International Civil Aviation Organization

EIGHTEENTH MEETING OF THE COMMUNICATIONS/NAVIGATION AND SURVEILLANCE SUG-GROUP (CNS SG/18) OF APANPIRG

Asia and Pacific Regional Sub-Office, Beijing, China
(21 – 25 July 2014)

Agenda Item 7: Surveillance

1) review report of the Twelfth Meeting of ADS-B Study and Implemenation Task Force

REVIEW REPORT OF THE THIRTEENTH MEETING OF AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST (ADS-B) STUDY AND IMEPLEMENTATION TASK FORCE

(Presented by the Secretariat)

SUMMARY

This paper presents the work accomplished by the Thirteenth Meeting of ADS-B Study and Implementation Task Force Meeting. Action by the meeting is indicated at paragraph 3.1.

1. INTRODUCTION

1.1 The Thirteenth Meeting of Automatic Dependent Surveillance – Broadcast (ADS-B) Study and Implementation Task Force (ADS-B SITF/13) hosted by DCA. Hong Kong China was held from 22 to 25 April 2014 in Hong Kong China. An ADS-B Seminar was held in conjunction with the ADS-B SITF/13 meeting.

1.2 The report of the meeting and other relevant documents are provided on the following ICAO APAC webpage: http://www.icao.int/APAC/Meetings/Pages/2014-ADSB-SITF13.aspx

2. DISCUSSION

2.1 The ADS-B SITF/13 meeting formulated 4 Draft Conclusions for consideration by this meeting. The meeting considered 22 Information Papers and 25 Working Papers. 15 presentations were made at the ADS-B Seminar.

2.2 The ADS-B Seminar provided an opportunity for sharing information and experience focused on mandating carriage/operational use of ADS-B from regulators; airframe and avionics manufacturers; air space users' perspective; system/equipment suppliers, and Air Navigation Service Providers. A number of questions were discussed and some clarifications were given by the speakers. The presentations were well received and appreciated.

Review outcome of SEA/BOB ADS-B WG/9 Meeting

2.3. The meeting reviewed with appreciation the report of the Ninth meeting of the SEA/BOB ADS-B Working Group (SEA/BOB ADS-B WG/9). Action taken on the report was consolidated in the report of the ADS-B SITF/13 meeting.

2.4 The SEA/BOB ADS-B Working Group meeting was held at ICAO Regional Sub-office in November 2013. A number of action actions agreed the Working Group and the follow-up actions taken by the members of the Task Force were noted by the ADS-B SITF. The report of the Working Group is available on the ICAO APAC website:
http://www.icao.int/APAC/Meetings/Pages/2013-SEABOB-ADSB-WG9.aspx

2.5 The SEA/BOB ADS-B WG/9 meeting noted that Mode S radars are being deployed by a number of States in the Region, however function of Mode S radar with DAPS for ATM automation system has not been fully utilized.

GPS Avionics Failure

2.6 Australia provided information at WG meeting discussing the ADS-B impact of GPS avionics failure in Boeing aircraft.

2.7 Hong Kong China advised that Boeing did not include the effect of GPS failure on ADS-B output in its MEL, and that this information should be included.

Systematic Performance Monitoring of ADS-B Equipped Aircraft

2.8 Hong Kong China recapped to the meeting that during the ADS-B SITF/12, a working paper was presented regarding a systematic algorithm based on an independent surveillance source and flight plan information to monitor and analyse avionics performance of ADS-B equipped aircraft. Moreover, APANPIRG/24 requested the ICAO Secretariat to seek the possibility of establishing a centralized database for sharing the monitoring results at the ICAO Regional Sub-office.

2.8.1 The analysis compared radar and flight plan information with ADS-B reported position, and examined the Navigation Uncertainty Category (NUC) and Flight Identification (FLTID) included in ADS-B reports, concluding that (a) ADS-B reported position deviation of greater than 1NM, (b) NUC of less than 4, and (c) FLTID mismatches against the ATS flight plan were examined if they were present in more than 5% of total reports by the aircraft. The system generated a list of aircraft meeting any of these criteria, including date/time of occurrence, ICAO Aircraft Address, a screen capture of radar and ADS-B tracks, graphical representation of NUC value changes and ADS-B/Radar track deviation. The monitoring and analysis of more than 350,000 ADS-B movements by more than 4,000 ADS-B equipped aircraft identified 3 major categories of problems:

- Category 1: ADS-B position report with good integrity (NUC 4 or greater), but position data bad when compared with radar;

- Category 2: FLTID not matching with Aircraft Identification in the flight plan; and

- Category 3: ADS-B position report with no integrity (NUC always 0)

2.8.2 Hong Kong China emphasized the safety implications to ATC for Category 1 problem, and recommended that monitoring results for Category 1 aircraft should be shared with other States capable of performing ADS-B monitoring and analysis to verify the findings, and that once verified a list should be promulgated on a central database for sharing with all parties. Concerned States and operators should then take remedial action, with ANSPs considering "blacklisting" affected aircraft from their ground systems before the problems were rectified.

2.8.3 Category 2 problems were observed for 15,598 (4.4%) ADS-B flights. Category 2 problem would trigger misleading conflict alert to ATC with cluttered screens - two target labels with different IDs (one for radar and another for ADS-B) being displayed to ATC, Hong Kong China recommended that these results should also be promulgated to concerned CAAs to follow up airworthiness issue with operators in question urging them for early rectification. Category 3 problems were observed for 16,612 (4.6%) ADS-B flights. It is recommended that concerned operators should initiate prompt action for rectification, otherwise they will be treated as non-equipped and requested to fly outside ADS-B airspace.

Outcome of the SG Chairpersons meeting on regional priorities ANRF

2.9 The meeting also reviewed the initial Air Navigation Report Form (ANRF) - Safety and Efficiency of Surface Operations for regional performance objective - ASBU B0-SURF and ASBU B0-ASUR (Initial capability for ground surveillance). While noting the forms are in the initial draft stage, the meeting was of the opinion that the metric or performance indicator for ASBU B0-ASUR should have a more detailed service delivery focus. More appropriate performance indicator would be the percentage of the airspace volume is covered using ADS-B, MLAT or radar. The ANRF on B0-SURF and B0-ASUR is provided in **Appendix A** to the meeting report and consolidated in WP/16 for consideration by CNS SG/18 meeting.

Formulate and follow-up response from ADS-B SITF to AN/Conf-12 Recommendations (WP/03 refers)

2.10 The meeting was provided with an update of a review undertaken by a small working group (SWG) established by ADS-B SITF/12 and comprising Australia, Hong Kong China and Singapore, tasked to make recommendations for practical ADS-B related initiatives in response to outcomes of the 12th Air Navigation Conference, as directed by *APANPIRG Conclusion 24/4 - Follow-up to AN-Conf/12 and Recommendations by States and International Organizations* and *Decision 24/5- Follow-up to AN-Conf/12 Recommendations by APANPIRG.*

2.10.1 Having reviewed the AN-Conf/12 recommendations, the SWG proposed that the ADS-B SITF respond to and take action on 16 of the 56 recommendations. The meeting reviewed and amended some draft responses developed by SWG, and formulated draft Conclusion 13/1 which has been consolidated in WP/03 for consideration by CNS SG/18 meeting.

TOR and Subject/Tasks

2.11 The meeting reviewed the Terms of Reference of the ADS-B SITF and did not identify the need to revise the ToR which was considered still appropriate for the time being. However, the meeting identified the need to reflect correct name of APANPIRG Sub-groups in the note of ToR as shown in **Appendix C** to the Task Force meeting report.

2.11.1 The meeting reviewed and updated Subject/Tasks list of the Task Force which is provided in **Appendix D** to the Task Force meeting report. In order to update status of Task No. 7/36, a survey was conducted during the meeting on the readiness of ADS-B ground stations that had been upgraded to be capable receiving ADS-B D0260B compliant ADS-B data. The result of the survey is provided in **Appendix E** to the meeting report and this paper.

ADS-B implementation Status

2.12 The meeting noted the updates on the **i**mplementation Status in Australia, Bangladesh, Canada, China, French Polynesia, India, Japan, Malaysia, Maldives, Republic of Korean, Singapore, Viet Nam and USA. The detailed information is provided in the report of ADS-B SITF/13 meeting.

2.12.1 The meeting reviewed information on ADS-B status in the APAC Region as presented by the Secretariat. The information was prepared with strong support provided by IATA and CANSO. States were urged to provide further updates to ensure that the data captured is current and accurate. The information updated during the meeting is provided in **Appendix F** to this Report.

Proposed Amendment to AIGD

2.13 In accordance with its Terms of Reference, ADS-B SITF was tasked to develop guidance material to assist States and airspace users in the Asia/Pacific Region in implementing ADS-B. Australia, Hong Kong China and Singapore proposed amendment to the ADS-B Implementation and Guidance Document (AIGD) to incorporate guidance for monitoring and analysis of the performance of ADS-B avionics.

2.13.1 The 9th meeting of the South East Asia/Bay of Bengal ADS-B Working Group (SEA/BOB ADS-B/WG/9) recommended that States intending to mandate ADS-B equipage should commence early monitoring, analysis and follow up work before the mandate to allow sufficient time for airline operators to rectify problems, and for States to collect/analyze the data and conduct safety assessments, leading to deployment of ADS-B for operational use.

2.13.2 The proposed amendment to AIGD is provided at **Appendix H**, with changes tracked. It was proposed to add a new Appendix 2 into the AIGD as shown in the **Appendix H2** to provide guidance materials on performance monitoring and analysis of ADS-B equipped aircraft, based on the experience gained by relevant States/Administration including Australia, Singapore and Hong Kong China.

2.13.3 There are other proposed amendment to AIGD, including guidance materials on synergy between ADS-B and GNSS, revised ATC phraseology and clarification on the flight planning requirements etc.

2.13.4 It was foreseeable that increasing number of States worldwide would start to formulate plans to implement ADS-B in order to meet their operational needs and implement relevant Aviation System Block Upgrades (ASBUs). It was recommended that the AIGD should be promulgated to States in other Regions as guidance materials for experience and knowledge sharing on ADS-B implementation in order to reap early operational benefits and save efforts. The Secretariat informed the meeting that the AIGD had been already forwarded to other ICAO Regional Office for their reference and agreed to seek assistance from ICAO Headquarters to make the AIGD available to States in other Regions to achieve better synergy in ADS-B implementation.

2.13.5 In view of foregoing, the meeting developed the following Draft Conclusion:

Draft Conclusion 13/2 - Revised ADS-B Implementation and Operational Guidance Document.

That, the revised ADS-B Implementation and Operational Guidance Document (AIGD) provided in **Appendix H** (including **H2**) to this report be adopted.

<u>Performance of ADS-B Stations and Avionics in Singapore FIR</u>

2.14 Singapore shared with the meeting the performance monitoring that Singapore is conducting. It was mentioned that the probability of detection for 1s update rate is checked to detect drops in sensor performance and the probability of detection for 10s update rate is checked to ensure that ICAO requirement is met.

2.14.1 Singapore further shared that when the low NUC values of the ADS-B reports is found, airlines will be contacted, where possible, to be informed of the issue, so that the issue could be checked during servicing and maintenance.

2.14.2 New Zealand asked whether a list of airline contacts could be provided to ANSPs to facilitate such reporting. IATA responded that IATA can provide a generic contact list, but the contact person may not be directly handling ADS-B related issues. For non-Asia/Pacific airlines, IATA could assist with establishing point of contact for specific airlines.

2.14.3 The Chair stressed the importance of correct allocation of ICAO Aircraft Address (24 bit code), and States were urged to inform aircraft operators immediately errors were detected due to the criticality of this information in various surveillance and ACAS applications.

<u>Flight Plan Association with ADS-B Surveillance Information</u>

2.15 The USA presented a proposed approach for associating surveillance track data with flight plan information in ATC automation systems including following priority scheme:

a) Matching Mode 3/A Code;
b) Matching Flight ID (if Mode 3/A Code not present or invalid); and
c) ICAO Aircraft Address, if Mode 3/A Code or Flight ID could not be matched.

2.15.1 The meeting was reminded that it was important that States develop a robust mechanism to ensure Flight ID was correctly input by crews. This could include training, education, incident reporting, or whatever other process was necessary to ensure compliance.

<u>Centralized Database for ADS-B Avionics Performance Monitoring also WP24 refers</u>

2.16 Since December 2013, when ADS-B mandates for some major traffic flows in certain airspace over the South China Sea had become effective, monitoring and analysis of avionics performance of ADS-B equipped aircraft had become a significant task for concerned States/Administrations. Problems detected/observed by performance monitoring could have safety implications, which required timely promulgation and rectification.

2.16.1 APANPIRG/24 requested and ICAO 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.

2.16.2 The APRD would be posted on a secure web-site accessible to States and Administrations, who would nominate a single point of contact for registration with the ICAO RSO. Points of contact would be notified each time the APRD was updated. The site would be administered by the ICAO RSO, and each registered State or Administration would be granted read-only, password protected access rights. A few States and/or Administrations with capabilities to monitor and analyze ADS-B avionics performance would also be accorded Administrator access rights.

2.16.3 States and Administrations were encouraged to establish a mechanism within their ANSP and regulatory authority to perform monitoring and analysis of ADS-B equipped aircraft. Guidance in establishing such mechanisms was provided in the ADS-B Implementation and Operations Guidance Document (AIGD).

2.16.4 IATA stated that the identification of operators and individual aircraft in a database that was accessible to a broad range of people was a concern. For example, while problems reported to the FANS 1/A CRA was de-identified the proposed APRD was not. There were concerns about being listed in an accessible database that was being interrogated by ANSPs and States, potentially with a view to “blacklisting: identified airframes.

2.16.5 The meeting discussed about a procedure that may be applied for restricted access to the database. More discussions on this subject is provided in **WP/24** from Hong Kong China.

Synergy between ADS-B and GNSS/PBN

2.17 Australia had recognized that for a large part of the aircraft fleet, fitment of ADS-B would require fitment of GNSS equipment to the aircraft at the same time. Planning for Australia’s transition to satellite based Navigation and Surveillance was well coordinated. For example:

- The one regulation requires both GNSS (for navigation) and ADS-B (for surveillance) to be fitted at approximately the same time;

- Regulations require all IFR aircraft to have appropriate GNSS equipment installed by February 2016, allowing Australia to decommission 50% of the existing NDB and VOR systems, whilst retaining the other 50% as a robust backup;

- The same regulation requires ADS-B to be installed in IFR aircraft on the same date for IFR operations in Western Australia, and in February 2017 for IFR operations throughout Australia; and

- New aircraft registered in Australia after Feb 2014, must already be equipped with ADS-B and GNSS.

2.17.1 The guidance material on the synergy between ADS-B and GNSS/PBN technology has been included in the AIGD.

ADS-B Data RVSM Safety Monitoring

2.18 In following up Task list 9 (His No 39) of ADS-B SITF/12 meeting, To date, the AAMA has monitored over 2800 individual airframes representing more than 122 operators and in excess of 4 billion separate data points, each of which has an associated ASE calculation. The data resulted in excess of 200 million minutes of monitoring output.

2.18.1 Using ADS-B for height monitoring has overcome numerous technical hurdles including: determining the geoid height reference; correcting data for bias due to ionosphere-induced errors in GNSS signals, position and time of day; developing statistical methods for small-data samples; and, the ability to efficiently analyse very large data sets (approximately 120 GB of data per month).

Research Plan RVSM performance monitoring

2.19 Japan also informed the meeting about their research plan regarding the viability of aircraft height keeping performance monitoring using ADS-B data. States are required to monitor the aircraft height-keeping performance in airspace where Reduced Vertical Separation Minimum (RVSM) is applied. The results of analysis were used to assess the viability of using ADS-B data as a means of height keeping performance monitoring. The outline of the research plan including consideration of characteristics of error sources and some issues for height monitoring was introduced.

Update on TPR901 Problem

2.20 Australia updated the meeting that Rockwell Collins had successfully introduced a Service Bulletin that solves the problem in Boeing aircraft. However, as reported at previous meetings, Australia had observed the problem with a number of Airbus aircraft. Rockwell has advised that a solution will not be available in the near future because of their commitment to DO260B development. The TPR901 transponder is used in a large number of commercial airliners.

2.20.1 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 (1 out of 10) 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.

2.20.2 Airbus has prepared a procedure to support power down before flight. However, 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. This new transponder will not exhibit the problem.

Performance monitor by India

2.21 India informed the meeting about their efforts undertaken by India to monitor and identify ADS-B equipped aircrafts flying in Indian FIRs emitting position information non-conforming to the associated position integrity levels, using in-house developed software. Therefore primarily this effort is to identify those ADS-B equipped aircrafts supplying bad position reports with integrity levels greater than 4. The in-house developed software compares the ADS-B equipped aircrafts position reports with that of the local RADAR, taken as reference, to determine the amount of deviation from the reference position reports.

2.21.1 It is found in the analysis carried out at various airports installed with ADS-B ground sensors that the maximum deviation of the ADS-B position reports from reference RADAR was less than 0.5 NM in more than 95% of the position reports.

Performance of Current ADS-B Version 2 Systems

2.22 USA provided initial analyses of observed ADS-B Version 2 quality parameters in comparison to the requirements of the U.S. ADS-B Out rule.

2.22.1 It was informed that FAA was analyzing both the current performance of U.S. secondary surveillance systems used for ATC and current ADS-B Version 2 avionics performance, to derive operationally realistic benchmarks for the availability of the ADS-B quality parameters required by 14 CFR 91.227.

2.22.2 The FAA gathers and records the performance of ADS-B emitters that are detected by the current operational ADS-B radio stations in the U.S. via the Surveillance and Broadcast System Monitor. The information paper quoted the data collected for a two-month period during June 1 – August 31, 2013.

ADS-B Implementation – ATC Phraseologies

2.23 IATA provided information on issues identified with ATC phraseologies which cannot be complied with by flight crew with existing aircraft equipage on board. Issues were identified with ATC using the following ATC phraseologies that require review:

- TRANSMIT ADS-B IDENT
- STOP ADS-B TRANSMISSION
- RE-ENTER ADS-B AIRCRAFT IDENTIFICATION

2.23.1 ADS-B transmission was an integral component of the aircraft transponder, which had no controls or switches to permit the pilot to interact with ADS-B functions independently from SSR functions. ADS-B OUT was automatically activated when the transponder was switched on.

2.23.2 Compliance with an instruction to STOP ADS-B TRANSMISSION required the pilot to turn off the transponder. As a result, the phraseologies had created confusion and unnecessary R/T congestion. Considering the lengthy process of proposing an amendment to PANS/ATM, the meeting agreed that an additional paragraph addressing the concerns on phrases to be included in the AIGD.

The Use of Flight Plan Data to Support ATM and the Effect of Variable Application of Flight Planning Requirements

2.24 Australia provided information on flight planning of ADS-B capability, the variable application of ICAO flight plan (FPL) requirements, the ATM system adaptation implemented in Australia to support ADS-B operations, and the effect of inconsistent application of flight planning methodology across aircraft operators.

2.24.1 Amendment 1 to the 15th Edition of ICAO Doc 4444 (PANS/ATM), effective in November 2012, introduced new, more detailed flight planning requirements improving the description aircraft capabilities in Items 10 and 18 of the ICAO FPL. Descriptors for surveillance equipment capabilities were provided for in Item 10b of the FPL. Descriptors for ADS-B capability were provided in both the “SSR Mode S” and “ADS-B” ranges of descriptors. The purpose of the ADS-B descriptors was to allow ATC to plan operations with an expectation that the aircraft will or will not be transmitting ADS-B as indicated in the FPL, before the aircraft was detected.

2.24.2 Examination of Flight Plan data indicated that serviceable ADS-B capability was not consistently indicated, perhaps due to a lack of clarity and understanding of the ICAO FPL requirements.

2.24.3 PANS/ATM Appendices 2 and 3 for use in FPL included two options for indicating an extended squitter (ADS-B) capability:

- E Transponder — Mode S, including aircraft identification, pressure-altitude and extended squitter (ADS-B) Capability

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

ADS-B descriptors in the flight plan include six options for ADS-B capability:

- B1 ADS-B with dedicated 1 090 MHz ADS-B “out” capability
- B2 ADS-B with dedicated 1 090 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
- V2 ADS-B “out” and “in” capability using VDL Mode 4

ICAO Doc 7030 *Regional Supplementary Procedures* for the North Atlantic (NAT) Region specified flight planning requirements for ADS-B:

– *NAT 2.1.15.1 All ADS-B approved aircraft intending to operate in the NAT Region shall insert either the B1 or B2 descriptor as appropriate in Item 10b of the flight plan;*

– While The SSR Mode S descriptors “E” and “L” provided for extended squitter (ADS-B) capability, in some cases it there may not be suitable GNSS / ADS-B input. Planning “E” or “L” could be based only on the extended squitter capability of the transponder, without regard for actual ADS-B compliance/capability of the aircraft;

– The ADS-B descriptors U1, U2, V1 and V2 were clear;

– B1 and B2 included the term “dedicated”, which could suggest an ADS-B transmitter which was separate from the Mode S transponder. Depending on interpretation, B1 or B2 could be planned, depending on interpretation, to indicate ADS-B capability, regardless of the transmitter hardware (being either the Mode S transponder or a discrete unit), or only where the ADS-B transmitter was separate from the Mode S transponder;

– There was no value in ATC knowing whether or not the ADS-B capability was in a discrete unit or not. ATC was only interested in whether the aircraft as a whole was transmitting useable ADS-B data;

- The majority of ADS-B equipped flight plans received by Australia indicated both the SSR Mode S capability, and the associated ADS-B capability, e.g. EB1, LB1, LB2. Some ADS-B equipped flights we observed to be planning "E" or "L", but without "B1" or B2";

- There were significant issues faced by other regions that required DO260B for operational purposes. Currently there were no means in the flight plan to distinguish between DO260 and DO260B. It was likely that Europe/USA would require a designator to indicate DO260B compliance. For example:

  - B1/B2 : DO260 (or DO260A)
  - B3/B4 : DO260B

- European organizations had discussed additions to Item 18 SUR/ to achieve this as an interim measure until the ICAO FPL could be revised again. European organizations had also identified potential redundancy between L (and E) and the B1/B2 designators.

- An understanding of each aircraft's ADS-B capability was important for the Air Traffic Controllers' traffic management and planning. :

- The variability of flight planning understanding among operators, pilots and ANSPs undermined the reliability of information presented to the air traffic controller. There were no known current or anticipated operational uses for the declaration of 1090 MHz Extended Squitter capability in the flight plan beyond declaration of ADS-B capability.

- It was recommended that ICAO Doc. 4444 (PANS/ATM) Appendix 2 (A2-7) and Appendix 3 (A3-13) be amended as follows:

  - E Transponder — Mode S, including aircraft identification, pressure-altitude and ~~extended squitter (~~ADS-B out~~)~~ Capability

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

  - B1 ADS-B ~~with dedicated 1 090 MHz ADS-B~~ "out" capability using 1 090MHz extended squitter.

  - B2 ADS-B ~~with dedicated 1 090 MHz ADS-B~~ "out" and "in" capability using 1 090MHz extended squitter.

- In this recommendation there was duplication of indication of ADS-B carriage for aircraft where the Mode S transponder was the transmission device.

- This recommendation would be unlikely to require significant changes to ATM systems; the descriptors were unchanged but their interpretation was clarified. Some adaptation changes could be required where ANSPs were currently using the descriptors as triggers for system processing such as controller HMI indications.

– Changes to flight planning systems would be required in cases where the text associated with each descriptor was provided for pilot reference and to individual States' AIP where ICAO DOC 4444 flight planning requirements were repeated.

– Some concerns on possible duplication were expressed regarding the proposed change on interpretation on code E and L. The meeting finally agreed to include the regional interpretation into the AIGD, and agreed to the following Draft Conclusion:

Draft Conclusion 13/3 – Flight Plan Item 10 ADS-B Indicators

That, ICAO be invited to consider to amend relevant contents in Doc. 4444 PANS/ATM Appendix 2 (A2-7) and Appendix 3 (A3-13) as shown below:

- E Transponder — Mode S, including aircraft identification, pressure-altitude and ~~extended squitter (~~ADS-B out~~)~~ capability
- L Transponder — Mode S, including aircraft identification, pressure-altitude, ~~extended squitter (~~ADS-B out~~)~~ and enhanced surveillance capability
- B1 ADS-B ~~with dedicated 1 090 MHz ADS-B~~ "out" capability using 1 090MHz extended squitter.
- B2 ADS-B ~~with dedicated 1 090 MHz ADS-B~~ "out" and "in" capability using 1 090MHz extended squitter.

<u>Air Traffic Service Provision and Regulator Roles in ADS-B</u>

2.25 Australia proposed a method for ADS-B service provision without requiring the involvement of the ANSP in certification issues.

2.25.1 Item 10b of the flight plan indicated surveillance equipment and capabilities. ICAO Doc 4444 (PANS/ATM) stated that capabilities comprised the following elements:

a) presence of relevant serviceable equipment on board the aircraft;

b) equipment and capabilities commensurate with flight crew qualifications; and

c) where applicable, authorization from the appropriate authority

2.25.2 In the SSR environment, the Air Traffic Control system continued to present the radar information, whether or not the SSR indicators were in the flight plan. The ANSP did not have the responsibility to check compliance, or the qualifications of the crew, or if certification of state of registry existed for the transponder. The ANSP assumed that the SSR equipment and altitude encoder was installed correctly, certified, maintained correctly, and that the pilot was capable of operating the equipment. SSR transmissions would not be made by aircraft unless the equipment was compliant with the standards. The same was true for ADS-B.

2.25.3 ADS-B data should not be transmitted unless the transmissions were compliant with the standards. This was endorsed by APANPIRG and reflected in Doc 7030 Regional Supplementary Procedures - MID/ASIA, Chapter 5 – Surveillance, Section 5.5.

2.25.4 As illustrated in **Figure 1**, The ANSP should also assume that if ADS-B was transmitted, the avionics is compliant. If the avionics was not compliant it should have been disabled as required in ICAO Doc 7030 Regional Supplementary Procedures - MID/ASIA, Chapter 5 – Surveillance, Section 5.5. The ANSP should assume that the crew was trained.

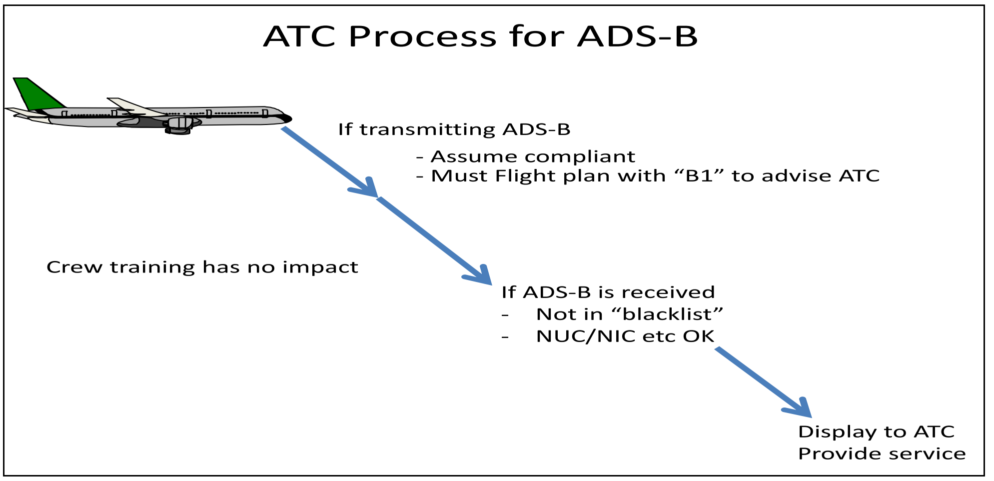


Figure 1: ATC Process for ADS-B

2.25.5 The absence of capability indicators in the FPL was sometimes used to indicate that crew training or State of registry approval did not exist. In all known operational implementations, received ADS-B data (with appropriate quality factors) was displayed to ATC whether or not the flight plan included ADS-B indicators.

2.25.6 It was not appropriate to discard ADS-B data based on the flight plan contents because flight plan indicators were sometimes wrong. There would be negative operational impact from removing the presence of an aircraft from display to ATC based on a single flight plan indicator.

ADS-B data should be used if:

a) the quality indicators (NUC/NIC etc.) were acceptable; and

b) the aircraft was not in a "blacklist" of airframes not compliant with the regulations.

2.25.7 The regulator had the role of monitoring and enforcing the standards. It was entirely appropriate that the regulator used appropriate methods to confirm that the regulations were followed. These could include *inter alia* documentation checks, ramp checks, personnel licensing etc. Figure 2 illustrates Regulatory processes relating to ADS-B compliance.

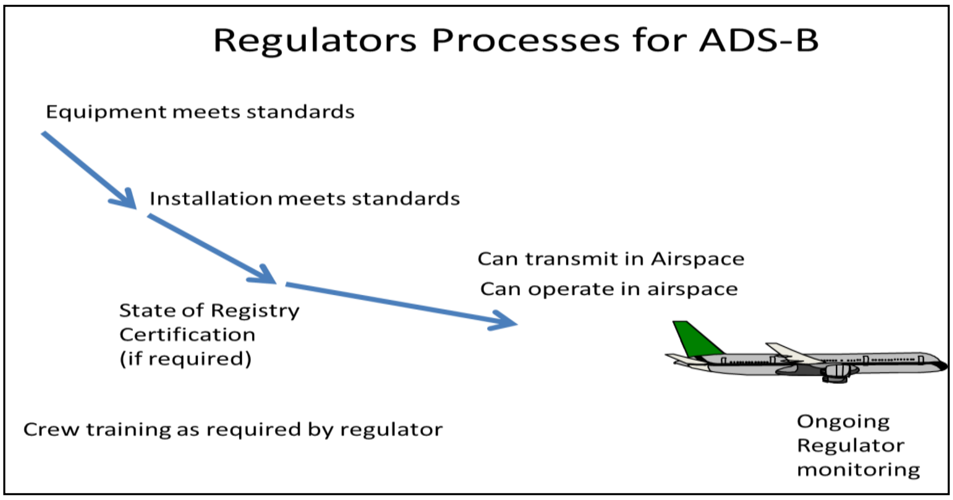


Figure 2: Regulatory Process for ADS-B

2.25.8 Regulators needed to be able to enforce requirements that non-compliant transmissions were to be disabled. In most cases, the regulator would be informed of detected non-compliance by the ANSP.

2.25.9 The operational specification process, whilst perhaps useful in the initial deployment of ADS-B, was seen as being a hindrance to maximizing operational use of ADS-B.

2.25.10 In discussions at SEA/BOB ADS-B WG/9 it was agreed that States in APAC Region did not require an "operational specification" (ops spec) to specify certification of non- equipment aspects such as crew training, maintenance etc. These issues were covered under the existing requirements (if any) for the GPS and transponder equipment. The operational approval requirements for ADS-B were considered to bring too little change to warrant an ops spec.

2.25.11 The requirement for aircraft operators to have an operational approval from their State arose from APANPIRG Conclusion 21/39, which was made in 2010.

2.25.12 Australia subsequently examined the performance of ADS-B data transmitted by aircraft that were not approved by their State of Registry, and found that in nearly all cases the data was as good as approved data. Those aircraft that were not transmitting compliant ADS-B were clearly detected by the ANSP mainly because of low or zero integrity (NUCp/NIC), or large track-jumps.

2.25.13 Australia consequently decided that the requirement for operational and technical approval from State of Registry was more of a hindrance than a help to both safety & efficiency.

2.25.14 It was noted that a number of Asia Pacific States required State of Registry operational approvals for the introduction of ADS-B airspace in December 2013, possibly to conform with the APANPIRG Conclusion/template.

2.25.15 Waiting for a State of registry operational approval process disqualified many fully compliant aircraft/crews from the advantages of ADS-B based ATC surveillance and its safety and efficiency benefits. Australia suggested that States reconsider the necessity for operational and technical approvals of aircraft by the State of Registry.

2.25.16 Australia recommended that States and ANSPs should reconsider any current requirements for "operational approval" for aircraft operators, and remove any such reference to a requirement for an "operational approval" or "operational specification" from State regulations and AIP.

2.25.17 New Zealand and USA supported the proposal to remove the requirement for operational approvals, and Canada advised that they also did not require operational approval. Other States stated that they would have difficulty in supporting ADS-B operations without an operational approval process. The meeting discussed the varying regulatory and legislative circumstances that may exist among Asia/Pacific States, and the evolutionary nature of each State's development of ADS-B regulations.

2.25.18 In view of the foregoing and in order to provide flexibility to those States until experience greater was gained, the following Draft Conclusion was developed by the meeting:

Draft Conclusion 13/4 - Regulations for Compliance of ADS-B Transmissions

That,

States be urged to implement regulations to give effect to Regional Supplementary Procedure Serial APAC-S12/10 – MID/Asia 5-3 to ensure that all aircraft transmitting ADS-B are compliant with the standards;

States in the Asia and Pacific Regions may choose to require or not require an Operations Specification or Operations Approval for ADS-B OUT.

ADS-B Operational Approval for Operations Outside of U.S. Domestic Airspace

2.26 USA provided information on how the FAA issued State of Registry operational approval for U.S.-registered aircraft to comply with ADS-B mandates of other States and discussing the burden to the aircraft operator and approving regulator of requiring "State of Registry" operational approval.

2.26.1 The Federal Aviation Administration (FAA) had created an operations authorization for U.S. Registered aircraft to comply with early ADS-B directives by Australia and Canada. The authorization, designated OpSpec/MSpec/LOA A353 was applicable to U. S. commercial and private aircraft conducting ADS-B operations outside U.S. designated airspace.

2.26.2 The process took three months on average from delivery of the application until HQ approved to issue the authorization. In earlier years this process was adequate as the FAA received less than ten applications per year. However, several ANSPs in the Asia/Pacific region had ADS-B mandates effective in December 2013 requiring operational approval by the State of registry. The number of applications had increased dramatically. Thus far in 2014 FAA had reviewed 93 applications, with a further 53 in the queue.

2.26.3 FAA had therefore decided to amend the process, and implement a new authorization; OpSpec/MSpec/LOA A153, with a reduced amount of documentation required from the operator and removal of the HQ review.

2.26.4 FAA believed that ADS-B operations should not require State of Registry operational approval. There were multiple air navigation service providers that safely managed ADS-B airspace without requiring State of Registry approval. The FAA's position was that State of Registry approval did not add value, but FAA would continue to use the new process to meet the requirements of other States while reducing the burden on the operator and decreasing the time period required for processing.

ADS-B Version 2 Installation in USA

2.27 The meeting noted that **a**s of March 01, 2014, number of ADS-B Version 2 aircraft identified (not including vehicles, FAA test aircraft and U.S. military aircraft) was as follows:

2493 total DO-260B (1090MHz) Aircraft
1201 total DO-282B (UAT) Aircraft
123 dual 260B and 282B

2.27.1 As result of performance compliance monitoring, some known System Installation Issues are highlighted as follows:

- Non-compliant GPS or GPS not compatible with ADS-B transmitter
- Improper software versions
- Mode 3/A mismatch (transponder / UAT)
- Improper entry of 24-bit ICAO addresses
- Improper entry of ADS-B installation data
- Flight ID Data Entry
- A380 doesn't transmit Geometric Altitude
- Issues primarily found in General Aviation

Space based ADS-B Surveillance Service (Canada)

2.28 An overview of NAV CANADA's plans for introduction of space-based ADS-B surveillance services was provided to the meeting. It was recommended That States to support worldwide value extraction from space-based ADS-B surveillance. The paper referred to the IP/1 presented at the Air Traffic Management Operations Panel (ATMOPSP) Send Working Group of the Whole Meeting (WG/WHL/2) held in Montreal, Canada – 31 March to 4 April 2014. The attached ATMOPSP Information Paper provides the detailed development proposed by NAV CANADA to extract value from ADS-B Out signals received by the Iridium Next constellation through the hosted payload sponsored by Aireon. The Concept of Operations at Attachment One to the Information Paper, developed in collaboration with NAV CANADA's customers, identifies the phased implementation in the evolution of the surveillance services and the associated Air Traffic Management (ATM) changes delivering quantifiable benefits. It was stated in the attached Information

2.28.1 The meeting appreciated the opportunities offered to States/Administrations in the APAC Region to receive additional information through a workshop on space-based ADS-B supported by NAV CANADA. The Secretariat agreed to explore appropriate opportunity including time and venue for a regional workshop on space based ADS-B. (One day workshop on space-based ADS-B will be arranged in conjunction with ADS-B SEA/BOB WG meeting on 11 November in Singapore.

Business Jet Aircraft Fitment Issues

2.29 Under this Agenda Item, the meeting also discussed about ADS-B fitment rate issue for Business jet aircraft. It was advised that a number of States/Administrations had received a letter from IBAC asking for suspension or withdrawal of the ADS-B mandates in the specified routes segments of the concerned State/Administrations' airspace.

2.29.1 The meeting noted that:

- The South China Sea project had received considerable publicity over many years. Most stakeholders (eg. IATA) had become involved and supported the project and the mandates;

- APANIRG has supported the project & mandates through adoption of Conclusions including the latest one Conclusion 22/8;

- Airframe OEM organisations such as Gulfstream have provided avionics and issued bulletins about the Australian and South China Sea mandates well before the effective date;

- Relevant States had published AIP/AIC documents years in advance of the effective date giving due period of time to compliance with the requirement and had received no objection from any organisations until after the effective date. The time for objections would have been in the formative stages of the project, not after implementation;

- IBAC affiliated organisations (eg. the Australian ABAA) were well aware of the Australian and South China Sea activities;

- The FAA published material referring the mandates well before they became effective;

- CANSO has supported the mandates and the activities had been well publicised in the industry;

- The Airlines and travelling public obtain safety & efficiency benefit as a result of ADS-B fitment and as a result of the homogeneous (ADS-B only) nature of the airspace;

- The requirement for State of Registry approval is in accordance with APANPIRG conclusion 21/39. It should be further noted that individual states may or may not choose to require State of Registry approvals;

- Due consideration should be also given to provide priority for access to the mandating airspace for aircraft with operative ADS-B as equipment over those aircraft not operating ADS-B equipment.

2.29.2 As a result of discussion, it is concluded that IBAC should have been well aware of the project and had numerous opportunities to attend or object during the past years. It is inappropriate to object after the mandate comes into effect.

2.29.3 Based on the directive of APANPIRG and deliberations at ADS-B Study and Implementation Task Force, a common position was developed among the Administrations concerned with respect to the response to the request from IBAC. The meeting also requested Secretariat to invite IBAC to participate future meeting of the Task Force.

Requirement for ICAO Aircraft Address in Flight Planning and Associated Issues

2.30 Australia provided information discussing issues on the inclusion of ICAO Aircraft Address in flight planning and proposing that this data item was not required for flight planning.

2.30.1 The ICAO Aircraft Address was a unique identifier allocated by individual States under ICAO Annex 10 Vol. 3 Chapter 9 *Aircraft Addressing System*. It was configured in the aircraft's transponder/s and was not accessible or configurable by the pilot. It served largely to support technical functions such as Mode S Selective Interrogation, ADS-B processing by ground stations, FANS 1/A logon correlation, data items in ASTERIX format messages to identify unique targets, etc. It could also be used as a unique identifier to support track fusion from multiple data sources as could occur in a multi-sensor tracking system.

2.30.2 Appendix 2 of ICAO Doc. 4444 (PANS/ATM) stated that CODE/ (where the Aircraft Address was expressed as hexadecimal characters) could be included in the FPL Item 18 as optional data. Some States had mandated the flight planning of CODE/, typically with the implementation of ADS-B services. The AIP of other States either reflected the availability of CODE/ as an optional entry in FPL Item 18, or made no mention of it at all.

2.30.3 Where the Aircraft Address was included in the FPL many ATM systems would then use it as one possible means of associating a surveillance track or FANS 1/A logon request with a FPL. Other means included Flight ID, SSR Mode 3/A code or (for ADS-C) the aircraft registration.

2.30.4 A mismatch between the Aircraft Address configured in the transponder and the CODE/ indicated in the FPL could cause issues in the ATM system such as warnings to ATC of the mismatch, or coupling of a surveillance system track to an incorrect flight plan, or failure to couple at all.

2.30.5 Where CODE/ was flight planned and aircraft were subsequently reallocated after flight plan submission, it would be necessary to update the filed FPL with the new aircraft address via a modification message (CHG). This was often not correctly done. During Australia's ADS-B trials of the use of CODE/ in flight planning for a medium sized operator of turbo-prop aircraft the relatively frequent number of aircraft changes, without corresponding FPL amendments, triggered numerous cases of incorrect couplings based on CODE/, in these cases via Mode S SSR.

2.30.6 A significant number of aircraft had incorrectly configured transponders, with an Aircraft Address not consistent with the allocation by the Civil Aviation Safety Authority.

2.30.7 Australia recommended that, where Flight ID and/or Mode 3/A SSR code were available as a means of associating a surveillance track to a flight plan in the ATM system, these should be the primary means of achieving such an association, and the flight planning of CODE should not be mandatory, but considered as a fallback methodology only for particular cases where Flight ID was not available to support coupling.

2.30.8 Noting the above information, the meeting after discussion, agreed that it was the prerogative of the individual State to determine the track association criteria and flight planning requirements that best suited its operational environment and traffic mix, rather than being stipulated at regional level.

Surveillance on Low Flying Aircraft Using ADS-B

2.31 Hong Kong China provided information highlighting the ADS-B ground station system in Hong Kong for provision of surveillance on both en-route and low-level aircraft including general aviation (GA) and helicopters equipped with ADS-B. Flight trials confirmed the system provided good surveillance coverage, enhancing surveillance capabilities and situational awareness for ATC and pilots, and facilitating Search and Rescue (SAR) operations and subsequent accident/incident investigations.

2.31.1 Flight trials were conducted by Hong Kong Civil Aviation Department in cooperation with the Government Flying Service (GFS), using their helicopter equipped with an on-board ADS-B test transponder. During the trials the aircraft maintained low altitude (e.g. 500 FT AMSL) as far as practicable, and descended for landing at selected locations. ADS-B and SSR data were recorded and compared. Target drops were observed in SSR data for aircraft flying at low altitude, but there were almost no ADS-B target drops.

2.31.2 Based on the satisfactory results of the flight trials, CAD would continue to work with GFS to equip their newly delivered fixed-wing aircraft and helicopters with ADS-B as a pilot scheme. With consideration of the cost-benefits, availability of avionics products and technical installation issues, CAD had kicked off discussion with local industry to explore the way forward in equipage of other locally registered GA aircraft and helicopters

2.31.3 Republic of Korea expressed appreciation to Hong Kong China for sharing such useful information with other States as Korea was conducting a study to work out a solution for the low flying GA aircraft. Regarding proposed GM to be developed, Hong Kong China agreed to prepare the GM for consideration by next meeting. The GM would include consideration of design and selection of locations for low level GA type traffic, etc.

Separation Minima, Airspace Capacity and ADS-B Mandates

2.32 The Secretariat presented information on operational capacity, efficiency and safety improvements enabled by ADS-B surveillance, the Regional expectation of implementation of these capacity and efficiency benefits, and on a Draft Conclusion developed for consideration by APANPIRG, through the ATM Sub-Group, intended to provide guidance to States on appropriate steps to be taken when planning and implementing mandates for aircraft ADS-B equipage.

2.32.1 The combined 4th Meeting of the South Asia/Indian Ocean ATM Coordination Group and 21st Meeting of the South East Asia ATS Coordination Groups (SAIOCG/4 & SEACG/2, Hong Kong, China, 24 to 28 February 2014) had noted that the imposition of an ADS-B mandate should be the final step in any ADS-B implementation process, and agreed to the following Draft Conclusion for consideration by the ATM Sub-Group and APANPIRG:

Draft Conclusion SAIOACG4/SEACG21-1: ADS-B Airspace Mandates

That, States considering airspace mandates for aircraft Automatic Dependent Surveillance-Broadcast (ADS-B) equipage are urged to ensure that the effective date of any such mandate is determined after consideration of the following:

a) appropriate consultation with affected airspace users;

b) the area of airspace requiring carriage and operation of ADS-B to be coordinated with affected Air Traffic Control (ATC) units, including those adjacent to the ADS-B airspace;

c) conduct of a safety case, which includes, inter alia, a human factors review and the integration of the ADS-B data with the ATC workstation;

d) pilot and ATC training for the provision of ADS-B surveillance-based separation;

e) the ability to provide an enhanced service delivery; and

f) promulgation of the ADS-B airspace with appropriate notice, and in accordance with the provisions of Annex 15.

The above Draft Conclusion was supported and endorsed by the ADS-B SI Task Force.

2.32.2 IATA urged States to consider and address the issues impeding the region from implementing the separation standards that would improve airspace capacity and efficiency by providing ATC with the tools to deliver optimal services.

ADS-B Data Sharing Between India and Myanmar

2.33 The meeting was provided with an update by India of the status of ADS-B data sharing between India and Myanmar, which had been agreed in principle between the States. Initial discussions initiated at ADS-B SITF/11 in April 2012 were further progressed at the ADS-B focus group meeting facilitated by CANSO in July 2012.

2.33.1 ADS-B SITF/12 (April 2013) had agreed to Draft Conclusion 12/2, adopting milestones for data sharing between India and Myanmar, who had earlier agreed in principle to share data from the Agartala, Port Blair, Sittwe and Coco Island sites.

2.33.2 The Port Blair and Agartala ADS-B ground station receivers were installed and regulatory approval was expected by end of May 2014. The installation at Sittwe had also been completed, but Coco Island’s was delayed till end of 2014 due to bad weather and logistics issues. The proposed data sharing agreement, based on the ICAO Asia/Pacific ADS-B Data Sharing Agreement Template, had been submitted to the Ministry of Civil Aviation, which was actively coordinating for inter-ministerial clearances which were expected by end of June 2014. The date for signing the data sharing agreement may be realistically expected in 2nd half of 2014 after approval from the Ministry of Civil Aviation.

Sub-regional ADS-B Implementation Plan Updates

2.34 On behalf of Indonesia, the Philippines and Viet Nam, Singapore presented updates on the progress of the collaborative efforts of the States for South China Sea project. Singapore received ADS-B data from the Indonesian islands of Matak and Natuna while Indonesia had also received ADS-B data from Singapore. Singapore also received ADS-B data from Vietnamese island of Con Son. As for the communications, VHF radios from Con Son is operational; while the VHF radios from Matak and Natuna were installed and expected to be operational within 2014. The Philippines and Singapore also agreed in-principle on ADS-B data sharing. The Philippines is securing a site in Quezon Palawan for the installation of ADS-B and VHF.

2.34.1 In response to a query, the Philippines clarified that as part of CNS/ATM project resumed recently, only one ADS-B ground station will be installed in Manila in 2016. The ADS-B station at Quezon Palawan being discussed between Singapore and the Philippines will not be integrated into the new ATM system. It was further informed that the interim ATS system to be made available at Manila by end of 2014 will be capable to process ADS-B data. In this connected, the Secretariat was requested to follow up with CAAP for appropriate arrangement to utilize the ADS-B data that will be available from Quenzon Palawan station at least for technical evaluation.

Regional Supplementary Procedures Amendment to Support ADS-B Mandates

2.35 The Secretariat presented a Proposal for Amendment (PfA) to Regional Supplementary Procedures (ICAO Doc 7030) to support State mandates for ADS-B equipage for aircraft operating outside territorial airspace but within the area of responsibility of the State.

2.35.1 The proposed amendment was in accordance with the concept of Seamless ATM and performance-based approaches, the Aviation System Block Upgrade (ASBU) initiative and Global Air Traffic Management Operational Concept (ICAO Doc 9854).

2.35.2 The ADS-B-related sections of the PfA are provided at **Appendix J**. The PfA would be presented for agreement by the Second Meeting of the Air Traffic Management Sub-Group of APANPIRG (ATM/SG/2) in August 2014, and subsequent endorsement by APANPIRG/25.

2.35.3 The meeting was informed that the PfA would be coordinated with the APANPIRG Chair, and processed through ATM Sub-Group and APANPIRG for formal presentation to the Council of ICAO after APANPIRG endorsement. Parallel coordination would be conducted with ICAO HQ to ensure the document was ready for processing by APANPIRG/25 (September 2014)

2.35.4 The meeting made a number of comments which are annotated in the attached draft PfA. The meeting supported the PfA in principle to be reviewed and adopted by APANPIRG in a form of Conclusion, subject to further amendment by relevant group of APANPIRG.

2.34.5 The meeting noted the readiness checklist contained in Appendix L to the ADS-B SITF/13 meeting report.

Note of appreciation

2.36 The meeting expressed its appreciation and gratitude to the Civil Aviation Department of Hong Kong China for hosting the ADS-B Seminar, the excellent arrangements made for the meeting and for all activities organized during the meeting including a visit to the new ATM facilities.

3. ACTION REQUIRED BY THE MEETING

3.1 The meeting is invited to review the report of the Thirteenth Meeting of ADS SITF and make recommendations on the draft Conclusions for consideration by APANPIRG/25.

— — — — — — — — — — —

THE REVISED TERMS OF REFERENCE OF
ADS-B STUDY AND IMPLEMENTATION TASK FORCE

- Compare currently available technologies with respect to concept of operations, relative costing, technical and operational performance and maturity of alternative technology/solutions (primary, secondary radar including Mode-S, ADS-B, multilateration, ADS-C);

- Develop an implementation plan for near term ADS-B applications in the Asia Pacific Region including implementation target dates taking into account:

  - available equipment standards
  - readiness of airspace users and ATS providers
  - identifying sub-regional areas (FIRs) where there is a positive cost/benefit for near-term implementation of ADS-B OUT
  - developing a standardised and systematic task-list approach to ADS-B OUT implementation; and
  - holding educational seminars and provide guidance material to educate States and airspace users on what is required to implement ADS-B IN & OUT.

- Study and identify applicable multilateration applications in the Asia and Pacific Region considering:

  - Concept of use/operation
  - Required site and network architecture
  - Expected surveillance coverage
  - Cost of system
  - Recommended separation minimums; and
  - If multilateration can be successfully integrated into an ADS-B OUT-system for air traffic control.

- Coordinate ADS-B implementation plan and concept of operations with other ICAO regions where ADS-B implementation is going on and with relevant external bodies such as EUROCONTROL, EUROCAE, RTCA and Industry.

Note: *The Task Force, while undertaking the tasks, should take into account of the work being undertaken by SAS, AS Panels with a view to avoid any duplication.*

The Task Force should report to the APANPIRG, through the CNS~~/MET~~ Sub-group and provide briefing to the ATM~~/AIS/SAR~~ Sub-group.

_ _ _ _ _ _ _ _ _ _ _ _

ADS-B SITF TASK 7/36 – States to advise when their ground stations can be upgraded to receive ADS-B D0260B compliant ADS-B data					
State or Administration	**No. of ADS-B Ground Stations Installed**	**D0260B Compliant?**			
		Yes (all)	**Yes (some)**	**No**	**If *some* or *No*, planned date of full D0260B capability**
Australia	33	☐	☒	☐	Sydney WAM (SYDWAM) site yet to be upgraded
Bangladesh	Nil	☐	☐	☐	
Hong Kong, China	9	☒	☐	☐	
Macao, China	Nil	☐	☐	☐	
India	21	☒	☐	☐	
Indonesia	31	☐	☐	☒	To be discussed
Japan	Nil	☐	☐	☐	
Malaysia		☐	☐	☐	
Maldives	4	☐	☒	☐	Not yet determined.
Myanmar		☐	☐	☐	

ADS-B SITF TASK 7/36 – States to advise when their ground stations can be upgraded to receive ADS-B D0260B compliant ADS-B data					
State or Administration	**No. of ADS-B Ground Stations Installed**	**D0260B Compliant?**			
		Yes (all)	**Yes (some)**	**No**	**If *some* or *No*, planned date of full D0260B capability**
Nepal	Nil	☐	☐	☐	
New Zealand	22	☐	☐	☒	December 2014
Philippines	Nil	☐	☐	☐	
Pakistan	1	☐	☐	☐	Test basis. Will discuss outcomes from ADS-B SITF Meeting.
Republic of Korea	2	☐	☐	☒	2017
Singapore	1	☒	☐	☐	
Thailand	1	☐	☐	☒	
USA	634	☒	☐	☐	
Viet Nam	3	☒	☐	☐	

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 31 ADS-B stations and 28 WAM stations are currently used. ATC system readiness since 2004. ADS-B data sharing with Indonesia operational since 2/2011. ASMGCS using multilateration is operational in Brisbane, Sydney & Melbourne. It is being installed in Perth. Additional 15 ADS-B stations from 2014-2016. OneSKY replacing current ATM system is estimated for full operational around 2020.	2009/effective date of mandating in UAP 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 for all IFR aircraft applies from 2/2017.	at/above FL290 UAP from 12/2013 for domestic & foreign aircraft. Mandates for additional flight level are considered for 2015 & 2017. WAM is operating in Tasmania since 2010 delivery 5 Nm separation service. WAM is also operating in Sydney for 3 Nm separation service in TMA and for precision runway monitoring function.	5 NM 3 NM SYDWAN	

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 2016. ADS-B data will be integrated with new ATS system at Dhaka.				
CAMBODIA	3 ADS-B ground stations have been installed in Cambodia since 2011 and able to provide full surveillance coverage for Phnom Penh FIR.				
CHINA	5 UAT ADS-B sites are used for flight training of CAFUC. 8 ADS-B stations installed by end of 2012. 200 ADS-B stations nationwide will deployed as 1st phase. 1 ADS-B station operational in Sanya FIR since 2008. Sanya ATC system ready since July 2009 to support L642	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
	and M771. Chengdu-Jiuzhai project finished in 2008 with 2 ADS-B stations and additional site is planned to enhance the surveillance coverage. Chengdu - Lhasa route surveillance project completed with 5 ADS-B stations using 1090ES since 2010. Trials planned from May 2011. 1 ADS-B site installed in Sanya FIR since 2008. 3 additional ground stations planned, Trial planned for Jun, 2011.				
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. ATS automation system to be ready in 2015

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 are planned in December 2013 and within HK FIR at or above FL 290 in December 2014. 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 planned to be put into operational use 6 months after new ATM System in operation
MACAO, CHINA	Mode S MSSR coverage available for monitoring purposes.				

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
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 will be provided in 2013.				
FRANCE *(French Polynesia)*	Project launched to install 9 ADS-B stations. 2 stations to be installed in 2014; 3 in 2015 and 4 will be installed in 2016.			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 international airports. ADS-B Ground Stations installed at 14 locations in phase one across continental and Oceanic airspace at Port Blair. 07 more ADS-B	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. Currently study the integrity of ADS-B data and evaluating in both Non-radar and radar environment for ATC purposes.

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
	Ground stations in phase two in 2014. ATS systems at 12 ACCs are capable of processing ADS-B data and provide the information on Display. Wide area Multilateration pilot project is being planned in Kolkata TMA to augment the surveillance coverage.				
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 planning and action concerning ADS-B Implementation within Indonesia FIR ADS-B data sharing with Australia and Singapore.				ADS-B Task Force Team is considering a mandate in 2016

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
JAPAN	Multilateration Systems for surface monitoring have been implemented at seven airports and are being implemented at another one airport. PRM (WAM) is planned to be implemented at Narita Airport. (Operation will start in 2014). Basic design of en-route WAM system completed in FY2013. Plans to start manufacture in FY2014 and estimated operational in FY2018. Plan to evaluate accuracy of ADS-B information and has intension to introduce ADS-B to the oceanic direction.				
MALAYSIA	Malaysia planned to start mandate ADS-B requirement in KL FIR in 2018 and full implementation of ADS-B service at	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**
	specific routes/exclusive airspace by end of 2020. Plan to install two ADS-B stations at Pulau Langkawi and Genting Highland by 2016. Data sharing with neighbouring by mid. 2017.				
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 plan to share ADS-B data with its adjacent FIRs.				Seaplane in Maldives equipped with ADS-B for AOC purpose. These seaplanes have ADS-B IN functions as well.

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
MONGOLIA	Five ADS-B ground stations for combination with SSR will be implemented first quarter of 2013. Full coverage for surveillance gaps will be implemented by 2015-2016.				
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 being used in Queenstown area (WAM) and Auckland (airport surface movements). ADS-B data available from all MLAT & SSR sites.				
PAKISTAN	Feasibility study for using ADS-B is in hand. One station was installed at ACC Karachi and evaluation is in progress.				
PAPUA NEW GUINEA	Legislation mandating ADS-B and guidelines for aircraft equipage and operational approval to be issued by 31/12/2011 with target mandatory date by mid-2015 and plans to provide ADS-B service above FL245				

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
	within Port Moresby FIR and also in specific higher traffic areas domestically.				
PHILIPPINES	One (1) ADS-B ground station in Manila ATM Center will 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 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				

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
	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 December 2013. AIP supplement published in Nov 2013 to remind operators of ADS-B exclusive airspace implementation.	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 planned for 26th June 2014 on ATS routes L642, M753, M771 and N892; 20nm panned for end 2015	Safety case was completed end of November. 2013.
SRI LANKA	ADS-B Trials planned for 2012 and implementation in 2013. The ADS-B station was planned at Pidurutalagala.				
THAILAND	Multilateration implemented in 2006 at Suvarnbhumi Int'l. Airport. An ADS-B Ground Station has been installed in Bangkok as test unit. ADS-B is planned to be part of future surveillance infrastructure. New ATM System to be in operational in 2015 will be				

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
	capable of processing ADS-B data.				
TONGA	Trial planned for 2017				
UNITED STATES	As of 31 March 2014, 634 radio sites had been installed; these sites cover the "baseline" set of Service Volumes planned by the FAA in 2007. Since 2007, FAA has planned and funded activities to activate additional Service Volumes that will constitute an additional 29 radio sites. Approximately 100 of the 230 U.S. air traffic control facilities are using ADS-B for ATC separation; all facilities are planned to be using ADS-B by 2019.	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 - independent 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).	

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
VIET NAM	Two phases ADS-B implementation plan adopted. Phase 1 implemented in March 2013. Phase 2 for whole lower and upper airspace of Ha Noi and Ho Chi Minh FIR to be completed by 2016.	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.

– – – – – – – – – – – – – –

INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

ADS-B IMPLEMENTATION AND OPERATIONS GUIDANCE DOCUMENT

Edition ~~6~~7.0 ~~-~~– September~~June~~ 201~~3~~4

Intentionally left blank

TABLE OF CONTENTS

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: ~~www.bangkok.icao.int/edocs/index.html~~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

(Intentionally blank)

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 ~~icao_apac@bangkok.icao.int~~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 ~~(i)~~(iv) Included clarification on Flight Planning

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	Surveillance 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 (Surveillance 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.

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~~http://www.bangkok.icao.int/edocs/index.html~~" 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.

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.bangkok.icao.int/edocs/index.html~~http://www.icao.int/APAC/Pages/edocs.aspx for reference by States.

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

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) data required;
3) functional processing;
4) functional performance; and
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) flight operations; and
2) 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	Date of Operational Approval	No need to harmonize	

5	Flight Level	SG, HK, CN : - At or Above FL290 (ADS-B airspace) - Below FL290 (Non-ADS-B airspace) VN to be confirmed	
6	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)
7	Flight Planning	Before 15 Nov 2012, as per AIDG On or after 15 Nov 2012, as per new flight plan format	
8	Aircraft Approval		
8a)	Procedures if Aircraft Not Approved or Aircraft without a Serviceable ADS-B Transmitting Equipment before Flight	SG, HK, CN : FL280 and Below VN to be confirmed	

8b)	Aircraft Approved but Transmitting Bad Data (Blacklisted Aircraft)	For known aircraft, treat as non ADS-B aircraft.	Share blacklisted aircraft among concerned States/Administration
9	Contingency Plan		
9a)	Systemic Failure such as Ground System / GPS Failure	Revert back to current procedure.	
9b)	Avionics Failure or Approved 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.
10	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

– – – – – – – – – – – – – –

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".

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.bangkok.icao.int/edocs/index.htm~~http://www.icao.int/APAC/Pages/edocs.aspx~~l~~" 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.

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~~http://www.bangkok.icao.int/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.

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 : <u>System design</u> 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.

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: <u>Training & Competency plans</u> 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: <u>Data collection & Review</u> :

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

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 the APANPIRG Conclusion 22/36 on the template for ADS-B mandate/regulations on provision of ADS-B based ground surveillance. Some States listed below have published their ADS-B mandate/regulations on their web sites that could 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 ~~Circular (AIC) ~~No. ~~09~~13/1~~1~~3 dated 2~~4~~9 ~~May~~October 2013~~1~~
"~~http://www.hkatc.gov.hk/HK_AIP/aic/AIC09-11.pdf~~http://www.hkatc.gov.hk/HK_AIP/supp/A13-13.pdf"

(c) Civil Aviation Authority of Singapore (CAAS)
Aeronautical Information Publication Supplment ~~Circular (AIC) ~~No. ~~14~~254/13~~0~~ dated 6~~28~~ ~~December~~November 201~~0~~3
"~~http://www.caas.gov.sg/caasWeb2010/export/sites/caas/en/Regulations/Aeronautical_Information/AIC/AIC_PDFs/AIC_14_2010.pdf~~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"

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.

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.bangkok.icao.int/edocs/index.html~~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 note the requirement for ADS-B specific phraseology equivalent to radar specific phraseology as well as the opportunity to use generic phraseology applicable to multiple systems.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:

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 [ADS-B or MODE S] AIRCRAFT 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
SQUAWKTRANSMIT ADS-B 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.
TO REQUEST TERMINATION OF SSR TRANSPONDER AND/OR ADS-B TRANSMITTER OPERATION

~~a) STOP SQUAWK. [TRANSMIT ADS-B ONLY];~~
~~b) STOP ADS-B TRANSMISSION [SQUAWK (code) ONLY].~~
~~*Note: In some cases the ADS-B transmitter cannot be operated independently of the SSR transponder and the loss of SSR and ACAS surveillance derived from the operation of the SSR transponder should be considered.*~~

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 ~~may~~ will not be possible in ~~all~~ 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.

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

Issue: ~~Some~~ Most aircraft ~~may~~ 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.

Comment [m1]: *Suggest this now be deleted as it is covered off in the body of section 9.9.1*

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.

~~For information, these include~~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

- 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.

9.10.3 Setting Aircraft ~~Flight~~ 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 (AC~~S~~ID) 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 Gyroplan~~c~~e 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 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; 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 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;

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 SIL.

Note:

1. It is considered equivalent to deactivation if NUCp or NIC 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 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.bangkok.icao.int/edocs/index.html~~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.

– – – – – – – – – – – – – – –

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

5.1 For States who have radar coverage, a systematic and efficient means to monitor and analyse the problem could be considered on top of relying on ATC to report the problem / sample checking. This can be achieved by developing a system to automatically compare radar and flight plan information with ADS-B reported position, and examine the ADS-B quality indicators [1] and Flight Identification (FLTID) contained in the ADS-B reports.

5.2 The system will intake all recorded information on ADS-B, radar targets and ATS flight plans in an offline manner. For each ADS-B flight, the system will compare it with its corresponding radar and flight plan information, and analyse if the following pre-defined criteria are met :-

(a) Deviation between ADS-B reported position and independent referenced radar position is greater than 1NM for more than 5% of total number ADS-B updates; or

(b) NUC of each ADS-B reported position is smaller than 4 for more than 5% of total number of ADS-B updates; or

(c) FLTID entered via cockpit interface and downlinked in ADS-B data (i.e. I021/170 in Asterix CAT 21) does not match with aircraft callsign in the ATS Flight Plan for more than 5% of total number of ADS-B updates.

5.3 For (a) above, deviation between ADS-B and radar tracks is set to 1NM in accordance with ICAO Circular 326 defining position integrity (NUC) shall be at least 4 (0.5NM < HPL < 1NM) for 3NM aircraft separation use, on assumption that radar targets are close to actual aircraft position. 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.

5.4 The system will generate a list of aircraft meeting the above pre-defined criteria showing full details of each occurrence such as date/time of occurrence, Mode S address, screen capture of radar and ADS-B history tracks, graphs of NUC value changes and deviation between radar and ADS-B tracks along the flight journey. A sample screen shot of the system is given at Attachment B for reference.

* * * * * * * *

[1] Navigational Uncertainty Category (NUC) for Version 0 avionics (DO260) and
Navigational Integrity Category (NIC) and Source Integrity Level (SIL) for Version 1 and Version 2 avionics (DO260A and DO260B)

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 DO260B development. 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 advise that a new TPR901 transponder compliant with DO260B will be available in 2014. This new transponder will not exhibit the 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 transmission.

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
				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) b) As the aircraft enters	**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
		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, QFA7550, QFA7552,	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
	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 report integrity too	Design error reports integrity one value worse than reality	**No.**	Can be treated in the same manner as a loss of transponder capability.

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
	conservatively		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.	
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 NUC occurs on certain airframe and

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
				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 when unexpected low NUC

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
				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.

Figure 1 - Track Jumping problem with TPR901

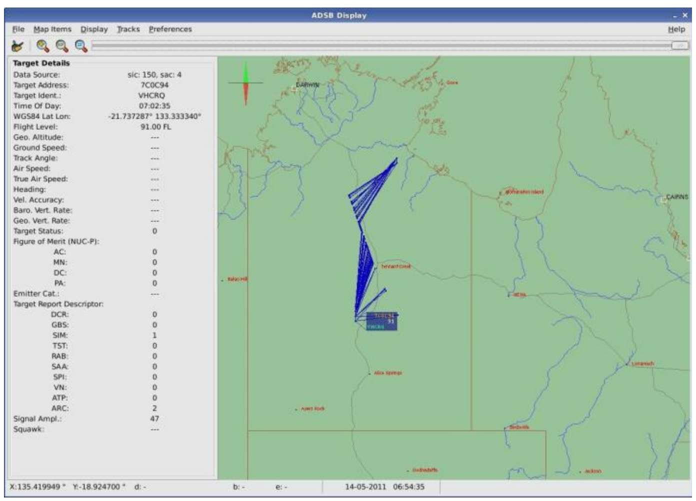


Figure 2 - Rockwell Collins TDR94 Old version. The pattern of erroneous positional data is very distinctive of the problem

Figure 3 - Garmin "N" Flight ID problem

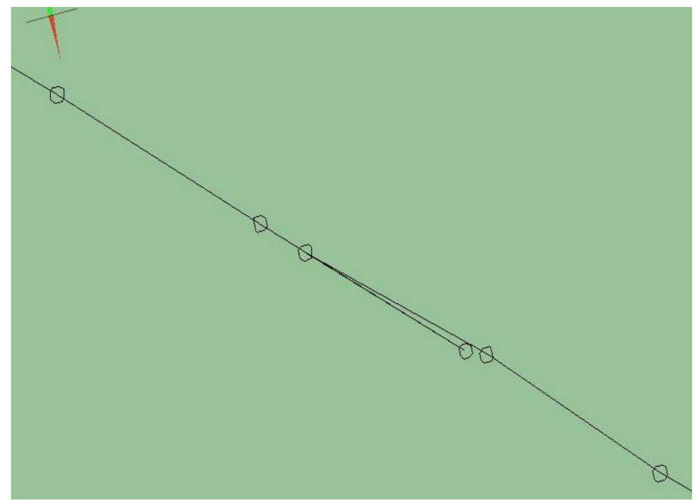


Figure 4 - Occasional small position jump backwards

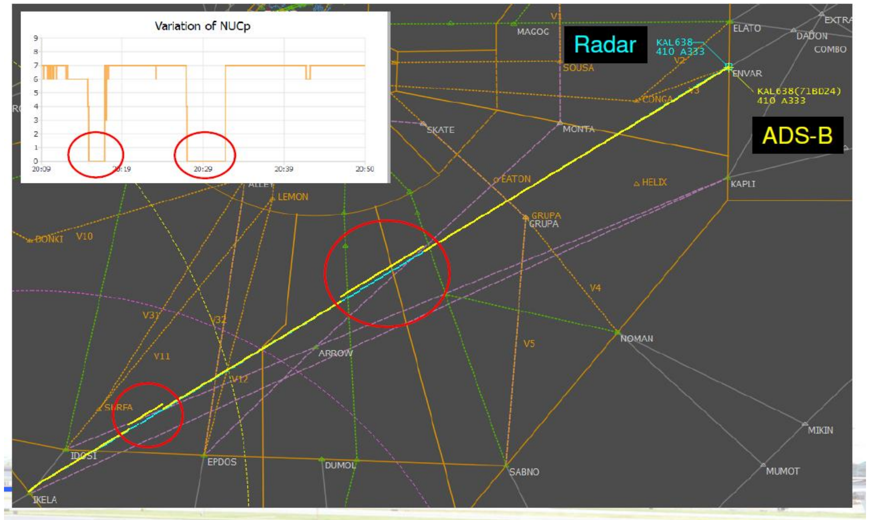


Figure 5 - NUC value toggling

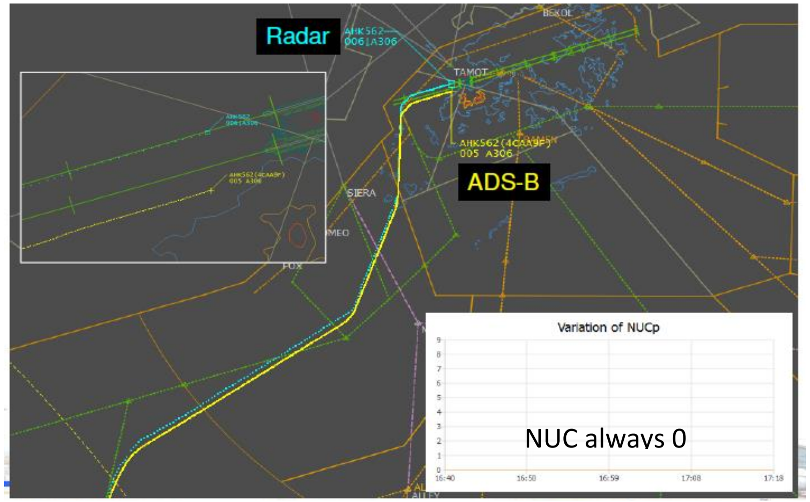


Figure 6 – Consistent low NUC

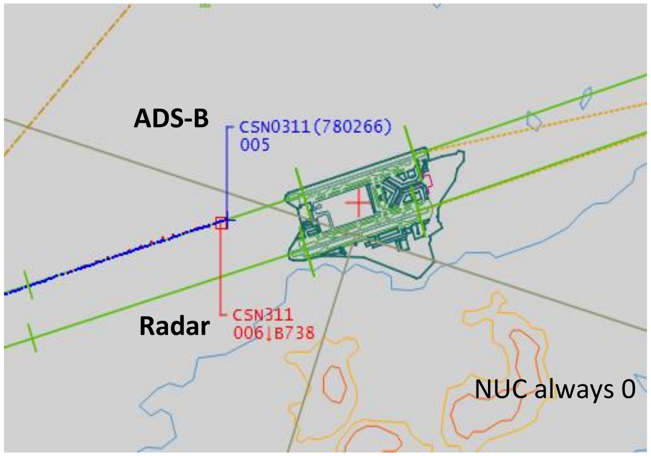


Figure 7a - Additional zero inserted

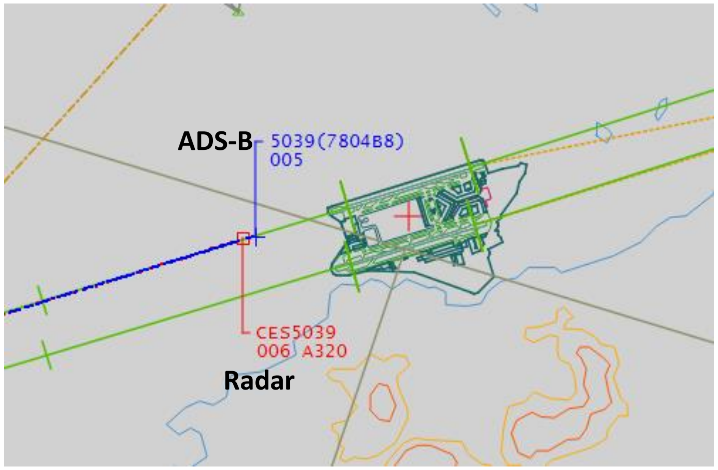


Figure 7b - ICAO Airline Designator Code dropped

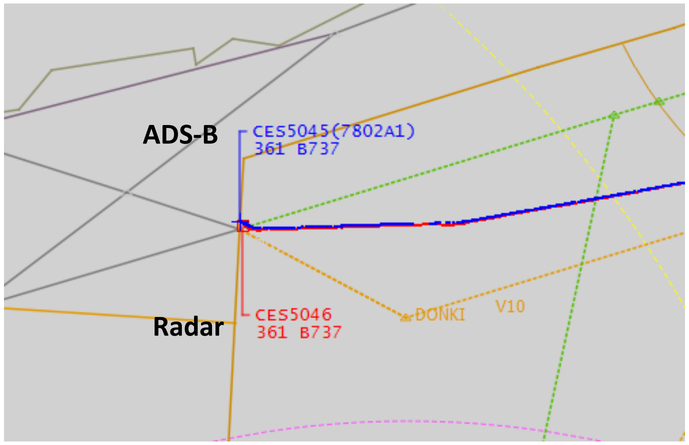


Figure 7c - Wrong numerical codes entered

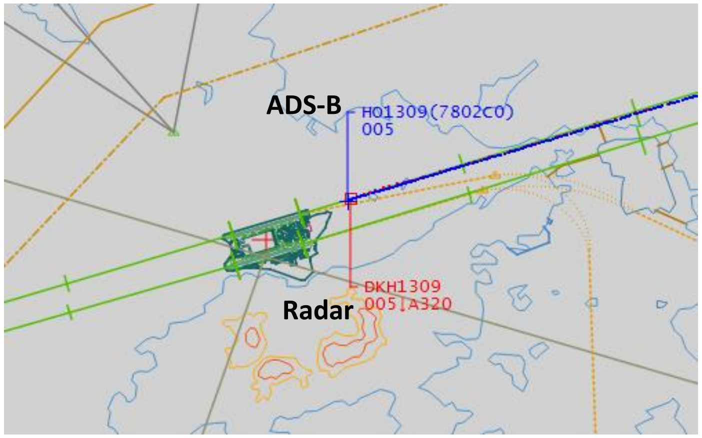
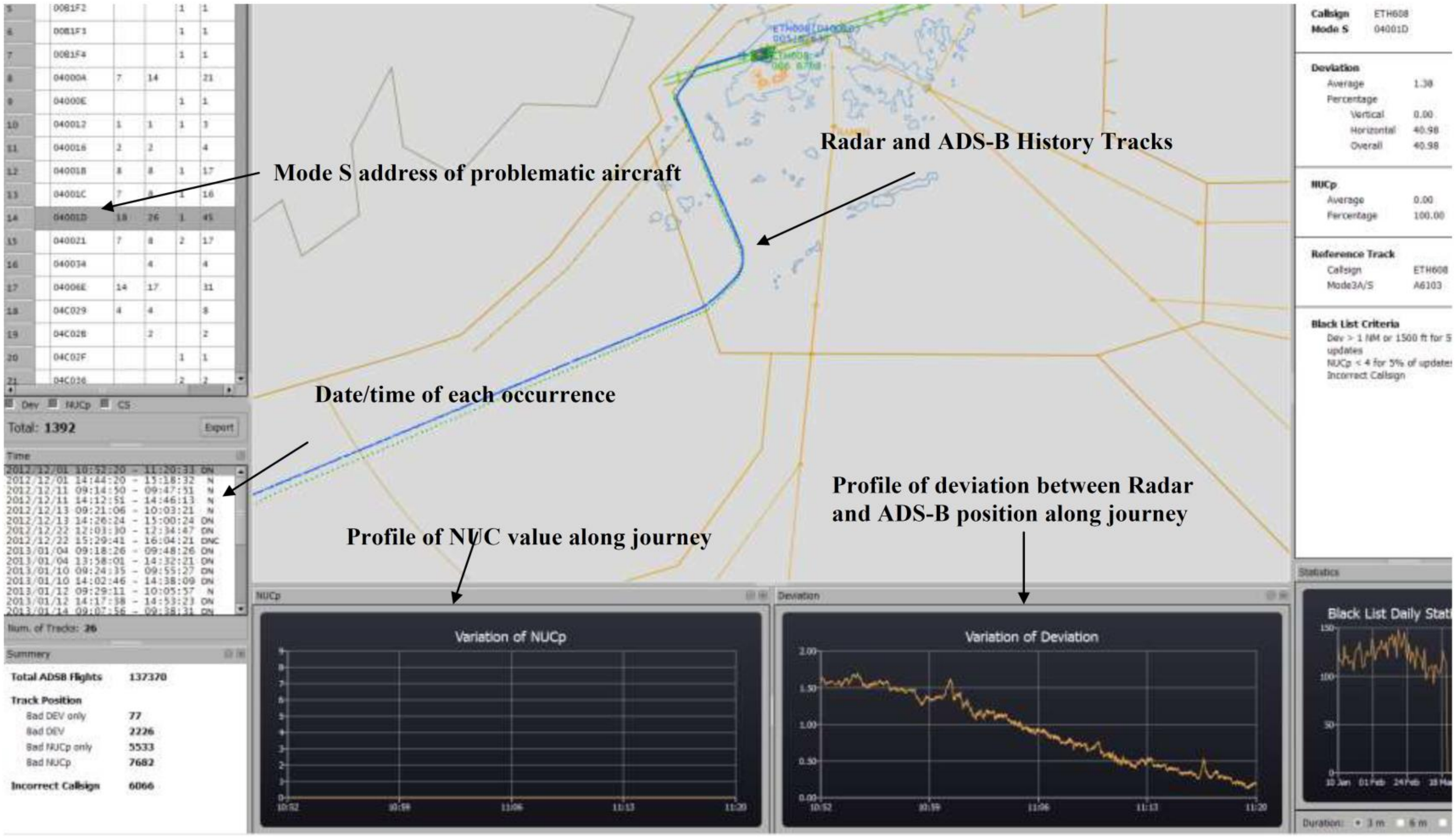


Figure 7d - IATA Airline Designator Code used

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



Appendix 1: Content and Format of the ADS-B Avionics Problems Reporting Database (APRD)

Mandatory Information
These fields must be provided in order to allow the data to be shared.

Desirable Information
These data are useful and desirable to be provided. However, as the data might not be always available at the time of problem being detected / observed, lack of these data shall not prevent the problem from being timely reported and shared.

Table 1a – Instances of Aircraft Exhibiting the Problem

Field	**Description**	**Mandatory (M) or Desirable (D)**
Instance ID	A unique identification number to specify the instance if aircraft exhibiting the problem	M
ICAO 24-bit Code	Unique aircraft address expressed in Hexadecimal form (e.g. 7432DB)	M
Date	UTC date when the problem was detected / observed for this aircraft	M
Time	UTC time when the problem was detected / observed for this aircraft	M
Aircraft Type	The aircraft type designator of the aircraft as specified in Doc 8643	M
Organisation*	The name of organisation reported the problem	M
Location	ICAO Designator of the Flight Information Region as specified in Doc 7910 where the problem was detected / observed	M
Problem Type	A reference linked to the Problem Type Table	M
Specific Description	Information to describe the problem specific to this occurrence in additional to the generic description under Problem Type	M
Operator	ICAO designator as specified in Doc 8585 for the current operator of the concerned aircraft	D
State of Registry	ICAO designator as specified in Doc 7910 for the current State of Registry of the concerned aircraft	D
State of Operator	ICAO designator as specified in Doc 7910 for the current State of Operator of the concerned aircraft	D
Departure Airport	The ICAO designator of the departure airport of the concerned aircraft as specified in Doc 7910.	D
Arrival Airport	The ICAO designator of the arrival airport of the concerned aircraft as specified in Doc 7910.	D
Registration	Registration number (tail number) of the concerned aircraft	D
Flight ID (FLTID)	The flight identification (Flight ID) transmitted by ADS-B for display on a controller situation display or a CDTI	D
Aircraft ID (ACID)	Aircraft Identification (ACID), not exceeding 7 characters, entered in Item 7 of the flight plan	D

Field	**Description**	**Mandatory (M) or Desirable (D)**
ADS-B Operational Approval	Yes or No to indicate whether ADS-B operational approval has been obtained from the State of Registry	D
Date of ADS-B Operational Approval	Date for granting ADS-B operational approval (if applicable)	D
Flight Plan	Text of the complete flight plan including surveillance indicators and field 18	D

Note : Data fields marked with asterisk (*) mean the data will only be accessible by the Database Administrator, and will not be shared in order to protect identity of the originator of the problem report.

Table 1b – Problem Type

Field	**Description**	**Mandatory (M) or Desirable (D)**
Problem Type	A unique identification number to specify a type of generic problem	M
Problem Description	A detailed description of this type of generic problem	M
Verifier	The name of organization verified the problem	M
Confirmed	Indication that whether the problem has been verified by the verifier (Yes / No)	M
Verifier comments	Comments by the verifier	M
ADS-B Transponder	Description on transponder manufacturer, parts number, software version as appropriate	D
Transponder Message Format	DO260, DO260A or DO260B	D
GNSS	GNSS manufacturer, parts number, software version as appropriate	D
Position Integrity	Description of NUC or NIC when problem is detected	D
Aircraft OEM Response	Response and/or rectification plans of Airframe Manufacturer when advised of problem	D
Avionics OEM Response	Response and/or rectification plans of Avionics Manufacturer when advised of problem	D
Problem Fixed	Indication that whether the problem has been rectified (Yes / No)	D

Field	**Description**	**Mandatory (M) or Desirable (D)**
Ground Station Manufacturer	Ground Station Manufacturer, model number and software version as appropriate (sometimes it is difficult to determine if the problem is airborne equipment or ground station equipment)	D

Table 1c - Format of the ADS-B Avionics Problems Reporting Database (APRD)

Field	**Type**	**Size**	**Remark**
Instance ID	Number	6 digits	1 - 999999
ICAO 24-bit Code	Text	6 chars	Hexadecimal form (e.g. 7432DB)
Date	Date	10 chars	Format : dd.mm.yyyy
Time	Time	5 chars	Format : hh.mm
Aircraft Type	Text	4 chars	e.g. A333
Organization	Free Text	200 chars	Name of the organization to which the originator belongs
Location	Text	4 chars	e.g. VHHK stands for Hong Kong FIR
Specific Description	Free Text	5,000 chars	Free text to be entered supplemented with attachments (e.g. diagrams, photos, screen shots etc.), if any, to illustrate any specific description on the instance
Operator	Text	3 chars	e.g. CPA stands for Cathay Pacific Airways
State of Registry	Text	2 chars	e.g. VH stands for Hong Kong China
State of Operator	Text	2 chars	e.g. VH stands for Hong Kong China
Departure Airport	Text	4 chars	e.g. VHHH stands for HKIA
Arrival Airport	Text	4 chars	e.g. VHHH stands for HKIA
Registration	Text	11 chars	The registration marking of aircraft (e.g. EIAKO, 4XBCD, OOTEK),
Flight ID (FLTID)	Text	7 chars	The ICAO three-letter designator for the aircraft operating agency followed by the flight identification (e.g. KLM511, BAW213, JTR25)

Aircraft ID (ACID)	Text	7 chars	The ICAO three-letter designator for the aircraft operating agency followed by the flight identification (e.g. KLM511, BAW213, JTR25)
ADS-B Operational Approval	Text	1 char	"Y" or "N" for Yes or No
Date of ADS-B Operational Approval	Date	10 chars	Format : dd.mm.yyyy or NA (not applicable)
Flight Plan	Text	5000 Chars	The ICAO Flight Plan
Problem Type	Number	4 digits	1 - 9999
Problem Description	Free Text	5,000 chars	Free text to be entered supplemented with attachments (e.g. diagrams, photos, screen shots etc.), if any, to illustrate the problem
Verifier	Free Text	200 chars	Name of the verifier on the problem
Confirmed	Text	1 char	"Y" or "N" for Yes or No
Verifier comments	Free Text	5,000 chars	Free text to be entered for verifier's comment
ADS-B Transponder	Free Text	5,000 chars	Free text to be entered on transponder manufacturer, parts number, software version as appropriate
Transponder Message Format	Text	6 char	DO260, DO260A or DO260B
GNSS	Free Text	5,000 chars	Free text to be entered on GNSS manufacturer, model number and software version as appropriate
Position Integrity	Free Text	200 chars	Free Text to be entered to describe the NUC or NIC value when the problem is detected
Aircraft OEM Response	Free Text	5,000 chars	Free text to be entered supplemented with attachments (e.g. diagrams, photos, screen shots etc.), if any, to illustrate the response and/or rectification plans of Aircraft Manufacturer

Avionics OEM Response	Free Text	5,000 chars	Free text to be entered supplemented with attachments (e.g. diagrams, photos, screen shots etc.), if any, to illustrate the response and/or rectification plans of Avionics Manufacturer
Problem Fixed	Text	1 char	"Y" or "N" for Yes or No
Ground Station Manufacturer	Free Text	5,000 chars	Free text to be entered on ground station manufacturer, model number and software version as appropriate

Appendix 2 : ADS-B Avionics Problem Reporting Form

<table>
<tr><td colspan="3">ADS-B Avionics Problem Reporting Form</td><td>ID : (to be filled by ICAO)</td></tr>
<tr><td>*Date UTC :</td><td></td><td>*Time UTC :</td><td></td></tr>
<tr><td>Registration :</td><td></td><td>Aircraft ID :</td><td></td></tr>
<tr><td>Flight ID :</td><td></td><td>*ICAO 24-bit Code:</td><td></td></tr>
<tr><td>*Aircraft Type :</td><td></td><td>*Location :</td><td></td></tr>
<tr><td>Departure Airport :</td><td></td><td>Arrival Airport :</td><td></td></tr>
<tr><td colspan="4">* Problem 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 may not be able to provide all the information (e.g. the controller may not know everything that happened on the aircraft), it would be helpful if they would coordinate with concerned parties to provide the requested information :
• A complete description of the problem being reported
• The route contained in the FMS and/or 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
• Diagrams and other additional information (such as printouts of message logs) may be appended to illustrate the reported problem if considered useful.</td></tr>
<tr><td>ADS-B Transponder :</td><td colspan="3"></td></tr>
<tr><td>GNSS :</td><td colspan="3"></td></tr>
<tr><td>Position Integrity :</td><td></td><td>Transponder Message Format :</td><td></td></tr>
<tr><td>Ground Station Manufacturer :</td><td colspan="3"></td></tr>
<tr><td>*Organization :</td><td></td><td>Operator :</td><td></td></tr>
<tr><td>State of Operator :</td><td></td><td>State of Registry :</td><td></td></tr>
<tr><td>ADS-B Operational Approval (Y/N) :</td><td></td><td>Date of ADS-B Operational Approval :</td><td></td></tr>
<tr><td>Flight Plan :</td><td colspan="3"></td></tr>
</table>

Note :
(a) The fields marked with asterisk (*) are mandatory fields required to be filled in.
(b) Please refer to Table 1a - 1b in Appendix 1 for detailed description of each field on the Form.

Proposal for Amendment of
Regional Supplementary Procedures ICAO Doc 7030/5
(Serial No. xxx APAC-S 14/09 – MID/ASIA/PAC)

a) **Regional Supplementary Procedures, Doc 7030/5:** MID/ASIA and PAC

b) **Proposing State:** ICAO

c) **Proposed Amendment:** 7. On page MID/ASIA 5-3 dated 30/11/07

5.5 Automatic Dependent Surveillance – Broadcast (ADS–B)

Insert the following text on 5.5.1:

5.5.1 Carriage and operation of ADS–B OUT

~~To improve safety, efficiency and to maximize seamless delivery of ATC services within the region, harmonized ADS-B OUT equipage mandates may be applied as follows :~~ [SS1]

5.5.1.1 All aircraft operating within the following FIRs shall carry and operate a serviceable ADS–B ~~facility~~ OUT [SS2] equipment within designated portions of airspace and the conditions mandated by the State with responsibility for the FIR concerned: Auckland Oceanic, Bangkok, Beijing, Brisbane, Chennai, Colombo, Delhi, Dhaka, Fukuoka, Guangzhou, Hanoi, Ho Chi Minh, Honiara, Hong Kong, Incheon, Jakarta, Kabul, Karachi, Kathmandu, Kolkata, Kota Kinabalu, Kuala Lumpur, Kunming, Lahore, Lanzhou, Male, Manila, Melbourne, Mumbai, Nauru, Phnom Penh, Port Moresby, Pyongyang, Sanya, Shanghai, Shenyang, Singapore, Taibei, Ujung Pandang, Ulan Bator, Urumqi, Vientiane, Wuhan, Yangon.

5.5.1.2 The portions of airspace referred to in 5.5.1.1 may only be designated [SS3]after the following actions had been undertaken:

a) appropriate consultation with affected airspace users and affected Air Traffic Control (ATC) units;

b) conduct of a safety case, which includes, *inter alia*, a human factors review [SS4]and the integration of data into the ATC workstation;

c) appropriate pilot and ATC training[SS5];

d) the ability to provide an enhanced service delivery; and

e) promulgation of the airspace mandate with appropriate notice, and in accordance with the provisions of Annex 15.

8. On page PAC 5-3 dated 30/11/07

5.5 Automatic Dependent Surveillance – Broadcast (ADS–B)

Insert the following text on 5.5.1:

5.5.1 Carriage and operation of ADS–B OUT

~~To improve safety, efficiency and to maximize seamless delivery of ATC services within the region, harmonized ADS-B OUT equipage mandates may be applied as follows :~~

5.5.1.1 All aircraft operating within the following FIRs shall carry and operate a serviceable ADS–~~B facility~~B OUT equipment within designated portions of airspace and the conditions mandated by the State with responsibility for the FIR concerned: Anchorage Oceanic, Auckland Oceanic, Nadi, Tahiti.

5.5.1.2 The portions of airspace referred to in 5.5.1.1 may only be designated after the following actions had been undertaken:

a) appropriate consultation with affected airspace users and affected Air Traffic Control (ATC) units;

b) conduct of a safety case, which includes, *inter alia*, a human factors review and the integration of data into the ATC workstation;

c) appropriate pilot and ATC training;

d) the ability to provide an enhanced service delivery; and

e) promulgation of the airspace mandate with appropriate notice, and in accordance with the provisions of Annex 15.

Coordinated implementation of ADS-B equipage mandates and associated ATC ground systems are essential to the improvement of safety, and efficiency, and to the maximization of seamless delivery of ATC services within the region,

d) **Proposers' Reasons for Amendment:**

Since 2011, the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) has agreed to a number of Conclusions designed to facilitate the enhancement of Air Navigation Services (ANS) within performance-based airspace. In essence, APANPIRG endorsed the concept of airspace mandates to improve the safety and efficiency of airspace, as long as there was appropriate consultation and a performance benefit to airspace users. The development of the Seamless ATM Plan in 2013 was the main mechanism for States to improve ANS and airspace performance on a region-wide basis. The Conclusions are as follows:

APANPIRG/22 (2011)

C 22/8 ADS-B Airspace Mandate
That, States intending to implement ADS-B based surveillance services may designate portions of airspace within their area of responsibility:
a) mandate the carriage and use of ADS-B equipment; or
b) provide priority for access to such airspace for aircraft with operative ADS-B as equipment over those aircraft not operating ADS-B equipment.

C 22/36 Amendment to Regional Supplementary Procedures on ADS-B
That, the Regional Supplementary Procedure Doc7030 MID/ASIA Chapter 5 be amended in accordance with the established procedure to include regional requirements on ADS-B as provided in the Appendix N to the report on Agenda Item 3.4.

While it is recognised that States may introduce restrictions and performance-based measures over their sovereign territory, mandates over the High Seas need to be implemented in line with regional air navigation agreements; in this case through APANPIRG. Thus it is necessary to introduce an amendment to the Regional Supplementary Procedures (ICAO Doc 7030) for Asia/Pacific FIRs that allows States to designate portions of performance-based airspace when they are able to provide the performance benefit and in accordance with aircraft equipage and capability.

The level of ANS capability and aircraft equipage varies throughout the Asia/Pacific, so it is intended that States will designate airspace when possible, in either exclusive or 'non-exclusive' (mixed mode with lower priority for non-equipped aircraft), as appropriate.

e) **Proposed Implementation Date of the Amendment:** Upon approval of the Council

f) **Proposal Circulated to the Following States and International Organizations:**

Afghanistan
Australia
Bangladesh
Brunei Darussalam
Cambodia
China
(cc: Hong Kong, China)
(cc: Macao, China)
Cook Islands
Democratic People's

Mongolia
Myanmar
Nauru
New Zealand
Palau, Republic of
Papua New Guinea
Philippines
Republic of Korea
Samoa
Singapore

Republic of Korea	Solomon Islands
Fiji	Sri Lanka
France	Thailand
Indonesia	Timor-Leste
Japan	Tonga
Kiribati	United States
Lao People's Democratic Republic	Vanuatu
	Viet Nam
Malaysia	IATA
Maldives	IFALPA
Marshall Islands	IFATCA
Micronesia, Federated States of	IBAC

g) **Secretariat Comments:**

The amendment of Doc 7030 in respect of ADS-B, ADS-C, ACAS II and Mode S transponders, together with amendment proposals APAC-S 14/07 and 14/08 for MID/ASIA and PAC Regions, provides a framework for the state to establish performance based airspace, with consideration of such matters as existing and proposed airspace user equipages, mandate timing, definition of airspace volumes (both vertical and horizontal), exclusive or non-exclusive application, exemption provisions and management of State aircraft.

The amendment is specifically intended to enable States to promulgate airspace mandates over the High Seas, and to encourage a regional approach to the establishment of such mandates, where it is appropriate to do so and recognizing that it is not practical for the Asia/Pacific Region to establish Sub-Regional or Region-wide simultaneous mandates. This is in accordance with the concept of the Seamless ATM and performance-based approaches, as well as the Aviation System Block Upgrade (ASBU) initiative and Global Air Traffic Management Operational Concept (ICAO Doc 9854).

READINESS CHECKLIST TABLE

Readiness	AUS	SING	INDO	VIET	CHINA	HK	INDIA	MAL	BAN
ADS-B targets displayed on operational ATC screen?	✓	✓	✓	SEP	✓	○	✓	Nov13	✓
Blacklist filtering system & procedures	✓	✓	○	○	TBC	✓	○	✗	✓
Foreign Filter system and Datasharing capability/willingness	✓	✓	✓	✓	TBC	✓	✓	✗	✓
ATC procedures & ATC training 7 ATC manual	✓	✓	○	✓	✓	○	✓	✗	✓
Maintenance support contract or arrangements	✓	✓	○	✓	TBC	✓	✓	✓	✓
Maintenance staff training & certification	✓	✓	✓	✓	TBC	○	✓	✓	✓
Mandate & process for ADS-B avionics failure	✓	✓	○	✓	✓	✓	○	✗	✓
Extensive publicity about mandate	✓		○	○	✗	✓	○	✗	✓
Recording, monitoring, analysis and feedback capability?	✓	✓	✓	✓	TBC	✓	✓	✓	✓
Avionics installer community engaged (GA &/or Bizjet)	✓		○	○	TBC	Biz	○	✗	NA
Contacts in Airlines, A/C Manufacturers, Avionics Co	✓	AL	○	AL	○	✓	✓	✓	A/L
Regulator & ATC management of Exemption flights inc state aircraft	✓	✓	○	○	✓	✗	○	✗	TBD
Fitment rate (do NOT include NUC=0 aircraft)	>90%	75	NA	60	85	85	60	75	
Remove display if without "operational approval"	✗	✗	✗	✗	✗	✗	○	✗	✗
AIP SUP or AIC	✓	✓	○	✓	✗	✓	soon	✗	✓
Flight ID correction & pilot performance	✓	✓	○	○	✓	○	✓	✗	✓
Has State given operational approval to own aircraft	✗	✓	✗ will	✓	✓	✓	✗ will	TBD	✗ will
Airline Flight planning OK	✓	✓	○	✓	○	○	○	adhoc	✓