Twenty Fifth Meeting of the
Informal South Pacific ATS Co-ordinating Group (ISPACG/25)

Honolulu, Hawaii, USA, 24-25 March 2011

Agenda Item 4: Review Open Action Items (AI 17-5)

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

Presented by the Federal Aviation Administration

SUMMARY

The purpose of this information paper is to present the U.S. Federal Aviation Administration (FAA) plan for conducting an ADS-B In-Trail Procedures (ITP) operational trial in the South Pacific.

1. INTRODUCTION

1.1 The U.S. Federal Aviation Administration (FAA) created the Surveillance and Broadcast Services (SBS) Program in September 2005 to develop a multi-segment, performance-based strategy that aligns with the FAA's Next Generation Air Transportation System (NextGen) and generates value for the U.S national airspace system (NAS). The SBS Program Office is overseeing and directing the acquisition of a number of surveillance and broadcast services in specified volumes on a NAS-wide basis.

1.2 The SBS Program Office is also developing a number of airborne ADS-B applications that are expected 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). In addition to providing benefits to operators who equip, these applications will help accelerate the understanding and acceptance of airborne ADS-B and provide an increased user base of equipped aircraft that will support future applications. One such airborne ADS-B application being developed is ADS-B In-Trail Procedures (ITP).

1.3 Due to significant interest by international partners, the United States, in collaboration with a number of other states, has been working, over the past several years, to develop procedures and standards for ADS-B ITP.

1.4 The FAA has entered into an agreement with United Airlines for the purpose of performing an operational trial of ADS-B ITP in the South Pacific on revenue flights. This agreement includes the development and certification of on-board systems that provide the ADS-B ITP criteria and display that information to the pilot.

1.5 The purpose of this paper is to provide a status update on the development of the ADS-B ITP procedure and the proposed operational trail scheduled to begin this summer.

2. BACKGROUND

2.1 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 change procedures, enabled by ADS-B ITP, can supplement oceanic standards creating greater operational efficiency.

2.2 This paper describes an application known as ADS-B ITP. ADS-B ITP will enable flight level changes for aircraft equipped with ADS-B receivers and on-board automation.

2.3 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
- Following climb
- Combined climb
- Leading descent
- Following descent
- Combined descent

While there is no limit of 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.

2.4 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 (leading or trailing) aircraft. Based on the ADS-B data from the non-maneuvering or reference aircraft, a pilot can make an ITP altitude change request to air traffic control (ATC). The controller then verifies that the ITP and reference aircraft are same track and that the maximum closing Mach differential is less than or equal to M of 0.06. If the controller determines that standard separation minima will be met 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.

2.5 To perform these procedures the aircraft desiring to climb or descend must be equipped with an ADS-B transceiver and an appropriate on-board decision support system, both of which would have to be certified for this application. Aircraft operators choosing to equip in this manner would be able to take advantage of this procedure when operating in proximity to aircraft equipped with a suitable ADS-B transmitter ("ADS-B Out").

2.6 Aircraft operators who choose to equip with an ADS-B transceiver and on-board automation will benefit through the ability to perform in-trail maneuvers to achieve

more time at optimum altitudes. This could result in more efficient and predictable flight profiles, thereby saving fuel and, in some cases, allowing operators to make operational decisions, such as carrying additional high value payload in lieu of additional contingency fuel. Aircraft operators have also indicated there may be other potential benefits associated with increased cockpit situational awareness resulting from ADS-B In traffic displays.

2.7 Detailed benefits analyses for ADS-B ITP have focused on savings that could be achieved in the North Atlantic Organized Track System (NATOTS) and in the South Pacific (SOPAC) Region, including flights that operate between the west coast of the United States and Australia or New Zealand (SOPAC).

2.8 A summary of the ITP criteria are as follows:

a. Maximum of two reference (target) aircraft; +/- 2000 feet from ITP aircraft altitude
b. Reference aircraft can be any combination of ahead of or behind the ITP aircraft
c. ITP aircraft can climb or descend at no less than 300 feet per minute
d. Initiated with at least 15 NM and no more than 20 knots (kts) of closure
e. The closing Mach number difference must be less than or equal to M of 0.06
f. ITP aircraft must maintain Mach number in climb
g. Reference aircraft must be level and non-manuevering
h. ITP aircraft must have certified ITP equipment onboard as well as CPDLC
i. Reference aircraft must have valid ADS-B Out signal

3. STATUS OF ADS-B ITP DEVELOPMENT

3.1 ADS-B ITP has been under development over many years. The work supporting the development of ITP has ranged from batch simulations to human-in-the-loop experiments and has included avionics and separation standards development. Some of these activities, which were detailed in the ADS-B ITP paper presented at ISPACG, include: development and approval of an ICAO Separation and Airspace Safety Panel (SASP) ITP Circular, ADS-B ITP Safety, Performance and Interoperability Requirements (SPR) Documents DO-312 and ED-159, NASA report detailing results from a human-in-the-loop experiment that investigated the viability of ADS-B ITP from a cockpit prospective, and a NASA report detailing results from a joint Airservices Australia and NASA validation experiment of the ATC procedures associated with ADS-B ITP.

3.2 In 2008, the FAA SBS program established a project for the purpose of performing an operational trial of ADS-B ITP in revenue service. The objectives of the project are to a) validate the operational performance and economic benefits of ITP; and b) develop and validate ADS-B ITP Minimum Operational Performance Specifications (MOPS) material.

3.3 As a part of this project, the FAA established agreements with United Airlines and Honeywell. The agreements include the work necessary for the development,

certification and installation of on-board systems for 12 United Airlines Boeing 747-400s. Goodrich Aerospace was selected by the partners to be the project's Electronic Flight Bag (EFB) supplier. These on-board systems will calculate the ADS-B ITP criteria and display that information to the pilot. Honeywell is primarily responsible for the development of the traffic computer and traffic computer software, as well as the ITP display software. Goodrich Aerospace is responsible for the EFB hardware and operating system software. United Airlines is responsible for overall coordination and installation of ITP equipment and conducting the flight trial. The ITP system development is nearly complete and certification activities are underway. Additionally, United Airlines has completed initial installations on 6 of the 12 aircraft to be used in the flight trial.

3.4 The FAA project has also been working with Oakland Oceanic Control Center (ZOA) and the FAA's Oceanic and Offshore Operations Office to develop controller procedures and safety analyses that are required to support the flight trial. The controller procedures were developed and tested using the FAA's Dynamic Simulation (DYSIM) simulation system. The safety analyses are being developed following the FAA's Safety Management System and will result in an ITP Safety Risk Management Document. The FAA has also been working on the development of an ITP Operational Specification, which is expected to be approved this April. United Airlines will submit a request for operational approval based on the ITP Operational Specification, an approved SRMD and certification of ITP avionics system.

4. ADS-B ITP OPERATIONAL TRIAL

4.1 As stated previously the goal of the FAA ITP project is to enable an operational trial of ADS-B ITP in revenue service. The FAA is planning on initiating this flight trial this summer. Details of the operational flight trial are outlined below.

4.1.1 Scope:

a. The trial will take place using equipped United Airlines Boeing 747-400's operating between the US West Coast and Australia and on return flights. The flights will be regularly scheduled passenger revenue flights, not test flights.
b. There will be designated data collection activity for both United Airlines and Oakland Oceanic Control Center (ZOA). Any significant adverse operational issues that are discovered (such as communication or workload) will result in an immediate suspension of all operational evaluation activity.
c. The data collected will be used to enhance the understanding of the economic and operational impact.
d. Regular line flight crews and air traffic controllers will be used. All pilots and controllers that are authorized to participate will have completed approved training.
e. Initial expectations are that a maximum of one or two ITP procedures will be performed per week of operations.
f. The operational trial flights will be conducted for a period of one year.

This operational trial has additionally been adopted as an initiative within the ASPIRE program. The initiative establishes a cooperative agreement between the FAA,

Airservices Australia, and Airways Corporation New Zealand, which will allow the organizations to share data and provide a mechanism for providing mutual support of the operational trial.

4.1.2 Objectives

a. Validate that air traffic controllers applying ADS-B ITP find it a useful tool.
b. With data collected from United Airlines, validate the impact on contingency fuel loading by dispatch and flight crews when they are aware that the aircraft will be ITP capable.
c. From post flight surveys, determine the significance and value of increased situation awareness for the flight crew.
d. Determine how often the procedure is requested, how often it is cleared.
e. Determine a measurable reduction in fuel burn on flights with the combined benefit of situation awareness and ITP climbs.
f. Validate SPR assumptions and gather data to support validation of a Minimum Operational Performance Specification (MOPS) currently under development for ADS-B ITP.

4.2 A copy of the Controller Pilot Data Link Communications (CPDLC) messages that will be used during the trial are included in Appendix 1. Until ITP message sets are built into airborne and ground-based communication platforms, pre-formatted text developed and endorsed by ICAO will be used.

4.3 A copy of the proposed controller procedures is included in Appendix 2.

5. SUMMARY

5.1 The FAA desires to initiate an operational trial of ADS-B ITP along South Pacific (SOPAC) routes this summer. The FAA has established agreements that are leading to the development and certification of on-board systems that provide the ADS-B ITP criteria and display that information to the pilot. The FAA has also been performing all required safety management system (SMS) processes and analyses, developing an ITP Operational Specification, and intends to obtain regional endorsement for conducting the ITP flight trial.

6. ACTION BY THE MEETING

6.1 The meeting is invited to:

a) Note the information presented in this paper; and
b) Support the planned ADS-B ITP operational trials in the South Pacific that could result in significant economic and efficiency benefits for both service providers and users. The trials are targeted to begin in the summer of 2011.

Appendix 1 – CPDLC messages

Use of downlink pre-formatted free text messages

The airborne system will append the vertical request message element with a free text message dM67.

When a vertical request for climbing (resp. for descending) has been prepared as part of an In Trail Procedure transaction, the aircraft shall send a downlink message containing dM9 REQUEST CLIMB TO [altitude] (resp. dM10 REQUEST DESCENT TO [altitude]) concatenated with message element dM67 containing the following text:

ITP procedure type (number and relative position of reference aircraft)	**dM67 Message Element content**
1 reference aircraft (ahead)	"ITP [Distance] BEHIND [Aircraftflightidentification]"
1 reference aircraft (behind)	"ITP [Distance] AHEAD OF [Aircraftflightidentification]"
2 reference aircraft (both ahead)	"ITP [Distance] BEHIND[Aircraftflightidentification] AND [Distance] BEHIND [Aircraftflightidentification]"
2 reference aircraft (both behind)	"ITP [Distance] AHEAD OF [Aircraftflightidentification] AND [Distance] AHEAD OF [Aircraftflightidentification]"
2 reference aircraft (one ahead and one behind)	"ITP [Distance] BEHIND [Aircraftflightidentification] AND [Distance] AHEAD OF [Aircraftflightidentification]"

Example of ITP request message:
REQUEST CLIMB TO FL360
ITP 25NM BEHIND SIA228 AND 21NM AHEAD OF AFR008

Use of uplink pre-formatted free text messages

The controller will append the vertical request message element with a free text message uM169.

When a vertical clearance for climbing (resp. for descending) has been prepared as part of an In Trail Procedure transaction, the ground system shall send an uplink message containing uM20 CLIMB TO AND MAINTAIN [altitude] (resp. uM23 DESCEND TO AND MAINTAIN [altitude]) concatenated with message element dM169 containing the following text:

ITP procedure type (number and relative position of reference aircraft)	uM169 Message Element content
1 reference aircraft (ahead)	"ITP BEHIND [Aircraftflightidentification]"
1 reference aircraft (behind)	"ITP AHEAD OF [Aircraftflightidentification]"
2 reference aircraft (both ahead)	"ITP BEHIND [Aircraftflightidentification] AND BEHIND [Aircraftflightidentification]"
2 reference aircraft (both behind)	"ITP AHEAD OF [Aircraftflightidentification] AND AHEAD OF [Aircraftflightidentification]"
2 reference aircraft (one ahead and one behind)	"ITP BEHIND [Aircraftflightidentification] AND AHEAD OF [Aircraftflightidentification]"

Example of ITP clearance message:
ITP BEHIND SIA228 AND AHEAD OF AFR008
CLIMB TO FL360
REPORT LEVEL FL360

Appendix 2 – Sample Controller Procedures

If any of the FOLLOWING STEPS ARE NOT TRUE, ADVISE the aircraft UNABLE

Validate ITP Request

- ☐ The PILOT-REPORTED DISTANCE between the ITP aircraft and any referenced aircraft IS AT LEAST 15NM

Initiate probe on ITP aircraft

- ☐ 1 OR 2 CONFLICTS EXIST
- ☐ All CALL SIGNS IN CONFLICT REPORT(S) are included in the ITP request
- ☐ All conflict aircraft are SAME DIRECTION TRAFFIC as ITP aircraft until vertical separation is re-established
- ☐ CLOSING MACH DIFFERENCE of ITP aircraft and any referenced aircraft is ≤ .06
- ☐ All conflict aircraft are WITHIN 2000’ of the ITP aircraft
- ☐ All conflict aircraft are AT A SINGLE-ASSIGNED ALTITUDE
- ☐ NO CONFLICT exists AT THE REQUESTED ALTITUDE
- ☐ No aircraft involved are cleared for a ROUTE DEVIATION