Twenty Third Meeting of the
Informal South Pacific ATS Co-ordinating Group (ISPACG/23)

Santiago, Chile, 26–27 March 2009

Agenda Item 4: Review Open Action Items

STATUS OF THE DEVELOPMENT AND IMPLEMENTATION OF ADS-B IN-TRAIL PROCEDURES

(Presented by Federal Aviation Administration)

SUMMARY

This paper summarizes the status of Automatic Dependent Surveillance – Broadcast (ADS-B) In-Trail Procedures (ITP) development.

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, life-cycle 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 leading the acquisition of a number of surveillance and broadcast services in specified volumes on a NAS-wide basis.

1.2 The SBS Program is also developing a number of airborne ADS-B applications that should 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 customers who equip, these applications will help accelerate the understanding and acceptance of airborne ADS-B and provide a growth path to future applications. One such airborne ADS-B application being developed is known as ADS-B In-Trail Procedures (ITP).

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

1.4 ADS-B ITP will enable flight level changes for aircraft equipped with ADS-B receivers and on-board automation. The proposed ITP will facilitate improved flight efficiency.

1.5 ADS-B ITP is comprised of a set of six flight level change geometries with the specific 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

1.6 For ADS-B ITP the maneuvering (trailing or leading) aircraft obtains the flight identification (ID), altitude, position and ground speed of the non-maneuvering (leading or trailing) aircraft from ADS-B data. 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 account 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.

1.7 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 approved 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 other aircraft equipped with an ADS-B transmitter.

1.8 Aircraft operators who choose to equip will benefit through the ability to perform in-trail maneuvers to achieve more optimum altitudes. This could result in more efficient and predictable flight profiles, thereby saving fuel and allowing operators to carry more high value payload. Aircraft operators have also indicated there may be other potential benefits associated with increased cockpit situational awareness of traffic.

1.9 Detailed benefits analyses for ADS-B ITP have also been performed. These analyses 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). The analyses identified different 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.

2. DISCUSSION

2.1 ADS-B ITP has been under development for over four years. Developmental activities have ranged from batch simulations to flight trials and have included

avionics and separation standards development. Some of those activities are summarized in the following sections.

2.2 One of the more significant ADS-B ITP developmental activities has been the work that was 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.

2.3 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/Aircraft Surveillance Applications System (ASAS) applications. ADS-B ITP was one of the early applications the RFG chose to focus on. This past year both 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.

2.4 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 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

[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", ICAO SASP draft circular, October 2008.
[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.

positive. Qualitatively, the ITP was found to be valid and acceptable. The results of these studies are contained in NASA TP 2008-215313[4].

2.5 In August 2007, Airservices Australia and NASA conducted a validation experiment of the Air 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].

2.6 The next step is to conduct an operational evaluation of ADS-B ITP. The objectives of this operational evaluation would be to validate operational performance of ADS-B ITP, validate economic benefits of ADS-B ITP, and establish a framework for global implementation of ADS-B ITP and follow-on airborne ADS-B applications.

2.7 The FAA desires to lead an operational evaluation of ADS-B ITP along South Pacific (SOPAC) routes within the next two years. The FAA is in the early stages of forming a partnership that would be focused on performing the work necessary to conduct this operational evaluation. 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. A variety of retrofit system interface options are being evaluated by the FAA and a number of avionics vendors. Other work required will include performing all required safety analyses, working with the international community on the development and approval of applicable standards.

2.8 The FAA and Airservices Australia have initiated discussions on future cooperation in support of an ADS-B ITP operational flight evaluation and plan to implement an agreement under the Asia and South Pacific Initiative to Reduce Emissions (ASPIRE) framework.

2.9 ADS-B ITP could be implemented on a test basis to determine its operational suitability as a future permanent procedure. Initial flight trials could be conducted in airspace under ATC surveillance, where the ITP separation minimum is larger than the applicable surveillance-based separation standard. In order to gather appropriate data and acceptance, the flight evaluation would be conducted on revenue flights by specifically approved participating airline partners.

3. ACTION BY THE MEETING

3.1 The meeting is requested to note the information in this paper.

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[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.