to December 2022.

<u>Executive Summary</u>

2.1 **Table 1** provides the Pacific airspace horizontal risk estimates. **Figure 1** presents the lateral and longitudinal collision risk estimate trends for Pacific airspace during the period January 2022 to December 2022.

Pacific Airspace – estimated annual flying hours = 1,482,049 hours ***(note: estimated hours based on Dec 2022 traffic sample data)***			
Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 27 Lateral Risk	*1.74×10^{-9}*	*5.0×10^{-9}*	*Below TLS*
RASMAG 27 Longitudinal Risk	*4.08×10^{-9}*	*5.0×10^{-9}*	*Below TLS*
Lateral Risk	**2.09×10^{-9}**	5.0×10^{-9}	**Below TLS**
Longitudinal Risk	**0.003×10^{-9}**	5.0×10^{-9}	**Below TLS**

Table 1: Pacific Airspace Horizontal Risk Estimates

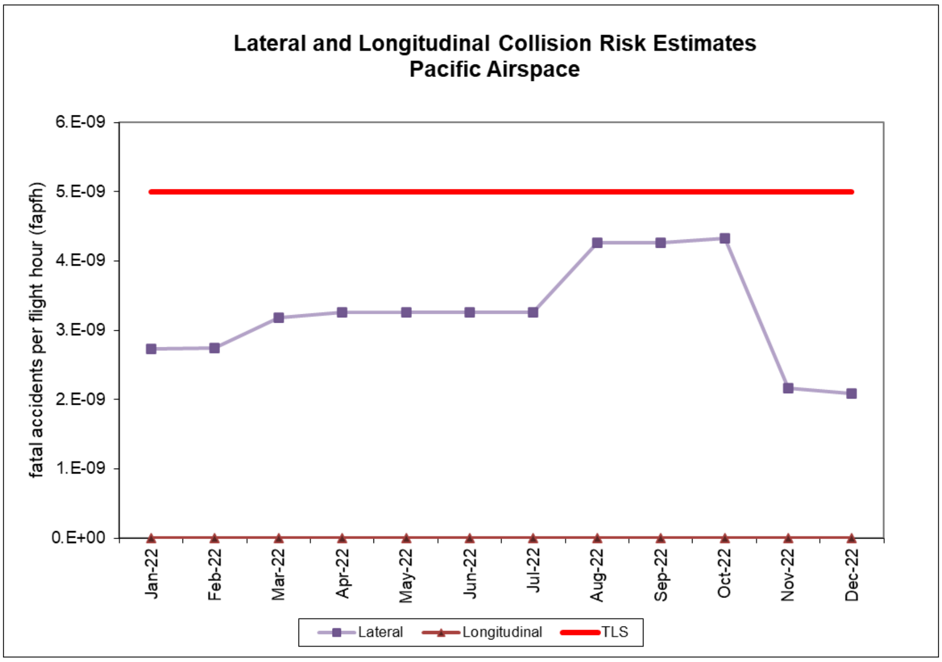

Figure 1: Pacific Airspace Horizontal Risk Estimates

2.2 **Table 2** contains a summary of Large Lateral Deviations (LLD) and Large Longitudinal Errors (LLE) received by PARMO for Pacific airspace.

Code	Deviation Description	No.
A	Flight crew deviates without ATC clearance in the horizontal dimension	16
B	Flight crew incorrect operation or interpretation of airborne equipment	1
C	Flight crew waypoint insertion error, due to correct entry of incorrect position or incorrect entry of correct position	0
D	ATC system loop error	4
E	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	86
F	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of equipment outage or technical issues	0
G	Navigation errors due to airborne equipment failure leading to a deviation in the horizontal dimension of which notification was not received by ATC or notified too late for action	0
H	Turbulence or other weather related causes (other than approved) leading to a deviation in the horizontal dimension;	0
I	An aircraft was provided with reduced horizontal separation minima but did not meet the RNP/RSP/RCP specification	0
J	Others	2
Total		109

Table 2: Summary of Pacific Airspace LLD and LLE Reports

2.3 The reported occurrences involving aircraft transfers from the Honolulu Control Facility (HCF) and Oakland Oceanic OCA affect the User Preferred Routes (UPRs) crossing fixed airways within the Oakland Oceanic OCA. These specific events occur frequently and require significant resources at the ATC facility to investigate underlying causes. A task force was established and determined remedial actions. The current plan is to implement the En Route Automation Modernization

(ERAM) system at the HCF, this is now planned for implementation by 2025. Prior to that time, both facilities have implemented mitigation strategies.

2.4 During calendar year 2022, there was a noticeable increase in deviations around adverse meteorological conditions. As a result, Oakland ARTCC provided operators with information on weather deviation procedures at a recent Oceanic Work Group (OWG) meeting. The presentation provided suggestions for aircraft operators to use in flight crew training. The most important part of the procedure is for the air crew is to contact ATC via CPDLC or voice, suggested phraseology is to indicate “WEATHER DEVIATION REQUIRED”. This provides ATC with the priority needed to ensure the safety of the requesting aircraft and other operations in the vicinity. If ATC is not able to issue a clearance to deviate for adverse weather, the air crew should advise ATC of intentions and execute the published procedure. Oakland ARTCC explained that a preliminary pilot deviation (PD) would be filed, however, the subsequent investigation would determine whether the published procedure was followed correctly. There would be no punitive outcome for air crews using the published procedure to avoid adverse meteorological conditions.

2.5 Published airspace fixes that were not contained within the automation system were removed from publications by an ATC-unit. This remedial action was taken after a reported occurrence which accounted for twenty-five percent of the estimated lateral risk. This occurrence was a long duration LLD in which the aircraft involved flew for 57 minutes with an incorrect profile in the automation system. The cause of this report was the use of published airspace fixes that were not in the ATC automation system, prompting the automation system to disregard those fixes. These airspace fixes have since been removed from publications and there have been no repeat incidents.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matters as appropriate.

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SAFETY REVIEW OF THE APPLICATION OF REDUCED HORIZONTAL SEPARATION MINIMA IN PACIFIC AIRSPACE
January 2022 TO December 2022

Prepared by
Pacific Approvals and Registry Monitoring Organization (PARMO) – ***August 2023***
(An ICAO APANPIRG approved Enroute Monitoring Agency)

1. Introduction

1.1 This report provides a safety review of the application of reduced horizontal separation minima in Pacific airspace. Specifically, this report utilizes data collected for the Anchorage, Auckland, Nadi, Oakland and Tahiti Flight Information Regions (FIRs).

2. Data Sources

2.1 **Traffic Sample Data (TSD).** A TSD covering the month of December 2022 for aircraft operations in the Anchorage, Auckland, Nadi, and Oakland FIRs was used as required by ICAO Regional agreement. **Table 1** indicates all FIRs have submitted a TSD to the PARMO.

Table 1: December 2022 TSD Submitted to PARMO

FIR	December 2022 TSD Submitted to PARMO
Anchorage	X
Auckland	X
Nadi	X
Oakland	X
Tahiti	X

2.2 **Large Lateral Deviations (LLDs) and Large Longitudinal Errors (LLEs).** A cumulative 12-month data set of LLD and LLE reports was used, covering January to December 2022. **Table 2** indicates those FIRs which submitted LLD and LLE reports including nil reports.

Table 2: Summary of LLD and LLE Reports submitted by FIRs

	Anchorage	Auckland	Nadi	Oakland	Tahiti
Jan 2022	X	X	X	X	X
Feb 2022	X	X	X	X	X
Mar 2022	X	X	X	X	X
Apr 2022	X	X	X	X	X
May 2022	X	X	X	X	X
Jun 2022	X	X	X	X	X
Jul 2022	X	X	X	X	X
Aug 2022	X	X	X	X	X
Sep 2022	X	X	X	X	X
Oct 2022	X	X	X	X	X
Nov 2022	X	X	X	X	X

	Anchorage	Auckland	Nadi	Oakland	Tahiti
Dec 2022	X	X	X	X	X

3. Summary of LLD and LLE Occurrences in Pacific Airspace

3.1 There were twenty-three LLDs and eighty-six LLEs reported to the PARMO during calendar year 2022. **Table 3** provides the number of reported LLDs and LLEs by month for all 109 reports.

Table 3: Summary of reported LLDs and LLEs for Pacific airspace – 2022

Month	No. of Reported LLDs and LLEs	Duration (min)	Number of tracks crossed w/o clearance
2022			
January	1	14	0
February	3	47	1
March	13	142	0
April	11	58	1
May	9	55	0
June	7	57	0
July	12	81	0
August	14	231.5	0
September	4	22	0
October	13	92	5
November	12	149	0
December	8	35	0
Total	109	983.5	7

3.2 **Table 4** summarizes the number of reported LLDs and LLEs by category code from 1 January 2022 to 31 December 2022 inclusive for Pacific airspace.

3.3 **Table 5** summarizes all reported LLDs and LLEs by month and category. **Figure 1** shows relative proportion of all reported LLDs and LLEs by category code.

Table 4: Summary of reported LLDs and LLEs by category – 2022

Code	Deviation Description	No.
A	Flight crew deviates without ATC Clearance	16
B	Flight crew incorrect operation or interpretation of airborne equipment	1
C	Flight crew waypoint insertion error, due to correct entry of incorrect position or incorrect entry of correct position	0

Code	Deviation Description	No.
D	ATC system loop error	4
E	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility due to human factor issues	86
F	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility due to technical issues	0
G	Navigation errors, including equipment failure of which notification was not received by ATC or notified too late for action	0
H	Turbulence or other weather related causes	0
I	An aircraft without PBN approval	0
J	Other	2
	Total	**109**

3.4 **Figure 2** provides a chart with the locations of the LLD and LLE reports. This graph also shows the LLD/LLE categories. The size of the plotted circle indicates the relative duration at that location compared to other plotted on the chart.

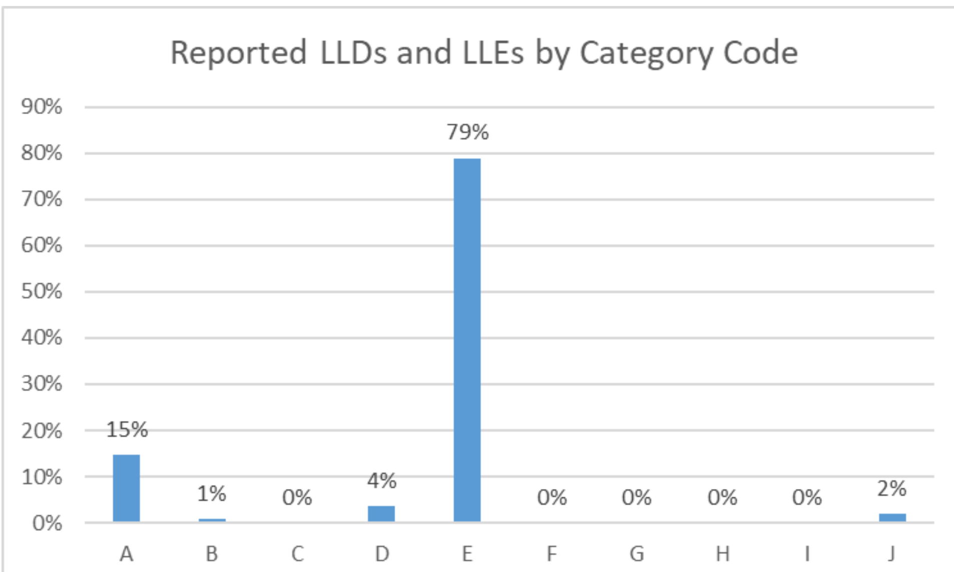

Figure 1: All Reported LLDs and LLEs by Category Code

3.5 Due to the variety of lateral separation standards available in Pacific airspace, it is necessary to examine each reported LLD to determine the eligible lateral separation standard(s) for the aircraft involved. It is not necessary that a lateral separation minimum been applied during the time of the occurrence. To determine eligibility for reduced separations, the filed required navigation performance (RNP), Required Communication Performance (RCP), and Required Surveillance Performance (RSP) specifications are examined. This practice, of analyzing reported LLD and LLE events by eligibility for reduced separation standards is a practice applied for risk estimates in other airspace such as the North Atlantic. This process is unique to horizontal risk estimation where there are a variety of performance-based separation minima available.

3.6 **Table 5** provides the number of reported LLDs and LLEs by month and category code. This table shows that category E reports is the top contributor to the number of reports. This result is similar to that observed in calendar years 2019, 2020, and 2021.

Table 5: Summary of LLD and LLE Reports submitted by FIRs

LLD and LLE Category Codes						
	A	B	D	E	J	Totals
Jan-22	0	0	0	0	1	1
Feb-22	1	0	1	1	0	3
Mar-22	3	0	2	7	1	13
Apr-22	0	0	1	10	0	11
May-22	1	0	0	8	0	9
Jun-22	0	0	0	7	0	7
Jul-22	0	0	0	12	0	12
Aug-22	1	1	0	12	0	14
Sep-22	0	0	0	4	0	4
Oct-22	8	0	0	5	0	13
Nov-22	1	0	0	13	0	14
Dec-22	1	0	0	7	0	8
Totals	16	1	4	86	2	109

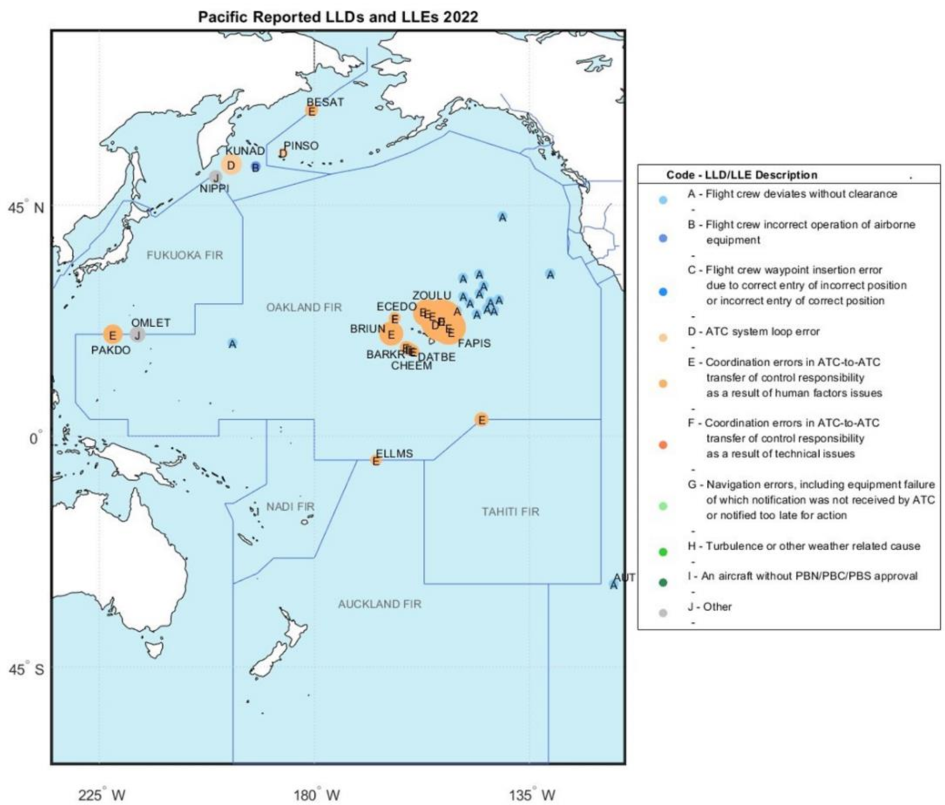

Figure 2: Locations of reported LLDs and LLEs – Calendar Year 2022

3.7 Trends Observed in Reported Large Lateral Deviations (LLDs)

3.8 **Table 6** shows the trends in the number of reported LLDs by category for 2018 through 2022. The LLD category descriptions are provided in Table 4. There were twenty-three reported LLDs for calendar year 2022. This is an increase in the overall number of reported LLDs received by PARMO compared to calendar year 2021. **Figure 3** shows the trend data in chart format for the categories related to aircrews. **Figure 4** shows the trend data for the categories related to ATC.

3.9 These data show a trend in category A LLDs for aircrews deviating in the horizontal dimension without ATC clearance. In 2022, twelve of the sixteen reported category A LLDs have indicated that weather (category H) was a secondary causal factor. In these twelve cases, the published procedures for weather deviations and other contingencies is oceanic controller airspace were not applied correctly. During calendar year 2022, many aircrews invoked the weather contingency procedures. There were nine reports in which the maneuvering around weather was done in accordance with procedures, these reports are excluded from this analysis. Only the twelve reports in which the weather contingency procedure was not correctly applied are included in the analysis.

3.10 **Figure 5** shows the locations of all reported LLDs by category in Pacific airspace. The LLD categories are enhanced if a secondary category was assigned. For example, Category A LLDs that involved a flight crew deviating for weather not in accordance with procedures are labeled as “Wx Deviation” in Figure 5. The size of the circles reflects the individual risk estimates calculated at each occurrence location. The calculated lateral risk estimate reflects the duration/magnitude of the deviation as well as the location within the airspace. A higher estimate of lateral risk results from reported occurrences within an area with high traffic density.

3.11 The lateral risk estimate for calendar year 2022 is 2.09×10^{-9} fatal accidents per flight hour (fapfh). The largest contributions to the lateral risk estimate are the category A LLD reports, which account for seventy-one percent of the estimated lateral risk. There were sixteen risk-bearing Category A LLD reports. The estimated lateral risk from all reported weather deviations not in accordance with procedures was 0.43×10^{-9} fapfh, which is roughly thirty percent of the lateral risk due to category A causes. Most of the reported weather deviations occurred within the Central East Pacific (CEP) routes, a high traffic density area. Figure 5 shows the approximate locations of the weather deviations with light blue circles, there is a noticeable cluster of light blue circles within the CEP. Another category A LLD report involved an aircraft contingency event within the CEP that accounted for the remaining seventy percent of the estimated risk from category A causes. The approximate location of this occurrence is shown with a large yellow circle within the CEP in Figure 5.

3.12 Due to the observed increase in deviations around adverse meteorological conditions, Oakland ARTCC provided operators with information on weather deviation procedures at a recent Oceanic Work Group (OWG) meeting. The presentation provided suggestions for aircraft operators to use in flight crew training. The most important part of the procedure is for the air crew is to contact ATC via CPDLC or voice, suggested phraseology is to indicate “WEATHER DEVIATION REQUIRED”. This provides ATC with the priority needed to ensure the safety of the requesting aircraft and other operations in the vicinity. If ATC is not able to issue a clearance to deviate for adverse weather, the air crew should advise ATC of intentions and execute the published procedure. Oakland ARTCC explained that a preliminary pilot deviation (PD) would be filed, however, the subsequent investigation would determine whether the published procedure was followed correctly. There would be no punitive outcome for air crews using the published procedure to avoid adverse meteorological conditions.

3.13 The second largest contribution towards the lateral risk estimate are the category D LLD reports, which account for twenty-five percent of the estimated lateral risk. There was one long duration LLD report in which the aircraft involved flew for 57 minutes with an incorrect profile in the automation system. The cause of this report is the use of published airspace fixes that are not in the ATC automation system causing the automation system to disregard those fixes. These airspace fixes have since been removed from publications and there have been no repeat incidents.

Table 6. Trends in reported LLDs by category, 2018 - 2022

LLD Category	2018	2019	2020	2021	2022
A	14	9	6	6	16
B	7	3	1	1	1

LLD Category	2018	2019	2020	2021	2022
C	0	0	0	0	0
D	2	1	0	3	3
E	9	11	1	2	2
F	0	0	0	0	0
G	1	2	0	0	0
H	0	0	1	0	0
I	0	0	0	0	0
J	1	0	1	1	1
Totals	34	26	10	13	23

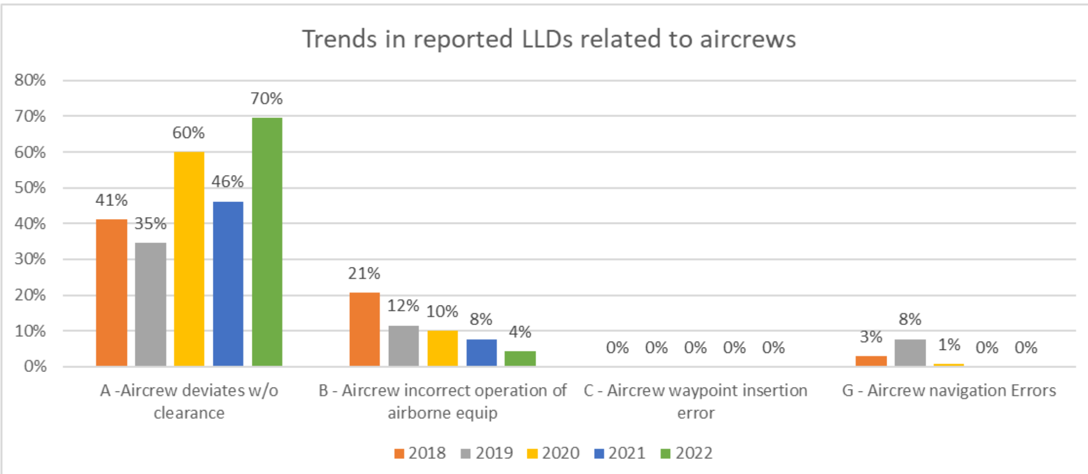

Figure 3: Trend in reported LLDs for categories related to aircrew (counts of LLD reports)

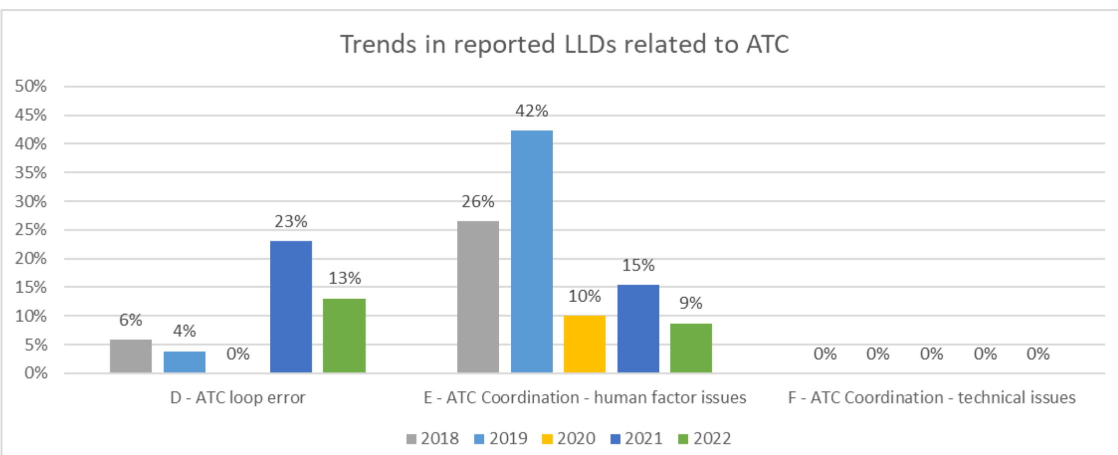

Figure 4: Trend in reported LLDs for categories related to ATC (counts of LLD reports)

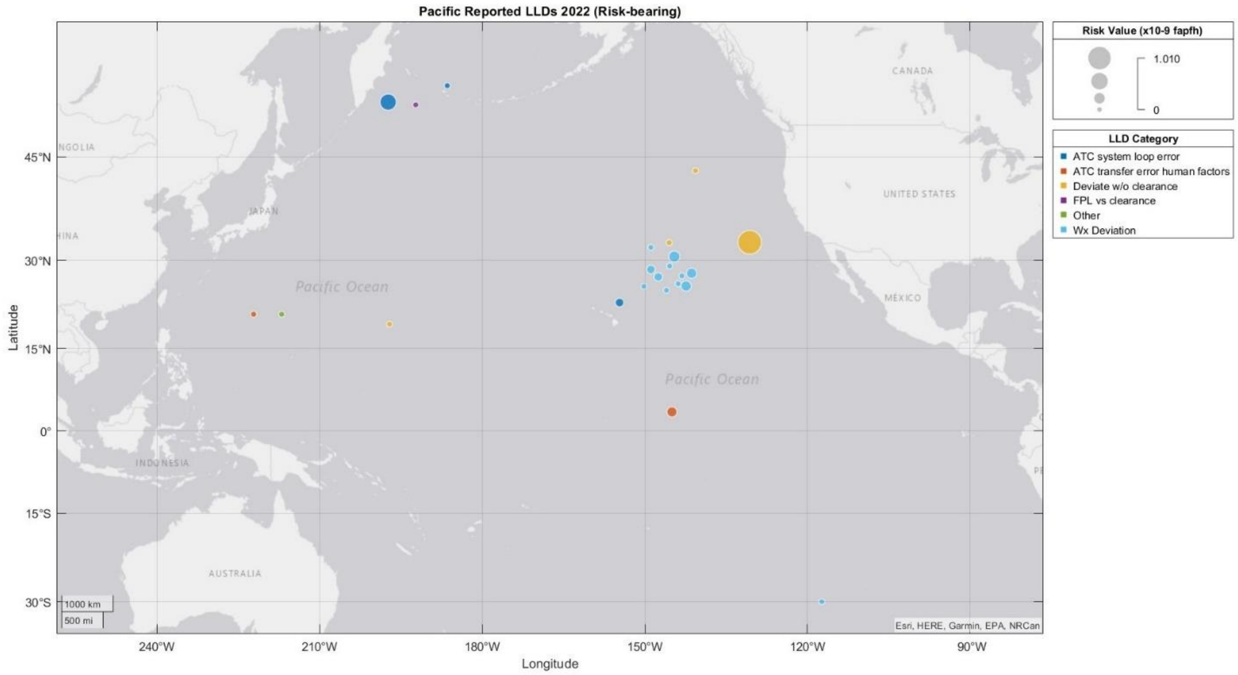

Figure 5: All Reported LLDs – 2022

3.14 Trends Observed in Reported Large Longitudinal Errors (LLEs)

3.15 **Table 7** shows the trends in the number of reported LLEs by category for calendar years 2018 through 2022. Table 4 provides a description of the categories. The high number of category E reported LLEs are due to reports for transfer errors between Honolulu Control Facility (HCF) and Oakland Oceanic FIR. There were eighty-four of these reported category E LLEs between HCF and Oakland Oceanic FIR in 2022. **Figure 6** shows the locations for the reported LLEs in 2022.

Table 7. Trends in reported LLEs by category, 2018 through 2022

Category	2018	2019	2020	2021	2022
A	0	1	0	0	0
B	1	0	0	0	0
C	0	0	0	0	0
D	0	0	0	0	1
E	2	62	64	98	84
F	1	1	0	0	0
G	0	0	0	0	0
H	0	0	0	0	0
I	1	0	0	0	0
J	0	0	0	0	1
Total	5	64	64	98	86

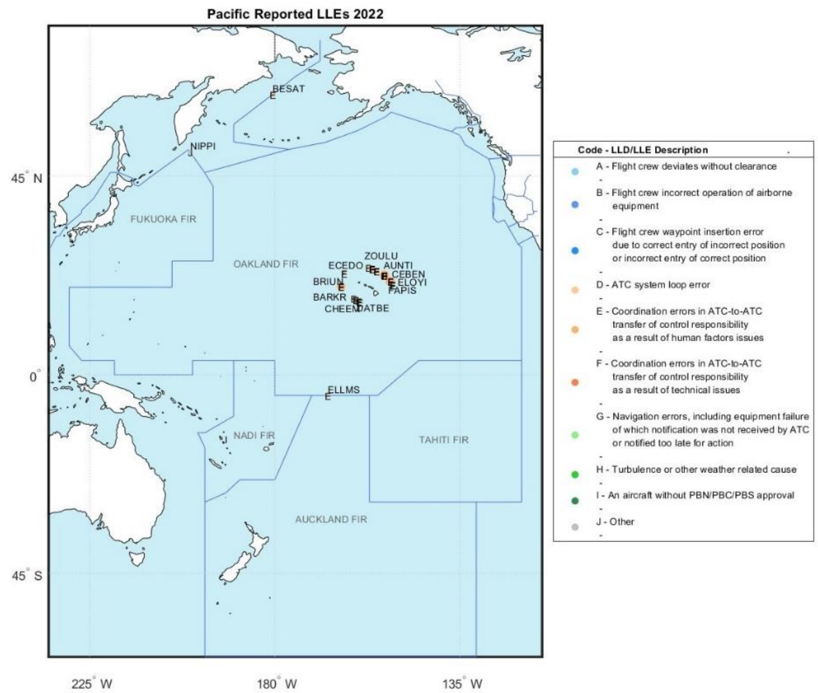

Figure 6: Reported LLE locations in Pacific airspace - 2022

3.16 The scrutiny review group informed PARMO these LLE occurrences between HCF and Oakland ARTCC affect the User Preferred Routes (UPRs) crossing fixed airways within Oakland Oceanic FIR. These type of events occur frequently and require significant resources at the ATC facility to investigate underlying causes.

3.17 A task force was established to further investigate these occurrences and determine remedial actions, the task force met at the HCF in 2021. The task force reviewed the current systems and procedures at the HCF. It was determined that the HCF does not have the functionality to update the aircraft profile and transfer the updated information to the next facility. The current automation system includes the Surveillance Data Processing (SDP) Microprocessor En Route Automated Radar Tracking System (Micro-EARTS) and the Offshore Flight Data Processing System (OFDPS). The FAA's offshore modernization plan had been delayed for many years due to higher priorities. The current plan to implement the En Route Automation Modernization (ERAM) system at the HCF is now planned for implementation by 2025. Prior to that time, both facilities have implemented mitigation strategies:

3.17.1 A procedure that requires the controller to determine the remaining travel time to the boundary fix is in use by the HCF. During this procedure, ATC computes an estimated time of arrival (ETA) for the boundary fix and manually transfers the ETA to the next facility. It is noted that this is a manual procedure and is a short-term solution.

3.17.2 Oakland ARTCC has implemented refresher training for the oceanic controllers. This training instructs the controllers on how to update an aircraft's profile/fix times using the coordination window within the ATC automation system.

3.17.3 All the reported occurrences of this type were validated by Oakland ARTCC using the radar information or ADS-C position information from the aircraft. There were extended periods in which the radar used for this validation was out of service, specifically from January 2022 through March 2022. During the outage periods, there are fewer reported occurrences due to the limited investigation and validation of such occurrences.

4. Horizontal Risk Assessment and Safety Oversight for Pacific Airspace

4.1 Collision Risk Model (CRM) Parameters

4.2 To calculate a lateral risk estimate for Pacific airspace, each reported large lateral deviation is examined to determine the time spent on an incorrect route and the number of tracks crossed without ATC clearance. This process is similar to that done for reported large height deviations (LHDs) except that the capabilities of the aircraft are considered due to the requirements for the different lateral separation minima. This methodology is used for lateral risk estimates in North Atlantic (NAT) airspace. This methodology provides a lateral risk estimate for the entire airspace rather than lateral risk estimates for specific portions of operations.

4.3 To determine whether time spent on an incorrect route and/or tracks crossed without clearance are appropriate, each reported occurrence is examined. The capabilities of the aircraft determine the appropriate Lateral Infringement Distance (LID). If the occurrence involves a lateral deviation from a cleared route, the magnitude of the deviation is compared to the appropriate LID. Based on the available lateral separation minima in Pacific airspace, the current LIDs are:

4.3.1 15 NM if the aircraft is eligible for a 23-NM lateral separation standard, therefore, is RNP4, RCP240 and RSP180 equipped (23 NM – 4 NM [RNP4] – 4 NM [2 × SLOP to account for opposite direction traffic])

4.3.2 36 NM if the aircraft is RNP10 (50 NM – 10 NM [RNP10] – 4 NM [2 × SLOP to account for opposite direction traffic])

4.4 The same risk-weighting method by traffic flows used in the calculation of the vertical risk is applied in the calculation of lateral risk. The values of the parameters in the CRM used to estimate risk in Pacific RVSM airspace, are summarized in **Table 8**. Other collision risk model parameters that vary by traffic flow include aircraft size and flying hours. These parameters are shown in **Table 9** by traffic flow.

Table 8: Estimates of the parameters in the horizontal CRM for Pacific airspace

Parameter	Description	Value
$\overline{\lvert \Delta V \rvert}$	Average relative same-direction speed	13 Knots
$\overline{\lvert V \rvert}$	Average aircraft speed	480 knots
$\overline{\lvert \dot{z} \rvert}$	Average relative vertical speed during loss of vertical separation	1.5 knots
$\overline{\lvert \dot{y}_o \rvert}$	Average absolute relative cross track speed for aircraft nominally on the same track.	5 knots
$\overline{\lvert \dot{y}_{60} \rvert}$	Average absolute relative cross track speed when one aircraft has committed a 1° waypoint insertion error.	80 knots
$P_z(0)$	Probability two aircraft at the same nominal level are in vertical overlap	0.42
T	ADS-C periodic report frequency	10 minutes

Table 9: Horizontal CRM Parameters that Vary by Traffic Flow

Traffic Flow	Annual Flying Hours	Percent	E_y(same)	E_y(opp)	Average Aircraft Length, λx (NM)	Average Aircraft Wingspan, λy (NM)	Average Aircraft Height, λz (NM)
NOPAC	238,655	16.10%	0.0443	0.0000	0.037	0.034	0.010
CENPAC	342,738.6	23.13%	0.0443	0.0000	0.037	0.035	0.010
CEP	474,686.8	32.03%	0.0572	0.0945	0.026	0.023	0.007
JPHAWA	30,836.7	2.08%	0.0005	0.0000	0.033	0.031	0.009
JPGUAM	6,335.2	0.43%	0.0005	0.0000	0.025	0.023	0.008
OTHER	15,213.6	1.03%	0.0005	0.0000	0.030	0.027	0.008
AUSNZSP	86,860.5	5.86%	0.0005	0.0000	0.025	0.023	0.007
NADI	27,577.0	1.86%	0.0005	0.0000	0.031	0.030	0.009
AUSNZJP	39,965.7	2.70%	0.0005	0.0000	0.034	0.033	0.009
SOPAC	219,179.8	14.79%	0.0443	0.0000	0.034	0.033	0.009
TOTAL	1,482,049.0	100.00%			0.032 NM	0.029 NM	0.009 NM
					192.5 ft	***178.0 ft***	***52.7 ft***

4.5 **Risk Estimation Results.** The results for the lateral and longitudinal risk for Pacific airspace are detailed in **Table 10**. **The risk estimates meet the specified TLS value** of 5.0×10^{-9} fapfh.

4.6 The estimate of overall lateral risk for 2022 increased from the estimate provided for calendar year 2020.

Table 10: Pacific Airspace Horizontal Risk Estimates

Pacific Airspace – estimated annual flying hours = 1,482,049 hours ***(note: estimated hours based on Dec 2022 traffic sample data)***			
Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 27 Lateral Risk	*1.74×10^{-9}*	*5.0×10^{-9}*	*Below TLS*
RASMAG 27 Longitudinal Risk	*4.08×10^{-9}*	*5.0×10^{-9}*	*Below TLS*
Lateral Risk	**2.09×10^{-9}**	5.0×10^{-9}	**Below TLS**
Longitudinal Risk	**0.003×10^{-9}**	5.0×10^{-9}	**Below TLS**

4.7 **Figure 7** presents the lateral and longitudinal collision risk estimate trends during the period from January to December 2022.

4.8 The estimate of longitudinal collision risk examines the observed separation between aircraft pairs in terms of distance and time. The observed spacing between aircraft pairs is compared to the distribution of aircraft spacing assumed in the collision risk model. The ICAO Separation and Airspace Safety Panel (SASP) has finalized the monitoring methodology for reduced longitudinal separation standards for the second edition of the ICAO Doc 10063, *Manual on Monitoring the Application of Performance-based Horizontal Separation Minima*.

4.9 The methodology essentially compares the observed aircraft pair spacings to those assumed in the collision risk model. **Figure 8** shows the direct comparison of the modeled versus observed longitudinal spacing. The red line in Figure 8 represents the modeled aircraft spacing, the blue line represents the observed aircraft spacing. The monitoring methodology provides results that meet the TLS when the blue line is below the red line. **Figure 9** shows the same results as Figure 8, but with a closer view of the most important area of the chart, the area close to the minimum separation distances.

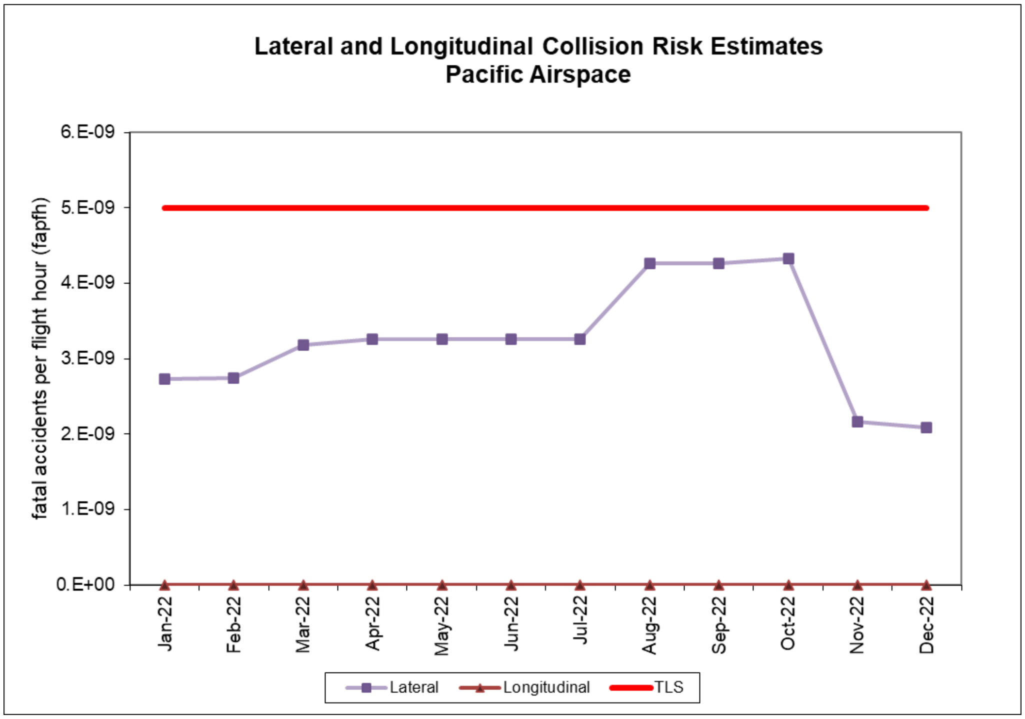

Figure 7: Trends of Horizontal Risk Estimates for Pacific Airspace

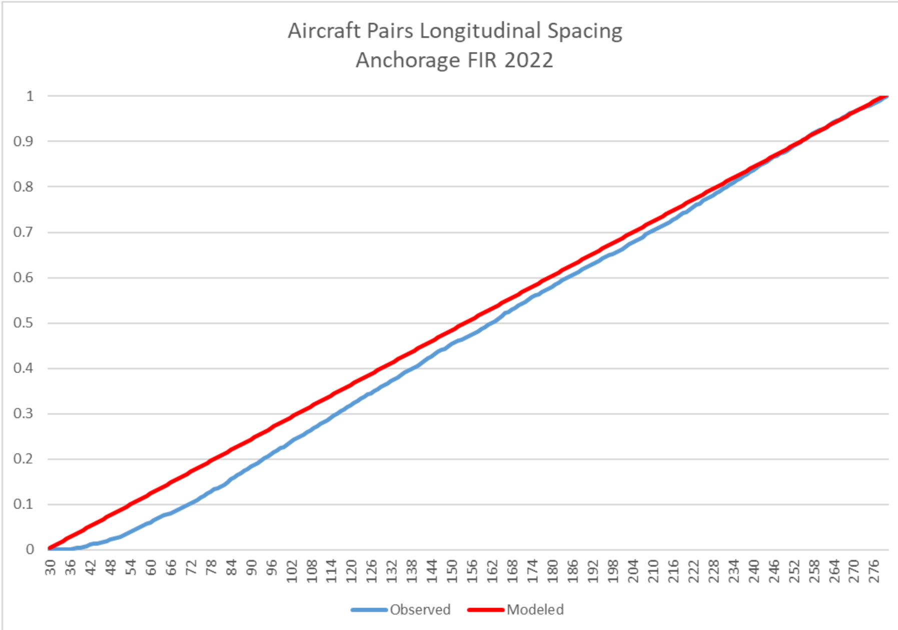

Figure 8: Longitudinal Aircraft Pair Spacing

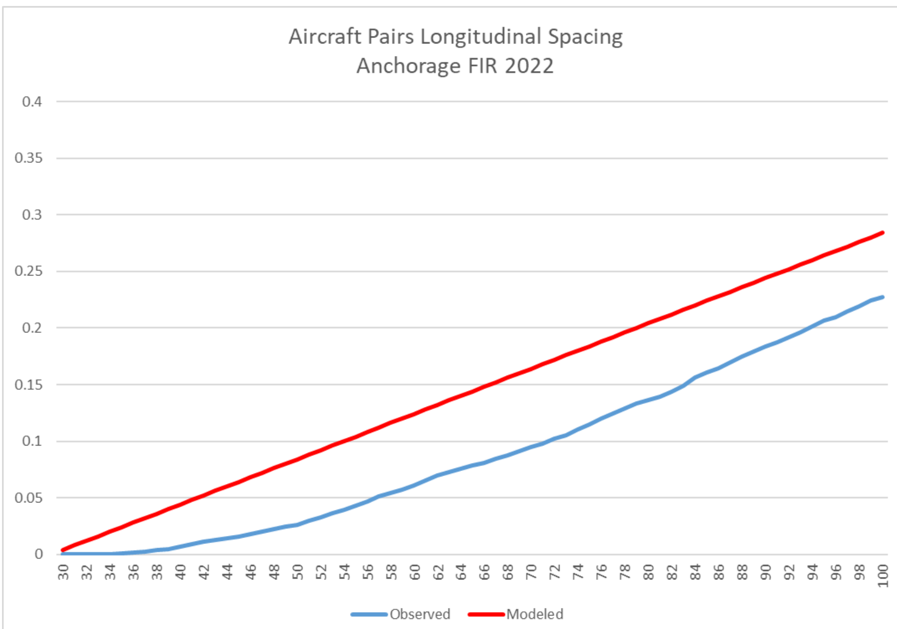

Figure 9: Longitudinal Aircraft Pair Spacing – closely spaced aircraft pairs