International Civil Aviation Organization
Twenty-Fifth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/25)
Video Teleconference, 27 – 30 October 2020

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

AKARA SAFETY ASSESSMENT

(Presented by PARMO)

SUMMARY

The Incheon FIR AKARA Corridor interface with Shanghai/Fukuoka/Taibei FIRs was identified in 2015 by RASMAG/20 as one of the LHD Hot Spot Areas (Hot Spot B) with the PARMO, China RMA, JASMA, MAAR as the RMAs assigned to this task. This paper presents analyses of the AKARA airspace using TSD and LHD reports for calendar years 2015 - 2019.

1. INTRODUCTION

1.1 The PARMO presented WP/12 to the RASMAG/23 (reference 1), which contained an analysis of the AKARA corridor airspace for calendar years 2015 through 2017. The China RMA, JASMA, MAAR and PARMO provide the relevant reports of LHDs to the PARMO for inclusion in the analysis. An analysis was presented to RASMAG/24 (reference 2) to include new TSD and reported LHDs for calendar year 2018.

1.2 This working paper provides an update to the analysis using the December 2019 TSD and reported LHD events in 2019.

2. DISCUSSION

2.1 The AKARA corridor airspace refers to the airspace involving four FIRs, specifically Fukuoka, Incheon, Taibei and Shanghai. The main airway is A593 with crossing routes Y711 and Y722/B576 within Incheon FIR. **Figure 1** contains a chart of the relevant airspace. Airway A593 is an east-west route between the Fukuoka, Incheon and Shanghai FIRs.

2.2 **Reference 3** provides a summary of the establish agreements between China and Japan, and Japan and the Republic of Korea for the operational arrangements of airway A593 between Fukue and Shanghai. Today, ATS services for flight operations on airway A593 are provided by Fukuoka ACC for traffic east of point SADLI and by Shanghai ACC for traffic west of point SADLI. There is a specified flight level orientation scheme (FLOS) in place; eastbound flights operate on FL250, FL290, FL310, and FL390 and westbound flights operate on FL240, FL280, FL300, and FL400. Incheon ACC provides ATS services for the north-south traffic that operates on the intermediate flight levels; FL260, FL270, FL320, FL330, FL340, FL350, FL360, FL370, FL380 and FL410. **Figure 2** shows the FLOS for airway A593.

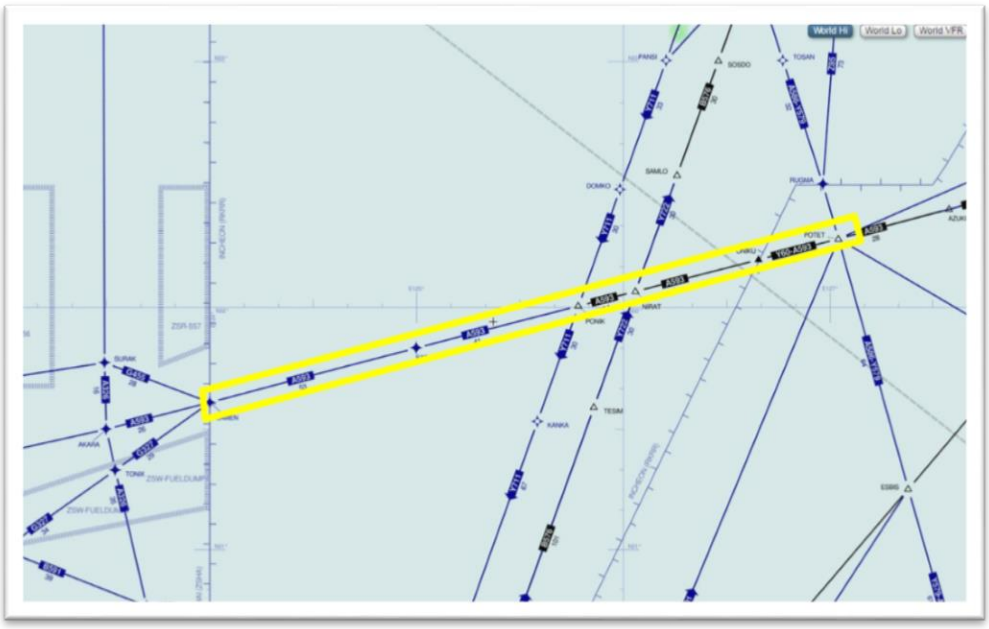

Figure 1. Airway A593 (source: https://skyvector.com/)

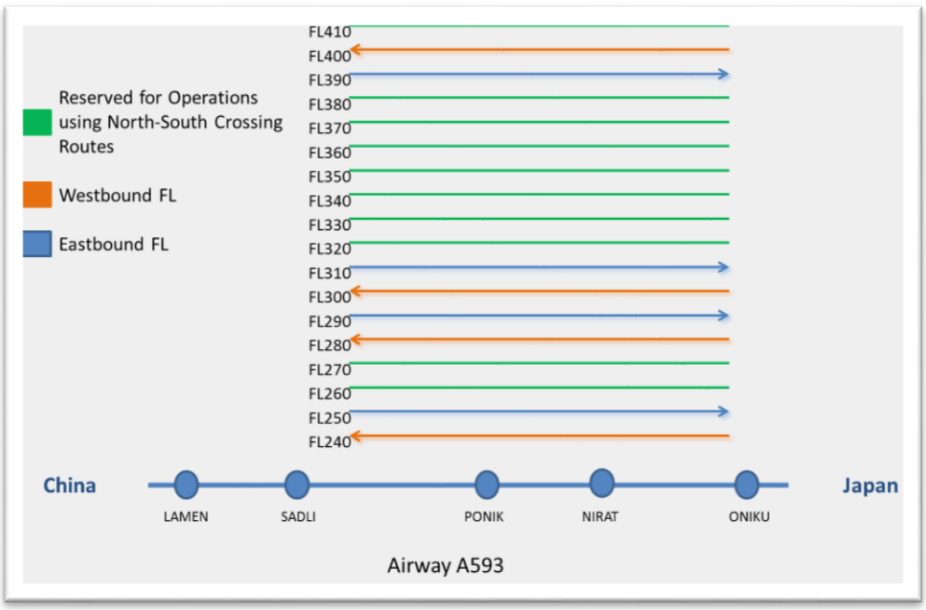

Figure 2. Flight Level Orientation Scheme (FLOS) for Airway A593

2.3 The merged TSD for the AKARA airspace was updated with the December 2019 TSD received from Republic of Korea.

2.4 Reported LHDs for the AKARA Airspace

2.5 There were twenty-nine reported LHDs in 2019 for the AKARA airspace. This is an increase over the nineteen reported LHDs in calendar year 2018. Three of the 2019 occurrences were reported by more than one ATS provider. China RMA, JASMA and PARMO shared the reported occurrence details for this report.

2.6 The reported LHDs for the AKARA airspace during calendar years 2015 through 2019 are summarized in **Table 1**. The last column of Table 1 specifies whether the report event contributes towards operational or technical vertical risk. Technical vertical risk is the risk of collision associated with aircraft height-keeping performance systems. Operational vertical risk is the risk of collision associated with incorrect action by air traffic control (ATC) and/or aircraft crew.

2.7 Each reported LHDs summarized in Table 1 represents a unique occurrence. The same date and location may appear on multiple rows indicating more than one occurrence took place on the same date and area.

Table 1. Reported LHD Events for the AKARA Airspace in Calendar Years 2015 - 2019

Date	Location	LHD Duration (min)	LHD Levels Crossed	LHD Cause Code	Operational or Technical Risk
30 Jan 2015	SADLI	0	0	E	Operational
29 Mar 2015	SADLI	1.8	0	D	Operational
24 Jul 2015	SADLI	0	0	E	Operational
3 May 2016	SADLI	0	0	E	Operational
31 Aug 2016	SADLI	0	0	E	Operational
20 Oct 2016	SADLI	0.1	0	I	Technical
28-Jan-2018	LAMEN	0	0	E	Operational
28-Jan-2018	LAMEN	0	0	E	Operational
15-Feb-2018	SADLI	0	0	E	Operational
22-Feb-2018	LAMEN	0	0	E	Operational
25-Feb-2018	ATOTI	0	0	E	Operational
15-Apr-2018	LAMEN	0	0	E	Operational
15-Apr-2018	SADLI	0	0	E	Operational
9-May-2018	SADLI	0	0	E	Operational
9-May-2018	SADLI	0	0	E	Operational
13-May-2018	SADLI	0	0	E	Operational
14-May-2018	SADLI	0	0	E	Operational
20-May-2018	SADLI	0	0	E	Operational
7-Jun-2018	SADLI	0	0	E	Operational
9-Jul-2018	SADLI	0	0	E	Operational
26-Jul-2018	NIRAT	0.15	6	D	Operational
28-Jul-2018	SADLI	0	0	E	Operational
29-Jul-2018	SADLI	0	0	E	Operational
20-Sep-2018	SADLI	0	4	D	Operational
8-Oct-2018	SADLI	0	0	E	Operational
18-Jan-2019	SADLI	0.00	0	E	OPERATIONAL
6-Feb-2019	NIRAT	0.00	1	D	OPERATIONAL
27-Feb-2019	SADLI	0	0	F	OPERATIONAL
16-Mar-2019	SADLI	0.00	0	E	OPERATIONAL
29-Apr-2019	NIRAT	0.50	1	D	OPERATIONAL
22-May-2019	SADLI	0	0	E	OPERATIONAL
14-Jun-2019	POTET	5.40	2	D	OPERATIONAL
30-Jun-2019	PONIK	0.00	1	J	TECHNICAL
20-Jul-2019	NIRAT	0.50	1	D	OPERATIONAL

Date	Location	LHD Duration (min)	LHD Levels Crossed	LHD Cause Code	Operational or Technical Risk
31-Jul-2019	SADLI	0.00	0	E	OPERATIONAL
4-Aug-2019	LAMEN	0	0	E	OPERATIONAL
4-Aug-2019	LAMEN	0	0	E	OPERATIONAL
4-Aug-2019	LAMEN	3	0	E	OPERATIONAL
4-Aug-2019	LAMEN	3	0	E	OPERATIONAL
14-Aug-2019	TESIM	0.50	0	E	OPERATIONAL
18-Aug-2019	LAMEN	0	0	E	OPERATIONAL
2-Sep-2019	LAMEN	0	0	E	OPERATIONAL
24-Sep-2019	LAMEN	0	0	E	OPERATIONAL
29-Sep-2019	POTET	0.00	2	A	OPERATIONAL
4-Oct-2019	SADLI	0.00	0	E	OPERATIONAL
4-Oct-2019	SADLI	0.00	0	E	OPERATIONAL
6-Oct-2019	SADLI	0.00	0	E	OPERATIONAL
28-Oct-2019	SADLI	1.00	1	D	OPERATIONAL
16-Nov-2019	SADLI	0.00	1	D	OPERATIONAL
23-Nov-2019	SADLI	0	0	B	OPERATIONAL
25-Nov-2019	SADLI	22.00	0	E	OPERATIONAL
29-Nov-2019	SADLI	0.00	1	J	TECHNICAL
10-Dec-2019	PONIK	0.00	1	J	TECHNICAL
12-Dec-2019	SADLI	0.00	1	D	OPERATIONAL

2.8 The reported LHDs with zero duration and zero levels crossed do not contribute towards the vertical collision risk estimate. In these cases the associated risk was mitigated by available surveillance, air traffic service inter-facility data Communication (AIDC), or other means. There are twenty-nine reported LHDs in Table 1 for 2019, sixteen of which are category E. Of the sixteen reported category E LHDs in 2019, twelve do not contribute towards the 2019 vertical collision risk estimate.

2.9 The 2019 reported LHDs were reviewed by Republic of Korea, China RMA, JASMA, and PARMO. Modifications were made to the resulting summary and parameters for some reported occurrences during this review. As with all reported occurrences, timeliness is important to obtain data from the various sources. Unfortunately, data were not available from all sources for a few reported LHDs because of late notification.

2.10 **Table 2** and **Figure 3** provide the summary of the LHD causes within AKARA airspace from January until December 2019.

LHD Category Code	LHD Category Description	No of LHD Occurrences	LHD Duration (Min)	No. of Flight Levels Transitioned Without Clearance
A	Flight crew failing to climb/descend the aircraft as cleared;	1	0	2
B	Flight crew climbing /descending without ATC clearance;	1	0	0

LHD Category Code	LHD Category Description	No of LHD Occurrences	LHD Duration (Min)	No. of Flight Levels Transitioned Without Clearance
C	Incorrect operation or interpretation of airborne equipment (e.g. incorrect operation of fully functional FMS, incorrect transcription of ATC clearance or re-clearance, flight plan followed rather than ATC clearance, original clearance followed instead of re-clearance etc.)	0	0	0
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message);	7	7.4	8
E	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues (e.g. late or non-existent coordination, incorrect time estimate/actual, flight level, ATS route etc not in accordance with agreed parameters);	16	28.5	0
F	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of equipment outage or technical issues;	1	0	0
G	Aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure);	0	0	0
H	Airborne equipment failure leading to unintentional or undetected change of flight level (e.g. altimetry errors)	0	0	0
I	Turbulence or other weather related causes	0	0	0
J	TCAS resolution advisory; flight crew correctly following the resolution advisory	3	0	3
K	TCAS resolution advisory; flight crew incorrectly following the resolution advisory	0	0	0
L	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
M	Other	0	0	0
	Totals	**29**	**35.9**	**13**

2.11 De-identified summaries of the reported LHDs in 2019 follow:

2.11.1 In oceanic airspace, an LHD occurrence with a duration of twenty minutes or more is considered to be a long duration event. For airspace with radar surveillance, a long duration LHD is considered for occurrences with durations of three minutes or more. There was **one** long duration LHD reported in 2019 for AKARA airspace. The primary cause of this occurrence was error in ATC-to-ATC transfer. The transferring ATC unit did not provide information to the receiving ATC unit. The duration for this reported occurrence was twenty-two minutes because the aircraft did not contact the receiving ATC unit at the boundary or respond to the attempted communications once inside the receiving ATC airspace. The impact of this reported occurrence on the risk estimate is significant due to the long duration.

2.11.2 There were two reported LHDs with a duration of 3 minutes each. Both occurrences took place on the same day and over the same reporting point. These reported LHDs were caused by errors in ATC-to-ATC transfer.

2.11.3 There was one reported LHD with a duration of thirty seconds. In this case, there was no transfer information sent to the receiving ATC unit. The thirty second duration is the time it took the receiving ATC to identify the aircraft information.

2.11.4 There were three reported LHDs provided by more than one ATS provider. All three of these occurrences involved errors in ATC-to-ATC transfers. In each case, the receiving ATC unit identified the error prior to the boundary crossing.

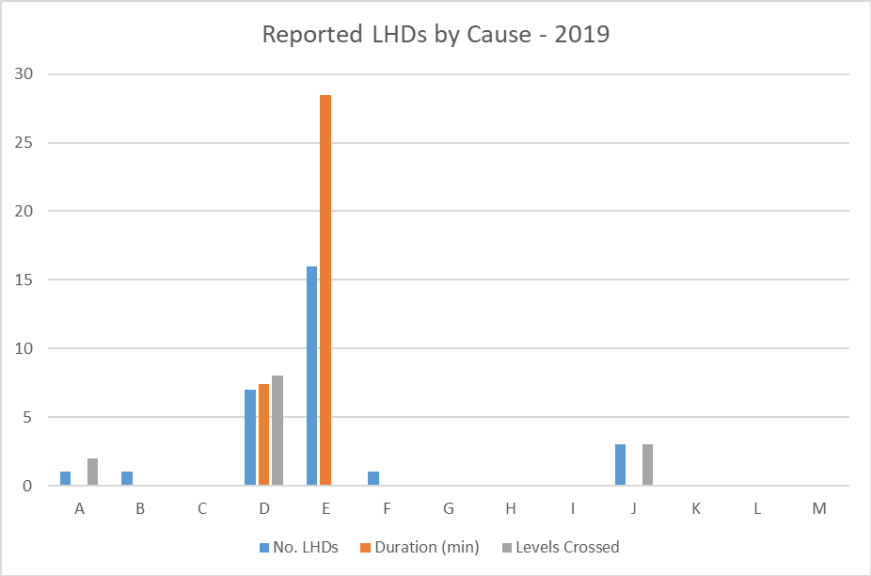

Figure 3. Reported LHDs for AKARA Airspace - 2019

2.11.5 There was one category F LHD in 2019. In this case, no inbound information was provided through AIDC or through alternative means. The receiving ATC unit recognized the aircraft prior to boundary crossing. There was zero duration assigned to this report.

2.11.6 There was one reported occurrence with a duration of five minutes twenty-four seconds (5.40 minutes) and two flight levels crossed without clearance. The occurrence began with an aircraft accepting an altitude clearance intended for a different aircraft with a similar aircraft identification (or callsign). The wrong aircraft climbed to and maintained the flight level intended for the other aircraft. The LHD duration is the time it took for ATC to realize the wrong aircraft accepted the altitude clearance and provide clearances to both aircraft involved. This LHD occurrence is classified as an ATC loop error, category D.

2.11.7 Six additional reported LHDs involve an aircraft accepting an altitude clearance intended for a different aircraft. One of these reports has a duration of one minute and one flight level crossed without clearance. Two reports each have a duration of 30 seconds and one flight level crossed without clearance. The remaining three reported LHDs in this category have zero duration and one flight level crossed without clearance. All of these reports are classified as an ATC loop error, category D.

2.11.8 One category A LHD was reported in 2019. In this case, the pilot descended below the cleared flight level. A descend clearance had been issued by the ATC unit, but the aircraft descended below the cleared flight level. There are two flight levels crossed without ATC clearance for this occurrence.

2.11.9 One category B LHD was reported in 2019. In this occurrence, the pilot descended due to turbulence. There was zero duration and zero flight levels crossed for this report.

2.11.10 There were three TCAS related occurrences reported in 2019. Two of these reports were considered to be nuisance TCAS RA. The remaining TCAS RA was due to high climb rate of an adjacent aircraft. All three of these reports are classified as technical risk occurrences.

2.11.11 **Figure 4** provides a map of the reported LHD locations and associated categories. All of the reported LHDs are shown in Figure 4, including those reports with zero duration. More than one reported LHD with different assigned categories may have the same airspace location (e.g. SADLI). The letter category codes are visible, but the color-code indicated on the legend may not match due to overlaps on the map.

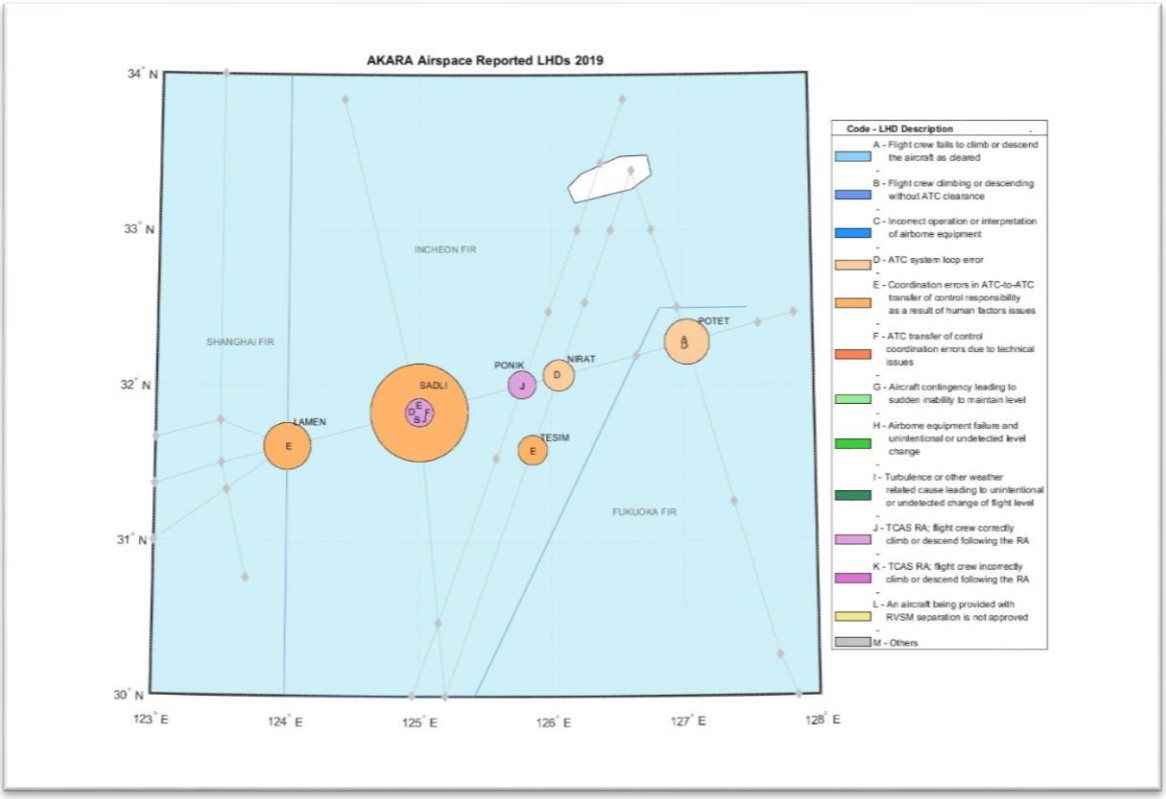

Figure 4. Locations of the reported LHDs in AKARA airspace - 2019

2.12 Vertical Risk Estimate

2.12.1 In the calculation of vertical collision risk, the time spent on uncleared flight levels and the number of flight levels transitioned without clearance are treated differently. There is a specific risk calculation for an aircraft crossing flight levels incorrectly from that used for aircraft occupying whole flight levels incorrectly.

2.12.2 There are twelve reported LHDs in calendar year 2019 that contribute towards the estimate of operational vertical risk. There are a total of 35.9 minutes of duration at an incorrect flight level and 10 flight levels crossed without ATC clearance.

2.12.3 These reports along with the parameters derived from the 2019 TSD are used to provide an updated annual estimate of vertical risk. The vertical collision risk model parameters are contained in **Table 3.**

Table 3. Parameters for Vertical Collision Risk Estimates - 2018

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
T	Estimated annual flying hours	183,392	2019 TSD
N_p	Number of vertical aircraft pairs on crossing routes per year	2,238	2019 TSD
$\overline{\lvert \Delta V \rvert}$	Average relative along-track speed between aircraft on same direction routes	38.3 knots	Value used in Incheon RVSM Collision Risk Estimate
$\overline{\lvert V \rvert}$	Average absolute aircraft ground speed	480 knots	Value used in Pacific RVSM Collision Risk Estimate
$\overline{\lvert \dot{y} \rvert}$	Average absolute relative cross track speed for an aircraft pair nominally on the same track	5 knots	Value used in Pacific RVSM Collision Risk Estimate
$\overline{\lvert \dot{z} \rvert}$	Average absolute relative vertical speed of an aircraft pair that have lost all vertical separation	1.5 knots	Value used in Pacific RVSM Collision Risk Estimate
$P_z(0)$	Probability two aircraft at the same nominal level are in vertical overlap	0.42	Value used in Pacific RVSM Collision Risk Estimate
$Py(0)$	Probability two aircraft operating on the same track and flight level are in lateral overlap	0.11	Value used in Pacific RVSM Collision Risk Estimate
$P_z(1000)$	Probability two aircraft nominally separated by 1000ft are in vertical overlap	4.68×10^{-9}	Value used in Pacific RVSM Collision Risk Estimate
Sx	Longitudinal window for identifying vertical proximate aircraft pairs	120 NM (15 mins)	Value used in Pacific RVSM Collision Risk Estimate
λ_x	Average aircraft length (NM)	0.0257	Based on 2019 TSD
λ_y	Average aircraft wingspan (NM)	0.0242	Based on 2019 TSD
λ_z	Average aircraft height (NM)	0.0078	Based on 2019 TSD
$E_z(same)$	Same direction vertical occupancy value	0.3547	2019 TSD for operations on Airway A593
$E_z(opp)$	Opposite direction vertical occupancy value	0.3633	2019 TSD for operations on Airway A593

2.12.4 Using the parameters provided in Table 3, the vertical collision risk estimates for the AKARA airspace are shown in **Figure 5**. The 2019 vertical technical risk estimate of 0.80×10^{-9} fapfh meets the TLS for vertical technical risk, the technical risk TLS is 2.5×10^{-9} fapfh. The overall vertical risk estimate of 247.0×10^{-9} fapfh exceeds the overall vertical TLS of 5×10^{-9} fapfh.

2.12.5 The 2019 vertical risk estimate is significantly higher than the estimate in 2018. This result is due to the increase the number of reported LHDs with non-zero duration. Removal of the reported long duration LHD (22-minute) reduces the overall vertical risk estimate by 57% to 106.1×10^{-9} fapfh, which still exceeds the TLS.

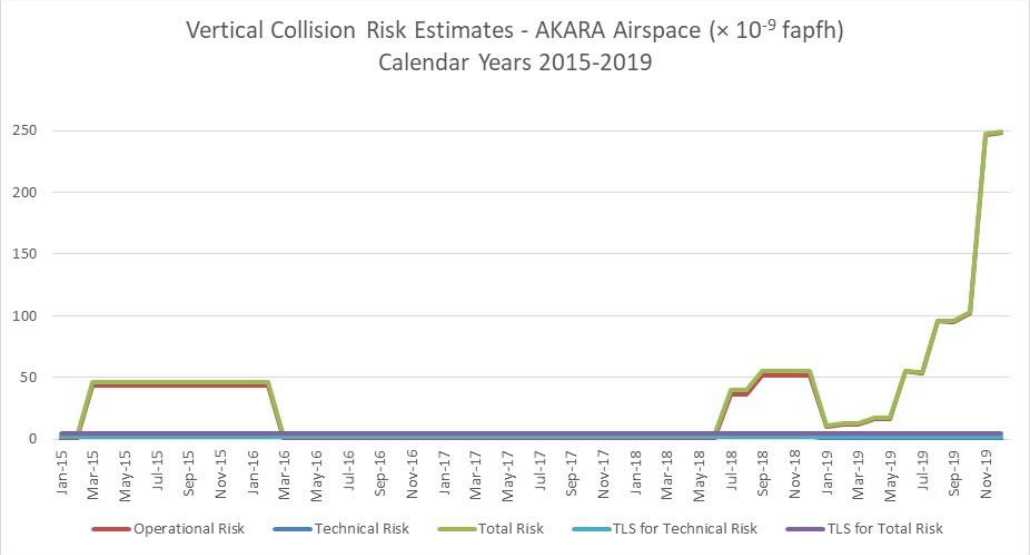

Figure 5. Twelve-month Rolling Vertical Collision Risk Estimates

2.12.6 The PARMO thanks the Republic of Korea, China RMA, JASMA, and MAAR for providing the needed data used in this analysis.

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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REFERENCES

1. PARMO, *Analysis for the Incheon FIR AKARA Corridor Interface with Shanghai/Fukuoka/Taipei FIRs*, RASMAG/22, WP/12 Revised, Bangkok, Thailand, July 2017.

2. PARMO, *AKARA Safety Assessment*, RASMAG/24, WP/11, Bangkok, Thailand, July 2019.

3. ICAO Asia and Pacific Office, *Draft Summary of Discussions of the Third Special ATS Coordination Meeting ATS Routes A593 and B576* (SCM/3-A593/B576), Bangkok, Thailand, 3-4 December 2007.
