International Civil Aviation Organization

Twenty-Sixth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/26)

Video Teleconference, 20 – 23 September 2021

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

PARMO HORIZONTAL SAFETY MONITORING REPORT

(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 2020. 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 2020. The COVID-19 pandemic and associated reduction in air travel had an effect on the traffic levels and reported occurrences during calendar year 2020. 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

2.1 **Attachment A** contains the PARMO Horizontal Safety Monitoring Report for January to December 2020.

<u>Executive Summary</u>

2.2 **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 2020 to December 2020.

Pacific Airspace – estimated annual flying hours = 858,079 hours *(note: estimated hours based on Dec 2020 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 25 Lateral Risk	3.35×10^{-9}	5.0×10^{-9}	*Below TLS*
RASMAG 25 30NM Longitudinal Risk	4.08×10^{-9}	5.0×10^{-9}	*Below TLS*
RASMAG 25 50NM Longitudinal Risk	2.22×10^{-9}	5.0×10^{-9}	*Below TLS*
Lateral Risk	$\mathbf{0.09 \times 10^{-9}}$	5.0×10^{-9}	**Below TLS**
30NM Longitudinal Risk	$\mathbf{4.08 \times 10^{-9}}$	5.0×10^{-9}	**Below TLS**
50NM Longitudinal Risk	$\mathbf{2.22 \times 10^{-9}}$	5.0×10^{-9}	**Below TLS**

Table 1: Pacific Airspace Horizontal Risk Estimates

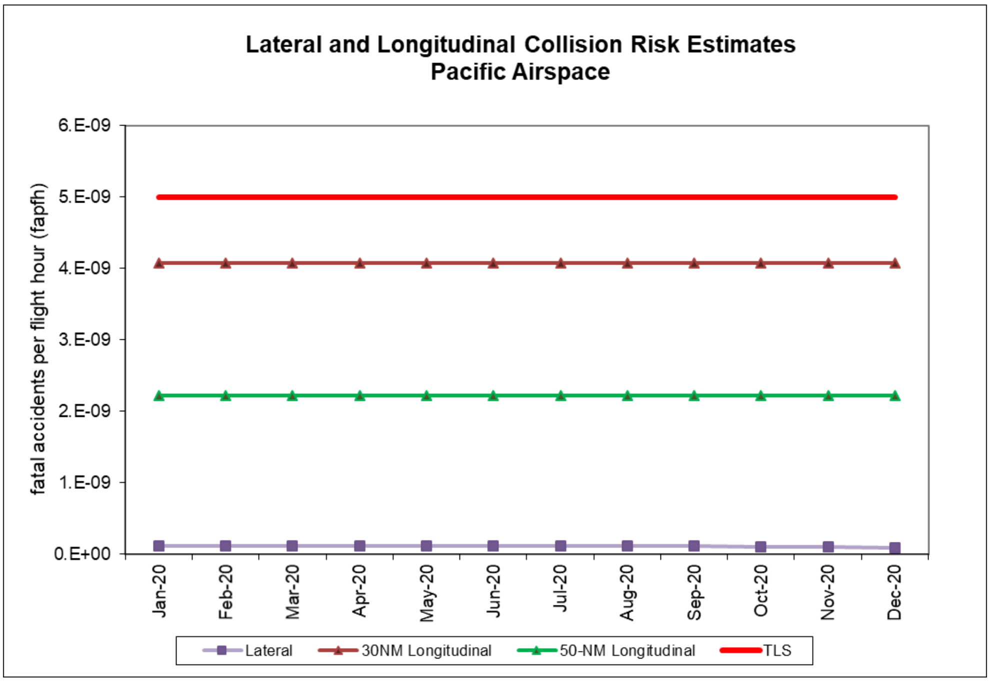

Figure 1: Pacific Airspace Horizontal Risk Estimates

2.3 **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	6
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	0
E	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	65
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;	1

Code	Deviation Description	No.
I	An aircraft was provided with reduced horizontal separation minima but did not meet the RNP/RSP/RCP specification	0
J	Others	0
Total		74

Table 2: Summary of Pacific Airspace LLD and LLE Reports

2.4 **Figure 2** provides the geographic location of risk bearing LLE and LLD reports within Pacific Airspace during the assessment period.

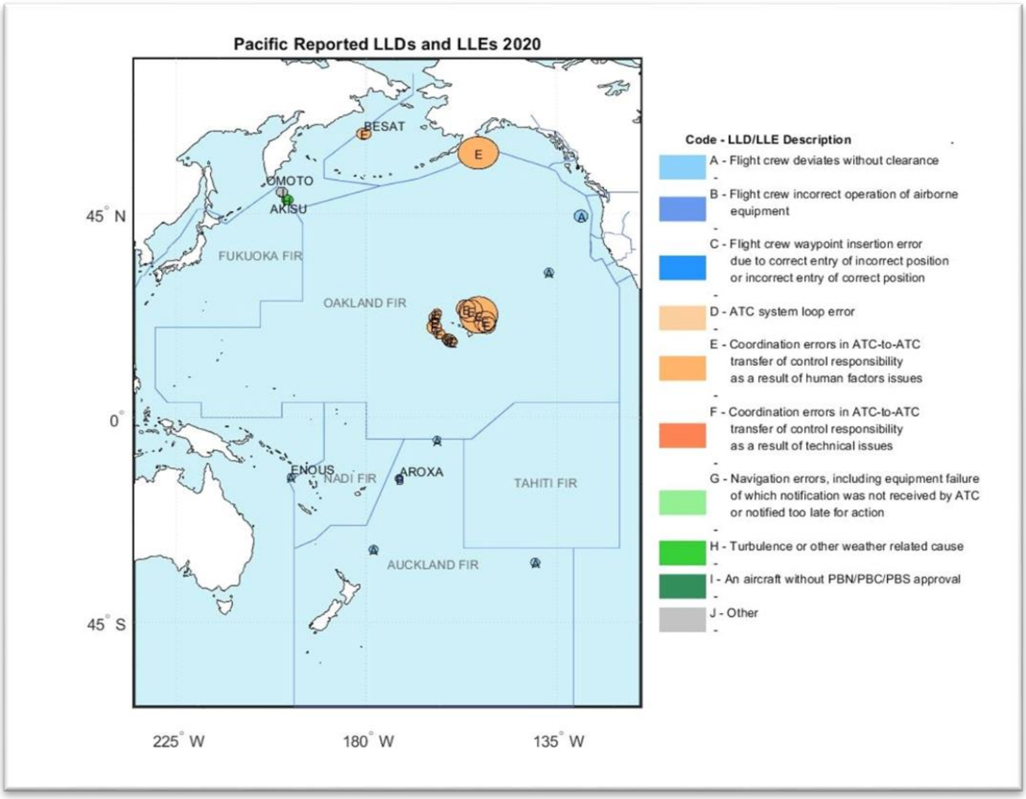

Figure 2: Pacific Airspace – Risk Bearing LLD/LLE

2.5 A task force has been established to develop mitigations for the high number of reported category E occurrences between Honolulu Control Facility (HCF) and Oakland center. A summary of the task force progress is provided in the attachment to this paper.

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 2020 TO December 2020

Prepared by
Pacific Approvals and Registry Monitoring Organization (PARMO) – ***August 2021***
(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 2020 for aircraft operations in the Anchorage, Auckland, Nadi, Oakland, and Tahiti FIRs was used as required by ICAO Regional agreement. **Table 1** indicates all FIRs have submitted a TSD to the PARMO.

FIR	December 2020 TSD Submitted to PARMO
Anchorage	X
Auckland	X
Nadi	X
Oakland	X
Tahiti	X

Table 1: December 2020 TSD Submitted to PARMO

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 2020. **Table 2** indicates those FIRs which submitted LLD and LLE reports including nil returns.

	Anchorage	Auckland	Nadi	Oakland	Tahiti
Jan 2020	X	X	X	X	X
Feb 2020	X	X	X	X	X
Mar 2020	X	X	X	X	X
Apr 2020	X	X	X	X	X
May 2020	X	X	X	X	X
Jun 2020	X	X	X	X	X
Jul 2020	X	X	X	X	X
Aug 2020	X	X	X	X	X
Sep 2020	X	X	X	X	X
Oct 2020	X	X	X	X	X
Nov 2020	X	X	X	X	X
Dec 2020	X	X	X	X	X

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

3. Summary of LLD and LLE Occurrences in Pacific Airspace

3.1 There were ten LLDs and sixty-four LLEs reported to the PARMO during calendar year 2020. **Table 3** provides the number of reported LLDs and LLEs by month for all seventy-four reports.

Month	No. of Reported LLDs and LLEs	Duration (min)	Number of tracks crossed w/o clearance
2020			
January	5	100	1
February	1	0	1
March	1	0	2
April	2	0	1
May	3	16	0
June	3	9	0
July	6	87	0
August	1	5	0
September	7	36	0
October	18	100	0
November	13	76	1
December	14	72	0
Total	74	501	6

Table 3: Summary of reported LLDs and LLEs for Pacific airspace – 2020

3.2 From the seventy-four reported occurrences, there were thirty-seven reported LLDs/LLEs that did not involve aircraft operations eligible for reduced separations. **Table 4** summarizes the number of reported LLDs and LLEs by category code from 1 January 2020 to 31 December 2020 inclusive for Pacific airspace.

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

Code	Deviation Description	No.
A	Flight crew deviates without ATC Clearance	6
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	0
E	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility due to human factor issues	65

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	1
I	An aircraft without PBN approval	0
J	Other	0
	Total	**74**

Table 4: Summary of reported LLDs and LLEs by category – 2020

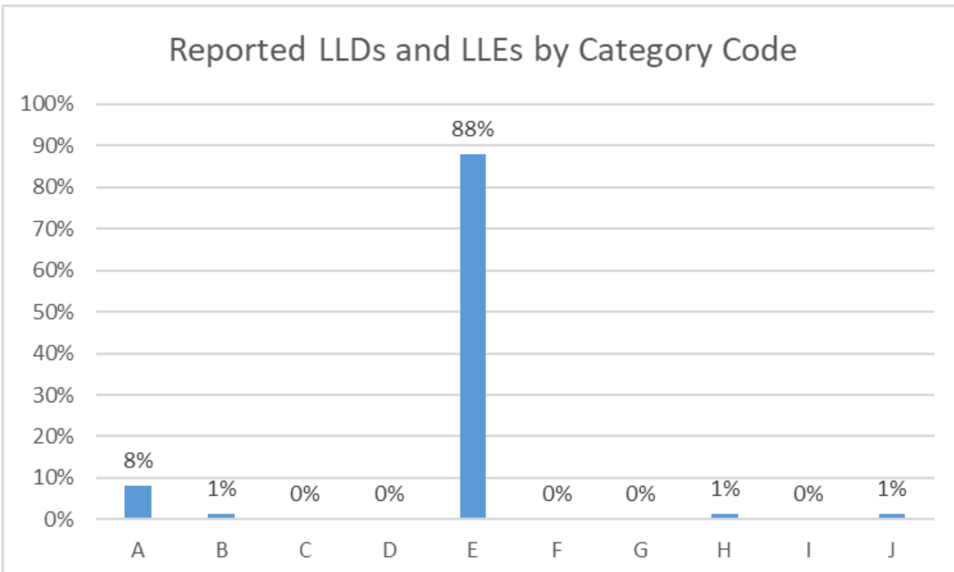

Figure 1: All Reported LLDs and LLEs by Category Code

3.4 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.

3.5 **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 year 2019.

LLD and LLE Category Codes								
	A	B	D	E	F	J	H	Totals
Jan-20	2	1	0	2	0	0	0	**5**
Feb-20	1	0	0	0	0	0	0	**1**
Mar-20	0	0	0	0	0	0	1	**1**
Apr-20	2	0	0	0	0	1	0	**3**
May-20	0	0	0	3	0	0	0	**3**
Jun-20	0	0	0	2	0	1	0	**3**
Jul-20	0	0	0	6	0	0	0	**6**
Aug-20	0	0	0	1	0	0	0	**1**
Sep-20	0	0	0	7	0	0	0	**7**
Oct-20	0	0	0	18	0	0	0	**18**
Nov-20	1	0	0	12	0	0	0	**13**
Dec-20	0	0	0	14	0	0	0	**14**
Totals	**6**	**1**	**0**	**65**	**0**	**2**	**1**	**74**

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

3.6 **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.

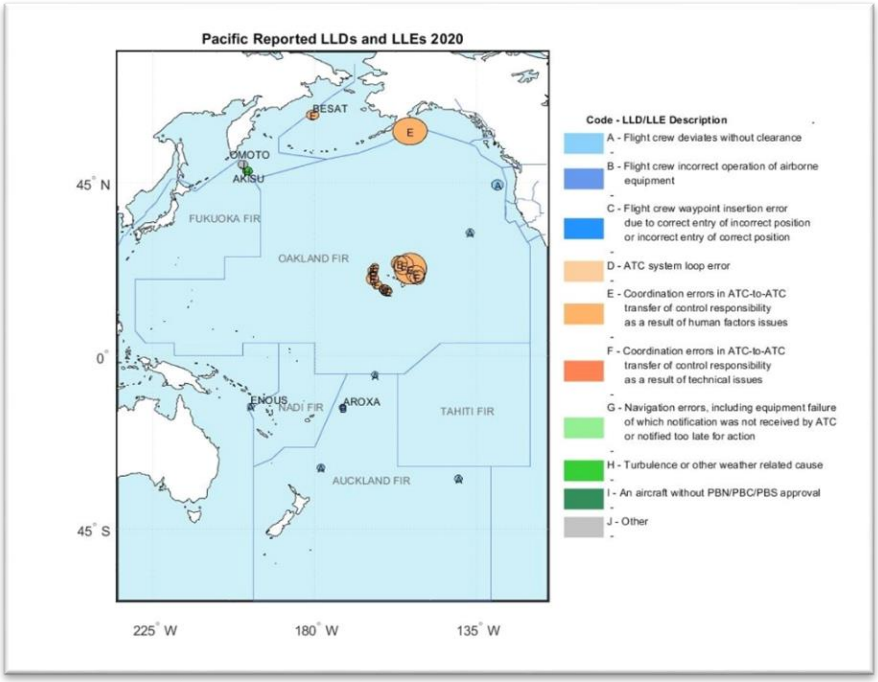

Figure 2: Locations of reported LLDs and LLEs – Calendar Year 2020

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 2017 through 2020. The LLD category descriptions were provided in Table 4. There were ten reported LLDs during calendar year 2020. This is a significant decrease in the overall number of reported LLDs and LLEs received by PARMO compared to previous years. This result is likely due to the COVID-19 pandemic and related reduction in air travel. **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 without ATC clearance. In 2020, three of the six reported category A LLDs have indicated that weather (category H) was a secondary causal factor.

3.10 These data also show a decreasing trend in category E LLDs for errors in ATC-to-ATC coordination from 2017 - 2020. **Figure 5** shows the locations for the reported LLDs by category in Pacific airspace. Some of the locations shown for category E LLDs are not along the FIR boundary, but correspond to the aircraft location at the ATC identified the error.

LLD Category	2017	2018	2019	2020
A	5	14	9	6
B	2	7	3	1
C	0	0	0	0
D	0	2	1	0
E	3	9	11	1
F	0	0	0	0
G	1	1	2	0
H	5	0	0	1
I	0	0	0	0
J	0	1	0	1
Totals	16	34	26	10

Table 6. Trends in reported LLDs by category, 2017 - 2020

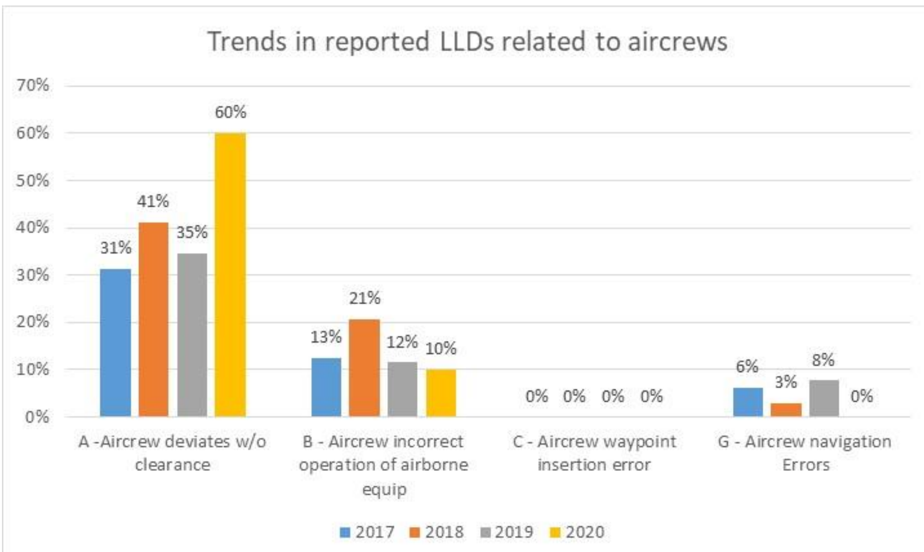

Figure 3: Trend in reported LLDs for categories related to aircrew

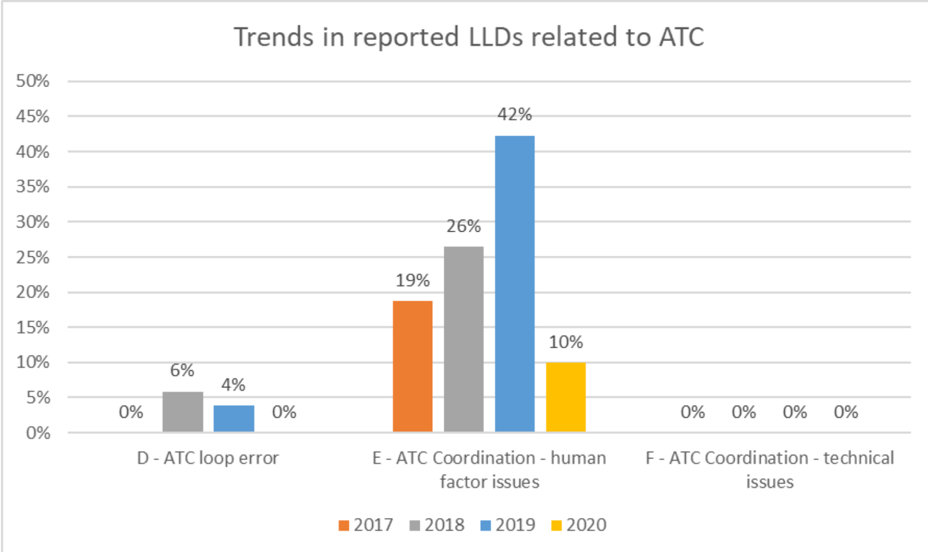

Figure 4: Trend in reported LLDs for categories related to ATC

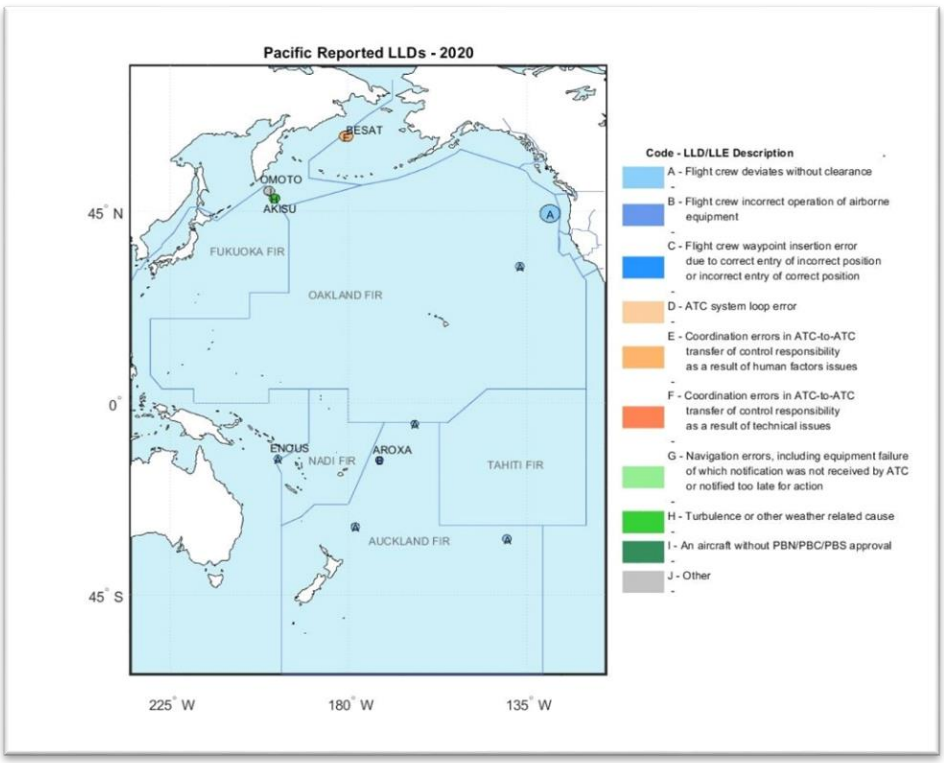

Figure 5: Reported LLD locations in Pacific airspace - 2020

3.11 Trends Observed in Reported Large Longitudinal Errors (LLEs)

3.12 **Table 7** shows the trends in the number of reported LLEs by category for calendar years 2018 through 2020. 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 sixty-three of these reported category E LLEs between HCF and Oakland Oceanic FIR in 2020Figure 6 shows the locations for the reported LLEs in 2020. All reports except for one LLE are in the HCF area.

Category	2018	2019	2020
A	0	1	0
B	1	0	0
C	0	0	0
D	0	0	0
E	2	62	64
F	1	1	0
G	0	0	0
H	0	0	0
I	1	0	0
Total	5	64	64

Table 7. Trends in reported LLEs by category, 2018 vs 2019

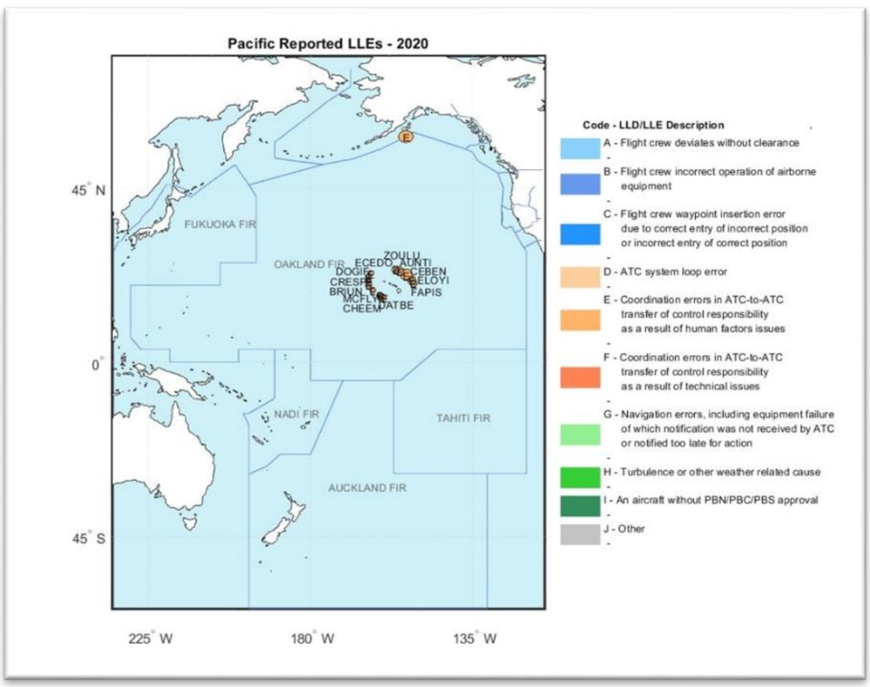

Figure 6: Reported LLE locations in Pacific airspace - 2020

3.13 The scrutiny review group informed PARMO these LLE occurrences between HCF and Oakland center 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. The resources needed for this activity were made available sporadically during calendar year 2020 due to the COVID-19 pandemic and associated staffing challenges at the Air Route Traffic Control Centers (ARTCCs).

3.14 A task force has been established to further investigate these occurrences and determine remedial actions. After being delayed due to the COVID-19 pandemic, the task force met at the HCF early 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 is to implement the En Route Automation Modernization (ERAM) system at the HCF by the end of calendar year 2025. Prior to that time, the task force developed the following mitigation strategies:

3.14.1 A procedure that requires the controller to determine the remaining travel time to the boundary fix was approved for the HCF. During this procedure, ATC will compute an estimated time of arrival (ETA) for the boundary fix and manually transfer the ETA to the next facility. It is noted that this is a manual procedure and is considered to be a short-term solution.

3.14.2 The task force will examine the resulting occurrence data once this short-term solution is in place. If the data show that the short-term solution is not sufficient, there is another procedure that could be implemented for the short-term. This other procedure involves the controller obtaining the ETA for the boundary fix from the air crew and then transferring that time to the receiving facility. This procedure is in use in other oceanic airspace where the United States provides air traffic services.

3.14.3 Another interim step considered by the task force is to develop Performance Based Navigation (PBN) route structures for HCF. Due to the timeline and funding required for the development of PBN routes, this activity may not be complete prior to the implementation of ERAM in calendar year 2025. However, the task force considered the associated benefits with PBN routes and suggested this this development activity may happen in parallel. The HCF and Oakland Oceanic ARTCC facilities continue the work of the task force established to examine repeated occurrences in ATC-to-ATC coordination. The current status of the task force work is ongoing, personnel from both facilities are involved in the effort.

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 have to be taken into account due to the various lateral separation minima. This methodology is in use for lateral risk estimates for 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 value 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.

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
Ey(same)	Same direction lateral occupancy, estimated from TSD	0.0005
Ey(opp)	Opposite direction lateral occupancy, estimated from TSD	0.0000
$P_z(0)$	Probability two aircraft at the same nominal level are in vertical overlap	0.42
T	ADS-C periodic report frequency	10 minutes

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

Traffic Flow	Annual Flying Hours	Percent	Average Aircraft Length, **λx** (NM)	Average Aircraft Wingspan, **λy** (NM)	Average Aircraft Height, **λz** (NM)
NOPAC	225,822.8	26.32%	0.037	0.034	0.010
CENPAC	288,890.9	33.67%	0.037	0.035	0.010
CEP	215,009.2	25.06%	0.026	0.022	0.007
JPHAWA	23,904.4	2.79%	0.033	0.032	0.009
JPGUAM	55,19.4	0.64%	0.027	0.025	0.008
OTHER	13,307.9	1.55%	0.026	0.023	0.008
AUSNZSP	26,258.0	3.06%	0.025	0.023	0.007
NADI	3,907.0	0.46%	0.031	0.030	0.009
AUSNZJP	11,864.5	1.38%	0.034	0.034	0.010
SOPAC	43,595.0	5.08%	0.035	0.034	0.010
TOTAL	858,079.0	100.00%	0.033 NM	0.031 NM	0.009 NM
			200.6 ft	***187.6 ft***	***55.0 ft***

Table 9: Horizontal CRM Parameters that Vary by Traffic Flow

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 2020 decreased from the estimate provided for calendar year 2019. This result is in part due to the COVID-19 pandemic and related reduction in air travel.

Pacific Airspace – estimated annual flying hours = 858,079 hours *(note: estimated hours based on Dec 2020 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
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RASMAG 25 50NM Longitudinal Risk	*2.22×10^{-9}*	*5.0×10^{-9}*	*Below TLS*
Lateral Risk	**0.09×10^{-9}**	5.0×10^{-9}	**Below TLS**
30NM Longitudinal Risk	**4.08×10^{-9}**	5.0×10^{-9}	**Below TLS**
50NM Longitudinal Risk	**2.22×10^{-9}**	5.0×10^{-9}	**Below TLS**

Table 10: Pacific Airspace Horizontal Risk Estimates

4.7 **Figure 7** presents the lateral and longitudinal collision risk estimate trends during the period from January to December 2020.

4.8 The estimates of longitudinal collision risk remain constant from the previous year. This result is due to the use of the Anderson-Hsu collision risk model; which was developed to support the distance-based longitudinal separation minima. The input parameters to this model include assumptions about the performance of the communication, navigation, and surveillance systems. ICAO Document 9869, *Performance-based Communication and Surveillance (PBCS) Manual*, and ICAO Document 10037, the *Global Operational Data Link (GOLD) Manual*, provide guidance for the use of the communication and surveillance systems needed for the distance-based longitudinal separation minima. The assumptions related to the aircraft navigation systems include lateral path-keeping performance (e.g. RNP 4).

4.9 The underlying CRM assumptions require ongoing monitoring to ensure the aircraft and airspace using these standards continue to meet the modeled assumptions. The ICAO Separation and Airspace Safety Panel (SASP) produced ICAO Circular 343, *Guidelines for the Implementation of Performance-based Longitudinal Separation Minima*. One objective of this circular is to provide specific monitoring requirements for the application of longitudinal separation minima that rely on PBCS and PBN systems. The monitoring requirements contained in Circular 343 specify criteria for aircraft speed errors and the proportion of aircraft pairs within specified separation distances. The SASP is close to finalizing the revised longitudinal monitoring methodology; which will be included in the 2nd edition of ICAO Doc 10063, *Manual on Monitoring the Application of Performance-based Horizontal Separation Minima*.

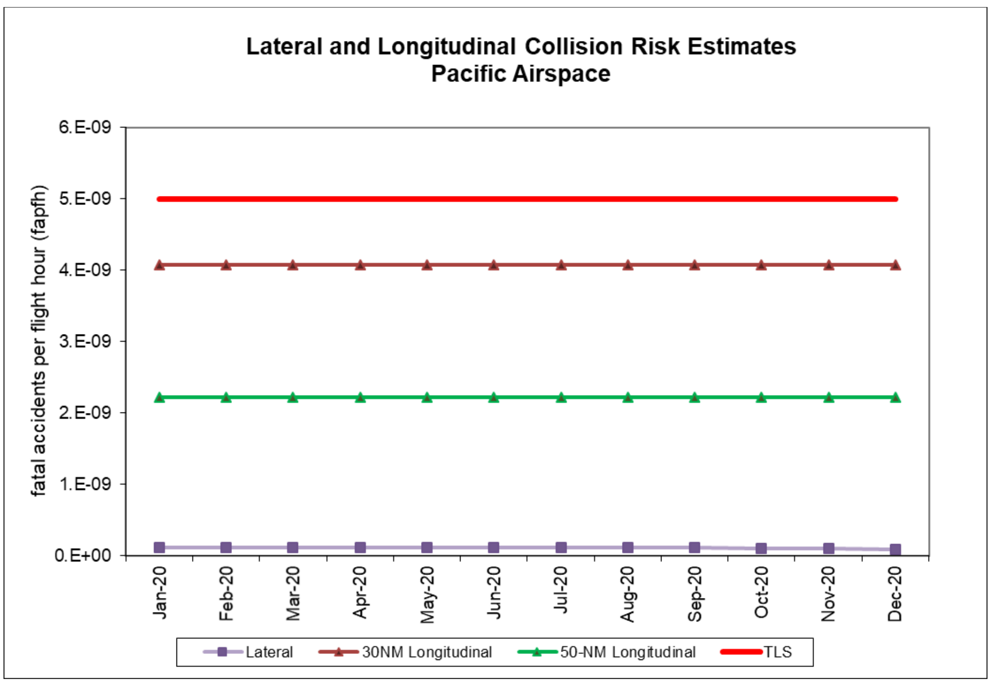

Figure 7: Trends of Horizontal Risk Estimates for Pacific Airspace