International Civil Aviation Organization

NINETEENTH MEETING OF THE COMMUNICATIONS/NAVIGATION AND SURVEILLANCE SUB-GROUP (CNS SG/19) OF APANPIRG

Bangkok, Thailand, 20 – 24 July 2015

Agenda Item 6.1: **Review Report of the Fourteenth Meeting of ADS-B Study and Implementation Task Force (ADS-B SITF/14) including the progress made by the SEA/BOB ADS-B Working Group and the ADS-B Seminar**

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

(Presented by the Secretariat)

SUMMARY

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

1. INTRODUCTION

1.1 The Fourteenth Meeting of the Automatic Dependent Surveillance – Broadcast (ADS-B) Study and Implementation Task Force (ADS-B SITF/14) hosted by the Civil Aviation Authority of New Zealand and Airways New Zealand was held in Christchurch, New Zealand from 14 to 17 April 2015. An ADS-B Seminar was held in conjunction with the ADS-B SITF/14 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/2015-ADS-B-SITF14.aspx

1.3 The Numbers of Appendices referred in this paper are the same of those attached to the meeting report of ADS-B SITF/14.

2. DISCUSSION

2.1 The ADS-B SITF/14 meeting formulated 6 Draft Conclusions for consideration by this meeting. The meeting considered 26 Information Papers and 18 Working Papers. 11 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. 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 Tenth meeting of the SEA/BOB ADS-B Working Group (SEA/BOB ADS-B WG/10). Action taken on the report was consolidated in the report of the ADS-B SITF/14 meeting.

2.4 The SEA/BOB ADS-B Working Group meeting was held in Singapore from 11 to 13 November 2014. The report of the Working Group and an associated ADS-B Seminar is available on the ICAO APAC website: http://www.icao.int/APAC/Meetings/Pages/2014-SEABOB-ADSBWG10.aspx

2.5 The SEA/BOB ADS-B WG meeting noted the updates on the implementation and coordination activities provided by Australia, Bangladesh, China (Sanya FIR), Hong Kong China, Indonesia and Sri Lanka. The meeting reviewed the implementation status in the APAC region which is provided in the Appendix A to this paper for further updates.

2.6 The meeting noted that lack of separation minima for using ADS-B/CPDLC and ADS-B/SATCOM Voice (DCPC) was an issue identified by the Working Group. After discussion, the meeting endorsed the following draft Conclusion formulated by SEA/BOB ADS-B WG:

Draft Conclusion ADS-B SITF 14/1 – Need Guidance on Separation Minima

That, ICAO (SASP) be invited to study the separation minima that can be applied using ADS-B with CPDLC and ADS-B with "DCPC" type (i.e. without operators) of SATCOM voice in remote airspace outside the range of VHF voice communications of the responsible ATC unit.

2.7 Regarding the need to formulate ADS-B performance standards for any future space-based ADS-B implementation, the meeting adopted the following Decision:

Decision ADS-B SITF 14/2 – Study the application of space based ADS-B

That, the ADS-B SITF or its alternate body to:

a) study the application of space-based ADS-B in the Asia Pacific region; and
b) focus on regional aspects, develop recommendations on implementation of ADS-B delivered from space-based platforms, and on required performance standards.

2.8 Regarding the performance requirement for the space based ADS-B service, the meeting also considered that it is a global issue therefore it would be more appropriate to refer it to ICAO Headquarters for further action.

2.9 The meeting also noted that the Terms of Reference of SEA/BOB ADS-B WG had been amended by the Working Group to include the identification of implementation issues and proposal of solutions for the identified issues.

2.10 Singapore had presented their monitoring result for ADS-B stations and the avionics to the WG meeting. Singapore had shared that about 90% of the ADS-B equipped airframes were equipped with DO-260 avionics, about 6% were equipped with DO-260A avionics and 4% were equipped with DO-260B avionics.

Date and venue for the next WG meeting

2.11 The working group meeting identified the need to organize another meeting to progress implementation of the sub-regional plan. The member States/Administrations of the Working Group were invited to coordinate with the Secretariat for hosting the next SEA ADS-B WG meeting in late 2015.

ADS-B Use in Complex Airspace

2.12 In response to one the action items, Australia provided clarification on the applicability of ICAO Circular 326 in complex airspace, and the definition of low-complexity airspace. The paper explained Circular 326 information relating to the measurement of ADS-B performance against the reference radar, the key minimum ADS-B performance requirements for 3NM or 5NM separation, and the specified reference radars used by SASP. It was noted that in all cases States/Administrations still need to do a safety assessment to cover any additional factors related to the airspace and traffic density mix.

2.13 It was clarified that dependent surveillance system requirements did not change with airspace complexity. In airspace with just two aircraft being separated, the need for update rate, accuracy, and resolution was just as great as the case when 50 aircraft were displayed to the controller. The minimum separation standard was the minimum that could be applied within the surveillance volume in the best conditions. Some States required higher reliability of service in more complex regions because contingency procedural separation may not be viable. Circular 326 did not impose any greater ADS-B or MLAT performance characteristics in complex airspace unless the relevant State has a higher surveillance performance baseline requirement than the reference MSSR used in Circular 326. Circular 326 arrived at the required performance figures through comparison of position accuracy, integrity, latency and update rate. Reliability/continuity, resolution and capacity may have also been considered. A number of recommendations for reference by States/ Administration were provided below:

1) Whether complex or not, States/Administrations should consider whether the current or required surveillance system performance was better, equivalent or worse than the SASP reference;

2) If the current or required surveillance system used by States/Administration was lower or equivalent in performance than the reference MSSR used in Circular 326 Appendix A, then that State may use the Appendix C performance criteria;

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

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

Amendment to AIGD

2.14 Based on the outcomes of the meeting and in response to Action Items the meeting identified the need for further update of the AIGD. The consolidated amendment to AIGD is provided in Appendix C to the report which is also attached to this working paper. The amendments included the following:

- Updated guidance on monitoring and analysis of ADS-B; Appendix 2 Section 5 rewritten (WP/14);

- Updated the categories of ADS-B avionics problems; added new category items 18, 19 and 20 to Appendix 2 (Attachment A to WP/13);

- Updated guidance materials on disabling ADS-B transmissions; amended paragraph 9.9.2.1 (WP/17); and

- Removed reference to 'operational approval' for use of ADS-B OUT by ATC; Paragraphs 5.2.5 (d) and 6.2 (Draft Conclusions ADS-B SITF 14/4 and 14/5)

2.15 In view of the foregoing, the meeting formulated the following Draft Conclusion for consideration by CNS SG:

Draft Conclusion ADS-B SITF 14/3 – AIGD Amendment

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

Operational Approval for Receiving ADS-B Surveillance Service

2.16 APANPIRG/25 held in September 2014 considered that the APAC Region would benefit from an alignment with the experience of States that have used ADS-B for many years. This would in turn provide substantial benefits to operators and enhance inter-regional operations. APANPIRG/25 therefore did not adopt the second part of the draft Conclusion formulated by ADS-B SITF/13 meeting i.e. "States in the Asia and Pacific Regions may choose to require or not require an Operations Specification or Operations Approval for ADS-B OUT". The APANPIRG/25 meeting agreed to form an ad hoc group to review the issue and develop a consensus on the requirement.

2.17 The outcomes of the ad-hoc group included 3 proposed Draft Conclusions, which were reviewed by the SEA/BOB ADS-B WG/10 and subsequently presented in WP/04.

2.18 Australia described the historical context and debate during the development of the ADS-B standards regarding provision of pilot capability to turn off ADS-B transmissions. In the end, the standards did not require this capability and most aircraft did not have the ability to allow the pilot to turn off ADS-B transmissions without turning off the ATC transponder. It was agreed by all parties that pilots should not turn of the ATC transponders to solve ADS-B issues.

2.19 It was noted that Australian procedures required ATC to request pilots to recycle and or select the secondary transponder if ADS-B issues were encountered - and appropriate incident reports be raised. In this connection, Australia shared with the meeting the following experience:

a) Relatively few aircraft have the ability to disabled ADS-B transmissions; and

b) The only action possible for most pilots, for an aircraft transmitting misleading ADS-B is to respond to ATC requests to recycle or select the alternate transponder.

2.20 Australia agreed to re-consider the CAO requirement for the avionics to "allow the pilot to activate and deactivate transmission during flight" to bring the CAO into line with accepted ADS-B standards.

2.21 Japan presented the view that removal of the need for Operational Approval could decrease safety due to a number of hazards, and that operational approvals would provide an additional safety barrier that would allow these risks to be better controlled. Japan further stated their view that operational approval would reduce the rate of misleading ADS-B transmissions. The hazards identified by Japan included:

- the need for higher reliability of ADS-B transmission in an environment of growing traffic and the use of ADS-B IN;
- higher numbers of misleading and non-compliant ADS-B could be expected due to the increase in the number of ADS-B-capable aircraft; and
- the number of operators unfamiliar with ADS-B would increase.

2.22 Following a series of side meetings to further discuss the issues, A Flimsy was prepared by the Secretariat to record the discussions on the issues, and to propose revised Draft Conclusions. As a result, the meeting accepted the following as self-evident:

a) Flight Crew should be competent to use ADS-B equipment in both normal & emergency modes;

b) ADS-B transmissions must be correct & misleading transmissions must be disabled as per 7030 Regional procedure;

c) States of Registry should ensure that operators equip with appropriate avionics & establish appropriate training programs; and

d) Maintenance, training and on-going airworthiness must ensure that ADS-B signals are correct.

2.23 The complete record of the meeting's discussions on operations approvals was provided in Appendix D to the meeting report.

2.24 Accordingly, the meeting agreed to the following Draft Conclusions, to be presented to CNS/SG/19 for endorsement and subsequently to APANPIRG/26 for adoption:

Draft Conclusion ADS-B SITF 14/4 – Airworthiness and Filtering Process for ADS-B Avionics Equipage

That, States:

a) do not require operational approval for the operational use of ADS-B OUT by ATC;

b) note that operational approval may be required for ADS-B IN applications where there is a safety case;

c) monitor ADS-B transmissions from aircraft and take action to ensure compliance with Regional Supplementary Procedure MID/ASIA Section 5.5; and

d) provide capabilities to either

- reject ADS-B data from aircraft which are known to transmit misleading ADS-B data until corrective actions have been successfully conducted; or

- implement procedures to ensure that such aircraft are safely managed.

Draft Conclusion ADS-B SITF 14/5 – Template for Promulgation of ADS-B Avionics Equipage Requirements

That, based on APANPIRG Conclusion 20/54, States intending to implement ADS-B based surveillance service for a defined airspace and having not published regulations be urged to promulgate mandating rules for ADS-B Avionics Equipage Requirements as soon as possible using the following template:

On and after dd/mm/yyyy, if an aircraft operates on airways (insert routes)…………at or above FLXXX………(or in defined airspace boundaries ……………. at or above FLXXX):

the aircraft must carry serviceable 1090 MHz ES ADS-B transmitting equipment that has been certificated as meeting EASA AMC 20-24, or FAA AC No. 20-165A – Airworthiness Approval of ADS-B, or meets the equipment configuration standards in Appendix XI of Civil Aviation Order 20.18 of the Civil Aviation Safety Authority of Australia.

Note: This Conclusion supersedes APANPIRG Conclusion 21/39 (i.e. removes any requirement for operations approval)

Draft Conclusion SITF 14/6 – Guidelines for Airworthiness Approval for ADS-B Avionics Equipage

That, States be advised to use the guidelines provided in **Appendix E** for Airworthiness Approval for ADS-B OUT Avionics Equipage.

Note: This Conclusion supersedes APANPIRG Conclusion 21/40

2.25 In addition, the meeting also agreed to update the AIGD by removal of the reference to operations approval for ATC use of ADS-B OUT. This amendment was included in the consolidated amendment to the AIGD.

2.26 The Task Force Chair thanked all parties for their cooperation, flexibility, perseverance and efforts made to reach consensus, especially noting the considerable work done by Japan in this regard.

ADS-B Flight Planning

2.27 Australia informed the meeting that many flight plans were submitted with incorrect ADS-B capability indicators in Item 10. Advice developed for operators by Australia was provided to the meeting for consideration. The meeting agreed to incorporate the information as part of consolidated amendment to the AIGD.

Catalogue of Known ADS-B Avionics Issues

2.28 Australia provided a catalogue of known ADS-B avionics issues experienced by Australia's ANSP. While almost all ADS-B avionics operated correctly, a few issues had been encountered by a number of States. Noting that there were few ADS-B avionics problems, and the solutions for most problems had been identified (usually transponder software revisions), Australia recommended that ANSPs report any identified ADS-B issues to their regulator, the aircraft operator, the avionics vendor and the ICAO regional ADS-B database custodian, including all appropriate details.

2.29 The meeting also agreed to include the catalogue in an amendment to the AIGD to be consolidated by Hong Kong China and Australia. The meeting reconfirmed the need for continuous performance monitoring for the ADS-B OUT service.

Enhancing Aviation safety through Establishment of a Regional ADS-B Avionics Problem Report Database (APRD)

2.30 Hong Kong China reported the latest satisfactory progress in establishment of a Regional ADS-B Avionics Problem Reporting Database (APRD) in collaboration with the ICAO Regional Sub-office (RSO), Australia and Singapore, and called for support on continuous development, operation and maintenance of the database.

2.31 At the previous ADS-B SITF meetings, Hong Kong China, Australia and Singapore presented working papers highlighting their work undertaken to monitor and analyse avionics performance of ADS-B equipped aircraft. In the 51st DGCA Conference held in November 2014, Hong Kong China presented a paper outlining a proposal on the establishment of the Regional APRD for sharing the analysis results with a view to enhancing aviation safety for the Region. The proposal gained support from the Conference. Subsequently, Hong Kong China, in collaboration with Australia and Singapore, has been working closely with the ICAO RSO to develop technical requirements for the database, together with procedures for provision and sharing of data. Hong Kong reported the progress in developing the database which had been satisfactorily demonstrated. The demonstration included the work flow of problem reporting and phases of processing, and also highlighted the roles of the reporting Administration/ANSP, ICAO, verifying and follow-up parties, as well as a prototype of the database and human-machine interface (HMI) design. Support from the participants on the work flow, database and HMI design was solicited with positive feedback being received. The feedback/opinion would be duly considered and incorporated into the detailed design of the APRD as appropriate.

2.32 Hong Kong China further highlighted that the APRD will contain useful information on the generic ADS-B avionics performance problem commonly encountered in the Region, and encouraged States/Administrations including the registered operators to make best use of the database to improve the quality of avionics equipage in ADS-B mandated airspace, to report and share ADS-B avionics problems with others, to keep abreast of the latest reported problems, and to exchange among themselves the lists of airframes exhibiting the problems for civil aviation authorities to follow-up with airline operators concerned for remedial action.

2.33 The APRD would be posted on an ICAO secure website, with States/Administrations requesting access required to nominate registered points-of-contact, who would be notified whenever there were updates to the APRD. A discussion forum would be created to facilitate the sharing of views on reported problems. The Appendix 1 to the working paper introduced the workflow of problem reporting and processing.

2.34 The meeting agreed that the reporting State should be added as a non-hidden field in the information accessible in the database, to allow other States to contact the reporting State directly to gain further information or detail. The meeting also considered that ICAO Aircraft Address was essential for validation of the reported issue as this information was broadcast in all ADS-B downlinked data, so it is already publicly available information.

2.35 In response to an enquiry on the plan for launching the database, Hong Kong China clarified that the date of launching of the database had not been determined, and that development completion was dependent on resources in ICAO and Hong Kong CAD.

Draft Guidance Material – Reporting and Analysis of ADS-B Anomalies

2.36 Australia, Hong Kong China and Singapore presented proposed changes to the AIGD to include general guidance on systematic collection of data on ADS-B anomalies (ADS-B SITF/14 WP/14 Appendix A), and addressing of them from a tactical/operational perspective as well as a more strategic perspective to identify the root cause and obtain corrections. As result of discussion, the meeting agreed to include the proposed changes to the AIGD.

IFR Flight to Australia Post-February 2017

2.37 Australia provided information (WP/11) reminding States of a number of instruments issued by the Australian regulator on 15 May 2014, requiring that all IFR flights to Australia on or after February 2017, including those by foreign operators, must be ADS-B OUT equipped. ADS-B transmitters shall be compliant with DO260 or DO260A or DO260B. The websites with relevant regulations published were provided in the working paper.

Regional ADS-B Requirement for New Aircraft

2.38 Based on the previous discussion on this subject, Australia proposed revised wording for an Asia/Pacific Region ADS-B forward fitment commencing in 2018. It was recalled that the Ninth Meeting of the South East Asia and Bay of Bengal Sub-regional ADS-B Implementation Working Group (SEA/BOB ADS-B WG/9) formulated a drafting the Conclusion 9/1 – ADS-B OUT Forward Fit, relating to requirement for fitment of Version 2 ES ADS-B avionics for APAC Region applicable to aircraft with airworthiness certificate issued on or after 8 January 2017.

2.39 The proposal was further proposed and discussed at CNS SG/18 meeting. The draft Conclusion was not endorsed due to concerns raised about the costs that it would impact the GA fleet in some States. Instead, States were encouraged to consider the cost effectiveness of publishing forward fit and retrofit mandates when planning their transition to ADS-B, and early promulgation of their mandates and transition plans for forward fit.

2.40 It was considered that adequate time had now elapsed to allow such consultation. The emergence of space based ADS-B further supported the proposal, and global tracking using ADS-B out would only be possible if all aircraft equipped with the proposed ADS-B 1090 technology used by space-based ADS-B. The meeting noted that the European Commission amended their ADS-B fitment regulations and delayed the forward fitment mandate from January 2015 to June 2016. The retrofit rule for existing aircraft was also delayed until June 2020.

2.41 It was pointed out that as the lowest cost of fitment of ADS-B was during manufacture, the proposal would allow the avoidance of later retrofit costs, bringing long term savings to the aviation community without any significant cost in the short term. The meeting discussed the benefits of a forward fit of DO260B avionics. While the Asia/Pacific Region had taken the pragmatic view of ADS-B implementation using DO-260 and DO-260A, implementation of DO-260B would leverage off the Europe and FAA mandates and promote global harmonization. Mandates for forward fit would minimize the economic burden on aircraft operators, as it would not apply to existing aircraft.

2.42 Defining a forward fit mandate according to the date of issue of a certificate of airworthiness could result in the mandate being applied to an imported aircraft that is quite old. Mandates determined by date of manufacture were a better option.

2.43 In this connection, the meeting also noted the approach of Japan on this matter provided in WP/17, in which Japan stated that they had no need for ADS-B forward fitment.

2.44 As result of discussions, the meeting clarified that the overall purpose was to commence the transition to a DO-260B environment by applying only to newly manufactured aircraft from a defined future date. Accordingly, the meeting developed a revised Draft Conclusion as follows:

Draft Conclusion ADS-B SITF 14/7 - ADS-B OUT Forward Fit Equipage

That, States/Administrations in APAC Region be strongly encouraged to mandate that registered aircraft with a maximum certified take-off mass exceeding 5 700 kg or having a maximum cruising true airspeed capability greater than 250 knots, with a date of manufacture on or after 8 June 2018 (two years after the European forward fitment mandate is effective) be equipped with ADS-B avionics compliant with Version 2 ES (equivalent to RTCA DO260B) or later version.

2.45 The purpose of this proposed forward fit mandate is to ensure that:

a) Operators avoid the more expensive retrofit activity of ADS-B by operators in the future; and

b) ANSPs and States minimise corresponding opposition to ADS-B fitment mandates in the future based on the cost of retrofit.

2.46 Status of Implementation issues and experience gained in monitoring performance of aircraft were provided by a number of States/Administrations at ADS-B SITF meeting including Australia, China, Indonesia, Japan, Philippines, Republic of Korea, Singapore and USA.

ADS-B and Mulitlateration Operational Service within New Zealand

2.47 The meeting was updated on Airways New Zealand's experience since the introduction of ADS-B and multilateration surveillance into the New Zealand Air Traffic Management System (ATMS) in December 2013. The multilateration network was originally designed to provide surveillance around Queenstown airport, and was later expanded to cover the lower South Island, for application in enroute separation provided by Christchurch Centre.

2.48 Operational and safety efficiencies for Airways and cost savings for aircraft operators were detailed, including reduced separation, increased surveillance coverage, increased track update rate at controller work positions, increased traffic handling capacity, controller acceptance and buy-in, a reduction in the number of air safety incident reports, less hold-downs for aircraft within surveillance coverage, and track shortening where applicable.

2.49 The wide area multilateration (WAM) system had become a critical tool for the provision of enroute ATC.

Update on the ADS-B Collaboration Project in the South China Sea

2.50 The meeting noted the progress of the collaborative efforts of Indonesia, Singapore and Viet Nam to achieve seamless ADS-B surveillance coverage over a portion of the South China Sea area, with the aim of improving safety, capacity and efficiency. ADS-B data from Singapore, Matak and Natuna were being shared between Indonesia and Singapore. The implementation of DCPC services from Matak and Natuna were ongoing. Singapore had received ADS-B data from Con Son, and VHF radio at Con Son had been commissioned and used operationally for ATS in the Singapore FIR.

2.51 Singapore and Viet Nam had agreed on a progressive phased approach to reduce longitudinal separation on specified ATS routes to allow airspace users the optimum benefits of ADS-B. From the previous 50 NM longitudinal separation, the minimum separation would be reduced to 20NM over 3 phases commencing in December 2013 and planned to be completed at the end of 2015.

Development of Asia/Pacific Regional ADS-B implementation plan and sub-regional ADS-B implementation plan

Review Information contained in the FASID Tables CNS 4A & 4B (WP/12)

2.52 The Secretariat presented the surveillance related planning/implementation information for the Asia and Pacific Regions including ADS-B contained in the Regional Air Navigation Plan Vol. II - the Facilities and Services Implementation Document (FASID) i.e. Table CNS 4A – Surveillance Systems and Table CNS 4B - ATS Automation Systems in Part IV of the ASIA/PAC FASID (Doc 9673).

2.53 The meeting noted the guidance from AN Conf/12 Recommendation 6/1 regarding alignment of regional air navigation plan with global air navigation plan and Decision 25/1 regarding development of the new APAC e-ANP.

2.54 It was noted that CNS Tables 4A and 4B are not included in the new harmonized ANP templates for Vol. II. The meeting noted that some part of the information contained in these Tables was considered useful by Ad Hoc CNS Working Group meeting (April 2015) for the national planning purpose and/or serving as a basis for air navigation service charges, some specific requirement for APAC region would be required for inclusion in the Vol. II as regional specific requirements.

2.55 The meeting supported the proposal of the ad hoc e-ANP WG to keep some essential information from these two tables, merged into one consolidated table as a regional specific requirement. In this connection, the meeting had no objection to the initial sample combination, as presented by Thailand at the e-ANP working group meeting. The information in the draft was expected to be further populated with assistance from States/Administrations and then presented to CNS SG/19 meeting for consideration.

ADS-B in the South Pacific

2.56 Tonga provided information on the ADS-B implementation plans of the governments of the Republic of Kiribati, Samoa, Tonga and Tuvalu (and potentially Vanuatu) under the Pacific Aviation Investment Program (PAIP), a World Bank initiative.

2.57 The PAIP included investments in four main components: Aviation Infrastructure Improvements, Aviation Sector Reform, Future Investments for Sustainability and Program Support and Training. The Aviation Infrastructure Improvements included ADS-B implementation and supporting communications. A rollout could begin almost immediately. ADS-B equipage was expected to be made mandatory for all resident aircraft.

Updates on South East Asia (SEA) and Bay of Bengal (BOB) Sub-regional Projects

2.58 The meeting reviewed and further updated the Sub-regional ADS-B implementation projects as presented by the Ad Hoc working groups (South East Asia, Bay of Bengal, Pacific Group and East Asia). The outcome of discussions by Ad Hoc working groups is consolidated and provided in Appendix F to this Report.

Review TOR of ADS-B SITF

2.59 The meeting considered there was no need to revise the TOR of the Task Force.

2.60 The meeting also discussed the issue of the life of the Task Force, outstanding issues/tasks, and whether any uncompleted tasks may be addressed by other contributory bodies of APANPIRG. It was recalled that the Task Force, which had met 14 times in the past 12 years. A number of guidance materials in particular for the AIGD had been developed and then adopted by APANPIRG from time to time to assist States in the planning and implementation of ADS-B. The Task Force would further discuss outstanding issues/tasks at its next meeting and, depending on the scale of work involved, any uncompleted tasks would be addressed by other contributory bodies of APANPIRG after the next meeting.

2.61 The meeting considered that there was a need for further work, whether by this group or another, on at least the following topics:

- ASBUs relating to ADS-B IN
- Implementation of Space Based ADS-B
- ASBU B0-NET using ADS-B
- Use of lower cost, lower performance ADS-B systems (TSO199)

2.62 The need for guidance on Mode S SSR planning and implementation was identified by the meeting, as the region was not taking advantage of the technology that was available to improve safety and efficiency outcomes and to protect the 1090 MHZ spectrum.

2.63 The meeting agreed that ADS-B SITF should meet in its present form for one more meeting in 2016 to provide the opportunity to finalize the current outstanding action items where possible, and to arrange for the transfer of action items and development of proposed TOR for a new or further evolved group that would potentially carry action items forward and conduct the work that was necessary in the study and implementation of broader surveillance technologies including ADS-B (including ADS-B IN and Space-Based), and SSR Mode S and Multilateration applications. The next meeting could be a joint meeting of a new Task Force and the ADS-B SITF.

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

2.65 States were invited to participate in an informal working group to develop proposed expanded Terms of Reference for a broader "Surveillance technology Task Force (STTF)", for consideration by CNS SG/19 in July 2015. The ad hoc working group was expected to meet during CNS SG/19 meeting and provide a proposal for the TOR of STTF.

Review of Cost Benefits for the Initial Phase of ADS-B Implementation over the South China Sea

2.66 As directed during the SEA/BOB WG, Singapore and CANSO reviewed the cost benefit study done in 2009. It was found that based on 30NM separation, the benefits outweigh the cost by $0.5 million in just one year (2014). It was noted that with further reduction in separation and increase in traffic, the benefits will increase significantly. Other benefits apart from economic savings include improved safety with enhanced tracking of aircraft and safer and more efficient weather deviations; enhanced aircraft surveillance with increased situational awareness for ATC and the facilitation of search and rescue as well as enhanced flight data collection for better analysis and planning. The meeting urged states to share ADS-B data as well as to expedite the implementation of similar ADS-B collaborations.

2.67 CANSO and IATA emphasized the importance of cooperation and collaboration between States/Administrations for implementation of the ADS-B based surveillance service and surveillance data sharing which is critical for improvement of ATM service in meeting rapid increase of air traffic in the sub-regions.

Australian Use of DAPs

2.68 Australia presented information describing the plan to utilize SSR Mode S Downlink Aircraft Parameters (DAPs). Mode S radars had the ability to interrogate 'registers' in Mode S SSR transponders to obtain useful information for ATC. Some ADS-B transmissions included the same information. Information already available from a large number of aircraft included Flight ID, selected vertical intention (pilot or FMS selected level and barometric pressure setting), track and turn report (roll angle, true track angle, groundspeed, track angle rate and true airspeed), heading and speed (magnetic heading, indicated airspeed, Mach no., true airspeed and inertial vertical velocity).

2.69 Airservices Australia used or planned to use DAPs for Flight ID, pilot or FMS selected level, indicated airspeed and true airspeed. The Australian Bureau of Meteorology was also expecting to use DAPs to support wind measurement and modelling.

2.70 The meeting was reminded of the need to ensure ground stations were upgraded to DO-260B capability. While existing non-DO-260B ground stations would produce good position information from DO-260B data, a ground station could misinterpret the data has having good integrity when the transmitted integrity was in fact zero (e.g. because SIL=0 and SIL is not processing). If DO260B data is being used by ground stations that have not been upgraded, States should ensure that they understand how DO260B transmissions are processed and that safety is preserved. Given the rapid increase in DO-260 aircraft equipage States were urged to upgrade their ground systems as soon as possible. The meeting reviewed the status of the ADS-B ground stations that capable in receiving DO260B data. The updated table of the compliant status is provided in Appendix G to this report.

Operational Use of Mode S and DAPs

2.71 New Zealand described their current and planned use of Mode S data and Downlink Aircraft Parameters (DAPs).

2.72 Aircraft Identification (Flight ID) was used to correlate SSR, WAM and ADS-B surveillance tracks with flight plans when a Mode A SSR code was not available or did not match the code in the flight plan, to identify VFR or IFR flights not correlated to a flight plan, and to alert ATC to a mismatch between transmitted Flight ID and the aircraft identification in the FPL.

2.73 ICAO Aircraft Address was used to correlate surveillance tracks to flight plans when a Mode A code was not available or did not match the code within the flight plan. Issues observed included incorrect Flight ID set by the crew (common), one observed occurrence of mismatch between the ICAO Aircraft Address transmitted and that recorded in the flight plan, and several instances of multiple aircraft transmitting the same ICAO Aircraft Address.

Note of appreciation

2.74 The meeting expressed its appreciation and gratitude to the Civil Aviation Authority of New Zealand and Airways New Zealand for hosting the ADS-B Seminar, the excellent arrangements made for the meeting and all activities arranged. The meeting also thanked CAA. Singapore for hosting the Tenth meeting of the ADS-B SEA/BOB WG meeting.

3. ACTION REQUIRED BY THE MEETING

3.1 The meeting is invited to review the report of the Fourteenth Meeting of ADS SITF and make recommendations on the draft Conclusions for consideration by APANPIRG/26.

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ADS-B IMPLEMENTATION STATUS IN THE APAC REGION

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
AFGHANISTAN	ADS-B & Multi Lateration system installed.				subject to safety assessment
AUSTRALIA	A total of 33 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 13 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 installed at Phnom Penh, Siem Reap and Stung Treng City since 2011 and able to provide full surveillance coverage for Phnom Penh FIR. Cambodia is willing to share data with others.				
CHINA	5 UAT ADS-B 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 nd M771. Chengdu-Jiuzhai project finished in 2008 with 2 ADS-B stations and	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
	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. 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	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. ADS-B operation in Hong Kong FIR re-scheduled for Dec. 2016. An AIP Supplement was issued on 29 Aug. 2014.

State/ Administration	ADS-B Ground Infrastructure and ATC System readiness or Implementation plan	Date of issue/effectiveness date of equipage mandate	Mandated Airspace and/or ATS-routes	Intended separation criteria to be applied	Remarks
	FL 290 within HK FIR was effective in December 2013 and within HK FIR at or above FL 290 is planned for December 2016. ADS-B ground station infrastructure completed in 2013. ADS-B trial using ADS-B signal provided by Mainland China to cover southern part of Hong Kong FIR commenced in 2010.				
MACAO, CHINA	Mode S MSSR coverage available for monitoring purposes.				
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.	ADS-B mandate commencing form 31st December 2013			
FRANCE *(French Polynesia)*	ATM system is ready for ADS-B sensors/Installation of 5 first GS expected at beginning of 2017. 2nd stage with implementation of 7 GS and associated VHF coverage.			5 NM for airspace under coverage.	

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
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 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.	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.
INDONESIA	30 Ground Station successfully installed. Since 2009, ATC Automation in MATSC has capabilities to support ADS-B application.	On 24 July 2014 DGCA published AIRAC AIP Supplement No. 10/14 for using ADS-B for situation awareness effective from 18 Sep. 2014 to 25 June 2015.			ADS-B Task Force Team is considering a mandate in 2016. Mandate for 3 ATS routes: B472, M768, R592

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
	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.	AIP Supplement on ADS-B Implementation (Tier-1)(mandate) being published with effective date on 25 June 2015.			from 25 June 2015 subject to safety assessment process.
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.				

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
MALAYSIA	Malaysia planned to start mandate ADS-B requirement in KL FIR in 2018 and full implementation of ADS-B service at specific routes/exclusive airspace by end of 2020. One station at Terrengganu. Plan to install two ADS-B stations at Pulau Langkawi and Genting Highland and new ATM centre being built for KL FIR. The project expected to complete by end of 2019.	Plan to issue mandate with target effective date end of 2018.			
MALDIVES	4 ADS-B stations installed in Nov. 2012 (2 at Male' Ibrahim Nasir Intl Airport, 1 at Kulhudhuffushi Island in the North and 1 at Fuah Mulah Island in the South to cover 95% of the FIR at/above FL290. Maldives' ADS-B is integrated with the ATM system (in November 2013), and under observation prior to commencing trials. Maldives has planned to share ADS-B data with its adjacent FIRs.				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.				
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.				

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 ZEALAND	MLAT and ADS-B data is being used from the WAM system centered in the Queenstown area to provide surveillance coverage and surveillance separation (5 nm) over the southern half of the South Island of New Zealand. Additionally MLAT data from the Auckland MLAT system is used to provide airport surface movements at NZAA. The New Zealand Navigation and Airspace and Air Navigation Plan "New Southern SKY" issued in May 2014			5 NM Surveillance Separation	
PAKISTAN	Tender for procurement of 5 ADS-B stations issued to be installed at Pasni, Lakpass, Rojhan, Dalbandin and Laram-top. Contract expected to be finalized by end of 2015. These stations will be DO260B compliant and operational by end of 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
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 within Port Moresby FIR and also in specific higher traffic areas domestically.				
PHILIPPINES	Four (4) ADS-B ground stations (Manila, Palawan, Pangasinan and Ilocos Norte) with target date to complete by end 2016. ATM Center expected to be available in 2016.				
REPUBLIC OF KOREA	ADS-B implemented 2008 for SMC in Incheon International Airport. ROK is developing ADS-B system since 2010 through R&D group. The testbed at Gimpor Airport 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				

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
	supplement to the radar in the terminal area and fill up the gap between radar coverage. The last phase from 2017 to 2020, ADS-B will be deployed for entire Incheon FIR.				
SINGAPORE	The airport MLAT system was installed in 2007 and "far-range" ADS-B sensor was installed in 2009. ATC system has been processing ADS-B data since 2013.	AIC was issued on 28 December 2010/effective from 12 Dec.2013. AIP supplement published in Nov 2013 to remind operators of ADS-B exclusive airspace implementation. AIP updated in Jan 2015 to remove the need for ops approval and to include the FAA standard as an additional accepted means to meet the equipage requirements.	L642 and M771. At and above FL290. Also affect the following ATS routes N891, M753, L644 & N892	40nm on ATS routes L642, L644, M753, M771, N891 and N892 30nm implemented on 26th June 2014 on ATS routes L642, M753, M771 and N892; 20nm planned for end 2015	Safety case was completed end of November. 2013.
SRI LANKA	ADS-B Trials planned for 2012 and implementation in 2013. 5 ADS-B ground station was planned and willing to share ADS-B data with neighbouring States through a cenral processor which is ready for trial in 4th Quarter 2014.				An AIC on ADS-B services with TMA of Colombo FIR issued on 10 Nov. 2014 (A02/14) with effective 1 Sep. 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
THAILAND	Multilateration implemented in 2006 at Suvarnbhumi Int'l. Airport. ADS-B Ground Stations (DO260B compliant) installed in Thailand for internal research and development project. ADS-B is planned to be part of future surveillance infrastructure. New ATM System to be operational in 2017 will be capable of processing ADS-B data.				
TONGA	Trial planned for 2017				
UNITED STATES	As of 1 April 2015, the "baseline" set of Service Volumes planned by the FAA in 2007 are operational, using data from 634 radio sites installed by Exelis. Since 2007, FAA has planned and funded activities to activate additional Service Volumes that Exelis will service using and additional 29 radio sites; 9 of these radio sites have been installed by Exelis as of 1 April 2015. As of 1 April 2015, 123 of the 231 U.S. air traffic control facilities are using	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 - indepen-	

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
	ADS-B for ATC separation; all facilities are planned to be using ADS-B by 2019.			dent parallel approach operations down to 4300 ft centreline separation - dependent parallel approach operations down to 2500 f centreline separation (currently 1.5 nm diagonal distance).	
VIET NAM	Two phases ADS-B implementation plan adopted. Phase 1 implemented in March 2013. Phase 2 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.

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INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

ADS-B IMPLEMENTATION AND OPERATIONS GUIDANCE DOCUMENT

Edition ~~7~~8.0 – September 201~~4~~5

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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: http://www.icao.int/APAC/Pages/edocs.aspx

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

1.4 CHANGES TO THE AIGD

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

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

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

1.5 EDITING CONVENTIONS

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1.6 AIGD REQUEST FOR CHANGE FORM

RFC Nr:	

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

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

1.7 AMENDMENT RECORD

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

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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~~ Source Integrity Level
SITF	Study and Implementation Task Force
STCA	Short Term Conflict Alert

2.2 GLOSSARY OF TERMS

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

3. REFERENCE DOCUMENTS

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

4. ADS-B DATA

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

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

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

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

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

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

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

5. ADS-B IMPLEMENTATION

5.1 INTRODUCTION

5.1.1 Planning

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

5.1.2 Implementation team to ensure international coordination

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

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

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

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

5.1.3 System compatibility

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

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

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

5.1.4 Integration

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

5.1.4.2 Communication system

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

5.1.4.3 Navigation system infrastructure

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

a) Data items; and

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

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

5.1.4.4 Other surveillance infrastructure

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

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

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

5.1.5 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~~1) air traffic certification of use;

e) implementation transition:

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

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

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

6. HARMONIZATION FRAMEWORK FOR ADS-B IMPLEMENTATION

6.1 BACKGROUND

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

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

6.2 TEMPLATE OF HARMONIZATION FRAMEWORK FOR ADS-B IMPLEMENTATION

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

45	Flight Level	SG, HK, CN : - At or Above FL290 (ADS-B airspace) - Below FL290 (Non-ADS-B airspace) VN to be confirmed	
56	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)
67	Flight Planning	Before 15 Nov 2012, as per AIGDDG On or after 15 Nov 2012, as per new flight plan format	
78	Aircraft ApprovalEquippage		
78a)	Procedures if Aircraft Not Approved Equipped or Aircraft without a Serviceable ADS-B Transmitting Equipment before Flight	SG, HK, CN : FL280 and Below VN to be confirmed	

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

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7. SYSTEM INTEGRITY AND MONITORING

7.1 INTRODUCTION

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

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

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

7.2 PERSONNEL LICENSING AND TRAINING

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

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

7.3 SYSTEM PERFORMANCE CRITERIA FOR AN ATC SEPARATION SERVICE

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

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

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

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The following recommendations need to be considered:

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

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

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

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

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

7.4 ATC SYSTEM VALIDATION

7.4.1 Safety Assessment Guidelines

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

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

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

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

7.4.2 System safety assessment

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

a) Identifying failure conditions;

b) Assigning levels of criticality;

c) Determining risks/ probabilities for occurrence;

d) Identifying mitigating measures and fallback arrangements;

e) Categorising the degree of acceptability of risks; and

f) Operational hazard ID process.

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

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

7.4.3 Integration test

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

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

7.4.4 ATS Operation Manuals

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

7.4.5 ATS System Integrity

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

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

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

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

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

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

7.5 SYSTEM MONITORING

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

Guidance materials on monitoring and analysis of ADS-B Avionics Performance are given at Appendix 2.

7.5.1 Problem Reporting System (PRS)

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

The PRS Administrator shall:

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

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

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

7.5.2 The monitoring process

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

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

a) ATS Providers;

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

c) Relevant State regulatory authorities;

d) Communication Service Providers being used;

e) Aircraft operators; and

f) Aircraft and avionics manufacturers.

7.5.3 Distribution of confidential information

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

7.5.4 ADS-B problem reports

Problem reports may originate from many sources, but most will fall within two categories; reports based on observation of one or more specific events, or reports generated from the routine analysis of data. The user would document the problem, resolve it with the appropriate party and forward a copy of the report to the PRS for tracking and distribution. While one occurrence may appear to be an isolated case, the receipt of numerous similar reports by the PRS could indicate that an area needs more detailed analysis.

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

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

b) Change to operating procedures;

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

d) Change to system design.

7.5.5 ADS-B periodic status report

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

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

7.5.6 Processing of Reports

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

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

b) Coordinate with aircraft operators;

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

d) Monitor the progress of problem resolution;

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

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

g) Coordinate with any Communication Service Providers used.

7.6 APANPIRG

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

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

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

c) monitor the progress of outstanding problem resolutions;

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

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

7.7 LOCAL DATA RECORDING AND ANALYSIS

7.7.1 Data recording

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

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

7.7.2 Local data collection

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

7.7.3 Avionics problem identification and correction

ATS providers need to develop systems to :

a) detect ADS-B avionics anomalies and faults

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

c) devise mechanisms and procedures to address identified faults

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

7.8 ADS-B PROBLEM REPORT

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

7.8.2 Description of Fields

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

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

8. RELIABILITY & AVAILABILITY CONSIDERATIONS

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

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

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

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

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

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

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

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

8.1 Reliability

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

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

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

8.2 Availability

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

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

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

8.2.4 Availability is calculated as

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

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

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

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

8.3 Recommendations for high reliability/availability ADS-B systems

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

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

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

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

- Having clear procedures in place which define who has authority to change configuration and records of the changes made including, inter alia

- The nature of the change including the reason
- Impact of the change & safety assessment
- An appropriate transition or cutover plan
- Who approved the change
- When the change was authorized and when the change was implemented

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

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

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

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

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

- Development and delivery of appropriate training to maintainers

- Competency based testing of trainees

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

E: Data collection & Review :

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

- Reports of actual achieved availability & reliability

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

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

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

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

- System and component obsolescence

- Staff skills and need for refresher training

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~~Appendix 3 on the template for ADS-B mandate/regulations ~~on provision of ADS-B based ground surveillance~~for aircraft avionics. Some States listed below have published their ADS-B mandate/regulations on their web sites that could also be used for reference.

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

"http://www.comlaw.gov.au/Details/F2012C00103/Download"

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

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

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

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

9.3 FACTORS TO BE CONSIDERED WHEN USING ADS-B

9.3.1 Use of ADS-B Level data

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

9.3.2 Position Reporting Performance

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

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

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

ADS-B reports with low integrity may be presented on situation displays, provided the controller is alerted (e.g. by a change in symbology and/or visual alert) to the change and the

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

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

<u>ADS-B Data-sharing for ATC Operations</u>

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

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

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

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

<u>ADS-B Data-sharing for Safety Monitoring</u>

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

Civil/Military ADS-B Data-sharing

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

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

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

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

9.3.5 Synergy of ADS-B and GNSS

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

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

If the fleet is equipped with ADS-B, they will already have most of the requirements to use GNSS for navigation satisfied. Similarly, if aircraft have suitable GNSS on board, they will have a position source to support ADS-B. It is noted however, that some care is needed to ensure that the requirements of GNSS/PBN and surveillance are both satisfied.

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

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

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

9.4 Reporting Rates

9.4.1 General

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

9.5 SEPARATION

9.5.1 General

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

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

9.5.2 Identification Methods

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

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

b) transfer of ADS-B identification;

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

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

9.5.3 ADS-B Separation

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

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

9.5.4 Vertical separation

9.5.4.1 Introduction

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

9.5.4.2 Vertical tolerance standard

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

9.5.4.3 Verification of ADS-B level information

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

9.6 AIR TRAFFIC CONTROL CLEARANCE MONITORING

9.6.1 General

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

9.6.2 Deviations from ATC clearances

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

9.7 ALERTING SERVICE

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

9.8 POSITION REPORTING

9.8.1 Pilot position reporting requirements in ADS-B coverage

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

9.8.2 Meteorological reporting requirements in ADS-B airspace

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

9.9 PHRASEOLOGY

9.9.1 Phraseology Standard

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

TO REQUEST THE CAPABILITY OF THE ADS-B EQUIPMENT

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

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

TO REQUEST RESELECTION OF AIRCRAFT IDENTIFICATION
REENTER FLIGHT IDENTIFICATION.

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

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

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

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

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

Note:

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

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

9.9.2 Operations of Mode S Transponder and ADS-B

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

9.9.2.1 STOP ADSB TRANSMISSION or STOP SQUAWK

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

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

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

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

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

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

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

9.9.2.3 TRANSMIT ADS-B IDENT

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

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

9.10 FLIGHT PLANNING

9.10.1 ADS-B Flight Planning Requirement – Flight Identity

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

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

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

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

Or,

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

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

2) the aircraft is not equipped with radio.

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

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

9.10.2 ADS-B Flight Planning Requirements

9.10.2.1 ICAO Flight Plan Item 10 – Surveillance Equipment and Capabilities

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

These are defined in ICAO DOC 4444 as follows:

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

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

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

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

States should consider use of the revised descriptors in AIP.

9.10.2.2 ICAO Flight Plan Item 18 – Other Information

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

CODE/7C432B

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

9.10.2.3 Transponder Capabilities

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

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

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

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

States should consider use of the revised descriptors in AIP.

9.10.2.4 Inconsistency between ADS-B Flight Planning and Surveillance Capability

Inconsistency between flight planning of ADS-B and surveillance capability of an aircraft can impact on ATC planning and situational awareness. States are encouraged to monitor for consistency between flight plan indicators and actual surveillance capability. Where discrepancies are identified, aircraft operators should be contacted and instructed to correct flight plans, or general advice (as appropriate to the operational environment and type of flight planning problems) should be issued to aircraft operators. An example of such advice is provided at Appendix 43.

9.10.3 Setting Aircraft Identification (Flight ID) in Cockpits

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

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

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

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

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

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

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

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

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

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

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

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

a) aircraft broadcasting incorrect message formats;

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

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

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

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

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

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

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

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

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

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

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

then:

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

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

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

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

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

(a) EASA AMC 20-24; or

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

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

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

the aircraft must not fly unless equipment is:

(a) deactivated; or

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

Note:

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

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

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

9.12 EMERGENCY PROCEDURES

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

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

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

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

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

Executive control responsibility

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

Emergency procedures

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

10. SECURITY ISSUES ASSOCIATED WITH ADS-B

10.1 INTRODUCTION

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

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

10.2 CONSIDERATIONS

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

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

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

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

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

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Commissioning Readiness

The requirement for this form is specified in the System Management Manual (Section 11.2 of V4), C-MAN0107

Project/Task Name	**SAP Project/Task ID:**	**Sites or Locations affected:**
Documentation prepared by:	**Date:**	**Commissioning Date:**
Affected System(s)	**System Criticality**	**Change Consequence Level**
Brief Description of Change:		

Commissioning Readiness Endorsement

The endorsement of this form by the appropriate authorities as specified in the System Management Manual certifies that the requirements detailed in this form (with the exception of the non-critical deficiencies[1] listed herein) have been completed prior to the commissioning of the system change or new system.

Chief Engineer or Technical or Maintenance Authority

Name:	**Signature:**	**Date**:
Designation:		
Name:	**Signature:**	**Date**:
Designation:		

Chief Operating/User Authority or Operating/User Authority

Name:	**Signature:**	**Date**:
Designation:		

Records Management Instructions

Place the completed Commissioning Readiness Form, together with any support documents on the Project file

Provide a copy of the completed Commissioning Readiness Form to P&E, Asset Lifecycle Manager, Planning and Integration

Note 1: Non-critical deficiencies (NCD) are those outstanding technical and operational issues that do not prevent the safe and effective use or maintenance of the facility, but will be addressed in a specified and agreed time. NCDs shall be listed on the Commissioning Certificate (C-FORMS0300) and recorded in the relevant system (ASID / HEAT / SAIR). It is preferable for each NCD to be recorded as a separate Issue.

Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
1	OPERATIONAL SAFETY			
1.1	Provide a link to the completed SCARD **SCARD** Template (AA-TEMP-SAF-0042) Note: For unregulated systems the SCARD shall be used to assess the impact of the change and perform a preliminary hazard analysis	Safety Change Management Requirements **AA-NOS-SAF-0104**	Completed ☐ N/A ☐	**Link to SCARD**
1.2	The outcome of the SCARD will be the requirement for one of the following for commissioning: **Safety Statement** – included in SCARD or standalone Safety Statement which must provide Airservices Australia management with sufficient information to demonstrate that safety has been considered and the change presents minimal or no safety issues. **Safety Plan & Safety Assessment Report, or** **Safety Plan & Safety Case** Safety Plans, Safety Assessment Reports and Safety Cases are required to be available in the Document Search Database	Safety Change Management Requirements **AA-NOS-SAF-0104** Document Search Database	Completed ☐ N/A ☐	**Link to Safety statement or** **Link to Safety Plan & Safety Assessment Report or** **Link to Safety Plan & Safety Case**
1.3	Safety risk management process completed and includes • any new hazards / impact to existing hazards identified? • controls identified and in place? and • residual risk justified and accepted.	Safety Risk Management Procedures **AA-PROC-SAF-0105**	Completed ☐ N/A ☐	
1.4	Impacts on the Operational Risk Assessments from residual risks have been assessed and implemented using Operational Risk Assessment Change Request and Acceptance Record – AA-FORM-SAF-0032	Operational Risk Assessment **AA-NOS-SAF-0006** Safety Risk Management Procedures **AA-PROC-SAF-0105**	Completed ☐ N/A ☐	Link to Operational Risk Assessment Change Request and Acceptance Record:
1.5	Arrangements for monitoring and review of risks are in place including arrangements for safety performance monitoring following the transition.	Safety Risk Management Procedures **AA-PROC-SAF-0105**	Completed ☐ N/A ☐	
1.6	CASA have approved / accepted or been advised of the change, as applicable	Safety Change Management Requirements **AA-NOS-SAF-0104**	Completed ☐ N/A ☐	

Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
2	WORKPLACE HEALTH & SAFETY			
2.1	Initial WHS Hazard Identification must be completed as per the template **AA-TEMP-SAF-0020**	Safety Risk Management Procedures **AA-PROC-SAF-0105** Initial WHS Hazard Identification **AA-TEMP-SAF-0020** Workplace Health and Safety Risk Management Summary **AA-TEMP-SAF-0016**	Completed ☐ N/A ☐	**Link to completed Workplace Health and Safety Management Summary AA-TEMP-SAF-0016**
2.2	Ensure employees and stakeholders are consulted when significant changes to work arrangements are being considered.	Working Together Workplace Consultation **AA-PROC-SAF-0009**	Completed ☐ N/A ☐	
2.3	Tower Access / Classification assessed? Working at Heights Safety Checklist & Daily Toolbox Meeting (**F098**) Fall arrest facility / equipment available	Working at Heights **PROC-157** Working at Heights Safety Checklist & Daily Toolbox Meeting **F098**	Completed ☐ N/A ☐	
2.4	WHS hazard controls are in place - Safe Work Method Statement completed - Plant risks managed - Radhaz survey completed, published on the Avnet and general public & occupational exposure boundaries identified	Safe Work Method Statement **AA-TEMP-SAF-0017** Managing WHS Risk for Contractors and Projects **AA-PROC-SAF-0012** Plant Risk Management **PROC-134** RF Radiation, Surveys & Health & Safety Mgmt **PROC-121**	Completed ☐ N/A ☐	**Link to completed Safe Work Method Statement AA-TEMP-SAF-0017** **Link to completed F131 Plant Risk Management Checklist**
2.5	At the completion of works ensure WHS Inspections are completed and hazard controls are in place. Building condition; clean, undamaged, all work completed.	Conducting Workplace Safety Inspections **AA-PROC-SAF-0008**	Completed ☐ N/A ☐	

Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
3	ENVIRONMENT			
3.1	Environmental Impact must be assessed using the Environmental Impact Screening & Assessment Criteria for Changes to On-ground Activities Assistance in assessing the Environmental Impact can be obtained from Environment and Climate Change Unit in Environment Group.	Environmental Screening & Assessment Criteria for Changes to On-ground Activities **AA-REF-ENV-0010** Environmental Assessment of Changes to On-ground Activities. **AA-NOS-ENV-2.200**	Completed ☐ N/A ☐	**Link to completed Environmental Impact Screening and Assessment Form** **If a stage 2 assessment is required provide ARMS reference and links to any Permits, Master Development Plans and relevant correspondence as required.**
3.2	Environmental Clearance obtained for ATM changes as per **AA-NOS-ENV-2.100** Assistance in assessing the Environmental Impact can be obtained from Environment and Climate Change Unit in Environment Group.	Environment Assessment Process for ATM Changes **AA-NOS-ENV-2.100**	Completed ☐ N/A ☐	**Provide ARMS reference and NRFC reference if ATM change required**
4	PEOPLE- SUPPORT			
ATC TRAINING				
4.1	ATC Training Needs Analysis completed and Training Plan developed?		Completed ☐ N/A ☐	**Link to Training Needs Analysis and Training Plan**
4.2	Sufficient number of trained, rated and endorsed ATC staff available.		Completed ☐ N/A ☐	**Number Trained:**
4.3	ATC staff individual training records in SAP database have been updated		Completed ☐ N/A ☐	
4.4	Plans are in place to complete any outstanding training, rating, and endorsement of remaining ATC staff (Normally an identified hazard)		Completed ☐ N/A ☐	**HAZLOG Register No:**

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Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
TECHNICAL TRAINING				
4.5	Training Needs Analysis completed and Training Plan developed for system support staff and field maintenance staff?		Completed ☐ N/A ☐	**Link to Training Needs Analysis and Training Plan**
4.6	TechCert codes have been created, assessment criteria developed or existing assessment criteria has been amended	**TechCert codes** **TechCert Guides and Forms**	Completed ☐ N/A ☐	**Link to TechCert Guides and Forms**
4.7	Sufficient system support staff and field maintenance staff appropriately trained?		Completed ☐ N/A ☐	
4.8	Are plans are in place to complete any outstanding training and certification of system support staff and remaining field maintenance staff?		Completed ☐ N/A ☐	
4.9	Field maintenance staff hold the relevant TechCert to perform duties.	Technical Certification **PROC-141**	Completed ☐ N/A ☐	
4.10	Statutory / special licensing obtained by field maintenance staff including high risk work competencies and licensing requirements?		Completed ☐ N/A ☐	
4.11	ABS and FMS staff training details sent to Technical Training Coordinator and training records updated as required?	Training **PROC-119**	Completed ☐ N/A ☐	
4.12	TechCert details sent to FMS System Support to update the Qualifications (TechCert) Database	Technical Certification **PROC-141**	Completed ☐ N/A ☐	
LOGISTICAL SUPPORT				
4.13	CMRD have been consulted regarding special test equipment, test beds, etc		Completed ☐ N/A ☐	

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Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
4.14	CMRD / NDC have been consulted regarding spares holdings and repair of LRUs from this equipment or in-house support of Depot Level Support Contract / repair contract		Completed ☐ N/A ☐	
4.15	TEMACC advised of any specialised test equipment requirements.	Test Equipment Management **PROC-150**	Completed ☐ N/A ☐	
4.16	Maintenance support contracts in place (external and/or internal)? – Appropriate vendor and/or internal support? – Appropriate Level 3 maintenance arrangements		Completed ☐ N/A ☐	
4.17	Test equipment provided to maintenance base. Note: Test equipment purchasing and calibration requirements detailed in Engineering Execution Readiness form.		Completed ☐ N/A ☐	
4.18	Specialised hardware or software system support and field maintenance tools, test / patch leads, adaptors, isolators, electronic discharge protection (mats, straps), etc supplied?		Completed ☐ N/A ☐	
4.19	System Business Continuity/ Disaster Recovery provisions supplied/updated?		Completed ☐ N/A ☐	
4.20	Spares – Supplied, storage correct, transport cases supplied?	Management of Goods & Supplies **PROC-118**	Completed ☐ N/A ☐	
4.21	Spares – Software / firmware loaded, tested & configured?		Completed ☐ N/A ☐	
4.22	Service Restoration Times (SRT) established?	Airways Service Data **PROC-207**	Completed ☐ N/A ☐	

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Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
4.23	Conduct Hardware physical configuration audit and ensure SAP Plant Maintenance has updated information of all installed and/or demolished equipment (including monitoring circuits) and sent to System Operations SAP PM DATA CHANGES.	Equipment Installed/Demolished Advice SAP Data Input Form **F104**	Completed ☐ N/A ☐	**Link to Email from SAP PM Support confirming update/s**
5	PROCEDURES			
ATC DOCUMENTATION				
5.1	System Requirements documentation including Operating Concept or Business Process Rules - produced/updated and approved?		Completed ☐ N/A ☐	**Link to documentation**
5.2	Manual of Air Traffic Services (MATS) reviewed / updated. Aeronautical information publications (AIP Book, AIP SUPP, AIC, DAP, ERSA, Charts, etc) reviewed / updated. Amendment times are determined by the AIS Distribution Schedule	**AA Publications** **AIS Distribution Schedule**	Completed ☐ N/A ☐	**NRFC No.**
5.3	National ATC Procedures Manual (NAPM) and any other relevant ATC procedures reviewed / updated.		Completed ☐ N/A ☐	**NRFC No.**
5.4	ATC contingency / continuity plans reviewed / updated.	**ATS Contingency Plans** Business Continuity Plans **C-BCP**	Completed ☐ N/A ☐	**ATS-CP No:** **C-BCP No:**
5.5	NOTAM and/or AIP SUP issued / amended / cancelled	Works Planning **PROC-213** Refer also **LOA3024**	Completed ☐ N/A ☐	**NOTAM No:**
5.6	ATC Temporary Local Instruction (TLI) issued notifying Operational staff of change?	**Temporary Local Instructions & Database**	Completed ☐ N/A ☐	**NRFC No.**

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Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
USER DOCUMENTATION				
5.7	User/operator manuals updated		Completed ☐ N/A ☐	
5.8	User/operator procedures provided/updated as applicable		Completed ☐ N/A ☐	
5.9	On-line user/operator documentation completed and published		Completed ☐ N/A ☐	
5.10	ARFF instructions updated		Completed ☐ N/A ☐	
5.11	Other Business Groups instructions updated?		Completed ☐ N/A ☐	
TECHNICAL DOCUMENTATION				
5.12	Software design documents updated, adequate and supplied to system support?		Completed ☐ N/A ☐	
5.13	Software and/or dataset Version or Release Description Documentation supplied and adequate?		Completed ☐ N/A ☐	**Link to Version Description Document or Release Description Document**
5.14	Software installation procedure and instructions supplied/updated and adequate?		Completed ☐ N/A ☐	**Link to Installation Procedure**

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Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
5.15	**SMP**: System Management Plan created / updated and adequate?	SMP Template	Completed ☐ N/A ☐	**SMP No:**
5.16	**SCP:** System Contingency / continuity plans supplied/updated and adequate?	SCP Template	Completed ☐ N/A ☐	**SCP No:**
5.17	Technical drawings updated and listed in Data Viewer and list supplied to system supporters and field maintenance staff.	Technical Drawing Management PROC-178	Completed ☐ N/A ☐	
5.18	Technical handbooks/manuals supplied to ABS or FMS Engineering/IT support and field maintenance staff (base and site copy).	Document Management PROC-103	Completed ☐ N/A ☐	
5.19	On-line system support and field maintenance documentation completed and published		Completed ☐ N/A ☐	
5.20	Technical documentation registered and placed under documentation control	Document Management PROC-103	Completed ☐ N/A ☐	
5.21	Appropriate engineering performance requirements specified and issued for ongoing use? System Specification documentation supplied/updated and adequate?	System Performance Requirements & Reporting Specification ASYS-106	Completed ☐ N/A ☐	
5.22	**Configuration & Modification AEI:** Equipment and System Modifications and Configuration (for hardware and software), and Software Release Authorisations are documented in a Part 2 AEI (or other approved documentation)	Development of Maintenance Instructions for Equipment PROC-151	Completed ☐ N/A ☐	**AEI No/s:** **Link to documentation detailing configuration and modification**
5.23	**Maintenance AEI:** Maintenance requirements, including Performance Inspection tolerances, have been defined and documented in AEIs (or other approved documentation). (AEI Part 3,4,7)	Development of Maintenance Instructions for Equipment PROC-151	Completed ☐ N/A ☐	**AEI No/s:**

Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
5.24	**AEI:** New maintenance AEIs trialled by maintenance staff	Development of Maintenance Instructions for Equipment **PROC-151**	Completed ☐ N/A ☐	
5.25	**TTD**: Temporary Technical Dispensation raised and published on the Document Search database.	Temporary Technical Dispensations **PROC-153**	Completed ☐ N/A ☐	**TTD No:**
5.26	Site Manifest updated	Site Manifests **FMS-304**	Completed ☐ N/A ☐	
6	SYSTEM			
DESIGN REQUIREMENTS				
6.1	System Requirements documentation including Operating Concept or Business Process Rules - supplied/updated and approved?	Design Control **PROC-146**	Completed ☐ N/A ☐	**Links to documentation**
6.2	Standards – Installation and equipment comply with all relevant Australian Standards? Building Codes - Structures comply with the relevant Building Codes? The relevant Australian Standards and Building Codes are to be determined by the Chief Engineer, Technical Authority or Maintenance Authority	Australian Standards Design Control **PROC-146**	Completed ☐ N/A ☐	
6.3	Other applicable Federal and/or State licensing requirements met? The relevant licensing requirements are to be determined by the Chief Engineer, Technical Authority or Maintenance Authority	Design Control **PROC-146**	Completed ☐ N/A ☐	

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Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
6.4	Electrical Mechanical, Structure and Building impacts have been assessed as adequate or modifications organised and completed through consultation with Engineering Branch, P&E? (Power supply capability / airconditioning capacity / mast loadings)	Design Control PROC-146	Completed ☐ N/A ☐	
6.5	Earthing and Lightning Protection meets Airservices requirements?	Earthing and Lightning Protection Systems for Operational Facilities AEI 3.1504 Site Earthing and Lightning Protection Systems for Existing Installations AEI 2.3011	Completed ☐ N/A ☐	
6.6	Battery Procurement as per Airservices requirements?	Lead Acid Batteries (Stationary) Procurement and Acceptance Testing AEI-3.7050 Panel Contract Arrangement C-PROC0140	Completed ☐ N/A ☐	
6.7	Assessing the impact of information systems against corporate objectives (7 Ticks process).	Information Technology Application Certification –'7 Ticks' MI-0804 and PROC-190	Completed ☐ N/A ☐	**Link to completed 7 Ticks Interim Certificate or Final Certificate**
6.8	IT Security measures appropriate and in place(ie. to ensure effective security and control practices to minimise the risks of unauthorised access, inappropriate use, modification, destruction or disclosure of electronically held data).	IT Security Roles and Responsibilities Statement MS-0013 Information Security MI-0808 ICT Resources – Conditions of Use MI-0829	Completed ☐ N/A ☐	

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Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
6.9	Information Security	Information Security C-PROC0184	Completed ☐ N/A ☐	**Link to completed security risk management plan**
INSTALLATION REQUIREMENTS				
6.10	Has met the regulation and safety requirements for Telecommunications Installations. Cable Markers installed (external)? Equipment complies with ACMA statutory requirement Telecommunication Labelling (Customer Equipment and Customer Cabling) Notice 2001 as amended (i.e. 'A' ticked on the equipment compliance plate)	Implementing Regulation and Safety Requirements for Telecommunications Installations PROC-138 Installation of Optical Fibre Cable - Underground AEI 4.5001 Underground Cable Marking AEI 4.3001	Completed ☐ N/A ☐	**Link to Telecommunications Cabling Advice**
6.11	MDF/IDF Records created / updated? Labelling/Colour Coding – Rack, Cable, Chassis, etc.?	Colour Coding of RJ45 Patch Leads for Voice and Data Installations AEI 7.3241	Completed ☐ N/A ☐	
6.12	Transmitters licence label affixed	Radio Communication Transmitter Labelling AEI 7.4238	Completed ☐ N/A ☐	
6.13	Electrical Certificate of Testing and Safety or Testing and Compliance on connection to a source of electricity (i.e. installation conforms to AS3000) are required to be supplied as soon as possible after connection or testing of any electrical installation or change. Labelling – Switch Boards, etc Meets Airservices Electrical Cable Colour Coding requirements?	Electrical Safety Regulation 2002 Sections 15 and 159 AS 3000 – Aust Standard Electrical Cable Colour Coding AEI 3.1502	Completed ☐ N/A ☐	**Links to Electrical Certificates**

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Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
6.14	All modifications complete and scratch plate labels affixed to equipments	Identification of Airways Systems Equipment Hardware Modifications **PROC-154**	Completed ☐ N/A ☐	
6.15	Integration with National Technical Monitoring has been organised and completed through Engineering Branch, P&E?		Completed ☐ N/A ☐	
6.16	Alarm monitoring installed and tested at TOC for local and remote site?		Completed ☐ N/A ☐	
6.17	Source media – supplied/backed up, stored, registered with system support?	Software Media Archival and Storage **PROC-147**	Completed ☐ N/A ☐	
6.18	Site installable media – supplied/backed up, appropriately stored and registered by field maintainers?	Software Media Archival and Storage **PROC-147**	Completed ☐ N/A ☐	
6.19	Software licences provided, registered and appropriately stored? (Including details of any third party licensing)		Completed ☐ N/A ☐	
6.20	Update HEAT and/or ASID database to incorporate new system/version number and assign issue management roles?		Completed ☐ N/A ☐	

Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
DESIGN CONFIRMATION				
6.21	Airservices Physical Security requirements met. The minimum security requirements are specified in C-GUIDE0157. Physical Security advise can be obtained from the relevant Security Advisor in Security and Crisis Planning, Safety & Environment Physical Access requirements are determined and established Siting and accommodation impact has been assessed as being satisfactory or modifications organised through National Property?	Physical Security – Critical Operational Facilities **C-GUIDE0157** Site Management **PROC-170**	Completed ☐ N/A ☐	
6.22	Network data load impact has been assessed as being satisfactory or modifications organised and completed through Engineering Branch, P&E?		Completed ☐ N/A ☐	
6.23	Spectrum licences (either cancelled if no longer required or for new licenses including if antenna moves by more than 10 metres)	Frequency Management: Obtaining a Frequency Assignment and Licence **AEI 7.4202**	Completed ☐ N/A ☐	
6.24	New system or system change acceptance tests (software and/or hardware) satisfactorily completed against the approved system requirements? – Test Plans provided? – FAT, SAT, UAT test results complete, passed to the required level and provided? – Test identified defect listings and re-test information provided?	System Management Manual **SMM** Design Control **PROC-146**	Completed ☐ N/A ☐	
6.25	Battery Acceptance Tests as per Airservices requirements?	Lead Acid Batteries (Stationary) Procurement and Acceptance Testing **AEI-3.7050**	Completed ☐ N/A ☐	**Link to Battery Acceptance Test Results**

Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
6.26	Standard Operating Conditions (SOCs) / Site Configuration Data (SCD) established / approved	Standard Operating Conditions & Site Configuration Data Management **PROC-143**	Completed ☐ N/A ☐	
6.27	Flight Test results supplied and satisfactory	Certification of Radio Navigation Aid Facilities **AEI 7.4003**	Completed ☐ N/A ☐	
6.28	Equipment operation is as per AEI specifications and any additionally specified requirements? Relevant requirements and performance specifications to be determined by the Chief Engineer, Technical Authority or Maintenance Authority		Completed ☐ N/A ☐	
7	TRANSITION			
PLANNING				
7.1	Does the system meet all critical user and technical requirements?		Completed ☐ N/A ☐	
7.2	If non-critical deficiencies are proposed to be accepted into operation, are they managed and tracked via ASID, HEAT or SAIR, including responsibilities and timings and attached to the Commissioning Certificate?		Completed ☐ N/A ☐	
7.3	Cutover Plan prepared and authorised by: – Appropriate level of engineering authority? – Appropriate level of User Authority?	Cutover Plan **C-TEMP0045**	Completed ☐ N/A ☐	**Link to Cutover Plan**
7.4	Works plan created at least 7 days before deployment	Works Planning **PROC-213**	Completed ☐ N/A ☐	**Works Plan No.**

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Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
NOTIFICATION				
7.5	Industry education / notification been completed?		Completed ☐ N/A ☐	
7.6	Relevant Business Managers advised of impending change?		Completed ☐ N/A ☐	
7.7	Change requester and/or sponsor notified?		Completed ☐ N/A ☐	
7.8	System Operations' TOC and Service Desk notified and accepted operating responsibility for the change.		Completed ☐ N/A ☐	
7.9	ABS/FMS Manager has accepted maintenance responsibility		Completed ☐ N/A ☐	
7.10	Notify the following (as appropriate) that the system is at **"OPERATIONAL READINESS"** and provide details of commissioning and any system changes: **ATC** System Supervisor, Melbourne (ATC) System Supervisor, Brisbane (ATC) National ATC Systems Manager Operating Authority (relevant)	**Sys to Svc List**	Completed ☐ N/A ☐	

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Item No:	Requirement:	Requirement Reference: (Procedure/instruction used to specified required input)	Completed or N/A	Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)
7.11	Notify the following (as appropriate) that the system is at **“ENGINEERING READINESS”** and provide details of commissioning and any system changes: **P&E** Technical Authority (relevant) Technical Operations Centre – Director Service Desk -Airways SAP PM Support	**Sys to Svc List**	Completed ☐ N/A ☐	

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COMMISSIONING CERTIFICATE

The requirement for this form is specified in the System Management Manual (Section 11.2 of V4), C-MAN0107

Project/Task Name	**SAP Project/Task ID:**	**Sites or Locations affected:**
Documentation prepared by:	**Date:**	**Commissioning Date:**
Affected System(s)	**System Criticality**	**Change Consequence Level**
Brief Description of Change:		

Commissioning Approval

The approval of this document by the appropriate authorities as specified in the System Management Manual certifies that the new system or system change is satisfactory to meet the specified service and performance requirements; that system operating and support requirements are in place; that required user and technical training is adequately provisioned; as detailed in the Commissioning Readiness Form and consequently the new system or system change is declared fit-for-purpose and can be deployed and operated until formally decommissioned or otherwise revoked.

This approval is provided subject to the non-critical deficiencies[1] listed herein.

Chief Engineer, Technical or Maintenance Authority

Name	**Signature:**	**Date**
Designation:		
Name:	**Signature:**	**Date**:
Designation:		

Chief Operating/User Authority or Operating/User Authority

Name:	**Signature:**	**Date**:
Designation:		

Records Management Instructions

Place the completed Commissioning Certificate, together with the completed Commissioning Readiness form on the Project file

Provide a copy of the completed Commissioning Certificate, and the completed Commissioning Readiness Form to P&E, Asset Lifecycle Manager, Planning and Integration

Note 1: **Non-critical deficiencies** are those outstanding technical and operational issues that do not prevent the safe and effective use of the facility by users or prevent effective technical maintenance, but will be addressed in a specified and agreed time.

LIST OF NON-CRITICAL DEFICIENCIES WAIVED AT TIME OF COMMISSIONING

Either list non-critical deficiencies here or attach a list if space insufficient

Issue	Issue Tracking Reference Number	Allocated to	Proposed Completion Date	Comments

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

1. Introduction

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

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

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

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

2. Problem Reporting and Feedback

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

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

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

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

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

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

3. Problem Categorisation

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

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

4. Managing the Problem

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

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

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

5. Systematic Monitoring and Analysis of the Problem

~~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 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 :-~~

~~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~~

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

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

5.1 Reporting Deficiencies

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

(a) Systematic capture of ATC reported events and engineering detected events into a database; and

(b) Manual or automatic detection of anomalous avionics behavior independent from controller reports

5.1.1 ATC Reported Deficiencies

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

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

5.1.2 Non ATC reported deficiencies

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

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

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

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

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

(a) Deviation between ADS-B reported position and independent referenced radar position is greater than 1NM[2], with the indication of good positional quality in the

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

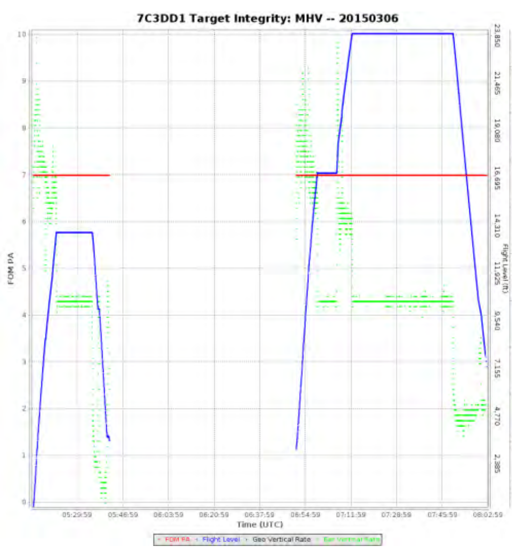
[2] For example, the deviation between ADS-B and radar tracks could be set to 1NM in accordance with ICAO Circular 326 defining position integrity (0.5NM < HPL < 1NM) for 3NM aircraft separation use, on

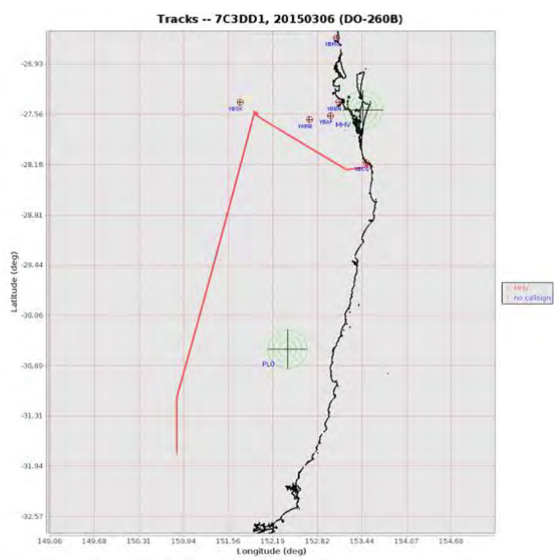
quality indicators for more than 5% of total number ADS-B updates. A sample screen shot of a system performing the analysis automatically is given at Attachment B for reference.

5.2 Managing and Processing Deficiencies

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

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





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

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

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

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

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

* * * * * * * *

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.
18	B787 position error with	Software issue - surveillance	**Yes.**	Problem identified and fix will be

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
	good NUC	system inappropriately "coasts" the position when data received by the transponder is split across multiple messages. System seems to self correct after some time. Can be corrected by surveillance system power off.	Misleading position presentation which is typically detected by ATC observing aircraft "off track" when in fact it is "on-track".	provided by Boeing at the same time as the availability of DO260B upgrade – late 2015.
19	A number of airlines have reported or experienced ADS-B outages for complete flight sectors in A330 aircraft. Appears as low reliability ADS-B and has afflicted both A & B side at same time.	Being actively investigated. One airline has implemented on-board recording which confirms that the MMRs are not providing HIL/HPL to the transponder whilst continuing to provide HFOM, GPS alt etc	**No.** Equivalent to a failed transponder.	Aircraft must be managed procedurally if outside radar coverage.
20	A380 flight ID lost after landing	For the A380 fleet, it has been confirmed that for some seconds after landing, the flight ID is set as invalid by FMS to AESS. Consequently, the current AESS design uses, as per design, the Aircraft Registration Number as a back-up source for A/C flight identification field in ADS-B broadcast messages.	**No.**	The correction to this logic is planned for next AESS standard release; planned for 2017.". Only a problem for arriving aircraft on surface surveillance systems.

Figure 1 - Track Jumping problem with TPR901

Figure 3 - Garmin "N" Flight ID problem

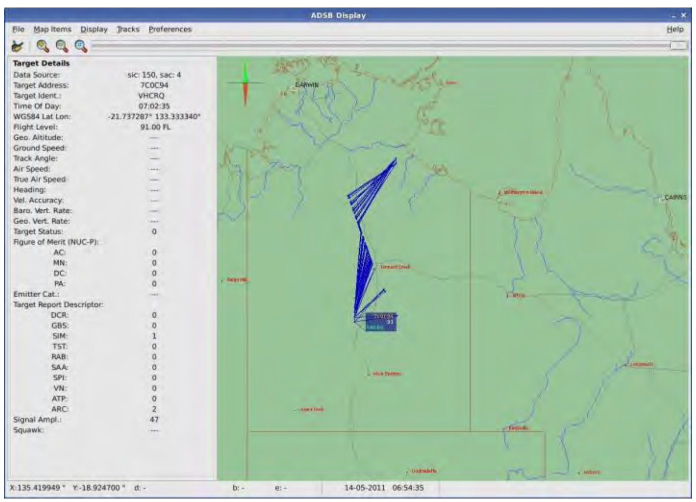


Figure 2 - Rockwell Collins TDR94 Old version. The pattern of erroneous positional data is very distinctive of the problem

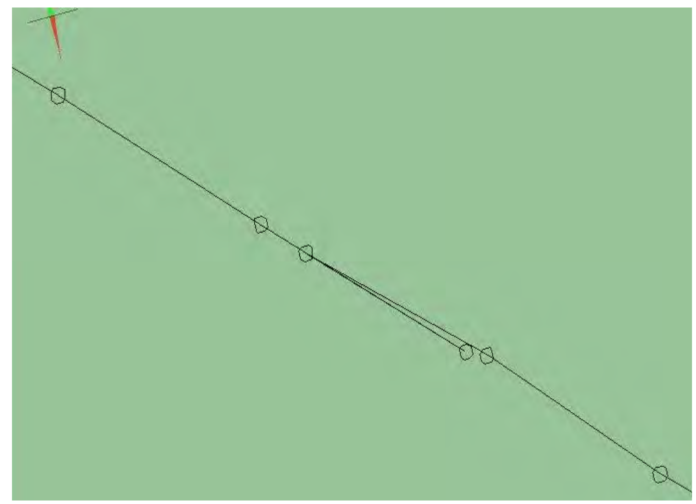


Figure 4 - Occasional small position jump backwards

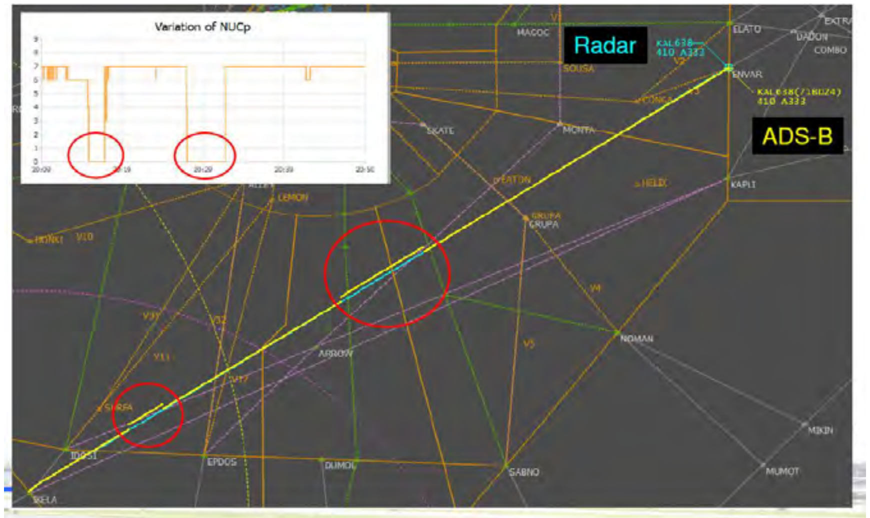


Figure 5 - NUC value toggling

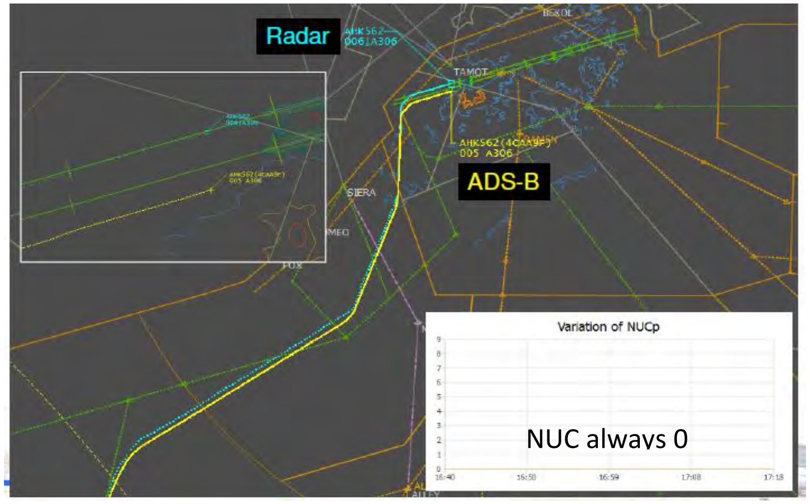


Figure 6 – Consistent low NUC

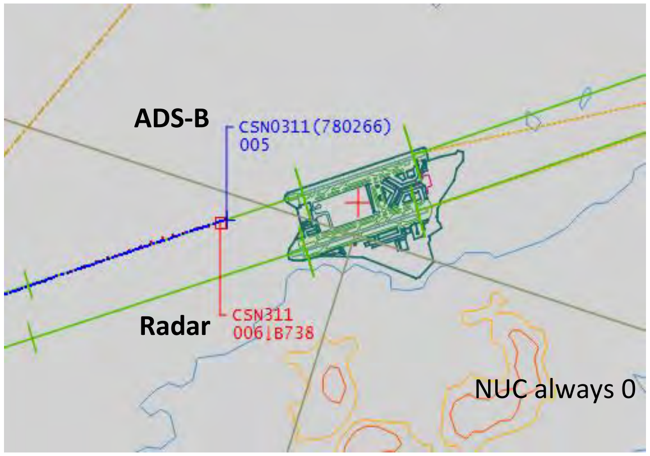


Figure 7a - Additional zero inserted

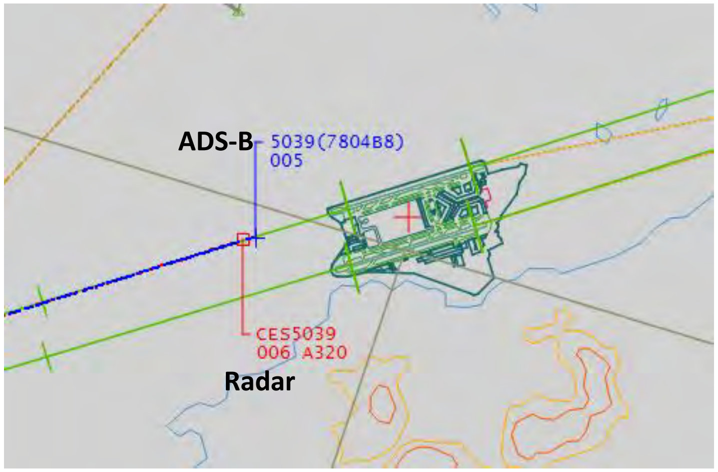


Figure 7b - ICAO Airline Designator Code dropped

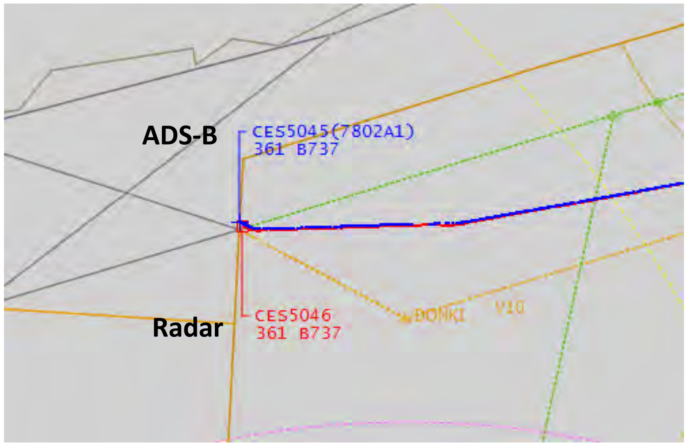


Figure 7c - Wrong numerical codes entered

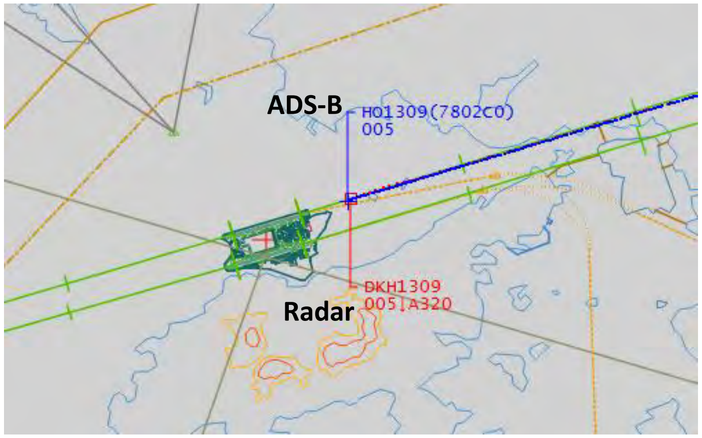
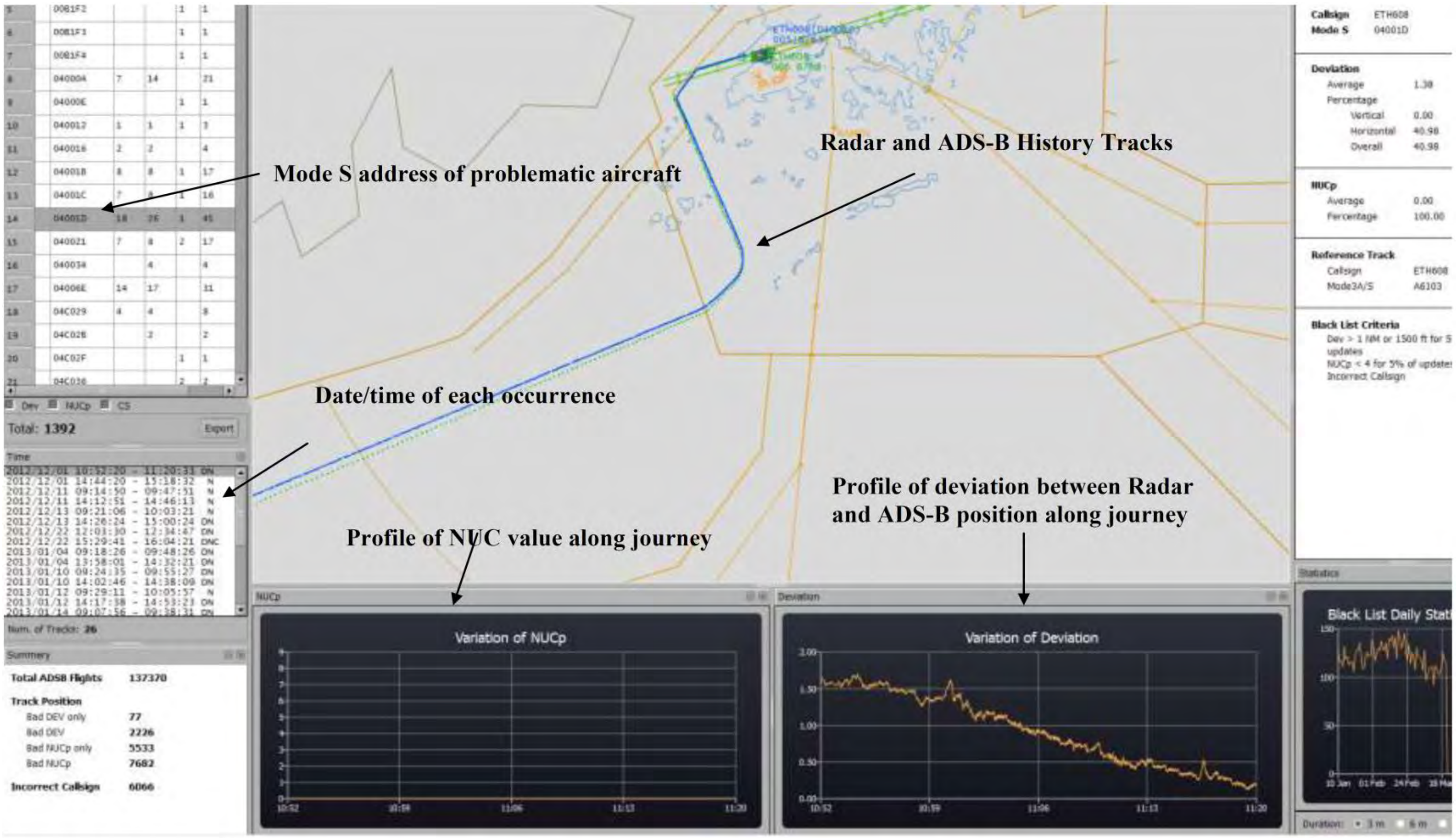


Figure 7d - IATA Airline Designator Code used

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



A Template for ADS-B Mandate/Regulations for Aircraft Avionics

(1) On and after dd/mm/yyyy, if an aircraft carries 1090MHz extended squitter (1090ES) ADS-B transmitting equipment for operational use in xxxxxxxx territory, the equipment must have been certificated as meeting :-[1]

(a) EASA AMC 20-24; or
(b) the equipment configuration standards in Appendix XI of Civil Aviation Order 20.18 of the Civil Aviation Safety Authority of Australia; or
(c) FAA AC No. 20-165A – Airworthiness Approval of ADS-B

(2) On and after dd/mm/yyyy, if an aircraft operates on airways (insert routes)…………at or above FLXXX………(or in defined airspace boundaries ……………. at or above FLXXX):[2]

The aircraft must carry serviceable 1090MHz extended squitter (1090ES) ADS-B transmitting equipment that has been certificated as meeting :-

(a) EASA AMC 20-24; or
(b) the equipment configuration standards in Appendix XI of Civil Aviation Order 20.18 of the Civil Aviation Safety Authority of Australia; or
(c) FAA AC No. 20-165A – Airworthiness Approval of ADS-B

(3) An aircraft carrying 1 090 MHz extended squitter (1090ES) ADS-B equipment shall disable ADS-B transmission unless:

(a) the aircraft emits position information of an accuracy and integrity consistent with the transmitted value of the position quality indicator; or
(b) the aircraft always transmits a value of 0 (zero) for one or more of the position quality indicators (NUCp, NIC, NAC or SIL); or
(c) the operator has received an exemption granted by the appropriate ATS authority.

(a) [1] This paragraph ensures all aircraft operating in the airspace, if equipped with ADS-B, are compliant to standards.
(b) [2] This paragraph provides mandate requirements within certain parts of the airspace.

An Example of Advice to Operators Concerning Inconsistency Between ADS-B Flight Planning and Surveillance Capability

1. Background

Newer technologies for aircraft surveillance are now available – such as Mode S and ADS-B – which in many aircraft are installed as replacements for older Mode A/C transponders.

Air Traffic Control makes use of these new capabilities, and uses the Flight Plan information as a decision support tool – to allow the Air Traffic Controller to predict the surveillance capability of a particular aircraft before it enters radar or ADS-B coverage.

Requirements for ADS-B and Mode S (**insert local reference document if applicable**) may mean that if flight planning does not accurately reflect the aircraft capability, services may be withheld (for example if ADS-B is mandatory, but not indicated on the flight plan **– this section to be modified for local requirements**).

2. Flight Planning Requirements for Transponder and ADS-B

The flight planning requirements for aircraft are described in **(local document reference or ICAO DOC 4444 Appendix 2)** and repeated below.

Surveillance Equipment

N if no surveillance equipment for the route to be flown is carried, or the equipment is unserviceable

OR

INSERT one or more of the following descriptors, to a maximum of 20 characters, to describe the serviceable surveillance equipment and/or capabilities on board:

SSR Modes A and C

A Transponder — Mode A (4 digits — 4 096 codes)

C Transponder — Mode A (4 digits — 4 096 codes) and Mode C

SSR Mode S

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

H Transponder — Mode S, including aircraft identification, pressure-altitude and enhanced surveillance capability

I Transponder — Mode S, including aircraft identification, but no pressure-altitude capability

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

P Transponder — Mode S, including pressure-altitude, but no aircraft identification capability

S Transponder — Mode S, including both pressure altitude and aircraft identification capability

X Transponder — Mode S with neither aircraft identification nor pressure-altitude capability

Note : Enhanced surveillance capability is the ability of the aircraft to down-link aircraft derived data via a Mode S transponder.

ADS-B

B1 ADS-B with dedicated 1 090 MHz ADS-B “out” capability[1]

B2 ADS-B with dedicated 1 090 MHz ADS-B “out” and “in” capability[1]

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

3. Additional information

The capability of your aircraft transponder, and ADS-B capability, will typically be available in the transponder manual, or in the aircraft flight manual for the aircraft. For General Aviation aircraft, the most common configurations for filing in the flight plan field 10b will be (listed in order of capability).

EB1 – An ADS-B equipped aircraft would typically file this to indicate the Mode S transponder capability with ADS-B out.

S – The majority of Mode S transponders (without ADS-B) will support pressure altitude information and Flight ID transmission.

C – For aircraft with an older Mode A/C transponder – most of which provide pressure altitude capability.

Less common configurations in General Aviation will include:

H, LB1 or LB2 – Enhanced surveillance capability is more usually associated with higher end aircraft. ADS-B IN (B2) is relatively rare at this time, but may be available for some aircraft.

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[1] Based on current version of ICAO Doc 4444

I, P or X – Most Mode S transponders will support Flight ID and pressure altitude, so these configurations are not common.

A – some low end GA aircraft may not provide pressure altitude information.

U1 or U2 – these ADS-B technologies are only authorized in a limited number of countries in the Asia Pacific Region.

Planning designations not to be used in Asia Pacific:

V1 or V2 – these ADS-B technologies are not authorised for use in Asia Pacific Region.

Remember:

Always flight plan the correct surveillance capability for your aircraft. If in doubt, consult the transponder manual, aircraft flight manual, or your Licenced Aircraft Maintenance Engineer.

Record of Discussion – ADS-B Operational Approvals

The meeting considered WP4 (Secretariat), WP07 (Australia) and WP18 (Japan) regarding the need for Operational approval before ATC operational use of ADS-B.
The history of Operational Approval is that:

a) At the very early stages of ADS-B, when we were all very unfamiliar with ADS-B, Australia commenced ADS-B services with just 9 selected airframes. Airservices ensured that each operator understood about ADS-B before operations were commenced and used a white list to ensure that only approved aircraft reached the ATC screen. At this stage there was no ICAO documentation supporting ADS-B. There was no Doc 4444 material on ADS-B, there was no ADS-B separation standard, and special (new design) equipment was fitted as the ADS-B transponder.

b) When SITF wrote the initial AIGD it was based largely on the experience of Australia at the time. The need for pilots and maintainers to be educated before ATC operation was recognised as a need and hence the concept of Operational approval was included in the AIGD.

c) After many years operation, Australia recognised that the procedure to require Operations Approval was an impediment to safety in that country because many operators did not obtain or could not obtain the necessary documents – and that safety services were not being delivered to aircraft with good equipment. Australia also realised the increasing workload for everyone preparing these approvals was inefficient and not very helpful in preventing issues.

   In addition, Australian regulations were published which required misleading ADS-B to be disabled. The responsibility of preventing misleading transmissions clearly became one for the operator.

d) Also during the years, ADS-B has matured, and is now throughout ICAO documentation, flight planning, guidance material and operational procedures and DOC 4444. It has become mainstream.

e) Australia also realised that Operational approvals are not required for ATC transponder and many other systems aboard aircraft – and that further – pilots already successfully operate ATC transponders and MMRs. Australia performed a formal hazid assessment and a formal Safety Case was prepared to transition to a black list instead of the white list. The white list required operational approval, the black list did not include operational approval requirements through its nature.

f) ICAO Doc. 7030Regional Supplementary Procedures now includes the requirement for misleading ADS-B data to be disabled.

g) The continuation of Operational approvals will bring increasing demands for a way to communicate Operational approval to the ANSP using the data so that ATC can choose to display or use ADS-B data or not. Differences across the region will create discontinuities between states if some require flight plans to indicate Operational approval and others do not.

h) Australia now seeks removal of the "Operational approval" references from the AIGD WP4 outlined the more recent history of the issue and noted in particular that APANPIRG did not accept the previous SITF proposal that States should choose or not the need for Operational approval.

APANPIRG 25 considered that the APAC Region would benefit from an alignment with the experience of States that have used ADS-B for many years. This would in turn provide substantial benefits to operators and enhance inter-regional operations.

APANPIRG/25 did not adopt second part of the draft Conclusion as mentioned above i.e. "States in the Asia and Pacific Regions may choose to require or not require an Operations Specification or Operations Approval for ADS-B OUT". APANPIRG/25 meeting agreed on a recommendation to review the conclusion with interested parties and to form an ad hoc group. APANPIRG therefore asked the ad hoc group to develop a consensus on the requirement.

WP07 described the historical context and debate during the development of the ADS-B standards regarding provision of pilot capability to turn off ADS-B transmissions. In the end, the standards do not require this capability and most aircraft do not have the ability to allow the pilot to turn off ADS-B transmissions - without turning off the ATC transponder. It was agreed by all parties that pilots should not turn of the ATC transponders to solve ADS-B issues.

WP/07 also outlined that Australian procedures required ATC to request pilots to recycle and or select the secondary transponder if ADS-B issues were encountered - and appropriate incident reports be raised.
At the same time, Australia's experience is that:

a) Relatively few aircraft have the ability to disabled ADS-B transmissions; and

b) The only action possible for most pilots for an aircraft transmitting misleading ADS-B is to respond to ATC requests to recycle or select the alternate transponder.

Australia agreed to re-consider the CAO requirement to "allow the pilot to activate and deactivate transmission during flight" to bring the CAO into line with accepted ADS-B standards.

In WP/18 Japan presented the view that the removal of a need for Operational Approval could decrease safety due to the following hazards:

a) Hazard a: Higher reliability of ADS-B transmission is required in an environment of growing traffic and the use of ADS-B In;

b) Hazard b: Higher numbers of misleading and non-compliant ADS-B can be expected due to the increase in the number of ADS-B capable aircraft; and

c) Hazard c: The number of operators unfamiliar with ADS-B will increase

Japan argued that Operational control would:

- Reduce the transmission rate of misleading ADS-B data;

- Increase the capability of flight crews to address erroneous operation of ADS-B and in particular the act of inadvertently turning off the ATC transponder.

Japan argued that Operational approval provided an additional safety barrier that would allow these risks to be better controlled. Further Japan argued that Operational approval would reduce the rate of misleading ADS-B transmission.

It is proposed that this meeting accepts the following as self-evident (to be recorded in the meeting report):

1. Flight Crew should be competent to use ADS-B equipment in both normal & emergency modes

2. ADS-B transmissions must be correct & misleading transmissions must be disabled as per 7030 Regional procedure

3. States of Registry should ensure that operators equip with appropriate avionics & establish appropriate training programs

4. Maintenance, training and on-going airworthiness must ensure that ADS-B signals are correct

However, the meeting considered that normal regulatory actions such as regulation, compliance inspection and enforcement of training, installation and operation were sufficient protection and that safety is not compromised by not implementing operational approvals for operational use of ADS-B OUT by ATC.

The meeting agreed that the costs of implementing an Operational Approval system for ATC use of ADS-B OUT is not warranted, although it may be considered for some specific ADS-B IN applications when there is a safety case.

The meeting agreed that experience to date shows that misleading ADS-B data has only been transmitted when there is a failure of design (software bugs) and that Operational approval will likely have no impact on the rate of this type of failure, because the Operational approval normally accepts the result of already performed software development and testing processes.

Overall, using these normal regulatory processes will adequately control the risk as it does today for the majority of aviation systems. The percentage of operators unfamiliar with ADS-B will not increase if there is adequate regulatory oversight including training and awareness of engineers and pilots as with the introduction of any new technology.

In the safety case conducted in Australia, it was found that increasing the compliance workload and excluding some aircraft as not operationally approved, actually lowered the safety level in the Australian environment.

The meeting considered that Operational approval of ADS-B OUT for operational use by ATC, could not mitigate the risks of misleading ADS-B data impacting ADS-B IN applications however, Operational approval may be required for the introduction of specific ADS-B IN applications based on safety case. The issue of ADS-B IN was not considered further.
The meeting also noted that if Operational approvals were required, a means would need to be found to advise the ATC provider of which flights are operated with operational approval and which are not. This would undoubtedly result in changes to the flight plans and result in discontinuities in operation between states in the region.

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GUIDELINES FOR AIRWORTHINESS APPROVAL FOR ADS-B AVIONICS EQUIPAGE

a) The airworthiness compliance of the aircraft under the airframe OEM Type Certificate approval in the Airplane Flight Manual, in an AFM supplement or other appropriate airworthiness documentation is normally accepted by the State of Registry. If the aircraft does not have an existing certification, compliance with Appendix XI of CASA CAO 20.18 specified requirements needs to be established;
http://www.casa.gov.au/wcmswr/_assets/main/download/orders/cao20/2018.pdf

b) The continuing airworthiness of ADS-B system must be assured. Existing established maintenance practices or a proposed maintenance programme for the aircraft needs to be reviewed to ensure that it meets relevant requirements. This is typically a demonstration that ADS-B is included as part of the normal maintenance process in the documentation provided; (NB: most ADS-B systems comprise transponder & GPS systems already the subject of existing maintenance and ongoing airworthiness programs);

c) The Minimum Equipment List needs to reflect the functional requirements of the ADS-B system;

d) Appropriate flight operations training programme and operational procedures are established to ensure that pilots are knowledgeable about their onboard operational equipment. This is typically a demonstration that all used aircraft systems are included in the training process and operational documentation including Flight Dispatch considerations; and

e) In light of the fact that usually there are no ADS-B specific actions that the flight crew can take, and that whilst desirable, ADS-B OUT training has minimal (if any) impact on the safety and efficiency of ADS-B OUT based operations, it is not considered essential that flight crew have been trained explicitly on ADS-B.

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REPORT FROM BAY OF BENGAL AD HOC WORKING GROUP

New Zealand, 14-17 April 2015

States Present: Pakistan

Malaysia
Thailand

Bangladesh, India, Maldives, Nepal, Sri Lanka and Myanmar were not present in the meeting

The participants met to update the status of implementation of ADS-B and possible data sharing between the neighboring States.

1. Bangladesh has planned to install four ADS-B ground stations at Dhaka, Barisal, Saidpur and Coxs Bazaar by 2H2016. (**Note**: Information as presented at the ADS-B SITF/13)

2. India informed that 21 ADS-B ground receivers have already been installed and AIP SUPP has been published to use ADS-B in the provision of ATS surveillance service. The data sharing agreement between India and Myanmar can be signed by 2H2014. (**Note**: Information as presented at the ADS-B SITF/13)

3. Maldives has installed and commissioned ADS-B ground stations at three locations. The integration of data to the ATM systems has already been completed. Maldives is willing to share ADS-B data with India and Sri Lanka (Expected date: 2015). Also, Maldives has planned to implement exclusive ADS-B airspace at and above FL290 by 2016. (**Note**: Information as presented at the ADS-B SITF/13)

4. Nepal is planning to install ADS-B ground stations in future. New MSSR system is going to install and the project will be completed by 2015. MLAT is under the process for a tender. (**Note**: Information as presented at the ADS-B SITF/13)

5. Pakistan informed that it has invited open tender action for procurement of five ADS-B Ground Stations for installation at Pasni, Lakpass, Rojhan, Dalbandin and Laram-top. The contract is expected to be finalize by the end of 2015. The objective is to provide ADS-B coverage in areas where there is no or limited Secondary Surveillance Radar (SSR) coverage. The data from the above ADS-B ground stations will be integrated with existing ATM systems at both Area Control Centres in Karachi and Lahore. Pakistan expects the ground stations to be DO-260B compliant and operational by the end of 2016.

6. Malaysia is currently in the progress of building new Air Traffic Control Centre for KL FIR and upgrading current CNS/ATM System, including installing two ADS-B ground stations. The project is expected to be completed by the end of 2019.

7. Thailand informed that ADS-B Ground Stations (DO-260B compliant) have been installed in Thailand for internal research and development project. ADS-B is planned to be part of future surveillance infrastructure. New ATM System with the capability of processing ADS-B data is expected to be operational in 2017.

REPORT FROM SOUTHEAST ASIA AD HOC WORKINGN GROUP

New Zealand, 14-17 April 2015

States Present
Australia
China
Indonesia
Singapore
The Philippines
Hong Kong China
Macau China

Previously Identified Projects

The South East Asia Group provide an update on the near term implementation of the following projects that were identified in the last task force meeting.

Project 1 – ADS-B Data Sharing Between Australia and Indonesia

Phase 1a
Indonesia and Australia sharing data from the following stations:

- Saumlaki ADS-B (Indonesia) (Installed)
- Merauke ADS-B (Indonesia) (Installed)
- Waingapu ADS-B (Indonesia) (Installed)
- Kintamani - Bali (Indonesia) (Installed)
- Thursday Island ADS-B (Australia) (Installed)
- Gove ADS-B (Australia) (Installed)
- Broome ADS-B (Australia) (Installed)
- Doongan ADS-B (Australia) (Installed)

Data Sharing Agreement signed in Nov 2010;
Benefits
Data used for air situational awareness and safety nets.
Enhanced Safety at FIR boundary.
Operational service commenced by Australia in Feb 2011.
Indonesia has been using the data for Tier 2 services since Sep 2014

Phase 1b
Indonesia and Australia sharing data from the following additional stations:

- Semarang (Indonesia) (Installed) – Target to commence data sharing by end 2015
- Alor (Indonesia) (Installed) – Target to commence data sharing by end 2015
- Timika (Indonesia) (Installed) - Commenced data sharing
- Kupang (Indonesia) (Installed) - Commenced data sharing
- Christmas Island (Australia) (Not yet installed)
- Timor Sea oil rig (Australia) (Not yet installed)

Data Sharing Agreement signed on 18 Jun 2014;

Indonesia published mandate on 24 July 2014 for situation awareness. The effective date of this mandate is from 18 Sep 2014 to 25 June 2015. Subsequently, Indonesia published mandate on 30 April 2015 for ADS-B operations (Tier 1 services) above FL290. The effective date of this mandate is from 25 June 2015.

Project 2 – ADS-B Data Sharing In South China Sea

Phase 1
Under the near term implementation plan, China, Hong Kong China, Indonesia, Singapore and Vietnam have commenced ADS-B data sharing the ADS-B data from the following stations:

- Singapore ADS-B (Singapore provide data to Indonesia)
- Natuna ADS-B (Indonesia provide data to Singapore)
- Matak ADS-B (Indonesia provide data to Singapore)
- Con Son ADS-B (Viet Nam provide data to Singapore)
- Sanya FIR ADS-B (China provide data to Hong Kong China)

VHF radio communication services (DCPC) were provided from the following stations to Singapore and Hong Kong China. This is to enable implementation of radar-like separations in the non-radar areas within the Singapore FIR as well as routes L642 and M771.

- Natuna VHF (Install for Singapore by Indonesia) (Installed)
- Matak VHF (Install for Singapore by Indonesia) (Installed)
- Con Son VHF (Install for Singapore by Viet Nam) (Installed)
- Sanya VHF (Install for Hong Kong China by China) (Installed)

ADS-B Data sharing and DCPC services agreement between Singapore and Indonesia signed in Dec 2010.
ADS-B Data sharing and DCPC services agreement between Singapore and Vietnam signed in Nov 2011.
DCPC services agreement between China and Hong Kong China signed in 2005.
ADS-B Data sharing agreement between China and Hong Kong China signed in 2013.

Operational Status
Singapore agreed on separation minima with Vietnam and have commenced on ADS-B operations. Singapore updated they have commenced 30nm separation between Singapore and Ho Chi Minh FIR. The plan is to further reduce to 20nm separation.

All 4 administrations (China, Hong Kong China, Singapore and Vietnam) agreed that operational approval is not required.

Initial Benefits
The above sharing arrangement will benefit L642, M771, N891, M753, N892 and L644. Enhanced safety and reduced separation has been applied. Mandate was effective in Singapore FIR 2013. Sanya will publish Mandate with effect from Jul 2015.

Phase 2
The Philippines will install 4 ADS-B stations (Manila, Palawan, Pangasinan and Ilocos Norte). These ADS-B stations are targeted to complete by end 2016

Singapore signed an MOU with the Philippines to share ADS-B data from the Philippines.

The proposed site at Quezon Palawan is not able to provide surveillance for Singapore FIR effectively. Singapore requested the Philippines to explore alternative sites which will be able to provide coverage at the North Eastern area of Singapore FIR.

The Philippines indicated that there is a surveillance gap at north western of Manila FIR. China mentioned that ADS-B stations in Sanya FIR will be able to cover part of the surveillance gap. China is prepared to share ADS-B data with neighbouring states. The Philippines will explore with China on data sharing. Technical details will be discussed further.

Brunei signed an MOU with Singapore agreeing in principal to share ADS-B data with Singapore and provide the VHF facilities for Singapore ATC use. The Brunei CNS ATM project includes ADS-B stations. The locations of the stations are yet to be determined.

Phase 3
Vietnam has ADS-B coverage at the Southern part of L625 and N892 and Vietnam is willing to share the ADS-B data with the Philippines and Singapore.

Project 3 – ADS-B data sharing between Indonesia and Malaysia

Indonesia and Malaysia are willing to share the ADS-B data from the following stations:

- Aceh ADS-B (Indonesia) (installed) - to help cover Kuala Lumpur FIR
- Genting (Malaysia) – To be installed by 2019

The project is still under discussion between Malaysia and Indonesia.

Initial benefits
Enhanced Safety at FIR boundary

Malaysia currently has one ADS-B station at Terrengganu. Malaysia is willing to share the ADS-B data from Terengganu station with Singapore for technical evaluation. Malaysia plans to install more ADS-B stations before 2020. The data from the stations may be shared in future.

Project 4 – ADS-B data sharing between Cambodia, Thailand and Viet Nam
(no updates, info based on previous reports)

Cambodia is willing to share the ADS-B data from the following stations:

- Phnom Penh International Airport ADS-B (installed)
- Siem Reap International Airport ADS-B (installed)
- Stung Treng City ADS-B (installed)

Vietnam is planning to install stations in the south of HCM FIR from 2015 to 2016. Vietnam is willing to share with Cambodia and Thailand.

Discussions between the three States are on-going.

Initial benefits
For redundancy

Project 5 – ADS-B data sharing between Indonesia and the Philippines

Indonesia is willing to share the ADS-B data from the following stations:

- Manado ADS-B (installed)
- Galela ADS-B (installed)
- Tarakan ADS-B (installed)

Where possible, Indonesia would like to receive ADS-B data from the Philippines from ADS-B stations near the Manila FIR – Ujung Pandang FIR boundary. Currently, the Philippines has no plans to install ADS-B stations at the South-eastern part of Manila FIR.

The project is still under discussion between Indonesia and the Philippines.

Initial benefits
Situational awareness

Project 6 – ADS-B data sharing between Australia, Indonesia and Papua New Guinea

Data Sharing between Australia and Papua New Guinea

- Thursday Island (Australia) (installed)
- Gove (Australia) (installed)
- Kintore (Australia) Not yet installed – Target to be installed by 2018
- Burns Peak – Port Moresby (PNG) (tender awarded)
- Mt Dimo Dimo (PNG) (tender awarded)
- Mt Robinson (PNG) (tender awarded)

Data Sharing between Indonesia and Papua New Guinea

- Burns Peak (PNG) (tender awarded)
- Mt Nauwein (PNG) (tender awarded)
- Mt Robinson (PNG) (tender awarded)
- Merauke (Indonesia) (installed)
- Timika (Indonesia) (installed)
- Biak (Indonesia) (installed)

The project is still under discussion between Australia, Indonesia and Papua New Guinea. They will probably sign a three-party agreement for data sharing.

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Harmonization Plan for L642 and M771			
No.	**What to harmonize**	**What was agreed**	**Issue / what needs to be further discussed**
1	Mandate Effective	SG, HK, VN: 12 Dec 2013 CN: Jul 2015.	
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	All states agreed that there is no need for operational approval	
5	Flight Level	SG, HK, VN: - At or Above FL290 (ADS-B airspace) - Below FL290 (Non-ADS-B airspace) CN: To be confirmed SG: AIC issued 28 Dec 2010, AIP Sup issued 6 Nov 13 VN: AIP Sup issued 31 Oct 13 HK: AIC issued 24 May 2011, AIP Sup issued 29 Oct 13	
6	Avionics Standard (CASA/AMC2024)	SG,HK,VN,CN allow CASA or AMC2024 or FAA (ES)	States should include supplement to include the FAA standard.

		SG, HK and VN confirmed that their ADS-B GS can accept DO260, DO260A and DO260B.	Status for CN to be confirmed. Indonesia is planning to upgrade their stations by end of 2016
7	Aircraft Equipage		
7a)	Procedures if Aircraft not equipped with a Serviceable ADS-B Transmitting Equipment before Flight	SG: FL280 and below. HK, CN, VN: Dependent on situation. ADS-B equipped aircraft will be given priority to operate above FL280.	
7b)	Aircraft equipped Approved but Transmitting Bad Data (Blacklisted Aircraft)	For known aircraft, treat as non-ADS-B aircraft. (China, Hong Kong - China and Singapore)	Share information on aircraft observations among concerned States/Administration.(Hong Kong China, Singapore and Vietnam) China to be confirmed.
8	Contingency Plan		
8a)	Systemic Failure such as Ground System / GPS Failure	Revert back to current procedure.	
8b)	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.
9	Commonly Agreed Route Spacing	SEACG	Need for commonly agreed minimal in-trail spacing throughout.

REPORT FROM PACIFIC AD HOC WORKING GROUP

New Zealand, 14-17 April 2015

Common key themes

- Implementation and planning is well underway: Fiji, Papua New Guinea, French Polynesia, Australia and New Zealand are all active in this area.

- ANSP deployment of systems is progressing, with some challenges around integration with ATM systems and training to deliver ADS-B surveillance services as a progression from procedural separation.
- Avionics: fleet equipage (retrofitting or requirements for new aircraft) is moving ahead steadily

- Education and training: there are clearly identified education and training needs in all of the States present. Needs are apparent among owners and operators, avionics engineers and installers.

- Three major issues in the Pacific states and territories are funding, knowledge and education, and bandwidth.

- The region is making good progress with implementation and this is encouraging. There are significant safety benefits are resulting from the deployment of ADS-B.

Papua New Guinea

Current capability is one SSR at Port Moresby. The current ATM system can't integrate ADS-B data; however a new ATM system will support ADS-B and is planned for installation this year with operational testing in early to mid-2016. The system will include a simulator. ADS-B coverage will across entire FIR above FL 245.

A multilat system will be deployed at Port Moresby

Regulations are required to support the changes to ADS-B. Industry consultation is ongoing and the ANSP is also discussing data sharing with AirServices.

Avionics: local Boeing 737 and 767 aircraft are ADS-B equipped. Most GA are not ADS-B capable and most are old airframes. Discussions were underway regarding possible government support to assist GA operators to equip and this needs to be resurrected.

New Zealand

ADS-B and multilateration systems are in use in New Zealand now. Planning and consultation with industry is underway prior to a planned mandate for ADS-B to be required for all aircraft above FL 245 at the end of 2018, and for all aircraft in controlled airspace at the end of 2021. Rule development is in progress and includes consideration of a performance-based rule to enable introduction of appropriate emerging technologies as they become available. Airways and CAA are working closely with the GA community to assist with their timely transition to an ADS-B environment.

Airways plans to issue an RFP in late 2015 to provide ADS-B coverage across the entire domestic FIR in two phases, as described by the mandate dates above.

Provision of contingency surveillance systems is also being considered, based on the outcomes of a surveillance system safety case and work of the New Southern Sky Safety Group. This work is closely linked to consideration of navigation contingency and possible implementation of GNSS sole means navigation.

FAA

FAA noted their close interest in developments of space-based ADS-B through the Aireon project. Over the next 18 months will be conducting comparison tests between the performance of ground and space-based ADS-B. Areas of particular interest are provision of ADS-B coverage in the Oakland FIR. FAA noted that they will consider extending the ground-based ADS-B network if the space-based option proves unsuitable.

Other Pacific States (summarised by Airways)

Issues currently faced by Kiribati, Tonga, Samoa, Vanuatu, and the Solomon Islands were summarised by George McNeur (Airways *Customer Relations Manager)*. The deployment of ADS-B in these states is intended to be funded by the World Bank PAIP project and discussions are ongoing to scope the introduction in each state.

French Polynesia (Tahiti)

Implementation of ADS-B in Tahiti is planned, specifically to replace their current SSR and avoid issues related to regular maintenance. There is no current backup for the SSR.

The first ADS-B station is planned for the end of next year, with tenders in beginning of 2017 for a more extensive network: Stage 1 is for 5 ADS-B stations and a further seven sites in stage 2, with VHF coverage. The existing ATM system is capable of integrating ADS-B data

Air Tahiti-Nui fleet of A340s is already ADS-B capable. It starts to renew its fleet. Two Boeing 787s are due in 2018 and these will be ADS-B capable. Air Tahiti has 9 ATR, 42 and 72 which are being replaced with ATR 42 and 72-600s which are ADS-B capable. Entire fleet should be replaced in 2018.

New Caledonia (provided by Greg Dunstone)

There are three ADS-B sites currently under test and evaluation. No further updates are currently available.

IFALPA – a pilot's perspective

Acknowledged that ADS-B delivers that cost effective surveillance system that provides significant benefits to airline users and operators. Education is required for some operators: pilots need to understand the implications of ADS-B being on or off; and some operators are good at educating crew while others need to do more.

Terminology used in the region should be standardised and consistent, and recognise what crew need to know.

States need to develop procedures for the use of DAPS in relation to operating procedures, for example the use of selected altitude information being displayed on the controllers' screens and related pilot practices: pilots and controllers need to be aware of each other's operating practices.

The QNH error detection feature is an important safety net feature particularly when conducting a non-precision approach.

There is a need to consider the capture, storage, and potential uses of ADS-B data. For example, in some states those data might be used to draw premature conclusions about the causes of an accident or incident and result in inappropriate or unwarranted enforcement action. In addition, there were concerns about who can access ADS-B data and for what purposes. Examples of inaccurate data being used by members of the public to make complaints about aircraft flight paths and noise impost are a concern.
System redundancy was highlighted as an issue in an environment increasingly dependent on GNSS.

Fiji

The eleven stations were installed and commissioned in August 2012 as planned. ATC surveillance training planned for August 2012 has been delayed.

The introduction of ADS B Tier 2 eventuated on 31st December 2013. Due to the non-fitment of all domestic aircraft, with required equipment, and the lack of ATC surveillance training, the original mandate of 13 December 2012 could not be met. As a result the 13 December 2012 mandate was amended by the Civil Aviation Authority of Fiji for 1600 hours 31st December 2013. Industry was made aware that this shift in dates would not be reviewed further and any aircraft not fitted on this date would be grounded.

On 31st December 2013 all Fiji registered aircraft and helicopters were ready for ADS B. Controller HMI training now completed, ADS B at Tier 2 level was commissioned.

Problems Faced – Training and Manpower

The first problem faced was the approval of the technical syllabus for ADS B training. Fiji has never had surveillance radar so there was no past experience to rely on. In approving any training the desire was to meet international standards on training requirements for ADS B. Fortunately the required information was found in a new publication for the training of Air Traffic Safety Electronics Personnel (ATSEP) Doc 7192/AN 857 – Part E2

Pre installation training was done at the ERA factory for two officers and on-site after installation for the rest of the technical staff. Air Traffic Controllers were invited to participate in the principal of operations portion of training.

The lack of any previous radar like surveillance controlling experience, and the unavailability of a training simulator, hinders Air Traffic Controllers obtaining the necessary surveillance ratings. For this reason and more importantly lack of manpower means Fiji will remain in Tier 2 level of operations for a while longer. It will take approximately 1 year from the start of any surveillance training for controllers to be able to move into the Tier 1 level of operations, and moving to surveillance training will only commence when there are adequate numbers of controllers available to maintain current operations and attend training.

Commissioning to Tier 2 level of Operations. The purpose of this section is to explain the method Fiji used to commission the ADS B System for Tier 2 level of operations

System was subjected to RAT – Reliability Acceptance Testing, CAT – Communication (Data Link) Acceptance Testing and Flight Test

The tiered level specification approved by APANPIRG 18 is shown below. This method of progression towards 5 n mile separation standards was found ideal for the Fiji situation, for it offered the opportunity to learn to "crawl before running" and adjust our progress to suit manning levels.

APANPIRG/18

BASELINE ADS-B SERVICE PERFORMANCE PARAMETERS

The following table provides guidelines for various performance requirements of ADS-B Category (Tier) 1, 2 or 3 services that States may consider when acquisition of an ADS-B managed service agreement with a service provider:

Service Parameter	**Category 1 (Tier 1) 5nm separation capable commensurate with Radars (separation/vectoring/high performance with reliability, integrity & latency)**	**Category 2 (Tier 2) Situational awareness similar to ADS-C (safety net alerts, SAR, supports procedural separation without voice, not 5nm separation)**	**Category 3 (Tier 3) Position Reporting with Enhanced Flight Operation**
Aircraft Updates	1 second < Rate < 5 seconds as Operationally required	1 second < Rate < 20 seconds as Operationally required	1 second < Rate < 60 seconds as Operationally required
Network Latency	95%: < 2 seconds of ground-station output	95%: < 15 seconds of ground-station output	95%: < 60 seconds of ground-station output
Reliability 1	2 autonomous ground-stations including antenna, each providing data, no common point of failure	1 unduplicated ground-station including antenna	1 unduplicated ground-station including antenna
Reliability 2 - MTBF	Each ground-station including antenna to have MTBF >10,000 hrs	Each ground-station including antenna to have MTBF >10,000 hrs	Each ground-station including antenna to have MTBF >10,000 hrs
Reliability – Communications Infrastructure	Completely duplicated, no common point of failure	Unduplicated, MTBF > 400 hrs	Unduplicated, MTBF > 200 hrs
Reliability – Total ADS-B Service	Total Service MTBF > 50,000 hrs	Total Service MTBF > 400 hrs	Total Service MTBF > 200 hrs
Availability – Total ADS-B Service	Total Service Availability > .999	Total Service Availability > .95	Total Service Availability > .90
Integrity – Ground Station	Site monitor, including GPS RAIM, monitored by RCMS	Site monitor, including GPS RAIM, monitored by RCMS	Site monitor, including GPS RAIM, monitored by RCMS
Integrity – Data Communications & Processing	All systems up to ATM system, errors < 1 x 10E-6	All systems up to ATM system, errors < 1 x 10E-6	All systems up to ATM system, errors < 1 x 10E-6

Over a period of time the performance of each station was analyzed. A sample of data over one 40 day interval is provided below

17/8/12 to 26/9/12 = 40 days or 960 hours

Station	**Network Latency** 95%<15 seconds		**Comms Link number Of failures**	**Reliability Comms Links** MTBF >400	**Number failure per station**	**Longest period of any one outage**	**Station Reliability** MTBF > 400 hrs	**Station Availability over 40 days** ➢ **95%**	**Station availability Over 24 hours > 95%**	**Reliability – Total ADS-B Service** MTBF>400 hrs	**Availability – Total ADS-B Service** ➢ **95 %**
	L1 mS	**L2 mS**									
00 Nadi	-		zero	≥ 960 Hrs	Zero	N/A	≥ 960 Hrs	100%	100%		
01 Nadi	-		zero	≥ 960 Hrs	Zero	N/A	≥ 960 Hrs	100%	100%		
O2 Denarau	0.5	3.5	zero	≥ 960 Hrs	Zero	N/A	≥ 960 Hrs	100%	100%		
03 Nawaka	0.5	3.5	zero	≥ 960 Hrs	Zero	N/A	≥ 960 Hrs	100%	100%		
O4 Nagado	3.5	4.0	zero	≥ 960 Hrs	Zero	N/A	≥ 960 Hrs	100%	100%		
05 Lomolomo	3.5	3.5	zero	≥ 960 Hrs	Zero	N/A	≥ 960 Hrs	100%	100%		
06 Monasavu	5.0	6.0	1	960 Hrs	10	>16 days	96 Hrs	40%	0		
07 Monasavu	5.0	6.0	1	960 Hrs	13	>16 days	73 Hrs	40%	0		
08 Nausori	5.5	5.0	1	960 Hrs	1	<1 min	960 Hrs	99.9991%	99.9652%		
09 Nausori	fault	4.5	0	160 Hrs	9	4 min	107 Hrs	99.9375%	99.7222%		
10 Delaikoro	14.5	5.0	zero	≥ 960 Hrs	5	5 mins		99.9565%[1a]	99.6527%[1b]		
11 Delaikoro	14.5	5.0			4	2 mins	240 Hrs	99.9861%	99.8611%		
12 Matei	13	13			20	1 min	48 Hrs	99.9652%	99.9305		
13 Lakeba	16	15			18	1 min	53 Hrs	99.9687%	99.9305		
14 Rotuma	366	359.5	-	-	-	-	N/A	-			
15 Rotuma	366	359.5	-	-	-	-	N/A	-			

Availability Calculations

Note 1a – Station Availability over the 40 day period of review. RPU 10 had 5 failures over the 40 day period. The longest outage time was 5 minutes. To work out availability multiplied 5 failures X 5 minutes. Calculation used. 40 days x 24hrs = 960 hrs = 57,600 mins. Av = 25/57600 X 100 – 100 = 99.95%

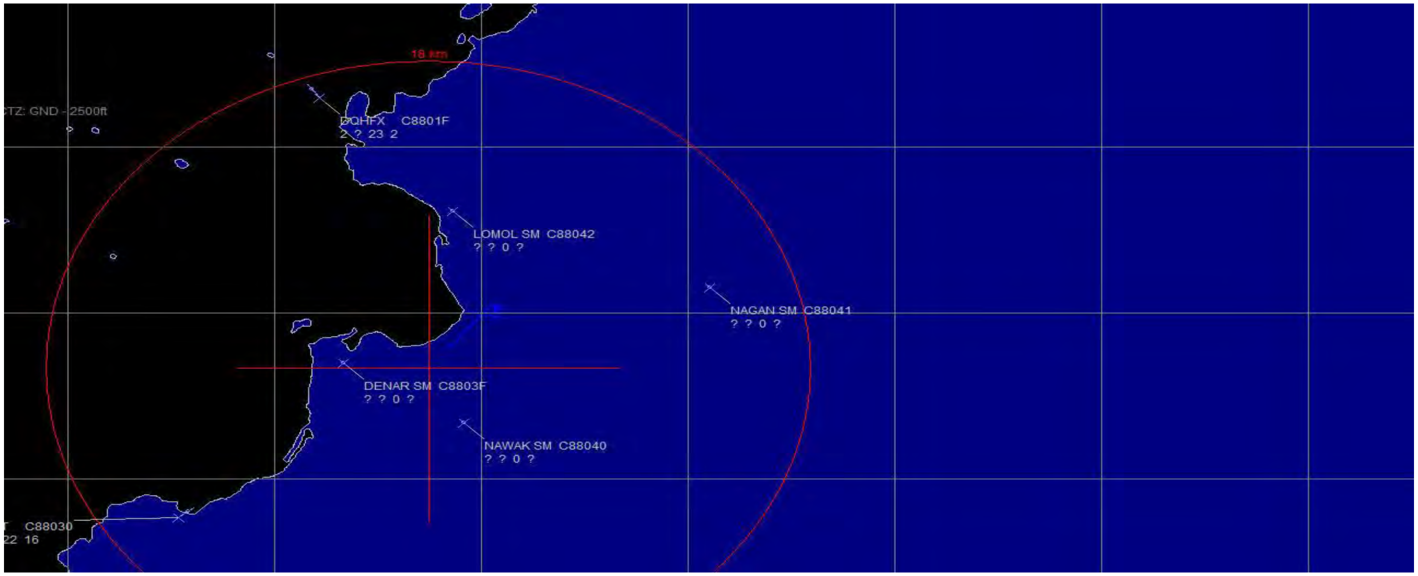
Note 1b This availability done over 24 hour period. To get this figure looked at the amount of failures (5) and chose the failure with the longest Outage time. The longest in the case of RPU 10 Delaikoro was 5 minutes. To work availability over 24 hours": 24x60 = 1440 minutes. Av. = (longest outage/1440 mins x 100) – 100. Equals 5mins/1440 X100 = 0.347 – 100 for final answer of 99.65%

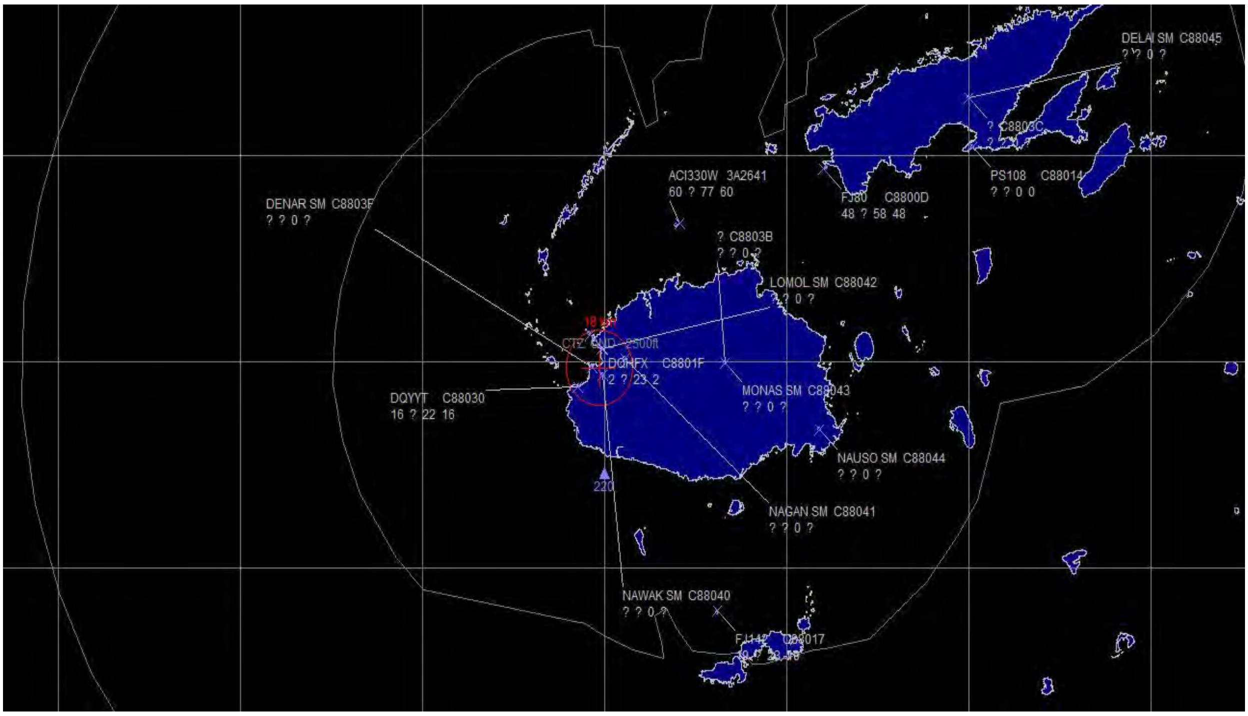
Flight Test

Fiji conducted one flight test each for ADS B and MLAT. The purpose of the flight test was in the main to provide the assurance that the accuracy of the positional reports. Fiji without radar to compare positional reports relied on comparison to a high accuracy differential GPS

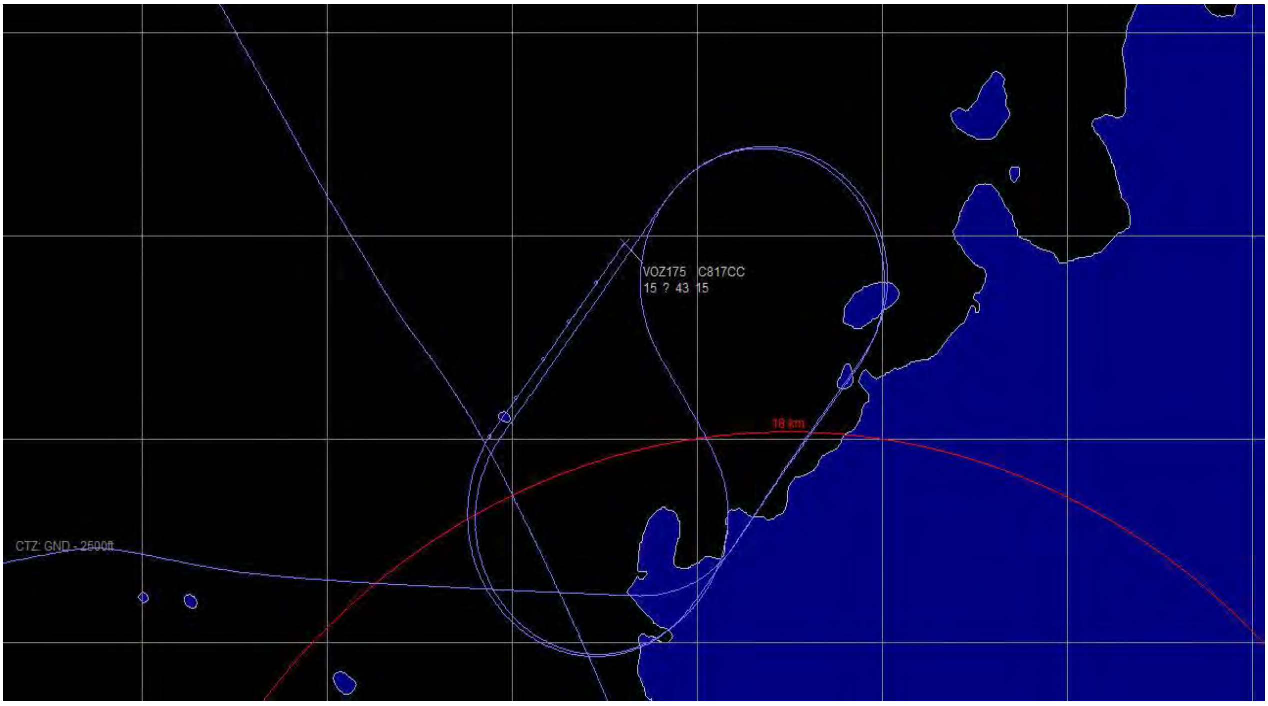
The end result showed little variations between the data recorded by the DGPS and the recorded positional reports of the ERA

Stations ADS B and MLAT around NADI


18 km
CTZ: GND - 2500ft
DQHFX C8801F
2 ? 23 2
LOMOL SM C88042
? ? 0 ?
NAGAN SM C88041
? ? 0 ?
DENAR SM C8803F
? ? 0 ?
NAWAK SM C88040
? ? 0 ?
C88030
22 16



Virgin VOZ175 C817CC in a holding pattern north of Nadi



REPORT FROM EAST ASIA AD-HOC WORKING GROUP
New Zealand, 14-17 April 2015

States for East Asia at the meeting
(Republic of Korea, Japan, China)

1. Introduction

ROK, Japan, & China are, geographically, close to each other. Each countries has plans to install next enhanced surveillance system, ADS-B and MLAT.

2. Discussion

ROK & Japan have discussed about II (Interrogator Identification) code which may cause interference and the time to provide ADS-B service and en-route (G597) procedure

3. Action by the meeting

The meeting is invited to:

a) share state' II code information of current condition and future plan for allocation; and

b) discuss the time to provide ADS-B service and en-route (G597) procedure

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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	☒	☐	☐	All ADS-B and WAM systems upgraded.
Bangladesh	Nil	☐	☐	☐	
China	20	☒	☐	☐	All stations have 260B ADS-B OUT Compliant, not yet for TIS-B.
Hong Kong, China	9	☒	☐	☐	
Macao, China	Nil	☐	☐	☐	No current plans for ADS-B
France (French Polynesia)	Nil	☐	☐	☐	No current GS
Fiji	??	☐	☐	☒	Upgrade TBD
India	21	☒	☐	☐	
Indonesia	31	☐	☐	☒	Planned for 2016
Japan	Nil	☐	☐	☐	No operational GS yet.

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**
Malaysia		☐	☐	☐	Tenders have been called for new GS. DO-260B capability included in specification
Maldives	4	☐	☒	☐	Not yet determined.
Myanmar		☐	☐	☐	
Nepal	Nil	☐	☐	☐	
New Zealand	22	☐	☐	☒	May 2015 (software upgraded by end of 2015) Software release is ready
Pakistan	1	☐	☐	☐	Test basis. Will discuss outcomes from ADS-B SITF Meeting.
Papua New Guinea	Nil	☐	☐	☐	ADS-B planned but no current GS.
Philippines	Nil	☐	☐	☐	No GS yet
Republic of Korea	2	☐	☐	☒	2020
Singapore	1	☒	☐	☐	

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**
Thailand	5	☒	☐	☐	Test basis
USA	634	☒	☐	☐	
Viet Nam	3	☒	☐	☐	