International Civil Aviation Organization

The Twenty-First Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/21)

Bangkok, Thailand, 14-17 June 2016

Agenda Item 5: Airspace Safety Monitoring Activities/Requirements in the Asia/Pacific Region

AIRSPACE ANALYSIS FOR THE INCHEON FIR AKARA CORRIDOR INTERFACE WITH SHANGHAI/FUKUOKA/TAIBEI FIRS

(Presented by United States/PARMO)

SUMMARY

This working paper presents an analyses of the Large Height Deviation (LHD) hot spot area identified at the RASMAG/20 meeting. The Incheon FIR AKARA Corridor interface with Shanghai/Fukuoka/Taibei FIRs was identified by RASMAG/20 as one of the LHD Hot Spot Areas with the PARMO, China RMA, JASMA, MAAR as the RMAs assigned to this task. This paper provides an initial investigation into the operations conducted in this area.

1. INTRODUCTION

1.1 This working paper contains an examination into the operations conducted within the Incheon FIR AKARA Corridor interface with Shanghai/Fukuoka/Taibei FIRs. The PARMO, China RMA, JASMA and MAAR contributed the December 2014 Traffic Sample Data (TSD) for this area and is used in the paper.

1.2 The RASMAG/20 Meeting (reference 1) developed Draft Conclusion RASMAG/20-4: Asia/Pacific LHD Hot Spot Action Plans. The details of this conclusion are as follows:

Draft Conclusion RASMAG/20-4: Asia/Pacific LHD Hot Spot Action Plans

That, the following Regional Monitoring Agencies (RMAs), States and ATC units should take urgent action* to establish a scrutiny group or an alternate means to address the following Large Height Deviation (LHD) hot spot areas and present Action Plans and details of progress made to the ICAO Regional Office, prior to 01 January 2016:

a) **MAAR**, India, Myanmar and Malaysia – Kolkata/Chennai FIRs interface with Yangon/Kuala Lumpur FIRs;

b) **PARMO**, China RMA, JASMA, MAAR, China, Japan, Republic of Korea and Taibei Area Control Centre (ACC) – Incheon FIR AKARA Corridor interface with Shanghai/Fukuoka/Taibei FIRs;

c) **China RMA**, MAAR, China and Hong Kong China – Hong Kong FIR interface with Guangzhou/Sanya FIRs;

d) **MAAR**, AAMA, JASMA, Hong Kong China, Indonesia, Japan and the Philippines – Manila FIR interface with Fukuoka/Hong Kong China/Singapore/Ujung Pandang FIRs; and

e) **China RMA**, MAAR, China and Pakistan – Urumqi FIR interface with Lahore FIR.

**Action should be taken as soon as practicable, even prior to APANPIRG/26 if possible.*

Note: the RMAs in bold were expected to take the lead in organising the scrutiny groups or alternative means to address the issues.

1.3 The third meeting of the RASMAG Monitoring Agency Working Group (MAWG/3) met in December 2015 in Canberra, Australia. The group discussed the RASMAG/20-4 draft conclusion regarding the Asia Pacific Hot Spot Action Plans and determined that a more complete assessment of the AKARA area is needed. The PARMO agreed to coordinate with China RMA, MAAR and JASMA to develop a detailed safety assessment for the AKARA corridor and provide the report RASMAG/21. This working paper contains the detailed safety assessment for the AKARA corridor.

2. DISCUSSION

2.1 The AKARA Corridor is the name used to refer to the airspace involving four FIRs, specifically Fukuoka, Incheon, Taibei, and Shanghai. Figure 1 contains a chart of the FIRs relevant to the AKARA corridor.

Figure 1. FIR Chart for the AKARA Corridor

2.2 The on-going safety monitoring for the AKARA Corridor airspace is conducted separately by four Asia Pacific RMAs: China RMA (Shanghai FIR), JASMA (Fukuoka FIR), MAAR (Taibei FIR) and PARMO (Incheon FIR). Each of these RMAs provided the 2014 traffic sample data (TSD) to PARMO for this analysis. Each TSD provide the observed traffic within the FIR for which the RMA has responsibility.

2.3 Know Your Airspace Analysis

2.3.1 The TSD were examined individually and then a combined TSD was analyzed. Table 1 provides basic statistics for each TSD representing the AKARA area. The statistics provided in Table 1 suggest that the northern portion of the AKARA Corridor experiences smaller flight counts in comparison to the flight counts observed in the southern portion of the airspace.

Table 1. TSD Available for the AKARA Corridor

Name of TSD	FIR	Number of Flights in December 2014	Average Number of Flights per Day	Number of Flights in TSD After Filter Applied
Incheon Dec 2014 TSD – PARMO	Incheon FIR	4,166	134	4,135
Shanghai/AKARA Dec 2014 TSD – China RMA	Subset of traffic in Shanghai FIR	4,107	132	4,107
Fukuoka/AKARA Dec 2014 TSD – JASMA	Subset of traffic in Fukuoka FIR	22,023	710	20,228
Taibei FIR Dec 2014 TSD – MAAR	Taibei FIR	35,339	1,140	35,332

2.3.2 Figure 2 provides the locations of all aircraft positions provided in the individual TSD. It is noted that the minimum requirements for aircraft position data within the TSD are the entry and exit aircraft positions. The ANSP may provide additional aircraft position data, which might include intermediate positions within the FIR if these data can be made available.

2.3.3 The TSD were filtered for aircraft positions within the airspace bounded by latitudes 20N to 40N and by longitudes 115E to 135E and flight levels greater than or equal to FL280. This filter results in slightly fewer flights within each FIR as shown in the last column of Table 1.

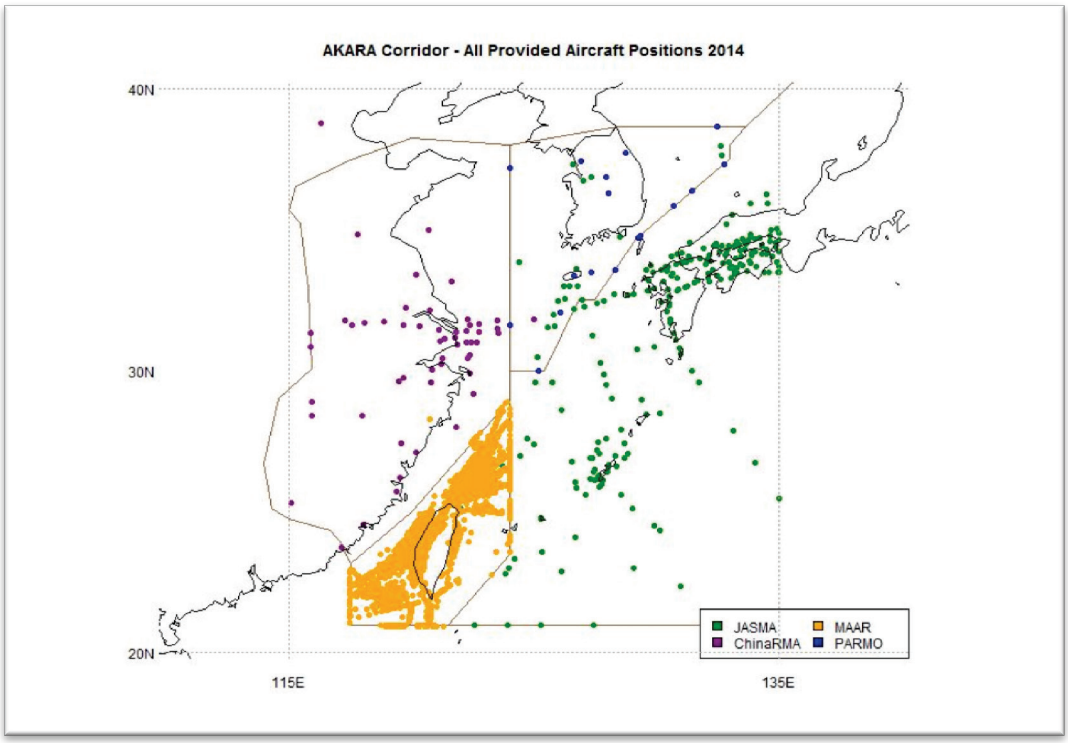

Figure 2. All Provided Aircraft Positions within 2014 TSD

2.3.4 The individual TSD were combined to form a single TSD for the AKARA Corridor. The number of flight operations observed in the combined TSD from December 2014 is 52,290 flights or approximately 1,686 flights per day. However, 16,998 of these flights had only one position in the

combined TSD. The flying hours calculated from the remaining 35,292 flights was 28,167 flight hours during December 2014 which equates to an annual estimate of approximately 338,000 flight hours. Figure 3 shows the aircraft tracks as provided in the available TSD data for each unique flight observed in the combined TSD.

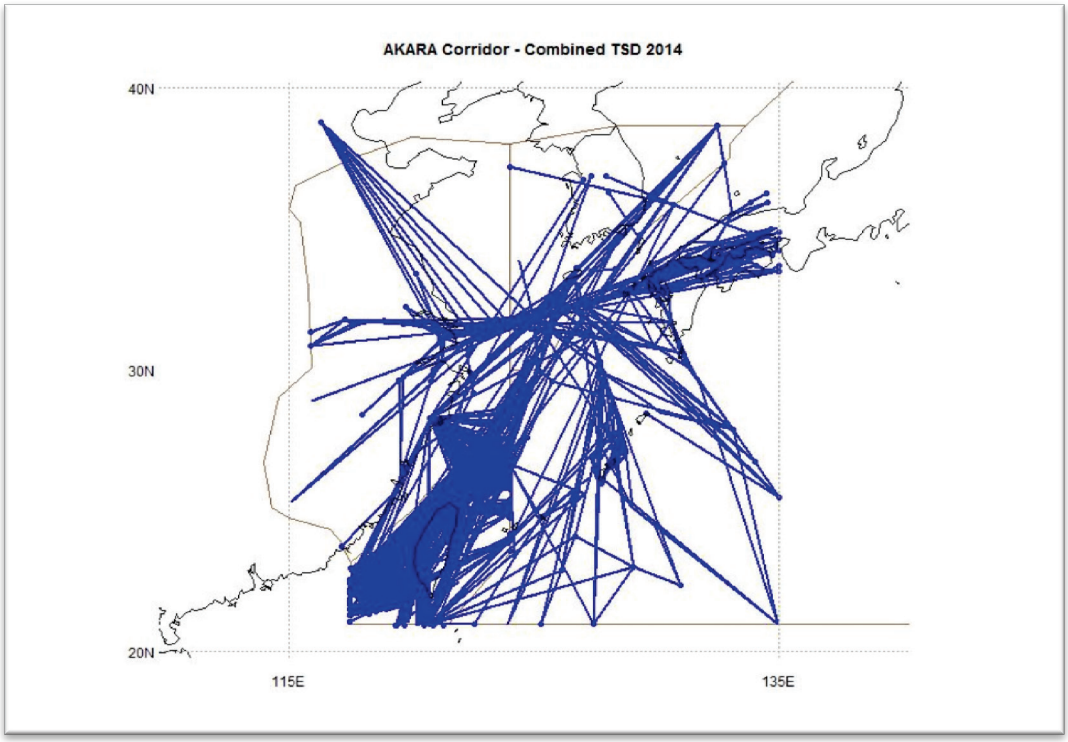

Figure 3. Combined TSD - 2014

2.3.5 The combined TSD for the AKARA Corridor was further analyzed to assess the characteristics of the airspace, such as the observed aircraft types, city-pair combinations, and operators within the airspace.

2.3.6 Figure 4 shows the top 20 aircraft types observed in the combined TSD by flying time. These aircraft types represent almost 98 percent of the flying hours observed in the combined TSD. The top five aircraft types; A333, B738, A320, A321, and B744 represent over 55 percent of the flying hours in the AKARA Corridor.

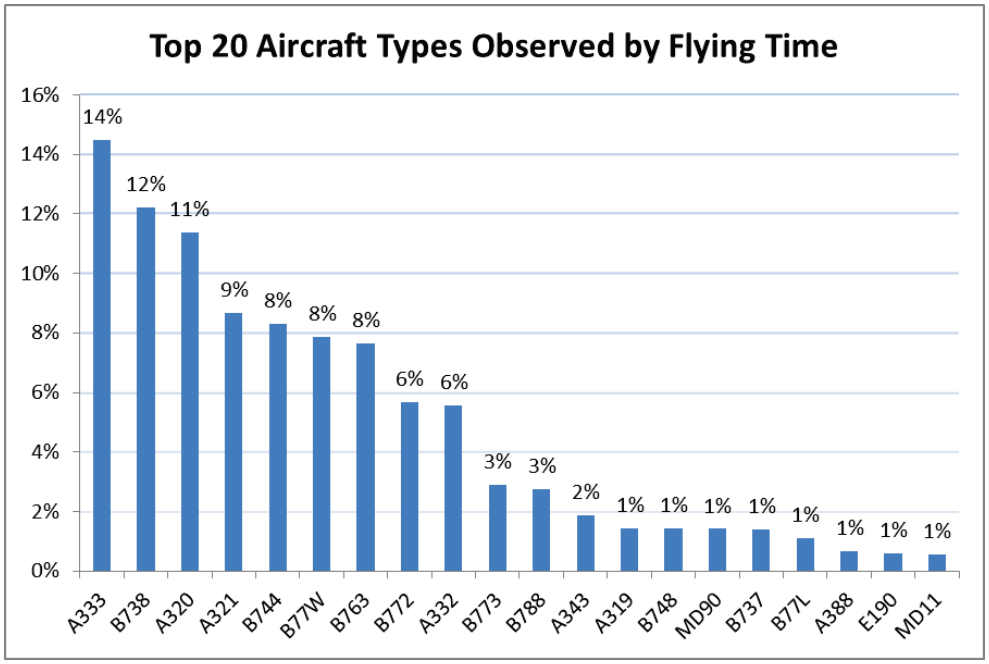

Figure 4. Top 20 Aircraft Types

2.3.7 The combined TSD yielded 736 unique city pairs. A unique city pair consists of two different aerodrome locations observed in the combined TSD. The count of flight operations by city pair includes both directions of the city pair, e.g. the count of flight operations for the Hong Kong – Taibei (VHHH – RCTP) city pair includes flight operations traveling from Hong Kong to Taibei and flight operations traveling from Taibei to Hong Kong.

2.3.8 The top 20 city pairs observed in the combined TSD are shown in Table 2. These twenty city pairs represent over 35 percent of the flight operations in the combined TSD. The top two city pairs, representing over 9 percent of the observed traffic are Hong Kong/Taibei and Hong Kong/Incheon.

Table 2. Top 20 Observed City Pairs in Combined TSD

Aerodrome1 Code	City	Aerodrome2 Code	City	Count	Percent
VHHH	Hong Kong	RCTP	Taibei	3,001	5.7%
VHHH	Hong Kong	RKSI	Incheon	1,817	3.5%
RJBB	Kansai	ZSPD	Shanghai Pudong	1,128	2.2%
RJAA	Narita	ZSPD	Shanghai Pudong	1,116	2.1%
RCTP	Taibei	RJAA	Narita	1,026	2.0%
RCTP	Taibei	RJBB	Kansai	945	1.8%
VTBS	Bangkok	RKSI	Incheon	858	1.6%
RCTP	Taibei	WSSS	Singapore	787	1.5%
RJAA	Narita	VHHH	Hong Kong	751	1.4%
RCTP	Taibei	ZSPD	Shanghai Pudong	747	1.4%
RKSI	Incheon	ZSPD	Shanghai Pudong	731	1.4%
RJBB	Kansai	VHHH	Hong Kong	726	1.4%

Aerodrome1 Code	City	Aerodrome2 Code	City	Count	Percent
RCKH	Kaohsiung	VHHH	Hong Kong	715	1.4%
RCTP	Taibei	VMMC	Macao	685	1.3%
RKSI	Incheon	RCTP	Taibei	656	1.3%
RKSI	Incheon	RPLL	Manila	647	1.2%
VVNB	HaNoi Vietnam	RKSI	Incheon	573	1.1%
WSSS	Singapore	RKSI	Incheon	562	1.1%
RCTP	Taibei	VTBS	Bangkok	549	1.0%
PANC	Anchorage	VHHH	Hong Kong	512	1.0%

2.3.9 Table 3 provides the top twenty-five operators in terms of number of operations in the combined TSD. These twenty-five operators represent over 78 percent of the observed operations in the combined TSD. The top 3 operators shown in Table 3, China Airlines (CAL), EVA Airways (EVA), and Cathay Pacific Airways (CPA), represent more than 25 percent of the observed operations. The proportion of International General Aviation (IGA) and State operations observed in the combined TSD were 0.5 and 0.1 percent, respectively.

Table 3. Top 25 Observed Operators in Combined TSD

Operator	Operator Name	Count	Percent
CAL	China Airlines	5,741	11.0%
EVA	EVA Airways	4,315	8.3%
CPA	Cathay Pacific Airways	3,471	6.6%
KAL	Korean Air	3,274	6.3%
ANA	ANA All Nippon Airways	2,974	5.7%
CES	China Eastern Airlines	2,721	5.2%
AAR	Asiana Airlines	2,625	5.0%
JAL	Japan Airlines	1,856	3.5%
CCA	Air China	1,549	3.0%
CSN	China Southern Airlines	1,372	2.6%
HVN	Vietnam Airlines	1,331	2.5%
THA	Thai Airways	1,205	2.3%
TNA	Trans Asia Airways	1,020	2.0%
HDA	Dragonair	878	1.7%
MDA	Mandarin Airlines	835	1.6%
FDX	Federal Express Corporation	775	1.5%
HKE	Hong Kong Express Airways	728	1.4%
JJA	Jeju Air	641	1.2%
JNA	Jin Air	615	1.2%
UPS	United Parcel Service Company	601	1.1%
AMU	Air Macau	569	1.1%
SIA	Singapore Airlines	486	0.9%
CRK	Hong Kong Airlines	477	0.9%

Operator	Operator Name	Count	Percent
CQH	Spring Airlines	461	0.9%
PAL	Philippine Airlines	440	0.8%

2.3.10 Table 4 shows the observed route usage for the top 10 routes in terms of observed counts specified in the combined TSD for calendar year 2014. It is noted that the TSD format requires only entry and exit information for each flight. Some of the individual TSD provide additional intermediate aircraft positions for each flight, in these samples, most flights were observed to be operating on more than one route. Therefore, the route usage may be somewhat skewed due to the differences in the individual TSD.

Table 4. Route Usage Observed in Combined TSD – Top 10 in terms of Provided Aircraft Positions in Combined TSD

Airway	Percent Aircraft Positions on Airway in Combined TSD
A593	22.2%
DCT/Fix Info Provided Only	12.2%
B576/Y722	10.9%
Y711	9.5%
A586/Y579	4.6%
M750	4.4%
Y60	4.1%
A1	2.8%
Y23	2.7%
Y81	2.5%

2.3.11 The data provided in Table 4 shows that the airway A593 contains the most traffic in the combined TSD. Airway A593 is an east-west route between within the Shanghai, Incheon, and Fukuoka FIRs. Figure 5 provides the location and fixes on airway A593 (source: https://skyvector.com/). The Y711, Y722/B576, A586/Y579 airways are north-south routes that intersect airway A593.

2.3.12 Figure 6 provides the observed flight level usage for airway A593 for all fixes. There is evidence of a flight level allocation scheme (FLAS) in the results shown in Figure 6. All the flight level information provided in the individual TSD were in units of feet, these data were rounded to the nearest whole flight level in Figure 6.

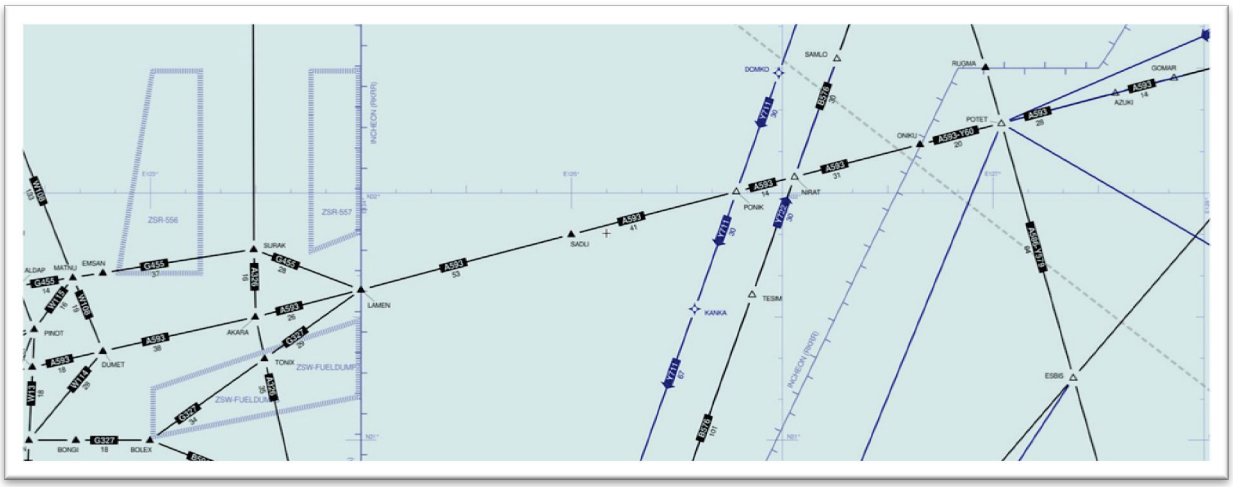

Figure 5. Airway A593 (source: https://skyvector.com/)

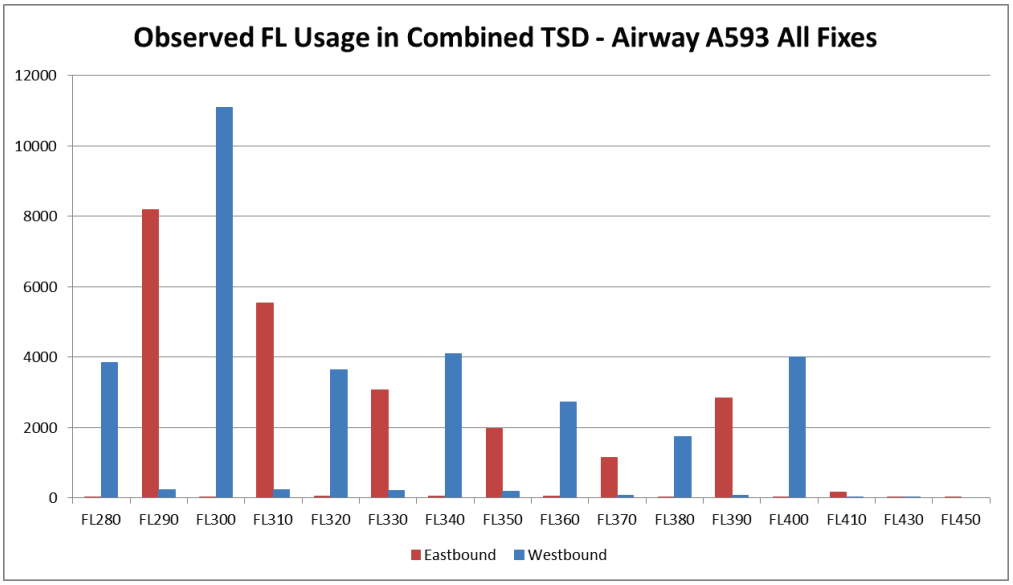

Figure 6. Observed Flight Level Usage on Airway A593 in Combined TSD

2.4 Initial Risk Analysis for the AKARA Corridor – Airway A593

2.5 The combined TSD is utilized to provide an initial risk analysis for traffic operating on airway A593. The initial goal is to determine the maximum tolerable number of LHD minutes allowed in order to meet the target level of safety (TLS). The vertical collision risk model (CRM) parameters estimated for this airspace are provided in Table 5.

Table 5. Vertical CRM Parameter Estimates for AKARA Corridor

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
$\overline{\lvert\Delta V\rvert}$	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	480 knots	Value used in Incheon RVSM

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
	speed		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
λ_x	Average aircraft length (NM)	0.029 NM	Based on combined TSD
λ_y	Average aircraft wingspan (NM)	0.027 NM	Based on combined TSD
λ_z	Average aircraft height (NM)	0.008 NM	Based on combined TSD
$E_z(same)$	Same direction vertical occupancy value	0.1766	Based on combined TSD for operations on Airway A593
$E_z(opp)$	Opposite direction vertical occupancy value	0.0532	Based on combined TSD for operations on Airway A593

2.6 The same and opposite direction occupancy values were estimated from the combined TSD for traffic observed in airway A593. Based on these values, the maximum number of LHD minutes allowed in order to meet the TLS is 41 minutes. The PARMO plans to assess the crossing traffic on airway A593 as well as the remaining traffic provided in the combined TSD.

2.7 The PARMO would like to thank the China RMA, JASMA, and MAAR for providing the needed TSD information 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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