



ICAO

*International Civil Aviation Organization*  
**Twenty-Fifth Meeting of the Regional Airspace Safety  
Monitoring Advisory Group (RASMAG/25)**

Video Teleconference, 27 – 30 October 2020

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**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 2019. 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 report covers the current reporting period 1 January to 31 December 2019 in the PARMO's ongoing process of providing periodic updates of information relevant to the continued safe use of the reduced lateral and longitudinal separation standards in Pacific airspace.

1.3 Within the report, the reader will find the large lateral deviation (LLD) and large longitudinal error (LLE) reports received by the PARMO during the reporting period. There were ninety such reports submitted to the PARMO during the reporting period. From the ninety reports received by PARMO, there were twenty-six LLDs and sixty-four LLEs reported.

**2. DISCUSSION**

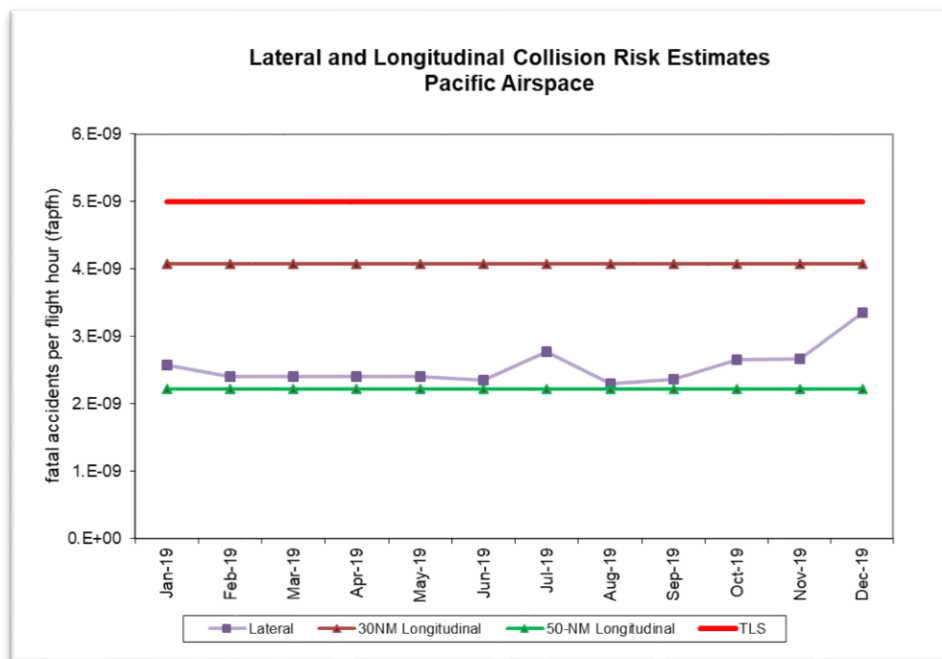
2.1 **Attachment A** contains the PARMO Horizontal Safety Monitoring Report for January to December 2019.

Executive Summary

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 2019 to December 2019.

<b>Pacific Airspace – estimated annual flying hours = 1,754,211 hours</b> <i>(note: estimated hours based on Dec 2019 traffic sample data)</i>			
<b>Risk</b>	<b>Risk Estimation</b>	<b>TLS</b>	<b>Remarks</b>
RASMAG 24 Lateral Risk	$0.16 \times 10^{-9}$	$5.0 \times 10^{-9}$	Below TLS
RASMAG 24 Longitudinal Risk	$4.08 \times 10^{-9}$	$5.0 \times 10^{-9}$	Below TLS
Lateral Risk	$3.35 \times 10^{-9}$	$5.0 \times 10^{-9}$	<b>Below TLS</b>
Longitudinal Risk	$4.08 \times 10^{-9}$	$5.0 \times 10^{-9}$	<b>Below TLS</b>

**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.

<b>Code</b>	<b>Deviation Description</b>	<b>No.</b>
A	Flight crew deviates without ATC clearance in the horizontal dimension	10
B	Flight crew incorrect operation or interpretation of airborne equipment	3
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	1
E	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	73
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	3
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	0
Total		90

**Table 2:** Summary of Pacific Airspace LLD and LLE Reports

2.4 There were two long duration LLDs reported in 2019, these reported LLDs had durations of eighty-three and forty-four minutes. Both occurrences involved a military operation on a “round-robin” flight. The primary cause of these reports was error in ATC-unit to ATC-unit transfer. The transferring ATC unit did not provide information to the receiving ATC unit. The aircraft operated within oceanic airspace without knowledge of the receiving ATC unit, the aircraft were radar identified near the destination airport. Both occurrences took place in low traffic areas of Pacific airspace, there were no losses of separation recorded. The primary LHD category for this report was ‘E’, error in ATC-unit-to-ATC-unit transfer. The transferring ATC unit was made aware of this occurrence. The reporting ATC units indicated that this is a specific problem associated with “round-robin” flights, which are unique operations. A software fix for the AIDC handling of round-robin flights is now in place along with a verbal procedure to ensure an invalid transfer message is not sent.

2.5 There were significant increase in category E reported LLEs are due to the large number of reports for transfer errors between Honolulu Control Facility (HCF) and Oakland Oceanic FIR. There were sixty-two of these reported category E LLEs between HCF and Oakland Oceanic FIR. A task force has been established to work on this problem. The current status of the task force work is ongoing, personnel from both facilities are involved in the effort.

2.6 AIDC has now been implemented for aircraft transfers between Anchorage Oceanic and Magadan FIRs. There was a reported LLD with an eighteen-minute duration in January 2019 which occurred prior to the AIDC implementation between the two facilities. This LLD occurrence helped to encourage establishing AIDC between the two facilities.

2.7 One ATC facility took action to organize a work group to examine “nuisance” messages because of reported occurrences. Here, the term, “nuisance” is used to describe alerts provided to the controller. The scrutiny review team informed PARMO there are, in general, many out-of-conformance alerts delivered to the controller by the automation system. Sometimes, the controllers receiving the out-of-conformance reports believe they already know the information contained in the alert before reading it completely. These “nuisance” alerts are sometimes discarded.

2.8 An ATC outage in an adjacent FIR and the related reported occurrences caused one ATC facility to initiate a system service review (SSR). A result of the SSR was to retrained controllers on the use of HOLD messages in the automation system. It took more than a month to have all ATC personnel retrained; this training is now part of the annual refresher training at the facility.

**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 2019 TO December 2019**

Prepared by  
**Pacific Approvals and Registry Monitoring Organization (PARMO) – July 2020**  
*(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 2019 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.

**Table 1:** December 2019 TSD Submitted to PARMO

FIR	December 2019 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 LHD reports was used, covering January to December 2019. **Table 2** indicates those FIRs which submitted LHD reports including nil returns.

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

	Anchorage	Auckland	Nadi	Oakland	Tahiti
Jan 2019	X	X	X	X	X
Feb 2019	X	X	X	X	X
Mar 2019	X	X	X	X	X
Apr 2019	X	X	X	X	X
May 2019	X	X	X	X	X
Jun 2019	X	X	X	X	X
Jul 2019	X	X	X	X	X
Aug 2019	X	X	X	X	X
Sep 2019	X	X	X	X	X

	Anchorage	Auckland	Nadi	Oakland	Tahiti
Oct 2019	X	X	X	X	X
Nov 2019	X	X	X	X	X
Dec 2019	X	X	X	X	X

### 3. Summary of LLD and LLE Occurrences in Pacific Airspace

3.1 There were twenty-six LLDs and sixty-four LLEs reported to the PARMO during calendar year 2019. **Table 3** provides the number of reported LLDs and LLEs by month for all ninety reports.

**Table 3:** Summary of reported LLDs and LLEs for Pacific airspace – 2019

Month	No. of Reported LLDs and LLEs	Maximum Magnitude (NM)	Maximum Duration (min)
<b>2019</b>			
January	3	0	18
February	4	15	18
March	0	0	0
April	1	0	0
May	0	0	0
June	1	0	0
July	3	5	5
August	3	5	12
September	9	18	10
October	48	0	83
November	11	15	11
December	7	25	44
<b>Total</b>	<b>90</b>	<b>25</b>	<b>83</b>

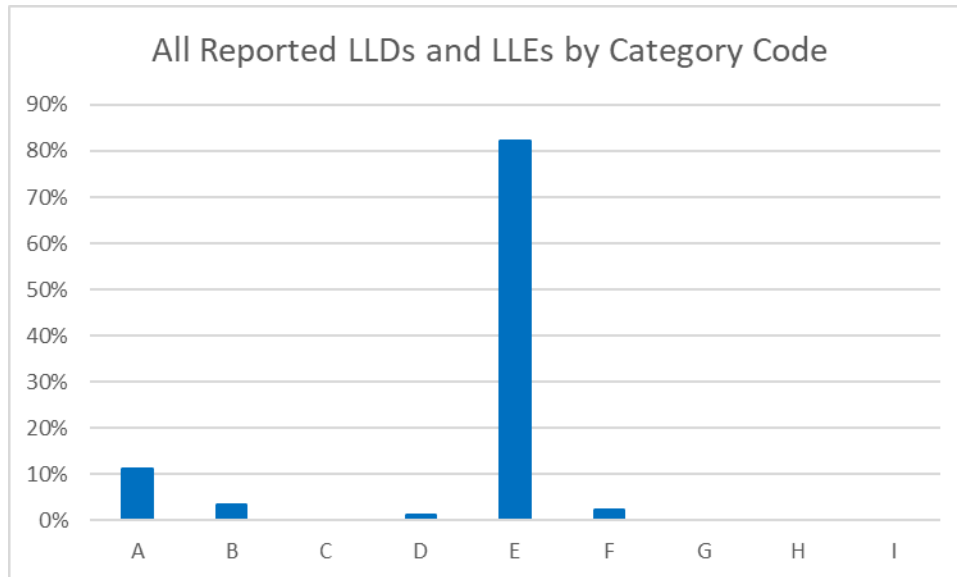
3.2 From the eighty-nine reported LLDs and LLEs there were forty-six reported LLDs/LLEs that did not involve aircraft operations eligible for reduced separations. **Table 4** summarizes the number of reported LLDs and LLEs by category code from 1 January 2019 to 31 December 2019 inclusive for Pacific airspace. *Note that the categories listed in Table 4 and in the remaining analysis contained in this report combine LLD/LLE reports caused by ATC-to-ATC transfer errors due to human factor causes and technical causes into one category. The classifications in this report do not exactly match the categories listed in the working paper Table 2. Future reports from PARMO will have these categories corrected.*

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

**Table 4:** Summary of reported LLDs and LLEs by category – 2019

Code	Deviation Description	No.
A	Flight crew deviates without ATC Clearance	10
B	Flight crew incorrect operation or interpretation of airborne equipment	3
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	1
E	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility	73
F	Navigation errors, including equipment failure of which notification was not received by ATC or notified too late for action	3
G	Turbulence or other weather related causes	0
H	An aircraft without PBN approval	0
I	Other	0
	<b>Total</b>	<b>90</b>

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

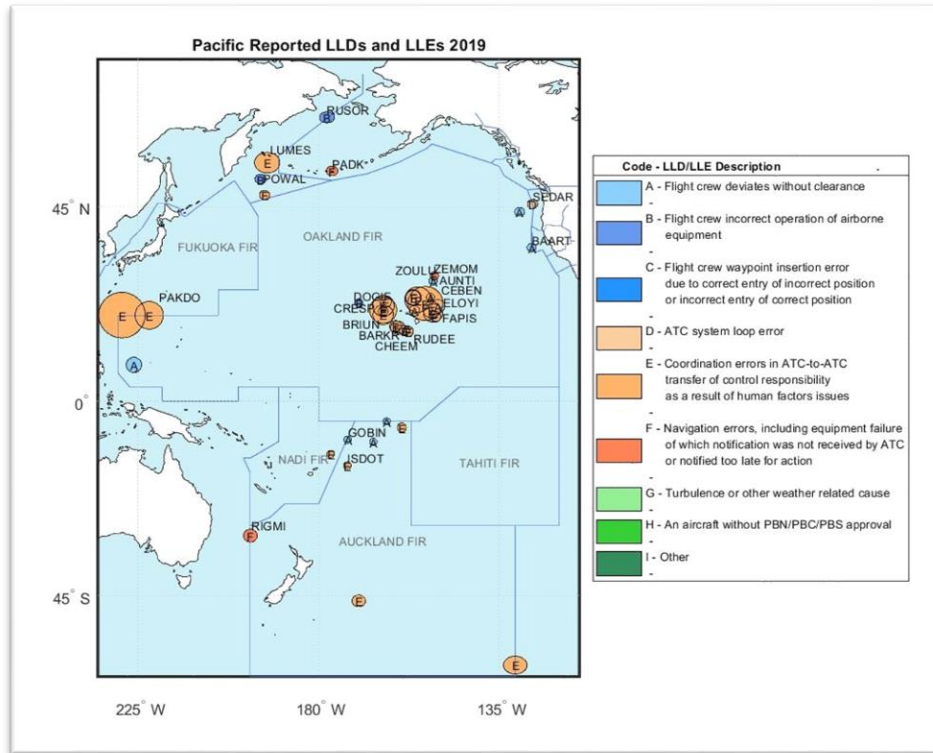
3.5 Due to the variety of lateral separation standards available in Pacific airspace, it is necessary to examine each reported LLD to determine the eligible lateral separation standard(s) for the aircraft involved. It is not necessary that a lateral separation minimum been applied during the time of 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 is a change from previous years where category A was the top contributor.

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

<b>LLD and LLE Category Codes</b>						
	<b>A</b>	<b>B</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>Totals</b>
<b>Jan-18</b>	0	1	0	2	0	<b>3</b>
<b>Feb-18</b>	3	0	0	0	1	<b>4</b>
<b>Mar-18</b>	0	0	0	0	0	<b>0</b>
<b>Apr-18</b>	1	0	0	0	0	<b>1</b>
<b>May-18</b>	0	0	0	0	0	<b>0</b>
<b>Jun-18</b>	0	0	0	1	0	<b>1</b>
<b>Jul-18</b>	0	1	0	2	0	<b>3</b>
<b>Aug-18</b>	1	1	0	2	0	<b>3</b>
<b>Sep-18</b>	1	0	0	7	1	<b>9</b>
<b>Oct-18</b>	0	0	0	48	0	<b>48</b>
<b>Nov-18</b>	1	1	0	9	0	<b>11</b>
<b>Dec-18</b>	3	0	1	2	1	<b>7</b>
<b>Totals</b>	<b>10</b>	<b>3</b>	<b>1</b>	<b>73</b>	<b>3</b>	<b>90</b>



**Figure 2:** Locations of reported LLDs and LLEs – Calendar Year 2019

3.7 **Figure 3** shows the number of reported LLDs and LLEs by category code. There were ninety reported LLDs during calendar year 2019. This is an increase in the overall number of reported LLDs and LLEs received by PARMO compared to 2018 and 2017. There were thirty-four reported LLDs and LLEs in 2018, and eighteen received in 2017.

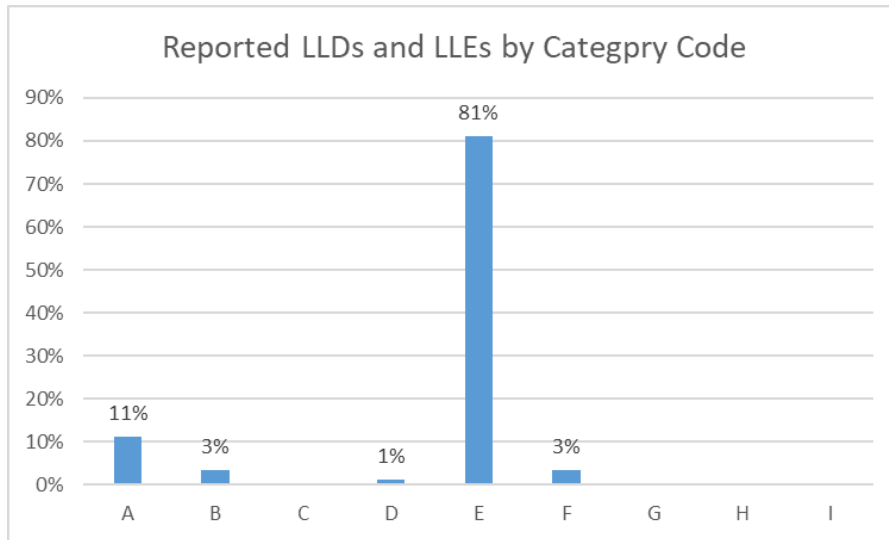
3.8 Another noticeable difference is the shift in the reported LLDs/LLEs categories. In 2018, more than 50 percent of the reports were category A. In 2019, more than 80 percent of the reports are category E. Table 4 provides the category definitions. The number of category A reports actually increases in 2019 [10] compared to 2018 [6]. However, the numbers of category E reports are much greater [73] in 2019 for Pacific airspace.

3.9 Trends Observed in Reported Large Lateral Deviations (LLDs)

3.10 **Table 6** shows the trends in the number of reported LLDs by category for 2017 through 2019. Table 4 provides a description of the categories. **Figure 4** shows the trend data in chart format for the categories related to aircrews. **Figure 5** shows the trend data for the categories related to ATC.

3.11 These data show a steady trend in category A LLDs for aircrews deviating without ATC clearance. In 2019, five of the nine reported category A LLDs have indicated that weather (category G) was a secondary causal factor.

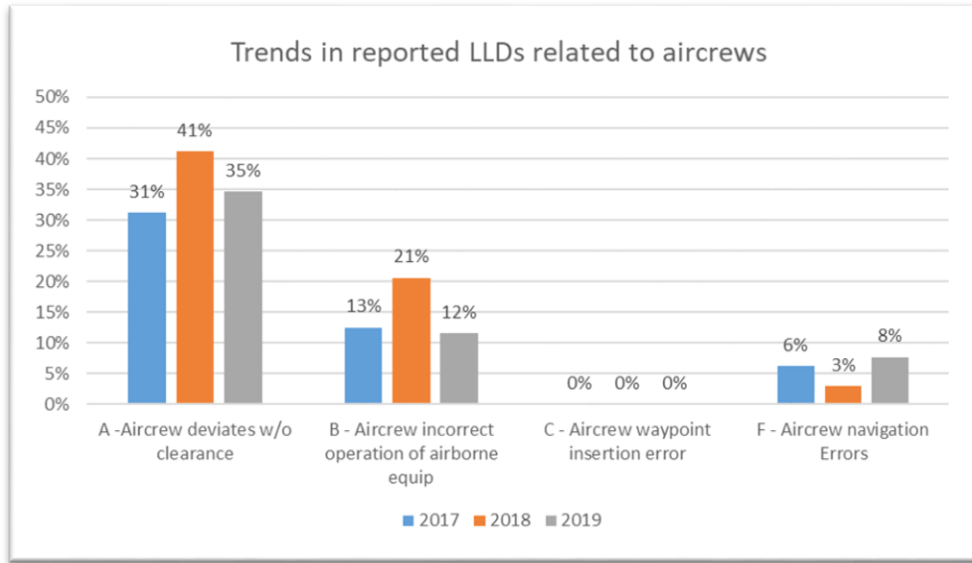
3.12 These data also show an increasing trend in category E LLDs for errors in ATC-to-ATC coordination from 2017 - 2019. **Figure 6** shows the locations for the reported LLDs by category in Pacific airspace. Some of the locations shown for category E LLDs are not along the FIR boundary, but correspond to the aircraft location at the ATC identified the error.



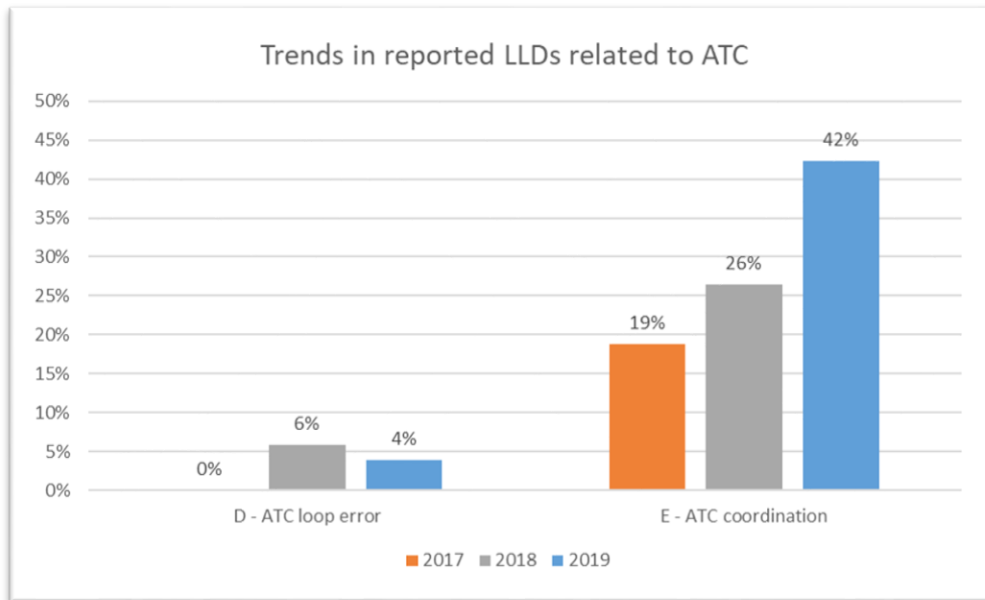
**Figure 3:** Reported LLDs and LLEs by Category Code

**Table 6.** Trends in reported LLDs by category, 2017 - 2019

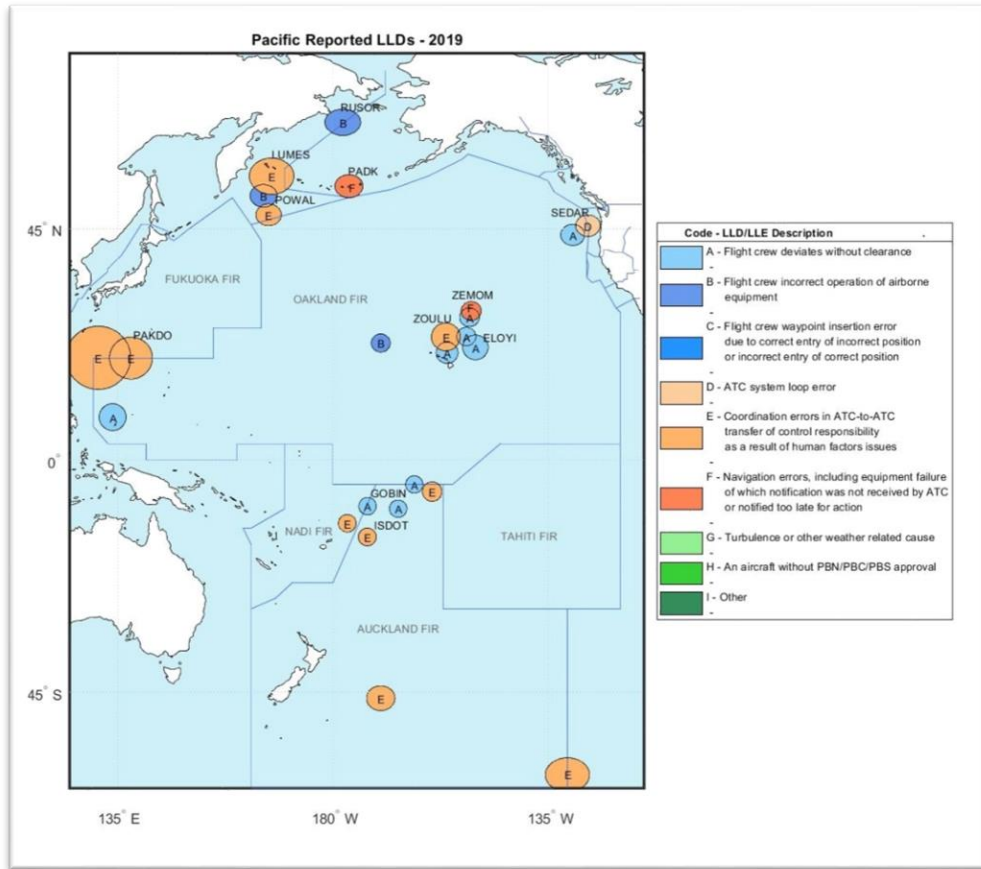
LLD Category	2017	2018	2019
<b>A</b>	5	14	9
<b>B</b>	2	7	3
<b>C</b>	0	0	0
<b>D</b>	0	2	1
<b>E</b>	3	9	11
<b>F</b>	1	1	2
<b>G</b>	5	0	0
<b>H</b>	0	0	0
<b>I</b>	0	1	0
<b>Totals</b>	16	34	26



**Figure 4:** Trend in reported LLDs for categories related to aircrew



**Figure 5:** Trend in reported LLDs for categories related to ATC



**Figure 6:** Reported LLD locations in Pacific airspace - 2019

3.13 There were two long duration LLDs reported in 2019, these are reported LLDs with duration at least twenty minutes. De-identified summaries of these two reports follow.

3.13.1 The longest LLD reported had a duration of eighty-three minutes. This event involved a military operation on a “round-robin” flight. The primary cause of this reported LLD was error in ATC-to-ATC transfer. The transferring ATC unit did not provide information to the receiving ATC unit. This aircraft operated within oceanic airspace without knowledge of the receiving ATC unit, it was radar identified near the destination airport. This event took place in a low traffic area of Pacific airspace, there was no loss of separation recorded. The primary LHD category for this report was ‘E’, error in ATC-to-ATC transfer. The transferring ATC unit was made aware of this occurrence. The reporting ATC units indicated that this is a specific problem associated with “round-robin” flights, which are unique operations. A software fix for the AIDC handling of round-robin flights is now in place along with a verbal procedure to ensure an invalid transfer message is not sent.

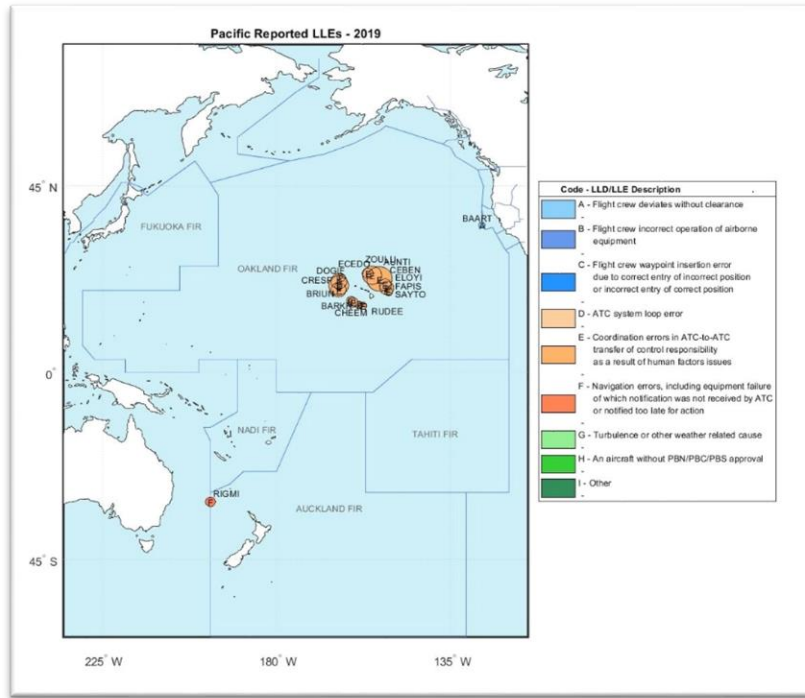
3.13.2 Another reported LLD had a duration of forty-four minutes. This was another event involving a military operation on a “round-robin” flight. This LLD occurred two months prior to the event listed above. This aircraft operated on an unexpected routing within oceanic airspace without knowledge of the receiving ATC unit, it was radar identified near the destination airport. This event took place in a low traffic area of Pacific airspace, there was no loss of separation recorded. The primary LLD category for this report was ‘E’, error in ATC-to-ATC transfer. The reporting ATC units indicated that this is a specific problem associated with “round-robin” flights, which are unique operations. A software fix for the AIDC handling of round-robin flights is now in place along with a verbal procedure to ensure an invalid transfer message is not sent.

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 2018 vs 2019. Table 4 provides a description of the categories. The significant increase in category E reported LLEs are due to the large number of reports for transfer errors between Honolulu Control Facility (HCF) and Oakland Oceanic FIR. There were sixty-two of these reported category E LLEs between HCF and Oakland Oceanic FIR. **Figure 7** shows the locations for the reported LLEs in 2019. All reports except for two LLEs are in the HCF area.

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

Category	2018	2019
<b>A</b>	0	1
<b>B</b>	1	0
<b>C</b>	0	0
<b>D</b>	0	0
<b>E</b>	2	62
<b>F</b>	1	1
<b>G</b>	0	0
<b>H</b>	0	0
<b>I</b>	1	0
<b>Total</b>	5	64



**Figure 7:** Reported LLE locations in Pacific airspace - 2019

3.16 The scrutiny review group informed PARMO these LLE occurrences between HCF and Oakland affect the user preferred routes (UPRs) crossing fixed airways within Oakland airspace. 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 during the September to November 2019 period, which helps to explain the inconsistent reporting for these occurrences. During this period, there were pauses in reporting occurrences as real-time improvements were made to both the process for examining the occurrences and the actual ATC-to-ATC transfer procedure itself. The current status of this work is ongoing; a task force has been established that includes personnel from both facilities.

3.17 Mitigations noted related to LLD and LLE occurrences

3.18 A few notable mitigations and improvements implemented as a result of the reported occurrences in 2019 are included in the following list:

3.18.1 AIDC has now been implemented for aircraft transfers between Anchorage Oceanic and Magadan FIRs. There was a reported LLD with an eighteen-minute duration in January 2019 which occurred prior to the AIDC implementation between the two facilities. This LLD occurrence helped to encourage establishing AIDC between the two facilities.

3.18.2 One ATC facility took action to organize a work group to examine “nuisance” messages because of reported occurrences. Here, the term, “nuisance” is used to describe alerts provided to the controller. The scrutiny review team informed PARMO there are, in general,

many out-of-conformance alerts delivered to the controller by the automation system. Sometimes, the controllers receiving the out-of-conformance reports believe they already know the information contained in the alert before reading it completely. These “nuisance” alerts are sometimes discarded.

- 3.18.3 An ATC outage in an adjacent FIR and the related reported occurrences caused one ATC facility to initiate a system service review (SSR). A result of the SSR was to retrained controllers on the use of HOLD messages in the automation system. It took more than a month to have all ATC personnel retrained; this training is now part of the annual refresher training at the facility.
- 3.18.4 The HCF and Oakland Oceanic ARTCC facilities established a task force 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 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 lateral buffer. If the occurrence involves a lateral deviation from a cleared route, the magnitude of the deviation is compared to the appropriate lateral buffer. Based on the available lateral separation minima in Pacific airspace, the current lateral buffers 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.

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

Parameter	Description	Value
$ \overline{\Delta V} $	Average relative same-direction speed	13 Knots
$ \overline{V} $	Average aircraft speed	480 knots
$ \overline{\dot{z}} $	Average relative vertical speed during loss of vertical separation	1.5 knots
$ \overline{\dot{y}} _0$	Average absolute relative cross track speed for aircraft nominally on the same track.	5 knots
$ \overline{\dot{y}} _{60}$	Average absolute relative cross track speed when one aircraft has committed a 1° waypoint insertion error.	80 knots
$E_y(\text{same})$	Same direction lateral occupancy, estimated from TSD	0.0715
$E_y(\text{opp})$	Opposite direction lateral occupancy, estimated from TSD	0.0008
$P_z(0)$	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	Average Aircraft Length, $\lambda_x$ (NM)	Average Aircraft Wingspan, $\lambda_y$ (NM)	Average Aircraft Height, $\lambda_z$ (NM)
NOPAC	228,621.0	13.03%	0.037	0.034	0.010
CENPAC	451,686.8	25.75%	0.037	0.035	0.010
CEP	499,785.8	28.49%	0.026	0.022	0.007
JPHAWA	101,600.9	5.79%	0.033	0.032	0.009
JPGUAM	15,850.4	0.90%	0.027	0.025	0.008
OTHER	19,873.1	1.13%	0.026	0.023	0.008
AUSNZSP	57,737.9	3.29%	0.025	0.023	0.007
NADI	22,603.0	1.29%	0.031	0.030	0.009
AUSNZJP	90,884.3	5.18%	0.034	0.034	0.010
SOPAC	265,568.1	15.14%	0.035	0.034	0.010
<b>TOTAL</b>	1,754,211.1	100.00%	0.032 NM	0.030 NM	0.009 NM
			<b>195.8 ft</b>	<b>183.7 ft</b>	<b>54.2 ft</b>

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  $5.0 \times 10^{-9}$  fapfh.**

4.6 The estimate of overall lateral risk for 2019 increased from the estimate provided for calendar year 2018. This result is due to the change in methodology for the evaluation of LLD reports and the associated contribution towards the estimate of collision risk. With the new methodology, the PARMO evaluates all reported LLDs against the lateral buffer criteria to determine whether a duration or tracks crossed are appropriate. The lateral risk estimate provided in 2018 considered only those LLDs reports involving for aircraft operations that filed RNP 4, RCP 240 and RSP 180 specifications.

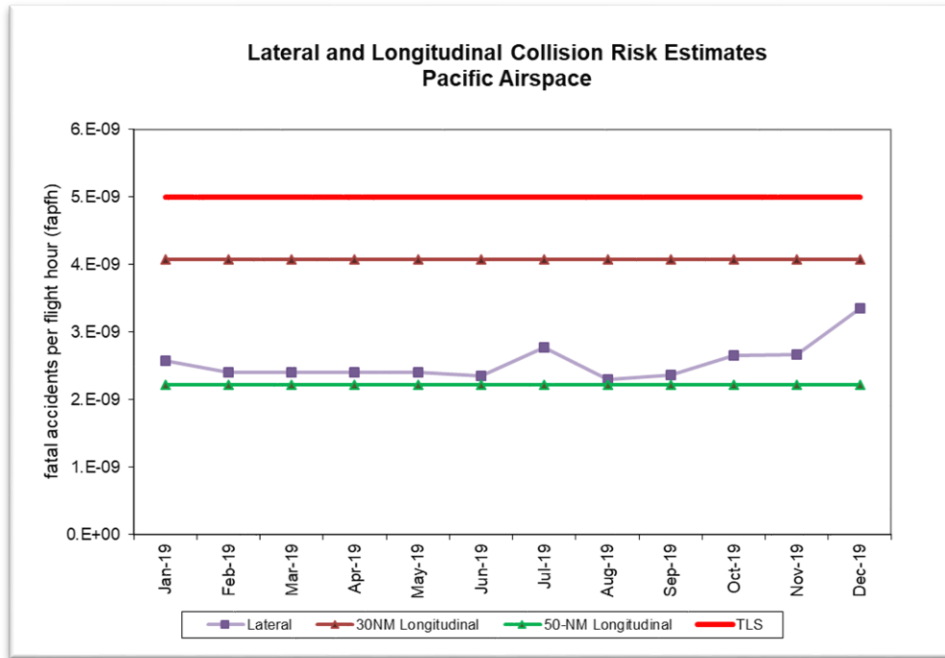
**Table 10: Pacific Airspace Horizontal Risk Estimates**

<b>Pacific Airspace – estimated annual flying hours = 1,754,211 hours</b> (note: estimated hours based on Dec 2019 traffic sample data)			
<b>Source of Risk</b>	<b>Risk Estimation</b>	<b>TLS</b>	<b>Remarks</b>
RASMAG 24 Lateral Risk	$0.16 \times 10^{-9}$	$5.0 \times 10^{-9}$	<i>Below TLS</i>
RASMAG 24 30NM Longitudinal Risk	$4.08 \times 10^{-9}$	$5.0 \times 10^{-9}$	<i>Below TLS</i>
RASMAG 24 50NM Longitudinal Risk	$2.22 \times 10^{-9}$	$5.0 \times 10^{-9}$	<i>Below TLS</i>
Lateral Risk	<b><math>3.35 \times 10^{-9}</math></b>	$5.0 \times 10^{-9}$	<b>Below TLS</b>
30NM Longitudinal Risk	<b><math>4.08 \times 10^{-9}</math></b>	$5.0 \times 10^{-9}$	<b>Below TLS</b>
50NM Longitudinal Risk	<b><math>2.22 \times 10^{-9}</math></b>	$5.0 \times 10^{-9}$	<b>Below TLS</b>

4.7 **Figure 8** presents the lateral and longitudinal collision risk estimate trends during the period from January to December 2019.

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 2<sup>nd</sup> edition of ICAO Doc 10063, *Manual on Monitoring the Application of Performance-based Horizontal Separation Minima*.



**Figure 8:** Trends of Horizontal Risk Estimates for Pacific Airspace