Twenty Fourth Meeting of the
Informal South Pacific ATS Co-ordinating Group (ISPACG/24)

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Agenda Item 4: Review Open Action Items

AUTOMATIC DEPENDENT SURVEILLANCE- BROADCAST 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, lifecycle-managed, and performance-based strategy that aligns with the 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 chose 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 related 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 onboard 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. Additionally, the group is invited to consider the application of this procedure for an operational trial in the South Pacific.

2. DISCUSSION

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, can supplement oceanic standards creating greater operational efficiency.

2.2 This paper describes an application known as ADS-B In-Trail Procedures (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 • Leading descent
- Following climb • Following descent
- Combined climb • Combined descent

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, who maintains separation responsibility at all times, would verify that the ITP and reference aircraft were same track and that the maximum closing Mach differential was not exceeded. This check is to assure that an expected ITP separation minimum will be maintained during the maneuver, accounting for potentially unsafe closure rates due to abnormal, adverse wind gradient conditions. 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. 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 onboard decision support system, both of which would have to be certified for this application. Those 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.

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 Region, including flights that operate between the west coast of the United States and Australia or New Zealand (SOPAC). These analyses identified different ADS-B ITP benefit mechanisms in different environments: improved flight efficiency in highly congested environments such as NATOTS; and reduced contingency fuel requirements in areas where conflicts may occur between aircraft with maximum takeoff weight limited flights that have a trade-off between payload and fuel, such as many South Pacific operations.

3. STATUS OF ADS-B ITP DEVELOPMENT

3.1 ADS-B ITP has been under development for over five years. These activities have ranged from batch simulations to flight trials in surveillance airspace and have included avionics and separation standards development. Some of those activities are summarized in the following sections.

3.2 One of the more significant ADS-B ITP developmental activities has been the work undertaken by the ICAO Separation and Airspace Safety Panel (SASP) beginning at the tenth meeting of the SASP Working Group of the Whole (WG/WHL/10) held in Australia in November 2006. The SASP agreed that there was a need to develop procedures and material for inclusion in Doc 4444 PANS-ATM in addition to work being undertaken concurrently to establish the separation minima by collision risk modeling. To this end, the longitudinal subgroup of SASP has developed a PANS-ATM amendment with the intent that these will set the requirements for the implementation of ADS-B ITP by regions or states. The mathematicians' subgroup of SASP supported this work by conducting collision risk modeling of the procedure. The results of this work can be found in a recently completed ADS-B ITP Circular[1] approved by SASP. This circular contains the proposed PANS-ATM amendment, an overview of all the work done to date, including a list of appropriate supporting working papers, and some examples of proposed supporting Controller Pilot Data Link Communications (CPDLC) message sets. Readers are encouraged to consult the circular for more details of the procedure.

3.3 Another significant ADS-B ITP activity was undertaken by the RTCA/European Organization for Civil Aviation Equipment (EUROCAE)-sponsored Requirements Focus Group (RFG). The RFG was established to perform co-ordinated requirements

determination and interoperability for early implementation of ADS-B/ASAS applications. ADS-B ITP was one of the early applications the RFG chose to focus on. RTCA and EUROCAE approved and published safety, performance and interoperability requirements documents for ITP. The documents are DO-312[2] and ED-159[3], respectively. These documents contain an Operational and Service Environment Description (OSED), an Operational Safety Assessment (OSA), an Operational Performance Assessment (OPA), and a collision risk model for ADS-B ITP. Note, the RFG's term for ADS-B ITP is Air Traffic Situational Awareness – In-Trail Procedures (ATSA-ITP). DO-312, or ED-159, provides more details of the procedure and the standards developed by RTCA and EUROCAE.

3.4 In support of ADS-B ITP development, the National Aeronautics & Space Administration (NASA) conducted a four week human-in-the-loop experiment that investigated the viability of ADS-B ITP from a cockpit prospective. Twelve (12) commercial airline pilots with current oceanic experience flew a series of simulated scenarios involving either standard or ITP flight level change maneuvers and provided subjective workload ratings, assessments of ITP validity and acceptability, and objective performance measures associated with the appropriate selection, request, and execution of ITP flight level change maneuvers. Workload ratings for ITP maneuvers were acceptable and not substantially higher than for standard flight level change maneuvers, and, for the majority of scenarios and subject pilots, subjective acceptability ratings and comments for ITP were generally high and positive. Qualitatively, the ITP was found to be valid and acceptable. The results of these studies are contained in NASA TP 2008-215313[4].

3.5 In August 2007, Airservices Australia and NASA conducted a validation experiment of the ATC procedures associated with ADS-B ITP. The experiment was conducted in the ATC simulator in Melbourne, Australia. This experiment involved 12 currently rated controllers and showed that controllers viewed ADS-B ITP as valid and acceptable. The experiment identified some aspects of the ITP, mainly in the communication and controller approval process, that could be improved. The results of this study are in a soon to be published NASA technical paper[5].

3.6 The CRISTAL (Co-opeRative validatIon of Surveillance Techniques and AppLications of ADS-B) ITP project was conducted by a consortium of four organizations, namely; Airbus, as leader of this consortium, ISAVIA, NATS and ALTICODE, in partnership with the Eurocontrol CASCADE (Co-operative Air Traffic Services through Surveillance and Communication Applications Deployed in ECAC) program. The project aimed at progressing validation of the ADS-B ITP application and also at providing an opportunity to prepare entry of ADS-B ITP in the North Atlantic oceanic environment using input from flight crews and controllers. Simulations of ADS-B ITP maneuvers included the use of Airbus aircraft simulator, NATS and ISAVIA ground system simulators, and NATS traffic simulation tool (NATSIM). Flight trials of the ITP procedure were successful and included an Airbus A340 test aircraft performing ITP maneuvers with reference to an SAS aircraft in a procedural environment, however under Reykjavik, Iceland, radar control. The ITP

trials were successful and CRISTAL ITP successfully achieved clarification of how the ITP procedure can be applied in the NAT airspace.

4. ADS-B OPERATIONAL TRIAL

4.1 While there has been a significant amount of developmental work for ADS-B ITP, the next step is to conduct an operational trial, or evaluation, of ADS-B ITP.

4.1.1 Scope:

a. The trial will take place on equipped United Airlines 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. The data collected will be used to enhance the understanding of the economic and operational impact.

b. There will be designated data collection activity for both United Airlines and Oakland Air Route Traffic Control Center (ARTCC). 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. 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.

d. It is planned that half of the 747's operating on the route will be equipped and authorized to request an ITP maneuver.

e. Initial expectations are that between one and two ITP procedures will be performed per week of operations.

f. If requested ITPs are approved, and there are no problems encountered, the operational trial flights will be conducted for a period of one year.

4.1.2 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 Corp New Zealand which will allow the organizations to share data and provide a mechanism for providing mutual support of the operational trial.

4.1.3 Objectives

a. Validate that air traffic controllers applying ADS-B ITP find it a useful tool, with minimal impact on their workload.

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, and for the times it is denied, what are the reasons for the denial.

e. There should be some 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.

5. SUMMARY

5.1 The FAA desires to lead an operational trial of ADS-B ITP along South Pacific (SOPAC) routes within the next 18 months. The FAA has formed a contractual partnership that is focused on the next steps necessary to conduct this operational trial. These steps include, but are not limited to, development and certification of onboard systems that provide the ADS-B ITP criteria and display that information to the pilot. Other work required will include performing all required safety management system (SMS) processes and analyses, obtaining FAA aircraft certification and flight standards approvals, and working with the international community on the development and approval of applicable separation standards and obtaining regional authorization for their application.

6 ACTION BY THE MEETING

6.1 The meeting is invited to:

a) Note the information presented in this paper; and
b) Comment on the planning of the ADS-B operational trials in the South Pacific that could result in significant economic and efficiency benefits for both service providers and users

REFERENCES

1 “Safety Assessment for the Development of Separation Minima and Procedures for In-Trail Procedure (ITP) Using Automatic Dependant Surveillance-Broadcast (ADS-B), Version 1.5.2”, ICAO SASP draft circular, November 2009.

2 “Safety, Performance and Interoperability Requirements Document for the In-Trail Procedure in Oceanic Airspace (ATSA-ITP) Application”, RTCA DO-312, June 19, 2008.

3 “Safety, Performance and Interoperability Requirements Document for ATSA-ITP Application”, EUROCAE ED-159, July 2008.

4 “Enhanced Oceanic Operations Human-In-The-Loop In-Trail Procedure Validation Simulation Study”, Murdoch, Jennifer, et. al., NASA TP 2008-215313, June 2008.

5 “In-Trail Procedure Air Traffic Control Procedures Validation Simulation Study”, Chartrand, Ryan, et. al., soon to be published NASA TM.