INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

REPORT

OF THE FIFTEENTH MEETING OF AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST (ADS-B) STUDY AND IMPLEMENTATION TASK FORCE (ADS-B SITF/15)

(Bangkok, 18 - 20 April 2016)

The views expressed in this Report should be taken as those of the Meetings and not the Organization.

Approved by the Meeting
and published by the ICAO Asia and Pacific Office, Bangkok

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1. INTRODUCTION

1.1 The Fifteenth Meeting of Automatic Dependent Surveillance – Broadcast (ADS-B) Study and Implementation Task Force (ADS-B SITF/15) was held in the ICAO Asia and Pacific Regional Office, Bangkok, Thailand from 18-20 April 2016.

1.2 In his opening remarks, Mr. Greg Dunstone, Chairman of the Task Force, welcomed all the participants, recalled history of the Task Force. He also highlighted important achievements of the Task Force and tasks need to be carried or forwarded to SURICG. He pointed out that the large number of participants and new members to the meeting indicated the increasing interest of work has been or being completed by the Task Force.

1.3 On behalf of Mr. Arun Mishra, Regional Director, ASIA/PAC Office, Mr. Li Peng, Regional Officer CNS extended warm welcome to all participants to the last meeting of the Task Force. He introduced the arrangements for the meeting.

2. ATTENDANCE

2.1 The meeting was attended by 85 participants from Australia, Bangladesh, Bhutan, Cambodia, China, Hong Kong China, Macao China, Fiji, India, Japan, Indonesia, Laos PDR, Malaysia, Maldives, Mongolia, New Zealand, Pakistan, Papua New Guinea, Philippines, Republic of Korea, Singapore, Sri Lanka, Thailand, USA, Viet Nam, CANSO, IATA and industry representatives from Airbus, Boeing and Rockwell Collins. List of participants is at **Attachment 1.**

3. OFFICERS AND SECRETARIAT

3.1 Mr. Greg Dunstone, Senior Engineering Specialist of Airservices Australia Chaired the Meeting. Mr. Li Peng, Regional Officer CNS and Mr. Shane Sumner, Regional Officer ATM, ICAO Asia and Pacific Regional Office, acted as Secretaries.

4. ORGANIZATION, WORKING ARRANGEMENTS AND LANGUAGE

4.1 The meeting met as a single body. The working language was English only inclusive of all documentation and this Report. The meeting considered 9 working papers, 31 information papers. A list of Working Papers and Information Papers presented at the Meeting is at **Attachment 2.**

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Agenda Item 1: Adoption of the Agenda

1.1 The tentative agenda items provided in WP/01 was adopted as the agenda items for the meeting.

Agenda Item 2: Review the outcome of the APANPIRG/26 on ADS-B SITF/14 and the Report of SEA/BOB ADS-B WG/10 Meetings

OUTCOME OF APANPIRG/26 on ADS-B (WP/2)

2.1 The meeting reviewed the outcome of APANPIRG/26 meeting on ADS-B. The follow-up actions taken by the Secretariat and States on the Conclusions of APANPIRG/26 were noted by the meeting. The reports of Fourteenth Meeting of ADS-B Task Force and Tenth Meeting of the SEA/BOB WG were reviewed by the CNS SG/19 in July 2015. APANPIRG/26 appreciated the efforts and progress made by the ADS-B SITF and the SEA ADS-B WG.

2.2 The meeting also noted that the revised AIGD (Version 8) adopted by APANPIRG/26 had been posted on the ICAO APAC website: http://www.icao.int/APAC/Pages/edocs.aspx .

2.3 Regarding APANPIRG/26/41, Hong Kong China informed the meeting, operational approval has been no longer required since February 2016. Viet Nam advised that they would remove such requirement from 2018. Maldives expressed that they were going to review their requirement for operational requirement in the AIP Supplements.

2.4 The meeting reviewed the ADS-B Implementation Status in the APAC Region. The updated Table is provided in **Appendix A** to this Report.

Action on Report of SEA/BOB ADS-B WG/11 (WP/03)

2.5 The meeting reviewed the report of Eleventh Meeting of South East Asia and Bay of Bengal Sub-regional ADS-B Implementation Working Group (SEA/BOB ADS-B WG/11), held in New Delhi, India 17 to 19 November 2015. The report of the Working Group is available on the ICAO APAC website: http://www.icao.int/APAC/Meetings/Pages/2015-SEA-BOB-ADS-B-WG11--.aspx .

2.6 The meeting also noted that the Working Group reviewed the outcome of 52nd Conference of Directors General of Civil Aviation (DGCAs) Asia and Pacific Regions. The Conference reaffirmed the need for expediting implementation of ADS-B and developed action Item 52/12 in this connection.

Significant development and achievements by the working group

2.7 The meeting noted the following significant developments and achievement since SEA/BOB WG/10 meeting held in November 2014 and during this meeting:

- In May 2015, India and Myanmar signed MOU on ADS-B data sharing;
- In October 2015, Singapore and the Philippines signed an MOU to share ADS-B data and VHF facilities. The project is expected to be completed by early 2017;
- Brunei and Singapore started discussions on data sharing; the MOU is expected to be signed in 2016;

- SEA/BOB WG/11 endorsed the draft contributed by India **on the additional functional requirements ADS-B Integration** from HMI perspective for consideration by ADS-B SITF;

- Input to updates the ADS-B Implementation status in APAC region; and

- Updates on action being taken by Boeing mitigating ADS-B error from B787 fleet.

2.8 The meeting discussed some important outcomes of the SEA/BOB ADS-B WG/11 meeting.

Review of Outcome of Ad Hoc Groups on South East Asia (SEA) and Bay of Bengal (BOB) projects

2.9 The meeting noted the latest report on the Sub-regional ADS-B implementation plan/projects presented by SEA and BOB Ad Hoc working groups during the 11th meeting SEA/BOB ADS-B Working Group. The discussions were based on the outcome of previous meetings of the ADS-B SITF/14 and SEA/BOB ADS-B WG/10 and information made available to the meeting. The outcome of discussions by Ad Hoc groups is provided in an Appendix to the working group report.

Review TOR of the WG

2.10 The slow response on regional collaboration on ADS-B data sharing was one of the concerns expressed by the working group. The working group was expected to gather difficulties and assist States in resolving them. The meeting noted that the reporting path of the Working Group to the ADS-B Study and Implementation Task Force need to amended to Surveillance Implementation Coordination Group from 2017 onwards. The meeting also identified the need to keep the ADS-B Working Group to promote implementation in two sub-regions. Whether the TOR of the WG needs to be enhanced to cope with other tasks is subject to consideration by the first meeting of SURICG in April 2016.

Regulator’s Engagement in ADS-B Implementation

2.11 The meeting noted that the lack of engagement by regulators in ADS-B implementation. Regulators need knowledge about the risks and benefits that ADS-B can bring to the safety of aviation. The meeting noted that previously SITF had conducted “regulator focused” workshops. Nevertheless around the world, regulators seem slower than ANSPs to embrace the technology. This issue was discussed by the working group which developed a draft Conclusion for consideration by the Task Force.

2.12 Importantly, the meeting considered that failure to deploy the safety improvements enabled by ADS-B could bring criticism and liability in the event of an adverse outcome. Whilst there are risks and mitigations required to deploy ADS-B, equally there are risks in doing nothing and continuing to rely on procedural ATC with its dependency on voice report of position. Accordingly, the meeting endorsed a revised draft Conclusion formulated by the SEA/BOB ADS-B Working Group:

Draft Conclusion 15/1 - Regulators active support and engage with ADS-B Implementation and Data sharing

That, considering

a) any delay in ADS-B deployment and operational use brings risks, liability and additional regulator responsibility as traffic grows in FIRs without surveillance and automated safety nets; and

b) the risks in doing nothing whilst continuing to rely on ATC procedures with dependency on voice position reports and lack of automation

States (regulatory authorities) are urged to:

- actively engage with ANSPs to support the ADS-B implementation, in particular the examination of risks, hazards, mitigations and benefits; and

- support the ADS-B data-sharing and collaboration among States to achieve harmonized implementation for maximizing benefits of ADS-B.

2.13. In response to a query, the Philippines advised that they were waiting for the completion of CNS/ATM project in later 2016 or early 2017 before planning ADS-B data sharing with neighbouring FIR.

Date and venue for the next WG meeting

2.14 The meeting noted that the working group identified the need to organize another meeting to progress implementation of the sub-regional plan. The member States/Administrations of the Working Group were invited to coordinate with the Secretariat for hosting the next SEA BOB ADS-B WG meeting in late October or early November 2016. China offered to host the next meeting of the SEA BOB ADS-B WG.

System Specifications for developing an ADS-B Monitoring System (WP/9)

2.15 In following up an action item of the SEA/BOB ADS-B WG/11 meeting, Malaysia presented the working paper highlighted the result of a survey that proposed a checklist for monitoring the ADS-B system. The survey was distributed on 22 February 2016. Nine (9) States/Administration responded to the survey, namely: New Zealand, Singapore, Japan, United States, India, Hong Kong-China, Thailand, Malaysia and Australia.

2.16. A checklist was developed based on the outcome of the survey picking up the most important common items/parameters for monitoring which are categorized into five main modules; Ground Station, Equipage, Avionics, Performance Level and ADS-B Display. The Ground Station module has three sub-modules, namely Site Monitoring, Remote Control & Monitoring and Logistic Support Monitoring.

2.17 The meeting noted that several common items and parameters for monitoring were included in the current version of the AIGD. In order to avoid duplication, it was agreed that Malaysia and Hong Kong China would work together to include relevant additional items for consideration by the meeting. A checklist of options for developing an ADS-B monitoring system was considered useful. The updated checklist table agreed by the meeting was included into the revised AIGD.

Agenda Item 3: Review Subject/Tasks List

Review Tasks/Actions items (WP/4)

3.1 Under this agenda item, the meeting reviewed and updated the list of action items for the Task Force. The meeting agreed to close some actions items which were considered completed. Some outstanding action items were agreed to be forwarded to either SURICG or SEA/BOB ADS-B WG for further action. The consolidated list of the outstanding action items is provided in **Appendix B** to this Report.

Amendment to AIGD

3.2 The meeting identified the need to further update the AIGD based on the discussions on the working papers presented to the meeting. The consolidated amendment to AIGD is provided in **Appendix C** to this Report. The amendments included the following:

- A checklist for monitoring of ADS-B system (revised table attached to WP/9);
- Additional functional requirements ADS-B Integration from HMI perspective for consideration, based on the contribution of the SEA/BOB ADS-B WG/11 meeting. Some editorial changes were made considering that general requirement should be considered rather than applicable to specific ATM system only (Appendix B to WP/03);
- Guidance on updating ADS-B ground stations to support Version 2 (DO 260B) based on the sample of DF17/DF18 Format Type Code 29 which have been changed significantly between versions (WP/6 refers); and
- General recommendation on a technical solution of acquiring Mode 3/A code for DO-260 aircraft via Mode S downlink. (WP/8 refers).
- Updated list of known ADS-B avionics problems in Appendix 2 - Attachment A.

Accordingly, the meeting formulated the following Draft Conclusion:

Draft Conclusion ADS-B SITF 15/2 – AIGD Amendment

That, the consolidated amendments to the AIGD provided in **Appendix C** be adopted.

Agenda Item 4: Review States' activities and interregional issues on Implementation of ADS-B and multilateration

Incorrect Processing of DO-260B Downlinks (WP/6)

4.1 Australia presented a paper on ADS-B ground stations which were not capable to support D0-260B that may include incorrect data in the ASTERIX output. Some operational issues were observed including:

a) Significant changes of the DF17/18 Format Type Code 29 between the 3 types of DO-260x versions;

b) Different utilization of Format Type Code 29 subtype in DO260A and DO-260B, resulting in misinterpretation of LNAV mode information received from DO-260B avionics as a radio communications failure;

c) Misinterpretation of airborne position messages resulting in the figure of merit in the ASTERIX Cat 21 message being incorrectly set to zero, removing the aircraft from ATC display;

4.2 The meeting agreed to highlight this issue in the revised AIGD. ICAO was requested to consider issuing a letter warning States of the issue, and reminding them of the need to upgrade ground stations to receive and process DO-260B downlinks. The meeting also encouraged States/Administrations capable to do so or through the vendors to conduct a thorough test as this may not be the only case.

Performance of Current ADS-B Version 2 Systems (IP/10)

4.3 Recent analyses of observed ADS-B Version 2 quality parameters in comparison to the requirements of the USA ADS-B OUT rule were presented by the USA to the meeting.

IFR Flights to Australia Post February 2017 (WP/7)

4.4 Australia reminded States that IFR flights to Australia on or after 2 February 2017 must be ADS-B equipped. On 15 May 2014, the Australian regulator issued a number of Instruments that require all foreign operators of IFR flights to be equipped with ADS-B commencing 2 February 2017. ADS-B transmitters compliant with DO260, DO260A or DO260B are permitted. Australia also requested the ICAO Secretariat to include this advice in all relevant regional meetings before February 2017.

Acquisition of Mode 3/A Code via Mode S Downlink for DO-260 Aircraft (WP/8)

4.5 The meeting noted that DO-260 aircraft will still be the dominant type of ADS-B aircraft in the region for the coming years despite an increasing trend of DO-260B aircraft under the U.S and European ADS-B mandate for DO-260B by 2020. While DO-260 aircraft does not have Mode 3/A code in their ADS-B target reports, association between ADS-B targets and Mode A/C SSR targets for fused display could be a potential problem for some of the air traffic management systems (ATMS), which rely on proximity analysis to associate ADS-B targets and Mode A/C SSR targets.

4.6 Hong Kong China highlighted that proximity analysis using the aircraft position and Mode C altitude to associate ADS-B with Mode A/C SSR targets might introduce ambiguity, in particular for the region close to the airport, where there might be GA/helicopters flying at the same altitude close to the aircraft. There are chances for incorrect association or missing association of tracks would affect the effectiveness of ADS-B implementation.

4.7 Hong Kong China shared with the meeting a technical solution to overcome this problem by acquiring Mode 3/A code information for DO-260 aircraft via Mode S downlink, and incorporate the Mode 3/A code information into the ADS-B Asterix CAT 21 data stream at the ADS-B ground stations for feeding into the ATMS. The Mode 3/A code information has to be acquired through either active or passive interrogation. With the Mode 3/A code information available in both ADS-B and Mode A/C SSR targets, the problem in integration of ADS-B with Mode A/C SSR targets at ATMs for fused display could be resolved.

4.8 The meeting noted the aforesaid technical solution could be one of the possible measures to tackle the problem during transition from Mode A/C to Mode S radar. Australia echoed and shared a similar experience in converting ADS-B data stream in ASTERIX CAT 21 format to CAT 48 for feeding into their ATMS as an interim measure. After discussion, the meeting endorsed

the proposal for updating the AIGD to incorporate technical details presented in this working paper. The Chairman remarked that it would be good to mention in the AIGD that upgrading Mode A/C radar to Mode S capability would be another alternative solution to resolve the problem through the use of Flight ID and/or aircraft 24 bit address to perform association between ADS-B and Mode S SSR targets.

Updates on ADS-B implementation by States and Industry

4.9 Under this Agenda Item, the meeting received comprehensive presentations or updates on the ADS-B planning and implementation activities in the APAC Region and USA including their monitoring programme and implementation issues observed. Summary of such information papers are provided in the following paragraphs.

ADS-B Out Avionics update by Rockwell Collins (IP/22)

4.10 This paper presented a recent analyses of observed ADS-B Version 2 quality parameters in comparison to the requirements of the U.S. ADS-B Out rule. The ADS-B Aviation Rulemaking Committee in 2008, which advised FAA on the U.S. ADS-B Final Rule, performed an analysis of GPS signal-in-space availability. This analysis showed that GPS receivers which are unaware that GPS Selective Availability (SA) has been deactivated (so called "SA-On" GPS receivers) will fail to achieve the requirements of 14 CFR 91.227 (specifically, for the Navigation Integrity Category, NIC, parameter) with high availability (equal to or greater than 99.9% availability) under some expected GPS constellation conditions. For more information, see Appendix Z in the 2008 "Report from the ADS-B Aviation Rulemaking Committee to the FAA" http://www.faa.gov/nextgen/programs/adsb/media/arcReport2008.pdf.

4.11 FAA showed a table describing the U.S. ATC operational impacts of various Navigation Integrity Category (NIC) and Navigation Accuracy Category for Position (NACp) conditions, which motivated this analysis. The showed that, as expected, the lowest average operational availability of NIC>6 is seen in the JBU, DAL and UPS fleets, as these fleets have the largest fraction of aircraft with SA-On GPS receivers. NIC<7 time periods were as expected for fleets with significant numbers of SA-On receivers and consistent with the average operational availability results. The SBAS-equipped fleet was generally the best performing, with no NIC<7 time periods of more than 10 seconds. The fleets with SA-Aware GPS receivers had almost no operationally meaningful periods of NIC<7 performance (as expected given the current GPS constellation). However, some NIC<7 time periods were observed that were not consistent with expectations and models for SA-Aware and SBAS receivers and these were further examined and discussed in this paper. NIC<5 time periods were generally as expected for the various fleets with a few exceptions that were further probed and discussed in this paper. Overall, this paper provided data to support why the FAA is treating GPS SA-On equipage differently from GPS SA-Aware equipage in Exemption 12555 (see IP13 for more details on this Exemption).

Update on ATC Surveillance Activities in Australia (IP/3)

4.12 Australia provided an updates on air traffic control surveillance activities in Australia, updating reports previously provided to the Task Force. Australia had recently completed a safety assessment approving the use of ADS-B for 3NM surveillance separation in the terminal area environment. Australian also noted the value of SA-aware GNSS to support ADS-B and this is the reason behind the December 2016 SA-aware forward fit requirement in Australia.

Australian Plans to Decommission Some Radar (IP/6)

4.13 In accordance with the Australian Surveillance deployment strategy, Australia planned to decommission 3 radars in 2017. Previous advice had been that 4 radars would be decommissioned. The locations of the three radars were introduced in the paper.

ADS-B Implementation Plan of LAO PDR (IP/7)

4.14 Lao PDR presented their ADS-B implementation plan, developed under the Civil Aviation Master Plan of Lao PDR. 2 ADS-B ground stations were installed in 2015 and 3 more ADS-B stations will be installed at the existing radar sites during 2016 to 2017 for the purpose of evaluation and to implement in the non-radar International airports surrounded by mountains and for the back to the radar system for the Lao FIR.

Status of ADS-B Implementation in the USA (IP/9)

4.15 USA presented a status summary of their ADS-B implementation activities. The FAA reviewed the sections with new or updated information from that presented at SITF/14: Paragraphs 1.1; 2.1.1; 2.1.2 (more details in IP11); 2.2.1.1; 2.2.3.1; 2.2.3.2 (new working group on ADS-B-In); 2.2.4.1; 2.2.5 (information on GIM-S implementation rollout); and 2.2.7.1 (new ITP reports posted on the FAA website).

ADS-B Implementation Progress in Viet Nam (IP/14)

4.16 Viet Nam presented information on the progress of ADS-B implementation in Viet Nam. Viet Nam has installed 11 ADS-B ground stations (07 stations within Ha Noi FIR and 04 stations within Ho Chi Minh FIR). Viet Nam also plans to install additional 12 ADS-B ground stations to fulfill the coverage of Ho Chi Minh FIR in 2016-2018. It was informed that Viet Nam, Singapore and Malaysia were cooperating to reduce minimum longitudinal separation, for suitably equipped aircraft to 20 NM following phased approach i.e. 30 NM commenced on 24 July 2014 and 20 NM planned in 2016. IATA and CANSO congratulated Viet Nam, Singapore and Malaysia for providing separation service based on the surveillance data sharing and VHF communication capability sharing which was one of the good examples for using the technology to deliver separation service.

ADS-B and MLAT Implementation Plan in Bangladesh (IP/16)

4.17 Bangladesh presented a revised plan of ADS-B and MLAT implementation. Bangladesh has taken public private partnership (PPP) project that includes the installation of 4 ADS-B grounds stations throughout the country as back up to the proposed new radar systems and as a means of filling the gap in radar coverage over the Bay of Bengal area. The target date for completing the PPP project is August 2019.

Implementation of ADS-B in the New Zealand Flight Information Region (IP/18)

4.18 New Zealand presented an update on their implementation of ADS-B OUT as the main component of a future surveillance system replacing the current SSR system.

The Operation Plan of ADS-B and UAT in the Republic of Korea (IP/20)

4.19 Republic of Korea introduced the operation plan of ADS-B and UAT which shares the simulation results for safety assessment prior to deployment of the systems. The Republic of Korea will provide ADS-B based service as backup for RADAR systems failures. The RADARs are the main surveillance systems for ATS in Korea, but they are considerably influenced by topography of the region. So, it is insufficient for air traffic safety to operate RADARs for low-altitude surveillance to flights in much mountainous terrains. The Republic of Korea is going to deploy the ADS-B system by 2018 and provide the commissioning service by 2020 after the test operation.

ADS-B – A Boeing Perspective (IP/30)

4.20 The meeting was provided with Boeing's perspective on ADS-B including the Air Transportation System Roadmap, ADS-B OUT status, GNSS/GPS status, production/retrofit capabilities, Boeing 787 ADS-B IN, and Boeing airspace assessment capabilities.

Boeing 787 ADS-B Deficiency Update (IP/5)

4.21 Australia, with contribution from Boeing, provided an update on the ADS-B problem experienced with Boeing 787 Aircraft, and details of the rectification plan.

4.21.1 It was noted that Air India and United had advised that they had now completed the execution of the Service Bulletin. States were requested to contact the operators of B787 aircraft registered in their state to ensure that they have already applied the service bulletin.

ADS-B Failures in Certain A330 Aircraft (IP/15)

4.22 Through the IP paper, Australia reported on instances of ADS-B service failures that had been reported on certain configurations of A330 aircraft. Technical detail was also provided for awareness and reference by other States/Administrations. The FAA noted that this issue was similar to one identified in version 2 avionics and that two Service Bulletins were available relating to the version 2 problem.

ADS-B avionics performance report (IP/08)

4.23 This paper described a new reporting capability that the FAA is fielding to assist operators (and other interested parties) in understanding an aircraft's ADS-B avionics performance relative to the requirements of the U.S. ADS-B mandate. This paper referred to an Attachment, which was the "User's Guide" for a new ADS-B avionics performance report that FAA has made available at the URL: http://www.compliancemonitor.faa.gov/Public/pcrRequest.aspx. This User's Guide both describes the report information available to an operator, and helps readers understand the scope of information that the FAA is collecting for all ADS-B Version 2 messages that are received by the FAA's ADS-B ground stations. To obtain this information, a user will need to know the aircraft's ICAO hexadecimal address and the date when the aircraft flew in U.S. airspace with ADS-B coverage (for coverage information, see http://www.faa.gov/nextgen/equipadsb/airspace/media/2020ADS-BAirspaceMap.kmz). If multiple flights occurred in a single day (as measured in the UTC date and time reference), then the information for the longest detected flight period will be returned to the requester

Selected Level Transponder Data (IP/4)

4.24 Australia provided information on the need for some transponders to be upgraded with an available Service bulletin to avoid misleading selected altitude data in ADS-B and Mode S downlink replies. Australia has a "blacklist" in place for misleading DAPS.

FAA AC 90-114A CHG1 and ADS-B Pre-flight Availability Prediction (IP/11)

4.25 FAA Advisory Circular (AC) 90-114A Change 1 was published on March 7, 2016 and contains three significant changes from the previous version of the AC: revised equipment qualification resulting from a technical amendment to U.S. 14 CFR 91.225, preflight planning requirements for flight into ADS-B-mandated airspace and FAA Exemption 12555.

4.26 In February 2015, the FAA issued a Technical Amendment to 14 CFR 91.225. In the amendment, the revised sections now state that the installed equipment must meet "the performance requirements" of the referenced TSOs. This means that compliance with the rule can be met with equipment that meets the performance requirements, but is not manufactured under TSO

Authorization. This is an important distinction which provides a means for compliance for the large number of Experimental category aircraft. AC 90-114A CHG 1 includes details for installation approval and qualification for ADS-B.

4.27 The AC summarizes the performance characteristics of SA-ON and SA-AWARE GPS position sources and their impact on rule performance. Operators with these systems are expected to perform a preflight availability prediction. Operators of aircraft equipped with Satellite Based Augmentation Systems (SBAS) are not expected to perform a preflight availability prediction. Preflight prediction methods described in the AC are:

- The operator may use their own tool
- The operator may use the FAA provided Service Availability Prediction Tool (SAPT)
  - Using the flight plan interface or the Extensible Markup Language (XML) interface batch submission; or
  - The flight plan interface is intended for single flight predictions.

4.28 In the event of predicted drop of NIC and NACp below ADS-B rule values, the flight must be delayed, canceled or re-routed, unless specific ATC authorization is obtained as described in the regulation.

4.29 Some operators, using TSO-C129-compliant (SA-On) or TSO-C196-compliant GPS receivers for ADS-B Out may obtain limited relief from NIC and NACp performance requirements under FAA Exemption 12555. It is a time-limited grant of exemption from the NIC and NACp requirement, and is subject to certain conditions and limitations.
Operators with Exemption 12555 with receivers meeting the performance requirements of TSO-C196() may operate in designated airspace for which ADS-B Out is required when the aircraft's NACp and NIC do not meet the performance specified in the rule. For these operations, the operator does not need to conduct any preflight availability prediction.

4.30 Operators with Exemption 12555 using TSO-C129-approved GPS receivers that do not meet the performance requirements of TSO-C196, TSO-C145, or TSO-C146 may operate in airspace where ADS-B Out is required when the aircraft's NIC and NACp do not meet the performance specified in the rule, when the FAA determines that other surveillance is available. These operators must use the FAA SAPT which will indicate if the FAA has determined that surveillance is predicted to be available during a predicted performance outage. Since the FAA must make the determination that alternate surveillance is predicted to be available, only the FAA SAPT may be used to convey the authorization.

USA ADS-B Equipage Monitoring and Post-Installation Performance Issues (IP/12)

4.31 USA provided a summary of the number of aircraft in U.S. Airspace identified as being equipped with Version 2 ADS-B Out equipment. The information contained in the presentation provided an overview of the number of aircraft that have currently been identified in U.S. Airspace as being ADS-B Out Version 2 equipped. The presentation showed ADS-B Version 2 equipage growth trends for U.S. General Aviation and U.S. Air Carrier aircraft and compared those trends to assumed equipage targets for January 1, 2020. Additionally, the paper outlined a number of issues identified with Version 2 ADS-B installations, identified through data provided by the FAA Performance Monitor. Using that data, the FAA is working with manufacturers, installers and operators to identify and rectify the causes of these issues.

4.32 The meeting noted that many States had ADS-B programs, but few had published equipage mandates. Promulgation of such mandates was needed well in advance of the implementation date, typically 5 years for airlines to prepare for the mandated equipage requirement. It was also important that States mandate standards for avionics output to support ICAO Doc 7030-*Regional Supplementary Procedures*. It was further noted that the need for a mandate was dependent on the operational requirement, such as whether ADS-B was the sole source of surveillance data or was a backup for radar surveillance.

USA Federal Aviation Administration Exemption 12555 Applicability and Process (IP/13)

4.33 This paper presents information about the U.S. FAA Exemption 12555, its applicability to operators, and describes the simple process by which it may be obtained. The Exemption is time-limited, has conditions and limitations and is available to any operator with qualifying ADS-B position source.

4.34 Exemption 12555 is a time-limited grant of exemption from the Navigation Integrity Category (NIC) and Navigation Accuracy Category for Position (NACp) requirements specified in Title 14 of the U.S. Code of Federal Regulations (CFR). Exemption 12555 is valid from January 1, 2020 through December 31, 2024 and is subject to certain conditions and limitations.

4.35 Exemption 12555 is intended for operators of aircraft with GPS receivers (position sources) compliant with the current edition of FAA Advisory Circular (AC) 20-165, Airworthiness Approval of Automatic Dependent Surveillance –Broadcast Out Systems, Appendix B, Identifying and Quantifying ADS-B Position Sources. The exemption is not limited to U.S. registered aircraft.

4.36 The conditions and limitations of Exemption 12555 are detailed in the Grant of Exemption (https://www.regulations.gov/#!documentDetail;D=FAA-2015-0971-0010) and are summarized here for the meeting:

4.36.1 The operator must notify the FAA of their intent to adopt the conditions and limitations of the exemption. Operators are encouraged to use the notification letter template found at http://www.faa.gov/nextgen/equipadsb/media/12555ExemptionLetterofNotificationTemplate.docx

4.36.2 The operator must create, maintain and update a GPS equipage plan for airplanes equipped for ADS-B Out and meet the performance requirements of U.S. Title 14 CFR 91.227(c). The plan must be submitted to the FAA by August 1, 2018 and updated as needed, but at least annually thereafter. The plans and updates will not be approved by the FAA but must be available for review. Prior to January 1, 2020, the operator's plan must be complete, in that it details each affected aircraft's scheduled date for compliance with 14 CFR § 91.227(c)(1)(i) and (iii). A template for this plan can be found at http://www.faa.gov/nextgen/equipadsb/media/12555UpgradePlanTemplate.xlsx.

4.36.3 The process for obtaining Exemption 12555 is detailed in FAA Information for Operators (InFO) 16003, Exemption 12555 Process. For detailed instructions refer to http://www.faa.gov/nextgen/equipadsb/media/UpdatePlanSubmissionInstructions.pdf and to http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/info/all_infos/media/2016/InFO16003.pdf). The process is summarized here for the meeting:

ADS-B Procurement Process (IP/17)

4.37 Airways New Zealand provided the meeting with an outline of New Zealand's ADS-B Implementation plans and associated ADS-B procurement process.

The Benefits of Trialling ADS-B Equipment Suppliers Prior to Signing a National Contract (IP/21)

4.38 New Zealand provided an outline of the benefits of side-by-side testing of prospective ADS-B equipment prior to signing a supply contract.

ADS-B Collaboration in the South China Sea Region (IP/23)

4.39 Singapore presented the developments of the ADS-B collaboration in the South China Sea region. Following the collaboration between Indonesia and Singapore and between Singapore and Viet Nam, the surveillance and DCPC gaps on L642, M771 and N892 are covered. The separation is now reduced to 30NM. A joint operational trial may be conducted with Viet Nam to assess the operational impact to reduce the separation to 20NM. Singapore will also work with Viet Nam and Indonesia to reduce separation on L625 and M758.

4.40 The Philippines and Singapore signed an ADS-B collaboration agreement in October 2015 to cover part of the surveillance gaps on routes N884 and M767. Discussions are on-going between Brunei and Singapore to cover the remaining gaps on N884 and M767. Singapore and Viet Nam are working on further collaboration to enhance the existing ADS-B coverage.

Equipage Status of Aircraft (IP/24)

4.41 Singapore provided the meeting with updated information on the ADS-B equipage status of aircraft and monitoring of avionics performance. Singapore shared with the Task Force that in late 2015 the percentage of aircraft with DO-260, DO-260A and DO-260B are about 84.3%, 8.2% and 7.5% respectively. There are more DO-260B and less DO-260A as compared to late 2015. This is partly due to B787s upgrading from DO-260A to DO-260B.

4.42 Aircraft that toggle between high to low NUC and aircraft that consistently transmit low or zero NUC over the last six months are reduced. Airlines will be informed if their aircraft exhibits such behaviours.

4.42.1 Due to the seriousness of the B787 deficiency, there was a need to resolve the problem urgently. Airworthiness process may not be a suitable means to expedite the application of service bulletin as the airworthiness process itself is lengthy. An efficient means would be for ANSPs to contact their users, either directly or via Boeing.

4.42.2 Member States/Administrations of the SURICG were requested to update the status at the next meeting whether their State registered B787s has already applied the service bulletin.

ADS-B Implementation in Indonesia for ATS Surveillance Separation (IP/25)

4.43 Indonesia presented information on the status of ADS-B implementation for 'Tier 1' operations in the Indonesian FIRs.

4.44 Noting Indonesia's intention to establish rules for the management of bad data in accordance with the AIGD and ICAO Doc 7030 *Regional Supplementary Procedures* (MID/Asia), the meeting was informed that ADS-B IN applications being developed by major airline manufacturers did not process NIC, and that the setting of NIC (only) to zero would not result in the filtering out of bad data by ADS-B IN aircraft. The meeting noted that this information may need to be further considered with a view to potentially proposing amendments to Doc 7030, the AIGD and the regulations of several States.

Current Status of ADS-B Implementation (IP/26)

4.45 Mongolia provided information on the current and planned implementation of ADS-B. Noting Mongolia's intention to mandate ADS-B equipage on certain routes by 2018, IATA requested that action to promulgate mandate information by AIC and AIP SUPP be taken as soon as possible, as 5 years' advance notice was normally required for aircraft operators to comply with the requirement for equipage.

ADS-B Implementation in the Maldives (IP/27)

4.46 Information was presented on the efforts by Maldives to implement ADS-B for the provision of ATS in the Male FIR. On 7th February 2016, Maldives started using ADS-B to enhance ATS surveillance capability in Male FIR. At current stage, the carriage of ADS-B equipment is not mandatory. The provision of ATS using ADS-B is for capable aircraft. Radar remains the primary surveillance tool within 200NM from Male International Airport.

Safety Case for ADS-B Under Radar Environment (IP/28)

4.47 Singapore shared with the Task Force the progress made by Singapore on the safety case for ADS-B under the radar environment. Singapore worked with MITRE Asia Pacific Singapore (MAPS) to study the use of ADS-B under radar environment. It is found that Multi-Sensor tracks or MST (which includes the fused ADS-B data) is as good as or better than the available radar tracks (known as Multi-Radar tracks or MRT).

4.48 The main hazards to consider are the loss of ADS-B tracks and incorrect ADS-B tracks. If there is a loss of ADS-B tracks, controllers can still rely on radars. If there is an incorrect ADS-B tracks, there will be alerts in the ATM system to warn the controllers. The integration of ADS-B into radar environment hardly introduces additional risks.

4.49 For ADS-B to improve the quality of MST, the flights have to be equipped and the ADS-B data has to have high NUC. 96% of the aircraft is equipped with ADS-B, 99% of the ADS-B data has NUC of 5 and above. The update rate of the ADS-B data also has to be high. 90% of the ADS-B data has update rates faster than 3s, which is better than radars.

4.50 With the positive results of the assessment, the Singapore ANSP is preparing a preliminary safety case to use ADS-B under radar environment in the near future. The meeting had a lengthy discussion on this topic. Clarifications were also provided.

Airbus ADS-B Presentation (IP/29)

4.51 Airbus provided information on ADS-B Out mandates, ADS-B in-service aircraft status, aircraft impacts of the FAA mandate, and ADS-B IN. The presentation also provided status of MMRs development.

ADS-B -A Boeing Perspective (IP/30)

4.52 Boeing made a presentation highlighted several topics including the Air Transportation System Roadmap; ADS-B Out Status; GNSS / GPS Status; Production / Retrofit Capabilities; 787 ADS-B In; Boeing Airspace Assessment Capabilities

Updates on ADS-B Activities in China (IP/31)

4.53 The meeting was provided with updated information on the status of ADS-B implementation in China.

4.54 Over 310 ADS-B stations will be installed by the end of 2017 as the phase 1. A phased approach for implementation and estimated coverage by ADS-B at different flight levels were shown in the paper. China is willing to share the ADS-B data from the ADS-B data processing center with neighbouring States/Administrations. In response to a query, it was clarified that the ADS-B ground stations will be capable to receive data compliance with all three versions of avionics. China has scheduled for the ADS-B mandate and will give reasonable lead time for aircraft operators.

Agenda Item 5: Asia/Pacific Regional ADS-B planning and implementation information in the e-ANP

Status of Surveillance Table in e-ANP (IP/02)

5.1 The meeting noted the information on the development of e-ANP presented in the IP/02. The meeting noted that new surveillance table resulted from combination of previous FASID Tables 4A and 4B was endorsed by APANPIRG/26. In accordance with Conclusion of APANPIRG/26/2, ICAO APAC Office issued the PfA T11/2.1-AP010/16 on 18 January 2016. The States were notified of approval of the Amendment on 11 April 2016. The meeting the approved surveillance table attached to the paper

Agenda Item 6: Review TOR of ADS-B SITF and works accomplished by the Task Force

Review Terms of Reference and Works done by ADS-B SITF (WP/05)

6.1 In order to identify any outstanding tasks, the meeting reviewed the TOR of ADS-B SITF. The meeting also reviewed the indicators of the achievements made by the Task Force in the past 13 years in terms of Conclusions and Decisions adopted by APANPIRG based on the recommendation of the Task Force.

6.2 As a result of review of the TOR, the following outstanding tasks were reconfirmed:

- ASBUs relating to ADS-B IN
- Study and Implementation of Space Based ADS-B

6.3 It was noted that SEA/BOB ADS-B WG had a reporting path through ADS-B SITF, but was formed by APANPIRG.

Agenda Item 7: Identify outstanding issues for consideration by SURICG and/or SEA/BOB ADS-B Working Group

7.1 The meeting initially discussed the following issues that need to be further considered by SURICG.

- ASBUs relating to ADS-B IN
- Implementation of Space Based ADS-B
- ASBU B0-NET using ADS-B
- Use of lower cost, lower performance ADS-B systems (TSO199)
- Use of Mode S DAPS in Asia Pacific region
- Use of electronic scan primary radars in Asia Pacific region
- Use of Mode C transponder veils in Asia Pacific region
- Use of Flight ID data from mode S interrogation and ADS-B
- Mode S problem reporting in Asia Pacific region

- Mode S analysis tools used in Asia Pacific region
- ADS-B test equipment used in Asia Pacific region
- Need to amend SUPPs 7030 on SIL matter
- Management issues with 24 bit ICAO codes in Asia Pac
- Update and maintain ADS-B problem database
- Consider need for aircraft transponder Mode S

Agenda Item 8: Implementation of ADS-B Avionics Problem Reporting Database (APRD)

8.1 The meeting was updated with current status of the APRD development. ICAO Regional Sub Office in coordination with CAD Hong Kong China has developed testing site of the APRD. It was considered necessary to be hosted in ICAO APAC website as a project. The database is still required some improvement. The meeting was also informed about the resource constrains in the ICAO sub regional office. ICAO RSO indicated they will make efforts in improve the database by the end of June 2016 and expected States would provide contacts of focal point for the operational testing. China, Hong Kong China, PNG, Singapore and Indonesia expressed their support by nominating the focal point for testing. Further follow-up action on this matter will be taken by SURICG.

8.2 In light of the resource constraints and the time being taken, the meeting agreed that we should attempt to use the database by mid. 2016 without waiting for it to be “perfect” or “fully functional”.

Agenda Item 9: Any Other Business

Evaluation Activities of DAPs (IP/19)

9.1 Japan presented a paper about DAPs evaluation plan to support the installation of new processing system, which is capable for DAPs and will be operated by FY2018. JCAB was also upgrading all SSRs in Japan with DAPs function through the aged SSR replacement program in next 10years. Therefore JCAB accumulated DAPs evaluation and installed the evaluation equipment since 2015.

9.2 The Advanced Surveillance Function Evaluation Equipment (ASFEE) for development of new surveillance system and the evaluation of DAPs was developed which is composed of the two radars as the proving device for DAPs. The evaluation started from the beginning of 2016. The DAPs equipage rate detected for 5 days in January 2016 indicated that Domestic airlines were 72.59% while foreign airlines were 93.81%. The lower rate of domestic airlines could be resulted from no ADS-B mandate policy in Japan. Most of DAPs capable aircraft are also corresponding to the EHS (Enhanced Surveillance). This was a problem that the value of register is duplicated with other registers in some cases.

Note of appreciation

9.3 The meeting expressed its appreciation and gratitude to those States/Administrations hosted the Task Force meetings and seminars in the past 13 years in particular, to Australia, Thailand, Fiji, India, China, Viet Nam, Indonesia, Singapore, Republic of Korea, Hong Kong China and New Zealand. The meeting thanked participants form States/Administrations, International Organizations and representatives from Industry for their active participation to the activities of the Task Force and contribution to the achievements and outcome of the Task Force.

9.4 The meeting also expressed appreciation to Mr. Greg Dunstone, the Chair of ADS-B Study and Implementation Task Force for his able leadership and to CAA Singapore for its contribution towards the development of the modernized regional Surveillance infrastructure and promotion of data sharing in the South China Sea sub-region, to CAD Hong Kong China for its

contribution to the development of the ADS-B Implementation and Operation Guidance Document (AIGD) for the APAC Region. In appreciation for their contribution, Mr. Arun Mishra, ICAO Regional Director presented memento plaques to Mr. Greg Dunstone, CAA Singapore and CAD Hong Kong China.

9.5 Singapore expressed its appreciation to those States and organizations who have supported and contributed towards the regional ADS-B collaboration project in the South China Sea area, in particular, to Australia, Brunei, China, Hong Kong China, Indonesia, Malaysia, the Philippines, Vietnam, CANSO and IATA.

9.6 IATA expressed their appreciation to the leadership of the ADS-B SITF in particular the Chairman of the Task Force. The outcomes of the Task Force were well supported from airlines perspective. The member airlines were expecting additional service outcomes based on the ground infrastructure installed and data sharing implemented. IATA wishes to record appreciation for all members States for the efforts in introducing ADS-B in a real world leading sense and Australia's leadership.

9.7 The Chairman then thanked the Task Force members for their contributions and indicated that the States participating should be proud of the progress that has been made over the life of the Task Force. States had contributed to aviation safety, efficiency and the wellbeing of their citizens through their actions.

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ADS-B IMPLEMENTATION STATUS IN THE APAC REGION

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
AFGHANISTAN	ADS-B & Multi Lateration system installed.				subject to safety assessment
AUSTRALIA	A total of 45 ADS-B ground stations and 28 WAM stations are operational (Total 73) ATC readiness since 2004 ADS-B data sharing with Indonesia operational since 2/2011. ADS-B data sharing planned with PNG ASMGCS using multilateration and ADS-B is operational in Brisbane, Sydney, Melbourne and Perth An additional 15 ADS-B ground stations are planned in 2017-2020 period. Onesky replacing the current ATM system is expected to be fully operational in 2020 period.	2009/effective date of mandating in upper airspace 12/12/2013. A forward fit ADS-B mandate also applies from 2/2014 for all IFR aircraft at all flight levels. An ADS-B mandate for all IFR aircraft applies from 2/2017.	At/above FL290 from 12/2013 for domestic & foreign aircraft. All airspace for IFR aircraft from 2/2017	3NM and 5 NM surveillance separation. 3/2016 - Manual of ATC updated to include 3 nautical mile separation using ADS-B in terminal control unit. Vectoring allowed using ADS-B Precision Runway Monitoring for Sydney WAM	WAM is operating in Tasmania since 2010 with 5 NM separation service. WAM is also operating in Sydney for 3 NM separation service in TMA and for precision runway monitoring function.

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
BANGLADESH	Bangladesh has a plan to commission four ADS-B ground stations to be installed at Dhaka, Cox's Bazar, Saidpur and Barisal Airports by 2019. ADS-B data will be integrated with new ATS system at Dhaka.				
CAMBODIA	3 ADS-B ground stations installed at Phnom Penh, Siem Reap and Stung Treng City since 2011 and able to provide full surveillance coverage for Phnom Penh FIR. Cambodia is willing to share data with others.				
CHINA	5 UAT ADS-B stations used for flight training at CAFUC to be upgraded to support 1090ES by 2017. 310 ADS-B stations nationwide will deployed as 1st phase by the end of 2017.	NOTAM issued on ADS-B trial operation			ADS-B signal alone won't be used for ATC separation

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	1 ADS-B station operational in Sanya FIR since 2008. Sanya ATC system ready since July 2009 to support L642 & M771. Additional 3 ground stations deployed in 2015. Chengdu-Jiuzhai project finished in 2008 with 2 ADS-B stations Chengdu - Lhasa route surveillance project completed with 6 ADS-B stations using 1090ES since 2010. Trials operated from May 2011. 9 ADS-B stations deployed on the routes H15 and Z1 in 2015.				
HONG KONG CHINA	A larger-scale A-SMGCS covering the whole Hong Kong International Airport put into operational use in April 2009.	AIP supplement issued on 29 Oct.2013/12 Dec. 2013 as effective date.	L642/M771 ATS routes.	To be determined.	ADS-B signals being fed to ATC controllers under an operational trial programme.

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	Data collection/ analysis on aircraft ADS-B equipage in Hong Kong airspace conducted on quarterly basis since 2004. ADS-B trial using a dedicated ADS-B system completed in 2007. ADS-B out operations over PBN routes L642 and M771 at or above FL 290 within HK FIR was effective in December 2013 and within HK FIR at or above FL 290 is planned for December 2016. ADS-B ground station infrastructure completed in 2013. ADS-B trial using ADS-B signal provided by Mainland China to cover southern part of Hong Kong FIR commenced in 2010.				ADS-B operation in Hong Kong FIR re-scheduled for Dec. 2016. An AIP Supplement was issued on 29 Aug. 2014.

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
MACAO, CHINA	Mode S MSSR coverage available for monitoring purposes.				Airspace – ATZ only
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA	ADS-B has been used as back-up surveillance of SSR since 2008.				
FIJI ISLANDS	ADS- B /multilateration ground stations installed. Situations awareness service provided in 2013. BY EMAIL	ADS-B mandate commencing form 31st December 2013			
FRANCE ***(French Polynesia)***	ATM system is ready for ADS-B sensors/Installation of 5 first GS expected at beginning of 2017. 2nd stage with implementation of 7 GS and associated VHF coverage.			5 NM for airspace under coverage.	
INDIA	ASMGCS (SMR + Multilat) is operational at Delhi, Mumbai, Chennai, Kolkata, Bangalore and Hyderabad Airports. ASMGCS is also being installed at 05 more	AIP supplement issued on 17th April 2014 with effective date of implementation from 29th May 2014.			ADS-B in India to provide redundancy for radar and filling the surveillance gaps. ADS-B data trial operations commenced in 2015 in

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	international airports. ADS-B Ground Stations were installed at 21 locations across continental airspace and including Oceanic airspace at Port Blair. Procurement of 10 more ADS-B Ground stations is under consideration in 2016.. ATM automation systems at 22 ATC Centres are capable of processing ADS-B data and provide the information on Display.				both Non-radar and radar environment , in Enroute & Terminal phases of flight for ATC purposes. AIP SUP 18 of 2014 issued
INDONESIA	30 Ground Station successfully installed. Since 2009, ATC Automation in MATSC has capabilities to support ADS-B application. ADS-B Task Force team established to develop	On 24 July 2014 DGCA published AIRAC AIP Supplement No. 10/14 for using ADS-B for situation awareness effective from 18 Sep. 2014 to 25 June 2015. AIP Supplement on ADS-B Implementation (Tier-1)(mandate) being published with effective date on 25 June 2015.	Mandate from Janaury 2018 for Class A airspace from FL290 to FL460	Intended to use for 5 NM separation	

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	planning and action concerning ADS-B Implementation within Indonesia FIR ADS-B data sharing with Australia and Singapore.				
JAPAN	Multilateration Systems for surface monitoring have been implemented at eight airports PRM (WAM) has been implemented at Narita Airport. En-route WAM system is manufacturing and will be put into operation in FY2018 Plan to evaluate accuracy of ADS-B information and has intension to introduce ADS-B to the oceanic direction.				
LAO PDR.	2 ADS-B ground stations were installed in Vientiane and Luangprabang Int’l Airport in				

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	2015 and the ADS-B data is fused with MSSR data target in the ATM Automation system. 3 additional ADS-B ground stations (DO-260B compliant) will be completed the installation at existing MSSR sites (Xiengkhouang, Savannakhet and Champasack) by 2016 to Q1 of 2017 to enhance the full ADS-B coverage of Lao FIR.				
MALAYSIA	Malaysia installing two (2) ADS-B ground stations in Genting Highland and Langkawi. The said ADS-B are expected to be commissioned by end of 2019. Malaysia revised the plan to start mandate ADS-B requirement for implementation of ADS-B service for exclusive airspace/route without radar coverage within	Revised Plan to issue mandate with target effective date by end of 2022.		ICAO approved surveillance separation.	

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	KL FIR by the end 2022. Specific Routes for ADS-B Implementation Plan: P574, N571, L510, P628, L645 & P627.				
MALDIVES	4 ADS-B stations installed in Nov. 2012 (2 at Male' Ibrahim Nasir Intl Airport, 1 at Kulhudhuffushi Island in the North and 1 at Fuah Mulah Island in the South to cover 95% of the FIR at/above FL290. Maldives' ADS-B is integrated with the ATM system (in November 2013), and under observation prior to commencing trials. Maldives has planned to share ADS-B data with its adjacent FIRs. Updated by email				Seaplane in Maldives equipped with ADS-B for AOC purpose. These seaplanes have ADS-B IN functions as well.
MONGOLIA	Ten ADS-B ground stations for combination SSR and filled the				

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	surveillance gaps implemented in 2015 and integrated with ATM system and trial operation in early 2016.				
MYANMAR	ADS-B ground stations to be installed at Sittwe, Co Co Island by end of 2014 as 1st phase Yango , Lashio and Myeik -2015 as 2nd phase; Kengteng, Myitkyina in 2016. Completion of integration to Euro Cat. C. in 2014. Agreed to share ADS-B data with India, agreement on sharing being negotiated.				Supplement radar and fill the gaps to improve safety and efficiency ADS-C/CPDLC integrated in Yangon ACC since 2010.
NEPAL	ADS-B feasibility study conducted in 2007.				

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
NEW CALEDONIA	Three ADS-B ground stations commissioned in 2010 to cover international traffic at La tontouta airport serving Tontouta ACC & APP. It is used for Situation awareness and SAR.				
NEW ZEALAND	MLAT and ADS-B data is being used from the WAM system centered in the Queenstown area to provide surveillance coverage and surveillance separation (5 nm) over the southern half of the South Island of New Zealand. Additionally MLAT data from the Auckland MLAT system is used to provide airport surface movements at NZAA. The New Zealand Navigation and Airspace and Air Navigation Plan "New Southern SKY" issued in May 2014	New Zealand has plans to introduce ADS-B OUT mandates as follows: ADS-B OUT equipment requirement for all aircraft operating in controlled airspace above FL 245 from 1 January 2019 ADS-B OUT equipment requirement for all aircraft operating in controlled airspace from 1 January 2022. A forward fit requirement for ADS-B equipage on all newly registered aircraft in 2017. The Rule will not specify particular Technical Standing Orders (TSO), or transponder GNSS receiver models for position input into ADS-B.		5 NM Surveillance Separation in en-route airspace, and 3NM surveillance separation in terminal airspace.	

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
PAKISTAN	Tender for procurement of 5 ADS-B stations issued to be installed at Pasni, Lakpass, Rojhan, Dalbandin and Laram-top. Contract expected to be finalized by end of 2015. These stations will be DO260B compliant and operational by end of 2017.				
PAPUA NEW GUINEA	Initially 8 ADS-B sites to be deployed across PNG to provide seamless coverage above FL285. First site to be installed May/June 2016, with remainder to be completed between May-July 2017. Up to an additional 7 sites to be rolled-out in the 2018/19 timeframe. Site location will be dependent on infrastructure, security and an analysis of Phase 1 site performance. In late 2016,	An ADS-B mandate is on CASA PNG roadmap, however legislation yet to be developed. The Australian mandates will largely drive equipage for overflights (e.g. East-Asia to Australia/South Pacific). Expectation is that PNGASL (the ANSP) will lead development of ADS-B mandate framework. Initial steps may include mandate above F245 – but will depend on performance of Phase 1 ADS-B deployment.	None	**Air Traffic Control** Approach/Arrivals 2017 – 5NM 2018 – 3NM (approach) Upper Airspace (>FL245) 2017/18 – Situational awareness. 2018/19 – 5NM Note: Implementation dictated by training requirements and new ATM system transition priorities. **Flight Service**	

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	PNGASL (ANSP) will be implementing a replacement ATM automation system. The system will support fusion of ADS-B and RADAR data. From 2017 onwards, PNGASL will be looking to share ADS-B data with Indonesia and Australia.	Country-wide mandate not envisaged before 2021/22.		Directed Traffic (FIS) 2017 – Situational awareness	
PHILIPPINES	Four (4) ADS-B ground stations (Manila, Palawan, Pangasinan and Zambales) with target date tocomplete by end 2016. ATM Center expected to be available in 2016.				
REPUBLIC OF KOREA	ADS-B implemented 2008 for SMC in Incheon International Airport. ROK is developing ADS-B system since 2010 through R&D group. The testbed at Gimpor Airport				

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	supporting both 1090ES and UAT, undergoing operational testing (2013-16). At Incheon Intl Airport, promotion of surface surveillance (2014-17) In 2nd phase from 2015 to 2016, ADS-B ground stations will supplement to the radar in the terminal area and fill up the gap between radar coverage. The last phase from 2017 to 2020, ADS-B will be deployed for entire Incheon FIR.				
SINGAPORE	The airport MLAT system was installed in 2007 and “far-range” ADS-B sensor was installed in 2009. ATC system has been processing ADS-B data since 2013.	AIC was issued on 28 December 2010/effective from 12 Dec.2013. AIP supplement published in Nov 2013 to remind operators of ADS-B exclusive airspace implementation. AIP updated in Jan 2015 to remove the need for ops approval and to include the FAA standard as an additional accepted means to meet the	L642 and M771. At and above FL290. Also affect the following ATS routes N891, M753, L644 & N892	40nm on ATS routes L642, L644, M753, M771, N891 and N892 30nm implemented on 26th June 2014 on ATS routes L642, M753, M771 and N892; 20nm planned for end 2016	Safety case was completed end of November. 2013.

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
		equipage requirements.			
SRI LANKA	Installation of five (05) ADS-B Ground Receiving stations have been re-planned to be completed by end of November 2016, with its commissioning & ATM System Readiness by end of December 2016.	Revised Date of Equipage mandate 31st Dec. 2016	All ATS Routes within Colombo TMA	Initially 5 nm within Approach Radar Coverage, 8 nm within Area Radar Coverage & Procedural Separation minima outside Radar Coverage.	Reduction of Terminal/En-route separation to 30 nm & Use of ADS-B alone for vectoring & separation only after safety assessment.
THAILAND	Multilateration implemented at VTBS in 2006, installed at VTBD in 2016 which to be implemented in 2017; and to be installed at VTCC and VTSP in 2017. ADS-B ground stations (DO-260B compliant) installed in Thailand for internal research & development project. Thailand is currently undergoing the operational approval	Plan to issue mandate with target effective date end of 2018.			

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	process to have ADS-B as part of surveillance infrastructure. Nationwide WAM+ADS-B covering all en-route and TMA airspace to be installed in 2017. New ATM System to be operational in 2017 will be capable of processing ADS-B and WAM data and integration of data from multiple sensor types.				
TONGA	Trial planned for 2017				
UNITED STATES	As of 1 April 2016, the “baseline” set of Service Volumes planned by the FAA in 2007 are operational, using data from over 600 radio sites installed by Harris. Since 2007, FAA has planned and funded activities to activate additional Service Volumes that Harris will	The U.S. ADS-B Out rule (14 CFR 91.225 and 14 CFR 91.227) was issued in May 2010 and specifies that the ADS-B Out mandate is effective on 1 January 2020.	Class A, B, and C airspace, plus Class E airspace above 10,000 ft MSL. See 14 CFR 91.225 for details.	The U.S. is using both terminal and en route (5nm) separation criteria, depending on the specific airspace and available surveillance information. Terminal separation includes the following separation criteria: - 3nm - 2.5nm	

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	service using additional radio sites; all but 16 of these radio sites have been installed and are operational as of 1 April 2016. As of 1 April 2016, 135 of the 226 U.S. air traffic control facilities are using ADS-B for ATC separation; all En Route Centers and major Terminal facilities are using ADS-B for ATC separation; all remaining facilities are planned to be using ADS-B by 2019.			- indepen-dent parallel approach operations down to 4300 ft centreline separation - dependent parallel approach operations down to 2500 ft centreline separation (currently 1.5 nm diagonal distance).	
VIET NAM	Two phases ADS-B implementation plan adopted. Phase 1 implemented in March 2013. Phase 2 commenced in 2015 for whole lower and upper Hanoi FIR and 2018 for Ho Chi Minh FIR	AIC issued on 20 June 2013/ADS-B mandating effective from 12 December 2013 in Ho Chi Minh FIR.	M771, L642, L625, N892, M765, M768, N500 and L628 At/above FL290.		Operators required to have operational approval from State of aircraft registry.

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LIST OF OUTSTANDING ACTION ITMES

No.	Subject	Forum Raised	Status / Target Date	Remarks / follow-up	Action Party	Status
1.	ATS operational letter of agreements between neighboring FIRs among South China Sea States for radar-like surveillance service (Operational agreement between Singapore and Viet Nam was signed first in Nov. 2013 and later updated in July 2014 for 30 NM separation)	SEA ADS-B WG/6	Ongoing – Reports at each meeting	Report progress at ADS-B SITF/15	China, Hong Kong China, Viet Nam and Singapore	On-going. Needs seamless agreement for the same minima for major traffic flow. SEA/BOB
2.	Harmonize process of detection bad TX for inclusion into “Blacklist”	SEA/BOB ADS-B WG/8	ADS-B SITF/15	Review and update on the monitoring mechanism	Singapore & Hong Kong China, RSO	On-going Requirement for monitoring (Items) identified
3.	~~Update “harmonization Framework Document” for BOB~~	~~SEA/BOB ADS-B WG/8~~	~~ADS-B SITF/15~~	~~Report progress – on-going. Agreement on data sharing signed.~~ It is considered completed at Task Force level The link between two States has been established.	~~India, Myanmar~~	~~On-going~~ SEA/BOB
4.	~~Explore possibility for installation of an ADS-B ground station on the Nicobar Islands to cover eastern gateway of BOB Sub-region~~ (alternate location nearby selected at Campbel Bay)	~~SEA/BOB ADS-B WG/8~~	~~ADS-B SITF/14~~	~~Report result of study~~	~~India~~	~~On-going SEA/BOB~~ Considered it has been completed

LIST OF OUTSTANDING ACTION ITMES

No.	Subject	Forum Raised	Status / Target Date	Remarks / follow-up	Action Party	Status
5.	In MEL not included the effect of GNSS failure on ADS-B output which should be included.	SEA/BOB WG/9	ADS-B SITF/15	Contact Boeing and Airbus through operators	IATA and Hong Kong China	Initial result based on contact with AIRBUS & BOEING subject to confirmation
6.	Develop and implement regional collaboration project for ADS-B out operational use including data sharing in Bay of Bengal area and report on implementation progress. Status reported at WG/10		April 2015	Develop and implement sub-regional ADS-B collaboration project.	Bay of Bengal States	Detailed needs to be finalized SEA/BOB
7.	States to advise when their ground stations can be upgraded to receive ADS-B DO260B compliant ADS-B data. A survey was conducted during ADS-B SITF/13 (Appendix E). On-going bases	SEA/BOB WG/9	On-going	Further updates the Table and report to ADS-B SITF WP/06 on this topic		On-going Table updated by ADS-B SITF/14 and to be maintained by Task Force
8.	General ADS-B Avionics Problem Reporting Database (APRD) (being implemented)	SEA/BOB WG/9	Specification and database agreed at ADS-B SITF/14	Further progress to be achieved at ADS-B SITF/15 On-going	Hong Kong China and RSO	On-going Progressed at ADS-B SITF15
9.	Develop and implement regional collaboration project for ADS-B out operational use including data sharing in South Pacific and report on implementation progress.	Previous meeting of ADS-B SITF and ADS-B SITF/13	ADS-B SITF/15	ADS-B SITF/15	South Pacific States On-going Transferred to SURICG	On-going Initial stage Report by Ad Hoc WG at ADS-B SITF14

LIST OF OUTSTANDING ACTION ITMES

No.	Subject	Forum Raised	Status / Target Date	Remarks / follow-up	Action Party	Status
10.	~~Study application of ADS-B and mutilate for precision runway monitoring.~~	~~Previous meeting of ADS-B SITF and ADS-B~~	~~ADS-B SITF/15~~	~~Guidance material for implementation~~	~~All Members On-going~~	~~On-going Task Force or alternate body~~
11.	Perform data collection and data analysis of ADS-B messages to examine GPS performance in different geographic areas.	Previous meeting of ADS-B SITF and ADS-B	ADS-B SITF/15	Report of data collected and analyzed - continuous	All Members On-going Transferred to SURICG	On-going
12.	TOR - ADS-B IN	Revised TOR	APANPIRG/23	Monitoring development	ALL Members Transferred to SURICG	On-going
13.	SSR Modes S DAPS	Emerging issue	ADS-B SITF/14 IP/7 IP/16	To be addressed	ADS-B SITF or alternate body Transferred to SURICG	Initial
14.	SSR II code coordination	Emerging issue	ADS-B SITF/15	To be addressed	ADS-B SITF or alternate body Transferred to SURICG	Initial
15.	ICAO Aircraft address managment	Emerging issue	ADS-B SITF/15	To be addressed	ADS-B SITF or alternate body Transferred to SURICG	Initial

In addition, SEA/BOB WG/11 meeting identified two actions for IATA and Malaysia to report at ADS-B SITF/15 meeting in April 2016

1.	Inform member airlines about the B787 ADS-B Deficiency and the service Bulletin (SB) B787-81205-SB340005-00 and accomplish the upgrade as soon as possible after the Service Bulletin release.	SEA/BOB WP/11	ADS-B SITF/15	Inform member airlines Transferred to SURICG	IATA
2.	Further develop a checklist for performance monitoring in coordination with Australia, India, Hong Kong China and Singapore. A WP on this subject prepared for consideration by next ADS-B SITF meeting (AIGD)	SEA/BOB WP/11	ADS-B SITF/15	Coordination and prepare a WP for review by the Task Force COMPLETED	Malaysia

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INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

ADS-B IMPLEMENTATION AND OPERATIONS GUIDANCE DOCUMENT

Edition ~~8.0~~ 9.0 – ~~September 2015~~April 2016

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TABLE OF CONTENTS

Appendix 5 – Checklist of Common Items or Parameters for the Monitoring of ADS-B System

1. INTRODUCTION

The Eleventh ICAO Air Navigation Conference held in 2003 recommended that States recognize ADS-B as an enabler of the global ATM concept bringing substantial safety and capacity benefits; support the cost-effective early implementation of it; and ensuring it is harmonized, compatible and interoperable with operational procedures, data linking and ATM applications.

The Twelve ICAO Air Navigation Conference held in 2012 endorsed the Aviation System Block Upgrades (ASBU) to provide a framework for global harmonization and interoperability of seamless ATM systems. Among the Block Upgrades, the Block 0 module "Initial Capability for Ground Surveillance" recommends States to implement ADS-B which provides an economical alternative to acquire surveillance capabilities especially for areas where it is technically infeasible or commercially unviable to install radars.

This ADS-B Implementation and Operations Guidance Document (AIGD) provides guidance material for the planning, implementation and operational application of ADS-B technology in the Asia and Pacific Regions.

The procedures and requirements for ADS-B operations are detailed in the relevant States' AIP. The AIGD is intended to provide key information on ADS-B performance, integration, principles, procedures and collaboration mechanisms.

The content is based upon the work to date of the APANPIRG ADS-B Study and Implementation Task Force (SITF) and various ANC Panels developing provisions for the operational use of ADS-B. Amendment to the guidance material will be required as new/revised SARPs and PANS are published.

1.1 ARRANGEMENT OF THE AIGD

The AIGD consists of the following Parts:

Section 1	Introduction
Section 2	Acronyms and Glossary of Terms
Section 3	Reference Documents
Section 4	ADS-B Data
Section 5	ADS-B Implementation
Section 6	Template of Harmonization Framework for ADS-B Implementation
Section 7	System Integrity and Monitoring
Section 8	Reliability and Availability Considerations
Section 9	ADS-B Regulations and Procedures
Section 10	Security Issues Associated with ADS-B

1.2 DOCUMENT HISTORY AND MANAGEMENT

This document is managed by the APANPIRG. It was introduced as draft to the first Working Group meeting of the ADS-B SITF in Singapore in October 2004, at which it was agreed to develop the draft to an approved working document that provides implementation guidance for States. The first edition was presented to APANPIRG for adoption in August 2005. It is intended to supplement SARPs, PANS and relevant provisions contained in ICAO documentation and it will be regularly updated to reflect evolving provisions.

1.3 COPIES

Paper copies of this AIGD are not distributed. Controlled and endorsed copies can be found at the following web site: http://www.icao.int/APAC/Pages/edocs.aspx

Copy may be freely downloaded from the web site, or by emailing APANPIRG through the ICAO Asia and Pacific Regional Office who will send a copy by return email.

1.4 CHANGES TO THE AIGD

Whenever a user identifies a need for a change to this document, a Request for Change (RFC) Form (see Section 1.6 below) should be completed and submitted to the ICAO Asia and Pacific Regional Office. The Regional Office will collate RFCs for consideration by the ADS-B Study and Implementation Task Force.

When an amendment has been agreed by a meeting of the ADS-B Study and Implementation Task Force then a new version of the AIGD will be prepared, with the changes marked by an "|" in the margin, and an endnote indicating the relevant RFC, so a reader can see the origin of the change. If the change is in a table cell, the outside edges of the table will be highlighted; e.g.:

Final approval for publication of an amendment to the AIGD will be the responsibility of APANPIRG.

1.5 EDITING CONVENTIONS

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1.6 AIGD REQUEST FOR CHANGE FORM

RFC Nr:	

Please use this form when requesting a change to any part of this AIGD. This form may be photocopied as required, emailed, faxed or e-mailed to ICAO Asia and Pacific Regional Office +66 (2) 537-8199 or APAC@icao.int

1. SUBJECT:				
2. REASON FOR CHANGE:				
3. DESCRIPTION OF PROPOSAL: [expand / attach additional pages if necessary]				
4. REFERENCE(S):				
5. PERSON INITIATING:			**DATE:**	
ORGANISATION:				
TEL/FA/X/E-MAIL:				
6. CONSULTATION	**RESPONSE DUE BY DATE:**			
	Organization	**Name**	**Agree/Disagree**	**Date**
7. ACTION REQUIRE :				
8. AIGD EDITOR			**DATE REC'D :**	
9. FEEDBACK PASSED			**DATE :**	

1.7 AMENDMENT RECORD

Amendment Number	Date	Amended by	Comments
0.1	24 December 2004	W. Blythe H. Anderson	Modified draft following contributions from ADS-B SITF Working Group members. Incorporated to TF/3 Working Paper #3.
0.2 (1.0)	24 March 2005	H. Anderson	Final draft prepared at ADS-B SITF WG/3
0.3 (1.1)	03 June 2005	Nick King	Amendments following SASP WG/WHL meeting of May 2005
0.4	15 July 2005	CNS/MET SG/9	Editorial changes made
1.0	26 August 2005	APANPIRG/16	Adopted as the first Edition
2.0	25 August 2006	Proposed by ADS-B SITF/5 and adopted by APANPIRG/17	Adopted as the second Edition
3.0	7 September 2007	Proposed by ADS-B SITF/6 and adopted by APANPIRG/18	Adopted as the second amendment (3rd edition)
4.0	5 September 2011	Proposed by ADS-B SITF/10 and adopted by APANPIRG/22	Adopted amendment on consequential change to the Flight Plan and additional material on the reliability and availability for ADS-B ground system
5.0	14 September 2012	Proposed by ADS-B SITF/11 and adopted by APANPIRG/23	Included sample template on harmonization framework
6.0	June 2013	Proposed by ADS-B SITF/12 and adopted by APANPIRG/24	Revamped to include the latest ADS-B developments and references to guidance materials on ADS-B implementation
7.0	September 2014	Proposed by ADS-B SITF/13 and adopted by APANPIRG/25	(i) Included guidance materials on monitoring and analysis of ADS-B equipped aircraft (ii) Included guidance materials on synergy between GNSS and ADS-B (iii) Revised ATC Phraseology (iv) Included clarification on Flight Planning
8.0	September 2015	Proposed by ADS-B SITF/14 and adopted by APANPIRG/26	(i) Updated the guidance materials on monitoring and analysis of ADS-B equipped aircraft (ii) Updated the categories of reported ADS-B avionics problems (iii) Updated the guidance materials on ADS-B flight

			plan (iv) Updated the guidance materials on disabling ADS-B transmissions (v) Remove reference to operational approval for use of ADS-B Out by ATC
9.0	September 2015	Proposed by ADS-B SITF/15 and adopted by APANPIRG/27	(i) Included a list of additional functional requirements for ADS-B integration (ii) Addition of a checklist of common items or parameters for monitoring of ADS-B System (iii) Amendment to emphasize the issue on potential incorrect processing of DO-260B downlinks by ADS-B ground stations during upgrade (iv) Updated the list of known ADS-B avionics problems (v) Included a general recommendation of technical solution on acquisition of Mode 3/A code information via Mode S downlink for DO-260 aircraft in ADS-B implementation with Mode A/C SSR environment ...

2. ACRONYM LIST & GLOSSARY OF TERMS

2.1 ACRONYM LIST

ACID	Aircraft Identification
ADS-C	Automatic Dependent Surveillance - Contract
ADS-B	Automatic Dependent Surveillance - Broadcast
AIGD	ADS-B Implementation and Operations Guidance Document
AIP	Aeronautical Information Publication
AIT	ADS-B Implementation Team
AMSL	Above Mean Sea Level
APANPIRG	Asia/Pacific Air Navigation Planning and Implementation Regional Group
ARINC	Aeronautical Radio Incorporate
ATC	Air Traffic Control (or Air Traffic Controller)
ATM	Air Traffic Management
ATS	Air Traffic Services
ATSP	ATS Provider
ATSU	ATS unit
CNS	Communications, Navigation, Surveillance
CRC	Cyclic Redundancy Check
CDTI	Cockpit Display Traffic Information
DAIW	Danger Area Infringement Warning
FIR	Flight Information Region
FLTID	Flight Identification
FMS	Flight Management System
FOM	Figure of Merit used in ASTERIX messaging
GPS	Global Positioning System (USA)
HPL	Horizontal Protection Level
ICAO	International Civil Aviation Organization
MSAW	Minimum Safe Altitude Warning
MTBF	Mean Time Between Failures
MTCA	Medium Term Conflict Alert
MTTR	Mean Time To Restore
NAC	Navigation Accuracy Category
NIC	Navigation Integrity Category
PRS	Problem Reporting System
RAI	Restricted Area Intrusion
RAM	Route Adherence Monitoring
RAIM	Receiver Autonomous Integrity Monitoring
RFC	Request for Change
RNP	Required Navigation Performance
SIL	Source Integrity Level
SITF	Study and Implementation Task Force
STCA	Short Term Conflict Alert

2.2 GLOSSARY OF TERMS

ADS-B In	An ADS-B system feature that enables the display of real time ADS-B tracks on a situation display in the aircraft cockpit.
ADS-B Out	An ADS-B system feature that enables the frequent broadcast of accurate aircraft position and vector data together with other information.
Asterix 21	Eurocontrol standard format for data message exchange
FOM (Figure of Merit)	A numeric value that is used to determine the accuracy and integrity of associated position data.
HPL (Horizontal Position Limit)	The containment radius within which the true position of the aircraft will be found for 95% of the time (See DO229c).
NAC (Navigational Accuracy Category)	Subfield used to announce the 95% accuracy limits for the horizontal position data being broadcast.
NIC (Navigational Integrity Category)	Subfield used to specify the containment radius integrity associated with horizontal position data.
NUCp (Navigation Uncertainty Category)	A numeric value that announces the integrity of the associated horizontal position data being broadcast.
SIL (Source Integrity Level)	Subfield used to specify the probability of the true position lying outside the containment radius defined by NIC without being alerted.

3. REFERENCE DOCUMENTS

Id	Name of the document	Reference	Date	Origin	Domain
1	Annex 2: Rules of the Air	Tenth Edition Including Amendment 43 dated 16/7/12	July 2005	ICAO	
2	Annex 4: Aeronautical Chart	Eleventh Edition including Amendment 56 dated 12/7/10	July 2009	ICAO	
3	Annex 10: Aeronautical Telecommunications, Vol. IV – Surveillance Radar and Collision Avoidance Systems	Fourth Edition Including Amendment 87 dated 12/7/10	July 2007	ICAO	
4	Annex 11: Air Traffic Services	Thirteenth Edition including Amendment 48 dated 16/7/12	July 2001	ICAO	
5	Annex 15: Aeronautical Information Services	Thirteen Edition	July 2010	ICAO	
6	PAN-ATM (Doc 4444/ATM501)	Fifteen Edition including Amendment 4 applicable on 15/11/12	2007	ICAO	
7	Manual on Airspace Planning Methodology for the Determination of Separation Minima (Doc 9689/AN953)	First Edition including Amendment 1 dated 30/8/02	1998	ICAO	
8	Doc 9859 Safety Management Manual (SMM)	Third Edition	2012	ICAO	
9	ICAO Circular 326 AN/188 "Assessment of ADS-B and Multilateration Surveillance to Support Air Traffic Services and Guidelines for Implementation".	First Edition	2012	ICAO	
10	Regional Supplementary Procedures (Doc 7030)	Fifth Edition including Amendment 5 dated 22/7/11	2008	ICAO	

4. ADS-B DATA

APANPIRG has decided to use 1090MHz Extended Squitter data link for ADS-B data exchange in the Asia and Pacific Regions. In the longer term an additional link type may be required.

To ensure interoperability of ADS-B ground stations in the Asia Pacific (ASIA/PAC) Regions, during the 16th APANPIRG Meeting held in August 2005, the ASTERIX Category 21 version 0.23 (V0.23) which had incorporated DO260 standard was adopted as the baselined ADS-B data format for deployment of ADS-B ground stations and sharing of ADS-B data in the ASIA/PAC Regions. At this time, DO260A and DO260B standards were not defined.

This baselined version provides adequate information so that useful ATC operational services, including aircraft separation, can be provided. V0.23 can be used with DO260, DO260A and DO260B ADS-B avionics/ground stations to provide basic ATC operational services. However, V0.23 cannot fully support the more advanced capabilities offered by DO260A and DO260B.

As the avionics standards changed through the different versions of DO260, the ADS-B ground station processing also needed to change, so that downlinks received from aircraft would be correctly interpreted in construction of the ASTERIX Category 21 messages. It is important that States with "older generation" ADS-B ground stations designed to support DO260 or DO260A, take action to upgrade to support the latest ADS-B avionics standard ~~(DO 260B in 2016)~~ as well as the older standards. DO260B avionics will become more common in the Asia Pacific region as the FAA and European ADS-B mandates for 2020 require this version.

States intending to implement ADS-B surveillance and share ADS-B data with others might consider to adopt a more updated version of ASTERIX in order to make use of the advanced capabilities offered by DO260A and DO260B compliant avionics.

A guidance material on generation, processing and sharing of ASTERIX Cat. 21 ADS-B messages is provided on the ICAO APAC website "http://www.icao.int/APAC/Pages/edocs.aspx" for reference by States.

In this guidance material, the ADS-B data contained inside ASTERIX Cat 21 are classified as Group 1 (mandatory), Group 2 (Desirable) and Group 3 (Optional). It is required to transmit all data that are operationally desirable (Group 2), when such data are received from the aircraft, in addition to the data that are mandatory (Group 1) in ASTERIX messages. Whether Group 3 optional data will need to be transmitted or not should be configurable on item-by-item basis within the ADS-B ground station depending on specific operational needs.

It is considered necessary that all data that are mandatory in ASTERIX messages (i.e. Group 1 data items) and operationally desirable (i.e. Group 2 data items) when such data are received from aircraft, should be included in data sharing. In the event that the data have to be filtered, the list of optional data items (i.e. Group 3 data items) needs to be shared will be subject to mutual agreement between the two data sharing parties concerned.

5. ADS-B IMPLEMENTATION

5.1 INTRODUCTION

5.1.1 Planning

There are a range of activities needed to progress ADS-B implementation from initial concept level to operational use. This section addresses the issues of collaborative decision making, system compatibility and integration, while the second section of this chapter provides a checklist to assist States with the management of ADS-B implementation activities.

5.1.2 Implementation team to ensure international coordination

5.1.2.1 Any decision to implement ADS-B by a State should include consultation with the wider ATM community. Moreover, where ADS-B procedures or requirements will affect traffic transiting between states, the implementation should also be coordinated between States and Regions, in order to achieve maximum benefits for airspace users and service providers.

5.1.2.2 An effective means of coordinating the various demands of the affected organizations is to establish an implementation team. Team composition may vary by State or Region, but the core group responsible for ADS-B implementation planning should include members with multidiscipline operational expertise from affected aviation disciplines, with access to other specialists where required.

5.1.2.3 Ideally, such a team should comprise representatives from the ATS providers, regulators and airspace users, as well as other stakeholders likely to be influenced by the introduction of ADS-B, such as manufacturers and military authorities. All identified stakeholders should participate as early as possible in this process so that their requirements can be identified prior to the making of schedules or contracts.

5.1.2.4 The role of the implementation team is to consult widely with stakeholders, identify operational needs, resolve conflicting demands and make recommendations to the various stakeholders managing the implementation. To this end, the implementation team should have appropriate access to the decision-makers.

5.1.3 System compatibility

5.1.3.1 ADS-B has potential use in almost all environments and operations and is likely to become a mainstay of the future ATM system. In addition to traditional radar-like services, it is likely that ADS-B will also be used for niche application where radar surveillance is not available or possible. The isolated use of ADS-B has the potential to foster a variety of standards and practices that, once expanded to a wider environment, may prove to be incompatible with neighbouring areas.

5.1.3.2 Given the international nature of aviation, special efforts should be taken to ensure harmonization though compliance with ICAO Standards and Recommended Practices (SARPs). The choice of systems to support ADS-B should consider not only the required performance of individual components, but also their compatibility with other CNS systems and prevailing avionics standards..

5.1.3.3 The future concept of ATM encompasses the advantages of interoperable and seamless transition across flight information region (FIR) boundaries and, where necessary, ADS-B implementation teams should conduct simulations, trials and cost/benefit analysis to support these objectives.

5.1.4 Integration

5.1.4.1 ADS-B implementation plans should include the development of both business and safety cases. The adoption of any new CNS system has major implications for service providers, regulators and airspace users and special planning should be considered for the integration of ADS-B into the existing and foreseen CNS/ATM system. The following briefly discusses each element.

5.1.4.2 Communication system

5.1.4.2.1 The communication system is an essential element within CNS. An air traffic controller can now monitor an aircraft position in real time using ADS-B where previously only voice position reports were available. However, a communication system that will support the new services that result from the improved surveillance may be necessary. Consequently, there is an impact of the ongoing ADS-B related work on the communication infrastructure developments.

5.1.4.3 Navigation system infrastructure

5.1.4.3.1 ADS-B is dependent upon the data obtained from a navigation system (typically GNSS), in order to enable its functions and performance. Therefore, the navigation infrastructure should fulfill the corresponding requirements of the ADS-B application, in terms of:

a) Data items; and

b) Performance (e.g. accuracy, integrity, availability etc.).

5.1.4.3.2 This has an obvious impact on the navigation system development, which evolves in parallel with the development of the surveillance system.

5.1.4.4 Other surveillance infrastructure

5.1.4.4.1 ADS-B may be used to supplement existing surveillance systems or as the principal source of surveillance data. Ideally, surveillance systems will incorporate data from ADS-B and other sources to provide a coherent picture that improves both the amount and utility of surveillance data to the user. The choice of the optimal mix of data sources will be defined on the basis of operational demands, available technology, safety and cost-benefit considerations.

5.1.4.4.2 A guidance material on issues to be considered in ATC multi-sensor fusion processing including integration of ADS-B data is provided on the ICAO website http://www.icao.int/APAC/Pages/edocs.aspx for reference by States.

5.1.4.4.3 Acquisition of Mode 3/A code for DO-260 aircraft through Mode S downlink~~in Mode A/C SSR environment~~

There is a potential problem for some of the air traffic management systems (ATMS) for fusion of ADS-B targets with Mode A/C SSR targets, because a common identifier to the aircraft, Mode 3/A code, is not available through ADS-B. Then ATMS can only rely on proximity analysis of aircraft position and Mode C altitude to determine whether detections from two distinct types of surveillance sources belong to the same aircraft. This matching technique might introduce ambiguity in associating ADS-B with Mode A/C SSR targets for fused display.

States may consider enhancing their ADS-B ground stations to listen to Downlink Format 5 and 21 (DF 5 and 21) of Mode S interrogation replies which carry the Mode 3/A code of the same aircraft. As a result, ADS-B target reports of the same DO-260 aircraft can be filled with Mode 3/A code acquired from Mode S downlink to facilitate matching with Mode A/C SSR targets before transmitting to the ATMS.

The transmission of DF 5 and DF 21 messages from a Mode S aircraft requires to be triggered by ground-based Mode S interrogators, either through active or passive interrogation. For active interrogation, Mode S interrogators can be installed alongside with ADS-B ground stations for actively triggering DF 5 and DF 21 messages transmission from the aircraft. The interrogators shall follow ICAO standard to perform periodic all-call and roll-call to the aircraft in range. For passive interrogation, the ADS-B ground stations will only passively listen to the DF messages from the aircraft for acquiring the Mode 3/A code. It is required to ensure that Mode S interrogations are performed by external systems, such as A-SMGCS, MLAT system or Mode S radar under their coverage.

The above provides an interim solution during transition from Mode A/C SSR to Mode S SSR. After upgrading to Mode S SSR, ATMS can have an alternative means to make use of Flight ID or Mode S aircraft address to perform association between ADS-B and Mode S radar targets without ambiguity.

5.1.4.4.4~~3~~ A guidance material on processing and displaying of ADS-B data at air traffic controller positions is provided on the ICAO website "http://www.icao.int/APAC/Pages/edocs.aspx" for reference by States.

5.1.4.5 Additional Functional Requirements for ADS-B Integration

5.1.4.5.1 The following ~~additional~~list of functions ~~al requirements are to~~could be considered by each individual States to see whether they are suitable for their own operational needs or applicable to local environment from ADS-B integration point of view:

- The priority of ADS-B sensor position data vs radar data ~~should~~ could be adaptable;
- For ADS-B aircraft, receipt of the Mode S conspicuity code ~~should~~could trigger use of the Flight ID / Aircraft Address for flight plan correlation;

- If, due to sensor or aircraft capability limitation, no SSR code is received for an aircraft, the system ~~should~~could use Flight ID/ Aircraft Address for track correlation;
- For correlation based on Flight ID, the received ID ~~should~~could exactly match the ACID of the flight plan;
- For correlation based on Aircraft Address, the received address ~~should~~could match the address entered in the flight plan field 18 CODE/ keyword;
- The system ~~should~~could generate an alert for a correlated flight for which the Flight ID from the track does not match the flight plan ACID and/or the Aircraft Address from the track does not match the code given in the flight plan field 18 CODE/ keyword;
- The system ~~should~~could allow the setting of ADS-B above or below the radar sources within the Surveillance Data Processor Tile Set on a per-tile basis;
- Priority ~~should~~could only apply to data received at or above the adapted NUCp, NACp, NIC, and/or SIL thresholds;
- The system ~~should~~could be configurable to either discard ADS-B data or display the track with an indication of ADS-B degradation if the received NUCp, NACp, NIC, or SIL is below an adapted threshold;
- If the system is configured to display the degraded track, the degraded position and status ~~should~~could only be displayed if there are no other surveillance sources available;
- The system ~~should~~could allow the adaptation of ADS-B emergency codes to map to SPC Mnemonics;
- The system ~~should~~could include an adaptable Downlinked Aircraft Parameters (DAP) field that invokes a popup with the following information from Mode-S and ADS-B aircraft:
    - Magnetic Heading
    - True Track Angle
    - Indicated Airspeed/Mach Number
    - Groundspeed
    - Track Angle Rate
    - True Airspeed
    - Roll Angle
    - Selected Altitude
    - Vertical Rate
- The system ~~should~~could generate a conformance alert if the Selected Altitude and the Cleared Flight Level do not match.

5.1.5 Coverage Predictions

5.1.5.1 Reliable and robust analysis and planning of ADS-B coverage to support seamless ATM initiative requires accurate and reliable coverage modelling. States should ensure that surveillance engineering/technical teams are provided with modelling tools to provide accurate and reliable coverage predictions for ATM planning and analysis.

5.2 IMPLEMENTATION CHECKLIST

5.2.1 Introduction

The purpose of this implementation checklist is to document the range of activities that needs to be completed to bring an ADS-B application from an initial concept to operational use. This checklist may form the basis of the terms of reference for an ADS-B implementation team, although some activities may be specific to individual stakeholders. An example of the checklist used by AirServices Australia is given at Appendix 1.

5.2.2 Activity Sequence

The activities are listed in an approximate sequential order. However, each activity does not have to be completed prior to starting the next activity. In many cases, a parallel and iterative process should be used to feed data and experience from one activity to another. It should be noted that not all activities will be required for all applications.

5.2.3 Concept Phase

a) construct operational concept:

1) purpose;
2) operational environment;
3) ATM functions; and
4) infrastructure;

b) identify benefits:

1) safety enhancements;
2) efficiency;
3) capacity;
4) environmental;
5) cost reductions;
6) access; and
7) other metrics (e.g. predictability, flexibility, usefulness);

c) identify constraints:

1) pair-wise equipage;
2) compatibility with non-equipped aircraft;
3) need for exclusive airspace;

4) required ground infrastructure;
5) RF spectrum;
6) integration with existing technology; and
7) technology availability;

d) prepare business case:

1) cost benefit analysis; and
2) demand and justification.

5.2.4 Design Phase

a) identify operational requirements:

1) security; and
2) systems interoperability;

b) identify human factors issues:

1) human-machine interfaces;
2) training development and validation;
3) workload demands;
4) role of automation vs. role of human;
5) crew coordination/pilot decision-making interactions; and
6) ATM collaborative decision-making;

c) identify technical requirements:

1) standards development;
2) prevailing avionics standards;
3) data required;
4~~3~~) functional processing;
5~~4~~) functional performance; and
6~~5~~) required certification levels;

d) equipment development, test, and evaluation:

1) prototype systems built to existing or draft standards/specifications;
2) developmental bench and flight tests; and
3) acceptance test parameters; and
4) select and procure technology;

e) develop procedures:

1) pilot and controller actions and responsibilities;
2) phraseologies;
3) separation/spacing criteria and requirements;
4) controller's responsibility to maintain a monitoring function, if appropriate;
5) contingency procedures;
6) emergency procedures; and
7) develop AIP and Information documentation

f) prepare design phase safety case:
   1) safety rationale;
   2) safety budget and allocation; and
   3) functional hazard assessment.

5.2.5 Implementation phase

a) prepare implementation phase safety case;

b) conduct operational test and evaluation:

   1) flight deck and ATC validation simulations; and
   2) flight tests and operational trials;

c) obtain systems certification:

   1) aircraft equipment; and
   2) ground systems;

d) obtain regulatory approvals:

   1) air traffic certification of use;

e) implementation transition:

   1) Promulgate procedures and deliver training
   2) continue data collection and analysis;
   3) resolve any unforeseen issues; and
   4) continue feedback into standards development processes;

f) performance monitoring to ensure that the agreed performance is maintained.

5.2.5.1 Once the implementation project is complete, ongoing maintenance and upgrading of both ADS-B operations and infrastructure should continue to be monitored, through the appropriate forums.

6. HARMONIZATION FRAMEWORK FOR ADS-B IMPLEMENTATION

6.1 BACKGROUND

6.1.1 It is obvious that full benefits of ADS-B will only be achieved by its harmonized implementation and seamless operations. During the 6th meeting of ADS-B SEA/WG in February 2011, Hong Kong, China initiated to strengthen collaboration among concerned States/Administrations for harmonized ADS-B implementation and seamless operations along two ATS routes L642 and M771 with major traffic flow (MTF). An ad-hoc workgroup comprising concerned CAAs/ANSPs from Hong Kong, China, Mainland China, Vietnam and Singapore was subsequently formed to elaborate and agree on a framework regarding implementation timelines, avionics standards, optimal flight levels, and ATC and engineering handling procedures. As a coherent effort, ADS-B implementation along ATS routes L642 and M771 has been harmonized while Hong Kong, China and Singapore have published respective Aeronautical Information Circulars and Airworthiness Notices on ADS-B mandates for these two routes with effect on 12 December 2013.

6.1.2 It is considered that the above implementation framework for ATS routes L642/M771 would serve as a useful template for extension to other high density routes to harmonize ADS-B implementation. Paragraph 6.2 shows the detailed framework.

6.2 TEMPLATE OF HARMONIZATION FRAMEWORK FOR ADS-B IMPLEMENTATION

Harmonization Framework for ADS-B Implementation along ATS Routes L642 and M771			
No.	**What to harmonize**	**What was agreed**	**Issue / what needs to be further discussed**
1	Mandate Effective	Singapore (SG), Hong Kong (HK), China (Sanya) : 12 Dec 2013 Vietnam (VN) : to be confirmed	
2	ATC Operating Procedures	No need to harmonize	Refer to SEACG for consideration of the impact of expanding ADS-B surveillance on ATC Operating Procedures including Large Scale Weather procedures.
3	Mandate Publish Date	No need to harmonize	To publish equipment requirements as early as possible.

4	Flight Level	SG, HK, CN : - At or Above FL290 (ADS-B airspace) - Below FL290 (Non-ADS-B airspace) VN to be confirmed	
5	Avionics Standard (CASA/AMC2024)	SG - CASA or AMC2024 or FAA AC No. 20-165 HK - CASA or AMC2024 or FAA AC No. 20-165 VN - CASA or AMC2024 or FAA AC No. 20-165 CN - CASA or AMC2024 or FAA AC No. 20-165	ADS-B Task Force agreed that DO260B will be accepted as well. SG, HK, and CN agreed their ADS-B GS will accept DO260, DO260A and DO260B by 1 July 2014 (Note 1)
6	Flight Planning	Before 15 Nov 2012, as per AIGD On or after 15 Nov 2012, as per new flight plan format	
7	Aircraft Equippage		
7a)	Procedures if Aircraft Not Equipped or Aircraft without a Serviceable ADS-B Transmitting Equipment before Flight	SG, HK, CN : FL280 and Below VN to be confirmed	

7b)	Aircraft Equipped but Transmitting Bad Data (Blacklisted Aircraft)	For known aircraft, treat as non ADS-B aircraft.	Share blacklisted aircraft among concerned States/Administration
8	Contingency Plan		
8a)	Systemic Failure such as Ground System / GPS Failure	Revert back to current procedure.	
8b)	Avionics Failure or Equipped Aircraft Transmitting Bad Data in Flight	Provide other form of separation, subject to bilateral agreement. From radar/ADS-B environment to ADS-B only environment, ATC coordination may be able to provide early notification of ADS-B failure.	Address the procedure for aircraft transiting from radar to ADS-B airspace and from ADS-B to ADS-B airspace.
9	Commonly Agreed Route Spacing	SEACG	Need for commonly agreed minimal in-trail spacing throughout.

Note 1: Also included two ADS-B GS supplied by Indonesia at Matak and Natuna

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7. SYSTEM INTEGRITY AND MONITORING

7.1 INTRODUCTION

The Communications, Navigation, Surveillance and Air Traffic Management (CNS/ATM) environment is an integrated system including physical systems (hardware, software, and communication networks), human elements (pilots, controllers and engineers), and the operational procedures for its applications. ADS-B is a surveillance system that may be integrated with other surveillance technologies or may also operate as an independent source for surveillance monitoring within the CNS/ATM system.

Because of the integrated nature of such system and the degree of interaction among its components, comprehensive system monitoring is recommended. The procedures described in this section aim to ensure system integrity by validation, identification, reporting and tracking of possible problems revealed during system monitoring with appropriate follow-up actions.

These procedures do not replace the ATS incident reporting procedures and requirements, as specified in PANS-ATM (Doc 4444), Appendix 4; ICAO's Air Traffic Services Planning Manual (Doc 9426), Chapter 3; or applicable State regulations, affecting the reporting responsibilities of parties directly involved in a potential ATS incident.

7.2 PERSONNEL LICENSING AND TRAINING

Prior to operating any element of the ADS-B system, operational and technical personnel shall undertake appropriate training as determined by the States, including compliance with the Convention on International Civil Aviation where applicable.

Notwithstanding the above requirement and for the purposes of undertaking limited trials of the ADS-B system, special arrangements may be agreed between the operator and an Air Traffic Services Unit (ATSU).

7.3 SYSTEM PERFORMANCE CRITERIA FOR AN ATC SEPARATION SERVICE

A number of States have started to introduce ADS-B for the provision of Air Traffic Services, including 'radar-like' separation. The ICAO Separation and Airspace Safety Panel (SASP) has completed assessment on the suitability of ADS-B for various applications including provision of aircraft separation based on comparison of technical characteristics between ADS-B and monopulse secondary surveillance radar. It is concluded that that ADS-B surveillance is better or at least no worse than the referenced radar, and can be used to provide separation minima as described in PANS-ATM (Doc 4444) whether ADS-B is used as a sole means of ATC surveillance or used together with radar, subject to certain conditions to be met. The assessment result is detailed in the ICAO Circular 326 AN/188 "Assessment of ADS-B and Multilateration Surveillance to Support Air Traffic Services and Guidelines for Implementation".

Regarding the use of ADS-B in complex airspace (as discussed in ICAO Circular 326), complex airspace may be considered to be airspace with the following characteristics:

- Higher aircraft density
- Higher route crossing point density
- A higher mixture of different aircraft performance levels
- A higher rate of aircraft manoeuvring (as distinct from straight and level flight).

The following recommendations need to be considered:

1. Whether complex or not, States are urged to consider whether the current or required surveillance system performance is better, equivalent or worse than the SASP reference.

2. If the current or required surveillance system used by a State is lower or equivalent in performance than the reference MSSR used in Circular 326 Appendix A, then that State may use the Appendix C performance criteria.

3. If the current or required surveillance system used by a State is higher performance than the reference MSSR used in Circular 326 Appendix A, then the State must ensure that the ADS-B system achieves the more demanding performance.

4. State should undertake, in all cases, a safety assessment that ensures that any additional risks and safety requirements already identified for the airspace where ADSB or MLAT is to be implemented, or any newly identified risks, are effectively controlled and risk is reduced to an acceptable level.

States intending to introduce ADS-B separation minima shall comply with provisions of PANS-ATM, Regional Supplementary Procedures (Doc 7030) and Annex 11 paragraph 3.4.1. States should adopt the guidelines contained in this document unless conformance with PANS-ATM specifications requires change.

7.4 ATC SYSTEM VALIDATION

7.4.1 Safety Assessment Guidelines

To meet system integrity requirements, States should conduct a validation process that confirms the integrity of their equipment and procedures. Such processes shall include:

a) A system safety assessment for new implementations is the basis for definitions of system performance requirements. Where existing systems are being modified to utilize additional services, the assessment demonstrates that the ATS Provider's system will meet safety objectives;

b) Integration test results confirming interoperability for operational use of airborne and ground systems; and

c) Confirmation that the ATS Operation Manuals are compatible with those of adjacent providers where the system is used across a common boundary.

7.4.2 System safety assessment

The objective of the system safety assessment is to ensure the State that introduction and operation of ADS-B is safe. This can be achieved through application of the provisions of Annex 11 paragraph 2.27 and PANS-ATM Chapter 2. The safety assessment should be conducted for initial implementation as well as any future enhancements and should include:

a) Identifying failure conditions;

b) Assigning levels of criticality;

c) Determining risks/ probabilities for occurrence;

d) Identifying mitigating measures and fallback arrangements;

e) Categorising the degree of acceptability of risks; and

f) Operational hazard ID process.

Following the safety assessment, States should institute measures to offset any identified failure conditions that are not already categorized as acceptable. This should be done to reduce the probability of their occurrence to a level as low as reasonably practicable. This could be accomplished through system automation or manual procedures.

Guidance material on building a safety case for delivery of an ADS-B separation service is provided on the ICAO APAC website "http://www.icao.int/APAC/Pages/edocs.aspx" for reference by States.

7.4.3 Integration test

States should conduct trials with suitably equipped aircraft to ensure they meet the operational and technical requirements to provide an ATS. Alternatively, they may be satisfied by test results and analysis conducted by another State or organization deemed competent to provide such service. Where this process is followed, the tests conducted by another State or organization should be comparable (i.e. using similar equipment under similar conditions).

Refer also to the *Manual on Airspace Planning Methodology for the Determination of Separation Minima* (Doc9689).

7.4.4 ATS Operation Manuals

States should coordinate with adjacent States to confirm that their ATS Operation Manuals contain standard operating procedures to ensure harmonization of procedures that impact across common boundaries.

7.4.5 ATS System Integrity

With automated ATM systems, data changes, software upgrades, and system failures can affect adjacent units. States shall ensure that:

a) A conservative approach is taken to manage any changes to the system;

b) Aircrew, aircraft operating companies and adjacent ATSU(s) are notified of any planned system changes in advance, where that system is used across a common boundary;

c) ATSUs have verification procedures in place to ensure that following any system changes, displayed data is both correct and accurate;

d) In cases of system failures or where upgrades (or downgrades) or other changes may impact surrounding ATS units, ATSUs should have a procedure in place for timely notification to adjacent units. Such notification procedures will normally be detailed in Letters of Agreement between adjacent units; and

e) ADS-B surveillance data is provided with equal to or better level of protection and security than existing surveillance radar data.

7.5 SYSTEM MONITORING

During the initial period of implementation of ADS-B technology, routine collection of data is necessary in order to ensure that the system continues to meet or exceed its performance, safety and interoperability requirements, and that operational service delivery and procedures are working as intended. The monitoring program is a two-fold process. Firstly, summarised statistical data should be produced periodically showing the performance of the system. This is accomplished through ADS-B Periodic Status Reports. Secondly, as problems or abnormalities arise, they should be identified, tracked, analyzed and corrected and information disseminated as required, utilizing the ADS-B Problem Report.

Guidance materials on monitoring and analysis of ADS-B Avionics Performance are given at Appendix 2. Checklist of common items or parameters that could be considered for monitoring is summarized at Appendix 5 for reference.
~~Checklist of common items or parameters for monitoring is summarized at Appendix 5 for reference.~~

7.5.1 Problem Reporting System (PRS)

The Problem Reporting System is tasked with the collection, storage and regular dissemination of data based on reports received from ADS-B SITF members. The PRS tracks problem reports and publish information from those reports to ADS-B SITF members. Problem resolution is the responsibility of the appropriate ADS-B SITF members.

The PRS Administrator shall:

a) prepare consolidated problem report summaries for each ADS-B SITF meeting;

b) collect and consolidate ADS-B Problem Reports; and

c) maintain a functional website (with controlled access) to manage the problem reporting function.

7.5.2 The monitoring process

When problems or abnormalities are discovered, the initial analysis should be performed by the organization(s) identifying the problem. In addition, a copy of the problem report should be entered in to the PRS which will assign a tracking number. As some problems or abnormalities may involve more than one organization, the originator should be responsible for follow-up action to rectify the problem and forward the information to the PRS. It is essential that all information relating to the problem is documented and recorded and resolved in a timely manner.

The following groups should be involved in the monitoring process and problem tracking to ensure a comprehensive review and analysis of the collected data:

a) ATS Providers;

b) Organizations responsible for ATS system maintenance (where different from the ATS provider);

c) Relevant State regulatory authorities;

d) Communication Service Providers being used;

e) Aircraft operators; and

f) Aircraft and avionics manufacturers.

7.5.3 Distribution of confidential information

It is important that information that may have an operational impact on other parties be distributed by the authorised investigator to all authorised groups that are likely to be affected, as soon as possible. In this way, each party is made aware of problems already encountered by others, and may be able to contribute further information to aid in the solution of these problems. The default position is that all states agree to provide the data which will be de-identified for reporting and record keeping purposes.

7.5.4 ADS-B problem reports

Problem reports may originate from many sources, but most will fall within two categories; reports based on observation of one or more specific events, or reports generated from the routine analysis of data. The user would document the problem, resolve it with the appropriate party and forward a copy of the report to the PRS for tracking and distribution. While one

occurrence may appear to be an isolated case, the receipt of numerous similar reports by the PRS could indicate that an area needs more detailed analysis.

To effectively resolve problems and track progress, the problem reports should be sent to the nominated point of contact at the appropriate organization and the PRS. The resolution of the identified problems may require:

a) Re-training of system operators, or revision of training procedures to ensure compliance with existing procedures;

b) Change to operating procedures;

c) Change to system requirements, including performance and interoperability; or

d) Change to system design.

7.5.5 ADS-B periodic status report

The ATS Providers should complete the ADS-B Periodic Status Report annually and deliver the report to the regional meeting of the ADS-B SITF. The Periodic Status Report should give an indication of system performance and identify any trend in system deficiencies, the resultant operational implications, and the proposed resolution, if applicable.

Communications Service Providers, if used, are also expected to submit Periodic Status Reports on the performance of the networks carrying ADS-B data at the annual regional meeting of the ADS-B SITF. These reports could also contain the details of planned or current upgrades to the network.

7.5.6 Processing of Reports

Each group in the monitoring process should nominate a single point of contact for receipt of problem reports and coordination with the other parties. This list will be distributed by the PRS Administrator to all parties to the monitoring process.
Each State should establish mechanisms within its ATS Provider and regulatory authority to:

a) Assess problem reports and refer them to the appropriate technical or operational expertise for investigation and resolution;

b) Coordinate with aircraft operators;

c) Develop interim operational procedures to mitigate the effects of problems until such time as the problem is resolved;

d) Monitor the progress of problem resolution;

e) Prepare a report on problems encountered and their operational implications and forward these to the PRS;

f) Prepare the ADS-B periodic status report at pre-determined times and forward these to the Secretary of the annual meeting of the ADS-B SITF; and

g) Coordinate with any Communication Service Providers used.

7.6 APANPIRG

APANPIRG, with the assistance of its contributory bodies, shall oversee the monitoring process to ensure the ADS-B system continues to meet its performance and safety requirements, and that operational procedures are working as intended. The APANPIRG'S objectives are to:

a) review Periodic Status Reports and any significant Problem Reports;

b) highlight successful problem resolutions to ADS-B SITF members;

c) monitor the progress of outstanding problem resolutions;

d) prepare summaries of problems encountered and their operational implications; and

e) assess system performance based on information in the PRS and Periodic Status Reports.

7.7 LOCAL DATA RECORDING AND ANALYSIS

7.7.1 Data recording

It is recommended that ATS Providers and Communication Service Providers retain the records defined below for at least 30 days to allow for accident/incident investigation processes. These records should be made available on request to the relevant State safety authority. Where data is sought from an adjacent State, the usual State to State channels should be used.

These recordings shall be in a form that permits a replay of the situation and identification of the messages that were received by the ATS system.

7.7.2 Local data collection

ATS providers and communications service providers should identify and record ADS-B system component failures that have the potential to negatively impact the safety of controlled flights or compromise service continuity.

7.7.3 Avionics problem identification and correction

ATS providers need to develop systems to :

a) detect ADS-B avionics anomalies and faults

b) advise the regulators and where appropriate the aircraft operators on the detected ADS-B avionics anomalies and faults

c) devise mechanisms and procedures to address identified faults

Regulators need to develop and maintain systems to ensure that appropriate corrective actions are taken to address identified faults.

7.8 ADS-B PROBLEM REPORT

7.8.1 Report Form			**PRS #**
Date UTC		**Time UTC**	
Registration		**Aircraft ID**	
Flight ID		**ICAO 24 Bit Code**	
Aircraft Type			
Flight Sector/ Location			
ATS Unit			
Description / additional information			
Originator		**Originator Reference number**	
Organization			

7.8.2 Description of Fields

Field	Meaning
Number	A unique identification number assigned by the PRS Administrator to this problem report. Organizations writing problem reports are encouraged to maintain their own internal list of these problems for tracking purposes. Once the problems have been reported to the PRS and incorporated in the database, a number will be assigned by the PRS and used for tracking by the ADS-B SITF.
Date UTC	UTC date when the event occurred.
Time UTC	UTC time (or range of times) at which the event occurred.
Registration	Registration number (tail number) of the aircraft involved.
Aircraft ID (ACID)	Coded equivalent of voice call sign as entered in FPL Field 7.
ICAO 24 Bit Code	Unique aircraft address expressed in Hexadecimal form (e.g. 7432DB)
Flight ID (FLTID)	The identification transmitted by ADS-B for display on a controller situation display or a CDTI.
Flight Sector/Location	The departure airport and destination airport for the sector being flown by the aircraft involved in the event. These should be the ICAO identifiers of those airports. Or if more descriptive, the location of the aircraft during the event.
Originator	Point of contact at the originating organization for this report (usually the author).
Aircraft Type	The aircraft model involved.
Organization	The name of the organization (airline, ATS provider or communications service provider) that created the report.
ATS Unit	ICAO identifier of the ATC Center or Tower controlling the aircraft at the time of the event.
Description	This should provide as complete a description of the situation leading up to the problem as is possible. Where the organization reporting the problem is not able to provide all the information (e.g. the controller may not know everything that happens on the aircraft), it would be helpful if they would coordinate with the other parties to obtain the necessary information. The description should include: • A complete description of the problem that is being reported • The route contained in the FMS and flight plan • Any flight deck indications • Any indications provided to the controller when the problem occurred • Any additional information that the originator of the problem report considers might be helpful but is not included on the list above If necessary to contain all the information, additional pages may be added. if the originator considers it might be helpful, diagrams and other additional information (such as printouts of message logs) may be appended to the report.

7.9 ADS-B PERFORMANCE REPORT FORM			
Originating Organization			
Date of submission		**Originator**	
Report Period			
TECHNICAL ISSUES			
OPERATIONAL ISSUES			
GENERAL COMMENTS			

8. RELIABILITY & AVAILABILITY CONSIDERATIONS

Reliability and Availability of ADS-B systems should normally be equivalent or better than the reliability and availability of radar systems.

Guidance material on Reliability and Availability standards for ADS-B systems and supporting voice communications systems are included in the document "Baseline ADS-B Service Performance Parameters" which is available on the ICAO APAC website at: http://www.icao.int/APAC/Documents/edocs/cns/ADSB_ServicePer.pdf

The "Baseline ADS-B Performance Parameters" document contains three Tiers of service performance parameters with different reliability and availability standards for each Tier. The appropriate Tier should be selected for the type of ADS-B service intended:

(a) Tier 1 standards are for a high performance traffic separation service;

(b) Tier 2 standards are for a traffic situational awareness service with procedural separation; and

(c) Tier 3 standards are for a traffic advisory service (flight information service)

To achieve high operational availability of ADS-B systems to support aircraft separation services, it is necessary to operate with duplicated/redundant systems. If one system fails, the service continues using an unduplicated system. This is acceptable for a short period, whilst the faulty system is being repaired, because the probability of a second failure during the short time window of repairing is low.

However, it is necessary to ensure that the repair does not take too long. A long repair time increases the risk of an unexpected failure (loss of service continuity); which in turn, introduces potential loss of service (low availability) and loss of aircraft operational efficiency and/or safety impacts.

Checklist of common items or parameters forthat could be considered for monitoringing is summarized at Appendix 5 for reference.

8.1 Reliability

8.1.1 Reliability is a measure of how often a system fails and is usually measured as Mean Time Between Failure (MTBF) expressed in hours. Continuity is a measure equivalent to reliability, but expressed as the probability of system failure over a defined period. In the context of this document, failure means inability to deliver ADS-B data to the ATC centre. Ie: Failure of the ADS-B system rather than an equipment or component failure.

8.1.2 Poor system MTBF has a safety impact because typically it causes unexpected transition from one operating mode to another. For example, aircraft within surveillance coverage that are safely separated by a surveillance standard distance (say, 5 NM) are unexpectedly no longer separated by a procedural standard distance (say 15 mins), due to an unplanned surveillance outage.

8.1.3 In general, reliability is determined by design (see para 8.3 B below)

8.2 Availability

8.2.1 Availability is a measure of how often the system is available for operational use. It is usually expressed as a percentage of the time that the system is available.

8.2.2 Poor availability usually results in loss of economic benefit because efficiencies are not available when the ATC system is operating in a degraded mode (eg using procedural control instead of say 5 NM separation).

8.2.3 Planned outages are often included as outages because the efficiencies provided to the Industry are lost, no matter what the cause of the outage. However, some organisations do not include planned outages because it is assumed that planned outages only occur when the facility is not required.

8.2.4 Availability is calculated as

Availability (Ao) = MTBF/(MTBF+MDT)

where MTBF= Mean Time Between SYSTEM Failure
MDT = Mean Down Time for the SYSTEM

The MDT includes Mean Time To Repair (MTTR), Turn Around Time (TAT) for spares, and Mean Logistic Delay Time (MLDT)
NB: This relates to the failure of the system to provide a service, rather than the time between individual equipment failures. Some organisations use Mean Time Between Outage (MTBO) rather than MTBF.

8.2.5 Availability is directly a function of how quickly the SYSTEM can be repaired. Ie: directly a function of MDT. Thus availability is highly dependent on the ability & speed of the support organisation to get the system back on-line.

8.3 Recommendations for high reliability/availability ADS-B systems

A : **System design** can keep system failure rate low with long MTBF. Typical techniques are :

- to duplicate each element and minimise single points of failure. Automatic changeover or parallel operation of both channels keeps system failure rates low. Ie: the system keeps operating despite individual failures. Examples are :
  - Separate communication channels between ADS-B ground station and ATC centre preferably using different technologies or service providers eg one terrestrial and one satellite
- Consideration of Human factors in design can reduce the number of system failures due to human error. E.g. inadvertent switch off, incorrect software load, incorrect maintenance operation.
- Take great care with earthing, cable runs and lightning protection to minimise the risks of system damage
- Take great care to protect against water ingress to cables and systems
- Establish a system baseline that documents the achieved performance of the site that can be later be used as a reference. This can shorten troubleshooting in future.
- System design can also improve the MDT by quickly identifying problems and alerting maintenance staff. Eg Built in equipment test (BITE) can significantly contribute to lowering MDT.

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B: **Logistics strategy** aims to keep MDT very low. Low MDT depends on logistic support providing short repair times. To achieve short repair times, ANSPs usually provide a range of logistics, including the following, to ensure that the outage is less than a few days :

- ensure the procured system is designed to allow for quick replacement of faulty modules to restore operations
- provide remote monitoring to allow maintainers to identify the faulty modules for transport to site
- provide support tools to allow technicians to repair faulty modules or to configure/setup replacement modules
- provide technicians training to identify & repair the faulty modules
- provide local maintenance depots to reduce the time it takes to access to the site
- provide documentation and procedures to "standardise" the process
- use an in-country spares pool to ensure that replacement modules are available within reasonable times
- use a maintenance contract to repair faulty modules within a specified turnaround time. I.e.: to replenish the spares pool quickly.

Whilst technical training and remote monitoring are usually considered by ANSPs, sometimes there is less focus on spares support.

Difficulties can be experienced if States :

a) Fail to establish a spares pool – because procurement of spares at the time of failure can bring extensive delays due to :
b) obtaining funds
c) obtaining approval to purchase overseas
d) obtaining approval to purchase from a "sole source"
e) difficulties and delays in obtaining a quotation
f) delays in delivery because the purchase was unexpected by the supplier
g) Fail to establish a module repair contract resulting in :
   - long repair times
   - unplanned expenditure
   - inability for a supplier to repair modules because the supplier did not have adequate certainty of funding of the work

Spares pool

ANSPs can establish, preferably as part of their acquisition purchase, adequate spares buffer stock to support the required repair times. The prime objective is to reduce the time period that the system operates un-duplicated. It allows decoupling of the restoration time from the module repair time.

Module repair contract

ANSPs can also enter into a maintenance repair contract, preferably as part of their acquisition purchase, to require the supplier to repair or replace and deliver failed modules within a specified time – preferably with contractual incentives/penalties for compliance. Such support contracts are best negotiated as part of the acquisition contract when competition between vendors is at play to keep costs down. Sometimes it is appropriate to demand that the support

contractor also keep a certain level of buffer stock of spares "in country".

It is strongly recommended that maintenance support is purchased under the same contract as the acquisition contract.

The advantages of a module repair contract are :

- The price can be determined whilst in the competitive phase of acquisition – hence avoids excessive costs
- The contract can include the supplier bearing all shipping costs
- Can be funded by a define amount per year, which support the budget processes. If the costs are fixed, the supplier is encouraged to develop a reliable system minimising module repairs.
- It avoids delays and funding issues at the time of the module failure

Other typical strategies are:

- Establish availability and reliability objectives that are agreed organization wide. In particular agree System response times (SRT) for faults and system failure to ensure that MDT is achieved. An agreed SRT can help organizations to decide on the required logistics strategy including number, location and skills of staff to support the system.

- Establish baseline preventative maintenance regimes including procedures and performance inspections in conjunction with manufacturer recommendations for all subsystems

- Use remote control & monitoring systems to identify faulty modules before travel to site. This can avoid multiple trips to site and reduce the repair time

- Have handbooks, procedures, tools available at the site or a nearby depot so that travel time does not adversely affect down time

- Have adequate spares and test equipment ready at a maintenance depot near the site or at the site itself. Vendors can be required to perform analysis of the number of spares required to achieve low probability of spare "stock out"

- Have appropriate plans to cope with system and component obsolescence. It is possible to contractually require suppliers to regularly report on the ability to support the system and supply components.

- Have ongoing training programs and competency testing to ensure that staff are able to perform the required role

The detailed set of operational and technical arrangements in place and actions required to maintain a system through the lifecycle are often documented in a Integrated Logistics Support Plan.

C: <u>Configuration Management</u> aims to ensure that the configuration of the ground stations is maintained with integrity. Erroneous configuration can cause unnecessary outages. Normally configuration management is achieved by :

- Having clear organizational & individual responsibilities and accountabilities for system configuration.

- Having clear procedures in place which define who has authority to change configuration and records of the changes made including, inter alia
  - The nature of the change including the reason
  - Impact of the change & safety assessment
  - An appropriate transition or cutover plan
  - Who approved the change
  - When the change was authorized and when the change was implemented

- Having appropriate test and analysis capabilities to confirm that new configurations are acceptable before operational deployment.

- Having appropriate methods to deploy the approved configuration (Logistics of configuration distribution). Suggested methods;

  - Approved configuration published on intranet web pages
  - Approved configuration distributed on approved media

D: Training & Competency plans aim to ensure that staff has the skills to safety repairs Normally this is achieved by:

- Conduct of appropriate Training Needs Analysis (TNA) to identify the gap between trainee skill/knowledge and the required skill/knowledge.

- Development and delivery of appropriate training to maintainers

- Competency based testing of trainees

- Ongoing refresher training to ensure that skills are maintained even when fault rates are low

E: Data collection & Review :

Regular and scheduled review should be undertaken to determine whether reliability/availability objectives are being met. These reviews need to consider :

- Reports of actual achieved availability & reliability

- Data regarding system failures including "down time" needs to be captured and analysed so the ANSP actually knows what is being (or not being) achieved.

- Any failure trends that need to be assessed. This requires data capture of the root cause of failures

- Any environmental impacts on system performance, such coverage obstructions such as trees, planned building developments, corrosion, RFI etc. Changes in infrastructure may also be relevant including air conditioning (temperature/humidity etc) and power system changes.

- System problem reports especially those that relate to software deficiencies (design)

- System and component obsolescence

- Staff skills and need for refresher training

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9. ADS-B REGULATIONS AND PROCEDURES

9.1 INTRODUCTION

ADS-B involves the transmission of specific data messages from aircraft and vehicle systems. These data messages are broadcast at approximately 0.5 second intervals and received at compatible ground stations that relay these messages to ATSU(s) for presentation on ATS situation displays. The following procedures relate to the use of ADS-B data in ATS ground surveillance applications.

The implementation of the ADS-B system will support the provision of high performance surveillance, enhancing flight safety, facilitating the reduction of separation minima and supporting user demands such as user-preferred trajectories.

9.2 ADS-B REGULATIONS

As agreed at APANPRIG 22/8, States intending to implement ADS-B based surveillance services may designate portions of airspace within their area of responsibility by:

(a) mandating the carriage and use of ADS-B equipment; or

(b) providing priority for access to such airspace for aircraft with operative ADS-B equipment over those aircraft not operating ADS-B equipment.

In publishing ADS-B mandate/regulations, States should consider to :

- define the ADS-B standards applicable to the State. For interoperability and harmonization, such regulations need to define both the standards applicable for the aircraft ADS-B position source and the ADS-B transmitter.

- define the airspace affected by the regulations and the category of aircraft that the regulation applies to.

- define the timing of the regulations allowing sufficient time for operators to equip. Experience in Asia Pacific Regions is that major international carriers are having high equippage rates of ADS-B avionics. However the equippage rates of ADS-B avionics for some regional fleets, business jets and general aviation are currently low and more time will be required to achieve high equippage rates.

- establish the technical and operational standards for the ground stations and air traffic management procedures used for ADS-B separation services, including the associated voice communications services.

States may refer to Appendix 3 on the template for ADS-B mandate/regulations for aircraft avionics. Some States listed below have published their ADS-B mandate/regulations on their web sites that could also be used for reference.

(a) Civil Aviation Safety Authority (CASA) of Australia
Civil Aviation Order 20.18 Amendment Order (No. 1) 2009, Civil Aviation Order 82.1 Amendment Order (No. 1) 2009, Civil Aviation Order 82.3 Amendment Order (No. 2) 2009, Civil Aviation Order 82.5 Amendment Order (No. 2) 2009 and Miscellaneous Instrument CASA 41/09 – Direction – use of ADS-B in foreign aircraft engaged in private operations in Australian territory
"http://www.comlaw.gov.au/Details/F2012C00103/Download"

(b) Civil Aviation Department (CAD) of Hong Kong, China
Aeronautical Information Publication Supplement No. 13/13 dated 29 October 2013
"http://www.hkatc.gov.hk/HK_AIP/supp/A13-13.pdf"

(c) Civil Aviation Authority of Singapore (CAAS)
Aeronautical Information Publication Supplment No. 254/13 dated 6 November 2013
"http://www.caas.gov.sg/caasWeb2010/export/sites/caas/en/Regulations/Aeronautical_Information/AIP_Supplements/download/AIPSUP254-13.pdf"

(d) Federal Aviation Administration (FAA)
ADS–B Out Performance Requirements To Support Air Traffic Control (ATC) Service, Final Rule
http://www.gpo.gov/fdsys/pkg/FR-2010-05-28/pdf/2010-12645.pdf

States are encouraged to mandate forward fit for newly manufactured aircraft on and after 8th June 2018, having a maximum certified takeoff weight of 5700kg or greater, or having a maximum cruising true airspeed capability of greater than 250 knots, with ADS-B avionics compliant to Version 2 ES (equivalent to RTCA DO-260B) or later version [1].

9.3 FACTORS TO BE CONSIDERED WHEN USING ADS-B

9.3.1 Use of ADS-B Level data

The accuracy and integrity of pressure altitude derived level information provided by ADS-B are equivalent to Mode C level data provided through an SSR sensor and subject to the same operational procedures as those used in an SSR environment. Where the ATM system converts ADS-B level data to display barometric equivalent level data, the displayed data should not be used to determine vertical separation until the data is verified by comparison with a pilot reported barometric level.

9.3.2 Position Reporting Performance

The ADS-B data from the aircraft will include a NUC/NIC/SIL categorization of the accuracy and integrity of the horizontal position data. This figure is determined from NIC/ NAC/ SIL values for DO260A/B compliant avionics and NUC values for DO260/ED102 compliant avionics.

In general, for 5NM separation, if the HPL value used to generate ADS-B quality indicators (NUC or NIC) is greater than 2 nautical miles the data is unlikely to be of comparable quality to that provided by a single monopulse SSR. ADS-B data should not be used for separation unless a suitable means of determining data integrity is used.

The key minimum performance requirements for an ADS-B system to enable the use of a 3 NM or 5 NM separation minimum in the provision of air traffic control is provided in the ICAO Circular 326 (especially Appendix C).

ADS-B reports with low integrity may be presented on situation displays, provided the controller is alerted (e.g. by a change in symbology and/or visual alert) to the change and the implications for the provision of separation. An ANS Provider may elect not to display ADS-B tracks that fail to meet a given position reporting performance criterion.

[1] Subject to endorsement by APANPIRG/26 in September 2015

9.3.3 GNSS Integrity Prediction Service

Early implementations of ADS-B are expected to use GNSS for position determination. As such, availability of GNSS data has a direct influence on the provision of a surveillance service.

ATS Providers may elect to use a GNSS integrity prediction service to assist in determining the future availability of useable ADS-B data. The integrity prediction service alerts users to potential future loss or degradation of the ADS-B service in defined areas. When these alerts are displayed, the system is indicating to its users that at some time in the future the ADS-B positional data may be inadequate to support the application of ADS-B separation. It is recommended that the prediction service is made available to each ATSU that is employing ADS-B to provide a separation service, to ensure that air traffic controllers are alerted in advance of any predicted degradation of the GNSS service and the associated reduction in their ability to provide ADS-B separation to flights that are within the affected area. This is similar to having advance warning of a planned radar outage for maintenance.

ADS-B should not be used to provide separation between aircraft that will be affected by an expected period of inadequate position reporting integrity.

If an unpredicted loss of integrity occurs (including a RAIM warning report from aircrew) then;

(a) ADS-B separation should not be applied by ATC to the particular aircraft reporting until the integrity has been assured; and

(b) The controller should check with other aircraft in the vicinity of the aircraft reporting the RAIM warning, to determine if they have also been affected and establish alternative forms of separation if necessary.

9.3.4 Sharing of ADS-B Data

ADS-B Data-sharing for ATC Operations

Member States should consider the benefits of sharing ADS-B data received from aircraft operating in the proximity of their international airspace boundaries with adjacent States that have compatible technology in an effort to maximize the service benefits and promote operational safety.

Data sharing may involve the use of the data to provide separation services if all the requirements for delivery of separation services are satisfied, In some cases, States may choose to use a lower standard that supports surveillance safety nets and situational awareness whilst operations are conducted using procedural separation standards.

Any agreement on the sharing of surveillance data should be incorporated in Letters of Agreement between the States concerned. Such agreements may also include the sharing of VHF communication facilities.

A template for ADS-B data-sharing agreement is provided on the ICAO APAC website "http://www.icao.int/APAC/Pages/edocs.aspx" for reference by States.

ADS-B Data-sharing for Safety Monitoring

With endorsement of the methodology by both the ICAO Separation and Airspace Safety Panel (SASP) and the Regional Monitoring Agencies Coordination Group (RMACG), ADS-B data can be used for calculating the altimetry system error (ASE) which is a measure of the height-keeping performance of an aircraft. It is an ICAO requirement that aircraft operating in RVSM airspace must undergo periodic monitoring on height-keeping performance. The existing methods to estimate aircraft ASE include use of a portable device, the Enhanced GPS Monitoring Unit, and ground-based systems called Height Monitoring Unit/Aircraft Geometric Height Measurement Element. The use of ADS-B data for height-keeping performance monitoring, on top of providing enhanced and alternative means of surveillance, will provide a cost-effective option for aircraft operators. States are encouraged to share ADS-B data to support the height-keeping performance monitoring of airframe.

Civil/Military ADS-B Data-sharing

Civil/military data sharing arrangements, including aircraft surveillance, were a key part of civil/military cooperation in terms of tactical operational responses and increasing trust between civil and military units.

Aircraft operating ADS-B technology transmit their position, altitude and identity to all listeners, conveying information from co-operative aircraft that have chosen to equip and publicly broadcast ADS-B messages. Thus there should be no defence or national security issues with the use and sharing of such data.

Some military transponders may support ADS-B using encrypted DF19 messages, but these data are normally not decoded or used at all by civil systems. In most cases today, tactical military aircraft are not ADS-B equipped or could choose to disable transmissions. In future, increasing numbers of military aircraft will be ADS-B capable, with the ability to disable these transmissions. ADS-B data sharing should not influence the decision by military authorities to equip or not equip with ADS-B. Moreover, it is possible for States to install ADS-B filters that prevent data from sensitive flights being shared. These filters can be based on a number of criteria and typically use geographical parameters to only provide ADS-B data to an external party if aircraft are near the boundary.

A guidance material on advice to military authorities regarding ADS-B data sharing is provided on the ICAO APAC website "http://www.icao.int/APAC/Pages/edocs.aspx" for reference by States.

9.3.5 Synergy of ADS-B and GNSS

States intending to implement GNSS/PBN or ADS-B should consider the efficiency of implementing the other technology at the same time due to the inherent efficiencies in doing so. GNSS systems provide navigation solutions to IFR aircraft for the conduct of enroute, terminal and non-precision approaches. The use of GNSS/PBN can provide higher performance and higher safety. Transition to GNSS can avoid significant ground infrastructure costs.

ADS-B systems provide surveillance based upon GNSS position source. ADS-B provides high performance and high update surveillance for both air-air and ATC surveillance. Transition to ADS-B can avoid the costs associated with ground based radar infrastructure. ADS-B system installations rely on acceptable GNSS equipment being installed in the aircraft to provide the position source and integrity.

If the fleet is equipped with ADS-B, they will already have most of the requirements to use GNSS for navigation satisfied. Similarly, if aircraft have suitable GNSS on board, they will

have a position source to support ADS-B. It is noted however, that some care is needed to ensure that the requirements of GNSS/PBN and surveillance are both satisfied.

There is significantly less cost for these systems to be installed in an aircraft at the same time. A single installation of GNSS & ADS-B will involve :

- a single design activity instead of two
- a single downtime instead of two
- installation of the connection between GPS and ADS-B transponder
- a single test, certification and aircraft flight test

For the affected aviation community (ANSP, regulator and operator), the lessons learnt and issues faced in both GNSS and ADS-B have significant commonality. This can lead to efficiencies in Industry education and training.

9.4 Reporting Rates

9.4.1 General

The ADS-B system shall maintain a reporting rate that ensures at least an equivalent degree of accuracy, integrity and availability as for a radar system that is used to provide a similar ATC service. The standard reporting rate is approximately 0.5 second from the aircraft, but the rate of update provided to the ATM system (for the situation display) may be less frequent (e.g. 5 seconds), provided the equivalency with radar is preserved.

9.5 SEPARATION

9.5.1 General

ADS-B data may be used in combination with data obtained by other means of surveillance (such as radar, flight plan track, ADS-C) for the application of separation provided appropriate minima as determined by the State are applied. It should be noted that the quality of communications will have a bearing on the determination of appropriate minima.

All safety net features (MSAW, STCA, MTCA, RAM and DAIW/ RAI etc) should possess the same responsiveness as equivalent radar safety net features.

9.5.2 Identification Methods

Some of the methods approved by ICAO for establishing identification with radar, may be employed with ADS-B (see PANS-ATM chapter 8). One or more of the following identification procedures are suggested:

a) direct recognition of the aircraft identification in an ADS-B label on a situation display;

b) transfer of ADS-B identification;

c) observation of compliance with an instruction to TRANSMIT ADS-B IDENT.

Note: In automated systems, the "IDENT" feature may be presented in different ways, e.g. as a flashing of all or part of the position indication and associated label.

9.5.3 ADS-B Separation

ADS-B Separation minima has been incorporated by ICAO in PANS-ATM (Doc 4444), and in Regional Supplementary Procedures (Doc 7030).

In a mixed surveillance environment, States should use the larger separation standard applicable between aircraft in the conflict pair being considered.

9.5.4 Vertical separation

9.5.4.1 Introduction

The ADS-B level data presented on the controllers situation display shall normally be derived from barometric pressure altitude. In the event that barometric altitude is absent, geometric altitude shall not be displayed on displays used for provision of air traffic services. Geometric altitude may be used in ATM systems for other purposes.

9.5.4.2 Vertical tolerance standard

The vertical tolerances for ADS-B level information should be consistent with those applied to Mode C level information.

9.5.4.3 Verification of ADS-B level information

The verification procedures for ADS-B level information shall be the same as those employed for the verification of Mode C level data in a radar environment.

9.6 AIR TRAFFIC CONTROL CLEARANCE MONITORING

9.6.1 General

ADS-B track data can be used to monitor flight path conformance with air traffic control clearances.

9.6.2 Deviations from ATC clearances

The ATC requirements relating to monitoring of ADS-B traffic on the situation display should be similar to those contained in PANS-ATM Ch.8.

9.7 ALERTING SERVICE

For ADS-B equipped aircraft, the provision of an alerting service should be based on the same criteria as applied within a radar environment.

9.8 POSITION REPORTING

9.8.1 Pilot position reporting requirements in ADS-B coverage

States should establish voice and/or CPDLC position reporting procedures consistent with those applicable with radar for aircraft that have been identified by ATC.

9.8.2 Meteorological reporting requirements in ADS-B airspace

ATSUs may promulgate in the AIP meteorological reporting requirements that apply within the nominated FIR. The meteorological reporting data required and the transmission methods to be used by aircrew shall be specified in AIP.

9.9 PHRASEOLOGY

9.9.1 Phraseology Standard

States should use common phraseology for both ADS-B and radar where possible, and should note the requirement for ADS-B specific phraseology in some instances. States shall refer to PANS ATM Chapter 12 for ADS-B phraseology:
ADS-B EQUIPMENT DEGRADATION
ADS-B OUT OF SERVICE (appropriate information as necessary).

TO REQUEST THE CAPABILITY OF THE ADS-B EQUIPMENT

a) ADVISE ADS-B CAPABILITY;
*b) ADS-B TRANSMITTER (data link);
*c) ADS-B RECEIVER (data link);
*d) NEGATIVE ADS-B.
* Denotes pilot transmission.

Note: For (b) and (c) – the options are not available for aircraft that are not equipped.

TO REQUEST RESELECTION OF AIRCRAFT IDENTIFICATION
REENTER FLIGHT IDENTIFICATION.

Note: For some aircraft, this option is not available in-flight

TERMINATION OF RADAR AND/OR ADS-B SERVICE
IDENTIFICATION LOST [reasons] (instructions).

TO REQUEST THE OPERATION OF THE MODE S OR ADS-B IDENT FEATURE
SQUAWK IDENT.

Note: For some standalone ADS-B equipage affecting General Aviation, the option of "TRANSMIT ADS-B IDENT" may be available

TO REQUEST AIRCRAFT SWITCHING TO OTHER TRANSPONDER OR TERMINATION OF ADS-B TRANSMITTER OPERATION
a) SWITCH TO OTHER TRANSPONDER
b) STOP ADS-B TRANSMISSION. SQUAWK (code) ONLY.

Note:
a) In many cases the ADS-B transmitter cannot be operated independently of the SSR transponder and switching off the ADS-B transmission would also switch off the SSR transponder operation

b) "STOP ADS-B TRANSMISSION" applies only to aircraft that have the facility to switch off the ADS-B transmission, while maintaining SSR operation.

9.9.2 Operations of Mode S Transponder and ADS-B

It should be noted that independent operations of Mode S transponder and ADS-B will not be possible in many aircraft (e.g. where ADS-B is solely provided by 1090 MHz extended squitter emitted from the transponder). Additionally, some desirable but optional features of ADS-B transmitters may not be fitted in some aircraft. Controller training on this issue, as it relates to the following examples of radio telephony and/or CPDLC phraseology is recommended.

9.9.2.1 STOP ADSB TRANSMISSION or STOP SQUAWK

Issue: In most commercial aircraft, a common "transponder control head" is used for SSR transponder, ACAS and ADS-B functionality. In this case, a pilot who complies with the instruction to stop operation of one system will also need to stop operation of the other systems – resulting in a loss of surveillance not intended or expected by the controller.

ATC need to be aware that an instruction to "Stop ADS-B Transmission" may require the pilot to switch off their transponder that will then stop all other functions associated with the transponder operations (such as ACARs etc). Pilots need to be aware of their aircraft's equipment limitations, the consequences of complying with this ATC instruction, and be aware of their company policy in regard to this. As with any ATC instruction issued, the pilot should advise ATC if they are unable to comply.

Recommendation: It is recommended that the concatenated phrases STOP ADSB TRANSMISSION, SQUAWK (code) ONLY or STOP SQUAWK, TRANSMIT ADSB ONLY are used. It is recommended that controller training highlights the possible consequences of **issuing** these instructions and that pilot training highlights the consequences of **complying** with this instruction. It is also recommended that aircraft operators have a clearly stated policy on procedures for this situation. Should a pilot respond with UNABLE then the controller should consider alternative solutions to the problem that do not remove the safety defences of the other surveillance technologies. This might include manual changes to flight data, coordination with other controllers and/or change of assigned codes or callsigns.

Very few aircraft provide the capability to turn off ADS-B without turning off TCAS. It is not recommended to switch off ATC transponders (& remove TCAS protection). The only action for most pilots of aircraft transmitting misleading ADS-B data in response to ATC requests is to recycle the transponder, or switch to the alternate transponder as appropriate. Besides, aircraft that do not support ADS-B OFF should have the details included in the flight manual including the undesirability of disabling TCAS.

9.9.2.2 STOP ADSB ALTITUDE TRANSMISSION [WRONG INDICATION or reason] and TRANSMIT ADSB ALTITUDE

Issue: Most aircraft will not have separate control of ADSB altitude transmission. In such cases compliance with the instruction may require the pilot to stop transmission of all ADSB data and/or Mode C altitude – resulting in a loss of surveillance not intended or expected by the controller.

Recommendation: It is recommended that, should the pilot respond with UNABLE, the controller should consider alternative solutions to the problem that do not remove the safety defences of other surveillance data. This might include a procedure that continues the display of incorrect level information but uses pilot reported levels with manual changes to flight data and coordination with other controllers.

9.9.2.3 TRANSMIT ADS-B IDENT

Issue: Some aircraft may not be capable or the ADSB SPI IDENT control may be shared with the SSR SPI IDENT function.

Recommendation: It is recommended that controllers are made aware that some pilots are unable to comply with this instruction. An alternative means of identification that does not rely on the ADSB SPI IDENT function should be used.

9.10 FLIGHT PLANNING

9.10.1 ADS-B Flight Planning Requirement – Flight Identity

The aircraft identification (ACID) must be accurately recorded in section 7 of the ICAO Flight Plan form as per the following instructions:

Aircraft Identification, not exceeding 7 characters is to be entered both in item 7 of the flight plan and replicated exactly when set in the aircraft (for transmission as Flight ID) as follows:
Either,

a) The ICAO three-letter designator for the aircraft operating agency followed by the flight identification (e.g. KLM511, BAW213, JTR25), when:

in radiotelephony the callsign used consists of the ICAO telephony designator for the operating agency followed by the flight identification (e.g. KLM 511, SPEEDBIRD 213, HERBIE 25).

Or,

b) The registration marking of the aircraft (e.g. EIAKO, 4XBCD, OOTEK), when:

1) in radiotelephony the callsign used consists of the registration marking alone (e.g. EIAKO), or preceded by the ICAO telephony designator for the operating agency (e.g. SVENAIR EIAKO),

2) the aircraft is not equipped with radio.

Note 1: No zeros, hyphens, dashes or spaces are to be added when the Aircraft Identification consists of less than 7 characters.

Note 2: Appendix 2 to PANS-ATM refers. ICAO designators and telephony designators for aircraft operating agencies are contained in ICAO Doc 8585.

9.10.2 ADS-B Flight Planning Requirements

9.10.2.1 ICAO Flight Plan Item 10 – Surveillance Equipment and Capabilities

An appropriate ADS-B designator shall be entered in item 10 of the flight plan to indicate that the flight is capable of transmitting ADS-B messages.

These are defined in ICAO DOC 4444 as follows:

B1 ADS-B with dedicated 1090 MHz ADS-B "out" capability

B2 ADS-B with dedicated 1090 MHz ADS-B "out" and "in" capability
U1 ADS-B "out" capability using UAT
U2 ADS-B "out" and "in" capability using UAT
V1 ADS-B "out" capability using VDL Mode 4
V2 ADS-B "out" and "in" capability using VDL Mode 4

During the ADS-B SITF/13 meeting held in April 2014, clarification of the B1 and B2 descriptors was recommended as follows. This will be progressed for change to ICAO DOC 4444, but may take some time for formal adoption:

B1 ADS-B "out" capability using 1090 MHz extended squitter
B2 ADS-B "out" and "in" capability using 1090 MHz extended squitter

States should consider use of the revised descriptors in AIP.

9.10.2.2 ICAO Flight Plan Item 18 – Other Information

Where required by the appropriate authority the ICAO Aircraft Address (24 Bit Code) may be recorded in Item 18 of the ICAO flight plan, in hexadecimal format as per the following example:

CODE/7C432B

States should note that use of hexadecimal code may be prone to human error and is less flexible in regard to airframe changes for a notified flight.

9.10.2.3 Transponder Capabilities

When an aircraft is equipped with a mode S transponder, that transmits ADS-B messages, according to ICAO Doc 4444, an appropriate Mode S designator should also be entered in item 10; i.e.: either s

- E Transponder — Mode S, including aircraft identification, pressure-altitude and extended squitter (ADS-B) capability, or
- L Transponder — Mode S, including aircraft identification, pressure-altitude, extended squitter (ADS-B) and enhanced surveillance capability.

During the ADS-B SITF/13 meeting held in April 2014, clarification of the E and L descriptors was recommended as follows. This will be progressed for change to ICAO DOC 4444, but may take some time for formal adoption:

- E Transponder — Mode S, including aircraft identification, pressure-altitude and ADS-B capability, or
- L Transponder — Mode S, including aircraft identification, pressure-altitude, ADS-B and enhanced surveillance capability.

States should consider use of the revised descriptors in AIP.

9.10.2.4 Inconsistency between ADS-B Flight Planning and Surveillance Capability

Inconsistency between flight planning of ADS-B and surveillance capability of an aircraft can impact on ATC planning and situational awareness. States are encouraged to monitor for consistency between flight plan indicators and actual surveillance capability. Where discrepancies are identified, aircraft operators should be contacted and instructed to correct flight plans, or

general advice (as appropriate to the operational environment and type of flight planning problems) should be issued to aircraft operators. An example of such advice is provided at Appendix 4.

9.10.3 Setting Aircraft Identification (Flight ID) in Cockpits

(a) Flight ID Principles
The aircraft identification (sometimes called the flight identification or FLTID) is the equivalent of the aircraft callsign and is used in both ADS-B and Mode S SSR technology. Up to seven characters long, it is usually set in airline aircraft by the flight crew via a cockpit interface. It enables air traffic controllers to identify and aircraft on a display and to correlate a radar or ADS-B track with the flight plan date. Aircraft identification is critical, so it must be entered carefully. Punching in the wrong characters can lead to ATC confusing once aircraft with another.

It is important that the identification exactly matches the aircraft identification (ACID) entered in the flight notification.

Intuitive correlation between an aircraft's identification and radio callsign enhances situational awareness and communication. Airline aircraft typically use a three letter ICAO airline code used in flight plans, NOT the two letter IATA codes.

(b) Setting Flight ID
The callsign dictates the applicable option below for setting ADS-B or Mode S Flight ID:

(i) the flight number using the ICAO three-letter designator for the aircraft operator if a flight number callsign is being used (e.g. QFA1 for Qantas 1, THA54 for Thai 54).

(ii) the nationality and registration mark (without hyphen) of the aircraft if the callsign is the full version of the registration (e.g .VHABC for international operations).

(iii) The registration mark alone of the aircraft if the callsign is the abbreviated version of the registration (eg ABC for domestic operations).

(iv) The designator corresponding to a particular callsign approved by the ANSP or regulator (e.g. SPTR13 for firespotter 3).

(v) The designator corresponding to a particular callsign in accordance with the operations manual of the relevant recreational aircraft administrative organization (e.g. G123 for Gyroplane 123).

9.11 PROCEDURES TO HANDLE NON-COMPLANT ADS-B AIRCAFT OR MIS-LEADING ADS-B TRANSMISSIONS

ADS-B technology is increasingly being adopted by States in the Asia/Pacific Region. Asia/Pacific Region adopted 1090 extended squitter technology. Reliance on ADS-B transmissions can be expected to increase over the coming years.

Currently a number of aircraft are transmitting ADS-B data which is misleading or non-compliant with the ICAO standards specified in Annex 10. Examples include:

a) aircraft broadcasting incorrect message formats;

b) aircraft broadcasting inertial positional data and occasionally indicating in the messages that the data has high integrity when it does not;

c) using GPS sources that do not generate correct integrity data, whilst indicating in the messages that the data has high integrity;

d) transmitting ADS-B data with changing (and incorrect) flight identity; and

e) transmitting ADS-B data with incorrect flight identity continuously.

If the benefits of ADS-B are to flow to the aviation industry, misleading and non-compliant ADS-B transmissions need to be curtailed to the extent possible.

The transmission of a value of zero for the NUCp or the NIC or the NAC or the SIL by an aircraft indicates a navigational uncertainty related to the position of the aircraft or a navigation integrity issue that is too significant to be used by air traffic controllers.

As such, the following procedure, stipulated in the Regional Supplementary Procedures Doc 7030, shall be applicable in the concerned FIRs on commencement of ADS-B based surveillance services notified by AIP or NOTAM:

If an aircraft operates within an FIR where ADS-B-based ATS surveillance service is provided, and

a) carries 1090 extended squitter ADS-B transmitting equipment which does not comply with one of the following:

   1) EASA AMC 20-24; or
   2) the equipment configuration standards in Appendix XI of Civil Aviation Order 20.18 of the Civil Aviation Safety Authority of Australia; or
   3) installation in accordance with the FAA AC No. 20-165 – Airworthiness Approval of ADS-B; or

b) the aircraft ADS-B transmitting equipment becomes unserviceable resulting in the aircraft transmitting misleading information;

then:

a) except when specifically authorized by the appropriate ATS authority, the aircraft shall not fly unless the equipment is:

   1) deactivated; or
   2) transmits only a value of zero for the NUCp or NIC or NAC or SIL

States may elect to implement a scheme to blacklist those non-compliant aircraft or aircraft consistently transmitting mis-leading ADS-B information, so as to refrain the aircraft from being displayed to ATC.

A sample template is given below for reference by States to publish the procedures to handle non-compliant ADS-B aircraft or misleading ADS-B transmissions in their ADS-B mandate/regulations:

After <insert earliest date that ADS-B may be used for any relevant operational purpose> if an aircraft carries ADS-B transmitting equipment which does no comply with :

(a) EASA AMC 20-24; or

(b) the equivalent configuration standards in Appendix XI of Civil Aviation Order 20.18 of the Civil Aviation Safety Authority of Australia; or

(c) Installation in accordance with the FAA AC No. 20-165 – Airworthiness Approval of ADS-B;

or the aircraft ADS-B transmitting equipment becomes unserviceable resulting in the aircraft transmitting misleading information;

the aircraft must not fly unless equipment is:

(a) deactivated; or

(b) set to transmit only a value of zero for the NUCp or NIC or NAC or SIL.

Note:

1. It is considered equivalent to deactivation if NUCp or NIC or NAC or SIL is set to continually transmit only a value of zero.

2. Regulators should take appropriate action to ensure that such regulations are complied with.

3. ATC systems should discard ADS-B data when NUC or NIC or NAC or SIL =0.

9.12 EMERGENCY PROCEDURES

ATC surveillance systems should provide for the display of safety-related alerts and warnings, including conflict alert, minimum safe altitude warning, conflict prediction and unintentionally duplicated SSR codes and aircraft identifications.

The ADS-B avionics may transmit emergency status messages to any ADS-B ground station within coverage. The controller receiving these messages should determine the nature of the emergency, acknowledge receipt if appropriate, and initiate any assistance required. An aircraft equipped with ADS-B might operate the emergency and/or urgency mode as follows:

a) emergency;
b) no communications;
c) unlawful interference;
d) minimum fuel; and/or
e) medical.

Selection of an emergency transponder code (e.g. 7600) automatically generates an emergency indication in the ADS-B message. However, some ADS-B transponders may only generate a generic emergency indication. That means, the specific type of emergency, e.g., communication failure, is not always conveyed to the controller in an ADS-B environment. The controller may only receive a generic emergency indication irrespective of the emergency codes being selected by the pilot.

Due to limitations of some ADS-B transponders, procedures should be developed for ATC to confirm the types of emergency with pilots based on operational needs of States.

Executive control responsibility

The responsibility for control of the flight rests with the ATSU within whose airspace the aircraft is operating. However, if the pilot takes action contrary to a clearance that has already been coordinated with another sector or ATSU and further coordination is not possible in the time available, the responsibility for this action would rest with the pilot in command, and performed under the pilot's emergency authority.

Emergency procedures

The various circumstances surrounding each emergency situation preclude the establishment of exact detailed procedures to be followed. The procedures outlined in PANS-ATM Chapter 15 provide a general guide to air traffic services personnel and where necessary, should be adapted for the use of ADS-B.

10. SECURITY ISSUES ASSOCIATED WITH ADS-B

10.1 INTRODUCTION

ADS-B technologies are currently "open systems" and the openness is an essential component of successful use of ADS-B. It was also noted that ADS-B transmission from commercial aircraft is a "fact of life" today. Many commercial aircraft are already equipped with ADS-B and have been transmitting data for some time.

It was noted that there has been considerable alarmist publicity regarding ADS-B security. To a large extent, this publicity has not considered the nature and complexity of ATC. Careful assessment of security policies in use today for ADS-B and other technologies can provide a more balanced view.

10.2 CONSIDERATIONS

A list of ADS-B vulnerabilities categorised into threats to Confidentiality, Integrity and Availability has been reviewed and documented into the guidance material on security issues associated with ADS-B provided on the ICAO APAC website "http://www.icao.int/APAC/Pages/edocs.aspx" under "Restricted Site" for reference by States. States could contact ICAO Regional Office to get access to the guidance material. The following recommendations are made to States :

(a) While ADS-B is recognized as a key enabling technology for aviation with potential safety benefits, it is recommended that States made aware of possible ADS-B security specific issues;

(b) It is recommended that States note that much of the discussion of ADS-B issues in the Press has not considered the complete picture regarding the ATC use of surveillance data;

(c) For current ADS-B technology implementation, security risk assessment studies should be made in coordination with appropriate national organisations and ANSPs to address appropriate mitigation applicable in each operational environment, in accordance with ATM interoperability requirements; and

(d) Future development of ADS-B technology, as planned in the SESAR master plan for example, should address security issues. Studies should be made to identify potential encryption and authentication techniques, taking into consideration the operational need of air to ground and air to air surveillance applications. Distribution of encryption keys to a large number of ADS-B receivers is likely to be problematic and solutions in the near and medium term are not considered likely to be deployed worldwide. Internet based encryption strategies are not deployable when ground stations are pass receivers.

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Guidance Materials on Monitoring and Analysis of ADS-B Avionics Performance

1. Introduction

1.1 The APANPIRG has endorsed the following Conclusion during its 24th Meeting to encourage States/Administration to exchange their ADS-B performance monitoring results and experience gained from the process :

Conclusion 24/45 - Exchange ADS-B Performance Monitoring Result
"That, States be encouraged to exchange findings/result of their ADS-B performance monitoring including experience gained in conducting the required performance monitoring."

1.2 Since the ADS-B mandate for some airspace in the Region became effective in December 2013, monitoring and analysis on avionics performance of ADS-B equipped aircraft has become an increasingly important task for concerned States. The APANPIRG has also requested and the ICAO has agreed to support establishing a centralized database to be hosted by the ICAO Regional Sub-office (RSO) for sharing the monitoring results in order to enhance safety for the Region. The specification for the database and relevant access procedures are being developed by the ADS-B Study and Implementation Task Force, and will be shared with States in due course.

1.3 This document serves to provide guidance materials on monitoring and analysis of avionics performance of ADS-B equipped aircraft, which is based on the experience gained by States.

2. Problem Reporting and Feedback

2.1 For ADS-B avionics problems, it is critical that an appropriate reporting and feedback mechanism be established. It is highly desirable that those discovering the problems should report them to the appropriate parties to take action, such as study and analyse the problems, identify the root causes, and rectify them. Those action parties include :-

(a) Air Navigation Service Providers (ANSPs) – upon detection of any unacceptable ADS-B reports from an aircraft, report the observed problem to the performance monitoring agent(s), if any, and the Aircraft Operators for investigation. In addition, ANSPs should take all actions to avoid using the ADS-B reports from the aircraft until the problem is rectified (e.g. black listing the aircraft), if usage of such reports could compromise safety.
(b) Regulators – to initiate any appropriate regulatory action or enforcement.
(c) Aircraft Operators – to allow avionics specialists to examine the causes and as customers of the avionics manufacturers ensure that corrective action will take place.

(d) Avionics Manufacturers and Aircraft Manufacturers – to provide technical evidence and knowledge about the problem and problem rectification

2.2 Incentives should be received by those parties acting on the problems including :-

(a) Regulations that require deficiencies to be rectified
(b) Regulatory enforcement
(c) Consequences if conduct of operations with problematic equipment (e.g. no access to the airspace requiring healthy equipment)

2.3 When an ADS-B avionics problem is reported, it should come along with adequate details about the problem nature to the action parties. In addition, the problem should be properly categorised, so that appropriate parties could diagnose and rectify them systematically.

3. Problem Categorisation

3.1 Regarding ADS-B avionics, their problems are quite diversified in the Region but can be categorized to ensure they will be examined and tackled systematically.

3.2 Based on the experience gained from States, the common ADS-B avionics problems in the Region are summarized under different categories in Attachment A. It is noted that only a relatively minor portion of the aircraft population exhibits these problems. It must be emphasized that aircraft transmitting incorrect positional data with NUC = 0 or NIC = 0 should not be considered a safety problem. The data transmitted have no integrity and shall not be used by ATC. This situation exists for many aircraft when their GNSS receivers are not connected to the transponders.

4. Managing the Problem

4.1 There are two major approaches to manage the problems :-

(a) Regulatory approach
Regulations which require non-approved avionics to disable ADS-B transmission (or transmit "no integrity"), and the concerned operators to file flight plans to indicate no ADS-B equipage. APANPIRG has endorsed this approach which is reflected in the Regional Supplementary Procedures (Doc 7030).

(b) Blacklist approach
Filtering out ("black listing") any airframes that do not comply with the regulations or transmitting bad data, and advising the regulator of the non-compliance. This approach is temporary which allows the ANSP to protect the system whilst regulatory action is underway.

5. Systematic Monitoring and Analysis of the Problem

States using ADS-B should have in place systematic ways to identify and manage ADS-B deficiencies similar to that described below :-

5.1 Reporting Deficiencies

States using ADS-B should have in place systematic ways to identify ADS-B deficiencies including :-

(a) Systematic capture of ATC reported events and engineering detected events into a database; and
(b) Manual or automatic detection of anomalous avionics behavior independent from controller reports

5.1.1 ATC Reported Deficiencies

ATC procedures should exist that allow services to continue to be provided safety, as well as to capture relevant information for later analysis. This should include :-

(a) ATC request for the pilot to select the alternate transponder; and
(b) ATC to adequately record the circumstances including Flight ID, ICAO Aircraft Address (if readily available) accurate time, Flight plan, and pilot provided information.

5.1.2 Non ATC reported deficiencies

5.1.2.1 Where capability is available, States should also identify non ATC reported deficiencies.

5.1.2.2 Without overlapping radar coverage: ADS-B data may be examined for the following :-

(a) NUC of each ADS-B reported position is smaller than required for service delivery for more than 5% of total number of ADS-B updates;
(b) NIC, NAC, SIL are smaller than required for service delivery for more than 5% of total number of ADS-B updates;
(c) ICAO Aircraft Address (i.e. I021/080) is inconsistent with the flight planned registration (REG) based on each state's ICAO Aircraft Address allocation methodology;
(d) Flight ID entered via cockpit interface and downlinked in ADS-B data (i.e. I021/170 in Asterix CAT 21) is a mismatch[1] with aircraft callsign in the ATS Flight Plan;
(e) Inconsistent vertical rate compared to flight level change; and
(f) Inconsistency of position reports and presence of "jumps.

[1] A missing Flight ID, or a Flight ID with only "spaces" should not be considered a mismatch.

5.1.2.3 Overlapping radar coverage: For States that have overlapping radar coverage, a systematic means to monitor and analyze ADS-B could be considered in addition to relying on ATC to report the problem, or utilising the evaluation criteria in 5.1.2.2 above. This can be achieved by comparing radar information with ADS-B reported position, velocity, flight level and vertical rate change data as well as examining the ADS-B quality indicators and Flight Identification (FLTID) contained in the ADS-B reports.

For each ADS-B flight, its ADS-B data could be compared with its corresponding radar information. For example, this would allow analysis to determine if the following pre-defined criteria are met :-

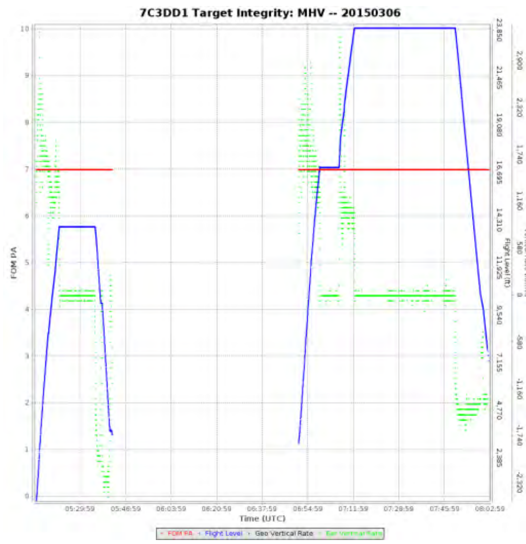
(a) Deviation between ADS-B reported position and independent referenced radar position is greater than 1NM[2], with the indication of good positional quality in the quality indicators for more than 5% of total number ADS-B updates. A sample screen shot of a system performing the analysis automatically is given at Attachment B for reference.

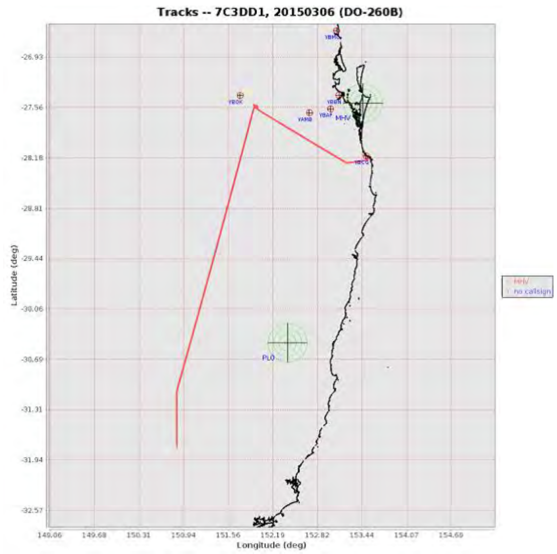
5.2 Managing and Processing Deficiencies

Whether detected by ATC or not, all deficiencies should trigger:

(a) Systematic recording of the details of each occurrence such as date/time of occurrence, ICAO aircraft address and flight plan information should be obtained. Graphical representations such as screen capture of radar and ADS-B history tracks, graphs of NUC/NIC value changes versus time and deviation between radar and ADS-B tracks along the flight journey would be desirable. Examples of typical graphical representations are shown below :-

[2] For example, the deviation between ADS-B and radar tracks could be set to 1NM in accordance with ICAO Circular 326 defining position integrity (0.5NM < HPL < 1NM) for 3NM aircraft separation use, on assumption that radar targets are close to actual aircraft position. The values of ADS-B quality indicators (NUC, NAC, SIL, NIC) could be chosen based on the definition in ICAO Circular 326 on Position Accuracy and Position Integrity for 3NM aircraft separation minimum. A threshold of 5% is initially set to exclude aircraft only exhibiting occasional problems during their flight journey. The above criteria should be made configurable to allow fine-turning in future. Evaluation of ADS-B vs radar may alternatively expose radar calibration issues requiring further investigation.





(b) Systematic technical analysis of each detected issue using ADS-B recorded data, to ensure that all detected issues are examined and addressed. Typically this will need:

- systems to record ADS-B data, replay ADS-B data and analyze ADS-B data
- staff and procedures to analyze each report
- A database system to manage the status of each event and to store the results of each analysis

(c) Procedures to support engagement with operators (domestic & foreign), regulators, other ANSPs, Airframe OEMs and avionics vendors to ensure that each issue is investigated adequately and maximize the probability that the root cause of the event is determined. The procedures could include :-

- Data collection procedures;
- Telephone & email contact details; and
- Mechanisms for reporting, as appropriate, to the Asia Pacific ADS-B Avionics Problem Reporting Database (APRD)

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Attachment A – List of known ADS-B avionics problems

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
1.	Track Jumping problem with Rockwell Collins TPR901 (See Figure1)	Software issue with TPR901 transponder initially only affecting Boeing aircraft. Does not occur in all aircraft with this transponder. Subsequent investigation by Rockwell Collins has found that the particular transponder, common to all of the aircraft where the position jumps had been observed, had an issue when crossing ±180 degrees longitude. On some crossings (10% probability), errors are introduced into the position longitude before encoding. These errors are not self-correcting and can only be removed by a power reset of the transponder. The problem, once triggered can last days, since many transponders are not routinely powered down.	**Yes.** Will present as a few wild/large positional jumps. Nearly all reports are tagged as low quality (NUC=0) and are discarded, however, some occasional non zero reports get through. Problem is very "obvious". Could result in incorrect longitudinal position of Flight Data Record track. Can trigger RAM alerts.	Rockwell Collins has successfully introduced a Service Bulletin that solves the problem in Boeing aircraft. The problem is known to exist on Airbus aircraft. Rockwell has advised that a solution ~~will not be available in the near future because of their commitment to~~is available in their DO260B ~~development~~upgrade. Rockwell Collins may not have a fix for some time. Workaround solutions are being examined by Airbus, Operators and Airservices Australia. The only workaround identified at this time is to power down the transponders before flight to states using ADS-B – after crossing longitude 180. It can be noted that in Airbus aircraft it is not possible to safely power down the transponder in flight. Airbus have prepared a procedure to support power down before flight. Airservices Australia have negotiated with 2 airlines to enact this procedure prior to flights to Australia.

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
				An additional partial workaround is : to ensure that procedures exist for ATC to ask the pilot to changeover transponders if the problem is observed. Since there is a 10% chance of the problem occurring on each crossing of ±180 degrees longitude, the chance that both transponders being affected is 1%. There is no complete workaround available for flights that operate across 180 degrees longitude directly to destination without replacing the transponder. Airbus advised that a new TPR901 transponder compliant with DO260B ~~will be available in 2014~~is available from December 2015. This new transponder ~~will~~ does not ~~exhibit~~ have ~~the~~ such problem.
2.	Rockwell Collins TDR94 Old version. The pattern of erroneous positional data is very distinctive of the problem. (See Figure 2)	Old software typically before version -108. The design was completed before the ADS-B standards were established and the message definitions are different to the current DO260. Rockwell has recommended that ADS-B be disabled on these models.	**Yes.** Will present as a few wild positional jumps. Nearly all reports are tagged as low quality (NUC=0) and are discarded, however, some occasional non zero reports get through. Also causes incorrect altitude reports. Problem is very "obvious".	Problem well known. Particularly affects Gulfstream aircraft which unfortunately leave the factory with ADS-B enabled from this transponder model. Rockwell has issued a service bulletin recommending that ADS-B be disabled for aircraft with this transponder software. See Service Information Letter 1-05 July 19, 2005. It is easy to disable the

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
				transmission. If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.
3.	Litton GPS with proper RAIM processing	Litton GNSSU (GPS) Mark 1 design problem. (Does not apply to Litton Mark II). GPS does not output correct messages to transponder.	**No.** Perceived GPS integrity changes seemingly randomly. With the GPS satellite constellation working properly, the position data is good. However the reported integrity is inconsistent and hence the data is sometimes/often discarded by the ATC system. The effected is perceived extremely poor "coverage". The data is not properly "protected" against erroneous satellite ranging signals – although this cannot be "seen" by ATC unless there is a rare satellite problem.	This GPS is installed in some older, typically Airbus, fleets. Data appears "Correct" but integrity value can vary. Performance under "bad" satellite conditions is a problem. Correction involves replacing the GNSSU (GPS) which is expensive. If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.
4.	SIL programming error for DO260A avionics	Installers of ADS-B avionics using the newer DO260A standard mis program "SIL". a) This problem appears for DO260A transponders, with SIL incorrectly set to 0 or 1 (instead of 2 or 3)	**No.** First report of detection appears good (and is good), all subsequent reports not displayed because the data quality is perceived as "bad" by the ATC system. Operational effect is effectively no ADS-B data. Hence no risk.	Would NOT be included in a "black list". Aircraft with "Dynon avionics" exhibit this behavior. They do not have a certified GPS and hence always set SIL = 0. This is actually correct but hence they do not get treated as ADS-B equipped.

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
		b) As the aircraft enters coverage, the ADS-B ground station correctly assumes DO260 until it receives the version number. c) The transmitted NIC (DO260A) is interpreted as a good NUC (DO260) value, because no SIL message has yet been received. The data is presented to ATC.		
5.	Garmin "N" Flight ID problem (See Figure 3)	Installers of Garmin transponder incorrectly set "Callsign"/Flight ID. This is caused by poor human factors and design that assumes that GA aircraft are US registered.	**Yes.** Flight ID appears as "N". Inhibits proper coupling.	Can be corrected by installer manipulation of front panel. Does not warrant "black list" activity.
6.	Flight ID corruption issue 1 – trailing "U" Flight ID's received : GT615, T615U ,NEB033, NEB033U, QF7550, QF7550U, QF7583, QF7583U, QF7585, QF7585, QF7585U, QF7594, QFA7521, QFA7531, QFA7531, QFA7531U, QFA7532, QFA7532U, QFA7532W,	TPR901 software problem interfacing with Flight ID source. Results in constantly changing Flight ID with some reports having an extra "U" character.	**Yes.** Flight ID changes during flight inhibits proper coupling or causes decoupling.	Affects mainly B747 aircraft. Boeing SB is available for Rockwell transponders and B744 aircraft. Rockwell Collins have SB 503 which upgrades faulty -003 transponder to -005 standard. If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
	QFA7550, QFA7552, QFA7581			
7.	Flight ID corruption issue 2	ACSS software problem results in constantly changing Flight ID. Applies to ACSS XS950 transponder Pn 7517800-110006 and Honeywell FMC (pn 4052508 952). ACSS fix was available in Sept 2007.	**Yes.** Flight ID changes during flight inhibits proper coupling or causes decoupling.	Software upgrade available. If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.
8.	No Flight ID transmitted	Various causes	**No.** Flight ID not available. Inhibits proper coupling.	Aircraft could "fail to couple with Flight Data Record". Not strictly misleading – but could cause controller distraction.
9.	ACSS Transponder 10005/6 without Mod A reports NUC based on HFOM.		**Yes.** Appears good in all respects until there is a satellite constellation problem (not normally detectable by ground systems).	Not approved and hence not compliant with CASA regulations. If known could be added to black list. Configuration is not permitted by regulation.
10.	Occasional small position jump backwards (See Figure 4)	For some older Airbus aircraft, an occasional report may exhibit a small "jump back" of less than 0.1 nm Root cause not known	**No.** Not detectable in ATC due to extrapolation, use of latest data and screen ranges used.	ATC ground system processing can eliminate these.
11.	Older ACSS transponders	Design error reports integrity	**No.**	Can be treated in the same manner as

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
	report integrity too conservatively	one value worse than reality	In poor GPS geometry cases the ATC system could discard the data when the data is in fact useable. Will be perceived as loss of ADS-B data.	a loss of transponder capability.
12.	Intermittent wiring GPS transponder	ADS-B transmissions switch intermittently between INS position and GPS position.	**Yes.** Normally the integrity data goes to zero when INS is broadcast, but sometimes during transition between INS and GPS, an INS position or two can be broadcast with "good" NUC value. Disturbing small positional jump.	If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.
13.	Wrong 24 bit code	Installation error	**No.** No direct ATC impact unless a rare duplicate is detected.	This is not a direct ADS-B problem, but relates to a Mode S transponder issue that can put TCAS at risk. Cannot be fixed by black list entry. Needs to be passed to regulator for resolution.
14.	Toggling between high and low NUC (See Figure 5)	Faulty GPS receiver/ADS-B transponder	**No.** ATC will see tracks appear and disappear discretely. No safety implications to ATC.	While it is normal for NUC value to switch between a high and low figure based on the geometry of GPS satellites available, it is of the view that more should be done to examine this phenomenon. It is observed that such switching between high and low

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
				NUC occurs on certain airframe and not on others. The issue was raised to the airlines so as to get a better understanding. On one occasion, the airline replied that a module on their GPS receiver was faulty. On another occasion, the airline replied that one of the ADS-B transponder was faulty. Good NUC was transmitted when the working transponder was in use and poor NUC was transmitted when the faulty ADS-B transponder was in use.
15.	Consistent Low NUC (See Figure 6)	GNSS receivers are not connected to the ADS-B transponders.	**No.** Data shall be filtered out by the system and not detectable in ATC	Not considered a safety problem but a common phenomenon in the Region – the concerned aircraft will be treated equivalent to "aircraft not equipped with ADS-B". While it is normal for aircraft to transmit low NUC, it is of the view that "consistent low NUC' could be due to the avionics problem (e.g. GNSS receiver is not connected to the ADS-B transponder). It is recognised that operators may not be aware that their aircraft are transmitting unexpected low NUC / NIC values, due to equipment malfunction. Hence, it is desirable for States to inform the operators

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
				when unexpected low NUC values are transmitted, where practicable. Concerned airline operators are required to take early remedial actions. Otherwise, their aircraft will be treated as if non-ADS-B equipped which will be requested to fly outside the ADS-B airspace after the ADS-B mandate becomes effective.
16.	ADS-B position report with good integrity (i.e. NUC >= "4") but ADS-B position data are actually bad as compared with radar (met criteria 5.2(a))	Faulty ADS-B avionics	**Yes.** As the ground system could not "automatically" discard ADS-B data with good integrity (i.e. NUC value >=4), there could be safety implications to ATC.	The problem should be immediately reported to the concerned CAA/operators for problem diagnosis including digging out the root causes, avionics/GPS types etc., and ensure problem rectification before the ADS-B data could be used by ATC. Consider to "blacklist" the aircraft before the problem is rectified.
17.	FLTID transmitted by ADS-B aircraft does not match with callsign in flight plan (see Figures 7a – 7d)	Human errors	**Yes.** Could lead to screen clutter - two target labels with different IDs (one for radar and another for ADS-B) being displayed, causing potential confusion and safety implications to ATC.	Issue regulations/letters to concerned operators urging them to set FLTID exactly match with callsign in flight plan.

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
18	B787 position error with good NUC	Software issue - surveillance system inappropriately "coasts" the position when data received by the transponder is split across multiple messages. System seems to self correct after some time. Can be corrected by surveillance system power off.	**Yes.** Misleading position presentation which is typically detected by ATC observing aircraft "off track" when in fact it is "on-track".	In December 2015, Boeing and Rockwell Collins released the DO-260B upgrade for the B787 fleet which fixes the extrapolation issue as well as adding DO-260B support to the airframe. Service Bulletin with no cost has been issued by Boeing to encourage operator to accomplish the update as soon as possible. In addition, 787 Type Certification has been amended to include the software upgrade. The upgraded ADS-B Out function is compliant with FAA AC 20-165A, EASA CS-ACNS Subpart D (Surveillance) and TSO-C166b. ~~Problem identified and fix will be provided by Boeing at the same time as the availability of DO260B upgrade – late 2015.~~
19	A number of airlines have reported or experienced ADS-B outages for complete flight sectors in A330 aircraft. Appears as	Being actively investigated. One airline has implemented on-board recording which confirms that the MMRs are not providing HIL/HPL to	**No.** Equivalent to a failed transponder.	Aircraft must be managed procedurally if outside radar coverage.

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
	low reliability ADS-B and has afflicted both A & B side at same time.	the transponder whilst continuing to provide HFOM, GPS alt etc		
20	A380 flight ID lost after landing	For the A380 fleet, it has been confirmed that for some seconds after landing, the flight ID is set as invalid by FMS to AESS. Consequently, the current AESS design uses, as per design, the Aircraft Registration Number as a back-up source for A/C flight identification field in ADS-B broadcast messages.	**No.**	The correction to this logic is planned for next AESS standard release; planned for 2017.". Only a problem for arriving aircraft on surface surveillance systems.

Figure 1 - Track Jumping problem with TPR901

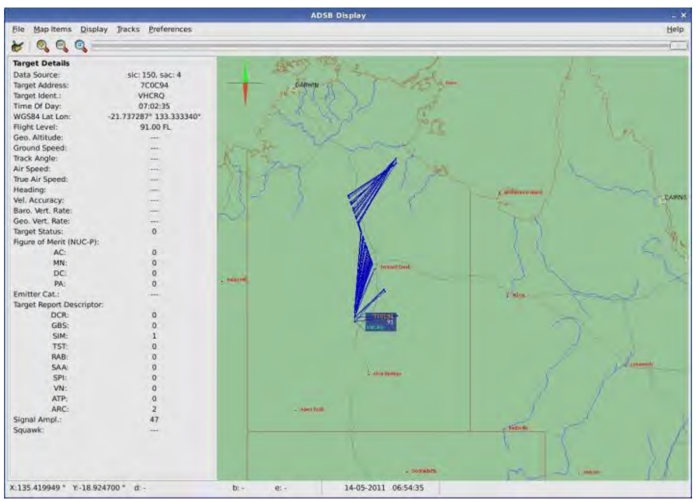


Figure 2 - Rockwell Collins TDR94 Old version. The pattern of erroneous positional data is very distinctive of the problem

Figure 3 - Garmin "N" Flight ID problem

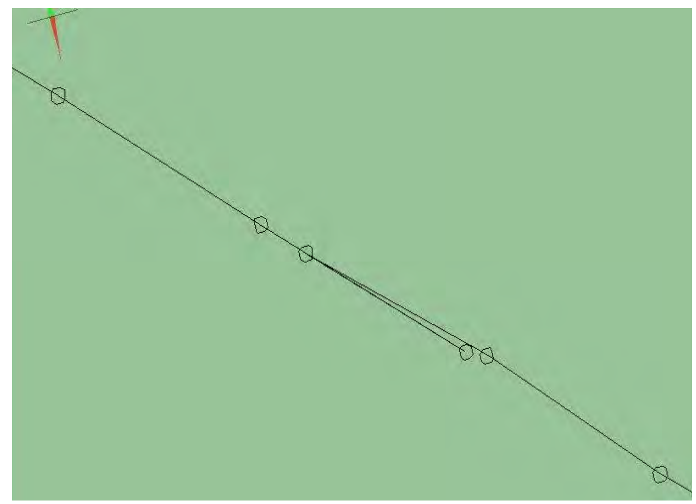


Figure 4 - Occasional small position jump backwards

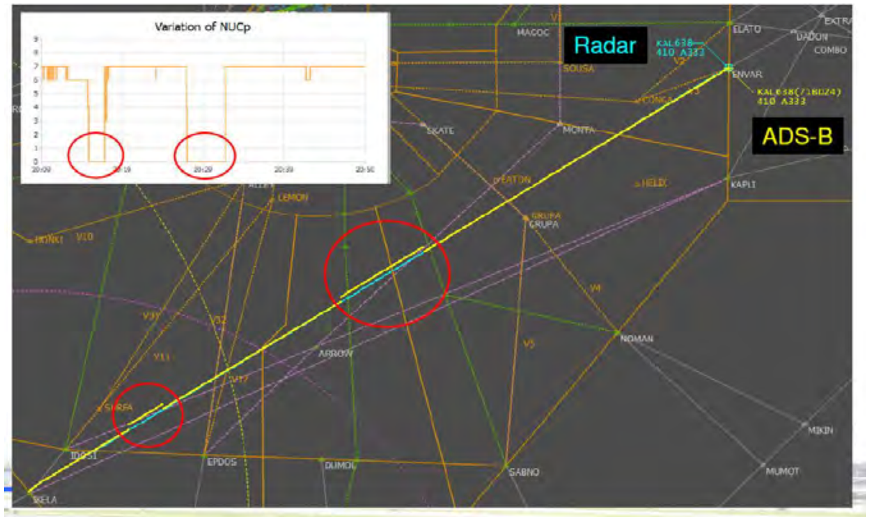


Figure 5 - NUC value toggling

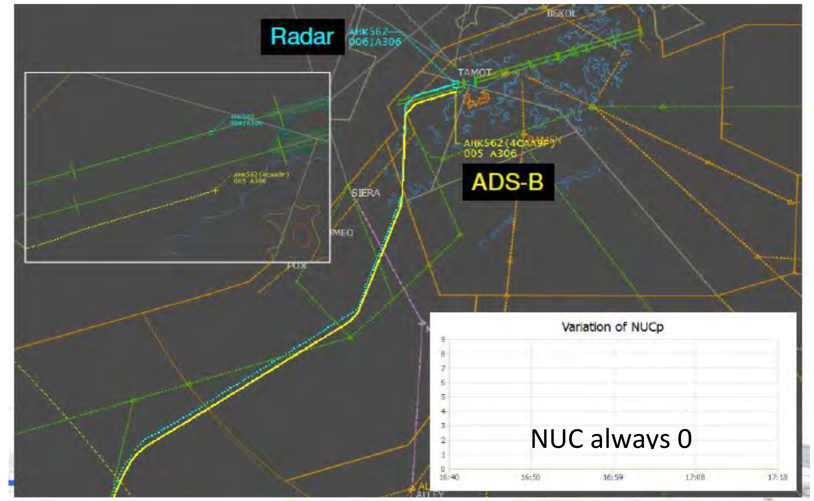


Figure 6 – Consistent low NUC

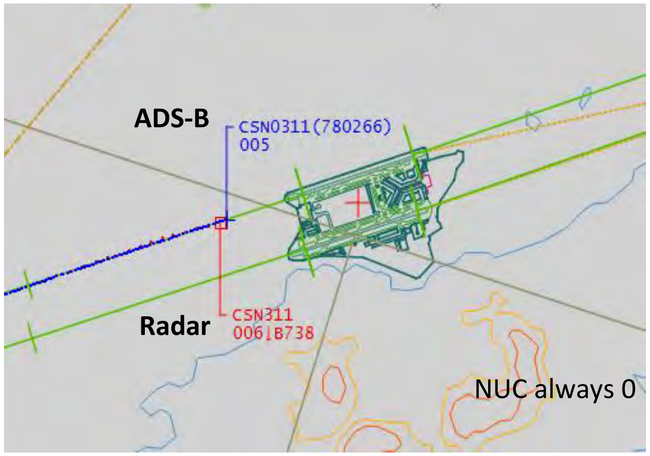


Figure 7a - Additional zero inserted

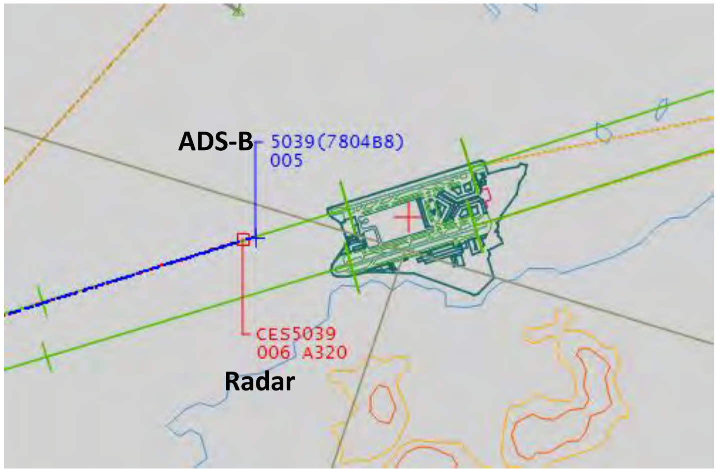


Figure 7b - ICAO Airline Designator Code dropped

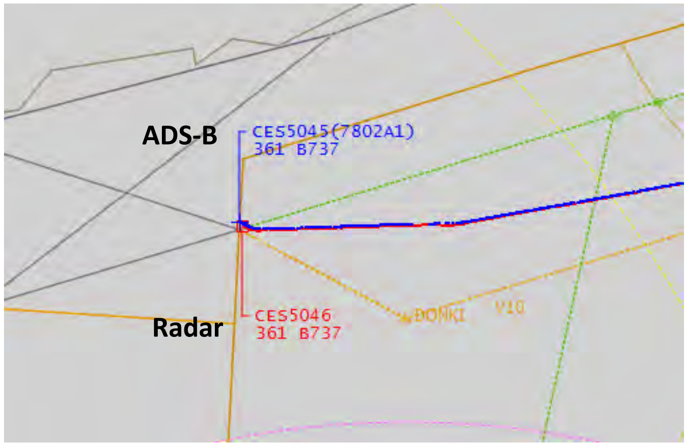


Figure 7c - Wrong numerical codes entered

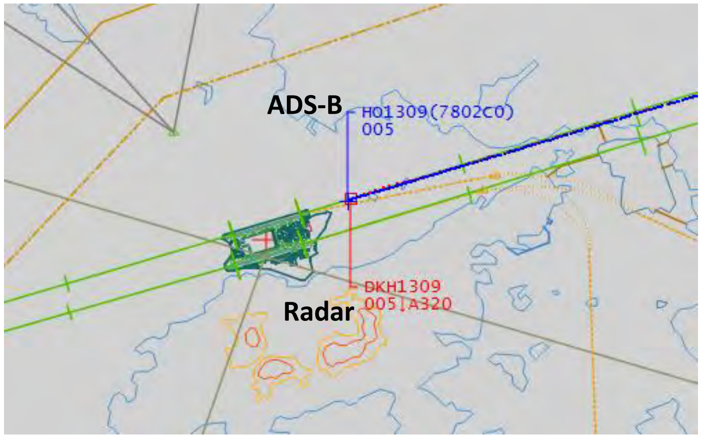
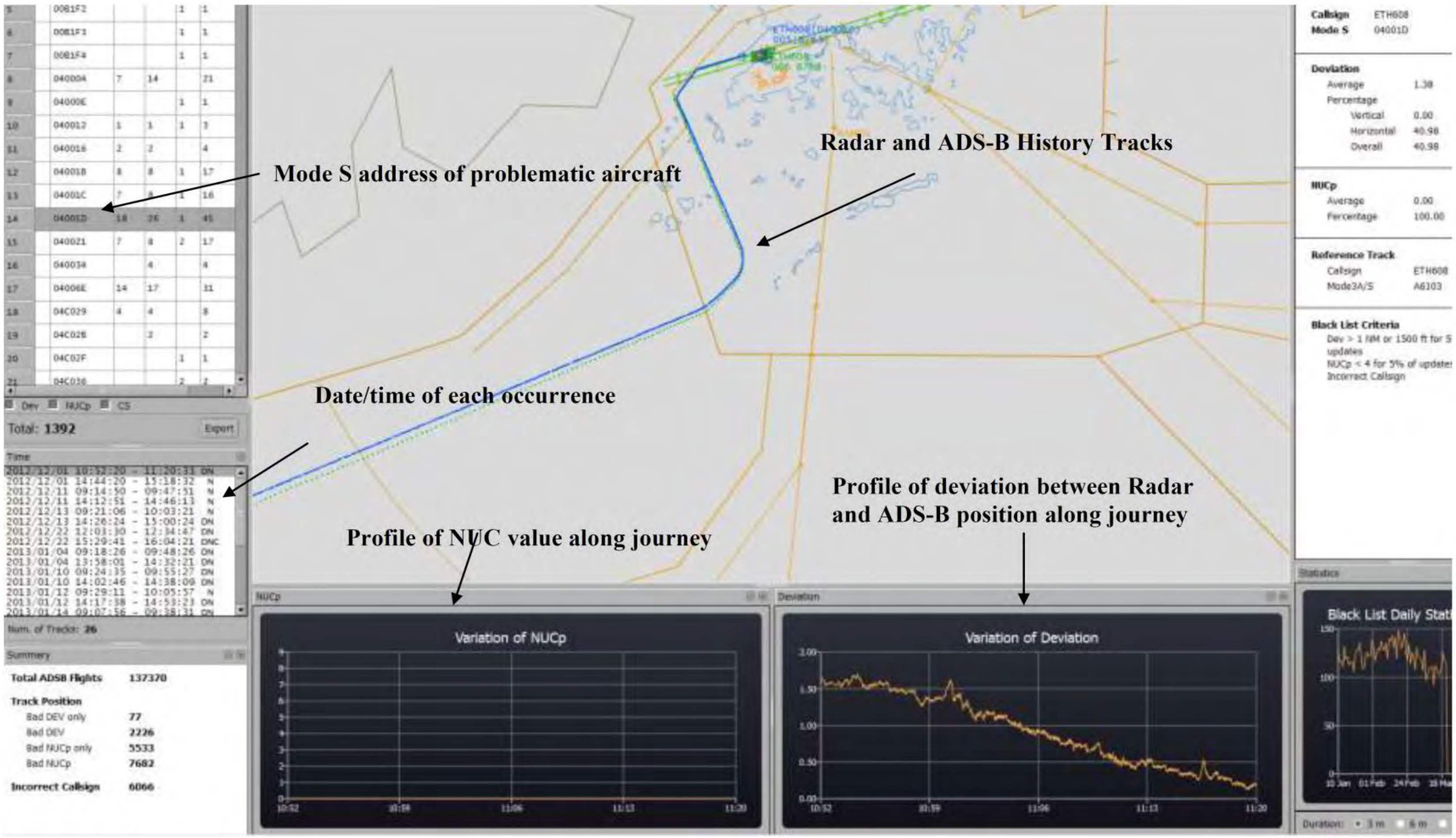


Figure 7d - IATA Airline Designator Code used

Attachment B - Sample screen shot of a system to monitor and analyse performance of ADS-B avionics



Checklist of Common Items or Parameters for the Monitoring of ADS-B System

1. ADS-B Ground Station

Site Monitoring

- Receiver Sensitivity
- Antenna Cable
- GPS Health
- Coverage Check
- Probability of Detection
- Station Service Availability
- Receiver Status

Remote Control & Monitoring (RCMS)

- CPU Process Operation
- Temperature
- ASTERIX Output Load
- Time Synchronization
- GPS Status
- Power Status
- Site Monitor Status
- Memory Usage
- Software Version (Operating System and RCMS Application)

Logistic Support Monitoring

- Record all failures, service outage and repair/return to service times

2. ADS-B Equipage Monitoring

- Update and maintain list of ADS-B equipped airframe details database
- Identify aircraft non-compliant to regional mandate

3. ADS-B Avionics Monitoring

- Track Consistency
- Valid Flight ID
- Presence of NAC/NIC/NUC Values
- Presence of Geometric Altitude
- Correctness of 24-bit Code
- Avionics Configuration and Connections
- Update and maintain list of aircraft with faulty avionics

4. ADS-B Performance Monitoring

- Percentage of aircraft with good integrity reports
- Accuracy of ADS-B Horizontal Position (Based on a reference sensor)
- Deviation between Geometric and Barometric Height
- Monitor the number of position jumps
- Message interval rate

5. ADS-B Display on ATC Display

- Split Track – ADS-B reported position might be off
- Coupling Failure – Wrong aircraft ID
- Duplicated ICAO 24-bit address
- Display of data block

FIFTEENTH MEETING OF THE ADS-B STUDY AND IMPLEMENTATION TASK FORCE (ADS-B SITF/15)

(Bangkok, Thailand 18 – 20 April 2016)

Attachment 1 to the Report

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International Civil Aviation Organization

FIFTEENH MEETING OF THE ADS-B STUDY AND IMPLEMENTATION TASK FORCE (ADS-B SITF/15)

Bangkok, Thailand, 18 - 20 April 2016

LIST OF WORKING, INFORMATION PAPERS AND PRESENTATIONS

WP/IP No.	Agenda	Subject	Presented by
		WORKING PAPERS	
WP/1	-	Provisional Agenda	Secretariat
WP/2	2	Review Outcome of APANPIRG/26 on ADS-B	Secretariat
WP/3	2	Review Report of the Eleventh Meeting of South - east Asia Bay of Bengal Sub-regional ADS-B Implementation Working Group (SEA/BOB ADS-B WG/11)	Secretariat
WP/4	3	Review Outstanding Action Items of the Task Force	Secretariat
WP/5	6	Review ADS-B SITF TOR and Works Done by the Task Force	Secretariat
WP/6	4	Incorrect Processing of DO-260B Downlinks by Non DO-260B Upgraded Ground Stations	Australia
WP/7	4	IFR Flights to Australia post February 2017	Australia
WP/8	4	Acquisition of Mode 3/A Code Via Mode S Downlink for DO-260 Aircraft	Hong Kong, China
WP/9	2	ADS-B Monitoring System: A Survey on Common Items/Parameters Monitored	Malaysia
		INFORMATION PAPERS	
IP/1	-	Meeting Bulletin	Secretariat
IP/2	5	E-ANP Status and ADS-B Planning in E-ANP	Secretariat
IP/3	4	Update on ATC Surveillance Activities in Australia	Australia
IP/4	4	“Selected Level” Transponder Data	Australia
IP/5	4	Boeing 787 ADS-B Deficiency Update	Australia (with contribution from Boeing)

WP/IP No.	Agenda	Subject	Presented by
IP/6	4	Australian Plans to Decommission some Radars	Australia
IP/7	4	ADS-B Implementation Plan of Lao PDR	Lao PDR
IP/8	4	U.S. Avionics Performance Report	USA
IP/9	4	Status of ADS-B Implementation in the U.S.	USA
IP/10	4	Performance of Current ADS-B Version 2 Systems	USA
IP/11	4	FAA Advisory Circular (AC) 90-114A CHG1 and ADS-B Preflight Availability Prediction	USA
IP/12	4	U.S. ADS-B Equipage Monitoring and Post-installation Performance Issues	USA
IP/13	4	U.S. Federal Aviation Administration Exemption 12555 Applicability and Process	USA
IP/14	4	ADS-B Implementation Progress in Viet Nam	Viet Nam
IP/15	4	ADS-B failures in certain A330 Aircraft	Australia
IP/16	4	ADS-B and MLAT Implementation Plan in Bangladesh	Bangladesh
IP/17	4	ADSB Procurement Process	New Zealand
IP/18	4	Implementation of ADS-B in the New Zealand Flight Information Region	New Zealand
IP/19	9	The Evaluation Activities of DAPs in Japan	Japan
IP/20	4	The Operation Plan of ADS-B and UAT in the Republic of Korea	Republic of Korea
IP/21	4	The Benefits of Trialing ADS-B Equipment Suppliers Prior to Signing a National Contract	New Zealand
IP/22	4	ADS-B Out	Rockwell Collins
IP/23	4	ADS-B Collaboration in South China Sea Region	Singapore
IP/24	4	Equipage Status of Aircraft	Singapore
IP/25	4	ADS-B Implementation in Indonesia for ATS Surveillance Separation (Tier-1)	Indonesia
IP/26	4	Current Status of ADS-B Implementation	Mongolia
IP/27	4	ADS-B Implementation in the Maldives	Maldives

WP/IP No.	Agenda	Subject	Presented by
IP/28	4	Safety Case for ADS-B under Radar Environment	Singapore
IP/29	4	ADS-B Out	Airbus
IP/30	4	A Boeing Perspective	Boeing
IP/31	4	Update on ADS-B Activities in China	China

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