**Twenty Seventh Meeting of the
Informal South Pacific ATS Co-ordinating Group
(ISPACG/27)**

**Auckland, New Zealand
27 February – 01 March 2013**

Agenda Item 5.1 – Seamless Airspace Chart

AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST (ADS-B) IN-TRAIL PROCEDURES (ITP) OPERATIONAL FLIGHT TRIAL PROJECT OVERVIEW

Presented by Federal Aviation Administration

SUMMARY

The purpose of this information paper is to present the U.S. Federal Aviation Administration (FAA) activities associated with the ADS-B In-Trail Procedures (ITP) operational trial being conducted in the Pacific.

1. INTRODUCTION

1.1 The U.S. Federal Aviation Administration (FAA) Surveillance and Broadcast Services (SBS) Program is developing a number of airborne Automatic Dependent Surveillance - Broadcast (ADS-B) applications to provide benefits to operators who choose to equip their aircraft with appropriate avionics, including "ADS-B In" (i.e. the ability to receive, process, and display ADS-B data from surrounding aircraft). One such airborne ADS-B application being developed is ADS-B In-Trail Procedures (ITP).

1.2 Aircraft operating in oceanic airspace are, at times, held at non-optimal flight levels due to conflicting traffic either at the desired flight level or at flight levels between the existing flight level and the optimal flight level. The use of flight level changes enabled by ADS-B ITP can supplement existing oceanic procedures creating greater operational efficiency.

1.3 The purpose of this paper is to provide an update on results from the ADS-B ITP operational trial that began in August 2011.

2. CONCEPT OVERVIEW

2.1 ADS-B ITP is comprised of a set of six flight level change geometries with each geometry dictated by whether the ITP aircraft desires to climb or descend and its proximate relationship with the other aircraft:

- Leading climb
- Leading descent
- Following climb
- Following descent

• Combined climb • Combined descent

While there is no limit on the total climb authorized in the ADS-B ITP flight level change, the other aircraft cannot be more than 2,000 feet above or below the ADS-B ITP aircraft's altitude. ADS-B ITP maneuvers may be conducted on up to two other aircraft.

2.2 For ADS-B ITP, the maneuvering (trailing or leading) aircraft obtains the flight identification (ID), altitude, position and ground speed transmitted by proximate ADS-B equipped non-maneuvering aircraft. Based on the ADS-B data from the non-maneuvering, or reference aircraft, a pilot can request clearance for an ITP altitude change to air traffic control (ATC). The controller verifies that the ITP and reference aircraft are same direction traffic and that the maximum closing Mach differential is less than or equal to a Mach Number of 0.06. If the controller determines that the requesting aircraft will maintain standard separation minima with all aircraft other than the ITP reference aircraft, a clearance for the climb or descent may be issued. After re-validating that the ITP initiation criteria are still valid, the maneuvering aircraft may then vertically transition through the altitude of the non-maneuvering aircraft.

3. ADS-B ITP OPERATIONAL EVALUATION

3.1 In 2008, the FAA SBS program established a project for the purpose of enabling an operational evaluation of ADS-B ITP by aircraft operating in revenue service. The objectives of the project were to a) validate the operational performance and economic benefits of ITP; and b) develop and validate ADS-B ITP Minimum Operational Performance Specifications (MOPS).

3.2 The entire ITP system was certified for use on a United Boeing 747 in June 2011. United Airlines subsequently received Operational Approval from FAA Flight Standards to commence ITP operations on 15 August 2011.

3.3 FAA En Route and Oceanic Safety and Operations Support authorized Oakland Air Route Traffic Control Center (KZAK) to initiate the operational evaluation in the SOPAC airspace on 15 August 2011. This authorization was expanded to include the entire Oakland Oceanic Flight Information Region (FIR) in December 2011. The original authorization was scheduled to expire in August of 2012. The authorization was amended to permit ADS-B ITP operations in the Oakland Oceanic FIR until August of 2013.

3.4 This operational evaluation has been adopted as an initiative within the Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) program. The ASPIRE program allows partner organizations to share data and provides a mechanism for providing mutual support of the operational evaluation.

3.5 The FAA is currently in discussions with the air navigation service providers (ANSPs) for New Zealand and Fiji about expanding the ITP operational evaluation into the Nadi FIR and the Auckland Oceanic FIR in 2013. The FAA has also held discussions with the Japan Civil Aviation Bureau about the potential for offering ITP in the Fukuoka FIR at some point in the future.

3.6 Additional background information can be obtained in ISPACG/26 WP-04.

4. OPERATIONAL EVALUATION RESULTS

4.1 The operational evaluation is being conducted using ITP-equipped United Airlines Boeing 747-400's operating in the Oakland Oceanic FIR. There is a comprehensive designated data collection activity for both United Airlines and Oakland ARTCC (ZOA). The data collected is being used to enhance the understanding of the economic, safety and operational impact of ADS-B ITP. Specifically this data will be used to validate operational performance and economic benefits of ITP, validate safety requirements and assumptions and monitor operational hazards. Any significant adverse operational issues that are discovered (such as communication or workload) that cannot be safely mitigated will result in an immediate suspension of all operational evaluation activity. The data is collected, analyzed and used to address key higher level metrics and hazard tracking.

4.2 The operational evaluation began on August 15, 2011. On the first day of the operational evaluation there were 9 ITPs performed by the two United flights that were flying from the United States to Sydney, Australia. Data collected from those flights were presented at ISPACG/26 and were reported on in WP-04.

4.3 Between September 2011 and July 2012, the first year of the ITP Operational, there were seven ITP requests resulting in three standard climb clearances granted and no ITP climb clearances. Four requests were denied due to operational issues such as opposite direction traffic and ITP requests being received close to an airspace boundary where the other airspace region was not authorized to grant an ITP clearance. Between August 2012 and December 2012, seventeen ITP requests were made resulting in eight ITP clearances and seven standard climb clearances. Two flight level changes were denied due for operational reasons.

4.4 Attachment A is an example of the monthly reports that are generated as a result of the data collection process. The attachment is a summary of the resulting "application validation metrics" and "safety measurements" for December 2012. The columns on the right represent the total results for the operational evaluation from August 2012 and December 2012.

4.5 The application validation metrics demonstrate how often ITP requests are being made and the results of the requests. This is done for flights in the South Pacific region as well as the Northern Pacific region (but all within the airspace managed by the Oakland Oceanic Control Center). For the month of December 2012, there were no ITP requests in the South Pacific region (out of 5 ITP qualified flights) and 2 ITP requests in the Northern Pacific region (out of 16 ITP qualified flights). The 2 ITP requests resulted in ITP clearances. As mentioned earlier there were a total of 17 ITP requests from August to December (shown in the far column). Economic data is being collected and analysed by United Airlines.

4.6 The safety measurements (the lower half of attachment A), show the data resulting from the two ITP requests made in December 2012. The combined data for August 2012 through December 2012 are shown in the far right columns. The data show that the results are more conservative than the expected measures.

4.7 The ITP system developed by Honeywell and installed on United Airlines 747-400s

includes a Honeywell traffic computer that has the potential for capturing detailed, electronic surveillance information. The data that is recorded includes ITP related parameters, signal-in-space data and ITP system health and status data. The data that is processed by the traffic computer is recorded on to a removable PCMCIA card. United and United ALPA developed an acceptable process for collecting, de-identifying and analyzing the electronic data. This electronic data greatly enhances the understanding of how the ITP system and procedure is working. The data obtained will be used to advance the understanding of ADS-B for future ADS-B In applications.

4.8 A sample of a portion of the type of data that has been obtained in attachment B. The data shows that the maximum range seen during the test flight varied from 155 miles up to 227 miles with an average of about 180 miles. It was also interesting to note that most Navigation Uncertainty Category (NUC) values were 6 or 7 with one reported NUC value of zero. Even with a NUC of zero the range information seemed plausible (although a NUC of zero would disqualify the data for use with ITP).

4.9 The first line of the application validation metrics section of attachment A lists the total number of United 747 pilots versus the number of pilots who have been trained to conduct ITP operations. As the numbers indicate, by the end of December 2012 only 100 of the 598 pilots had been trained. The low number of ITP trained pilots combined with the requirement that both pilots in the control seats be trained in order to make an ITP request has resulted in a low number of ITP requests.

4.10 The recent merger of United Airlines and Continental Airlines impacted overall 747 training and, along with it, ITP training for these same pilots. At the beginning of January 2013, United and United ALPA signed an agreement regarding ITP training. As a result there were an additional 71 pilots who completed ITP training in the month of January (for a total of 171 ITP trained pilots). United projects that by the end of February there will be at least 450 pilots trained in ITP operations. As the percentage of trained pilots increases, there should be a corresponding increase in ITP requests and clearances granted.

5. SUMMARY

5.1 The FAA began an operational evaluation of ADS-B ITP along SOPAC routes in August 2011 which has been expanded to all oceanic airspace controlled by Oakland Air Route Traffic Control Center (KZAK) in December 2011. There is a comprehensive designated data collection activity for the operational evaluation. The data collected is being used to enhance the understanding of the economic, safety and operational impact of ADS-B ITP.

5.2 For additional information on the operational evaluation, please contact Mr. Ken Jones at Kenneth.M.Jones@nasa.gov or +1 (757) 864-5013.

6. ACTION BY THE MEETING

6.1.1. The meeting is invited to:

a) Note the information presented in this paper

b) Support the ADS-B ITP operational trials in the Pacific

ATTACHMENT A – December 2012 Operational Evaluation Results

Operational and Economic Metrics

Application Validation Metric	Southern Pacific		Northern Pacific		Totals
	Expected Measurement	Actual Measurement	Expected Measurement	Actual Measurement	8/12 – 12/12
Number of trained and approved pilots (actuals for entire 747 subfleet)	598 (Expected) / 100 (Actual)				100
Number of ITP capable flights per month (ITP aircraft, pilot and airspace)	60	5	120	16	
Number of ITP requests per month	2	0	30	2	17
Number of ITP maneuvers performed per month	1	0	3	2	8
Number of "standard" flight level changes from an ITP request per month	1	0	24	0	7
Ave amnt of reduced discretionary extra fuel for ITP capable aircraft per flight	300 lbs		0		
Avg amnt of increased payload for ITP capable aircraft per flight	150 lbs		0		
Average fuel burn reduction for ITP capable aircraft per flight	60 lbs		800		

Safety related metrics

Parameter to be Monitored	Expected Ave. Measurement	Actual Data for Dec 2012			Measurements (8/12 – 12/12)		
		Min	Mean	Max	Min	Mean	Max
ITP Initiation Distance	20 nm	37.8	39.2	40.5	19.1	29.8	59.1
ITP Distance at Co-altitude	18 nm	36.4	38.3	40.2	20.2	30.0	59.7
Time From ITP Initiation to Level Off at New Altitude	7 min	3	3.5	4	2.0	3.8	6.0
Percentage of ITP maneuvers where a wake encounter occurred and a wake turbulence incident was reported	2%						
Wake Turbulence Incident Severity (5-1)	5						

ATTACHMENT B – Sample Electronic Data Results

MODE S ID	INITIAL RECEPTION RANGE	INITIAL RECEPTION BEARING	TARGET ALT AT ACQUISITION	OWNSHIP ALTITUDE AT ACQUISITION	FINAL RECEPTION RANGE	FINAL RECEPTION BEARING	TARGET ALT AT LOSS	OWNSHIP ALTITUDE AT LOSS	MAX RECEPTION RANGE	MAX RANGE BEARING	AVG NUC
GGFIGB25	154.69	192.71	37975.00	33997.00	134.70	118.66	38000.00	34000.00	154.69	192.71	6
GONCNM12345	135.68	309.11	40000.00	28178.00	169.08	34.67	40000.00	34002.00	169.08	34.67	6
GMLBIC135	167.56	201.47	37000.00	23795.00	117.35	74.31	35050.00	34002.00	167.56	201.47	0
UMRCLD0123	184.66	76.27	35000.00	18978.00	199.24	79.12	35000.00	34001.00	199.24	79.12	7
GLIJFC45	171.09	177.79	37975.00	34000.00	165.95	97.42	38000.00	34003.00	171.09	177.79	7
GDMFCD1234	197.94	263.55	30000.00	37000.00	141.62	177.16	30000.00	37001.00	197.94	263.55	6
UELICU0145	227.29	306.10	30000.00	36998.00	105.82	136.45	30000.00	37000.00	227.29	306.10	6