

**Twenty Eighth Meeting of the
Informal South Pacific ATS Co-ordinating Group
(ISPACG/28)**

**Papeete, Tahiti
5-7 March 2014**

Agenda Item 5.1 Seamless Airspace Chart

**Automatic Dependent Surveillance – Broadcast (ADS-B)
In-Trail Procedures (ITP) Operational
Flight Trial Project Status**

Presented by Federal Aviation Administration

SUMMARY

This paper presents an update to the U.S. Federal Aviation Administration (FAA) activities associated with the ADS-B ITP operational trials being conducted in the Pacific.

1. INTRODUCTION

1.1 The 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 that 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 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 with 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 Operation 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 South Pacific (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 2012. The authorization was amended to permit ADS-B ITP operations in the Oakland Oceanic FIR until August 2013. On 30 September 2013, ADS-B ITP operations in the Oakland Oceanic FIR were authorized until 29 September 2014.

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 has worked with the air navigation service providers (ANSPs) for New Zealand and Fiji to expand the ITP operational evaluation into the Nadi FIR and the Auckland Oceanic FIR in late 2013. Airports Fiji Ltd and Airways Corporation New Zealand are conducting operational evaluations of ADS-B ITP and are offering ADS-B ITP services in their flight information regions. The FAA has also held discussions with the Civil Aviation

Bureau, Japan (JCAB) 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/27 WP-04.

4. OPERATION 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 15 August 2011. On the first day of the operational evaluation there were 9 ITPs performed by the two United Airlines flights that were flying from the United States to Sydney, Australia. Data collected from those flights were reported in ISPACG/26 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.

4.4 Attachment A is an example of the monthly reports that have been generated as a result of the data collection process. The attachment is a summary of the resulting "application validation metrics" and "safety measurements" for January 2014. The tables are divided into three different time periods. The middle of the table includes data from the current month (in this case January 2014). The columns on the right side of the table are for the current portion of the third year of the operational evaluation (August 2013 – January 2014) and the entire operational evaluation completed to date (August 2011 – January 2014).

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 January 2014, there was one ITP request in the South Pacific region and eight ITP requests in the Northern Pacific region. The nine ITP requests resulted in four ITP climbs, three standard climbs, and two denials of the ITP request.

4.6 The last three categories mentioned in the chart were not included in previous reports of ADS-B ITP operational data. Previously these situations would have been included in the number of denials. A detailed analysis of the data revealed that, while flight crews did not



receive an ITP or standard climb to their desired altitude, in many cases they did receive a partial climb or received a delayed climb to their desired altitude or intermediate altitude. In order to more accurately reflect the data, the following additional categories were added to the list of potential outcomes from an ITP request:

- Immediate limited climb using standard separation techniques: ITP request results in immediate standard climb, but not to the ITP requested altitude. An example would be a clearance for a 1000 foot climb that resulted from request for a 3000 foot ITP climb with traffic 2000 feet above the ITP aircraft and the first 1000 is free of traffic conflicts.
- Climb after moving the reference aircraft: controller moves the reference aircraft and then clears the ITP aircraft to the altitude that the reference aircraft vacated
- Standard climb after other traffic conflicts cleared: a climb (either to the desired altitude or an intermediate altitude) that was issued after the initial request was made and the ITP aircraft was initially told “stand by” after which the conflict aircraft moved and resolved the conflict (or at least part of the conflict). An example of this would be a situation where an ITP flight crew was told stand by and then the conflict aircraft requests and is granted a climb, enabling the ITP aircraft an opportunity to climb.

It should also be noted that controllers were provided ITP refresher training and since that training was completed, there have been no more instances of these partial climbs.

4.7 From the last column of attachment A, for the entire operational evaluation (August 2011 to January 2014), there have been 160 ITP requests resulting in 31 ITP clearances, 59 standard climb clearances, nine immediate limited standard climbs, 10 standard climbs after moving reference aircraft, and six standard climbs after other conflicts cleared. There have been 45 flight level change denials for operational reasons (e.g., opposite direction traffic, close to other airspace boundaries).

4.8 The safety measurements (the lower half of attachment A), show the safety related data resulting from ITPs that have been performed. The ITP climbs performed during January were performed at an average initiation distance of 29.9 nautical miles and took an average of 4.5 minutes to accomplish. The data for the third year of the operational evaluation (August 2013 – January 2014) and the entire operational evaluation (August 2011 – January 2014) demonstrate that the measured results are more conservative than the expected measures. For the entire ITP operational evaluation, ITP flight level changes were initiated at an average value of 29.8 nautical miles and the ITP distance at co-altitude was an average of 30.4 nautical miles; an increase of 0.6 nautical miles during the flight level change.

4.9 The ITP system developed by Honeywell, and installed on United Airlines Boeing 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 Airlines and United Airline Pilots Association (ALPA) developed an acceptable process for collecting, de-identifying and analyzing the electronic data. This electronic data will greatly enhance 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. Beginning in mid-July 2013, United Airlines initiated a regular install/remove

process for these data cards on the ITP-equipped aircraft. Selected results from these data cards will be included in a future ISPACG information paper.

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 Airlines and United ALPA signed an agreement regarding ITP training. As a result of the agreement, a significant amount of ITP training occurred between January 2013 and April 2013. As of 17 April 2013, all United Boeing 747 pilots were trained and authorized to perform ITP operations. This resulted in a noticeable increase in ITP requests in the Oakland Oceanic FIR. The average requests in early 2013 were about 2-5 per month, rising to 11 in April 2013, and then a new range of 14-18 per month from May through July 2013. As noted in section 3.3, the second year of the operational evaluation was completed in August of 2013 and the third year began on September 2013. Due to the delay in the start of the third year of the operational evaluation, there was a resulting drop off in the number of ITP requests. The data indicates that the number of ITP request is back in the range of 9-14 per month.

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 KZAK in December 2011. Airports Fiji, Ltd and Airways Corporation New Zealand joined the operational evaluation in late 2013, which expanded the availability of ADS-B ITP to the Nadi and Auckland FIRs. 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 The meeting is invited to note the information provided in this paper and attachment.



ATTACHMENT A

Data for January 2014

Application Validation Metric	Southern Pacific		Northern Pacific		Totals	
	Expected	Actual	Expected	Actual	8/2013 - 1/2014	8/2011 - 1/2014
Number of ITP capable flights	60	66	180	191	1420	2786
Number of ITP requests	2	1	12	8	57	160
Number of ITP maneuvers performed	1	0	2	4	9	31
Number of "standard" flight level changes (from an ITP request)	1	1	7	2	21	59
Number of denied flight level changes (from an ITP request)	0	0	3	2	16	45
Number of immediate limited standard climbs	0	0	0	0	5	9
Number of climbs after moving reference aircraft	0	0	0	0	5	10
Number of standard climbs after period of time	0	0	0	0	1	6

Safety Related Parameter	Expected Avg.	Measurements (current month)			Measurements (8/2013 - 11/2014)			Measurements (8/2011 - 1/2014)		
		Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
ITP Initiation Distance	20 nm	20.8	29.9	47.2	20.8	33.2	67.7	19.1	29.8	88.4
ITP Distance at Co-altitude	18 nm	21.5	30.5	46.6	21.5	33.7	67.9	20.2	30.4	88.5
Time From ITP Initiation to Level Off at New Altitude	7 min	3	4.5	7	2.0	4.5	7.0	2.0	4.8	8.0
Percentage of ITPs where a wake encounter occurred and a wake incident was reported	2%					0.0			0.0	
Wake Turbulence Incident Severity (5-1) (5 minimal, 1 catastrophic)	5		N/A			N/A			N/A	