INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

REPORT OF THE NINTH MEETING OF ADS-B STUDY AND IMPLEMENTATION TASK FORCE

JAKARTA, INDONESIA
18 – 19 AUGUST 2010

The views expressed in this Report should be taken as those of the Task Force and not for the Organization. This Report will be submitted to the APANPIRG/21 Meeting for review and any formal action taken will be published in due course as a part of Report of APANPIRT/21 Meeting.

HISTORY OF THE MEETING

SUMMARY ON AGENDA ITEMS

List of Appendices:

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1. INTRODUCTION

1. The Regulator's Workshop on Automatic Dependent Surveillance – Broadcast (ADS-B) Avionics Equipage Requirements and the Ninth Meeting of ADS-B Study and Implementation Task Force (ADS-B SITF/9), hosted by Directorate General of Civil Aviation (DGCA), Indonesia was held from 16 to 19 August 2010 at the Mandarin Oriental Hotel, Jakarta, Indonesia.

2. OPENING OF THE WORKSHOP AND THE MEETING

2.1 The workshop and the meeting were inaugurated by Mr. Yurlis Hasibuan, Director of Airworthiness and Aircraft Operation on behalf of Mr. Herry Bakti, Director General of DGCA. In his opening remarks, he extended a warm welcome to all the participants to Jakarta. Mr. Yurlis emphasized the importance of regional cooperation for implementation of advanced technologies like ADS-B which will increase the capacity and efficiency of air navigation services. He thanked ICAO for organizing these ADS-B events in Indonesia and expressed pleasure in hosting the events. He informed that Indonesia will be running for the Council election during ICAO Assembly session in 2013 and hopes to have support from the States. He further stated that through compliance with ICAO standard and requirements, implementation of ADS-B will improve the Indonesian domestic and regional air navigation service. Indonesia conducted an ADS-B regional trial in 2006 to validate the effectiveness of the technology. The success of this trial provided the basis for roadmap and a phased approach for early commissioning of an ADS-B network across Indonesia. He wished the workshop and meeting success in its outcome.

2.2 On behalf of Mr. Mokhtar A. Awan, Regional Director, ICAO Asia and Pacific Office, Mr. Li Peng, Regional Officer CNS, ICAO Regional Office expressed gratitude and appreciation to the DGCA for hosting a series of ICAO regional meetings in Jakarta this year and for the excellent arrangements made for these activities. He highlighted significant activities in CNS fields since the last meeting of the Task Force. He mentioned the tasks completed by the Task Force and outlined the objective of the ADS-B Regulatory Workshop and the Ninth Task Force Meeting. He emphasized the important role of the Task Force and the Workshop in exchanging ADS-B related information particularly for avionics standard and equipage requirements for the identified ADS-B Out application in the region. He thanked all participants and guest speakers for their contribution and their active support for the success of the workshop and the meeting.

2.3 Mr. Greg Dunstone, Chairman of the Task Force, thanked the DGCA for hosting the ADS-B events and the organizing team for the significant efforts made at short notice after the change of date and venue for the meeting. He also expressed condolence for the sudden loss of Mr. Keith William Tebby who was the Business Development Manager for Asia of Sensis Corporation and often provided contributions to the ADS-B Seminars in the past. He also expressed sympathy to participants from Pakistan for the damage and loss of life caused by the recent floods. He emphasized the need to progress the work of the Task Force and encouraged participants for fruitful deliberations. He also reminded the meeting of the need for action after the meeting.

3. ATTENDANCE

3.1 The Regulatory Workshop was attended by 84 participants and the Meeting was attended by 53 participants from Australia, Brunei Darussalam, China, Hong Kong China, Macao China, Fiji Islands, Indonesia, Japan, Malaysia, Nepal, New Zealand, Pakistan, the Philippines, Republic of Korea, Singapore, Thailand, USA, CANSO, IATA and representatives from industrial groups. List of participants is at **Attachment 1.**

4. OFFICERS AND SECRETARIAT

4.1 Mr. Greg Dunstone, Surveillance Program Leader of Airservices Australia chaired the workshop and the meeting. Mr. Brian Harris, Airways Engineer of Civil Aviation Safety Authority, Australia facilitated the discussions on the regional harmonization of ADS-B Out avionics requirement. Mr. Li Peng, Regional Officer CNS, ICAO Asia and Pacific Office was the Secretary.

5. ORGANIZATION, WORKING ARRANGEMENTS AND LANGUAGE

5.1 The workshop and the meeting met as a single body except on 19 August 2010, when the three ad hoc working groups (Regulators' WG, SEA WG and BoB & SA WG) met to progress proposals for regulatory issues, sub-regional implementation plans and development of guidance material for the regional harmonized requirements for ADS-B Out avionics equipage.

5.2 The working language was English inclusive of all documentation and this Report. List of Working Papers and Information Papers presented at the Workshop and the Meeting is at **Attachment 2.**

6. REGULATOR'S WORKSHOP ON ADS-B AVIONICS REQUIREMENT

6.1 The Regulator's Workshop on ADS-B Avionics Equipage Requirements was conducted in conjunction with the ADS-B SITF/9 which was organized in accordance with APANPIRG Conclusion 20/51. The objective of the workshop was to:

- inform APAC Regulators of the existing and proposed technical standards and model national rules for aircraft ADS-B OUT avionics equipment;

- establish the primary operational requirement (if any) of each State and APAC generally for the use of ADS-B in the decade to 2020.

- note APANPIRG Conclusion, for Regulators to define their State's intention in establishing:

  a) ADS-B OUT fitment requirements for international aircraft fitment;
  b) Proposed compliance timelines;

- agree with the content of a draft rule that addresses the APAC operational requirements/compliance timings for ADS-B; and

- prepare an APAC rule template

6.2 The Workshop was supported by Australia and USA. A number of speakers from various States, International Organizations and Industries provided valuable contribution on ADS-B equipage requirement related information. Twenty four presentations covering following topics on the ADS-B equipage requirements were presented and discussed by the Workshop:

- ADS-B Concept Introduction
- Operational use of ADS-B in the Asia and Pacific Region
- Standards and equipment
- Review existing equipage mandates
- Existing and Future Equipment Certification
- Need to harmonize and compliance timing
- Avionics products
- View of air space users and ANSPs
- Harmonization and guidance material

6.3 The States which attended the Workshop provided status of their ADS-B implementation plans. The Workshop reconfirmed the significance of Conclusion 19/37 regarding the revised mandate for the regional ADS-B. States intending to implement ADS-B based surveillance service were urged to publish mandate as soon as possible but no later than 2010 with the implementation target date after mid. 2012.

6.4 A dinner reception hosted by Director General of DGCA in honor of participants of the ADS-B events was sponsored by the COMSOFT GmbH on the occasion of Indonesia’s National Day.

6.5 A demonstration on ADS-B data processing system using 1090 ES link was also provided by the COMSOFT GmbH during the Workshop.

6.6 The outcome of deliberations at the Workshop was presented to the Task Force meeting for further consideration.

6.7 Based on the feedback survey conducted during the events, it was indicated that the ADS-B Workshop was very well received by the participants.

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Agenda Item 1: Adoption of Agenda

1.1 The agenda adopted by the meeting was as follows:

Agenda Item 1: Adoption of Agenda

Agenda Item 2: Review the outcome of the APANPIRG/20 on ADS-B SITF/8 and SEA ADS-B WG/4 Meetings

Agenda Item 3: Review progress made by ADS-B related ICAO panels

Agenda Item 4: Review the Terms of Reference and Subject/Tasks List as attached to this provisional agenda below

Agenda Item 5: Report and updates by the leading member of the Task Force on Tasks assigned

Agenda Item 6: Review States' activities and interregional issues on trials and implementation of ADS-B and multilateration

Agenda Item 7: Development of Asia/Pacific Regional ADS-B implementation plan and sub-regional based ADS-B implementation plan

- Review report of the Fifth meeting of the South East Asia ADS-B Implementation Working Group;
- Divide into working groups as follows and subsequently report conclusions to Plenary;
    - Regulatory authorities working group;
    - South East Asia working group
    - Bay of Bengal and South Asia working group;
- Develop a sample document for the regional harmonized requirements for ADS-B Out avionics equipage.

Agenda Item 8: Any other business

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Agenda Item 2: Review the outcome of the APANPIRG/20 on ADS-B SITF/8 and SEA ADS-B WG/4 meetings

Outcome of APANPIRG/20 on ADS-B

2.1 The meeting noted that the APANPIRG/20 reviewed the work accomplished by the Eighth Meeting of the ADS-B Study and Implementation Task Force and the Fourth Meeting of the SEA ADS-B Working Group. The report of the Eighth Meeting of ADS-B Task Force was also reviewed by CNS/MET SG/13 held in Bangkok from 20 to 24 July 2009 and noted by ATM/AIS/SAR SG/19 in June 2009.

2.2 The meeting noted that APANPIRG/20 appreciated the efforts and progress made by the ADS-B Study and Implementation Task Force and the SEA ADS-B Working Group. APANPIRG/20 adopted the revised guidelines for ADS-B Out planning and implementation. APANPIRG/20 also adopted several Conclusions relating to implementation of ADS-B including the comprehensive amendments to FASID CNS Tables on surveillance and automation systems. The extract from the report of APANPIRG/20 on ADS-B is provided in **Appendix A** to this report.

2.3 APANPIRG/20 expressed gratitude to CAAV and VANSCORP for hosting the ADS-B Seminar and ADS-B SITF/8 meeting and to Airservices Australia for hosting the fourth meeting of the SEA ADS-B Working Group. The meeting noted that relevant guidance material adopted by APANPIRG/20 has been posted on the ICAO ASIA/PAC website: http://www.bangkok.icao.int/edocs

Need for Flight Inspection/Validation of ADS-B Ground Stations

2.4 The meeting reviewed and discussed the APANPIRG decision 20/47 which was developed by the *seminar on Navigation and Surveillance Facilities and Validation of Flight Procedures* held in August 2009. APANPIRG/20 adopted the following Decision recommending assessment of the need for developing guidance material for inspection/validation of ADS-B ground stations.

Decision 20/47 - Guidance Material for flight inspection/validation of ADS-B G round Stations

That, ADS-B SITF be tasked to study the need for developing guidance material for flight inspection/validation of ADS-B ground stations.

2.4.1 In this connection, the meeting noted that one of the topics being studied by Aeronautical Surveillance Panel was the development of guidance on flight testing of ADS-B and Multilateration systems. While recognizing that the flight inspection for ADS-B ground stations may be required to validate the theoretical coverage against predictions, the meeting considered that it could be achieved by alternate means.

2.4.2 It was agreed that further monitoring of outcome of ASP study in this regard is required.

2.4.3 The ADS-B Study and Implementation Task Force agreed that a formalized flight validation/testing program of ADS-B ground station should not be considered as a mandatory requirement. While the meeting noted that States may at their own discretion conduct such a program, this was beyond the minimum requirements. In view of the foregoing, the meeting recommended that there is no need for the ADS-B Study and Implementation Task Force to develop such guidance material. Detailed deliberations on this topic are provided in the **Appendix B** to this Report.

2.5 The meeting also noted that ATM/AIS/SAR/SG/19 meeting had supported the ADS-B ITP operational trials conducted by FAA in the South Pacific, noting the significant economic and efficiency benefits for both the service providers and the airspace users. Australia informed the meeting that Airservices Australia is conducting the trials jointly with FAA.

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Agenda Item 3: Review progress made by ADS-B related ICAO Panels

Update of ICAO Panels on ADS-B Related issues

Aeronautical Surveillance Panel (ASP)

3.1 The meeting noted that the following developments made by the Working Group of the Whole (WGW/1) of the Aeronautical Surveillance Panel in December 2008 was adopted by the ICAO Council in March 2010 for inclusion in Amendment 85 to Annex 10 to be applicable in November 2010:

a) updates to existing SARPs on secondary surveillance radar (SSR), automatic dependent surveillance — broadcast (ADS-B) and airborne collision avoidance system (ACAS) in light of operational experience;

b) introduction of new requirements for forward fit (from 1 January 2014) and retrofit (by 1 January 2017) of aircraft ACAS installations with an upgraded collision avoidance logic (known as TCAS Version 7.1);

c) introduction of new chapter in Volume IV entitled “Multilateration Systems” that contains system and functional requirements with an emphasis on the protection of the 1 030/1 090 MHz radio frequency environment from excessive interrogations; and

d) introduction of a new chapter in Volume IV entitled “Technical Requirements for Airborne Surveillance Applications” that contains system – level and functional requirements for onboard systems/equipment used for processing and displaying other traffic/aircraft based on information received from ACAS and ADS-B IN.

3.2 Other major products of the ASP WGW/1 were as follows:

a) the new Aeronautical Surveillance Manual (Doc 9924) which combines the updated and relevant parts of outdated *Manual of the Secondary Surveillance Radar (SSR) Systems* (Doc 9684) and *Manual on Mode S Specific Services* (Doc 9688) with new guidance material on systems such as multilateration, ADS-B, surveillance data sharing and so on in a single document. The new manual is posted on the ICAO-Net pending its publication in the ICAO languages. Once the new manual is published, the aforementioned old manuals will be taken out of circulation; and

b) information and/or guidance on “*sustainability of the 1 030/ 1090 MHz RF environment*”, “*incorrect SSR practices by some military authorities”*and “*guidance on ground testing of SSR transponders*” that were sent out via State letter SP 44/1-09/88 dated 2 December 2009.

3.3 The meeting also noted that ASP is also expected to finalize the data formats of a new set of 1 090 MHz extended squitter (ES) messages used for automatic dependent surveillance — broadcast (ADS-B) and traffic information service — broadcast (TIS-B) at its next working group meeting in October 2010. The new set of messages (called Version 2) that are in line with the latest industry standards (essentially the RTCA DO-260B, Minimum Operational Performance Standards (MOPS) for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B) issued in December 2009 and the EUROCAE ED-102A - MOPS for 1090 MHz Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B) & Traffic Information Services - Broadcast (TIS-B) - Issued in December 2009) will be included in the second edition of *Manual on Technical Provisions for Mode S Services and Extended Squitter* (Doc 9871). The respective changes to SARPs invoking Version 2 of ES messages will be proposed at the second meeting of the Working Group of the Whole (WGS) in October 2011 and are expected to be incorporated in Annex 10 — *Aeronautical Telecommunications*, Volume IV — *Surveillance and Collision Avoidance Systems* as part of Amendment 86 for applicability in November 2013.

3.4 Other major topics being studied and developed by ASP include:

a) increasing the capacity of 1 090 MHz ES by introducing additional phase modulation;

b) guidance on flight testing of ADS-B and Multilateration systems (MLAT);

c) multistatic primary radar (using emissions from sources like radio and TV transmitters);

d) possible need for a new generation of ACAS; and

e) sense & avoid (in terms of avoiding collision with other aircraft) for unmanned aircraft system (UAS).

3.5 The Aeronautical Communications Panel (ACP) will soon be finalizing a new set of messages for the universal access transceiver (UAT) (in line with Version 2 of 1 090 MHz ES messages) for incorporation in *Manual on the Universal Access Transceiver (UAT)* (Doc 9861) in harmony and coordination with the ASP.

3.6 The newly established Airborne Surveillance Task Force (ASTAF) held its first meeting in Montreal from 26 to 28 May 2010 mainly to organize itself for carrying out the work. It was agreed that the first product of the task force should be a manual containing guidance material for initial applications enabled by the use of ADS-B IN.

3.7 The approved work programme of the ASTAF by end of 2011included *air traffic situational awareness (ATSA)-in-trail procedure (ATSA-ITP) in oceanic airspace and identification of the reference aircraft in radiotelephony (e.g. ICAO three-letter designator versus call sign), etc.*

3.8 The Chairman of the Task Force noted that correct use of 24 bit aircraft address is very important for providing ADS-B and multilateration based surveillance services. The work of ASTAF on ITP is also relevant to the works carried out in the APAC Region.

Separation and Airspace Safety Panel (SASP) and Operational Data Link Panel (OPLINKP)

3.9 SASP completed the development of guidance material to support In-Trail Procedure (ITP) which included the planned proposed amendments to *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) in 2009. The material will be presented to the Air Navigation Commission during the fall of 2010. The draft circular entitled "*Safety Assessment for the Development of Separation Minima and Procedures for In-Trail Procedure (ITP) using ADS-B (Version 1.5.3)*" which contains, among other things, the planned proposed amendments to PANS-ATM is currently being subjected to coordination by various bodies of experts.

3.10 Finally, SASP and OPLINKP will be developing provisions (SARPs, Procedures for Air Navigation Services (PANS) and/or guidance material) in the 2012/2013 timeframe including the following subjects:

- in-trail climb using ADS-B and controller-pilot data link communications (CPDLC); and

- Criteria for the use of ADS-B and MLAT for the provision of 3 NM separation.

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Agenda Item 4: Review the Terms of Reference and Subject/Tasks List

4.1 Under this agenda item, the meeting reviewed the TOR adopted by APANPIRG/18 and discussed the Subject and Tasks of the Task Force assigned by APANPIRG.

4.2 The TOR was considered appropriate and the meeting did not propose any changes to the TOR.

4.3 The meeting reviewed and updated the Subject/Tasks List adopted by APANPIRG/20 meeting and formulated the following draft Decision:

Draft Decision 9/1 - Subject/Tasks List of ADS-B Study and Implementation Task Force

That, the Subject/Tasks List for ADS-B Study and Implementation Task Force provided in **Appendix C** to the Report be adopted.

Processing and Display of ADS-B Tracks

4.4 The meeting, under this agenda item, reviewed the progress on tasks assigned to members of the Task Force. Australia presented a draft Guidance Material on Processing and Display of ADS-B tracks at Air Traffic Controller's Positions. The draft material was further updated based on a recommendation made during the meeting including replacement of the word "SHALL" with "SHOULD" and additional guidance for the use of WGS84. The meeting considered appropriate to recommend it for adoption by APANPIRG as a regional guidance material. Accordingly, the meeting formulated the following draft Conclusion:

Draft Conclusion 9/2 – Guidance Material on Processing and Display of ADS-B Tracks on Air Traffic Controller Positions

That, the Processing and Display of ADS-B Tracks on Air Traffic Controller positions provided in **Appendix D** be adopted.

Building a safety case for ADS-B separation service

4.5 The meeting further reviewed a draft guidance material on building a Safety Case for delivery of an ADS-B separation services presented by Australia.

4.5.1 The Draft document makes reference to and includes extracts from two relevant existing ICAO documents, as well as some other guidance material derived from a previously prepared Safety Case covering an ADS-B separation service in Australia. The Civil Aviation Safety Authority Australia has previously produced a Civil Aviation Advisory Publication (CAAP) on the topic of Safety Case preparation. It also provides generic guidance material. The CAAP is titled "**Guidelines for the Preparation of Safety Cases covering Airways Systems**". It can be accessed on the following Webpage:
http://casa.gov.au/wcmswr/_assets/main/download/caaps/airways/airway_1.pdf

4.5.2 The draft material provides guidance on the steps and contents i.e. the topic headings, with a brief description of each topic that may be included under each heading for inclusion in an ADS-B Design and Implementation of Safety Case. This listing of topic has been derived from the Safety Case for the ADS-B Upper Airspace Program (UAP) prepared in Australia by the ANSP.

4.5.3 The meeting noted that the ICAO Circular 311 as referenced in draft Guidance Material had been pulled out of circulation and replaced by Circular 326 which will be available by December 2010. The meeting considered it more appropriate to defer the adoption of the Draft material till new Circular 326 is available. At the same time, the members of the Task Force were requested to review the structure and contents of the draft Guidance Material provided in **Appendix E** and provide comments and other feedback to the Mr. Brian Harris, the lead member for this task. The draft guidance material will be further updated with information in the new Circular 326 and the comments to be received from the members of Task Force and updated version will be provided for review by the next meetings of the SEA ADS-B working group and ADS-B Study and Implementation Task Force scheduled to be held in the first half of 2011. Accordingly the meeting made following Decision:

Decision 9/3 – Development of Guidance Material on Building a Safety Case for Delivery of an ADS-B Separation Service

That, the draft Guidance Material on Building a safety case for delivery of an ADS-B separation service provided in **Appendix E** to the Report be further updated for review by the next meetings of SEA ADS-B WG and ADS-B SITF/10.

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Agenda Item 5: Report and updates by the leading member of the Task Force on Tasks assigned

5.1 Under this agenda item, the meeting noted relevant information prepared by Australia for Task No 16 which requires development of guidance material on a sample ADS-B avionics mandate for the APAC Region.

5.2 The following four source documentations were identified that may be considered in the development of any template for a regulatory mandate.

- **CASA Australia Civil Aviation Order.** The ADS-B mandate that has actually been issued in final regulatory application is the relevant Civil Aviation Order of the Civil Aviation Safety Authority Australia. That is one source of material for consideration for use in forming a template. The Australian rule has been based on operations in a NRA environment but may also be satisfactory for a RAD environment. The updated Australian CAO is provided at following webpage: http://www.casa.gov.au/wcmswr/_assets/main/download/orders/cao20/2018.pdf

- **Eurocontrol ENPRM/10-003A.** In April 2010, Eurocontrol issued its ***ENPRM/10-003 Surveillance Performance and Interoperability (SPI) Requirements*** under its Single European Sky Mandate on Surveillance. The ENPRM proposes a 2015 mandate for application in a RAD environment. The material is available at following webpage: http://www.eurocontrol.int/enprm/public/standard_page/enprm1003.html

- **EASA AMC 20-24.** ***EASA AMC 20-24 'Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHZ Extended Squitter'*** was issued on 02/05/2008 as an Acceptable Means of Compliance for the airworthiness and operational approval of aircraft installations.

- **FAA Final Rule for ADS-B Out equipage mandate**

Revised Australian Standards for Aircraft ADS-B Avionics

5.3 Australia informed the meeting that CASA has amended its legislation that specifies the standards for aircraft ADS-B equipment configurations for use in Australia. The main issue taken into consideration was the Selective Availability Aware (SA Aware) capability of the GNSS equipment. The revised Australian standards for ADSB avionics were issued and it took effect on 22 December 2009.

5.4 The revised rules are applicable to Australian aircraft and foreign aircraft operating in Australia. Existing airline aircraft having FDE and HPL technology in their GNSS systems are not affected. This includes most existing airline aircraft used on international services.

5.5 CASA has taken account of recent representations and information from a number of sources including airline aircraft manufacturers, airlines, IATA, as well as information presented at several APANPIRG Meetings:

- ADS-B SITF/8 Meeting held in Hanoi in May 2009;
- CNS/MET SG/13 meeting held in Bangkok in July 2009; and
- APANPIRG/20 meeting held in September 2009.

5.6 The existing date of 12 December 2013 after which all aircraft operating in airspace at and above FL290 must have ADS B equipment is not affected by the amendments. As this change has an effect on air traffic surveillance by ATC, the proposal was coordinated with Airservices Australia. Safety outcomes will not be affected as Airservices is planning to make changes to the current NUC and NIC integrity level thresholds of aircraft ADS B transmissions for display on ATC screens. The revision will not impose any additional requirements on aircraft operators. A copy of amended Australian ADS-B rule is provided in **Appendix F** to this report.

5.7 IATA reiterated position of airspace users regarding the equipage requirements. According to standing Conclusions 19/37 adopted by APANPIRG, States have been encouraged to publish equipage mandates as soon as possible for near term implementation plans, recognizing the timeline required of a minimum 4 to 5 years for establishment of equipage mandates (exclusivity arrangements). It was also suggested to consider arrangements for the sharing of database of approval information to simplify the approval processes.

Template for promulgation of ADS-B Avionics Equipage Requirements

5.8 With respect to APANPIRG Conclusion 20/54, the meeting established an ad hoc working group including Regulators from States and IATA to develop a template to be used by States for the promulgation of Aircraft Equipage Requirements and the associated regulatory processes.

5.8.1 The meeting noted that the promulgation of airspace requirements for ADS-B implementation by States needs to occur as early in the process as possible. This includes potential upgrades/retrofits and IATA had indicated earlier that a general minimum time frame of 4-5 years should be considered.

5.8.2 The meeting endorsed the recommendation developed by the ad hoc working group for consideration by those States intending to implement ADS-B based surveillance service. i.e. when promulgating requirements for mandating ADS-B airspace, States should include the following information in the documentation:

a) Specify the airspace or routes that will require ADS-B equipage;

b) Define the ADS-B performance standard(s) required recognising both EASA AMC 20-24 and CASA CAO 20.18 Appendix XI;

c) The dates for initial implementation and if any upgrades required. These dates and timeline should identify when the ground capability becomes available and when full compliance with the requirements becomes effective.

d) Provide appropriate justification for the mandate including safety analyses and business case.

5.8.3 In view of the foregoing, the meeting considered a template for use by APAC States to issue a regulatory mandate for aircraft ADS-B equipment carriage in defined airspace and formulated following draft Conclusion:

Draft Conclusion 9/4 – 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 rule for ADS-B Avionics Equipage Requirements as soon as possible using the following template:

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

a) the aircraft must carry serviceable ADS-B transmitting equipment that has been certificated as meeting EASA AMC 20-24, or meets the equipment configuration standards in Appendix XI of Civil Aviation Order 20.18 of the Civil Aviation Safety Authority of Australia; and

b) the aircraft operator must have the relevant operational approval from the State of Registry.

Airworthiness and Operational Approval for ADS-B Avionics Equipage

5.9 The meeting agreed that while operational approval was necessary, it should follow the established procedures for other operational approvals such as RVSM and PBN. This will ensure that an undue burden is not placed on either regulators or operators and will maintain a simple consistency through the regulatory approval process.

5.9.1 There is a regime in place for both PBN and RVSM where States must manage the approvals. RVSM approvals are also registered with a Regional Monitoring Agency (RMA) while a global database of PBN approvals is being established jointly by ICAO and IATA. There was a recommendation that a similar regional monitoring agency process be established for ADS-B OUT and eventually ADS-IN approval.

5.9.2 The meeting reviewed the approval process that the State of Registry is responsible for the operational approval of their aircraft in accordance with Annex 6 Chapter 4. With respect to ADS-B equipage and operation authorizations, the meeting discussed several aspects that need to be considered by the Regulators for assessing an aircraft and the operator for ADS-B operation. As result of discussion, the meeting endorsed the guidelines developed by the ad hoc working group and recommended APANPIRG to consider following draft Conclusion:

Draft Conclusion 9/5 – Guidelines for Airworthiness and Operational Approval for ADS-B Avionics Equipage

That, States be advised to use the guidelines provided in **Appendix G** to this Report for Airworthiness and Operational Approval for ADS-B Out Avionics Equipage.

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Agenda Item 6: Review States' activities and interregional issues on trials and Implementation of ADS-B and multilateration

Updates on ADS-B Upper Airspace Project

6.1 Australia informed the meeting that the ADS-B Upper Airspace Project (UAP) was operationally commissioned on 19 December 2009 and air traffic controllers are now authorized to provide 5 NM separation services using ADS-B based surveillance service for air traffic at and above FL290. The coverage is currently available across the whole continent from 29 ADS-B ground station sites and one Wide Area Multilateration system comprising 14 sites. The meeting was informed that operational feedback since commissioning has been extremely positive and more than 73 per cent of all scheduled international flights in Australia are ADS-B approved aircraft.

6.1.1 The last ADS-B ground station of UAP Phase 1 at Broken Hill was commissioned in February 2010. Additional 18 stations are planned to be installed as part of UAP Phase 2 to provide ADS-B coverage within existing SSR coverage to provide a backup and improve tracking performance which will extend ADS-B coverage to all en-route sectors.

6.1.2 The meeting congratulated Australia for commissioning the Upper Airspace Project which indicates significant milestone for ADS-B implementation that has been achieved. It will motivate other States for early implementation. While commending the achievement, IATA provided positive feedback received from one airline as response time of clearance to requests for changing flight level has been reduced.

ADS-B development in China

6.2 China provided updates on the ADS-B development and deployment plan. ADS-B technology is considered as an important surveillance technology over western airspace and a significant supplementary measure for the radar surveillance in eastern part of China. ADS-B application in oceanic areas and airport surface will also be promoted and 1090ES has been chosen as the primary data link. In April 2010, CAAC issued the Chinese Technical Standards Orders of "Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Service-Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 MHz" for manufactures applying for Chinese Technical Standard Order Authorization for 1090ES ADS-B and TIS-B equipment. In May 2010, CAAC issued the Advisory Circular of "Airworthiness and Operational Approval of Automatic Dependent Surveillance-Broadcast Application in Non-Radar Areas via 1090 MHz Extended Squitter" for the manufactures, modification units and operators who want to get airworthiness approval for ADS-B airborne equipment. The translated English version of the Advisor Circular is provided in **Appendix H** to this Report.

6.3 In March 2009, CAAC set up an ADS-B station to serve ATS Routes L642 and M771 in the South China Sea area. In addition to the Chengdu-Jiu Zhai ATS route, CAAC is now working on a project of communication and surveillance with 5 ADS-B ground stations covering Chengdu-Lhasa ATS route to be completed by the end of 2010. CAAC also has a plan to install ADS-B stations along Lhasa-Ali route and B215 route from Yinchuan to Urumqi. Further, CAAC has scheduled to build ADS-B stations nationwide according to "the twelfth five-year plan". In the same period, the relevant automatic air traffic management systems will be upgraded to be able to receive, process and display ADS-B data.

Hong Kong China reconfirmed its plan to:

- mandate ADS-B carriage, by end 2013 for aircraft flying on ATS routes L642/M771;
- mandate ADS-B carriage, by end 2014, for aircraft flying within Hong Kong FIR;
- mandate ADS-B carriage, after 2015 to be confirmed, for low flying aircraft including general aviation aircraft and helicopters.

Indonesia

6.3.1 Indonesia informed the meeting that 27 ADS-B Ground stations with dual system had been installed at Makassar, Sorong, Natuna, Kupang, Merauke, Banda Aceh, Matak, Cilacap, Soekarno Hatta Airport-Jakarta, Tarakan, Pangkalan Bun, Palu, Kintamani - Bali, Waingapu, Alor, Galela, Ambon, Saumlaki, Medan, Pakanbaru, Palembang, Pontianak, Timika, Biak, Kendari, Manado, and Surabaya amongst which 18 Stations in the Eastern part of Indonesia are connected to Makkasar Air Traffic Service (MAATS) ATM system and 9 ADS-B Ground Station in the Western part of Indonesia are linked to the Remote Control Monitor System (RCMS) in JAATS-Jakarta. The Test-Bed system at DGCA Headquarters is able to monitor and control the ADS-B Data from these 27 ADS-B Ground Stations.

6.3.2 MAATS-Makassar has been upgraded from Eurocat-X version 2.4 to version 3.15 integrating ADS-B capabilities and was commissioned in December 2009. DGCA will establish Implementation Team for ADS-B implementation. Required regulations such as Operational Concept, Safety Assessment, ADS-B Procedure will be developed and introduced into CASR. For Near Term, DGCA has a plan to use ADS-B for Situational Awareness in MAATS Center. Cross FIR boundary operational data sharing has been identified as the initial application of ADS-B Services. Based on experience gained in using ADS-B for situational awareness, Indonesia will provide separation services using ADS-B.

6.3.3 The meeting congratulated Indonesia for the work completed and significant milestone achieved. In response to a query, it was clarified that ADS-B based separation service is expected to be provided in 2013. The meeting also supported the intention of Indonesia for ADS-B data sharing from which huge benefits could be derived.

Malaysia

6.3.4 Updates from Malaysia were as follows:

- DCA Malaysia had a discussion with DGCA Indonesia at Special Coordination Meeting which was held in June 2009 regarding ADS-B data sharing from Banda Acheh for ATC surveillance in Bay of Bengal. The discussion is still on-going;

- Malaysia had started upgrading the ATM System which will be able to integrate all the surveillance data inclusive of ADS-B. The project is scheduled to be completed in April 2011;

- Malaysian airspace is covered by radar except for a small portion in the Bay of Bengal which at the moment is covered by ADS-C. Nevertheless DCA Malaysia has submitted in 10^{th} Malaysia Plan to install ADS-B station and also upgrade and refurbish the present radars;

- DCA Malaysia expects the timeline for ADS-B mandatory equipage in Kuala Lumpur and Kota Kinabalu FIRs to be before 2020.

6.3.5 Malaysia was encouraged to advance its plan for providing ADS-B based surveillance service for its air space in BoB area.

New Caledonia

6.3.6 France provided an update on the ADS-B implementation status in New Caledonia. Implementation of three ADS-B ground stations was completed in the first half of 2010 to provide situation awareness service for international traffic at La Tontouta airport, the domestic traffic at Magenta airport and Air Traffic Service within Nadi FIR. The ADS-B controller display positions are also available since 30 July 2010. Most of commercial flights are now displayed on the screen for air traffic controllers whose work has become easier as now they have a better representation of the air traffic situation with more accurate information. However, some air traffic (military, general aviation etc) is not displayed and air traffic controllers still use procedure control to separate aircraft.

6.3.7. Aircraft operators flying to/from airports in New Caledonia and through sector of New Caledonia airspace are invited to equip their fleet. New Caledonia is also proposing cooperation for ADS-B data sharing with neighboring air navigation service providers such as instantaneous recordings for SAR purposes.

Singapore

6.3.8 Singapore informed the meeting that the Civil Aviation Authority of Singapore (CAAS) installed an ADS-B station and an ADS-B data processor in Singapore on 7 December 2009. The facility will:

a) complement the existing surveillance coverage by the Long Range Radar;
b) allow Singapore to perform operational trial using ADS-B data; and
c) complement the coverage of Indonesia and Vietnam through data sharing.

6.3.9 The ground station supplied by Comsoft GmbH supports ASTERIX Cat 21 versions 0.23, 0.26 and 1.3 with coverage of about 290 NM based on targets of opportunity. The ADS-B data processor can also process versions 0.23, 0.26 and 1.3 of ASTERIX Cat 21. The processing system is able to fuse ADS-B data from various sources and customized filtered dataset for each user.

6.3.10 It was also informed that the ADS-B data is currently used mainly for technical evaluation and familiarization. CAAS is considering to purchase a stand-alone controller position to conduct operational trials, before the commissioning of the new ATM automation system in early 2012. Singapore is ready to share ADS-B data with other States.

GPS Time Tagging Issue

6.4 The meeting noted the GPS Time Tagging issues as presented by Australia. GPS time currently differs from Coordinated Universal Time (UTC) by 15 seconds due to UTC "leap seconds". Some GPS receivers erroneously output GPS time (as if it were UTC) until a new offset is received in a GPS navigation message. It can be 14 minutes before such a message is received. If these GPS receivers are used for ADS-B time tagging, before the offset arrives false position reports can be shown to ATC. A number of protections can limit the impact of this issue as follows :

a) Operational procedures that do not put the ADS-B ground station back into service until 15 minutes after switch on; and

b) ATC system functionality that tests the reasonableness of the time tag. If the time tag is say more than 5 seconds old, or more than 0.5 second ahead of current time, then the data could be discarded.

6.4.1 The same issue could impact ATC centres, radars, multilat and other systems that use or generate time tags. States were encouraged to check their ADS-B systems if they suffer from this time tagging problem.

6.4.2 While discussing this issue which would be easily overlooked, it was recommended to uses dedicated GPS products for aviation use which should have been tested validated and approved. There would be side effect if low end and non aviation products are used for aviation purpose.

Presentation by ITT on ADS-B OUT Implementation in USA

6. 5 A presentation by ITT provided information on current status of ADS-B deployment for FAA into National Airspace System of USA. It introduced the system coverage by 794 radio sites. The meeting noted the implementation status and high level programme schedule in the presentation. The 800 ground stations will be commissioned by end of 2013. It was concluded that ADS-B technology is proven. It was informed that ITT Team has successfully designed, developed, and integrated an exceptional ADS-B ground infrastructure solution.

ADS-B Seminar for Civil Aviation Authority of the Philippines (CAAP)

6. 6 CANSO informed the meeting that an ADS-B seminar for the CAAP was conducted by the CANSO in Manila on 11 August 2010. The Seminar discussed the benefits of the Philippines participating in the South China Sea project and recommended that apart from the ADS-B site at Puerto Princesa, the CAAP considers adding another ADS-B station, taking into account the need to provide coverage of the 2 trunk routes (N884 and M767). A possible site identified was Quezon Palawan. The seminar recommended that the CAAP consider location of additional ADS-B sites based on possible cost allocation to other user States.

6. 7 CANSO also reported on the recent visit to DCA Brunei where Brunei was encouraged to participate in the South China Sea project. An ADS-B station in Brunei coupled with an ADS-B ground station in Quezon Palawan would enable surveillance coverage over the two trunk routes N884 and M767 and allow for a significant increase in airspace capacity and efficiency. The proposed ADS-B station in Brunei could also serve as a backup to its radar and used for airport surface movement surveillance.

6. 8 The meeting discussed the need to optimize overall benefits of ADS-B implementation for flights in South China Sea airspace and supported the recommendation for the Philippines to install an ADS-B station on a site in the South like Quezon Palawan to cover the above two trunk routes. In this connection, the meeting also supported the recommendation that Brunei consider installing an ADS-B ground station in Brunei.

Review of CNS/ATM Implementation and Planning Matrix

6. 9 The Secretariat presented the matrix reflecting implementation status of CNS/ATM systems in Asia/Pacific Region. It was noted that the CNS/ATM Implementation Planning Matrix was developed in accordance with the Conclusion 11/37 of APANPIRG and the Matrix has since been updated regularly. CNS/ATM Implementation Matrix reflects the status of implementation of major CNS/ATM elements in the region which includes ATN, AIDC, CPDLC, GNSS, ADS-C and ADS-B. The meeting was informed that the Matrix was updated by the Fifth meeting of ATN Study and Implementation Task Force held in May 2010.

6. 10 The meeting encouraged the member States of the Task Force to provide updates to the information contained in the Table from time to time. It was not considered necessary to wait for meetings to update the information as the updates can be provided to the Secretariat any time.

6. 11 The meeting reviewed and updated the information in the Matrix in particular on surveillance related information and the updated matrix is provided in **Appendix I** to this Report.

Review Regional Surveillance Strategy for APAC Region

6. 12 The meeting reviewed regional surveillance strategy for Asia and Pacific Regions adopted by APANPIRG/19 in 2008. It was recalled that initial version of the strategy was developed by the ADS-B Study and Implementation Task and Force and the CNS/MET SG/12 meeting had endorsed the amended Surveillance Strategy proposed by an ad hoc working group.

6. 13 The meeting updated the strategy taking into account comments from fourteenth meeting of CNS/MET Sub-group of APANPIRG held in July 2010 which suggested inclusion of information regarding newly developed standard DO260B (Version 2 ES being developed by ICAO to be applicable in November 2013) and insert additional word "cooperation" at last bullet paragraph as follows: Ensure civil-military c*ooperation* and interoperability.

6. 14 The updated regional surveillance strategy for Asia and Pacific Regions provided in **Appendix J** to this report was recommended for adoption by APANPIRG and the meeting formulated the following draft Decision:

Draft Conclusion 9/6 – Revised Regional Surveillance Strategy for Asia and Pacific Regions

That, the revised Regional surveillance strategy for Asia and Pacific Regions provided in **Appendix J** to the Report be adopted.

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Agenda Item 7: Development of Asia/Pacific Regional ADS-B implementation plan and sub-regional based ADS-B implementation plan

- Review report of the Fifth meeting of the South East Asia ADS-B Implementation Working Group;
- Develop a sample document for the regional harmonized requirements for ADS-B Out avionics equipage.
- Divide into working groups as follows and subsequently report conclusions to Plenary;

Updates on the Implementation Plan in the South China Sea Area

7. 1 Indonesia and Singapore updated the implementation plan in the South China Sea area. It was informed that Indonesia, Singapore and Vietnam have been jointly working on the installation of ADS-B ground stations and VHF radios. Discussions were also held between the parties concerned on the ADS-B data and VHF radio facilities sharing.

7. 2 ADS-B operations will be implemented in the Singapore FIR in 2 phases. In Phase I, ADS-B operations will apply to ATS routes L642 and M771 while other ATS routes in the Singapore FIR could be covered in Phase II. ADS-B operations will be exclusive and applicable between FL310 and FL410. Aircraft intending to operate in ADS-B airspace will need to be ADS-B equipped and certified accordingly. The task list and proposed milestones to achieve this is shown in **Appendix K** to this Report.

7. 3 IATA supported efforts made by the States to enable ADS-B data and DCPC capability sharing. IATA totally endorsed the proposed steps and emphasized the very important role of the project with clear timelines. Member Airlines are expecting to receive early benefits as best equipage should be able to receive best service.

7. 4 The meeting supported task and milestones as specified in the paper. States concerned were urged to progress the project according to the proposed timelines. Indonesia informed the meeting that JAATS will be ready by the end of 2012.

7. 5 It was clarified that confirmation to the final version of the timeline was not received from Viet Nam. As Viet Nam was not represented at the Task Force meeting, the ICAO Secretariat was requested to seek comments from Viet Nam on the implementation timelines and milestones as indicated in the proposed roadmap presented by Indonesia and Singapore. Accordingly the meeting made following Decision:

Decision 9/7 - Development of Roadmap of the ADS-B Implementation serving ATS Routes L642 and M771

That, Secretariat be requested to seek comments from Viet Nam on the implementation Timelines and milestones as indicated in the proposed roadmap for the ADS-B Implementation in the South China Sea area servicing ATS route L642 and M771.

Australia-Indonesia Data Sharing Project

7. 6 Australia and Indonesia provided an update on their data sharing project between the Brisbane and Pandang FIRs. Airservices Australia has approved Phase 1A. Indonesia’s DGCA has also approved Phase 1A and an ADS-B Filter has been installed in MAATS, Makassar. The ADS-B Filter has been tested and integrated into the ATC System in MAATS (Eurocat X). The tests were conducted between two States and the result of the test was successful. The need to re establish satellite channel previously used between Bali and Brisbane had been identified.

7. 7 The meeting noted that four ADS-B ground stations at Merauke, Saumlaki, Thursday Island and Gove have been installed and are operating. A draft agreement is in the final stage of co-ordination for signature by the two States. The draft is based on large part of the sample agreement developed by SEA ADS-B WG. The meeting noted the planned schedule of the projects and target dates of some specified milestone. Recognising that the agreement needs approval from Foreign and Defence Ministries of Indonesia, the meeting encouraged DGCA to make every effort to get it approved by the authorities as early as possible.

7. 8 It should be clarified that no issue of sovereignty is involved as the data derived from aircraft has been shared in ADS-C applications for years. The difference between ADS-C and ADS-B is updating rates. It is not like radar data which may involve liability concerns. The target date of using ADS-B data for situational awareness and safety nets by ATC is set for 1 November 2010.

7. 9 The project is expected to extend to Phase 1B and possibly Phase 2. The Phase 1A shall be operational before requesting approval to commence phase 1B which would comprise following additional sites: Broome, Doongan in Australia and Kintamani, Kupang in Indonesia. The Phase 2 would transform to full radar like separation when both parties have in place suitable infrastructure such as duplicated data communication links and DCPC capability. The meeting appreciated the progress made by the two States and supported the continued execution of the project.

7. 10 The meeting congratulated Indonesia and Australia for making progress on ADS-B data sharing and appreciated efforts made. IATA emphasized that cost effective solution of surveillance service is achieved through ADS-B data sharing and commended two states on the enormous achievements for ADS-B data sharing as good example of cooperation. CANSO also echoed and cited it as an excellent example of neighbouring ANSPs working together for the common benefits of aviation.

Sample agreement for data sharing

7. 11 Indonesia and Singapore shared with the meeting their experiences on the adoption of the sample agreement. It was explained that the entire agreement has been revamped quite a bit as the parties tried to make the agreement more comprehensive, precise, simple, easier to read and more acceptable by both parties. At the same time, the number of annexes was agreed to be reduced. In addition, the agreement was subject to vetting by various authorities, which resulted in further amendments. However, the intents of the original sample agreement remain unchanged. The brief description of the currently updated draft is attached in **Appendix L** to this report.

7. 12 The member States of the Task Force were requested to provide comments and feed back on their experience in using the draft data sharing template. Singapore was requested to provide an updated version of the data sharing agreement template based on the version signed with Indonesia at next SEA ADS-B Working Group meeting.

Approved Aircraft and Avionics

7. 13 Australia informed the meeting that before ATC uses ADS-B data in Australia, approval must be obtained for each airframe from the safety regulator (CASA). This process is being used to ensure that equipment which does not meet the performance requirements is not inadvertently used during the transition to ADS-B technology. Australia intends to remove the aircraft by aircraft, approval process in the near future.

7. 14 The approved types of airframe and avionics combinations by Australia up to mid. July 2010 are provided in **Appendix M** to this report. There are 1341 approved airframes.

Misleading ADS-B Transmissions

7.15 Australia presented a paper indicating that a number of ADS-B avionics products transmit ADS-B data which could be considered misleading.

Examples of these are:

- A product which transmits messages formats similar to, but not the same as DO260, DO260A or DO260B. When interpreted as DO260 messages, these can be misinterpreted as a good integrity messages with an incorrect position.

- A product which transmits DO260 NUC based solely on the accuracy value HFOM instead of the integrity value HPL. This can be interpreted as a DO260 message with good integrity when in fact integrity is poor.

- Other transponder and GPS products that fail to meet the published requirements of the Australian regulations

7.16 In environments where all airspace participants are required to have compliant equipment, the risk of using such misleading data is low because of existing regulatory controls

However, in an airspace which does not mandate ADS-B equippage, ADS-B transmissions may still be used, and the risk of use of such misleading data is higher. Examples include the following:

- In Airspace where ATC separation services are delivered in voluntary equipage airspace

- In Airspace where ADS-B is used for ATC situational awareness only and ADS-B equipage is not mandatory

- In Airspace where ADS-B IN may be used

7.17 Australia published regulations, first in 2006, which prohibit transmission of data which does not comply with the published standards. An updated version of this regulation is applicable today in Australian airspace even during the period before mandatory fitment applies. The following extract from the Australian Civil Aviation Order (reference section 9B of Civil Aviation Order 20.18) illustrates the rule.

5. If an aircraft carries ADS-B transmitting equipment which does not comply with an approved equipment configuration, the aircraft must not fly in Australian territory unless the equipment is:

(a) deactivated; or

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

Note: It is considered equivalent to deactivation if NUCp or NIC is set to continually transmit only a value of zero.

7.18 The exception related to transmission of NIC or NUCp=0 is made because NIC or NUCp = 0 indicates that the data has no integrity and the Australian ATC system will discard such messages. Many aircraft with compliant ATC transponders, without GPS systems, transmit inertial positional data in ADS-B messages with NUC or NIC=0. It is also expected that ADS-B IN systems will discard NUC/ NIC=0 data.

7.19 In view of the foregoing, the meeting recommended all Asia/Pac States intending to implement ADS-B based surveillance service to consider publishing additional provisions in their mandating rule and formulated following Draft Conclusion:

Draft Conclusion 9/8 – Rule on Misleading ADS-B Transmissions

That, States where ADS-B may be used, even voluntarily, promulgate rule for ADS-B Avionics Equipage Requirements consider publishing additional provisions for misleading ADS-B transmission as follows:

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 not comply with

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.

the aircraft must not fly unless the equipment is:
(a) deactivated; or
(b) set to transmit only a value of zero for the NUCp or NIC.

Note:
1. It is considered equivalent to deactivation if NUCp or NIC 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=0

Review of SEA and Bay of Bengal/South Asia Sub-regional Projects

7.20 The meeting reviewed the updates on the Sub-regional ADS-B implementation project from South East Asia (SEA) as presented by the ad hoc working groups at the ADS-B SITF/9 meeting. The discussions were based on the outcome of previous meetings of the ADS-B SITF/8 and SEA ADS-B WG/5. The outcome of discussions by SEA Ad Hoc working groups is provided in **Appendix N** to this report which could serve as a basis for further development of the sub-regional implementation plan.

7.21 While discussing the implementation of ADS-B in the Bay of Bengal and South Asia, the meeting reviewed a proposal for data sharing between Indonesia and Malaysia which would potentially provide benefits for air traffic across the Bay of Bengal. The meeting noted that India plays a key role in the sub-region. The Chairman questioned whether a similar working group arrangement to SEA ADS-B WG could be made in developing ADS-B implementation Plan for the sub-region. IATA informed the meeting that the subject had been discussed at the BOB-RHS Task Force meetings. It was further noted that due to resource constraints, the parent ATS Coordination Group – BBACG was not convened this year. There is significant potential for ADS-B deployment in the sub-region as five States are there in a very small corner of airspace with a significant traffic levels. Geographically the area lent itself to extended coverage by ADS-B and the possibilities should be explored in the near term. IATA suggested that while another sub regional working group may be desirable, the nature of operations would either mean overlapping membership of the existing SEA ADS-B WG or that the proposed group would require significant coordination with the existing group.

7.22 The meeting considered that a more pragmatic solution in the near term is to invite India and Myanmar to the next meeting of the SEA ADS-B Working Group, which had already been discussed and agreed by the working group. It was also suggested that both Pakistan and Nepal should also be invited.

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Agenda Item 8: Any other business

Review Regional Performance Framework Form on ADS-B

8. 1 The meeting reviewed the Regional Performance Framework Objective (APAC Objective 10) on ADS-B which was reviewed by SEA ADS-B WG/5 meeting in January and CNS/MET SG/14 meeting held in July 2010. The updated Performance Framework Form (PFF) on ADS-B provided in **Appendix O** to the Report will be incorporated into other updated PFFs for consideration by APANPIRG/21 in September 2010.

Note of appreciation

8. 2 The meeting expressed its appreciation and gratitude to the Diretorate General of Civil Aviation, Indonesia for hosting the ADS-B Regulatory Workshop and the Ninth Meeting of ADS-B Study and Implementation Task Force (ADS-B SITF/9). The meeting also thanked the DGCA Indonesia for the hospitality, excellent support provided and for all activities organized during the meeting.

Time and Venue of Next Meeting

8. 3 The sixth meeting of SEA ADS-B Working Group is scheduled in early 2011. Brunei Darussalam will look into the possibility of hosting the meeting. Singapore expressed that if no offer is received from other States, Singapore would like to host next working group meeting.

8. 4 The next meeting of ADS-B Study and Implementation Task Force is scheduled for April or May 2011. Since no offer for hosting the next meeting was received during the meeting, the members of the Task Force will be informed well in advance of the exact date and venue of the meetings after consultation with the concerned. Representative from SENSIS Corporation expressed their willingness to sponsor activities at the next Working Group and Task Force meetings.

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EXTRACT FROM REPORT OF APANPIRG/20
(7 – 11 SEPTEMBER 2009) ON ADS-B

3.4 CNS/MET matters

The meeting reviewed the outcomes of the Thirteenth Meeting of Communications, Navigation and Surveillance/Meteorology Sub-Group (CNS/MET SG/13) of Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) held in Bangkok from 20 to 24 July 2009.

Seminar on Testing Of Navigation and Surveillance Facilities and Validation of Flight Procedures

3.4.44 The meeting was informed that in accordance with APANPIRG Conclusion 19/32 a *'Seminar on Navigation and Surveillance Facilities and Validation of Flight Procedures'* was held at the Regional Office, Bangkok from 5 to 7 August 2009. It was jointly hosted by ICAO and Aeronautical Radio of Thailand (Aerothai). After reviewing the outcomes of the Seminar, the meeting adopted the following Decision recommending assessment of the need for developing guidance for inspection/validation of ADS-B ground stations.

Decision 20/47 - Guidance material for flight inspection/validation of ADS-B ground stations

That, ADS-B SITF be tasked to study the need for developing guidance material for flight inspection/validation of ADS-B ground stations.

Surveillance Systems

Review Report of the Eighth Meeting of ADS-B Study and Implementation Task Force

3.4.75 The meeting reviewed the outcome of ADS-B Seminar and the Eighth Meeting of Automatic Dependent Surveillance – Broadcast (ADS-B) Study and Implementation Task Force (ADS-B SITF/8), hosted by CAAV and VANSCORP Viet Nam in Ha Noi, Viet Nam from 18 to 22 May 2009.

3.4.76 The objective of the ADS-B Seminar was to provide information to the participants on ADS-B planning and implementation and to facilitate discussions at the meeting. The Seminar covered a comprehensive list of topics on the ADS-B implementation and was well received by the participants.

Terms of Reference and Subject/Tasks List of the ADS-B Study and Implementation Task Force

3.4.77 The meeting noted that no changes to the TOR was proposed and agreed with the Subject/Tasks List updated by the ADS-B SITF and adopted the following Decision:

Decision 20/50 - Subject/Tasks List of ADS-B Study and Implementation Task Force

That, the Subject/Tasks List for ADS-B Study and Implementation Task Force provided in **Appendix P** to the Report on Agenda Item 3.4 be adopted.

3.4.78 The meeting considered it essential to develop common understanding for the regulators to publish equipage requirement for ADS-B OUT based service. The meeting supported to organize a regulators workshop on ADS-B OUT equipage requirement before May 2010 as recommended by the Task Force. Australia and USA reconfirmed to support the workshop through coordinating and providing experts including those from industry for the Workshop. Accordingly, the meeting formulated the following Conclusion:

Conclusion 20/51 - Workshop on ADS-B OUT equipage requirement

That, ICAO be invited to organize a workshop on ADS-B OUT equipage requirement before May 2010 with the assistance from Australia and USA.

Updates on ADS-B Planning and Implementation

3.4.79 The meeting reviewed implementation status updated by States at the Task Force meeting and noted some issues observed during the trials and implementation.

Australia

3.4.80 Australia provided explanation and analysis on requirements for TSO 145/6 GPS receiver that includes FDE and SA Aware capabilities and examined ADS-B NUC values for various GPS MMR and transponders. Australia encouraged other States to perform similar analysis to further confirm or refute Australian findings with respect to SA ON avionics ADS-B service reliability.

3.4.81 The meeting noted that a PC based ADS-B Filter called Foreign ADS-B Filter (FAF) is being developed by Australia to control the exchange of ADS-B data between Australia and its neighbors. The development of FAF is expected to be completed in 2009. The functional and system requirement were provided for consideration by other States who wish to share ADS-B derived data. The meeting felt that the FAF could be installed at either site or at both the sites which should be specified in the data sharing agreement. The reliability and redundancy of FAF should also be taken into account when a PC based system is used.

3.4.82 The meeting noted experience gained and lessons learnt in deploying Wide Area Multilateration in Tasmania, Australia. The project started in May 2006 and the Site Acceptance testing commenced in May 2008. A number of flight tests have been conducted as part of Site Acceptance Testing. Final flight test and conclusion of SAT is expected in 2009.

China

3.4.83 China provided the result of the Trial & Evaluation Project conducted in South Western part of China to support ADS-B implementation. Several issues including analysis of the invalid data were identified. The meeting discussed and analyzed some issues resulting from the ADS-B evaluation project including velocity and heading evaluation, low updates rate, etc. The issues and findings observed in the real flight testing were considered very useful.

Hong Kong, China

3.4.84 It was noted that Hong Kong, China plans to:

a) mandate ADS-B carriage, by end 2013, for aircraft flying over L642/M771;

b) mandate ADS-B carriage, by end 2014, for aircraft flying within the Hong Kong FIR; and

c) mandate ADS-B carriage, after 2015 (TBC), for low flying aircraft, including general aviation aircraft and helicopters.

New Caledonia

3.4.85 Three ground stations were installed at the existing VHF sites in New Caledonia in March 2009. Technical testing will be conducted during October to December 2009 and operational testing will start from end of 2009 and will be completed by mid. 2010.

Pakistan

3.4.86 The meeting noted that most of the Pakistan airspace currently is already under radar surveillance, some gaps in the west, northern mountain regions and some portion in the south and southwest airspace need to be brought under positive visibility/surveillance. PCAA considers ADS-B, a potential option to fill up the gaps in radar surveillance and also considers using ADS-B to provide partial back up to the existing radar. One ADS-B station was installed at Karachi ACC on trial basis for a period of one year.

The Philippines

3.4.87 The Civil Aviation Authority of the Philippines (CAAP) installed a new Mode S SSR capable of processing ADS-B reports based on 1090ES. This enables the monitoring of ADS-B equipped aircraft in the 100NM radius from the radar station. The ADS-B function of the radar will be used to observe and evaluate population of aircrafts equipped with ADS-B within 100 NM. The CAAP has planned to install two stand alone ADS-B stations in Manila and Puerto Princesa by 2012. The CAAP also intends to include the ADS-B function in all other Mode S SSR stations that will be installed in 2012.

Viet Nam

3.4.88 Viet Nam has been participating in South East Asia's programme on ADS-B implementation and has committed to share ADS-B data with its neighboring States. Viet Nam will also consider sharing VHF communication capabilities with neighboring FIR when ADS-B control is applied. Viet Nam had preliminary discussion with stakeholders on upgrading ATM system in Ho Chi Minh AACC to process ADS-B data and sharing of ADS-B data with Singapore.

ADS-B Data Sharing

3.4.89 ADS-B data sharing between Australia and Indonesia is expected to be operational in the 2nd Quarter 2010. This phase (Phase 1A) will use single data communications infrastructure to support situational awareness and safety nets. It is proposed to use an existing satellite data communications link between Australia and Indonesia. Phase 1A, for which funding has been approved will include data sharing from existing ADS-B sites at:

- Thursday Island (installed)
- Gove (to be installed in 2009)
- Merauke (installed)
- Saumlaki (installed)

3.4.90 The meeting noted that Indonesia has offered to share its ADS-B data from Banda Aceh ground station with Malaysia during the fourth South-East Asia sub-regional ADS-B implementation working group meeting. It was noted that the ADS-B data from Banda Aceh station is expected to enhance Malaysia surveillance capability within its AOR in the Bay of Bengal Area. The meeting further noted that the current Kuala Lumpur ATCC ADS-C/Radar integrated workstation for oceanic (Bay of Bengal) Sector is capable of processing and integrating ADS-B data.

3.4.91 Indonesia confirmed that the ADS-B ground station has been installed with data format ASTERIX 21 version .23 and is ready to further discuss with Malaysia data sharing arrangements. It was encouraging to note the initiatives being taken by Malaysia and Indonesia for

ADS-B data sharing in the Bay of Bengal area. States concerned were encouraged to consider sharing VHF communication capability wherever they are applicable.

FASID Tables on Surveillance Systems

3.4.92 The meeting noted that the Tables CNS 4A and 4B of the Asia and Pacific Air Navigation Plan, Volume II, FASID, Doc 9673 were reviewed and updated by the Task Force meeting. Table CNS 4 renamed as Table CNS 4A – Surveillance Systems in 2006 specifies Surveillance System requirements and Table CNS 4B renamed from the Table ATS 3 specifies ATS Automation Systems requirements. The meeting accordingly adopted the following Conclusion:

Conclusion 20/52 - Table CNS 4A and Table CNS 4B

That, the FASID Table CNS 4A and Table CNS 4B be replaced with updated Tables provided in **Appendix Q** and **Appendix R** to the Report on Agenda Item 3.4 in accordance with the established procedure.

South East Asia (SEA) ADS-B Working Group

3.4.93 The meeting noted the outcome of the fourth meeting of the South East Asia ADS-B Working group hosted by Airservices Australia in Melbourne on 9-10 February 2009. The meeting agreed with the following actions to expedite ADS-B implementation in South China Sea area:

i) complete installation of ADS-B stations at Natuna and Matak Islands, Singapore and Con Son Island by 2010;

ii) sharing of ADS-B data and DCPC capability between Indonesia, Singapore and Vietnam to facilitate application of radar-like separation standards;

iii) commence ADS-B operational trials in 2010 along air routes L642 and M771; and

iv) the earliest operational trial to be conducted approximately by the end of 2010 depending on new ATC automation system capabilities in the States. It was envisaged that an ADS-B mandate for some flight levels could come into effect in 2013.

Cost benefit study for South China Sea area

3.4.94 CANSO provided information on the outcome of a Cost Benefit Study conducted by CANSO and IATA for initial phase of ADS-B implementation over the South China Sea. The study results indicated a positive business case and highlighted operational efficiencies and savings that can be derived through the implementation. FAA was helping in the analysis, and CAA Singapore was helping with the collection of operational and technical data. The meeting appreciated the outcome of the cost benefit study.

Guidelines for Development of ADS-B Implementation plan

3.4.95 The meeting recalled the “Guidelines for development of ADS-B Implementation plan by States” adopted by APANPIRG/19 meeting under Conclusion 19/35. The meeting endorsed a proposal by Viet Nam and agreed by the Task Force to revise the guidelines with additional information and formulated the following Conclusion:

Conclusion 20/53 - Revised Guidelines for Development of ADS-B Implementation Plan by States

That, the revised guidelines for Development of ADS-B Implementation Plan by States provided in **Appendix S** to the Report on Agenda Item 3.4 be adopted.

Australian ADS-B aircraft mandate

3.4.96 Australia informed the meeting that in March 2009, the Civil Aviation Safety Authority (CASA) issued legislation for an ADS-B aircraft equipment mandate both for Australian and foreign registered aircraft for flight in the upper Australian territorial airspace (at and above FL290), with a compliance date on and from 12 December 2013. The text of the mandate is available on the following webpage: http://www.casa.gov.au/newrules/airspace/jcp/nfrm_jcp_annexb.pdf
The meeting noted additional information provided by Australia at APANPIRG/20 meeting about their plans to revise ADS-B aircraft equipage mandate to make the technical specifications for GNSS position source equipment for aircraft more explicit and extend the date for certain technical compliances (SA Aware) till 2015. These revisions are based on the outcome of various regional meetings which include ADS-B SITF and CNS/MET SG meetings. It was assured that the revision will neither increase the cost nor impose any additional technical requirements. The meeting noted that IATA and their members have been the early supporters of ADS-B and recognized that Australia has been leading the world in many developments. IATA continues to support the intent of the Australian ADS-B mandate.

Options for states to establish Aircraft ADS-B avionics mandate

AMC20-24

3.4.97 The meeting noted the considerations of third meeting of South East Asia ADS-B WG in July 2008 on AMC20-24 published on 25 April 2008 by the European Aviation Safety Agency (EASA) which defines acceptable means of compliance for the airworthiness and operational approval of the "Enhanced Air Traffic Services in Non-Radar Areas using ADS-B Surveillance" The working group meeting agreed that AMC20-24 with proposed changes serves as baseline document for further consideration. The AMC20-24 with proposed changes by SEA ADS-B WG is provided in the Appendix J to the Report of the ADS-B SITF/8.

ADS-B OUT Equipage Standards - IATA

3.4.98 The meeting noted a proposal for ADS-B OUT Equipage Standards proposed by IATA for the Asia/Pacific Region. It was stated that both the Australian approval method and AMC 20-24 are suitable standards for Asia Pacific. EASA AMC20-24 is better recognized as a global benchmark detailing an acceptable means of compliance for operation in non-radar areas. AMC 20-24 should eventually be adopted as the equipage standard for Asia and Pacific. Forward fit aircraft should comply from commencement of operations while retrofit aircraft must comply by 2013.

3.4.99 Regarding approval process for ADS-B OUT, IATA expressed that it should be no different for any other avionics equipment. The contracting States shall recognize as valid an air operator certificate issued by another Contracting State. Australia informed the meeting that a possible way is to endorse the list of CASA approved aircraft that can be provided on request.

Regional ADS-B Equipage Requirement

3.4.100 The meeting noted the information of options for states to establish harmonized Aircraft ADS-B avionics mandates including Australian ADS-B mandate for upper airspace from 12 December 2013, AMC20-24 published on 25 April 2008 by the European Aviation Safety Agency (EASA) which defines acceptable means of compliance for the airworthiness and operational approval of the "Enhanced Air Traffic Services in Non-Radar Areas using ADS-B Surveillance". The meeting also noted the current state of development of the regulations in Canada and USA.

3.4.101 The meeting agreed that the Australian approval method and AMC20-24 are suitable standards for Asia/Pacific Region. However, it was also recognized that some aircraft configurations are currently unable to obtain AMC 20-24 certification without upgrade despite being in compliance with the current Australian standard. In the interim, these aircraft can and should be authorized to operate ADS-B in the Asia/Pacific Region. At the same time, the benefits of SA aware avionics and FDE were recognized and it is recommended that new aircraft should be fitted with these capabilities. Therefore, States are recommended to identify these capabilities as forward fit requirements as soon as reasonable.

3.4.102 The meeting, after considering additional comment from IATA regarding introduction of appropriate regulations to allow any of the stated requirements, adopted following two Conclusions:

Conclusion 20/54 - Regional ADS-B Equipage Requirement

That, States be urged to issue ADS-B authorizations for the interim period 2010-2020 (or until requirements can be harmonized globally) in Non-Radar Areas (NRA) airspace based on:

- AMC20-24 certification or
- Approval by CASA Australia or
- The requirements of the CASA Civil Aviation Order 20.18 Amendment (No. 1) 2009 and Advisory Circular AC21-45

Note: States that have not yet published regulations should implement necessary regulations that recognize that any one of the above requirements is acceptable and not specify an individual requirement

Conclusion 20/55 - Forward Fitment Requirements for SA Aware and FDE functionality

That, ICAO recommend States concerned to adopt forward fitment requirements which include SA aware and FDE functionality as soon as reasonable.

Sub-regional ADS-B implementation projects

3.4.103 The meeting noted the outcome of the discussion by the three ad hoc working groups established during the Task Force meeting to further develop proposals for sub-regional implementation plans for South East Asia, Bay of Bengal and South Asia and Pacific. The outcome is provided in Appendix K to the report of ADS-B SITF/8.

Note of appreciation

3.4.104 The meeting appreciated the efforts and progress made by the ADS-B SITF and the SEA ADS-B WG and expressed its appreciation and gratitude to the Civil Aviation Authority of Viet Nam and VANSCORP for hosting the ADS-B Seminar and the Task Force meeting. The meeting also expressed appreciation to Airservices, Australia for hosting the fourth meeting of the SEA ADS-B Working Group.

Time and Venue of Next Meeting

3.4.105 The fifth meeting of SEA ADS-B Working Group is scheduled to be held during the end of 2009 or early 2010 in Indonesia and the next meeting of ADS-B Study and Implementation Task Force is scheduled for April/May 2010.

<u>Under Agenda Item 3.2 of APANPIRG/20 Report</u>:

USA - Operational Trial of ADS-B In-Trail Procedures

3.2.33 The United States provided an in-depth update on planning by the FAA to conduct an operational trial of ADS-B In-Trail Procedures (ITP) in the South Pacific. For ADS-B ITP, the maneuvering aircraft obtains the flight identification on proximate ADS-B equipped non-maneuvering aircraft using ADS-B 'IN' technologies. Based on the ADS-B data from the non-maneuvering or reference aircraft, a pilot can make an ITP altitude change request to ATC. The controller, who maintains separation responsibility at all times can then approve the manoeuvre. The planned trial will be undertaken with United Airlines B747 aircraft, and will be closely monitored and supervised by the FAA. The ATM/AIS/SAR/SG/19 meeting supported the ADS-B ITP operational trials in the South Pacific, noting the significant economic and efficiency benefits for both service providers and airspace users.

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CONSIDERATION OF FLIGHT TESTING OF ADS-B GROUND STATIONS

1. The meeting further noted that while ADS-B OUT provides similar surveillance capability to radar, the architecture of the system design has more similarities in function to a VHF radio. While a flight validation for a radar provides ground engineers ability to confirm the optimisation of the site after determining a significant number of site specific parameters, most ADS-B systems have minimal numbers of such settings affecting their performance.

2. ADS-B data is transmitted via data link from aircraft. The positional accuracy performance of radar must be verified since it is the position measuring device. The position of an aircraft derived from ADS-B is provided by the aircraft itself and should not be affected by the ground station capability.

3. Flight testing requirements for ADS-B ground station could baseline the coverage envelope including cone of silence (if any) with a minimum transmission power transponder. Flight testing as part of SAT has higher value when testing the “first of type” of a particular vendor’s product. The risk of mismatch between theoretical charts and practice is much reduced in ADS-B compared to radar due to the significantly reduced factors determining coverage. In most cases coverage is limited by line of sight limitations.

4 The meeting also noted the following relevant issues that may be involved in flight inspection for ADS-B ground stations:

– Accuracy is a function of the avionics and GPS geometry. Flight testing of the ground station is not useful for accuracy validation.

– Range is a function of antenna pattern/gain, feeder cable loss, receiver sensitivity and line of sight issues.

– Line of sight issues which may be impacted by obstructions like buildings or mountains or due to earth curvature causing aircraft to disappear below the horizon. Providing there is a sufficient quantity of regular ADS-B equipped traffic/targets of opportunity, line of sight coverage limitations are best characterised by recording the accumulated tracks from regular traffic over an extended period. It does not require a flight test aircraft.

– Antenna pattern/gain issues. This is probably the only area where it might be useful to check performance at commissioning with an aircraft equipped with a transponder calibrated to have minimum specification power output level. Areas to look at are the 'cone of silence’ at short range, and the long range coverage limit due to loss of signal. However, data from targets of opportunity can provide fairly good indications of antenna performance.

– Ground station validation where an ADS-B test message is injected at the antenna to provide continuous performance monitoring of feeder cable loss and receiver sensitivity would reduce or remove the need for flight testing.

- For ongoing monitoring of antenna performance, periodic comparison of the coverage from targets of opportunity can be compared to a baseline derived from similar traffic.

- It should be noted that for ADS-B ground stations designed for long range coverage, the aircraft is likely to disappear below the horizon before detection is lost due to signal falling below receiver noise level. In this case flight testing with a calibrated transponder yields no further information than would a collection of targets of opportunity.

- ADS-B ground stations designed for short range coverage (e.g. as part of an airport A-SMGCS) may have lower gain antennae and lose coverage before the horizon, but this is of little interest if the requirement is just airport coverage.

5. However, the benefits of such activity need to be compared to the significant costs to conduct the flight test. Alternatives to flight testing can be achieved using:

- targets of opportunity in the period between installation of equipment and prior to the introduction of operations by recording and mapping the receipt of actual ADS-B transmissions from aircraft;

- measuring and monitoring the minimum signal strength at the antenna necessary to generate an ADS-B report; and

- measurement in-band interference at the site and assessing its impact on detection

6. The meeting was advised that Australia did not perform calibration aircraft flight tests when commissioning 29 ADS-B ground stations in the continent and does not plan to do so with future sites based on the limited benefits derived from the activity.

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UPDATED ADS-B SUBJECT/TASKS LIST

No.	Subject/Tasks List	Associated with Strategic Objective	Associated GPI	Deliverables	Target Date	Action to be taken and led by
1	Conduct study and present a paper on a study for the use of ADS-B technology in airspace in the North Asia.	D. Efficiency	GPI01/02/05/06/07/09/ 14/16/17/21/22	Report of study for the use of ADS-B in North Asia area	Completed (04/2008)	IATA
2	Report Organizational Policy on ADS-B data sharing with neighbors.	A. Safety D. Efficiency	GPI01/02/05/06/07/09/ 10/11/14/16/17/21/22	Status report	Completed (04/2008)	All Members
3	Each member State report on the number of airframes fitted and transmitting with good NUC/NIC.	D. Efficiency	GPI01/05/06/09/14/16/ 17/21/22	Report on statistics conducted	4/2011	All Members with Ground Stations
4	Develop draft comparison of surveillance technologies document including required site and network architecture, expected surveillance coverage, cost of system.	D. Efficiency	GPI01/02/05/06/07/09/ 14/16/17/21/22	A regional guidance material for implementation	Completed (4/2007)	Greg Dunstone
5	Develop draft update to AIGD to incorporate multilateration.	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	The second amendment to the AIGD	Completed (4/2007)	Nick King, Chainan Chaisompong & Howard Anderson
6	Provide a paper with an update on available equipment standards: (ARINC, Eurocae, RTCA, ICAO, TSO)	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	An information document for implementation	Closed (08/2010)	Information proviided to ADS-B workshop
7	Develop a table detailing readiness of Airspace users & ATS providers.	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Report of a survey conducted	Completed (4/2007)	Singapore
8	Provide details of potential areas (FIRs) that where there is a positive cost/benefit for near term implementation of ADS-B Out	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Report of result of studies	Completed (4/2008)	All -Corner meetings

No.	Subject/Tasks List	Associated with Strategic Objective	Associated GPI	Deliverables	Target Date	Action to be taken and led by
9	Develop a paper on how Probability of detection should be reported for ADS-B so that it can be compared to radar probability of detection	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Guidance material for implementation	Completed (4/2008)	
10	Develop guidelines on how ADS-B equipage should be reported in future, especially the definition of "equipped".	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Guidelines for implementation	Completed (4/2008)	Greg Dunstone
11	Develop outline of the performance criteria and identify issues to be considered when introducing ADS-B into an Air Traffic Control multi-sensor fusion process	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Guidance material for implementation	Completed (4/2008)	Rick Castaldo, Greg Dunstone Michel G. Procoudine
12	Deveop brief guidance paper on security issues associated with ADS-B	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Guidance material for implementation	Completed (4/2008)	Patrick Souchu, Greg Dunstone, Mike Gahan
13	Exam the feasibiity of the use of ADS-B for height monitoring	A. Safety	GPI01/05/06/09/ 14/16/17/21/22	Result of feasibility study - Advice on ADS-B capability to RVSM Groups.	Completed the advice material (4/2008)	TBD
14	Guidance material on how to build safety case for delivery of separation services.	Safety	GPI01/05/06/09/ 14/16/17/21/22	Guidance material for implementation	Apr-11	Australia
15	Guidance material on display of ADS_B tracks on displays.	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Guidelines for implementation	Completed (/8/2010)	Australia
16	Sample mandate material defining ADS-B avionics including the positional data source including task by 45th DGCA Conference.	A. Safety	GPI01/05/06/09/ 14/16/17/21/22	Guidance material for implementation	Completed (/8/2010)	Australia + Regulators Workshop
17	Guidance on legal liability issues for ADS-B data sharing.	A.Safety	GPI01/05/06/09/ 14/16/17/21/22	Guidance material for implementation	Aug-10	U.S.A.
18	Develop and implement regional collaboration project for ADS-B Out operational use including data sharing in SEA and report on implementation progress	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Sub-regional ADS-B collaboration project has been .	Jul-08/ Apr-11	SEA WG

No.	Subject/Tasks List	Associated with Strategic Objective	Associated GPI	Deliverables	Target Date	Action to be taken and led by
19	Develop and implement regional collaboration project for ADS-B out operational use including data sharing in South Pacific and report on implementation progress	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Develop and implement sub-regional ADS-B collaboration project.	Apr-09/ Dec-11	South Pacific States
20	Develop common compliance procedures for regulatory surveillance of ADS-B avionics installations and operation.	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Sample document	Completed (5/2009)	Australia
21	Study application of ADS-B and multilat for precision runway monitoring.	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Guidance material for implementation	Apr-11	All Members
22	Perform data collection and data analyis of ADS-B messages to examine GPS performance in different geographic areas.	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Report of data collected and analyzied - continous	Apr-11	All Members
23	Develop and implement regional collaboration project for ADS-B out operational use including data sharing in Bay of Bengal area and report on implementation progress	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Develop and implement sub-regional ADS-B collaboration project.	Apr-09/ Dec-11	Bay of Bengal States
24	Working Paper for CNS/MET/SG/13 on the need for global harmonized equipage requirements for ADS-B surveillance service in NRA	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Working Paper	Closed 9/2009	member from US Workshop on this conducted
25	Provide feedback to the proposed amendment and template for datasharing based on experience gained by Indonesia and Signapore	D. Efficiency	GPI01/05/06/09/ 14/16/17/21/22	Comments	April-10	All Members

INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

GUIDANCE MATERIAL ON
PROCESSING AND DISPLAY OF ADS-B DATA
AT AIR TRAFFIC CONTROLLER POSITIONS

Version 1.0

27 April 2010

GUIDANCE MATERIAL ON PROCESSING AND DISPLAY OF ADS-B DATA

1 Introduction

A wide variety of ATC systems will process and display ADS-B data. The displays can be simple PC based standalone systems or sophisticated automation systems. The displays could support enroute, terminal, tower ATC.

This document considers the ATC display component of the ATC system only – and will ignore the sensor capabilities.

2 The need for ATC Surveillance

Surveillance plays an important role in Air Traffic Control (ATC). The ability to accurately and reliably determine the location of aircraft has a direct influence on the separation distances required between aircraft (i.e. separation standards), and therefore on how efficiently a given airspace may be utilised.

In areas without electronic surveillance, where ATC is reliant on pilots to report their position (either by voice or CPDLC),, aircraft have to be separated by relatively large distances to account for the uncertainty in the estimated position of aircraft and the timeliness of the information.

Conversely in terminal areas where accurate and reliable surveillance systems are used and aircraft positions are updated more frequently, the airspace or airport surface can be used more efficiently to safely accommodate a higher density of aircraft. It also allows aircraft vectoring for efficiency, capacity and safety reasons.

ATC surveillance serves to close the gap between ATC expectations of aircraft movements based on clearances or instructions issued to pilots, and the actual trajectories of these aircraft. In this way it indicates to ATC when expectations are not matched, providing an important safety function. Surveillance provides “blunder” detection.

The demand for increased flexibility to airspace users by reducing restrictions associated with flying along fixed routes requires improved navigation capability on board the aircraft. Equally, accurate surveillance is required to assist in the detection and resolution of any potential conflicts associated with the flexible use of the airspace which is likely to result in a more dynamic environment.

Accurate surveillance can be used as the basis of automated alerting systems. The ability to actively track aircraft enables ATC to be alerted when an aircraft is detected to deviate from its assigned altitude or route, or when the predicted future positions of two or more aircraft conflict. It also supports minimum safe altitude warnings, danger area warnings and other similar alerts.

Surveillance is used to update flight plans, improving estimates at future waypoints and also removing the workload for pilots in providing voice reports on reaching waypoints.

3 General Requirements of an Air - Ground Surveillance System

The most basic function of a surveillance system is to periodically provide an accurate estimate of the position, altitude and identity of aircraft. PANS ATM Section 8.2 SITUATION DISPLAY provides further details.

Depending on the ATC application that a surveillance system is intended to support, there will be other requirements of the system.

A surveillance system may be characterised in terms of the parameters listed below:

1. Coverage volume – the volume of airspace in which the system operates to specification.
2. Accuracy – a measure of the difference between the estimated and true position of an aircraft.
3. Integrity – an indication that the aircraft's estimated position is within a stated containment volume of its true position. Integrity includes the concept of an alarm being generated if this ceases to be the case, within a defined time to alarm. Integrity can be used to indicate whether the system is operating normally.
4. Update rate – the rate at which the aircraft's position on the ATC display is updated.
5. Reliability – the probability that the system will continue operating to specification within a defined period. Sometimes this is called continuity.
6. Availability – the percentage of the total operating time during which the system is performing to specification.

Other issues which need to be considered when designing a surveillance system for ATC are:

1. The ability to uniquely identify targets.
2. The impact of the loss of surveillance of individual aircraft both in the short (few seconds) and long term
3. The impact of the loss of surveillance over an extended area.
4. Backup or emergency procedures to be applied in the event of aircraft or ground system failure.
5. The ability to operate to specification with the expected traffic density.
6. The ability to operate in harmony with other systems such as the Airborne Collision Avoidance Systems (ACAS) and Airborne Separation Assistance Systems (ASAS).
7. The ability to obtain Aircraft Derived Data (ADD).
8. The interaction between communication, navigation, and surveillance functions.

4 The ADS-B display is One Part of a Surveillance System

Whilst this paper concentrates on ADS-B display, this is just one part of an overall system that provides data for use in ATC. A complete system includes:

- Position and altitude sensors. Some of these sensors may be ground based (e.g. radars) or may be airborne (e.g. altitude sensors). Datalinks are used to transmit data from airborne sensors to the ground,
    - The Fundamental Data provided to the air traffic controller is aircraft position, aircraft identity and altitude. Further information such as aircraft direction, speed, the rate of climb may also be provided.
- A system to transmit the data from the reception point on the ground to the ATC centre,
- A display system or ATC automation system
    - Data from a sensor system may be presented on a standalone display or combined with data from other sensor(s) and/or other data in an automation system and then presented on a plan view situation display.
    - The situation display provides Air Traffic Controllers with plan view of the position of aircraft relative to each other and to routes, waypoints and geographic features. Suitable maps are required on ATC displays. Such displays support controllers in providing Separation and other services to aircraft.
    - Automation systems may use surveillance data to implement automated safety net functions such as Route Adherence Monitoring, Cleared Level Alarm, Conflict Alert, Lowest Safe Altitude and Danger Area Infringement Warning. These facilities increase overall safety.
    - Appropriate Surveillance system monitoring /alerting – eg parrots & site monitors
- Suitably trained air traffic controllers, aircrew and
- Suitable standards and procedures to use the system including separation minima
    - ICAO PANS-ATM (Doc.4444, Chapter 8) details radar separation minima of five (5) and three (3) nautical miles. These minima allow for a considerable increase in airspace utilisation compared to procedural control. Changes to ICAO documents were published in 2007 recognising ADS-B use to support 5 nautical mile separation standards. ICAO's Separation & Airspace Safety Panel (SASP) is working on proposals to allow 3 nautical mile separation standards using ADS-B.
    - Due to the low update rate, ACARS based ADS-C surveillance is unlikely to ever support 3 and 5 nautical mile separation standards. However it is used to support 30/30 and 50/50 nautical mile procedures used in some regions. ATN and VDL2 based ADS-C may reduce the achievable separation standards in some regions.

5 Essential Display System Requirements

The following display system processing is considered the minimum necessary for any display to ATC :

5.1 Filtering data which has inadequate positional quality.

It is essential that data which does not meet the required quality standards be filtered so that misleading data is not displayed to ATC. Typically this will involve testing the Figure of Merit (FOM) in Asterix Cat 21 [1]messages.

5.2 Filtering data from aircraft known to have poor avionics.

ADS-B data transmitted from some avionics is not suitable for operational use[2]. Usually there are State regulations that prohibit ADS-B data transmissions not complying with the standards. However, sometimes such aircraft are still detected. The overall system needs to have a mechanism to protect ATC from misleading data from such aircraft. A database and/or ATC supervisor function could also be used to temporarily or permanently disable ADS-B data from particular aircraft with defined 24 bit codes.

5.3 Process multiple reports from same aircraft

ADS-B data is derived in the aircraft. Therefore messages received at separate ground stations will (assuming no signal loss) be identical. No fusion, merging or weighting of positional data is needed because the most recent data is the most valuable. As a result it is necessary to ignore ADS-B positional data which is received with a time stamp earlier than other positional data from the same aircraft. A single position symbol should be presented to the controller. Other data associated with report from ground station may or may not be useful.

5.4 Display of positional data

Positional data provided by ADS-B is expressed in latitude and longitude, referenced to WGS84. This data must be accurately mapped onto the display system so that it registers correctly with maps and other sensor data.

5.5 Adjustment of positional data based on time of applicability

The processing of positional data must also correct the positional data to allow for aircraft movement between the time of applicability of the data and the display time. The system should ignore data

[1] Asterix Category 21 messages are the internationally accepted means of transmission of data from ADS-B systems to ATC automation systems. The FOM data in the Asterix messages is usually derived from ADS-B quality parameters including NUC or NIC,NAC,SIL.

[2] Eg: Some transponder models can transmit intermittent or incorrect data, some transmit integrity data based on HFOM, some avionics have faults.

when the time of applicability is too far in the past[3]. Typically the ADS-B velocity vector is used, however the velocity vector can be calculated by the ATC system. Additionally, the system must allow for 'coasting' of the track in the event of missed reports to minimise occurrences of 'dropped' or 'jumping' tracks.

5.6 Positional data reasonableness checking

Reasonableness checking of ADS-B position data to detect and reject invalid position jumps is also required. Some avionics occasionally transmit incorrect (~300 Nm in error) positional data for one or two reports. These misleading reports should be discarded.

5.7 Display of altitude data

Barometric altitude data must be processed in the same way as SSR mode C data. It can be displayed as a flight level or, when below the transition level/altitude, it shall be QNH corrected.

5.8 Display of Flight ID

Flight ID should be unambiguously displayed to ATC. This may be based upon the received Flight ID or may be based upon Flight Plan data that has been appropriately correlated with the ADS-B data.. FlightID is received less frequently by the ground station and the ATC system may need to implement a timeout system to "coast" FlightID for a parameter time.

5.9 Emergency alerts

The display system shall appropriately alert ATC when emergency situations are flagged in ADS-B messages.

5.10 ADS-B failure indication

The display system shall appropriately alert ATC when ADS-B data is not available.

5.11 Velocity vector

It is highly desirable that the display system is able to use and display ADS-B velocity vectors graphically. These can be derived from the ADS-B messages (preferred) or calculated by the display system itself.

6 Display of ADS-B and radar/multilat.

When ADS-B is to be displayed with radar or multilateration[4], a number of issues need to be considered as follows : An example of one State's display of ADS-B data is shown in Appendix B.

A	Is ATC to be made aware that a particular position report is ADS-B	It is useful for ATC to know that data is based on ADS-B. This allows ATC to be aware of susceptibility to failure modes

[3] This can protect against ADS-B ground stations incorrectly time tagging data : eg : using GPS time instead of UTC time at GPS engine startup.

[4] Multilateration can be considered to be "radar like" because the positional data is not dependent on aircraft position determination.

	based?	relevant to the technology (such as RAIM outage) or airborne avionics failure. Eg: The aircraft crew can be asked to switch to an alternate GPS if the failure is due to GPS avionics failure.
B	Is ATC to be made aware that ADS-B data is being received from an aircraft under radar/multilat surveillance?	It is useful for ATC to know that ADS-B data is being received from an individual aircraft before it leaves radar coverage. Unexpected loss of surveillance data at edge of radar coverage could result in a separation breakdown. Confirmation of continued surveillance allows the use of more efficient separation standards.
C	When ADS-B and radar/multilat data is received from the one aircraft, is the positional data from radar and ADS-B to be “fused” (eg: using a Kalman filter) or does radar/multilat or ADS-B have priority?	Some states have used a priority system whereby ADS-B is only displayed to controllers when there is no radar detection. This has been useful for a gradual transition to ADS-B. A “fusion” system takes value from high quality ADS-B position, velocity data and update rate. Fusion allows the positional and other “aircraft state” data to be presented to controllers as truly merged/ fused data taking into account the relative strengths and weaknesses of the various surveillance technologies. “Fusion” needs to use a number of criteria to ensure that the items being fused relate to the same aircraft. These criteria could include position, velocity, 24 bit ICAO code, FlightID (transmitted callsign), altitude, Mode A code if available, whether the tracks are coupled to the same flight plan.
D	If displayed separately, is the radar/multilat data and ADS-B time synchronized for display	ADS-B data can be extrapolated to the time of display of nearby aircraft detected by radar or multilateration. Equally radar/multilat data can be extrapolated to the time of display of nearby aircraft supported by ADS-B data, or both can be extrapolated till time of display (asynchronous from either radar/multilat or ADS-B reports)
E	Do the safety alerts work appropriately for ADS-B only, radar/multilat only and targets with both radar/multilat and ADS-B?	It is desirable that safety nets work in all situations.
F	Is a Flight Plan indicator for ADS-B equipage used.	It is desirable for ATC to know whether the aircraft is ADS-B capable before the aircraft enters ADS-B coverage. This assists with strategic planning performed by the controller.

7 Other Display System Requirements

A large number of optional ADS-B processing capabilities/functions can be deployed. These are listed in Appendix A. States should consider whether the listed functionality is required in their environment.

8 Processing ADS-B like radar data

ADS-B has several characteristics that make it desirable for it to be treated differently from radar:

However, in some cases, States may wish to minimize ATC system modification and prefer to feed ADS-B to the display system as if it were a radar. This is possible but has some disadvantages shown below that need to be considered and managed. In most cases performance can be expected to be no worse than existing radars. Rather, such a system will simply fail to take full advantage of all the ADS-B performance benefits available.

A	ADS-B accuracy and update rate may be degraded if treated as a radar	Existing ATC systems may quantize the data in relatively coarse steps degrading the data. Extrapolation of ADS-B so that it is reported in a radar azimuth order may also degrade performance. Existing ATC systems may not support high update rate “radar feeds” containing ADS-B data.
B	ADS-B has very different error characteristics compared to radar.	This may have an impact on tracking, but probably no worse than existing radar.
C	ADS-B has different failure modes and the controller needs to be aware that the data is ADS-B derived – and hence susceptible to GPS outage effects. Existing ATC system may display ADS-B using same symbology as a radar.	If there is a predicted GPS RAIM[5] outage, the controller will need to know which targets may be affected. Equally, ADS-B is likely to be available during a period of radar down-time.
D	ADS-B data transmission usually begins whilst the aircraft is on the airport surface, whereas radar transmission usually start after takeoff.	Processing may be required to remove aircraft on airport surface. This can be done in the ground station or the ATC system.
E	Different emergency alert flags are	If radar message formats are used, it may not be

[5] Receiver Autonomous Integrity Monitoring (RAIM) confirms the ongoing integrity of ADS-B data derived from GPS. In some circumstances the integrity may not be able to be confirmed to the desired level. RAIM prediction systems can predict when such loss of integrity may occur, based on GPS geometry and GPS maintenance notifications (NANUs).

	possible compared to radar	possible to convey all desired emergency alerts to the controller
F	Flight ID and 24 bit code are available for matching report-to-report and report-to-flight plan. These fields are available from ADS-B and Mode S radars for Mode S transponders, but are otherwise not available.	Some radar processing systems are unable to manage the processing and display of FlightID or 24 bit code received from the “radar”.
G	4 digit SSR octal code may not be available from ADS-B transmissions. In this case, consideration is required of how the ATC system will match ADS-B data to the flight plan	Some radar processing systems rely on Mode A code for tracking or for matching the target to a flight plan. Mode A code may not be available from DO260 ADS-B avionics.

APPENDIX A

POSSIBLE ATC AUTOMATION ADS-B FEATURES

	Feature	Description	Comment
DISPLAY	Allow "coasting" so that low quality ADS-B data is useable for a limited time.	Technique to allow "coasting" through short GPS geometry ADS-B outages	Increased reliability/continuity
	Display different position symbol when ADS-B comes from a source without adequate communications reliability for 5 Nm separation.	Indicate to controller that ATC separation is not possible with this lower quality ADS-B data	Optional use of lower quality symbol
	RAIM display	Consider if a RAIM prediction system is required to indicate to controllers or supervisor possible GPS outages in particular airspace	Optional warning to ATC regarding GPS constellation status
	Indicate failure of ADS-B receiver to technical or operational staff		Typically this will involve site monitor processing
	Delete reports for aircraft "on ground"	If ATC does not desire to "see" traffic still on airport surface	
	Option to display 24 bit code	Eg: if no flight ID is available or to resolve matching problems. Possibly display mode A code if available.	
	Update ATC simulator to support ADS-B	ADS-B training must include ability to manage ADS-B events such as loss of GPS	
	Indicate to a controller that an aircraft is being detected by ADS-B whilst inside radar coverage	Advise controller that if the displayed aircraft leaves radar coverage, surveillance will continue with ADS-B (whereas non equipped aircraft will leave surveillance coverage)	Aircraft could be non ADS-B because it is not equipped, or because it is not within the ADS-B coverage area. This processing could be considered unnecessary by some states especially if an ADS-B mandate exists.

	Feature	Description	Comment
	Decide if and how to use geometric altitude	Possible use of geometric altitude if baro is not available. Possible use for checking QNH value is correct?	
	Decide if and how to use barometric altitude in geographic areas without QNH sensors	Possible altitude filtering in these areas to prevent display of misleading altitude	
PROCESS	Ability to process all appropriate fields of ADS-B Asterix Cat 21 V0.23	Process appropriately position, velocity, Flight ID, 24 bit code, geo and baro altitude, SPI, emergency indicators, FOM etc	
	Protect or warn against Duplicate 24 bit codes within airspace. Eg: From different ground stations		Possibility exists of 2 aircraft on same 24 bit code
	Protect and manage against invalid 24 bit codes		Possibility exists of receiving invalid 24 bit codes
	Black list processing :Remove selected aircraft (24 bit codes) if these airframes are known to transmit inadequate ADS-B data.		Can be used in environments where the regulatory process required all transmitters to be compliant to the standards
	White list processing :Remove all aircraft except selected aircraft (24 bit codes) which are known to transmit adequate ADS-B data.		Useful when there is uncertainty about the ADS-B avionics in the fleet.
	Allow manual uncoupling of ADS-B report and flight plan	In case of erroneous coupling allow controller to detach so that ADS-B data does not update flight plan	
	Allow manual coupling if ADS-B report and flight plan	In cases where for various reasons automatic coupling does not occur.	
	Allow for QNH correction of ADS-B data below transition level/altitude	Normal QNH processing but applied to ADS-B	

	Feature	Description	Comment
	Vertical rate smoothing	Vertical rate data from ADS-B can be “noisy” and may need smoothing for some applications, especially for vertical velocity prediction for safety alerts. Need to consider geo and baro vertical rates.	
	ADS-B data to update flight plan		
	ADS-B data to match to flight plan using Flight ID in ADS-B message to Flight ID of flight plan. May also use 24 bit code if the 24 bit code is in the flight plan.	Direct matching to FlightID, perhaps using other criteria to reduce risk of false matching.	
	Support appropriate safety nets	STCA, RAM, CLAM, DAIW,….	
	Support flight plan indicators that advise of ADS-B equipage	Advises equipage but does not confirm that it is working!	
	Ensure playing area accounts for new coverage	New coverage may be provided by ADS-B	
	ADS-B bypass processing	Provide for ADS-B bypass channel if required	Consider flight plan matching, QNH correction, extrapolation, FOM filtering etc
	Recording and replay of ADS-B data	Same as for radar but processing required for ADS-B	
	Allow for visibility of ADS-B ground transmissions	Matching to flight plan may occur before departure because ADS-B data may be received whilst taxiing	Aircraft transmit ADS-B messages whilst taxiing. These messages can be received and processed.
	Site monitor processing	An integrity monitoring tool and fault detection tool	Monitor position, signal strength, HPL, GPS satellite ranging errors….

OTHER POSSIBLE ADS-B FEATURES

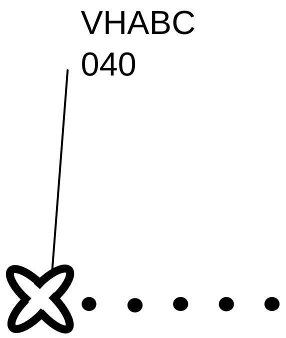
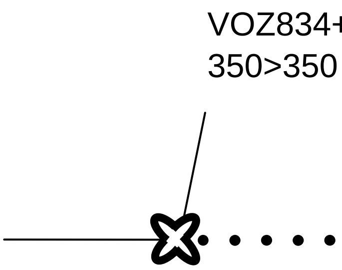
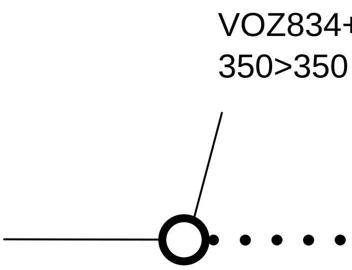
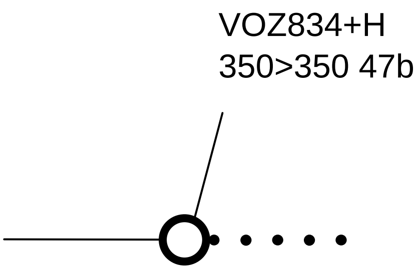
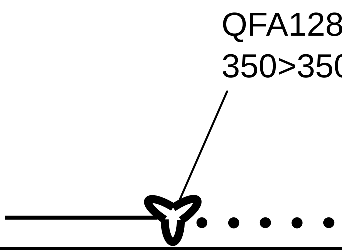
Feature	Description	Comment
Capability to manually disable display of ADS-B returns from a	Allow data to be discarded from a designated aircraft.	Could be useful in the unlikely event of erroneous data from an

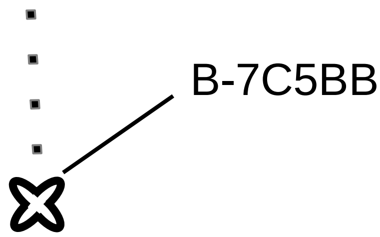
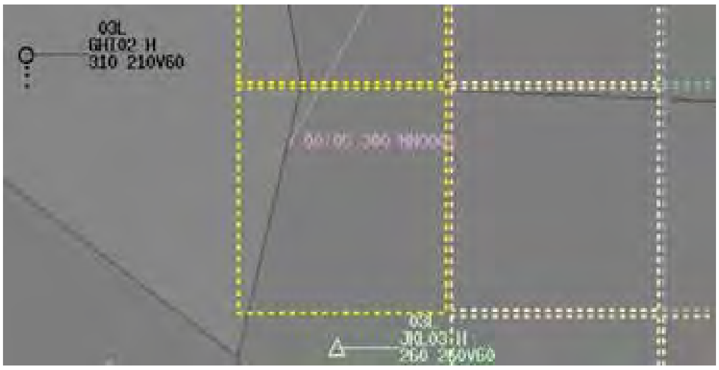
Feature	Description	Comment
particular target		aircraft
Display of new alerts (if used)	Lifeguard / medical and Minimum fuel. Also future “selected altitude” mismatch with Cleared flight level alert.	
Display of ACAS RA events		A downlink message has been defined in ICAO Doc 9871
Alert controllers to significant difference between ADS-B and other surveillance source		
RVSM Monitoring	Provide RVSM validation based on comparison of Geometric (GPS) altitude data and Barometric ADS-B data.	The capability to perform RVSM monitoring using ADS-B is not yet confirmed – however confirmation is currently expected by 2012.

APPENDIX B

ADS-B Display employed by one state

The following shows the ADS-B symbology used by Australia in 2010.

ADS-B track NOT matched to Flight Plan. Includes FlightID (from ADS-B transmission) and Altitude	
ADS-B track matched to Flight Plan	
Radar track – no ADS-B from this aircraft)	
Radar track – ADS-B being detected from this aircraft ("b" included in label – this is only displayed when the ADS-B data is of sufficient quality to allow its use for separation)	
ADS-B track – data from low reliability site – not suitable for 5 Nm separation	

ADS-B track optional 24 bit code display "B-" indicates that 24 bit code expressed in hex follows	
ADS-B site monitor display on technical & supervisor display only.	
RAIM Prediction Display Dashed lines indicate areas of predicted RAIM outage in next 10 and 30 minutes. Radar and ADS-C tracks shown	

Attachment to ADS-B SITF/9 - WP/7

INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

DRAFT

GUIDANCE MATERIAL ON

BUILDING A SAFETY CASE FOR

DELIVERY OF AN ADS-B SEPARATION SERVICE

Version xx

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CONTENTS

GUIDANCE MATERIAL
ON
BUILDING A SAFETY CASE FOR DELIVERY OF AN ADS-B SEPARATION SERVICE

PRIMARY REFERENCES

This guidance material relies heavily on references to the following three reference documents. Much of the information needed for the preparation of a Design Safety Case for an ADS-B surveillance service can be derived from this documentation. The aspects that need to be separately covered by a proponent are those arising from any differences in the specific airspace for the surveillance system, and the system engineering of the surveillance services if they differ from the reference systems.

1. ICAO Doc 9859 AN/474 Safety Management Manual (SMM), Second Edition 2009 – in particular Chapter 4 ‘Hazards’, and Chapter 5 ‘Safety Risks’

2. ICAO Circular 311 AN/177 ‘Assessment of ADS-B to Support Air Traffic services and Guidelines for Implementation, First Edition 2006’

3. RTCA DO-303/EUROCAE ED-126 December 13, 2006 ‘Safety, Performance and Interoperability Requirements Document for the Non-Radar Airspace Application’

INTRODUCTION

This document provides basic guidance on the building of a Safety Case for delivery of an ADS-B separation service. It relies on referencing existing guidance material in the two ICAO publications listed above, as well as some existing Safety Cases covering early ADS-B services.

A number of discrete ‘steps’ in the building of a Safety Case are described to progress to a completed document.

The first steps cover the generic requirements for the preparation of a Safety Case for any airways system, including any surveillance systems used for separation by ATC. The primary reference is Chapters 4 and 5 of ICAO Doc 9859.

The remaining steps cover the elements of a Safety Case <u>specific</u> to a new ADS-B surveillance service. The basic references are ICAO Circular 311 and RTCA DO-303/Eurocae ED-126. These documents contain a significant amount of information on hazard identification and risk assessment of an enroute ADS-B service in Non-Radar Airspace (NRA). The final steps are provided as guidance to the actual content headings of a Safety Case for an ADS-B service.

Definitions

Accuracy: A measure of the difference between the aircraft position reported by the surveillance system, as compared to the true position

ALARP: As Low as Reasonably Practicable (in risk mitigation)

Availability The probability that a system will be able to perform its intended function when required for use

Continuity The probability of a system to perform its required function without unscheduled interruption, assuming the system is available when the procedure is initiated (Circ 311)

Failure: Inability of the system to perform its intended service or function

Fault: Degradation in the performance of a system

Hazard: A condition or set of conditions of a system, or an object, with the potential to cause injury to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function.

Hazard identification: The process of recognising that a hazard exists and defining its characteristics

Integrity: The ability of a system to provide timely warnings to users when the system should not be used for navigation (and, in the case of ADS-B for surveillance).

Maintainability: The ability of a system to be retained in, or restored to service

NRA: Non-Radar Airspace

Operational requirement: The stated purpose of the (surveillance) system

Reliability: The probability that, during a certain period of time, a system performs its prescribed functions (usually expressed in MTBF)

Risk: The probability of occurrence, together with the severity of the consequence(s), of a hazardous event

Risk assessment: The process of determining the risk involved in the occurrence of a hazardous event, and the tolerability of that risk

Risk management: The systematic application of management policies, procedures and practices to the tasks of identifying hazards and assessing and controlling risks

Safety: The state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management. (Doc 9859)

Safety Case: A document which provides substantial evidence that the system to which it pertains meets its safety objectives

PART A: GENERIC GUIDANCE FOR SAFETY CASE PREPARATION

1 What is a Safety Case?

1.1 One of the primary purposes of a Safety Management System is to predict what accidents or incidents may occur, how they may happen, and how they may be prevented. The processes for safety assurance may differ in details; however they all prescribe the systematic undertaking of safety risk assessment and the presentation of evidence that the particular system is safe.

One way of presenting such evidence is by preparing a Safety Case. A Safety Case is an explicit documentation of a safety critical system, its corresponding safety objectives, and the associated safety risk assessment and risk management of the system, at appropriate milestones in the life of the system.

2 Generic contents of a Safety Case

2.1 A Safety Case is a documented record of the steps or processes undertaken by the system proponent to ensure that the system has been designed, tested and implemented as safely as reasonably practicable. Its basic component is a structured, comprehensive statement of the hazards and the corresponding safety risks of the occurrence of the hazards surrounding the provision of an operational service. This should include the significance of the hazards in terms of their likelihood of occurrence and potential effects on aviation safety, and the means whereby they are to be managed. The essential features of a Safety Case are that it should:

a) fully describe the surveillance system including the operational role and functions which it covers (i.e. the configuration and the boundaries of the system);
b) define or reference the performance standards and specifications of the system;
c) establish the safety objectives and the safety requirements for the system;
d) identify the hazards and the operational consequences of the hazards. Identification of hazards and consequences must ensure that all possible failure and fault modes have been identified under all normal and abnormal modes of operation;
e) assess the associated risks (in terms of frequency of occurrence and severity) of each identified operational consequence;
f) categorize each of the risks within a recognised risk tolerability classification scheme;
g) establish the controls necessary to ensure the risks are tolerable.

3 Safety planning

3.1 It is expected that safety will be built into any new surveillance system from its early inception and that the management of safety related activities will be undertaken in a planned manner over the lifecycle of the system.

3.2 The safety plan may be a discrete element of a project management plan, if applicable, or it may stand-alone. The Safety Plan is an important basic document that sets out the safety objectives and requirements and the actions and processes to be followed in the development of the system.

3.3 The safety plan should provide the basis for the development of the several parts of the Safety Case at defined milestones as the development, design and implementation of the surveillance system progresses to commissioning and normal day-to-day operation.

4 A Safety Case may have several discrete parts over the system lifecycle

4.1 ATC surveillance systems have a lifecycle consisting of several distinct phases. The safety hazards and associated risks may differ in type and degree in each phase, and their identification and control treatment will be more appropriately undertaken at a particular phase in the lifecycle. Accordingly, Safety Cases need to be developed to separately consider the safety situation in each of the lifecycle phases. This may require several parts of the Safety Case, with each part building on the previous part as the system is developed.

4.2 The distinct phases of a surveillance system's life which may be covered by a Safety Case, are normally:

a) **the operational requirements phase**, when the role and broad functionality of the new system is determined. This phase should identify the safety objectives of the system and its applicable system safety requirements, (these may be based on ICAO SARPS, the State's regulatory requirements, and the service provider's internal safety standards);
b) **the design and procurement phase**, when the system is designed and developed to meet the specified operational and/or engineering requirements. In this phase, the system configuration and operation is defined, incorporating the safety objectives and requirements within the evolving design. A full hazard and risk assessment is usually undertaken at this time;
c) **the implementation phase,** when the system is subject to procedural and/or engineering readiness testing against the design specifications, followed by operational trials, such as ghosting or mimicking. At this phase, the risk assessment is tested and validated by actual trials and testing of the installed system, and specific safety related operational, engineering and/or management procedures are developed to obviate or control the identified risks; and
d) **the routine operations phase,** when the safety of the system continues to be monitored and improved as any hazards are identified as they arise, and the risks are mitigated during actual operations.

4.3 The Safety Case should describe the historical and current safety status of the system or service as it develops throughout its entire lifecycle.

5 STEP 1 – State the purpose and scope of the safety case

5.1 The purpose and scope of the Safety Case should be clearly stated in its introductory paragraphs, and should include:

a) A statement of the purpose and role of the surveillance system under consideration, i.e. its Operational Requirement.

b) A description of the system and its location; its configuration including the sub-system elements; the system boundaries; the elements of the system which have been considered within the scope of the document, i.e., whether it covers equipment, procedures, airspace, personnel, etc.; and the interfaces with other external systems.

c) A statement of the assumptions upon which the Safety Case is based. This should include the defined or known levels of safety, or integrity, of each of the interfacing or support systems/services, and those other services externally provided by third parties, such as those provided by telecommunications service providers, electrical power service providers, etc.

5.2 The relevant lifecycle phase of the system, covered by the particular part/s of the Safety Case should also be defined.

6 STEP 2 – Develop and document the safety objectives and system safety requirements

6.1 The overall safety objectives and related system safety and safety related performance requirements supporting the objectives for the system should be defined as far as possible, particularly at the design stage. Safety objectives and system safety/performance can be derived by reference to the Operational Requirement and the type of service involved – for example an enroute surveillance service may have a lower level of criticality of availability and continuity than a terminal surveillance service. The safety requirements of a particular service may be established by assessing the effect of possible functional failure or fault modes as the source of safety hazards and the associated effect on the operation of the system.

6.2 The fault modes analysis should cover conceivable faults or eventualities affecting system performance including the possibility of human errors, common mode failures, simultaneous occurrences of more than one fault, and external eventualities which cause or result in the loss of, or affect the integrity of, external data, services, security, power supply, or environmental conditions.

6.3 The assessment of the safety objectives may then result in an iterative process of revision and further development of the system design, the adoption of modified operational procedures, or the establishment of contingency arrangements. For this reason, as far as possible the safety objectives should be expressed in a form that is clear and unambiguous so that they can be tested against, and the compliance of the system determined.

6.4 The selection of an appropriate way of expressing the safety objectives is important. Traditional measures include the specification of ***reliability, availability, continuity, maintainability, recoverability, accuracy,*** *etc.,* which have some interdependence. In the case of surveillance systems, specifying only availability, without also specifying a limit on the rate of occurrence of failures and faults, and the recoverability of the system following failure, could be insufficient to adequately define the safety requirements. For instance, a very infrequent occurrence of a fairly long down-time may be less hazardous than more frequent failures with shorter down-times, particularly for an ADS-B service in NRA where reversion to procedural separation is the contingency for system failure.

6.5 Quantitative statements of safety objectives and system performance requirements should be used where possible, however, in many areas (e.g.; where people and procedures are involved) it may not be feasible to define quantitative values. For these, qualitative values can be established. Where possible, these should be equated to or assigned corresponding quantitative values.

For a surveillance system, it is obviously important for safety that the voice or data communications service between pilot and ATC has a level of reliability (i.e. availability and continuity) at least of the same levels of performance as that assigned to the surveillance system itself. Obviously the two systems should be designed so that no single point of failure can result in both systems simultaneously failing at remote stations where single power source may only be available. Bearer links back to the ATC Centre will normally need to be duplicated on separate bearer circuits in order to achieve the reliability required for surveillance services.

6.6 In the development of the Australian ADS-B surveillance service in low density enroute airspace, the following basic safety and performance requirement for both the ADS-B service and the related voice communication service were established:

Table 1 – Basic Performance Parameters for ADS-B ground system (aircraft component not included)

SERVICE	SERVICE CATEGORY	GROUND SYSTEM OPERATIONAL AVAILABILITY	GROUND SYSTEM RELIABILITY per sector. MTBF (95%confidence level)
Enroute surveillance and voice comms (low density airspace)	Essential	.999	5000 hours
Terminal surveillance and voice comms (high density airspace)	Critical	.99999	10000 hours

Source: Airservices Australia Ops Requirements Doc v2.0

7 STEP 3 – Develop a Safety Risk management methodology

7.1 An appropriate, recognised methodology for safety risk management, i.e. for hazard identification; risk assessment; risk management, control, and mitigation, of a surveillance system, is required. The methodology may vary depending upon the type and safety implications of the proposed surveillance system, and the use of different methods, or combinations thereof, may be appropriate for the different elements and lifecycle phases included in the safety case.

7.2 Chapters 3 and 4 of the ICAO SMM are recommended as an appropriate methodology for States to adopt. Persons preparing Safety Cases are encouraged to familiarise themselves with the concepts in those two Chapters. The following Steps 4 – are based on and derived from those Chapters.

8 STEP 4 – Process for Hazard Identification and Analysis

8.1 Surveillance systems for aircraft separation services provide significant safety enhancement compared with procedural systems. However, there are safety consequences that predominantly arise during abnormal conditions or in fault or failure situations. Potential risks arise if related systems for air ground communication fail, or aircraft navigation or transponder avionics lose integrity or fail. Lesser impacts on safety might occur where the integrity of a system is degraded or lost but where there are alternative back-up systems, or contingency arrangements, that can be reverted to in order to maintain separation.

8.2 The process for hazard identification and analysis is set out in section 4.5 of the ICAO SMM, from which some of the information in this section is extracted and summarised.
It is essentially a 3 step process:

a) First: Identify the generic hazard (also known as top level hazard, or TLH). Generic hazard is used as a term that intends to provide focus and perspective on a safety issue, while also helping to simplify the tracking and classification of many individual hazards flowing from the generic hazard.
b) Second: Break down the generic hazard into specific hazards components of the generic hazard. Each specific hazard will likely have a different and unique set of causal factors, thus making each specific hazard different and unique in nature.
c) Third: Link specific hazards to potentially specific operational consequences, i.e. specific events or outcomes of the occurrence of the hazard.
d) Fourth: Document the hazards and its consequence.

8.3 Techniques for hazard identification and analysis for a new surveillance system may include:

a) the use of data or experience with similar systems/changes undertaken by overseas or other
b) respected providers of ATC surveillance services;
c) quantitative modelling based on sufficient data, a validated model of the change, and analyzed assumptions; e.g. RAM modelling.
d) the application and documentation of expert knowledge, experience and objective judgement by specialist staff;
e) trial implementation of a proposed change in an “off-line” system, or under a pre-existing surveillance service, and with sufficient backup facility to revert to the existing system before the change, if risks cannot be mitigated;
f) event tree analysis (ETA);
g) failure modes and effects analysis (FMEA);
h) human factors analysis (HFA);
i) hazard identification workshop with expert personnel (HAZID).

9 STEP 5 – Establish the Safety Risk of each Hazard

9.1 The reference for this process is section 5.4 and 5.5 of the ICAO SMM, and Tables 30 and 31 of RTCA DO-303/Eurocae ED-126.

9.2 For each of the identified operational consequences of the identified hazards, the safety risk should be established by assessing the probability of occurrence, and the severity of the consequence or outcome.

9.3 Safety risk probability is defined in the SMM as the likelihood that an unsafe event or condition might occur. Safety risk severity is defined as the possible consequences of an unsafe event or condition.

9.4 The following tables have been extracted from the SMM as the criteria for the risk assessment process.

9.5 Particular attention should be given to hazards that have operational consequences of common mode failure. For example, for an ADS-B surveillance service, failure or drop-out or short term loss of integrity of the GNSS may lead to total or partial loss of ATC surveillance and aircraft navigation. The risk control avenues open to a service provider may identify that a safety requirement is to ensure a means of backup to provide continuity of navigation and surveillance during the loss of GNSS, particularly for a terminal are service. Alternatively procedural mitigation may be implemented. Service providers should identify the most appropriate means or combination of risk controls based on local infrastructure and operational circumstances.

Table 2: Safety Risk Probability Table (source ICAO SMM)

Probability	Meaning	Value
Frequent	Likely to occur many times	5
Occasional	Likely to occur sometimes	4
Remote	Unlikely to occur, but possible	3
Improbable	Very unlikely to occur	2
Extremely improbable	Almost inconceivable that the event will occur	1

Table 3: Safety Risk Severity Table (source ICAO SMM)

Severity of Occurrence	Meaning	Value
Catastrophic	Equipment destroyed Multiple deaths	A
Hazardous		B
Major	A significant reduction in safety margins, physical distress or a workload	C
Minor	Nuisance Operating limitations Use of emergency procedures Minor incident	D
Negligible	Little consequences	E

10 STEP 6 – Establish the Safety Risk Assessment Criteria

10.1 In order to ensure that the range of possible safety risks are appropriately classified and controlled, it is necessary for service providers to establish standard, stand-alone, criteria for safety risk assessment and classification. Such a safety risk classification scheme provides a structure for deriving the safety requirements for any airways system, as well as the criteria for risk control decisions. Typically, such schemes provide a standard relationship between the probability of occurrence of each risk and the categorised severity of the risk in terms of its potential impact on safety.

10.2 A Safety Case document must include or reference the risk assessment criteria (also termed a Risk Tolerability Classification scheme) adopted by the service provider for system safety management.

10.3 The following two Tables (Table 4 and Table 5) have been extracted from the ICAO SMM for Safety Risk Assessment criteria and Safety Risk Tolerability criteria:

Table 4: Safety Risk Assessment Matrix (source ICAO SMM)

Risk Probability	Risk Severity				
	Catastrophic A	**Hazardous B**	**Major C**	**Minor D**	**Negligible E**
Frequent 5	5A	5B	5C	5D	5E
Occasional 4	4A	4B	4C	4D	4E
Remote 3	3A	3B	3C	3D	3E
Improbable 2		2B	2C	2D	2E
Extremely Improbable 1	1A	1B	1C	1D	1E

Table 5: Safety Risk Tolerability Matrix (source ICAO SMM)

Suggested criteria	Assessment risk index	Suggested criteria
INTOLERABLE	5A, 5B,5C, 4A, 4B, 3A	Unacceptable
TOLERABLE/MITIGATE	5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C	Acceptable based on risk mitigation. May require management decision
ACCEPTABLE	3E, 2D, 2E, 1A, 1B, 1C, 1D, 1E	Acceptable

10.4 A further reference, specifically for a surveillance service is shown in. Table 30 of that document presents a qualitative Hazard Classification Matrix derived from ED-78A/DO-264 with 5 grades of risk severity. However, the Risk Classification Scheme (RCS) actually used in the Operational Safety Analysis presented in RTCA DO-303/EUROCAE ED-126 at Table 31 is derived from Table 30 and is based on 5 grades of Safety Targets with the Risk Classification per flight hour of each expressed quantitatively. The scheme is repeated in Table 6 below for reference:

Table 6: DO-303 OSA - Risk Classification Scheme for ADS-B Surveillance Service

Safety Targets	Risk per flight-hour	Risk per flight
ST1 Accident	**1e-08**	**1e-08**
ST2 Serious Incident	**1e-05**	**1e-05**
ST3 Major Incident	**1e-04**	**1e-04**
ST4 Significant Incident	**1e-02**	**1e-02**
ST5 No immediate effect on safety	**Not rated**	**Not rated**

11 STEP 7 – Process for Risk Control and Mitigation

11.1 A risk control process to eliminate, control or mitigate all risks categorised as intolerable or unacceptable, to at least to a tolerable or acceptable level, must also be defined. Risk controls may vary considerably, and employ any one, or a combination of, the following:

a) system redesign, modification or replacement;
b) process or procedures redesign, particularly procedures by operational personnel;
c) reliability improvement schemes;
d) personnel education and/or training;
e) various management controls on personnel, operational procedures and equipment; and
f) regulatory controls; including aircraft equipage mandates, limitations on entry to airspace by unequipped aircraft; equipage requirements in accordance with ICAO SARPs, etc..

11.2 Any identified risks which cannot be controlled to a tolerable level shall be explicitly included in a section of the Safety Case which includes a full discussion on all relevant aspects of the risk. The rationale for any decision to proceed with the development or operation of the system while the risk prevails is to be stated and justified.

11.3 **Precedence of Risk Controls.** In the application of the above or other risk control processes, a safety precedence sequence should be adopted and applied. For instance, control of identified hazards should normally be sought first through improved system design or equipment changes, followed then by specific operational procedures or training. For some risks, only one type of mitigation process will be feasible, others may need several means of risk control to bring the overall risk into tolerability. Whichever means of control is implemented the control process should demonstrate how the risks are being brought within the acceptable or tolerable areas of the criteria.

12 STEP 8 – Document and track the Hazards and their Risks

12.1 A standard method of documenting and tracking Hazards and Risks should be established.

12.2 Figure 4.2 of Chapter 4 of the ICAO SMM indicates the process involved in hazard/risk documentation.

12.3 The proformae used for the purpose of documenting/tracking Hazards relevant to ADS-B service as used by two States are shown in ICAO Circular 311 at Attachments E-1/E-2 (Australia) and Attachment E-3 (USA).

13 STEP 9 – Safety Case coverage over the lifecycle of the surveillance system

13.1 As previously discussed, Safety Cases should be developed in separate parts to define the safety situation of the system over the discrete stages of its lifecycle. A four part Safety Case has been adopted by some service providers to define the safety situation at the Operational Requirements stage, at the completion of the Design and Procurement phase, at the Implementation stage, and for the routine Operational phase.

13.2 The contents of the Safety Case will differ for each part. For some systems, it may be appropriate to have more or fewer parts of the Safety Case. For all parts, the level of description and detail included should be sufficient to provide a reasonably informed reader with an understanding of the safety situation, without the need to refer extensively to supporting references.

13.3 A guide to the coverage of each part of a four part Safety Case is included in Attachment A 'Safety Case Coverage for a Four Part Safety Case'.

14 STEP 10 – Authority for issue and change of the Safety Case

14.1 Safety Cases should be placed under a documentation control process. The Safety Case should be authorised by competent authority designated by the service provider. An authority or authorities covering System Requirements, System Design, System Operation, and System Maintenance should be appointed, and the issue of the parts of the Safety Case should be made under the authorization of one or more of these designated bodies, as appropriate to the content of each part.

PART B: SPECIFIC ELEMENTS FOR INCLUSION IN SAFETY CASE COVERING ADS-B BASED SURVEILLANCE SYSTEMS

Primary references:

ICAO Circular 311, in particular:

Chapter 2: ATC Surveillance

Chapter 3: Assessment of ADS-B surveillance

Chapter 4: State Implementation Roadmap

Attachment A: General Description of the Reference SSR

Attachment B: Technical Comparison between Reference SSR and ADS-B

Attachment C: Key ADS-B Performance Requirements to Support the Claim that ADS-B Surveillance "Is As Good As the Reference SSR"

Attachments E1,E2: HAZID and Mitigation (Australia)

Attachment E3: Hazard Analysis Report (US Capstone Program)

RTCA DO-303/EUROCAE ED-126 December 13, 2006 Safety, Performance and Interoperability Requirements Document for the ADS-B Non-Radar Airspace Application
Note: This document is also included in ICAO Circ 311 as Attachment N)

Secondary reference:

ICAO Doc 9689 AN/953 Manual on Airspace Planning Methodology for the Determination of Separation Minima First Edition 1998

Introduction

This Part itemises the topics that should specifically be included in a Design and Implementation Safety Case for the introduction of an ADS-B based surveillance system in non-radar airspace. The information herein is derived from two sources; ICAO Circular 311, and the actual Design Safety Case that was produced by the Australian ANSP to gain the approval of the aviation regulator for the commissioning of the Upper Airspace ADS-B surveillance system. That Safety Case was essentially based on a comparative assessment showing that ADS-B was as good as or better than a Monopulse SSR system when used for the same surveillance purposes in the same airspace by ATC. This comparative assessment approach has been documented by the ICAO SASP in Circular 311 as an appropriate means of assessing the safety of an ADS-B separation service in non-radar enroute airspace.

1 STEP 11 – State Implementation Roadmap

1.1 For this STEP, readers should first acquaint themselves with Chapters 3 and 4 of ICAO Circular 311.

1.2 In Chapter 3 of ICAO Circular 311, the ICAO SASP describes the assessment it undertook of the use of ADS-B to support ATS. The assessment methodology compared

ADS-B to a Reference SSR which the SASP defined in terms of its technical performance. The assessment demonstrated that ADS-B surveillance is better or at least no worse than the

Reference SSR and therefore no less safe than Radar. The SASP concluded that, if a number of ADS-B performance requirements relating to the integrity and accuracy of the received ADS-B transmissions from aircraft and the overall latency and update rates of the system are met, then ADS-B can be used as a means of supporting the provision of a 5NM separation minima similar to that used with radar.

1.3 However, in making that conclusion, the SASP noted that its assessment was undertaken based on global assumptions and was for low complexity airspace and for the defined reference radar. In its Conclusion to Chapter 3, for reasons it explains in the Chapter, it noted that there remained the requirement for a region or State to undertake a State or local assessment that demonstrates the intended safety level will be met using ADS-B surveillance. To this end, a 'State implementation roadmap' was provided for the guidance of States.

1.4 Circular 311 provides the references and technical evidence to show that ADS-B is as good as or better than an MSSR when used for an enroute 5NM separation service by ATC. It is therefore unnecessary to demonstrate that in a Safety Case covering a State or local surveillance service. A State can make reference to that finding in Circular 311 rather than prove that in a Safety Case. However, it should be noted that the Circular clearly points out that the analysis by the SASP makes assumptions on a generic airspace situation which may not be totally relevant to the airspace situation in any particular State, and that State and/or local level assessments should be undertaken where there is any difference between the Sate's conditions and those in the assumptions made in the Circular. (Refer to Sections 4.5.1 and 4.5.2 of Circular 311.) Further, there always remains the requirement to undertake State or local level hazard identification and risk analysis of all hazards. For that purpose, the further value of Circular 311 as guidance material for ADS-B Safety Case preparation is that it provides a Compendium of Hazards and Mitigation Measures which has been extracted from several site-specific ADS-B Safety Cases of ADS-B trials and implementation undertaken in two States (USA and Australia), as well as those identified by EUROCAE in the Annexes to ED-126 also attached to Circular 311. This Hazard Compendium will be of value as a reference to those States embarking on safety assessment of their own ADS-B programs.

1.5 The State Implementation Roadmap in Circular 311 comprises four distinct Processes. Process C is the Safety Assessment (Initial, Implementation and Operational), implying that a three part Safety Case is required for those three phases of system development. General guidance on the undertaking of all four Processes is given in Section 4.6 of Circular 311. It is recommended that authors of Safety Case documents for ADS-B surveillance should familiarize themselves with that Section.

1.6 **ADS-B System Design - Performance standards**. In Attachment C to Circular 311 the ICAO SASP identified the key ADS-B performance requirements for an ADS-B system to enable use of a 3NM or 5NM separation minimum in the provision of ATC. Subsequently, at its WG/WHL/13 Meeting in May 2008, the ICAO SASP agreed to update its Circular 311 including Attachment C to the effect that ADS-B 3NM and 5 NM separation services could be delivered when ADS-B data quality indicators met the following requirements:

Table 6: SASP Comparative Assessment – ADS-B Performance Characteristics (extracted from ICAO Circ 311).

	Characteristic	Minimum Requirement 3NM separation service	Minimum Requirement 5NM separation service
1	Position: Accuracy	NACp = 6 or better; corresponds to HFOM < 0.3NM	NACp = 4 or better; corresponds to HFOM < 0.5NM
2	Position: Integrity	NUC = 5 or better; OR NIC = 5 or better ; corresponds to HPL containment radius < 1NM SIL = 2 or better	NUC = 4 or better; OR NIC = 4 or better; corresponds to HPL containment radius < 2NM SIL = 2 or better
3	Position: Latency	4 seconds	4 seconds
4	Position: Update Rate	12 seconds	12 seconds

Note 1: These values in Table 6 differ from those presently included in Attachment C to Circular 311. It is recommended that these performance parameters in Table 6 can be used by States for ADS-B system design pending the publication of the amendments to Attachment C to Circular 311 by ICAO.

2 STEP 12 – Safety Case for ADS-B NRA

2.1 **RTCA DO-303/EUROCAE ED-126**. Extensive guidance material to assist in preparation of a Design Safety Case on the ADS-B NRA Application is contained in RTCA DO-303/EUROCAE ED-126. That document is a virtual Safety Case and the publication can be used as a reference alongside ICAO Circular 311. The complete document is relevant although the **Operational Safety Assessment** at Annex C has most relevance. Annex C contains the following Steps:

a) Hazard Classification Matrix as per DO-264/ED-78A (Table 30)
b) Safety Targets and Risk Classification Scheme (Table 31)
c) Operational Hazards Identification by Expert Analysis (Table 33)
d) Allocation of Safety Objectives (the maximum frequency or probability at which an operational hazard can be tolerated to occur) and the Safety Requirements for Operational Hazard mitigation.

3 STEP 13 – Safety Case Contents

3.1 **Contents of the Safety Case**. Guidance material on the **contents** (i.e. the topic headings, with a brief description of each topic that may be included under each heading) for inclusion in an ADS-B Design Implementation Safety Case is at Attachment B . This topic listing has been derived by reference to the Safety Case for the ADS-B Upper Airspace Program (UAP) prepared in Australia by the ANSP. (That particular Safety Case was the basis of the regulatory approval by CASA of the now implemented ADS-B UAP of Airservices Australia.)

ATTACHMENT A

Safety Case Coverage for a Four Part Safety Case

The following is a guide to the structure of a four part Safety Case over the life of an airways system.

Safety Case Part 1 - Operational Requirements Phase
A Safety Case Part 1 contains the Safety Objectives and the corresponding Safety Requirements for the proposed system, and will normally be the initial document provided to advise the proposed project's existence and its safety significance. The Safety Case at this stage should be an evaluation of the proposed system, perhaps most appropriately carried out by means of a Preliminary System Safety Assessment (PSSA), supplemented as necessary by overseas or previous experience, and in-house expertise and knowledge of deficiencies in existing systems which the new system is to replace.

Safety Case Part 2 - Design and Procurement Phase
Part 2 of the Safety Case is essentially to assure that the design of the system supports and provides for the safety requirements. Arguments to support the design rationale and the proposed technology of the system, and to verify and validate that such satisfies the safety requirements will be provided. The human factors aspects of the design, and the safety implications of the design of the procedures, and the ability of personnel to safely operate to the design procedures, should also be considered. Here, a full hazard and risk evaluation of the detailed design, including hardware, software, man/machine interface, human factors, equipment and administrative interfaces and external factors, should be undertaken.

Safety Case Part 3 – Implementation Phase
Part 3 of the Safety Case will provide an analysis of the safety situation following its installation and integration. The functional testing to be carried out for installation and pre-commissioning evaluation of the safety situation is detailed in this part. A testing regime aimed at validating the risk assessment made in Part 2 of the Safety Case, and identifying safety hazards not previously identified at Part 2 which arise during testing and integration and related activities, should be defined , with the strategy for assessing and managing these hazards and the safety issues which arise from such testing also specified.

Safety Case Part 4 - Normal Operations Phase
Part 4 of the Safety Case will provide the evidence that the system is safe in operational service. It will address all relevant operational and management issues, and will take account of the safety findings from the preceding three parts of the Safety Case. This part of the Safety Case is maintained as a living document for the life of the system, to define and document any further hazards, identified at post-commissioning or during routine operations, and the risk control actions taken to maintain compliance with safety objectives, in the light of actual day-to-day knowledge and experience with the system.

Note in respect to all Parts
It is important that all parts of the Safety Case be retained and maintained as necessary over the life of the system, reflecting the safety situation for any approved modifications or changes to the system.

ATTACHMENT B

Sample Headings and Content for an ADS-B System Implementation Safety Case

No.	Heading	Brief Description of Content
1	Title	State the Title of the Safety Case. E.G. ADS-B Upper Airspace Program – Implementation Phase Safety Case
2	Purpose/Background/Operational Requirement	State the background to the development of the system. State the previous trials leading up to the implementation of the surveillance system. State the operational requirement of the system; the scope of the system and the scope of the safety case.
3	Scope	Define the scope of the system covered by the Safety Case. Operational staff impact. Technical staff impact. Changes to voice comms system. System coverage, engineering and operational standards adopted. Include coverage and location of ground station infrastructure, ground station design, bearer link network design, changes to ATM facilities at Area Centres. System transition management. Relativity to other programs. Existing system upgrade requirements. Development of new ATC procedures. Regulatory approval requirements/plans.
4	System Overview and Description	Overall system description/diagram. Ground Stations locations. Site Monitor. Terrestrial and satellite bearer links to ATC Centres. ATC System Processors. ATC Display. Remote Control and Monitoring System. RAIM prediction system. Power supply system(s). Provide schematic diagram of overall system including third party provided services and data-links
5	VHF Communication System	Overall voice comms system description/performance standards/overview/ bearers/third party provided services.
6	New ATC Procedures and Staff Training plan	Define existing separation standards and the intended new separation standard(s). Define ATC staff training required for 'radar-like service'.
7	Logistics support	Define all aspects of the ILS plan including hardware and software maintenance, spares support plan,
8	Safety Requirements	Establish the safety standards and requirements in terms of system performance parameters (RAM).
9	Assumptions, Constraints and Dependencies	Comparison with radar for 5NM separation service. Proposed aircraft operational accuracy (NAC) and integrity (HPL) standards. State dependencies with related projects (voice, data bearers, aircraft equipage requirements, ATC system upgrades, etc)
10	Responsibilities	Establish the relevant staff responsibilities for the project implementation and safety management. Include all specialist and management personnel and responsibilities
11	Consultation and Communication	State the external consultation undertaken with stakeholders including any issues in relation to safety

No.	Heading	Brief Description of Content
		considerations. Provide references to documentation of consultation outcomes.
12	Design Process	Define the design process undertaken in system development. Define the design test plan/procedures and the outcome of design reviews.
13	Design Safety Risk Management	Describe the processes undertaken for Safety Risk Management at the design phase. Include reference to design HAZID and HAZLOG reviews undertaken. Establish the current status of all hazards identified in the design phase
14	Design Limitations and Shortcomings	Itemize all design phase deficiencies remaining (major and minor) and their safety status and impact
15	Implementation Process	Establish engineering transition plan. Establish operational transition plan. Establish contingency plan for reversion to existing system.
16	Status of Safety Controls and Safety Requirements	State the status of all safety controls and requirements. All outstanding Hazards and all safety requirements not satisfied to be subject to individual documentation
17	Engineering Support and Engineering System Maintenance	Describe the means of future engineering support – internally and externally to the organisation as applicable. Provide references to documented system maintenance procedures.
18	Criteria for Maintenance Technician certification	Establish the technician competency requirements for system monitoring, operation and maintenance.
19	Safety Performance Monitoring	Describe or reference the process for monitoring and management of safety performance after implementation of the system.
20	ATC Staff Training and Education Plan	Establish the ATC staff training plan and comprehensive training package.
21	Pilot Information Package	Provide reference to the Pilot Information and the dissemination of the package.
22	SystemTransition Plan	
23	RAM End-to-End System Analysis	Undertake Reliability, Availability, Maintainability analysis of the end-to-end system. (Use manufacturer provided RAM data or field data if available.) Compare results with established design standards/requirements.
24	System Test Procedure	Describe generally and provide reference to the detailed System Test Plan.
25	System Test Results	State the outcome of the system tests undertaken
26	**Define the System Safety Risk Management plan**	**Provide documentation of the safety risk management plan**
27	**Define Risk Management Process used for the Safety Case**	**Risk Management Process to be defined or referenced. Include process for Hazard Identification, Risk Assessment, Risk Classification, and Risk Control processes.**
28	**HAZID**	**Provide the record of all HAZID activities undertaken**
29	**Status of Hazards (HAZLOG)**	**Provide documentation of the status of all Hazards.**
30	**List all Hazards not controlled to tolerable level**	**List all Hazards not controlled to tolerable level, the reasons and justification.**
31	Post implementation review plan	Establish the plan, timing and procedures for post

No.	Heading	Brief Description of Content
		implementation review of the performance and safety of the system.
32	Related documentation	Include listing of references to all related or referenced documents

Attachment to ADS-B SITF/9-IP/2

Australian ADS-B rule applicable to foreign airline aircraft operating in Australia - Extract from Civil Aviation Order 82.5

Paragraph 10.8

10.8 The operator of a foreign registered aircraft must ensure that it complies with the requirements (***Directions***) in Appendix 4. The definitions in Appendix 4 also apply for Appendix 5.

Appendix 4

Directions relating to carriage and use of automatic dependent surveillance – broadcast equipment

1 In this Appendix:

ADS-B means automatic dependent surveillance – broadcast.

ADS-B test flight means a flight to prove ADS-B transmitting equipment that is newly installed on the aircraft undertaking the flight.

aircraft means a foreign aircraft.

aircraft address means a unique combination of 24 bits assigned to an aircraft by, or under the authority of, an NAA for the purpose of air to ground communications, navigation and surveillance.

approved equipment configuration means an equipment configuration that:

(a) meets the conditions for approval set out in Appendix 5; or

(b) is approved in writing by CASA.

Note Equipment configurations approved by CASA are published in Appendix D of Advisory Circular 21-45.

ATSO means Australian Technical Standard Order of CASA.

EASA means the European Aviation Safety Agency.

EASA AMC 20-24 means EASA document AMC 20-24 titled *Certification Considerations for Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) via 1090 MHZ Extended Squitter*, dated 2 May 2008.

ETSO means European Technical Standard Order of the EASA.

FAA means the Federal Aviation Administration of the United States.

FDE means Fault Detection and Exclusion, a feature of a GNSS receiver that excludes faulty satellites from position computation.

FL 290 means flight level 290.

Note Flight level 290 is defined in subregulation 2 (1) of CAR 1988.

GNSS means the Global Navigation Satellite System installed in an aircraft to continually compute the position of the aircraft by use of the GPS.

GPS means the Global Positioning System.

HPL means the Horizontal Protection Level of the GNSS position of an aircraft as an output of the GNSS receiver or system.

NAA has the same meaning as in regulation 1.4 of the *Civil Aviation Safety Regulations 1998*.

Note "***NAA***, for a country other than Australia, means:

(a) the national airworthiness authority of the country; or

(b) EASA, in relation to any function or task that EASA carries out on behalf of the country."

NIC means Navigation Integrity Category as specified in paragraph 2.2.3.2.7.2.6 of RTCA/DO-260A.

NUCp means Navigation Uncertainty Category — Position as specified in paragraph 2.2.8.1.5 of RTCA/DO-260.

RTCA/DO-229D means document RTCA/DO-229D titled *Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System Airborne Equipment*, dated 13 December 2006, of the RTCA Inc. of Washington D.C. USA (***RTCA Inc.***).

RTCA/DO-260 means RTCA Inc. document RTCA/DO-260 titled *Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance – Broadcast*, dated 13 September 2000.

RTCA/DO-260A means RTCA Inc. document RTCA/DO-260A titled *Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B)*, dated 10 April 2003.

SA means Selective Availability, and is a function of the GPS that has the effect of degrading the accuracy of the computed GPS position of a GNSS-equipped aircraft.

TSO means Technical Standard Order of the FAA.

Note NAA is defined in regulation 1.4 of the *Civil Aviation Safety Regulations 1998*.

2 If an aircraft carries ADS-B transmitting equipment for operational use in Australian territory, the equipment must comply with an approved equipment configuration.

3 If an aircraft carries serviceable ADS-B transmitting equipment for operational use in Australian territory, the equipment must transmit:

(a) a flight identification that corresponds exactly to the aircraft identification mentioned on the flight notification filed with, or relayed to air traffic control (***ATC***) for the flight; or

(b) another flight identification directed or approved by ATC.

4 If an aircraft carries serviceable ADS-B transmitting equipment that complies with an approved equipment configuration, the equipment must be operated continuously during the flight in all airspace at all altitudes unless the pilot is directed or approved otherwise by ATC.

5 If an aircraft carries ADS-B transmitting equipment which does not comply with an approved equipment configuration, the aircraft must not fly in Australian territory unless the equipment is:

(a) deactivated; or

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

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

6 However, the equipment need not be deactivated as mentioned in clause 5 if the aircraft is undertaking an ADS-B test flight in VMC in airspace below FL 290.

7 On and after 12 December 2013, if an aircraft operates at or above FL 290, it must carry serviceable ADS-B transmitting equipment that complies with an approved equipment configuration.

Note On and after 12 December 2013, an aircraft must carry and continuously operate compliant ADS-B transmitting equipment in accordance with clause 7.

Apart from this, there is no obligation to carry compliant ADS-B transmitting equipment.

However, including the effect of clause 4 above, if compliant ADS-B transmitting equipment is in fact carried, whether voluntarily or in accordance with the obligation under clause 7, it must be operated continuously in all airspace, at all altitudes.

8 Clause 7 does not apply to an aircraft if the aircraft owner, operator or pilot has written authorisation from CASA for the operation of the aircraft without the equipment.

Appendix 5

Paragraph 10.8 and definition of ***approved equipment configuration***
in clause 1 of Appendix 4

Part A

Approved equipment configuration

1 An equipment configuration is approved if it complies with the standards specified in Part B or Part C of this Appendix.

Part B

ADS-B transmitting equipment — standard for approval

2 ADS-B transmitting equipment must be of a type that:

(a) is authorised by:

(i) the FAA in accordance with TSO-C166 as in force on 20 September 2004, or a later version as in force from time to time; or

(ii) CASA, in writing, in accordance with:

(A) ATSO-C1004a as in force on 16 December 2009, or a later version as in force from time to time; or

(B) ATSO-C1005a as in force on 16 December 2009, or a later version as in force from time to time; or

(b) meets the following requirements:

(i) the type must be accepted by CASA as meeting the specifications in RTCA/DO-260 dated 13 September 2000, or a later version as in force from time to time;

(ii) the type must utilise HPL at all times HPL is available; or

(c) is otherwise authorised, in writing, by CASA for the purposes of subsection 9B of Civil Aviation Order 20.18 as being equivalent to one of the foregoing types.

GNSS position source equipment — standard for aircraft manufactured on or after 28 June 2012

3 For an aircraft manufactured on or after 28 June 2012, the geographical position transmitted by the ADS-B transmitting equipment must be determined by:

(a) a GNSS receiver of a type that is authorised by the FAA in accordance with TSO-C145a or TSO-C146a as in force on 19 September 2002, or a later version as in force from time to time; or

(b) a GNSS receiver of a type that is authorised by the FAA in accordance with TSO-C196 as in force on 9 September 2009, or a later version as in force from time to time; or

(c) a GNSS receiver or system which meets the following requirements:

(i) is certified by an NAA for use in flight under the I.F.R.;

(ii) has included in its specification and operation the following:

(A) FDE, computed in accordance with the definition at paragraph 1.7.3 of RTCA/DO-229D;

(B) the output function HPL, computed in accordance with the definition at paragraph 1.7.2 of RTCA/DO-229D;

(C) functionality that, for the purpose of HPL computation, accounts for the absence of the SA of the GPS in accordance with paragraph 1.8.1.1 of RTCA/DO-229D; or

(d) another equivalent system authorised in writing by CASA.

Note The following GNSS receivers meet the requirements of clause 3, namely, those certified to TSO-C145a or TSO-C146a, or later versions, or those manufactured to comply with TSO-C196.

GNSS position source equipment — standard for aircraft manufactured before 28 June 2012

4 For an aircraft manufactured before 28 June 2012, the geographical position transmitted by the ADS-B transmitting equipment must be determined by:

(a) a GNSS receiver or system that complies with the requirements of clause 3, other than sub-subparagraph 3 (c) (ii) (C) which is optional; or

(b) an equivalent GNSS receiver or system that has been approved in writing by CASA.

Note The following GNSS receivers meet the requirements of clause 4, namely, those certified to TSO-C145a or TSO-C146a, or later versions, or those manufactured to comply with TSO-C196. Some later versions of GNSS receivers certified to TSO-C129 may also meet the requirements, i.e. those having FDE and HPL features incorporated.

Altitude source equipment — standard

5 The pressure altitude transmitted by the ADS-B transmitting equipment must be determined by:

(a) a barometric encoder of a type that is authorised by:

(i) the FAA in accordance with TSO-C88a as in force on 18 August 1983, or a later version as in force from time to time; or

(ii) EASA in accordance with ETSO-C88a as in force on 24 October 2003, or a later version as in force from time to time; or

(b) another equivalent system authorised in writing by CASA.

Aircraft address — standard

6 Unless otherwise approved in writing by CASA, the ADS-B transmitting equipment must:

(a) transmit the current aircraft address; and

(b) allow the pilot to activate and deactivate transmission during flight.

Note The requirement in paragraph 6 (b) is met if the ADS-B transmitting equipment has a cockpit control that enables the pilot to turn the ADS-B transmissions on and off.

Part C

Alternative approved equipment configuration — standard for aircraft manufactured on or after 28 June 2012

7 For an aircraft manufactured on or after 28 June 2012, an equipment configuration is approved if:

(a) it has been certified by EASA as meeting the standards of EASA AMC 20-24; and

(b) the aircraft flight manual attests to the certification; and

(c) the GNSS receiver or system complies with the requirements of clause 3 in Part B.

Alternative approved equipment configuration — standard for aircraft manufactured before 28 June 2012

8 For an aircraft manufactured before 28 June 2012, an equipment configuration is approved if:

(a) it has been certified by EASA as meeting the standards of EASA AMC 20-24; and

(b) the aircraft flight manual attests to the certification; and

(c) the GNSS receiver or system complies with the requirements of clause 4 in Part B.

Guidelines for Airworthiness and Operational 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. As part of the operational approval process, 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;

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 ADS-B operations and their onboard operational equipment. This is typically a demonstration that ADS-B is included in the training process and operational documentation including Flight Dispatch considerations;

e) When the airworthiness, continuing airworthiness and operational requirements are met, the State of Registry will issue an operational approval to the operator in accordance with their normal procedures. Common methods include Ops Specs revision, Instrument of Authorisation or Letter of Approval;

f) When so required, the approval is registered with the relevant Regional Approval Monitoring Agency to be identified. With an operational approval from the State of Registry, an operator should be accepted to conduct operations in foreign States.

g) If a State Regulator does not have the ability to carry out the operational approval as described above, it is recommended that they seek technical assistance from a State Regulator that has the capability to provide the support.

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Airworthiness and Operational Approval Guidance for Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) via 1090 MHZ Extended Squitter

(Translation from Chinese)

1. Purpose

This advisory circular (AC) is to provide airworthiness and operational approval guidance for operation of Automatic Dependent Surveillance - Broadcast (ADS-B) system in Non-Radar Areas via 1090 MHZ Extended Squitter. It may describe an example of an acceptable means, but not the only means acceptable to Civil Aviation Administration of China (CAAC) demonstrating compliance.

2. Applicability

This AC is applicable to all manufacturers or modification organizations intending to obtain airworthiness approval on onboard ADS-B system(hereinafter referred to as Applicant) and air operators under CCAR91, 121 and 135 intending to obtain operational approval on onboard ADS-B system.

This AC is based on ADS-B OUT via 1090 MHz ES datalink. UAT datalink, ADS-B IN, and other techical standards will be described in subsequent ACs.

3. Definitions

a. Automatic Dependent Surveillance-Broadcast（ADS-B）. ADS-B is a surveillance technology that uses air/ground and air/air data communication to monitor traffic and transmit flight information. The surveillance data may come from various onboard data sources (e.g. horizontal position, barometric altitude, ATC transponder control panel). Onboard ADS-B consists of two functions: ADS-B-out and ADS-B in.

b. ADS-B OUT . ADS-B out, defined as the capability necessary for the aircraft to transmit ADS-B messages. The onboard transmitter periodically transmits various flight information, including aircraft identification; position; altitude and velocity, heading, climb rate, etc. OUT is the basic function of onboard ADS-B equipment, which shall have adequate surveillance data provision capability, ADS-B message processing (encoding and generation) capabilities, and ADS-B message transmission capabilities. ADS-B OUT system is automatic since it functions without intervention from the flight crew as long as the necessary avionics are in place, connected and functioning.

c. ADS-B IN. ADS-B IN refers to the ability to receive and display ADS-B messages and broadcast services, both from the ground and directly from other aircraft so as to provide operational support for the crew. A typical application of ADS-B IN is the Cockpit Display of Traffic Information （CDTI）via which the crew knows the operation status of other aircrafts so as to improve their air traffic situation awareness.

4. Reference Documents

a. Chinese Technical Standard Order CTSO-C166b - *1090 MHz ES-Based Automatic Dependent Surveillance - Broadcast（ADS-B）and Traffic Information Services – Broadcast（TIS-B）Equipment*

b. Transport Canada AC700-009 - *Automatic Dependent Surveillance - Broadcast*

c. European Aviation Safety Agency（EASA）AMC 20-24 - *Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHz Extended Squitter*

d. RTCA DO-260/EUROCAE ED-102 - *MOPS for 1090MHz ADS-B*

e. RTCA DO-260A - *MOPS for 1090 MHz Extended Squitter ADS-B and TIS-B*

f. RTCA DO-260B - *MOPS for 1090 MHz Extended Squitter ADS-B and TIS-B*

g. RTCA DO-303/EUROCAE ED-126 - *Safety, Performance and Interoperability Requirements Documents* for ADS-B-NRA Application

h. RTCA DO-264/EUROCAE ED-78A - *Guidelines for Approval of the Provision and Use of Air Traffic Services Supported by Data Communications*

i. TSO-129/TSO-129A（ETSO-129A）- *Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)*

j. ETSO-2C112b - *Minimum Operational Performance Specification for SSR Mode Transponders*

k.TSO-145/TSO-146;TSO-145A/TSO-146A(ETSO-145/ETSO-146) - *Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Satellite Based Augmentation System*

l．TSO-166b（ETSO-166b）- *1090 MHz Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B) and Traffic Information*

Services - Broadcast (TIS-B)

m. AMC 20-13 - *Certification of Mode S Transponder Systems for. Enhanced Surveillance*

n . EUROCAE ED-26 - *MPS for Airborne Altitude Measurements and Coding Systems*

o．Federal Aviation Administration（FAA）AC 20-138A - *Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment*

5. Background

ADS-B is defined by International Civil Aviation Organization（ICAO）as a major surveillance technology for the future. To implement ADS-B OUT in non-radar airspace will bring obvious benefits, including providing more accurate aircraft position information, improving traffic situation awareness of controller, application of 5 nautical miles lateral separation in lieu of procedural separation minima, increasing opportunities of user preferred flight paths and fuel saving, expanding surveillance coverage and enhancing air safety, and improving alert and ATC services in non-radar areas.

Other background information can be referred to the information bulletin IB-FS-2008-002 - *Application of ADS-B in Flight Operations*.

This AC is equivalent to AMC 20-24.

6．Assumptions

6.1 Air Traffic Service Provider (ATSP)

ATSP implements the ADS-B application compliant with relevant requirements of the safety, performance and interoperability requirements of DO-303/ED-126 (or equivalent). Deviations from, or supplements to the established standards are assessed by the ATSP. Deviations that potentially impact the airborne domain should be assessed in coordination with relevant stakeholders as per DO-264/ED-78A.

6.1.1 Consistency of position quality indicators with associated position information at time of transmission

In cases where position quality indicators are not consistent with actual position quality (e.g., due to uncompensated latency in position transmissions), the implementing ATSP might:

（a）treat the higher quality indicator encodings as an advised lower one (e.g. NUC=7 may be treated as NUC=5 for DO260 compliant transponder);

(b) consider, for separation purpose, a quality indicator more stringent than the one stated in DO-303/ED-126 (e.g. NUC =5 rather than NUC=4 for DO260 compliant transponder).

6.1.2 Encoding of NUC Quality Indicator (DO-260 compliant transponders)

In order to mitigate the encoding of the NUC quality indicator based on accuracy quality information (HFOM) in the case of the unavailability of the GPS RAIM function (i.e. unavailability of HPL information), the implementing ATSP may, for instance, rely on the analysis of the frequency and duration of the unavailability of the RAIM function as part of the local safety assessment.

6.1.3 Transmission of generic emergency indicator only

In order to mitigate the transmission of only the generic emergency indicator (and not also the discrete codes selected by the flight crew), it is assumed that appropriate operational procedures have been established by the implementing ATSP and that pilots and controllers have been trained in their use.

6.1.4 Communications Service Provider (CSP)

Refer to the related performance requirements of DO-303/ED-126 for surveillance data communication service level.

6.2 Aeronautical Information Service

Information related to the surveillance provisions, schedule, relevant procedures shall be published in AIP.

7. Airworthiness Considerations

7.1 Airworthiness Certification Objectives

For the purposes of the ADS-B-NRA application, the ADS-B System installed in the aircraft needs to be designed to deliver data that satisfy the airborne domain requirements in line with DO-303/ED-126 Section 3.4 (Appendix 2 provides a summary for information purposes).

7.2 ADS-B System

7.2.1 The (overall) ADS-B System integrity level with respect to the processing of horizontal position data and horizontal position quality indicators, which covers the processing (and data exchange) chain from horizontal position data source(s) to ADS-B transmit data string encoding needs to be 10^{-5}/fh (refer also to Table 1 in Appendix 2).

7.2.2 The (overall) ADS-B System continuity level needs to be $2*10^{-4}$ /fh (refer also to Table 1 in Appendix 2).

Note 1: this integrity level is required to adequately protect against the corruption of horizontal position data and horizontal position quality indicators when applying separation.

Note 2: These performance figures have been set for the ADS-B out function, to be used in ADS-B NRA operations as laid down by the Operational Safety Assessment in Annex C of DO-303/ED-126.

Note 3: Compliance with these performance figures do not constitute per se a demonstration that the safety objectives of ADS-B-NRA operations allocated to avionics are achieved.

Note 4: This AC is applicable to various ATM services in ADS-B-NRA application, including separation services. This AC adopts the methods in DO-264/ED-78A and satisfies the ADS-B-NRA safety, performance and interoperability requirements of DO-303/ED-126. The requirements of this AC are based on 5 NM sepearation services in DO-303/ED-126 (en route and terminal area). The ATSP, based on the local safe operation status, may select the ATM services in ADS-B-NRA, including applicable minimum ATM separation services.

7.2.3 The latency of the horizontal position data, including any uncompensated latency, introduced by the (overall) ADS-B System does not exceed 1.5 second in 95% and 3 seconds in 99.9% of all ADS-B message transmission cases (refer also to Table 1 in Appendix 2).

7.3 ADS-B Transmit System

7.3.1 Compliance with the surveillance data transmission requirements, as a minimum, as specified in DO-303/ED-126(refer to Appendix 3), needs to be demonstrated. :

- A unique ICAO 24 bit aircraft address (contained within each ADS-B message transmission);
- Horizontal Position (latitude and longitude);
- Horizontal Position Quality Indicator(s) (position integrity for both DO-260/ED-102 and DO-260A or DO-260B based ADS-B transmit systems, as well as accuracy for DO-260A or DO-260B based ADS-B transmit systems);
- Barometric Altitude;
- Aircraft Identification;
- Special Position Identification (SPI);
- Emergency Status and Emergency Indicator;
- Version Number (in aircraft operational status message, if avionics are DO-260A or DO-260B compliant).

7.3.2 Compliance with the data transmission requirements as specified in Section 7.3.1 should be demonstrated by the relevant tests documented in:

- DO-181C or ED-73B/ETSO-2C112b;
- DO-260/ED-102, DO-260A or DO-260B.

7.3.3 ADS-B transmit systems need to transmit horizontal position quality indicators consistent with the associated position information at the time of transmission. For the expression of the position accuracy quality, the related indicator should therefore reflect:

- The quality (in terms of both integrity and accuracy) of the position measurement itself; and
- Any (uncompensated) latency incurring prior to transmission.

Note: Guidance on the quality indicators is provided in Appendix 4.

The applicant needs to demonstrate the correctness of consistent quality indicator encodings in line with (minimum) position source quality and any (uncompensated) maximum latency as expressed in 7.2.3.

<u>Permissible deviation for initial implementations of ADS-B:</u>

For initial implementations, some aircraft installations may not take into account any (uncompensated) latency in the encoding of the position accuracy quality indicator as applicable at the time of transmission. Hence, such installations might transmit horizontal position quality indicators that are consistent with the associated position only for lower quality indicator encodings (e.g. NUC=5 or NAC=5) but not higher ones (e.g. NUC=7 or NAC=7). Such deviation from the above target requirement need to be listed in the Aircraft Flight Manual (refer to Section 8.4.3).

Note: This is a consequence of the definition of the quality indicator encoding describing an interval of values between a lower and an upper bound (refer also to Appendix 4). For instance, a NUC=5 encoding expresses an upper bound of position accuracy quality indication of 0.3NM whilst a NUC=7 encoding expresses an upper bound of 0.05NM. Therefore, in case of e.g. the actual GNSS position source performance, a NUC=5 encoding provides sufficient margin to also correctly express the effects of on-board uncompensated latency whilst this is not the case for a NUC=7 encoding any more.

7.3.4 The value of the horizontal position quality indicators need to be based on the integrity information for the encoding of NUC （DO-260/ED-102）and NIC（DO-260A, DO-260B） and the accuracy information for the encoding of NAC （DO-260A, DO-260B）, as related to the horizontal position sources.

7.3.5 In case of DO-260/ED-102 based ADS-B transmit systems, the NUC Quality Indicator value need to be encoded based on the integrity containment radius only (that is GPS HPL/HIL）.

Permissible deviation for initial implementations of ADS-B application

For initial implementations, some GPS position source based aircraft installations may encode the NUC Quality Indicator on accuracy quality information (HFOM) under rare satellite constellation circumstances leading to the temporary unavailability of the integrity monitoring (RAIM) function (i.e. unavailability of integrity containment radius calculation). Such deviation from the above target requirement need to be listed in the Aircraft Flight Manual (refer to Section 8.4.3).

7.3.6 If the ADS-B transmit system does not have a means to determine an appropriate integrity containment radius and a valid position is reported, then the Quality Indicator need to be encoded to indicate that the integrity containment radius is unknown (i.e. NUC/NIC should be set to zero).

7.3.7 Transmitter antenna installation needs to comply with guidance for installation of ATC transponders to ensure satisfactory functioning. (Refer to DO-181C/ED-73B).

7.3.8 If more than one ADS-B transmit system is installed, simultaneous operation of both transmit systems needs to be prevented.

7.4 Horizontal Position Data Sources

7.4.1 The requirements on horizontal position data sources are based on the DO-303/ED-126 safety and performance assessments.

7.4.2 Components of horizontal position data sources external to the aircraft ADS-B system (such as the GPS space segment) fall outside these airworthiness considerations. Such external components are assumed to operate in accordance with their specified nominal performance.

Nevertheless, failures of the external data source components are required to be detected through on-board monitoring (as expressed in section 7.4.3).

7.4.3 Any eligible horizontal position data source needs to meet the following minimum requirements (refer also to Table 2 in Appendix 2):

- Correct encoding of quality indicator information in line with the actual performance of the selected horizontal position data source(s), i.e. in relation to position integrity containment bound (DO-260/ED-102, DO-260A and DO-260B compliant transmit systems) and position accuracy (DO-260A and DO-260B compliant ADS-B transmit systems);
- Position source failure probability: 10^{-4} per hour

Note: For GPS based position sources, the failure occurs outside the aircraft system and is therefore expressed as per ATSU-hour. Proof of compliance of alternative solely aircraft based sources should take this into account and might have to express the requirement as 10^{-5}

per flight hour (i.e. for the en-route environment).

- Position integrity alert failure probability, commensurate with the performance of GPS integrity monitoring characteristics: 10^{-3} (per position source failure event);

Note: Position integrity alert failure is realised through receiver autonomous integrity monitoring (RAIM), including its characteristics of increasingly less likely to fail for position errors beyond the horizontal protection limit.

- Position integrity time to alert: 10 seconds.

7.4.4 If available and valid, integrity containment radius information should be provided to the ADS-B transmit system from the position data source, or equivalent, on the same interface.

7.4.5 If the integrity containment radius is not provided by the horizontal position data source, the ADS-B transmit system may use other means to establish an appropriate integrity containment radius (based on the known RAIM protection threshold HPL/HIL) provided a requirements compliant integrity alert mechanism is available.

7.4.6 Use of GPS Systems as Primary Position Data Source

7.4.6.1 GPS is considered as primary horizontal position data source for the provision of an acceptable accuracy and integrity performance in support of the ATC separation services contained within the ADS-B-NRA application.

The DO-303/ED-126 safety and performance assessments are based on the specified performance and characteristics of GPS systems, including receiver autonomous integrity monitoring (RAIM). Therefore, for GPS systems as specified in section 7.4.6.2, a safety and performance demonstration is not required.

7.4.6.2 If GPS is used as a positional source, the GPS system should be either compatible with:

（a）TSO-C129, TSO-C129A or ETSO C-129A;

（b）TSO C-145A/C-146[a] or ETSO C-145/C-146;

capable of delivering position data with a periodic interval of no more than 1.2 s.

Note: Compared with （a）,（b）provides additional functions. For example, GPS processing (SA off), Satellite Based Augmentation System（SBAS）signal processing (if available), and fault detection and exclusion functions as basic functions. Therefore,（b）normally provides higher integrity quality than (a) .

7.4.6.3 For GPS systems compatible with (E)TSO C-129 (any revision), it is highly desired that the system incorporates Fault Detection and Exclusion capability as defined in FAA AC 20-138A, Appendix 1.

7.4.7 Use of Alternative Compliant Position Data Sources

As the DO-303/ED-126 safety and performance assessments are based on the performance and characteristics of GPS systems, for alternative position sources a dedicated safety and performance assessment is required to demonstrate compliance with the DO-303/ED-126 requirements.

7.4.8 Use of Temporary Back-up Position Data Sources

Back-up position data sources may prove very useful in enhancing the continuity of ADS-B surveillance provision during temporary outages of the primary (or equivalent alternative) position data sources.

Any such back-up position data source may not comply with Section 7.4.3, but needs to report its accuracy and integrity performance to the ADS-B transmit system, in a format compliant with DO-260/ED-102, DO-260A or DO-260B, as appropriate.

7.5 Barometric Altitude Data Sources

7.5.1 Pressure altitude provided to the ADS-B transmit system needs to be in accordance with existing requirements for ATC transponders.

7.5.2 The digitizer code selected needs to correspond to within plus or minus 38.1 m (125 ft), on a 95% probability basis, with the pressure-altitude information (referenced to the standard pressure setting of 1013.25 hectopascals), used on board the aircraft to adhere to the assigned flight profile. (ICAO Annex 10, Vol IV, 3.1.1.7 and 12.2.4. See also ED-26).

The performance of the encoders and of the sensors needs to be independent from the pressure setting selected.

7.5.3 The transponder should indicate correctly the altitude resolution used, i.e. 25ft (from an appropriate source, default resolution) or 100ft (Gillham's coded source, permissible alternative resolution). The conversion of Gillham's coded data to another format before inputting to the transponder is not permitted unless failure detection can be provided (for instance, this need can be satisfied by means of dual independent altitude corrected sensors together with an altitude data comparator (which may be incorporated and enabled in the ADS-B transmit system)) and the resolution is set in the transmitted data to indicate 100ft.

7.5.4 In case more stringent barometric altimetry requirements are applicable in line with e.g. airspace requirements (e.g. RVSM) or other function requirements (e.g. ACAS II), then these requirements and their related regulation take precedence.

7.6 Aircraft Identification

7.6.1 Identification needs to be provided to the ADS-B transmit system so that the information is identical to the filed ICAO flight plan. This information may be provided from:

- A flight management system; or;
- A pilot control panel; or;
- For aircraft, which always operate with the same flight identification (e.g. using registration as the flight identification) it may be programmed into equipment at installation.

7.6.2 In case no ICAO flight plan is filed, the Aircraft Registration needs to be provided to the ADS-B transmit system.

7.7 Special Position Identification (SPI)

For ATC transponder-based ADS-B transmit systems, the SPI capability needs to be provided. The SPI capability should be integrated into the transponder functionality and should be controlled from the transponder control panel.

7.8 Emergency Status/Emergency Indicator

7.8.1 When an emergency status (i.e. discrete emergency code) has been selected by the flight crew, the emergency indicator needs to be set by the ADS-B transmit system.

7.8.2 For ATC transponder-based ADS-B transmit systems, the discrete emergency code declaration capability should be integrated into the transponder functionality and should be controlled from the transponder control panel.

<u>Permissible deviation for initial implementations of ADS-B</u>

For initial implementations, instead of the required transmission of the discrete emergency codes 7500, 7600 and 7700 when selected by the flight crew, the transmission of only the generic emergency indicator can satisfy this requirement. Such deviation from the above target requirement needs to be listed in the Aircraft Flight Manual (refer to Section 8.4.3).

7.9 Airworthiness Considerations regarding Optional Provisions

7.9.1 Ground Velocity

As per DO-303/ED-126 Section 4, ADS-B system is recommended to satisfy the transmission requirements of optional surveillance data Ground Velocity.

Ground velocity, e.g. from an approved GPS receiver, in the form of East/West and North/South Velocity (including a velocity quality indicator) is recommended to be provided.

7.9.2 Special Position Identification (SPI)

For non-ATC transponder-based ADS-B transmit systems (i.e.

installations based on dedicated ADS-B transmitters), a discrete input or a control panel should be provided to trigger the SPI indication.

7.9.3 Emergency Status/Emergency Indicator

For non-ATC transponder-based ADS-B transmit systems (i.e. installations based on dedicated ADS-B transmitters), a discrete input or a control panel should be provided to indicate the emergency status (discrete emergency code).

7.9.4 Flight Deck Control Capabilities

7.9.4.1 Means should be provided to the flight crew to modify the Aircraft Identification information when airborne.

7.9.4.2 Means should be provided to the flight crew to disable the ADS-B function on instruction from ATC without disabling the operation of the ATC transponder function.

Note: It is recommended to implement an independent ADS-B disabling function. For future ADS-B application such flight deck capability may become mandatory. It should be recalled that disabling the operation of the transponder will disable also the ACAS function.

7.9.4.3 Means should be provided to the flight crew to disable the transmission of the barometric altitude.

7.10 All ADS-B broadcast data must be correct. This is based on the intended function, which is to operate where ADS-B messages are used. Incorrect data that are not required for compliance with AC should be either corrected or silenced for approval of the ADS-B installation. For the purpose of this AC, correct means that the message meets the specific requirements of the current version of any design standard, including those published by ICAO, a civil aviation authority, RTCA or EUROCAE .

8. Airworthiness Approval

8.1 Equipment approval

The 1090 MHz ES ADS-B equipment which is intended to obtain Chinese Technical Standard Order Approval （CTSOA）shall satisfy the minimum performance standards as specified in CTSO-C166b.

For the 1090 MHz ES ADS-B equipment with approval from a foreign airworthiness certification agency, obtain from CAAC the Validation of Design Approval (VDA) or CTSOA in case of individual import for the first time.

8.2 Equipment installation approval

In accordance with CCAR 21: *Procedures for Civil Aviation Products and Parts*, installation of ADS-B equipment may be approval via Supplement Type Certificate (STC）, Validation of Supplement Type Certificate (VSTC) or Modification Design Approval（MDA）. In addition, the original manufacturer of aircraft may also obtain installation approval via type certificate （TC）, validation of type certificate （VTC）or type design approval and changes to be made thereto.

Note: CTSOA or VDA is only approval of the equipment itself, and excludes installation approval. Corresponding installation approval shall be obtained for installing onboard ADS-B equipment under CTSOA or VDA.

To install ADS-B equipment onboard an aircraft, it is essential to comply with the airworthiness considerations in this AC and other airworthiness requirements(for example, if the ADS-B equipment is installed onboard a transport-category aircraft, the requirements under CCAR 25 : *Airworthiness Standards for Transport-Category Airplanes* shall be satisfied).

8.3 Existing installations

8.3.1 The Applicant will need to submit, to the Agency, a compliance statement, which shows how the criteria of this AC have been satisfied for the ADS-B installations completed before issue of this AC. Compliance may be supported by design review and inspection of the installed system to confirm the availability of required features, functionality and acceptable human-machine interface.

8.3.2 Where the design review finds items of non-compliance, the applicant may offer mitigation that demonstrates an equivalent level of safety and performance. Items presented by the applicant which impact safety, performance and interoperability requirements will need to be coordinated in accordance with DO-264/ED-78A.

8.4 Airworthiness compliance

8.4.1 Airworthiness

8.4.1.1 The applicant will need to submit, to the Agency, a certification plan and a compliance statement that shows how the criteria of this AC have been satisfied, together with evidence resulting from the activities described in the following paragraphs.

a. Compliance with the airworthiness requirements for intended function and safety may be demonstrated by equipment qualification, safety analysis of the interface between the ADS-B equipment and data sources, structural analyses of new antenna installations, equipment cooling verification, evidence of a human to machine interface, suitable for ADS-B-NRA.

b. The safety analysis of the interface between the ADS-B transmit system and its data sources should show no unwanted interaction under normal or fault conditions.

c. The functionality for ADS-B-NRA application may be demonstrated by testing that verifies nominal system operation, the aircraft derived surveillance data contained in the ADS-B messages, and the functioning of system monitoring tools/fault detectors (if any).

8.4.1.2 The functionality for ADS-B-NRA application may be further demonstrated by ground testing, using ramp test equipment where appropriate, that verifies nominal system operation, the aircraft derived surveillance data contained in the ADS-B messages, and the functioning of system monitoring tools/fault detectors (if any).

Note: this limited testing assumes that the air-ground surveillance systems have been shown to satisfactorily perform their intended functions in the flight environment in accordance with applicable requirements.

To minimise the certification effort for follow-on installations, the applicant may claim credit, from the Agency, for applicable certification and test data obtained from equivalent aircraft installations.

8.4.2 Performance

Where compliance with a performance requirement cannot readily be demonstrated by a test, then the performance may be verified by an alternative method such as analysis, including statistical analysis of measurements under operational conditions.

8.4.3 Aircraft Flight Manual

The Aircraft Flight Manual (AFM) or the Pilot's Operating Handbook (POH), whichever is applicable, needs to provide at least a statement of compliance that the ADS-B System complies with Section 7 of this AC and if deviations are applicable, deviations, as appropriate may be included or referred to.

8.4.4 Documentation of the approved configuration should identify the part number (hardware and software) of data sources that are capable of providing data for transmission. Integrated equipment capable of affecting compliance should also be identified. Provisions for additional data sources that were not evaluated for the approval should be identified, for example, a second GPS not installed. The documentation should be prepared in a form that may be used to conform the installation of a particular aeroplane for operational approval and to perform a conformity inspection when such an inspection is recommended by maintenance instructions.

9. OPERATIONAL CONSIDERATIONS

9.1 Operational Safety

9.1.1 A unique ICAO 24 bit aircraft address should be assigned by the responsible authority to each airframe.

9.1.2 In all cases, flight crews should comply with the surveillance provisions, schedules and relevant procedures.

9.1.3 Direct controller-pilot VHF voice communications should be available at all times.

9.1.4 If flight crew receive equipment indications showing that position being broadcast by the ADS-B system is in error (e.g. GPS anomaly), they should inform the ATSP, as appropriate, using any published contingency procedures.

9.1.5 When there is not an independent Flight Deck Control selection between the ADS-B function (ADS-B on/off) and the ATC transponder function, the crew must be fully aware that disabling the ADS B function will also lead to disable the ACAS function.

9.2 Operation Manual

9.2.1 The Operation Manual should include a system description, operational and contingency procedures and training elements for use of the ADS-B-NRA application.

9.2.2 The Operation Manual should contain the operational aspects described in this guidance material.

9.2.3 In order to use ADS-B applications , the operator operating under CCAR 91 but without operation manual should develop similar training and operational procedures to the ones described in this guidance material.

9.3 Training

9.3.1 Aircraft operators should ensure that flight crew are thoroughly familiar with all relevant aspects of ADS-B applications.

9.3.2 Flight crew training should address the:

a. General understanding of the ADS-B technique and technology;
b. Specific ADS-B associated phraseology;
c. General understanding of ADS-B-NRA operating procedures;

d. Characteristics and limitations of the flight deck human-machine interface, including an overview of ADS-B environment and system descriptions;

e. Need to use the ICAO defined format for entry of the Aircraft Identification or Aircraft Registration marking as applicable to the flight;

Note 1: ICAO Document 8168-OPS/611 Volume I (Procedures for Air Navigation Services) requires that flight crew of aircraft equipped with Mode "S" having an aircraft identification feature should set the aircraft identification into the transponder. This setting is required to correspond to the aircraft identification that has been specified at Item 7 of the ICAO flight plan and consists of no more than seven characters. If the aircraft identification consists of less than seven characters, no zeros, dashes or spaces should be added. If no flight plan has been filed, the setting needs to be the same as the aircraft's registration, again, up to a maximum of seven characters.

Note 2: The shortened format commonly used by airlines (a format used by International Airlines Transport Association (IATA)) is not compatible with ICAO provisions for the flight planning and ATC services used by ATC ground systems.

f. Operational procedures regarding the transmission of solely the generic emergency flag in cases when the flight crew actually selected a discrete emergency code (if implemented, refer to section 7.8) and SPI;

g. Indication of ADS-B transmit capability within the ICAO flight plan but only when the aircraft is certified according to this AC;

h. Handling of data source errors (refer to 9.1.4);

i. Incident reporting procedures;

j. Crew Resources Management and associated human factors issues.

9.3.3 The operator shall make training programs for maintenance and dispatch personnel.

10. MAINTENANCE

10.1 Maintenance tests should include a periodic verification check of aircraft derived data including the ICAO 24 bit aircraft address using suitable ramp test equipment. The check of the 24 bit aircraft address should be made also in the event of a change of state of registration of the aircraft.

10.2 Maintenance tests should check the correct functioning of system fault detectors (if any).

10.3 Maintenance tests at ADS-B transmit system level for encoding altitude sensors with Gillham's code output should be based on the transition points defined in ED-26, Table 13.

10.4 Periodicity for the check of the ADS-B transmitter should be established.

11. Operational Approval

11.1 Application documents

The operator shall provide the following application documents:

a. Certificates showing that the airworthiness approval has been obtained for onboard equipment as required in Section 8 of this AC.

Note: The statement of compliance with this AC (or equivalent) contained in AFM, POH or manufacturer's letter may be certificates of airworthiness approval for the onboard equipment and installation.

b. Minimum Equipment List. The MEL will need to be revised to indicate the despatch requirements on the ADS-B system.

c. Operation Manual. The relevant operation manual may be made as per Section 9.2 of this AC.

d. Training program. The training program may be made as per Section 9.3 of this AC.

e. Maintenance program. The maintenance program may be made as per Section 10 of this AC.

11.2 Method of approval

The Administrator will grant approval in the form of letter of authorization to operators under CCAR91 , and in the form of operation specifications to operators under CCAR 121 and 135.

Appendix 1 ATS Operation Environment

This AC assumes that operation is under the following ATS environment.

1. Summary of core ADS-B Operational Assumptions
    a. The ADS-B application assumes implementation of the procedures contained in the ICAO Doc 4444: PANS-ATM. Fallback procedures from the radar environment apply to ADS-B-NRA operation when necessary. For example, ATC could apply alternate procedural separation (e.g., a vertical standard) during degraded modes.
    b. En route traffic density is assumed to be the same as in the current environment in which single radar coverage would enable the provision of a 5NM separation service for en route regions. This corresponds to low or medium density.
    c. Direct Controller-Pilot Communication (VHF) is assumed to be available at all times.
2. Summary of core ADS-B Ground Domain Assumptions
    a. Controller operating procedures are assumed to be unaffected by the selection of an ADS-B data link, i.e., the ADS-B data link is assumed to be transparent to the controller.
    b. Air Traffic Controllers are assumed to follow existing procedures for coordination and transfer of aircraft, including coordinating appropriate information and agreements regarding separation standards.
    c. Appropriate ATS authorities are assumed to provide controllers with adequate contingency procedures in the event of ADS-B failures or degradation.
    d. It is assumed that there is a monitoring capability in the ADS-B Receive Subsystem that monitors the health and operation of the equipment and sends alerts and status messages to the Air Traffic Processing Subsystem.

Appendix 2 ADS-B-NRA Airborne Safety and Performance Requirements

Table 1: Overall Minimum Airborne ADS-B System Requirements

Parameter	Requirement
Integrity	10^{-5}/fh
Continuity	2×10^{-4}/ fh
Horizontal Position Latency	1.5 Sec /95%

Note: The parameter "Horizontal Position Latency" is the uncompensated delay measured from to the time of validity of position measurement until ADS-B transmission.

Table 2: Minimum Horizontal Position Source Requirements

Parameter	Requirement
Horizontal Position Source	
• Accuracy (95%)	5 NM Sep: 926 m
• Integrity	
✓ Containment Radius (Rc)	5 NM Sep: Rc=2 NM
✓ Source Failure Probability	10^{-4}/fh
✓ Alert Failure Probability	10^{-3} (per position source failure event)
✓ Time to Alert	5 NM Sep: 10 sec

Note 1: For GPS based functions, the parameter "Source Failure Probability" is expressed as an assumption of GPS performance.
Note 2 : For DO-260 based ADS-B transmit systems, the related encoding of the horizontal position quality indicator through the Navigation Uncertainty Category (NUC) effectively leads to a containment radius requirement of 1NM for a 5 NM separation service.
Note 3: Accuracy and integrity containment radius requirements are expressed here as guidance to related horizontal position source regulation (refer to section 7.4).
Note 4: The containment bound requirements reflect the outcomes of both the collision risk assessment and time-to-alert assessment.
Note 5: The accuracy and integrity containment radius requirements have to be met by the horizontal position source, taking into account the effects of on-board latency (if not compensated for).
An uncompensated latency of 1.5 seconds translates into a dilution in the order of 450 metres (assuming an aircraft speed of 600 knots in en-route

airspace). This value of 450 metres has to be added to the actual performance of the horizontal position source(s), the sum of which has to be within the required bounds.

The GPS equipment specified in 7.4.6 shall meet the overall accuracy and integrity requirements, including the effects of an uncompensated latency of maximum 1.5 seconds accumulated up to the time of transmission.

Table 3: Other Minimum ADS-B Surveillance Data Requirements

Parameter	Requirement
Barometric Altitude	• Accuracy: as per the installed sensors (refer to section 7.5.2) • Maximum Latency: 1 sec (as for SSR)
Aircraft Identification, SPI, Emergency Status	As for SSR [AMC20-13].

Table 4: Failure Condition Categories

Parameter	Loss	Corruption	Note
Barometric Altitude	Minor	Minor	As for SSR [AMC20-13]
Aircraft Identification	Minor	Minor	As for SSR [AMC20-13]

Appendix 3 ADS-B-NRA Air-to-ground Interoperability Requirements

The minimum set of parameters that should be provided to support the ADS-B-NRA application are summarised in the following table extracted from DO-303/ED-126.

Table 5: Mandatory ADS-B-NRA Parameters

Parameter		BDS Register	Version 0		Version 1	Version 2
			ICAO Annex 10 Amendment 79, VOL III, App to chap 5	DO-260/ED-102	DO-260A	DO-260B
Aircraft identification		0.8	§2.3.4	§2.2.3.2.5	§2.2.3.2.5	§2.2.3.2.5
SPI		0.5	§2.3.2.6	§2.2.3.2.3.2	§2.2.3.2.3.2	§2.2.3.2.3.2
Emergency indicator		0.5	§2.3.2.6	§2.2.3.2.3.2	§2.2.3.2.3.2	§2.2.3.2.3.2
Barometric altitude		0.5	§2.3.2.4	§2.2.3.2.3.4	§2.2.3.2.3.4	§2.2.3.2.3.4
Quality indicator （NUC/NIC）		0.5	§2.3.1	§2.2.3.2.3.1	§2.2.3.2.3.1	§2.2.3.2.3.1
Position	Latitude	0.5	§2.3.2.3	§2.2.3.2.3.7	§2.2.3.2.3.7	§2.2.3.2.3.7
	Longitude	0.5	§2.3.2.3	§2.2.3.2.3.8	§2.2.3.2.3.8	§2.2.3.2.3.8
Emergency status		6.1	Table 2-97	§2.2.3.2.7.9	§2.2.3.2.7.8	§2.2.3.2.7.8
Quality indicator （NACp）		6.5	No definition	No definition	§2.2.3.2.7.2.7	§2.2.3.2.7.2.7
Quality indicator（SIL）		6.5	No definition	No definition	§2.2.3.2.3.1.1	§2.2.3.2.3.1.1

Version Indicator	6.5	No definition	No definition	§A.1.4.10.5	§A.1.4.10.5

Note 1: The notion of version 0, version 1 and version 2 differentiates between DO-260/ED-102 and DO-260A and DO-260B transponders.

Note 2: Assume that the parameter SPI is provided by flight deck controls.

Note 3: Assume that the parameter "Emergency status" is provided by flight deck controls.

Note 4: For special conditions under which the non-transmission of selected discrete emergency codes is allowed, refer to Section 7.8.2.

Note 5: The parameter "Version Indicator" is only for D0-260A or DO-260B based ADS-B transmit systems.

Table 6: Optional ADS-B-NRA Parameters

Parameter	BDS register	Version 0		Version 1	Version 2
		ICAO Annex 10 Amendment 79, VOL III, App to chap 5	DO-260/ED-102	DO-260A	DO-260B
Ground Velocity	0.9	§2.3.5	§2.2.3.2.6	§2.2.3.2.6	§2.2.3.2.6

Appendix 4 Guidance on Encoding of Positional Quality Indicators

In order to be able to check the compliance of the actually transmitted ADS-B data with the required quality on the recipient side, ADS-B message transmissions contain Quality Indicators. These are expressed for ED-102/DO-260 and DO-260A or DO-260B compliant ADS-B transmit systems as follows:

- DO-260/ED-102: Navigation Uncertainty Category (NUC), a combined expression of (accuracy and) integrity requirements through a single parameter;
- DO-260A or DO-260B: Navigation Accuracy Category (NACp) to express the position accuracy (as a 95 percentile), Navigation Integrity Category (NIC) to express the integrity containment radius and Surveillance Integrity Level (SIL) to specify the probability of the true position lying outside that containment radius without alerting.

Minimum acceptable NUC and NIC/NACp values in support of 5 NM ADS-B-NRA separation services, based on the requirements summarised in Table 2 of Appendix 2, are as follows (see Table 7 for conversion relation):

NUC values (encoding based on HPL, with the accuracy requirements met by GPS systems by design and in line with the related NACp values in below conversion table):

5 NM separation: NUC = 4;

The corresponding NIC/NACp values are as follows.

5 NM separation: NIC = 4, NACp = 5;

The SIL value is established to SIL≥2 in line with the combination of the position source failure and position integrity alert failure requirements, as summarised in Table 2 of Appendix 2.

Note 1: In case the SIL value is not output by the position data sources, it is recommended that the ADS-B transmit system provides for the static setting of SIL as part of the installation procedure and as demonstrated for the applicable position data source configuration.

Note 2: DO-303/ED-126 provides, based on its reference collision risk analysis only, arguments for an equally appropriate encoding of a SIL=2 as a matter of expressing the system integrity as well. As for the presentation of the values presented in this document, it is at the discretion of the ATSP to decide upon the appropriate threshold values required in support of the separation services in its airspace.

Table 7: NUC conversion to NIC and NACp

NUC (max Rc NM)	NIC (max Rc NM)	NACp (95% bound)
9 (0.003)	11 (0.004)	11 (3m)
8 (0.01)	10 (0.013)	10 (10m)
-	9 (0.04)	9 (30m)
7 (0. 1)	8 (0.1)	8 (0.05NM)
6 (0. 2)	7 (0. 2)	7 (0.1NM)
5 (0.5)	6 (0. 6)	6 (0.3NM)
4 (1.0)	5 (1.0)	5 (0. 5NM)
3 (2.0)	4 (2.0)	4 (1NM)
-	3 (4.0)	3 (2NM)
-	2 (8.0)	2 (4NM)
2 (10)	1 (20)	1 (10NM)
1 (20)	1 (20)	1 (10NM)
0 (no integrity)	0 (>20)	0 (Unknown)

附录 5 缩略语

AC Advisory Circular 咨询通告

ACAS Airborne Collision Avoidance System 空中防撞系统

ADS-B Automatic Dependent Surveillance- Broadcast 广播式自动相关监视

ADS-B-NRA Enhanced ATS in Non-Radar Areas using ADS-B Surveillance 无雷达区 ADS-B 应用

AFM Aircraft Flight Manual 航空器飞行手册

AMC Acceptable Means of Compliance 可接受的符合性方法

ATC Air Traffic Control 空中交通管制

ATSU Air Traffic Service Unit 空中交通服务组件

BDS Comm-B Data Selector B 类通信数据选择器

CCAR Chinese Civil Aviation Regulation 中国民航规章

CDTI Cockpit Display of Traffic Information 驾驶舱交通信息显示

CTSOA Chinese Technical Standard Order Approval 中国技术标准规定项目批准书

EASA European Aviation Safety Agency 欧洲航空安全局

ES Extended Squitter 扩展电文

ETSO European Technical Standard Order 欧洲技术标准规定

EUROCAE European Organization for Civil Aviation Equipment 欧洲民航设备组织

FAA Federal Aviation Administration 美国联邦航空局

IATA International Air Transport Association 国际航空运输协会

IB Information Bulletin 信息通告

ICAO International Civil Aviation Organization 国际民航组织

GNSS Global Navigation Satellite System 全球导航卫星系统

GPS Global Positioning System 全球定位系统

HFOM Horizontal Figure of Merit 水平品质因数

HIL Horizontal Integrity Limit 水平完好性限制

HPL Horizontal Protection Limit 水平保护限制

MDA Modification Design Approval 改装设计批准书

NAC Navigation Accuracy Category 导航精度类别

NACp Navigation Accuracy Category - Position 位置导航精度类别

NIC Navigation Integrity Category 导航完好性类别

NUC Navigation Uncertainty Category 导航不确定度类别

PANS-ATM Procedures for Air Navigation Services-Air Traffic Management 航行服务程序—空中交通管理

POH Pilot's Operating Handbook 飞行员使用手册

RAIM Receiver Autonomous Integrity Monitoring 接收机自主完好性监视

Rc Horizontal Position Integrity Containment Radius 水平位置完好性保护半径

RVSM Reduced Vertical Separation Minimum 最小垂直间隔

RTCA Radio Technical Commission for Aeronautics 美国无线电技术委员会

SBAS Satellite Based Augmentation System 星基增强系统

SIL Surveillance Integrity Level 监视完好性水平

SPI Special Position Identifier 特殊位置识别

STC Supplement Type Certificate 补充型号合格证

TC Type Certificate 型号合格证

TDA Type Design Approval 型号设计批准书

TIS-B Traffic Information Service-Broadcast 广播式交通情报服务

TSO Technical Standard Order 技术标准规定

UAT Universal Access Transceiver 通用访问收发机

VDA Validation of Design Approval 设计批准认可证

VSTC Validation of Supplement Type Certificate 补充型号认可证

VTC Validation of Type Certificate 型号认可证

WAAS Wide Area Augmentation System 广域增强系统

CNS/ATM Implementation Planning Matrix

				Navigation*					
State/Organization	**ATN G/G Boundary Intermediate System (BIS) Router/AMHS**	**AIDC**	**CPDLC**	**En-route**	**Terminal**	**Approach**	**ADS-B/ Multilateration**	**ADS-C**	**Remarks**
AFGHANISTAN									
AUSTRALIA	ATN tests were conducted. BIS Router and Backbone BIS Router and AMHS implemented.	AFTN based AIDC Implemented between Brisbane and Melbourne, Auckland, Nadi and Auckland. AIDC is also in use between Melbourne and Mauritius.	Implemented and integrated with ATM systems to support FANS1/A equipped aircraft.	Implemented	Implemented		A total of 29 UAP and 14 WAM stations are delivering ADS-B data to serve a 5 Nm separations service and fully operational. ADS-B mandate applies from 12/2013 at and above FL290. WAM operating in Tasmania. Commissioned in 2010. WAM being installed in Sydney to serve 3 Nm separation service and PRM application, expected to be operation 2010.	FANS 1/A ADS-C implemented.	

				Navigation*					
State/Organization	**ATN G/G Boundary Intermediate System (BIS) Router/AMHS**	**AIDC**	**CPDLC**	**En-route**	**Terminal**	**Approach**	**ADS-B/ Multilateration**	**ADS-C**	**Remarks**
AUSTRALIA (Cont'd)							ASMGCS using multilateration operational in Melbourne & Sydney in 2010. Brisbane and Perth being installed.		
BANGLADESH	BIS Router and AMHS planned for 2011.	AIDC between Dhaka and CTG, Dhaka and Sylhet planned for 2011.		Not yet planned	Not yet planned		Not yet planned	Not yet planned	
BHUTAN	ATN BIS Router and UA service 2011.					Procedures developed for NPA.			
BRUNEI DARUSSALAM	ATN BIS Router planned for 2009 and AMHS planned for 2009-2011.								
CAMBODIA	BIS Router and AMHS planned for 2011.	Planned 2009	Planned 2009			Procedure developed for NPA.			
CHINA	ATN Router and AMHS deployed in 2008. Tripartite BBIS trial completed with Bangkok and Hong Kong, China	AIDC between some of ACCs within China has been implemented. AIDC between several other ACCs are being	Implemented to ATS Rout. L888 route, Trial on HF data link conducted for use in	Implemented in certain airspace. L888, Y1 and Y2 routes.	RNAV (GNSS) implemented in certain airports. Beijing, Guangzhou, Tianjin.	Ali, Linzhi and Lhasa airports	ADS-B trial has been conducted in 2006. 5 UAT ADS-B sites are operational and used for flight training of	FANS 1/A based ADS-C implemented. L888 route.	

				Navigation*					
State/Organization	**ATN G/G Boundary Intermediate System (BIS) Router/AMHS**	**AIDC**	**CPDLC**	**En-route**	**Terminal**	**Approach**	**ADS-B/ Multilateration**	**ADS-C**	**Remarks**
	in Jan. 2003. ATN trial with Hong Kong using XOT over internet conducted in 2006, Further trials planned in 2009. AMHS/ATN technical tests with Macau completed in 2009. ATN/AMHS tests with ROK, India , Hongkong China planned in 2010.	implemented. AIDC between Sanya and Hong Kong put in to operational use in Feb 2007. AIDC between Qingdao and Incheon planned for 2013.	western China.				CAFUC. Another ADS-B project for ATS route between Chengdu and Jiuzhai using 1090ES conducted since 2008. Will be followed by Chengdu – Lhasa and B215 route.		
HONG KONG, CHINA	ATN and AMHS technical trial with Japan conducted in 2003. 64 Kbps ATN Link with Bangkok put into operational use in June 2004. Preliminary ATN/AMHS technical trials with China (Beijing) using VPN over Internet connection	AFTN-based AIDC with Sanya put into operational use in February 2007. AIDC trial with other adjacent ATS authorities planned for end 2009/2010. AIDC technical trial with Taibei to be undertaken in 2010.	FANS 1/A based CPDLC trials completed in 2002. VDL Mode-2 technical trial conducted in 2002. D-ATIS, D-VOLMET and 1-way PDC implemented in 2001. PDC service	Implemented in certain airspace	Implemented in certain airspace	RNAV (GNSS) departure procedures implemented in July 2005. RNP AR APCH procedures for 07L/25R runways implemented in June 2010.	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	FANS 1A trials for ADS-C completed in 2002.	

				Navigation*					
State/Organization	**ATN G/G Boundary Intermediate System (BIS) Router/AMHS**	**AIDC**	**CPDLC**	**En-route**	**Terminal**	**Approach**	**ADS-B/ Multilateration**	**ADS-C**	**Remarks**
	conducted in September 2006. Operational AMHS commissioned in July2009. ATN/AMHS circuit with Macao put into operational use in Dec. 2009. ATN/AMHS interoperability tests with other adjacent communications centres commenced in late 2009, viz Taibei (2009), Beijing (2010), Japan (2012) AMHS trial with Philippines in late 2010. ATN/AMHS into operation in end 2009.	AIDC technical trial with Philippines to be undertaken by end 2010.	upgraded to 2-way data link in June 2008.				quarterly basis since 2004. ADS-B trial using a dedicated ADS-B system was conducted in April 2007. Further ADS-B trial planned for 2010.		
MACAO, CHINA	ATN/AMHS interoperability test with Beijing commenced in Mar 2009.								ATZ within Hong Kong and Guangzhou FIRs. In ATZ full VHF

				Navigation*					
State/Organization	**ATN G/G Boundary Intermediate System (BIS) Router/AMHS**	**AIDC**	**CPDLC**	**En-route**	**Terminal**	**Approach**	**ADS-B/ Multilateration**	**ADS-C**	**Remarks**
	ATN/AMHS circuit with Hong Kong put into operational use in end Dec 2009.								coverage exist. Radar coverage for monitoring purposes.
COOK ISLANDS									
DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA	The ATN BIS Router and AMHS to be implemented in 2011.	With neighboring ACCs to be implemented TBD		Implemented in certain ATS routes G711, B467		RNAV(GNSS) Non-precision approach to be implemented in 2011.	ADS-B has been used as back-up surveillance of SSR since 2008.		
FIJI	ATN BIS Router and AMHS implementation by 4th quarter 2010.	AFTN based AIDC implemented between Nadi, Brisbane, Auckland and Oakland.	Implemented and integrated with ATM systems to support FANS1/A equipped aircraft.	Implemented		Implemented	ADS- B /multilateration ground stations installed. Surveillance service will be provided starting from end of 2012	FANS 1/A ADS-C implemented.	
FRANCE ***(French Polynesia Tahiti)***		Implementation of limited message sets with adjacent centres under discussion.	FANS-1. Implemented since 1996.					FANS 1/A ADS-C implemented since March 1999.	
INDIA	ATN BBIS router and AMHS Physical installation over. SAT in May	AFTN Based AIDC Coordinating with Bangladesh	FANS-1 implemented at Kolkata, Chennai,	SBAS Technical development in 2007.			Trial planned for 2006. ASMGCS	FANS 1/A ADS-C implemented at Kolkata,	

State/Organization	ATN G/G Boundary Intermediate System (BIS) Router/AMHS	AIDC	CPDLC	Navigation* En-route	Terminal	Approach	ADS-B/ Multilateration	ADS-C	Remarks
	2008, Operational trials being conducted with Singapore with live traffic exchange. Coordinating with China, Thailand , Pakistan and Oman for conduct of test.	and Pakistan and, we are ready.	Mumbai and Delhi.	Implementation planned for 2009.			Implemented at IGI Airport New Delhi.	Chennai, Delhi and Mumbai.	
INDONESIA	ATN BIS Router and AMHS planned for trial in 2009. Trial with Singapore planned. ATNBIS Router and AMHS are still on going trial with Singapore to be finished in 2010 (Part D: AMHS Commission)	Brisbane and Makassar in planned in June 2009. Makasar and Brisbane is still on going trial AIDC, planned operational in 2011	FANS-1/A. CPDLC in Ujung Pandang FIRs already trial start from 2008 and will be implemented in 2009. FANS-1/A CPDLC in Ujung Pandang FIRs is completely trial operational and will be full operational for designated route on September 2010.				27 ADS-B ground stations have been installed in 2009. Upgrading ATC automation at Makasar for ADS-B application capabilities in 2009. Plan to install 3 additional ground stations.	FANS-1/A ADS-C trial planned at Jakarta and Ujung Pandang ACC in 2007. FANS-1/A ADS-C in Ujung Pandang FIRs is completely trial operational and will be full operational in September 2010.	

				Navigation*					
State/Organization	**ATN G/G Boundary Intermediate System (BIS) Router/AMHS**	**AIDC**	**CPDLC**	**En-route**	**Terminal**	**Approach**	**ADS-B/ Multilateration**	**ADS-C**	**Remarks**
JAPAN	ATN BBIS router and AMHS installed at 2000. Connection tests with USA 2000 - 2004 and put into operational use in 2005. Connection test with Taibei 2008 - ongoing. Connection tests with Australia, China, Hong Kong, Singapore, Republic of Korea, Europe and Russian Federation is TBD	AFTN based AIDC implemented with Oakland, Anchorage and Incheon. Planned between Fukoka ATMC and Taibei ACC for 2012.	FANS1/A system Implemented in Fukuoka FIR.	SBAS implemented RNAV5 implemented.	RNAV1 implemented	RNP Approach implemented	Two Multilateration Systems have been implemented at Narita and Haneda airports.	FANS 1/A. ADS-C implemented in Fukuoka FIR.	
KIRIBATI									
LAO PDR	ATN BIS Router and AMHS completed planned for implementation with Bangkok in 2010.	AIDC with Bangkok planned for 2010.		Implemented. Planned for 2011.					
MALAYSIA	ATN BIS Router completed 2007. AMHS planned in 2011	AFTN AIDC planned with Bangkok ACC in 2011.	Implemented for Bay of Bengal in July 2008.	Implemented for Oceanic Routes.	Basic RNAV implemented	NPA at KLIA implemented	Implementation of ADS-B proposed in 2010 - 2015.	FANS 1/A ADS-C already implemented for Bay of Bengal area.	

				Navigation*					
State/Organization	**ATN G/G Boundary Intermediate System (BIS) Router/AMHS**	**AIDC**	**CPDLC**	**En-route**	**Terminal**	**Approach**	**ADS-B/ Multilateration**	**ADS-C**	**Remarks**
MALDIVES	ATN BIS Router/AMHS planned for implementation in the 2011.	Planned for 2011.	FANS1/A installed Trials planned in last quarter of 2007.	Trials planed for 2005-2008. Implementation in later 2008.			Trials planned for 2007-2008. Implementation in late 2008.		
MARSHALL ISLANDS						NPA implemented at Majuro Atoll.			
MICRONESIA (EDERATED STATES OF)									
Chuuk				Implemented					
Kosrae				Implemented					
Pohnpei				Implemented					
Yap				Implemented					
MONGOLIA	ATN BIS Router and AMHS planned for 2005 and 2006. Trial with Bangkok conducted.		Function available. Regular trials are conducted.		GPS procedures are being developed and implemented at 10 airports.		ADS-B trial in progress implementation planned for 2006.	FANS 1/A ADS-C implemented since August 1998.	
MYANMAR	Implementation of AMHS to be completed by the end of 2010.	The capability of ATM Automation system to support AIDC by 2011	Implemented since August 1998.				A plan to implement ADS-B by 2011	Implemented since August 1998.	
NAURU									

				Navigation*					
State/Organization	**ATN G/G Boundary Intermediate System (BIS) Router/AMHS**	**AIDC**	**CPDLC**	**En-route**	**Terminal**	**Approach**	**ADS-B/ Multilateration**	**ADS-C**	**Remarks**
NEPAL	BIS Router and AMHS planned for 2011.	AFTN/AMHS based AIDC between KTM-CAL, KTM-BAN, KTM-LHASA planned for 2011.			GPS departure and approach has been developed for 8 airports and planned for implementation in 2008.		ADS-B feasibility study planned for 2007.		
NEW CALEDONIA							Three ADS-B ground stations implemented in 2009 to cover international traffic at La tontouta airport serving Tontouta ACC & APP.		
NEW ZEALAND	BIS Router and AMHS implementation planned for 2010.	AFTN based AIDC implemented between New Zealand, Australia, Fiji, Tahiti, Chile and USA.	FANS-1/A. Implemented	Will be implemented as required.	RNAV procedures being implemented as developed.	RNP AR APCH implemented at Queenstown (ZQN).	Domestic trial was conducted in New Zealand. Use will be re-evaluated in 2008. Trial of Area MLAT conducted in 2006. ADS-B planned as an element of MLAT at specific sites for domestic use.*	FANS 1/A Implemented	*MLAT being implemented in Auckland (Surface Movement) and Queenstown.

				Navigation*					
State/Organization	**ATN G/G Boundary Intermediate System (BIS) Router/AMHS**	**AIDC**	**CPDLC**	**En-route**	**Terminal**	**Approach**	**ADS-B/ Multilateration**	**ADS-C**	**Remarks**
PAKISTAN	ATN/AMHS considered as Phase II implemented since 2010.	Implemented between Karachi and Lahore ACCs Plan to implement AIDC with Mumbai and Muscat for December 2010	Implementation planned from 2005-2010.	Planned for 2005-2010.	RNAV arrival and departure procedure being developed.	NPA (RNP) procedure are being developed and under flight inspection.	Feasibility study for using ADS-B is in hand. One station was installed at ACC Karachi and evaluation is in progress.	Planned for 2005-2010.	Existing Radar system being upgraded.
PAPUA NEW GUINEA				Implemented		Implemented at certain aerodromes.			
PHILIPPINES	ATN G/G BIS Router/AMHS implemented in 2006. AMHS trials with Singapore by end 2008 and Hong Kong planned in 2009.	Planned for 2011.	CPDLC Planned for 2011.				Two ground stations scheduled for implementation in 2013.	FANS 1/A ADS-C planned for 2011.	

State/Organization	ATN G/G Boundary Intermediate System (BIS) Router/AMHS	AIDC	CPDLC	Navigation* En-route	Terminal	Approach	ADS-B/ Multilateration	ADS-C	Remarks
REPUBLIC OF KOREA	ATN BIS Router/AMHS planned for 2011.	AFTN based AIDC implemented between ACC and Fukuoka ATMC. AIDC between Incheon and Qingdao to be implemented.	PDC & D-ATIS implemented 2003.	RNAV 5 to be implemented 2012.	RNAV 1 to be implemented 2012.	APV Baro VNAV to be implemented 2012.	ADS-B implemented 2008 for SMC in Incheon International Airport.	FANS 1/A based ADS-C implemented since 2003 for contingency purpose.	
SINGAPORE	AMHS implemented. ATN BIS Router trial with Malaysia commenced in 2007 and with Indonesia in 2009. ATN/AMHS interoperability trial with India completed in Oct 2009. Commenced pre-ops trial in Dec 2009. Co-ordinating with UK and Australia on ATN/AMHS trial in Q4 2010.	AFTN based AIDC to be implemented	Implemented since 1997. Integrated in the ATC system in 1999.		RNAV SIDS and STARS implemented in 2006.	NPA Procedure implemented in 2005.	The airport M-lat system was installed in 2007 and "far-range" ADS-B sensor was installed in 2009.	FANS 1/A ADS-C implemented since 1997. Integrated with ATC system in 1999.	

				Navigation*					
State/Organization	**ATN G/G Boundary Intermediate System (BIS) Router/AMHS**	**AIDC**	**CPDLC**	**En-route**	**Terminal**	**Approach**	**ADS-B/ Multilateration**	**ADS-C**	**Remarks**
SRI LANKA	ATN BIS Router Planned for 2009. AMHS planned along with BIS in 2009.		PDLC in trial operation since November 2000.				ADS-B Trials planned for 2010 and implementation in 2011.	FANS 1 /A ADS-C trial since November 2000.	GPS based domestic route structure being developed.
THAILAND	BBIS/BIS Routers already implemented. Target date for AMHS in 2008.	AFTN based AIDC planned for 2010.	FANS-1/A Implemented.	Under implementation	Implemented at Phuket Airport	Implemented at Phuket	Multilateration implemented in 2006 at Suvarnbhumi Int'l. Airport. ADS-B is planned to be part of future surveillance infrastructure	FANS 1/A ADS-C Implemented.	
TONGA	AMHS planned for 2008.					NPA planned for 2007.	Trial planned for 2010		CPDLC and ADS-C is not considered for lower airspace
UNITED STATES	AMHS implemented. AMHS Atlanta Sept 2009 to serve CAR/SAM,/ North Atlantic/Europe	AFTN based AIDC implemented.	FANS-1/A based CPDLC implemented.	Implemented	Implemented		Being implemented. Fully coverage by end of 2013 for NAS.	Implemented	
VANUATU									

				Navigation*					
State/Organization	**ATN G/G Boundary Intermediate System (BIS) Router/AMHS**	**AIDC**	**CPDLC**	**En-route**	**Terminal**	**Approach**	**ADS-B/ Multilateration**	**ADS-C**	**Remarks**
VIET NAM	BIS Routers planned for 2009. ATN/AMHS trial in 2010 and operation in 2012.	AFTN based AIDC implemented in 2009. Trial for ATN based AIDC planned in 2010.	CPDLC operational trial conducted in early 2007.	For en-route TBD.	RNAV		TBD	FANS 1/A ADS-C operational trial conducted for oceanic area of Ho Chi Minh FIR since March 2002.	

* Navigation – Navigation including Performance Based Navigation (PBN), APV and precision approach

SURVEILLANCE STRATEGY FOR THE ASIA/PACIFIC REGION

Considering that:

1. States are implementing CNS/ATM systems to gain safety, efficiency and environmental benefits, and have endorsed the move toward satellite and data link technologies;

2. The future air traffic environment will require increased use of aircraft-derived surveillance information for the implementation of a seamless automated air traffic flow management system;

3. The 11th Air Navigation Conference endorsed the use of ADS-B as an enabler of the global air traffic management concept and encouraged States to support cost-effective early implementation of ADS-B applications;

4. APANPIRG has decided to use the 1090MHz Extended Squitter data link for ADS-B air-ground and air-air applications in the Asia/Pacific Region, noting that in the longer term an additional link type may be required;

5. SSR and ADS-C will continue to meet many critical surveillance needs for the foreseeable future;

6. ACAS acts as situational awareness tool and last resort for safety conflict resolution;

7. SARPs, PANS and guidance material for the use of ADS-B have been developed;

8. ADS-B avionics and ground systems are available; and

9. Multilateration is a technology that can supplement SSR and ADS-B.

THE SURVEILLANCE STRATEGY FOR THE ASIA/PACIFIC REGION IS TO:

1. Minimise the reliance upon pilot position reporting, particularly voice position reporting, for surveillance of aircraft;

2 Maximise the use of ADS-B on major air routes and in terminal areas, giving consideration to the mandatory carriage of ADS-B Out as specified in Note 1 and use of ADS-B for ATC separation service;

3. Reduce the dependence on Primary Radar for area surveillance;

4 Provide maximum contiguous ATS surveillance coverage of air routes using 1090MHz Extended Squitter ADS-B and Mode S SSR based on operational requirements;

5. Make full use of SSR Mode S capabilities where radar surveillance is used and reduce reliance on 4-digit octal codes;

6. Make use of ADS-C where technical constraint or cost benefit analysis does not support the use of ADS-B, SSR or Multilateration;

7. Make use of Multilateration for surface, terminal and area surveillance where appropriate as an alternative or supplement to other surveillance systems;

8. Increase the effectiveness of surveillance and collision avoidance systems through mandatory use of pressure altitude reporting transponders;

9. Improve safety through sharing of ATS surveillance data across FIR boundaries;

10. Ensure provision of communication, navigation, and data management capabilities necessary to make optimal use of surveillance systems;

11. Enhance ATM automation tools and safety nets through the use of aircraft-derived data such as flight identification, trajectories and intentions; and

12. Ensure civil-military *cooperation and* interoperability.

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Note 1:

a) Version 0 ES as specified in Annex 10, Volume IV, Chapter 3, Paragraph3.1.2.8.6 (up to and including Amendment 82 to Annex 10) and Chapter 2 of Technical Provisions for Mode S Services and Extended Squitter *(ICAO Doc 9871) (Equivalent to DO260) to be used till at least 2020.*

b) Version 1 ES as specified in Chapter 3 of Technical Provisions for Mode S Services and Extended Squitter *(ICAO Doc 9871) (Equivalent to DO260A);*

c) Version 2 ES (including provisions for new set of 1 090 MHz extended squitter (ES) messages and traffic information service – broadcast (TIS-B) being developed by the Aeronautical Surveillance Panel (ASP) and scheduled to be incorporated in Annex 10 Vol. IV - Surveillance and Collision Avoidance System as part of Amendment 86 with target applicable date in November 2013. (Equivalent to DO260B and EUROCAE ED-102A which were issued in December 2009).

ADS-B SITF/9 – WP 16

IMPLEMENTATION OF ADS-B OPERATIONS IN THE SOUTH CHINA SEA AREA

<u>Tasks and Proposed Milestones</u>

A Installation of ADS-B ground stations

- i) Natuna and Matak - completed
- ii) Singapore - completed
- iii) Con Son - 2H 2010

B Installation of VHF stations and links

- i) Natuna and Matak - 2H 2010 (for 1 frequency) and 1H2011 (for 2 frequencies)
- ii) Conson - 2H 2010

C Signing of ADS-B data and VHF radio facility sharing agreement

- i) Between Indonesia and Singapore - 2H 2010
- ii) Between Vietnam and Singapore - 2H 2010

D Conduct of Safety Assessment - 2H 2010

E Signing of LOA between Ho Chi Minh and Singapore ACCs - 2H 2010

F Issue AIP Supplement on aircraft equipage mandate - 2H 2010

G Integration with Singapore ATC system - 2H 2011

H Conduct of ADS-B monitoring - 1H 2011

I Operational trial without priority - 2H 2011

J Priority for suitably-equipped aircraft and Phase II - 2H 2012

K Implementation of ADS-B operations - 1H 2014

EXPERIENCE IN ADOPTING THE SAMPLE AGREEMENT FOR ADS-B DATA SHARING (Singapore and Indonesia)

Final agreement with brief description	Original wordings in sample agreement
Pre-amble [We reworded the pre-amble stating that: a) ADS-B will enhance safety; b) Recognising the benefits, APANPIRG established the ADS-B task force to implement ADS-B; c) Airlines expressed their desire to reap operational benefits through ADS-B d) CANSO voiced support for collaboration between ANSPs to share ADS-B data and VHF facilities; e) The parties are desirous of cooperation to enhance air traffic services; **f)** Parties enter into the agreement to reap full potential of ADS-B for the benefit of airlines.]	**Pre-amble** (A) Having regard to the South East Asia Sub-regional Automatic Dependent Surveillance – Broadcast (ADS-B) Implementation Working Group (SEA ADS-B WG) objectives, including the optimisation of the provision and use of the ADS-B surveillance function through the installation of new facilities or the sharing of ADS-B data; (B) With a view to the establishment of the categories of services through the airspace of the regions specified in Annex A and I;
Article 1 – Definitions [We created a new section to define the various terms used in the agreement.]	[Not in existing template.]
Article 2 – Objective of the Agreement [We include the provision of VHF voice communication services (VHF services) as part of the objective.]	**Article 1 – Objective of the Agreement** 1 The objective of this Agreement is to improve safety and operations efficiency of civil air traffic by enhancing ADS-B coverage and ADS-B data availability in the Flight Information Regions for which the User is responsible and the areas within 150Nm from the boundaries of these Flight Information Regions

Final agreement with brief description	Original wordings in sample agreement
	2 For this purpose, the Provider shall provide its ADS-B data to the User with effect from [date] and in accordance with the implementation schedule in Annex G. 3 The ADS-B data to be provided are specified in Annex B, H and I.
Article 3 – Installation of Required Equipment and Private Circuits [We amended the clause to include the provision of VHF services.]	**Article 3 – Installation** 1 The Provider and the User shall install all required equipment at their respective premises. 2 Both the Provider and the User shall arrange for the provision, installation and commissioning of private circuits and other associated equipment as specified in Annex B and F, required for the transmission of the ADS-B data from the Provider to the User. 3 Initial testing of the equipment and private circuits for the provision of the ADS-B data be carried out in conjunction with the Provider and the User. 4 The provision of the present article shall also apply in the event of modifications to the equipment or private circuits.
Article 4 – Operations and Maintenance [The maintenance of the equipment and the quality of the data are associated. Hence, the two articles are combined.]	**Article 4 – Maintenance** 1 Unless otherwise specified in Annex C, the routine maintenance, repair and replacement service for the equipment and the private circuits installed for the provision of ADS-B data under this Agreement shall be executed by technical staff available at the Provider's and at the User's premises. 2 Unless otherwise specified in Annex D, the routine maintenance, repair and replacement at the Provider's premises referred to in paragraph 1 hereof shall be carried out free of charge by the Provider to the standards of maintenance commonly adopted by the Provider.

Final agreement with brief description	Original wordings in sample agreement
	3 The routine maintenance, repair and replacement at the User's premises shall be done by and at the expense of the User to the standard of maintenance commonly adopted by the User. **Article 7 – Integrity** 1 The Provider shall take all reasonable steps, in accordance with the standards commonly adopted by him, to monitor and maintain the quality and continuity of the provision of ADS-B data of the facilities specified in Annex B and F. 2 Where this is reasonably practicable the Provider shall give the User such notice in respect to any planned periodic break in service as soon as such information is available and a minimum of 24 hours notice in case of any other planned break in service. 3 The Provider shall report immediately or at the earliest reasonable opportunity any failure in the provision of the ADS-B data or any abnormality of ADS-B data provided, to the User's technical supervisor centre. 4 The User shall, in accordance with the standards commonly adopted by him, monitor the ADS-B data received from the Provider and report immediately or at the earliest reasonable opportunity any failure in the reception or any abnormality of the ADS-B data, to the Provider's technical supervisor centre.
Article 5 – Modifications [We include VHF and other services as part of the possible proposed changes by the Users. The amended clauses address the costs of modification to be born by each party.]	**Article 5 – Modifications** 1 Both the Provider and the User shall implement any modification in the equipment and the private circuits for the provision of ADS-B data at their respective premises due to any decision of the Provider. The modification shall be carried out in accordance with Article 3.

Final agreement with brief description	Original wordings in sample agreement
	2 The User may propose technical modifications of the specifications for the provision of ADS-B data to the Provider. The Provider shall decide on the implementation of it. 3 The modifications to be implemented shall be specified by the Provider in writing to the User not less than six months before the date the modification shall be implemented.
Article 6 – Cost [We include VHF as part of the article.]	**Article 6 – Cost** 1 The cost apportionment for the use of ADS-B data as specified in Annex A, B and I shall be in accordance with Annex D.
Article 7 – Limitations on Use and Communication of ADS-B Data [In the original template, either party is only allowed to use the information for civil Air Traffic Services only. We added a provision stating that any other usage is subjected to the provider's approval.]	**Article 2 – Limitations** 1 The User shall use the ADS-B data provided only to ensure the safe, proper and continuous operation of civil Air Traffic Services or activities in support of his Air Traffic Services and for technical demonstration, evaluation and test purposes related to his operational tasks, unless otherwise specified in Annex A. 2 The User shall not communicate to any party not specified in this Agreement in any matter of form whatsoever any information supplied pursuant to this Agreement. The said information shall not be used for any purpose other than those specified in paragraph 1 hereof, without the prior written consent of the Provider.
Article 8 – Liability [The Provider will not be held liable if there are interruptions to the services.]	**Article 8 – Liability** [The requirements on this Article should be agreed bilaterally between States]
Article 9 – Force Majeure [We stated that the Provider is not in breach of this agreement in case of failure to perform its duty due to	**Article 9 – Legal Aspect / Settlement of Dispute** [The requirements on this Article should be agreed bilaterally between States]

Final agreement with brief description	Original wordings in sample agreement
force majeure.]	
Article 10 – Settlement of Disputes [We stated that disputes are to be resolved amicably between the parties.]	**Article 9 – Legal Aspect / Settlement of Dispute** [The requirements on this Article should be agreed bilaterally between States]
Article 11 – Correspondence [This article mentions about the official means of correspondence, which is by email, fax or letter.]	**Article 10 – Correspondence** 1 Correspondence to be applied in the framework of this Agreement is specified in Annex E.
Article 12 – Duration [Editoral changes to simplify the clause.]	**Article 12 – Duration** 1 The present Agreement shall enter into force on the day on which it is signed by the last of the contracting Parties, for a period of [duration to be decided by the Parties]. 2 Thereafter, that period shall be automatically prolonged unless any of the contracting Parties has, by giving written notice at least [duration to be decided by the Parties] before the expiry of the contract period or the termination date of prolonged period, terminated the Agreement. 3 The Agreement can early terminate in the event the provision of ADS-B data as specified in Annex A hereof is to be permanently withdrawn from service. The Provider shall give to the User not less than [duration to be decided by Parties] notice in writing in advance thereof. 4 The Agreement can early terminate on request of the User in the event of modifications to be implemented. The User shall give to the Provider not less than [duration to be decided by Parties] notice in writing in advance thereof.
Article 13 – Entire Agreement [The agreement and the annexes form the entire agreement between the parties.]	**Article 11 – Annexes** 1 Annex A, B, C, D, E, F, G, H and I are attachments to this Agreement. The Provider and User, in mutual consent and formal acceptance, are allowed to amend and up-date, as circumstances deem

Final agreement with brief description	Original wordings in sample agreement
	necessary, the contents of the Annexes, in so far as the amendments are not in contradiction to or out of scope with the text in this Agreement. Annex A – Parties Annex B – Interface Specifications Annex C – Maintenance Annex D – Cost Annex E – Correspondence Annex F – Equipment Provided By One Party to the Other Annex G – Implementation Schedule Annex H – Functional Performance Requirement Annex I – Coverage or Ground Station Details
Article 14 – Amendment [This article states the mechanism in which an amendment is valid.]	**Article 11 – Annexes** 1 Annex A, B, C, D, E, F, G, H and I are attachments to this Agreement. The Provider and User, in mutual consent and formal acceptance, are allowed to amend and up-date, as circumstances deem necessary, the contents of the Annexes, in so far as the amendments are not in contradiction to or out of scope with the text in this Agreement. Annex A – Parties Annex B – Interface Specifications Annex C – Maintenance Annex D – Cost Annex E – Correspondence Annex F – Equipment Provided By One Party to the Other Annex G – Implementation Schedule Annex H – Functional Performance Requirement Annex I – Coverage or Ground Station Details

Final agreement with brief description	Original wordings in sample agreement
Article 15 – Final Provisions [We include an article stating that nothing in the agreement shall prejudice the primary obligation of the parties whether under statute or otherwise, to ensure the safe, proper and continuous provision of civil air traffic services.]	[Not in existing template.]
Article 16 – Rights of Third Parties [Third parties are not allowed to enforce any terms in this agreement.]	[Not in existing template.]
Annex A – Providers and Users of ADS-B and DCPC Facilities [Defines the providers and users]	**Annex A – Parties** **Annex F – Equipment Provided By One Party to the Other**
Annex B – Implementation Schedule [Defines the implementation schedule]	**Annex G – Implementation Schedule**
Annex C – Technical Scope of Work [The various technical details are combined to one annex]	**Annex B – Interface Specifications** **Annex C – Maintenance** **Annex H – Functional Performance Requirement** **Annex I – Coverage or Ground Station Details**
Anenx D – Cost [This annex deals with cost issues]	**Annex D – Cost**

THE APPROVED AIRCRAFT TYPES AND AVIONICS COMBINATIONS BY CASA

In mid July 2010 there are 1341 approved airframes of the following types:

Aircraft Type	Number approved
AIRBUS INDUSTRIE A319-	2
AIRBUS INDUSTRIE A320-	72
AIRBUS INDUSTRIE A321-	4
AIRBUS INDUSTRIE A330-	187
AIRBUS INDUSTRIE A340-	60
AIRBUS INDUSTRIE A380-	42
Beech Aircraft Cor B200	16
BELL HELICOPTER CO 206L-	1
De Havilland DHC-8	1
Jabiru	1
Kawasaki BK117	1
THE BOEING COMPANY A330-	1
THE BOEING COMPANY B737-	99
THE BOEING COMPANY B747-	295
THE BOEING COMPANY B757-	1
THE BOEING COMPANY B767-	59
THE BOEING COMPANY B777-	380
THE BOEING COMPANY DHC-8	1
THE BOEING COMPANY MD11F	38
THE BOEING COMPANY MD-11	60
PIPER 200T	1
PILATUS AIRCRAFT L PC-12	6
Pilatus PC-12	1
Hawker Beechcraft B350	3
Hawker Beechcraft Super	5
Lancair IV-P	1
Cessna 210N	1
MOONEY M-20K	1
Total	1341

Avionics

The ADS-B avionics comprises a GPS position source and an ADS-B transmitter.

The following combinations of equipment are currently approved. Other types are in the process of being approved. Others would qualify for approval but have not been submitted for approval.

Avionics approved for ADS-B Services		
Equipment Combinations		
ACSS XS-950 ##	Rockwell GLU-920	334
ACSS XS-950 ##	Rockwell GLU-925	8
ACSS XS-950 ##	Honeywell GR-550	49
ACSS XS-950 ##	Honeywell RMA-55B	24
Garmin	Garmin	6
Honeywell TRA-67A	Rockwell GLU-920	166
Honeywell ISP-80A	Rockwell GLU-925	42
Honeywell TRA-67A	Rockwell GLU-925	40
Honeywell TRA-67A	Honeywell GR-550	65
Honeywell TRA-67A	Honeywell GR-551	2
Honeywell KT-73	Honeywell KLN900 **	4
Honeywell KT-73	Honeywell KLN-94 **	8
Honeywell KT-73	Honeywell KMH 820 **	1
Honeywell KT-73	Honeywell KMH0820 **	4
Honeywell TRA-67A	Litton LTN2001Mk 2	41
Honeywell TRA-67A	Honeywell RMA-55B	220
Honeywell TRA-67A	Thales TLS755	36
Rockwell TPR-901	Rockwell GLU-920	127
Rockwell TPR-901	Rockwell GLU-925	79
Rockwell TPR-901	Honeywell GNSSU	11
Rockwell TDR-94D	Rockwell GPS-4000S	18
Rockwell TPR-901	Honeywell GR-550	16
Rockwell TPR-901	Honeywell HG2021	1
Rockwell TPR-901	Honeywell RMA-55	1
Rockwell GLU-920	ACSS XS950	38
		1341

** GPS outputs RAIM flags & not true HPL
Transponder must be “Mod A” to use HPL (rather than HFOM)

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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

Indonesia and Australia will share data from the following stations:

<u>Phase 1a (by 2010)</u>

- Saumlaki ADS-B (Indonesia) (Installed)
- Merauke ADS-B (Indonesia) (Installed)
- Kupang 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 to be signed by November 2010.
Data sharing to commence in November 2010.

<u>Initial Benefits</u>
Data to be used for air situational awareness and safety nets.
Enhanced Safety at FIR boundary.

<u>Phase 1b (Tentatively after 2012)</u>

- Waingapu ADS-B (Indonesia) (Installed)
- Another station from Australia (Location to be determined)

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

Under the near term implementation plan, Indonesia, Singapore and Vietnam would share the ADS-B data from the following stations:

- Singapore ADS-B (Singapore provide data to Indonesia) (Installed)
- Natuna ADS-B (Indonesia provide data to Singapore) (Installed)
- Matak ADS-B (Indonesia provide data to Singapore) (Installed)
- Con Son ADS-B (Viet Nam provide data to Singapore) (Installed by 2010) (Date to be confirmed by Viet Nam)

VHF radio communication services (DCPC) would be provided from the following stations to Singapore. This is to enable implementation of radar-like separations in the non-radar areas within the Singapore FIR.

- Natuna VHF (Install for Singapore, may be installed by Indonesia and/or Singapore) (Installed by Dec 2010)
- Matak VHF (Install for Singapore, may be installed by Indonesia and/or Singapore) (Installed by Dec 2010)
- Con Son VHF (Vietnam install for Singapore) (Installed by 2010) (Date to be confirmed by Viet Nam)

ADS-B Data sharing and DCPC services agreement between Singapore and Indonesia would be signed by Sep 2010.

ADS-B Data sharing and DCPC services agreement between Singapore and Vietnam would be signed (date to be determined).

Initial Benefits
The above sharing arrangement will benefit L642 and M771. Enhanced safety and reduced separation may be applied. Mandate may be effective in 2013. (Subjected to Viet Nam concurrence)

Phillipines will look into the provision a station in Quezon Palawan to help cover N884 and M767. The group supported CANSO's proposal to request Brunei to install an ADS-B to cover the said routes. The group will futher explore other possibilities cover L625 and N892 in future discussions.

Additions to this project
China expressed the possibility of sharing an the data from an ADS-B station at Xisha with Philippines. Currently, the ADS-B data is shared with Hong Kong, China.

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

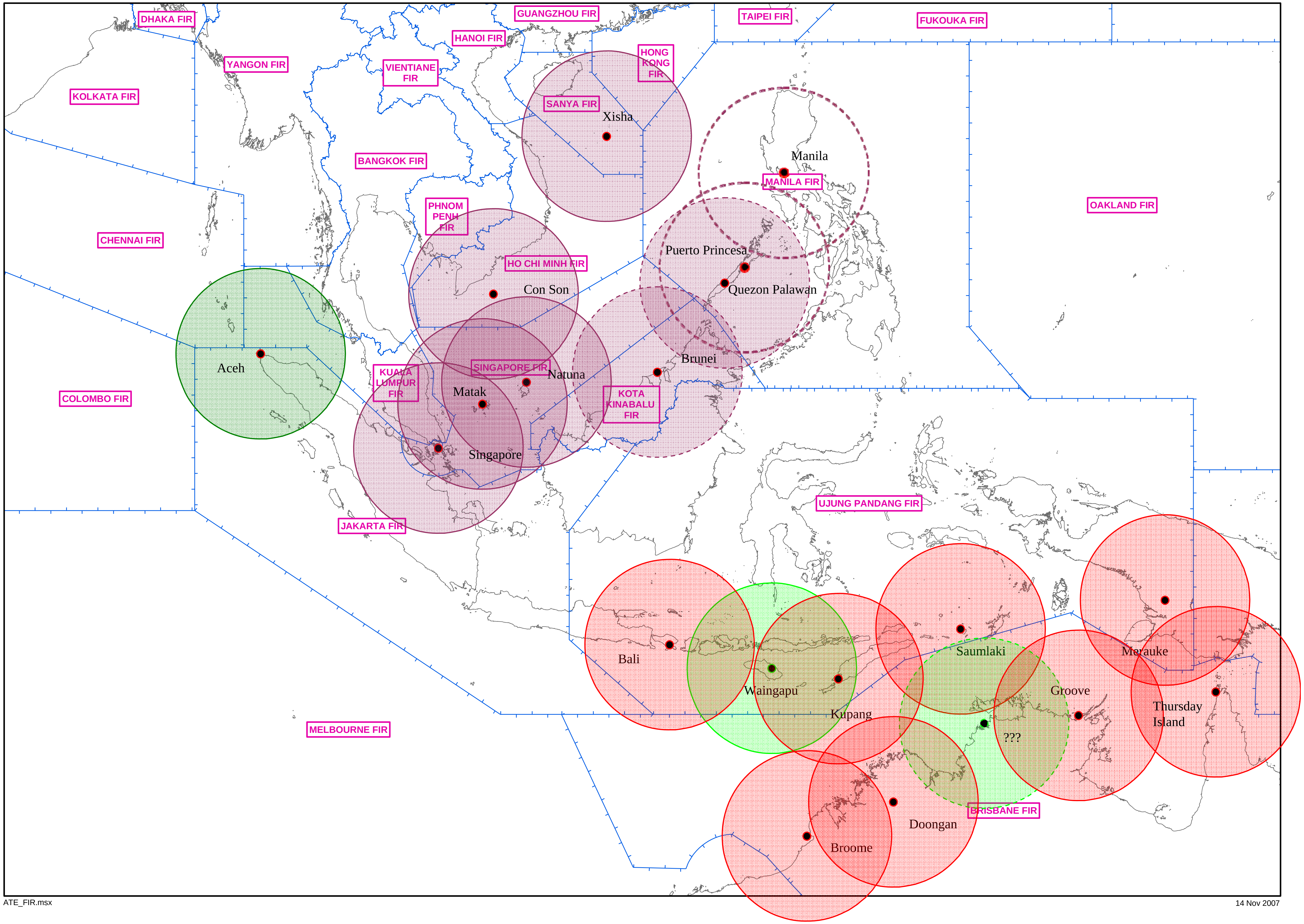
Indonesia would share the ADS-B data from Aceh with Malaysia. The station is already installed. The data sharing arrangement is still under discussion.

Initial benefits
Enhanced Safety at FIR boundary

Project 4 – ADS-B data sharing between Cambodia, Thailand and Viet Nam

Cambodia requested ADS-B data sharing from Thailand and Viet Nam. A meeting will be planned between the three States.

Initial benefits
Situational awareness



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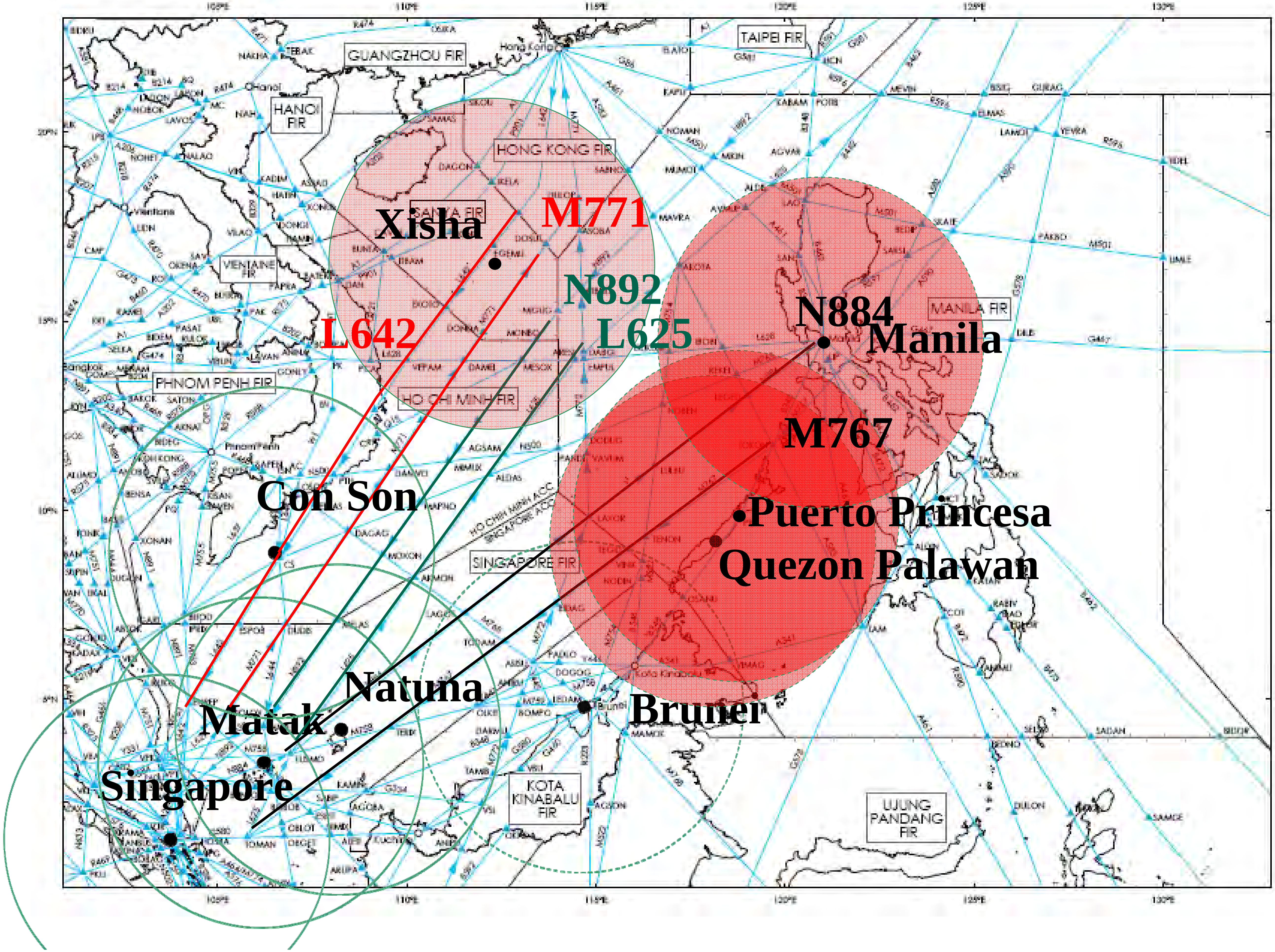
Xisha
M771
N892
L642
L625
N884
Manila
M767
Con Son
Puerto Princesa
Quezon Palawan
Natuna
Matak
Brunei
Singapore
GUANGZHOU FIR
HANOI FIR
HONG KONG FIR
SANYA FIR
VIENTIANE FIR
PHNOM PENH FIR
HO CHI MINH FIR
SINGAPORE FIR
TAIPEI FIR
MANILA FIR
KOTA KINABALU FIR
UJUNG PANDANG FIR

ASIA/PACIFIC REGION

PERFORMANCE FRAMEWORK FORM

(REGIONAL)

(*Amended in July 2010)*

REGIONAL PERFORMANCE OBJECTIVE: ***APAC Objective 10***					
IMPROVED SITUATIONAL AWARENESS AND SURFACE SURVEILLANCE- IMPLEMENTATION OF THE ADS-B TO GROUND SURVEILLANCE					
Benefits					
Environment	• Reductions in fuel consumption and subsequent lower gas emissions				
Efficiency	• Increased flexibility and flow of traffic operations • Ultimately, when performing *radar-like* control, potential redesign of airspace taking into account the application of reduced separation minima, integrate use of aircraft navigation and surveillance capability				
Safety	• Introduction of surveillance in a non-radar environment • Support to search and rescue operations				
Strategy ***Medium Term (2011-2015)*** ***Short term (2010)***					
ATM OC COMPONENTS	**TASKS**	**TIME FRAME STARTED**	**RESPONSIBILITY**	**STATUS**	**REMARKS**
AOM *(Airspace Organization and Management)* **CM** *(Conflict Management)* **AUO** *(Airspace Users Operations)*	Implementation of ADS-B based surveillance service in the sub-regions.				
ATM SDM (ATM *Service Delivery Management)*	• Compare current technologies with respect to concept of operations, relative costing, technical and operational performance and maturity of alternative technology/solutions (primary, secondary radar including Mode-S, ADS-B, multilateration, ADS-C)	2009	ADS-B Study and Implementation Task Force (ADS-B SITF)	In progress	COMPLETED Regional Guidance material on comparison of technologies developed and issued

	• Develop an implementation plan for near term ADS-B applications in the Asia Pacific Region including implementation target dates taking into account: o available equipment standards; readiness of airspace users and ATS providers; o identifying sub-regional areas (FIRs) where there is a positive cost/benefit outcome expected for near-term implementation of ADS-B OUT; o developing a standardized and systematic task-list approach to ADS-B OUT implementation; and o holding educational seminars and provide guidance material to educate States and airspace users on what is required to implement ADS-B OUT	2009-10	ADS-B Study and Implementation Task Force	In progress	The FASID Table CNS 4A and 4B – surveillance and ATM automation being updated; ADS-B Seminar conducted annually in conjunction with Task Force meetings. Potential sub-regions for using ADS-B identified; Requirement for avionics specification for the near term application are being developed based on AMC2024 and Australian CASA document.
	• Develop Guidance Material to support harmonized regulation of ADS-B systems required on board the aircraft.	2010	ADS-B Study and Implementation Task Force	In progress	Forty Fifth DGCA Conference, through its Action Item 45/3 invited ICAO APANPIRG ADS-B SITF to develop the guidance material. The Guidance material has been developed by Regulators Workshop and ADS-B SITF/9 held in Aug. 10.

	• Study and identify applicable multilateration applications in the Asia and Pacific Region considering: - Concept of use/operations; - Required site and network architecture; - Expected surveillance coverage; Cost of system; Recommended separation minimas; and - If multilateration can be successfully integrated into an ADS-B OUT system for air traffic control	2011	ADS-B Study and Implementation Task Force	In progress	Concept of using multlateration has been developed; Some states have plan in place to introduce multilateration in particular & integrate it with A-SMGCS and Terminal area and en-route surveillance application
	• Coordinate ADS-B implementation plan and concept of operations with other ICAO regions where ADS-B implementation is going on and with relevant external bodies such as EUROCONTROL, EUROCARE, RTCA and Industry.	2013	ADS-B Study and Implementation Task Force	On- going	Updated information on ADS-B in Europe and North American Regions is provided to Task Force Meeting annually; Some Industry representatives provide input at ADS-B Seminar and meetings
	• Develop **Terms of Co-operation** for SEA which will include: • Establishing model documents for possible use by States when - Agreeing to share ADS-B data and DCPC (such as VHF radio voice communication) capability between adjoining States for various ADS-B applications (including a sample letter of agreement); or - Establishing ADS-B avionics fitment mandates	2011	South East Asia (SEA) Sub-Regional ADS-B Implementation Working Group	In progress	Terms of co-operation developed; sample agreement of data sharing developed; Some location for ADS-B ground stations identified. CBA for SEA project has been completed; Implementation plan for Australia-Indonesia and South China Sea Data and VHF communication

	• Identifying optimum coverage for ADS-B ground stations and associated VHF radio voice communication in the sub-regional FIR boundary areas.				capacity sharing projects are being developed by the SEA ADS-B WG.
	Develop an implementation plan for near term ADS-B application in SEA which will deliver efficient airspace and increased safety on a regional basis that includes: • Schedule and priority dates to bring into effect ADS-B based services taking into account: - Timing of any equipage mandates; - Timing of any ATC automation upgrades to support ADS-B; - Timing of commissioning of any ADS-B data sharing and associated VHF radio voice communication facilities; • Consideration of major traffic flows.	2013	South East Asia (SEA) Sub-Regional ADS-B Implementation Working Group	In progress	Major traffic flow from Australia to Singapore through Indonesia and Singapore to Hong Hong along L642 and M771 in South China Sea being progressed.
linkage to GPIs	GSI-12 Use of Technology to Enhance Safety; GPI/9 Situational Awareness; GPI/5: RNAV and RNP, GPI/7: dynamic and flexible ATS route management, GPI/17: data link applications and GPI/22: Communication Infrastructure;				
References	• *Report of AN CONF/11;* • *Global ATM Operational Concept (Doc9854);* • *Global Air Navigation Plan (Doc9750);* • *Technical Provisions for Mode S Services and Extended Squitter (Deco9871)* • *APANPIRG/16/17/19/20 report on ADS-B* • *ADS-B related regional guidance materials adopted by APANPIRG*				

Regulator's Workshop on ADS-B Avionics Equipage Requirements
Jakarta, Indonesia, 16 – 17 August 2010

The Ninth Meeting of Automatic Dependent Surveillance – Broadcast (ADS-B) Study and Implementation Task Force (ADS-B SITF/9)
Jakarta, Indonesia, 18 – 19 August 2010

ATTACHMENT 1 TO THE REPORT

LIST OF PARTICIPANT

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International Civil Aviation Organization

REGULATOR'S WORKSHOP ON ADS-B AVIONICS EQUIPAGE REQUIREMENTS

Jakarta, Indonesia, 16 – 17 August 2010

LIST OF WORKING, INFORMATION PAPERS AND PRESENTATIONS

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		WORKING PAPERS	
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		INFORMATION PAPERS	
IP/1	1	Meeting Bulletin	Secretariat
IP/2	6	Explanation of the Australian ADS-B Rule	Australia
		PRESENTATIONS	
SP/1		ADS-B Workshop Objectives	Secretariat
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SP/3		ADS-B Standards Organisations	Eurocontrol
SP/4		Boeing ADS-B	Boeing
SP/5		Australian Rule – ADS-B Out Mandate for enroute Surveillance	Australia
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SP/7		ADS-B IN	Airbus
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SP/11		IATA View on ADS-B	IATA
SP/12		Surveillance/Traffic/ADS-B/GPS Overview	Rockwell Collins

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SP/14		ADS-B Technology Basic	Australia
SP/15		Overview of ADS-B Cost Benefit Study	CANSO
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SP/17		Key Performance Criteria	Australia
SP/18		ICAO Asia Pacific Briefing	USA
SP/19		ADS-B Transmitter Standards	Australia
SP/20		GNSS Avionics Standards	USA
SP/21		Feedback on Certification of ADS-B Applications	EASA
SP/22		European Regulation	EUROCONTROL

International Civil Aviation Organization

THE NINTH MEETING OF AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST (ADS-B) STUDY AND IMPLEMENTATION TASK FORCE (ADS-B SITF/9)

Jakarta, Indonesia, 18 -19 August 2010

LIST OF WORKING AND INFORMATION PAPERS

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		WORKING PAPERS	
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WP/3	3	Australian ADS-B Update	Australia
WP/4	4	Draft Guidance Material for Processing & Display of ADS-B Data	Australia
WP/5	6	GPS Time Tagging Issue	Australia
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WP/7	4	Guidance Material on Preparation of a Safety Case for Delivery of Separation Services	Australia
WP/8	7 (1)	Review Report of the Fifth Meeting of South East Asia Sub-regional ADS-B Implementation Working Group (SEA ADS-B WG/5)	Secretariat
WP/9	4	Review Terms of Reference and Task List of ADS-B Study and Implementation Task Force	Secretariat
WP/10	8	Review Regional Performance Objective on ADS-B	Secretariat
WP/11	6	CNS/ATM Implementation and Planning Matrix	Secretariat
WP/12	6	Review Surveillance Strategy for Asia/Pacific Region	Secretariat
WP/13	6	CANSO ADS-B Seminar for the Philippines	CANSO
WP/14	7	ADS-B Data Sharing: Indonesia – Australia	Australia & Indonesia
WP/15	7	ADS-B Equipage Requirements	IATA
WP/16	7	Update on the Implementation of ADS-B Operations in the South China Sea	Singapore
WP/17	7	Prohibition of “Bad” Transmissions	Australia
WP/18	5	Harmonization of ADS-B Airspace Mandates and Operational Approvals	New Zealand

WP IP/No.	Agenda Item	Title	Presented by
		INFORMATION PAPERS	
IP/1	1	Meeting Bulletin	Secretariat
IP/2	7	Australian Rule for Aircraft ADS-B Avionics – As revised December 2009	Australia
IP/3	3	Update on the Work of the Organization on Surveillance and Collision Avoidance June 2010	Secretariat
IP/4	7	The Development of ADS-B in China	China
IP/5	6	Briefing by ITT Corporation on Current Status of ADS-B Development for the F.A.A. into N.A.S	ITT
IP/6	6	New Caledonia ADS-B Programme	New Caledonia
IP/7	7	Approved Aircraft and Avionics	Australia
IP/8	7	Experience in Adopting the Sample Agreement	Singapore

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