INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

ADS-B IMPLEMENTATION AND
OPERATIONS GUIDANCE DOCUMENT

Edition 8.0 – September 2015
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1. **INTRODUCTION**

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

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

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

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

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

1.1 **ARRANGEMENT OF THE AIGD**

The AIGD consists of the following Parts:

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<td>Acronyms and Glossary of Terms</td>
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<td>10</td>
<td>Security Issues Associated with ADS-B</td>
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1.2 **DOCUMENT HISTORY AND MANAGEMENT**

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

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

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

1.4 CHANGES TO THE AIGD

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

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

|     |     |     |

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

1.5 EDITING CONVENTIONS

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1.6 AIGD REQUEST FOR CHANGE FORM

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

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<td>5. PERSON INITIATING:</td>
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| 7. ACTION REQUIRE: |
| 8. AIGD EDITOR    |
| 9. FEEDBACK PASSED|

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<td>24 March 2005</td>
<td>H. Anderson</td>
<td>Final draft prepared at ADS-B SITF WG/3</td>
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<td>0.3 (1.1)</td>
<td>03 June 2005</td>
<td>Nick King</td>
<td>Amendments following SASP WG/WHL meeting of May 2005</td>
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<td>15 July 2005</td>
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<td>Proposed by ADS-B SITF/10 and adopted by APANPIRG/22</td>
<td>Adopted amendment on consequential change to the Flight Plan and additional material on the reliability and availability for ADS-B ground system</td>
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<td>Proposed by ADS-B SITF/12 and adopted by APANPIRG/24</td>
<td>Revamped to include the latest ADS-B developments and references to guidance materials on ADS-B implementation</td>
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| 7.0              | September 2014   | Proposed by ADS-B SITF/13 and adopted by APANPIRG/25 | (i) Included guidance materials on monitoring and analysis of ADS-B equipped aircraft  
(ii) Included guidance materials on synergy between GNSS and ADS-B  
(iii) Revised ATC Phraseology  
(iv) Included clarification on Flight Planning |
| 8.0              | September 2015   | Proposed by ADS-B SITF/14 and adopted by APANPIRG/26 | (i) Updated the guidance materials on monitoring and analysis of ADS-B equipped aircraft  
(ii) Updated the categories of reported ADS-B avionics problems  
(iii) Updated the guidance materials on ADS-B flight plan  
(iv) Updated the guidance materials on disabling ADS-B transmissions  
(v) Remove reference to operational approval for use of ADS-B Out by ATC |
2. **ACRONYM LIST & GLOSSARY OF TERMS**

2.1 **ACRONYM LIST**

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<td>ACID</td>
<td>Aircraft Identification</td>
</tr>
<tr>
<td>ADS-C</td>
<td>Automatic Dependent Surveillance - Contract</td>
</tr>
<tr>
<td>ADS-B</td>
<td>Automatic Dependent Surveillance - Broadcast</td>
</tr>
<tr>
<td>AIGD</td>
<td>ADS-B Implementation and Operations Guidance Document</td>
</tr>
<tr>
<td>AIP</td>
<td>Aeronautical Information Publication</td>
</tr>
<tr>
<td>AIT</td>
<td>ADS-B Implementation Team</td>
</tr>
<tr>
<td>AMSL</td>
<td>Above Mean Sea Level</td>
</tr>
<tr>
<td>APANPIRG</td>
<td>Asia/Pacific Air Navigation Planning and Implementation Regional Group</td>
</tr>
<tr>
<td>ARINC</td>
<td>Aeronautical Radio Incorporate</td>
</tr>
<tr>
<td>ATC</td>
<td>Air Traffic Control (or Air Traffic Controller)</td>
</tr>
<tr>
<td>ATM</td>
<td>Air Traffic Management</td>
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<tr>
<td>ATS</td>
<td>Air Traffic Services</td>
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<td>ATSP</td>
<td>ATS Provider</td>
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<td>ATSU</td>
<td>ATS unit</td>
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<td>CNS</td>
<td>Communications, Navigation, Surveillance</td>
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<td>CRC</td>
<td>Cyclic Redundancy Check</td>
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<td>CDTI</td>
<td>Cockpit Display Traffic Information</td>
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<tr>
<td>DAIW</td>
<td>Danger Area Infringement Warning</td>
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<tr>
<td>FIR</td>
<td>Flight Information Region</td>
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<tr>
<td>FLTID</td>
<td>Flight Identification</td>
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<tr>
<td>FMS</td>
<td>Flight Management System</td>
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<tr>
<td>FOM</td>
<td>Figure of Merit used in ASTERIX messaging</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System (USA)</td>
</tr>
<tr>
<td>HPL</td>
<td>Horizontal Protection Level</td>
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<tr>
<td>ICAO</td>
<td>International Civil Aviation Organization</td>
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<tr>
<td>MSAW</td>
<td>Minimum Safe Altitude Warning</td>
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<tr>
<td>MTBF</td>
<td>Mean Time Between Failures</td>
</tr>
<tr>
<td>MTCA</td>
<td>Medium Term Conflict Alert</td>
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<tr>
<td>MTTR</td>
<td>Mean Time To Restore</td>
</tr>
<tr>
<td>NAC</td>
<td>Navigation Accuracy Category</td>
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<td>Navigation Integrity Category</td>
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<td>STCA</td>
<td>Short Term Conflict Alert</td>
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### 2.2 GLOSSARY OF TERMS

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

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4. **ADS-B DATA**

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

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

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

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

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

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

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

5.1 INTRODUCTION

5.1.1 Planning

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

5.1.2 Implementation team to ensure international coordination

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

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

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

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

5.1.3 System compatibility

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

5.1.3.2 Given the international nature of aviation, special efforts should be taken to ensure harmonization though compliance with ICAO Standards and Recommended Practices (SARPs). The choice of systems to support ADS-B should consider not only the required performance of individual components, but also their compatibility with other CNS systems.
5.1.3.3 The future concept of ATM encompasses the advantages of interoperable and seamless transition across flight information region (FIR) boundaries and, where necessary, ADS-B implementation teams should conduct simulations, trials and cost/benefit analysis to support these objectives.

5.1.4 Integration

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

5.1.4.2 Communication system

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

5.1.4.3 Navigation system infrastructure

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

a) Data items; and

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

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

5.1.4.4 Other surveillance infrastructure

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

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

5.1.5 Coverage Predictions

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

5.2 IMPLEMENTATION CHECKLIST

5.2.1 Introduction

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

5.2.2 Activity Sequence

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

5.2.3 Concept Phase

a) construct operational concept:

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

b) identify benefits:

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

c) identify constraints:

1) pair-wise equipage;
2) compatibility with non-equipped aircraft;
3) need for exclusive airspace;
4) required ground infrastructure;
5) RF spectrum;
6) integration with existing technology; and
7) technology availability;

d) prepare business case:
1) cost benefit analysis; and
2) demand and justification.

5.2.4 Design Phase

a) identify operational requirements:
1) security; and
2) systems interoperability;

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

c) identify technical requirements:
1) standards development;
2) data required;
3) functional processing;
4) functional performance; and
5) required certification levels;

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

e) develop procedures:
1) pilot and controller actions and responsibilities;
2) phraseologies;
3) separation/spacing criteria and requirements;
4) controller’s responsibility to maintain a monitoring function, if appropriate;
5) contingency procedures;
6) emergency procedures; and
7) develop AIP and Information documentation
f) prepare design phase safety case:
   1) safety rationale;
   2) safety budget and allocation; and
   3) functional hazard assessment.

5.2.5 Implementation phase

a) prepare implementation phase safety case;

b) conduct operational test and evaluation:
   1) flight deck and ATC validation simulations; and
   2) flight tests and operational trials;

c) obtain systems certification:
   1) aircraft equipment; and
   2) ground systems;

d) obtain regulatory approvals:
   1) air traffic certification of use;

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

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

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

6.1 BACKGROUND

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

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

<table>
<thead>
<tr>
<th>No.</th>
<th>What to harmonize</th>
<th>What was agreed</th>
<th>Issue / what needs to be further discussed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mandate Effective</td>
<td>Singapore (SG), Hong Kong (HK), China (Sanya) : 12 Dec 2013</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vietnam (VN) : to be confirmed</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ATC Operating Procedures</td>
<td>No need to harmonize</td>
<td>Refer to SEACG for consideration of the impact of expanding ADS-B surveillance on ATC Operating Procedures including Large Scale Weather procedures.</td>
</tr>
<tr>
<td>3</td>
<td>Mandate Publish Date</td>
<td>No need to harmonize</td>
<td>To publish equipment requirements as early as possible.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>
| **4** | **Flight Level** | SG, HK, CN:  
- At or Above FL290 (ADS-B airspace)  
- Below FL290 (Non-ADS-B airspace)  
VN to be confirmed |
| **5** | **Avionics Standard (CASA/AMC2024)** | SG - CASA or AMC2024 or FAA AC No. 20-165  
HK - CASA or AMC2024 or FAA AC No. 20-165  
VN - CASA or AMC2024 or FAA AC No. 20-165  
CN - CASA or AMC2024 or FAA AC No. 20-165  
ADS-B Task Force agreed that DO260B will be accepted as well.  
SG, HK, and CN agreed their ADS-B GS will accept DO260, DO260A and DO260B by 1 July 2014 (Note 1) |
| **6** | **Flight Planning** | Before 15 Nov 2012, as per AIGD  
On or after 15 Nov 2012, as per new flight plan format |
| **7** | **Aircraft Equippage** |   |
| **7a)** | **Procedures if Aircraft Not Equipped or Aircraft without a Serviceable ADS-B Transmitting Equipment before Flight** | SG, HK, CN: FL280 and Below  
VN to be confirmed |
<table>
<thead>
<tr>
<th>7b)</th>
<th>Aircraft Equipped but Transmitting Bad Data (Blacklisted Aircraft)</th>
<th>For known aircraft, treat as non ADS-B aircraft.</th>
<th>Share blacklisted aircraft among concerned States/Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Contingency Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8a)</td>
<td>Systemic Failure such as Ground System / GPS Failure</td>
<td>Revert back to current procedure.</td>
<td></td>
</tr>
<tr>
<td>8b)</td>
<td>Avionics Failure or Equipped Aircraft Transmitting Bad Data in Flight</td>
<td>Provide other form of separation, subject to bilateral agreement. From radar/ADS-B environment to ADS-B only environment, ATC coordination may be able to provide early notification of ADS-B failure.</td>
<td>Address the procedure for aircraft transiting from radar to ADS-B airspace and from ADS-B to ADS-B airspace.</td>
</tr>
<tr>
<td>9</td>
<td>Commonly Agreed Route Spacing</td>
<td>SEACG</td>
<td>Need for commonly agreed minimal intrail spacing throughout.</td>
</tr>
</tbody>
</table>

*Note 1: Also included two ADS-B GS supplied by Indonesia at Matak and Natuna*
7. SYSTEM INTEGRITY AND MONITORING

7.1 INTRODUCTION

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

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

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

7.2 PERSONNEL LICENSING AND TRAINING

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

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

7.3 SYSTEM PERFORMANCE CRITERIA FOR AN ATC SEPARATION SERVICE

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

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

- Higher aircraft density
- Higher route crossing point density
- A higher mixture of different aircraft performance levels
- A higher rate of aircraft manoeuvring (as distinct from straight and level flight).
The following recommendations need to be considered:

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

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

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

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

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

7.4.1 Safety Assessment Guidelines

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

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

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

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

7.4.2 System safety assessment

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

a) Identifying failure conditions;

b) Assigning levels of criticality;

c) Determining risks/probabilities for occurrence;

d) Identifying mitigating measures and fallback arrangements;

e) Categorising the degree of acceptability of risks; and

f) Operational hazard ID process.

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

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

7.4.3 Integration test

States should conduct trials with suitably equipped aircraft to ensure they meet the operational and technical requirements to provide an ATS. Alternatively, they may be satisfied by test results and analysis conducted by another State or organization deemed competent to provide such service. Where this process is followed, the tests conducted by another State or organization should be comparable (i.e. using similar equipment under similar conditions).
Refer also to the *Manual on Airspace Planning Methodology for the Determination of Separation Minima* (Doc9689).

### 7.4.4 ATS Operation Manuals

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

### 7.4.5 ATS System Integrity

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

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

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

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

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

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

## 7.5 SYSTEM MONITORING

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

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

### 7.5.1 Problem Reporting System (PRS)

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

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

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

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

7.5.2 The monitoring process

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

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

a) ATS Providers;

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

c) Relevant State regulatory authorities;

d) Communication Service Providers being used;

e) Aircraft operators; and

f) Aircraft and avionics manufacturers.

7.5.3 Distribution of confidential information

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

7.5.4 ADS-B problem reports

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

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

b) Change to operating procedures;

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

d) Change to system design.

7.5.5 ADS-B periodic status report

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

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

7.5.6 Processing of Reports

Each group in the monitoring process should nominate a single point of contact for receipt of problem reports and coordination with the other parties. This list will be distributed by the PRS Administrator to all parties to the monitoring process.

Each State should establish mechanisms within its ATS Provider and regulatory authority to:

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

b) Coordinate with aircraft operators;

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

d) Monitor the progress of problem resolution;

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

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

g) Coordinate with any Communication Service Providers used.
7.6 APANPIRG

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

a) review Periodic Status Reports and any significant Problem Reports;
b) highlight successful problem resolutions to ADS-B SITF members;
c) monitor the progress of outstanding problem resolutions;
d) prepare summaries of problems encountered and their operational implications; and
e) assess system performance based on information in the PRS and Periodic Status Reports.

7.7 LOCAL DATA RECORDING AND ANALYSIS

7.7.1 Data recording

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

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

7.7.2 Local data collection

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

7.7.3 Avionics problem identification and correction

ATS providers need to develop systems to:

a) detect ADS-B avionics anomalies and faults
b) advise the regulators and where appropriate the aircraft operators on the detected ADS-B avionics anomalies and faults
c) devise mechanisms and procedures to address identified faults

Regulators need to develop and maintain systems to ensure that appropriate corrective actions are taken to address identified faults.
7.8 ADS-B PROBLEM REPORT

7.8.1 Report Form

<table>
<thead>
<tr>
<th>Date UTC</th>
<th>Time UTC</th>
<th>PRS #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>Aircraft ID</td>
<td></td>
</tr>
<tr>
<td>Flight ID</td>
<td>ICAO 24 Bit Code</td>
<td></td>
</tr>
<tr>
<td>Aircraft Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flight Sector/Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATS Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description / additional information</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Originator</th>
<th>Originator Reference number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization</td>
<td></td>
</tr>
</tbody>
</table>
### 7.8.2 Description of Fields

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

<table>
<thead>
<tr>
<th>Originating Organization</th>
<th>Date of submission</th>
<th>Originator</th>
<th>Report Period</th>
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**TECHNICAL ISSUES**

**OPERATIONAL ISSUES**

**GENERAL COMMENTS**
8. RELIABILITY & AVAILABILITY CONSIDERATIONS

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

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

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

(a) Tier 1 standards are for a high performance traffic separation service;
(b) Tier 2 standards are for a traffic situational awareness service with procedural separation; and
(c) Tier 3 standards are for a traffic advisory service (flight information service)

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

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

8.1 Reliability

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

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

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

8.2 Availability

8.2.1 Availability is a measure of how often the system is available for operational use. It is usually expressed as a percentage of the time that the system is available.
8.2.2 Poor availability usually results in loss of economic benefit because efficiencies are not available when the ATC system is operating in a degraded mode (eg using procedural control instead of say 5 NM separation).

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

8.2.4 Availability is calculated as

\[
\text{Availability (Ao) } = \frac{MTBF}{MTBF + MDT}
\]

where \( MTBF \) = Mean Time Between SYSTEM Failure

\( MDT = \text{Mean Down Time for the SYSTEM} \)

The MDT includes Mean Time To Repair (MTTR), Turn Around Time (TAT) for spares, and Mean Logistic Delay Time (MLDT)

NB: This relates to the failure of the system to provide a service, rather than the time between individual equipment failures. Some organisations use Mean Time Between Outage (MTBO) rather than MTBF.

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

8.3 Recommendations for high reliability/availability ADS-B systems

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

- to duplicate each element and minimise single points of failure. Automatic changeover or parallel operation of both channels keeps system failure rates low. Ie: the system keeps operating despite individual failures. Examples are:
  - Separate communication channels between ADS-B ground station and ATC centre preferably using different technologies or service providers eg one terrestrial and one satellite

- Consideration of Human factors in design can reduce the number of system failures due to human error. E.g. inadvertent switch off, incorrect software load, incorrect maintenance operation.

- Take great care with earthing, cable runs and lightning protection to minimise the risks of system damage

- Take great care to protect against water ingress to cables and systems

- Establish a system baseline that documents the achieved performance of the site that can be later be used as a reference. This can shorten troubleshooting in future.

- System design can also improve the MDT by quickly identifying problems and alerting maintenance staff. Eg Built in equipment test (BITE) can significantly contribute to lowering MDT.
B: **Logistics strategy** aims to keep MDT very low. Low MDT depends on logistic support providing short repair times. To achieve short repair times, ANSPs usually provide a range of logistics, including the following, to ensure that the outage is less than a few days:

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

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

Difficulties can be experienced if States:

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

**Spares pool**

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

**Module repair contract**

ANSPs can also enter into a maintenance repair contract, preferably as part of their acquisition purchase, to require the supplier to repair or replace and deliver failed modules within a specified time – preferably with contractual incentives/penalties for compliance. Such support contracts are best negotiated as part of the acquisition contract when competition between vendors is at play to keep costs down. Sometimes it is appropriate to demand that the support contractor also keep a certain level of buffer stock of spares “in country”.
It is strongly recommended that maintenance support is purchased under the same contract as the acquisition contract.

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

Other typical strategies are:

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

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

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

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

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

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

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

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

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

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

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

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

- Having appropriate methods to deploy the approved configuration (Logistics of configuration distribution). Suggested methods;
  o Approved configuration published on intranet web pages
  o Approved configuration distributed on approved media

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

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

- Development and delivery of appropriate training to maintainers

- Competency based testing of trainees

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

E: Data collection & Review:

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

- Reports of actual achieved availability & reliability

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

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

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

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

- System and component obsolescence

- Staff skills and need for refresher training
9. ADS-B REGULATIONS AND PROCEDURES

9.1 INTRODUCTION

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

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

9.2 ADS-B REGULATIONS

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

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

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

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

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

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

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

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

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

(a) Civil Aviation Safety Authority (CASA) of Australia
Civil Aviation Order 20.18 Amendment Order (No. 1) 2009, Civil Aviation Order 82.1 Amendment Order (No. 1) 2009, Civil Aviation Order 82.3 Amendment Order (No. 2) 2009, Civil Aviation Order 82.5 Amendment Order (No. 2) 2009 and Miscellaneous Instrument CASA 41/09 – Direction – use of ADS-B in foreign aircraft engaged in private operations in Australian territory
(b) Civil Aviation Department (CAD) of Hong Kong, China
Aeronautical Information Publication Supplement No. 13/13 dated 29 October 2013

(c) Civil Aviation Authority of Singapore (CAAS)
Aeronautical Information Publication Supplement No. 254/13 dated 6 November 2013

(d) Federal Aviation Administration (FAA)
ADS–B Out Performance Requirements To Support Air Traffic Control (ATC) Service, Final Rule

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

9.3 FACTORS TO BE CONSIDERED WHEN USING ADS-B

9.3.1 Use of ADS-B Level data

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

9.3.2 Position Reporting Performance

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

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

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

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

1 Subject to endorsement by APANPIRG/26 in September 2015
9.3.3 GNSS Integrity Prediction Service

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

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

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

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

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

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

9.3.4 Sharing of ADS-B Data

ADS-B Data-sharing for ATC Operations

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

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

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

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

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

Civil/Military ADS-B Data-sharing

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

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

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

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

9.3.5 Synergy of ADS-B and GNSS

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

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

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

There is significantly less cost for these systems to be installed in an aircraft at the same time. A single installation of GNSS & ADS-B will involve:
- a single design activity instead of two
- a single downtime instead of two
- installation of the connection between GPS and ADS-B transponder
- a single test, certification and aircraft flight test

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

9.4 Reporting Rates

9.4.1 General

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

9.5 SEPARATION

9.5.1 General

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

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

9.5.2 Identification Methods

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

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

b) transfer of ADS-B identification;

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

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

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

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

9.5.4 Vertical separation

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

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

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

9.6 AIR TRAFFIC CONTROL CLEARANCE MONITORING

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

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

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

9.8 POSITION REPORTING

9.8.1 Pilot position reporting requirements in ADS-B coverage
States should establish voice and/or CPDLC position reporting procedures consistent with those applicable with radar for aircraft that have been identified by ATC.

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

9.9 PHRASEOLOGY

9.9.1 Phraseology Standard

States should use common phraseology for both ADS-B and radar where possible, and should note the requirement for ADS-B specific phraseology in some instances. States shall refer to PANS ATM Chapter 12 for ADS-B phraseology:

- ADS-B EQUIPMENT DEGRADATION
- ADS-B OUT OF SERVICE (appropriate information as necessary).

**TO REQUEST THE CAPABILITY OF THE ADS-B EQUIPMENT**

a) ADVISE ADS-B CAPABILITY;

*b) ADS-B TRANSMITTER (data link);

*c) ADS-B RECEIVER (data link);

*d) NEGATIVE ADS-B.

* Denotes pilot transmission.

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

**TO REQUEST RESELECTION OF AIRCRAFT IDENTIFICATION**

REENTER FLIGHT IDENTIFICATION.

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

**TERMINATION OF RADAR AND/OR ADS-B SERVICE**

IDENTIFICATION LOST [reasons] (instructions).

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

SQUAWK IDENT.

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

**TO REQUEST AIRCRAFT SWITCHING TO OTHER TRANSPONDER OR TERMINATION OF ADS-B TRANSMITTER OPERATION**

a) SWITCH TO OTHER TRANSPONDER

b) STOP ADS-B TRANSMISSION. SQUAWK (code) ONLY.

*Note:

a) In many cases the ADS-B transmitter cannot be operated independently of the SSR transponder and switching off the ADS-B transmission would also switch off the SSR transponder operation*
b) “STOP ADS-B TRANSMISSION” applies only to aircraft that have the facility to switch off the ADS-B transmission, while maintaining SSR operation.

9.9.2 Operations of Mode S Transponder and ADS-B

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

9.9.2.1 STOP ADSB TRANSMISSION or STOP SQUAWK

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

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

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

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

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

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

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

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

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

9.10 FLIGHT PLANNING

9.10.1 ADS-B Flight Planning Requirement – Flight Identity

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

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

Either,

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

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

   Or,

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

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

   2) the aircraft is not equipped with radio.

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

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

9.10.2 ADS-B Flight Planning Requirements

9.10.2.1 ICAO Flight Plan Item 10 – Surveillance Equipment and Capabilities

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

These are defined in ICAO DOC 4444 as follows:

- B1 ADS-B with dedicated 1090 MHz ADS-B “out” capability
B2 ADS-B with dedicated 1090 MHz ADS-B “out” and “in” capability
U1 ADS-B “out” capability using UAT
U2 ADS-B “out” and “in” capability using UAT
V1 ADS-B “out” capability using VDL Mode 4
V2 ADS-B “out” and “in” capability using VDL Mode 4

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

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

States should consider use of the revised descriptors in AIP.

9.10.2.2 ICAO Flight Plan Item 18 – Other Information

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

CODE/7C432B

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

9.10.2.3 Transponder Capabilities

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

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

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

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

States should consider use of the revised descriptors in AIP.

9.10.2.4 Inconsistency between ADS-B Flight Planning and Surveillance Capability

Inconsistency between flight planning of ADS-B and surveillance capability of an aircraft can impact on ATC planning and situational awareness. States are encouraged to monitor for consistency between flight plan indicators and actual surveillance capability. Where discrepancies are identified, aircraft operators should be contacted and instructed to correct flight plans, or
general advice (as appropriate to the operational environment and type of flight planning problems) should be issued to aircraft operators. An example of such advice is provided at Appendix 4.

9.10.3 Setting Aircraft Identification (Flight ID) in Cockpits

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

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

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

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

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

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

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

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

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

9.11 PROCEDURES TO HANDLE NON-COMPLIANT ADS-B AIRCRAFT OR MIS-LEADING ADS-B TRANSMISSIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

then:

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

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

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

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

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

(a) EASA AMC 20-24; or
(b) the equivalent configuration standards in Appendix XI of Civil Aviation Order 20.18 of the Civil Aviation Safety Authority of Australia; or

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

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

the aircraft must not fly unless equipment is:

(a) deactivated; or

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

Note:

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

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

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

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

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

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

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

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

Executive control responsibility

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

Emergency procedures

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

10.1 INTRODUCTION

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

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

10.2 CONSIDERATIONS

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

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

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

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

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

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

<table>
<thead>
<tr>
<th>Project/Task Name</th>
<th>SAP Project/Task ID:</th>
<th>Sites or Locations affected:</th>
</tr>
</thead>
</table>

Documentation prepared by:  
Date:  
Commissioning Date:  

Affected System(s)  
System Criticality  
Change Consequence Level

Brief Description of Change:

Commissioning Readiness Endorsement

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

Chief Engineer or Technical or Maintenance Authority

Name:  
Signature:  
Date:  
Designation:

Name:  
Signature:  
Date:  
Designation:

Chief Operating/User Authority or Operating/User Authority

Name:  
Signature:  
Date:  
Designation:

Records Management Instructions

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

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

Note 1: Non-critical deficiencies (NCD) are those outstanding technical and operational issues that do not prevent the safe and effective use or maintenance of the facility, but will be addressed in a specified and agreed time. NCDs shall be listed on the Commissioning Certificate (C-FORMS0300) and recorded in the relevant system (ASID / HEAT / SAIR). It is preferable for each NCD to be recorded as a separate issue.
<table>
<thead>
<tr>
<th>Item No.</th>
<th>Requirement:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Provide a link to the completed SCARD Safety Change Management Requirements (AA-NOS-SAF-0104)</td>
</tr>
<tr>
<td>1.2</td>
<td>The outcome of the SCARD will be the requirement for one of the following for commissioning: Safety Statement – included in SCARD or standalone Safety Statement which must provide Airservices Australia with sufficient information to demonstrate that safety has been considered and the change presents minimal or no safety issues. Safety Plan &amp; Safety Assessment Report, or Safety Plan &amp; Safety Case</td>
</tr>
<tr>
<td>1.3</td>
<td>Safety Risk Management procedures completed and includes any new hazards, risk identified and residual risk justified and accepted.</td>
</tr>
<tr>
<td>1.4</td>
<td>Impacts on the Operational Risk Assessment for residual risks are in place including arrangements for safety performance monitoring, monitoring and review of risks are in place including arrangements for safety performance monitoring</td>
</tr>
<tr>
<td>1.5</td>
<td>Arrangements for monitoring and review of risks are in place including arrangements for safety performance monitoring</td>
</tr>
<tr>
<td>1.6</td>
<td>CASA have approved/accepted or been advised of the change, as applicable</td>
</tr>
<tr>
<td>Item No:</td>
<td>Requirement:</td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
</tr>
<tr>
<td>2.1</td>
<td>Initial WHS Hazard Identification must be completed as per the template AA-TEMP-SAF-0020</td>
</tr>
<tr>
<td>2.2</td>
<td>Ensure employees and stakeholders are consulted when significant changes to work arrangements are being considered.</td>
</tr>
<tr>
<td>2.3</td>
<td>Tower Access / Classification assessed? Working at Heights Safety Checklist &amp; Daily Toolbox Meeting (F098) Fall arrest facility / equipment available</td>
</tr>
<tr>
<td>2.5</td>
<td>At the completion of works ensure WHS Inspections are completed and hazard controls are in place. Building condition; clean, undamaged, all work completed.</td>
</tr>
</tbody>
</table>
**ENVIRONMENT**

3.1 Environmental Impact must be assessed using the Environmental Impact Screening & Assessment Criteria for Changes to On-ground Activities. Assistance in assessing the Environmental Impact can be obtained from Environment and Climate Change Unit in Environment Group.

<table>
<thead>
<tr>
<th>Requirement Reference:</th>
<th>Completed or N/A</th>
<th>Evidence of Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Screening &amp; Assessment Criteria for Changes to On-ground Activities</td>
<td>Completed</td>
<td>Link to completed Environmental Impact Screening and Assessment Form</td>
</tr>
<tr>
<td>Environmental Assessment of Changes to On-ground Activities. AA-NOS-ENV-2.200</td>
<td>N/A</td>
<td>If a stage 2 assessment is required provide ARMS reference and links to any Permits, Master Development Plans and relevant correspondence as required.</td>
</tr>
</tbody>
</table>

3.2 Environmental Clearance obtained for ATM changes as per AA-NOS-ENV-2.100. Assistance in assessing the Environmental Impact can be obtained from Environment and Climate Change Unit in Environment Group.

<table>
<thead>
<tr>
<th>Requirement Reference:</th>
<th>Completed or N/A</th>
<th>Evidence of Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment Assessment Process for ATM Changes AA-NOS-ENV-2.100</td>
<td>Completed</td>
<td>Provide ARMS reference and NRFC reference if ATM change required</td>
</tr>
<tr>
<td>Environmental Screening &amp; Assessment Criteria for Changes to On-ground Activities AA-NOS-ENV-2.100</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

**PEOPLE SUPPORT**

**ATC TRAINING**

4.1 ATC Training Needs Analysis completed and Training Plan developed?

<table>
<thead>
<tr>
<th>Completed or N/A</th>
<th>Evidence of Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed</td>
<td>Link to Training Needs Analysis and Training Plan</td>
</tr>
<tr>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

4.2 Sufficient number of trained, rated and endorsed ATC staff available.

<table>
<thead>
<tr>
<th>Completed or N/A</th>
<th>Evidence of Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed</td>
<td>Number Trained:</td>
</tr>
<tr>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

4.3 ATC staff individual training records in SAP database have been updated

<table>
<thead>
<tr>
<th>Completed or N/A</th>
<th>Evidence of Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed</td>
<td></td>
</tr>
<tr>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

4.4 Plans are in place to complete any outstanding training, rating, and endorsement of remaining ATC staff (Normally an identified hazard)

<table>
<thead>
<tr>
<th>Completed or N/A</th>
<th>Evidence of Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed</td>
<td>HAZLOG Register No:</td>
</tr>
<tr>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Item No: 4.5</td>
<td>Requirement: Training Needs Analysis completed and Training Plan developed for system support staff and field maintenance staff?</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Item No: 4.6</td>
<td>TechCert codes have been created, assessment criteria developed or existing assessment criteria has been amended</td>
</tr>
<tr>
<td>Item No: 4.7</td>
<td>Sufficient system support staff and field maintenance staff appropriately trained?</td>
</tr>
<tr>
<td>Item No: 4.8</td>
<td>Are plans are in place to complete any outstanding training and certification of system support staff and remaining field maintenance staff?</td>
</tr>
<tr>
<td>Item No: 4.9</td>
<td>Field maintenance staff hold the relevant TechCert to perform duties.</td>
</tr>
<tr>
<td>Item No: 4.10</td>
<td>Statutory / special licensing obtained by field maintenance staff including high risk work competencies and licensing requirements?</td>
</tr>
<tr>
<td>Item No: 4.11</td>
<td>ABS and FMS staff training details sent to Technical Training Coordinator and training records updated as required?</td>
</tr>
<tr>
<td>Item No: 4.12</td>
<td>TechCert details sent to FMS System Support to update the Qualifications (TechCert) Database</td>
</tr>
</tbody>
</table>

**LOGISTICAL SUPPORT**

| Item No: 4.13 | CMRD have been consulted regarding special test equipment, test beds, etc | | Completed       | |

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Form approved by: Branch Manager, Operational Integrity & Compliance

Commercial in Confidence
<table>
<thead>
<tr>
<th>Item No:</th>
<th>Requirement:</th>
<th>Requirement Reference:</th>
<th>Completed or N/A</th>
<th>Evidence of Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.14</td>
<td>CMRD / NDC have been consulted regarding spares holdings and repair of LRUs from this equipment or in-house support of Depot Level Support Contract / repair contract</td>
<td></td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>4.15</td>
<td>TEMACC advised of any specialised test equipment requirements.</td>
<td>Test Equipment Management PROC-150</td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>4.16</td>
<td>Maintenance support contracts in place (external and/or internal)?</td>
<td></td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td></td>
<td>— Appropriate vendor and/or internal support?</td>
<td></td>
<td>N/A □</td>
<td></td>
</tr>
<tr>
<td></td>
<td>— Appropriate Level 3 maintenance arrangements</td>
<td></td>
<td>N/A □</td>
<td></td>
</tr>
<tr>
<td>4.17</td>
<td>Test equipment provided to maintenance base. Note: Test equipment purchasing and calibration requirements detailed in Engineering Execution Readiness form.</td>
<td></td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>4.18</td>
<td>Specialised hardware or software system support and field maintenance tools, test / patch leads, adaptors, isolators, electronic discharge protection (mats, straps), etc supplied?</td>
<td></td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>4.19</td>
<td>System Business Continuity/ Disaster Recovery provisions supplied/updated?</td>
<td></td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>4.20</td>
<td>Spares – Supplied, storage correct, transport cases supplied?</td>
<td>Management of Goods &amp; Supplies PROC-118</td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>4.21</td>
<td>Spares – Software / firmware loaded, tested &amp; configured?</td>
<td></td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>4.22</td>
<td>Service Restoration Times (SRT) established?</td>
<td>Airways Service Data PROC-207</td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>Item No:</td>
<td>Requirement:</td>
<td>Requirement Reference:</td>
<td>Completed or N/A</td>
<td>Evidence of Compliance</td>
</tr>
<tr>
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</tr>
<tr>
<td>4.23</td>
<td>Conduct Hardware physical configuration audit and ensure SAP Plant Maintenance has updated information of all installed and/or demolished equipment (including monitoring circuits) and sent to System Operations SAP PM DATA CHANGES.</td>
<td>Equipment Installed/Demolished Advice SAP Data Input Form F104</td>
<td>Completed</td>
<td>Link to Email from SAP PM Support confirming update/s</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>System Requirements documentation including Operating Concept or Business Process Rules - produced/updated and approved?</td>
<td></td>
<td>Completed</td>
<td>Link to documentation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Manual of Air Traffic Services (MATS) reviewed / updated. Aeronautical information publications (AIP Book, AIP SUPP, AIC, DAP, ERS4, Charts, etc) reviewed / updated. Amendment times are determined by the AIS Distribution Schedule</td>
<td>AA Publications</td>
<td>Completed</td>
<td>NRFC No.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>5.3</td>
<td>National ATC Procedures Manual (NAPM) and any other relevant ATC procedures reviewed / updated.</td>
<td></td>
<td>Completed</td>
<td>NRFC No.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>5.4</td>
<td>ATC contingency / continuity plans reviewed / updated.</td>
<td>ATC Contingency Plans Business Continuity Plans C-BCP</td>
<td>Completed</td>
<td>ATS-CP No:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td>C-BCP No:</td>
</tr>
<tr>
<td>5.5</td>
<td>NOTAM and/or AIP SUP issued / amended / cancelled</td>
<td>Works Planning PROC-213 Refer also LOA3024</td>
<td>Completed</td>
<td>NOTAM No:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>5.6</td>
<td>ATC Temporary Local Instruction (TLI) issued notifying Operational staff of change?</td>
<td>Temporary Local Instructions &amp; Database</td>
<td>Completed</td>
<td>NRFC No.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Item No.</td>
<td>Requirement</td>
<td>Evidence of Compliance</td>
<td>Requirement Reference: (Procedure/instruction used to specified required input)</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------------------</td>
<td>--------------------------------------------------------------------------------</td>
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<tr>
<td></td>
<td><strong>USER DOCUMENTATION</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5.7</td>
<td>User/operator manuals updated</td>
<td>Completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.8</td>
<td>User/operator procedures provided/updated as applicable</td>
<td>Completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.9</td>
<td>On-line user/operator documentation completed and published</td>
<td>Completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.10</td>
<td>ARFF instructions updated</td>
<td>Completed</td>
<td></td>
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</tr>
<tr>
<td>5.11</td>
<td>Other Business Groups instructions updated</td>
<td>Completed</td>
<td></td>
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</tr>
<tr>
<td>5.12</td>
<td>Software design documents updated, adequate and supplied to system support</td>
<td>Completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.13</td>
<td>Software and/or dataset Version or Release Description Documentation supplied and adequate?</td>
<td>Completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.14</td>
<td>Software installation procedure and instructions supplied/updated and adequate?</td>
<td>Completed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Form approved by: Branch Manager, Operational Integrity & Compliance

Commercial in Confidence

Version 3. Effective 21 August 2012
<table>
<thead>
<tr>
<th>Item No:</th>
<th>Requirement:</th>
<th>Requirement Reference:</th>
<th>Completed or N/A</th>
<th>Evidence of Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.15</td>
<td>SMP: System Management Plan created / updated and adequate?</td>
<td>SMP Template</td>
<td>Completed</td>
<td>SMP No:</td>
</tr>
<tr>
<td>5.16</td>
<td>SCP: System Contingency / continuity plans supplied/updated and adequate?</td>
<td>SCP Template</td>
<td>Completed</td>
<td>SCP No:</td>
</tr>
<tr>
<td>5.17</td>
<td>Technical drawings updated and listed in Data Viewer and list supplied to system supporters and field maintenance staff.</td>
<td>Technical Drawing Management PROC-178</td>
<td>Completed</td>
<td></td>
</tr>
<tr>
<td>5.18</td>
<td>Technical handbooks/manuals supplied to ABS or FMS Engineering/IT support and field maintenance staff (base and site copy).</td>
<td>Document Management PROC-103</td>
<td>Completed</td>
<td></td>
</tr>
<tr>
<td>5.19</td>
<td>On-line system support and field maintenance documentation completed and published</td>
<td>Document Management PROC-103</td>
<td>Completed</td>
<td></td>
</tr>
<tr>
<td>5.20</td>
<td>Technical documentation registered and placed under documentation control</td>
<td>Document Management PROC-103</td>
<td>Completed</td>
<td></td>
</tr>
<tr>
<td>5.22</td>
<td>Configuration &amp; Modification AEI: Equipment and System Modifications and Configuration (for hardware and software), and Software Release Authorisations are documented in a Part 2 AEI (or other approved documentation)</td>
<td>Development of Maintenance Instructions for Equipment PROC-151</td>
<td>Completed</td>
<td>AEI No/s: Link to documentation detailing configuration and modification</td>
</tr>
<tr>
<td>5.23</td>
<td>Maintenance AEI: Maintenance requirements, including Performance Inspection tolerances, have been defined and documented in AEIs (or other approved documentation). (AEI Part 3,4,7)</td>
<td>Development of Maintenance Instructions for Equipment PROC-151</td>
<td>Completed</td>
<td>AEI No/s:</td>
</tr>
<tr>
<td>Item No:</td>
<td>Requirement:</td>
<td>Requirement Reference:</td>
<td>Completed or N/A</td>
<td>Evidence of Compliance</td>
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</tr>
<tr>
<td>5.24</td>
<td>AEI: New maintenance AEIs trialled by maintenance staff</td>
<td>Development of Maintenance Instructions for Equipment PROC-151</td>
<td>Completed</td>
<td>N/A</td>
</tr>
<tr>
<td>5.25</td>
<td>TTD: Temporary Technical Dispensation raised and published on the Document Search database.</td>
<td>Temporary Technical Dispersions PROC-153</td>
<td>Completed</td>
<td>N/A</td>
</tr>
<tr>
<td>5.26</td>
<td>Site Manifest updated</td>
<td>Site Manifests FMS-304</td>
<td>Completed</td>
<td>N/A</td>
</tr>
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</table>

### 6 SYSTEM DESIGN REQUIREMENTS

#### 6.1 System Requirements documentation including Operating Concept or Business Process Rules - supplied/updated and approved?
- **Requirement Reference:** Design Control PROC-146
- **Evidence of Compliance:** Completed

#### 6.2 Standards – Installation and equipment comply with all relevant Australian Standards? Building Codes - Structures comply with the relevant Building Codes?
- **Requirement Reference:** Australian Standards Design Control PROC-146
- **Evidence of Compliance:** Completed

#### 6.3 Other applicable Federal and/or State licensing requirements met?
- **Requirement Reference:** Design Control PROC-146
- **Evidence of Compliance:** Completed
<table>
<thead>
<tr>
<th>Item No:</th>
<th>Requirement:</th>
<th>Requirement Reference:</th>
<th>Completed or N/A</th>
<th>Evidence of Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.4</td>
<td>Electrical Mechanical, Structure and Building impacts have been assessed as adequate or modifications organised and completed through consultation with Engineering Branch, P&amp;E? (Power supply capability / airconditioning capacity / mast loadings)</td>
<td>Design Control PROC-146</td>
<td>Completed</td>
<td>Link to completed 7 Ticks Interim Certificate or Final Certificate</td>
</tr>
<tr>
<td>6.5</td>
<td>Earthing and Lightning Protection meets Airservices requirements?</td>
<td>Earthing and Lightning Protection Systems for Operational Facilities AEI 3.1504 Site Earthing and Lightning Protection Systems for Existing Installations AEI 2.3011</td>
<td>Completed</td>
<td></td>
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<tr>
<td>6.6</td>
<td>Battery Procurement as per Airservices requirements?</td>
<td>Lead Acid Batteries (Stationary) Procurement and Acceptance Testing AEI-3.7050 Panel Contract Arrangement C-PROC0140</td>
<td>Completed</td>
<td></td>
</tr>
<tr>
<td>6.7</td>
<td>Assessing the impact of information systems against corporate objectives (7 Ticks process).</td>
<td>Information Technology Application Certification –7 Ticks MI-0804 and PROC-190</td>
<td>Completed</td>
<td></td>
</tr>
<tr>
<td>6.8</td>
<td>IT Security measures appropriate and in place (ie, to ensure effective security and control practices to minimise the risks of unauthorised access, inappropriate use, modification, destruction or disclosure of electronically held data).</td>
<td>IT Security Roles and Responsibilities Statement MS-0013 Information Security MI-0808 ICT Resources – Conditions of Use MI-0829</td>
<td>Completed</td>
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<tr>
<td>Item No:</td>
<td>Requirement:</td>
<td>Requirement Reference: (Procedure/instruction used to specified required input)</td>
<td>Completed or N/A</td>
<td>Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)</td>
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<td>6.9</td>
<td>Information Security</td>
<td>Information Security C-PROC0184</td>
<td>Completed N/A</td>
<td>Link to completed security risk management plan</td>
</tr>
<tr>
<td>6.10</td>
<td>Has met the regulation and safety requirements for Telecommunications Installations.</td>
<td>Implementing Regulation and Safety Requirements for Telecommunications Installations PROC-138 Installation of Optical Fibre Cable - Underground AEI 4.5001 Underground Cable Marking AEI 4.3001</td>
<td>Completed N/A</td>
<td>Link to Telecommunications Cabling Advice</td>
</tr>
<tr>
<td>6.11</td>
<td>MDF/IDF Records created / updated?</td>
<td>Colour Coding of RJ45 Patch Leads for Voice and Data Installations AEI 7.3241</td>
<td>Completed N/A</td>
<td></td>
</tr>
<tr>
<td>6.12</td>
<td>Transmitters licence label affixed</td>
<td>Radio Communication Transmitter Labelling AEI 7.4238</td>
<td>Completed N/A</td>
<td></td>
</tr>
<tr>
<td>6.13</td>
<td>Electrical Certificate of Testing and Safety or Testing and Compliance on connection to a source of electricity (i.e. installation conforms to AS3000) are required to be supplied as soon as possible after connection or testing of any electrical installation or change.</td>
<td>Electrical Safety Regulation 2002 Sections 15 and 159 AS 3000 – Aust Standard Electrical Cable Colour Coding AEI 3.1502</td>
<td>Completed N/A</td>
<td>Links to Electrical Certificates</td>
</tr>
<tr>
<td>Item No:</td>
<td>Requirement:</td>
<td>Requirement Reference:</td>
<td>Completed or N/A</td>
<td>Evidence of Compliance</td>
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<td>6.14</td>
<td>All modifications complete and scratch plate labels affixed to equipments</td>
<td>Identification of Airways Systems Equipment Hardware Modifications PROC-154</td>
<td>Completed ☐</td>
<td>N/A ☐</td>
</tr>
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<td>6.15</td>
<td>Integration with National Technical Monitoring has been organised and completed through Engineering Branch, P&amp;E?</td>
<td></td>
<td>Completed ☐</td>
<td>N/A ☐</td>
</tr>
<tr>
<td>6.16</td>
<td>Alarm monitoring installed and tested at TOC for local and remote site?</td>
<td></td>
<td>Completed ☐</td>
<td>N/A ☐</td>
</tr>
<tr>
<td>6.17</td>
<td>Source media – supplied/backup up, stored, registered with system support?</td>
<td>Software Media Archival and Storage PROC-147</td>
<td>Completed ☐</td>
<td>N/A ☐</td>
</tr>
<tr>
<td>6.18</td>
<td>Site installable media – supplied/backup up, appropriately stored and registered by field maintainers?</td>
<td>Software Media Archival and Storage PROC-147</td>
<td>Completed ☐</td>
<td>N/A ☐</td>
</tr>
<tr>
<td>6.19</td>
<td>Software licences provided, registered and appropriately stored?</td>
<td></td>
<td>Completed ☐</td>
<td>N/A ☐</td>
</tr>
<tr>
<td>6.20</td>
<td>Update HEAT and/or ASID database to incorporate new system/version number and assign issue management roles?</td>
<td></td>
<td>Completed ☐</td>
<td>N/A ☐</td>
</tr>
<tr>
<td>Item No:</td>
<td>Requirement:</td>
<td>Requirement Reference</td>
<td>Completed or N/A</td>
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<tr>
<td>6.21</td>
<td>Airservices Physical Security requirements met.</td>
<td>Physical Security – Critical Operational Facilities C-GUIDE0157 Site Management PROC-170</td>
<td>Completed ☐</td>
<td>N/A ☐</td>
</tr>
<tr>
<td></td>
<td>The minimum security requirements are specified in C-GUIDE0157. Physical Security advise can be obtained from the relevant Security Advisor in Security and Crisis Planning, Safety &amp; Environment</td>
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<td></td>
<td>Physical Access requirements are determined and established</td>
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<td></td>
<td>Siting and accommodation impact has been assessed as being satisfactory or modifications organised through National Property?</td>
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<tr>
<td>6.22</td>
<td>Network data load impact has been assessed as being satisfactory or modifications organised and completed through Engineering Branch, P&amp;E?</td>
<td></td>
<td>Completed ☐</td>
<td>N/A ☐</td>
</tr>
<tr>
<td>6.23</td>
<td>Spectrum licences (either cancelled if no longer required or for new licenses including if antenna moves by more than 10 metres)</td>
<td>Frequency Management: Obtaining a Frequency Assignment and Licence AEI7.4202</td>
<td>Completed ☐</td>
<td>N/A ☐</td>
</tr>
<tr>
<td>6.24</td>
<td>New system or system change acceptance tests (software and/or hardware) satisfactorily completed against the approved system requirements?</td>
<td>System Management Manual SMM Design Control PROC-146</td>
<td>Completed ☐</td>
<td>N/A ☐</td>
</tr>
<tr>
<td></td>
<td>– Test Plans provided?</td>
<td></td>
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<tr>
<td></td>
<td>– FAT, SAT, UAT test results complete, passed to the required level and provided?</td>
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<tr>
<td></td>
<td>– Test identified defect listings and re-test information provided?</td>
<td></td>
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</tr>
<tr>
<td>6.25</td>
<td>Battery Acceptance Tests as per Airservices requirements?</td>
<td>Lead Acid Batteries (Stationary) Procurement and Acceptance Testing AEI-3.7050</td>
<td>Completed ☐</td>
<td>Link to Battery Acceptance Test Results</td>
</tr>
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<tr>
<td>6.26</td>
<td>Standard Operating Conditions (SOCs) / Site Configuration Data (SCD) established / approved</td>
<td>Standard Operating Conditions &amp; Site Configuration Data Management PROC-143</td>
<td>Completed</td>
<td>N/A</td>
</tr>
<tr>
<td>6.27</td>
<td>Flight Test results supplied and satisfactory</td>
<td>Certification of Radio Navigation Aid Facilities AEI7.4003</td>
<td>Completed</td>
<td>N/A</td>
</tr>
<tr>
<td>6.28</td>
<td>Equipment operation is as per AEI specifications and any additionally specified requirements? Relevant requirements and performance specifications to be determined by the Chief Engineer, Technical Authority or Maintenance Authority</td>
<td></td>
<td>Completed</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### 7 TRANSITION PLANNING

#### 7.1 Does the system meet all critical user and technical requirements?  
Completed | N/A |
#### 7.2 If non-critical deficiencies are proposed to be accepted into operation, are they managed and tracked via ASID, HEAT or SAIR, including responsibilities and timings and attached to the Commissioning Certificate?  
Completed | N/A |
#### 7.3 Cutover Plan prepared and authorised by:  
- Appropriate level of engineering authority?  
- Appropriate level of User Authority?  
Completed | Link to Cutover Plan |
#### 7.4 Works plan created at least 7 days before deployment  
Completed | Works Plan No. |

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<table>
<thead>
<tr>
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<th>Requirement:</th>
<th>Requirement Reference: (Procedure/instruction used to specified required input)</th>
<th>Completed or N/A</th>
<th>Evidence of Compliance (If a requirement is N/A, a reason why it is N/A is required to be entered)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5</td>
<td>Industry education / notification been completed?</td>
<td></td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>7.6</td>
<td>Relevant Business Managers advised of impending change?</td>
<td></td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>7.7</td>
<td>Change requester and/or sponsor notified?</td>
<td></td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>7.8</td>
<td>System Operations’ TOC and Service Desk notified and accepted operating responsibility for the change.</td>
<td></td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>7.9</td>
<td>ABS/FMS Manager has accepted maintenance responsibility</td>
<td></td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td>7.10</td>
<td>Notify the following (as appropriate) that the system is at “OPERATIONAL READINESS” and provide details of commissioning and any system changes:</td>
<td></td>
<td>Completed □</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ATC</td>
<td>Sys to Svc List</td>
<td></td>
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<tr>
<td></td>
<td>System Supervisor, Melbourne (ATC)</td>
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<td></td>
<td>System Supervisor, Brisbane (ATC)</td>
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<tr>
<td></td>
<td>National ATC Systems Manager</td>
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<td></td>
<td>Operating Authority (relevant)</td>
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</tr>
<tr>
<td>Item No:</td>
<td>Requirement:</td>
<td>Requirement Reference:</td>
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<tr>
<td>7.11</td>
<td>Notify the following (as appropriate) that the system is at &quot;ENGINEERING READINESS&quot; and provide details of commissioning and any system changes: <strong>P&amp;E</strong> Technical Authority (relevant) Technical Operations Centre – Director Service Desk -Airways SAP PM Support</td>
<td><strong>Sys to Svc List</strong></td>
<td>Completed ☐ N/A ☐</td>
<td>(If a requirement is N/A, a reason why it is N/A is required to be entered)</td>
</tr>
</tbody>
</table>
### COMMISSIONING CERTIFICATE

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

<table>
<thead>
<tr>
<th>Project/Task Name</th>
<th>SAP Project/Task ID:</th>
<th>Sites or Locations affected:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Documentation prepared by:</th>
<th>Date:</th>
<th>Commissioning Date:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Affected System(s)</th>
<th>System Criticality</th>
<th>Change Consequence Level</th>
</tr>
</thead>
</table>

**Brief Description of Change:**

---

### Commissioning Approval

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

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

---

### Chief Engineer, Technical or Maintenance Authority

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature:</th>
<th>Date</th>
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<tbody>
<tr>
<td>Designation:</td>
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### Chief Operating/User Authority or Operating/User Authority

<table>
<thead>
<tr>
<th>Name:</th>
<th>Signature:</th>
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### Records Management Instructions

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

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

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

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

<table>
<thead>
<tr>
<th>Issue</th>
<th>Issue Tracking Reference Number</th>
<th>Allocated to</th>
<th>Proposed Completion Date</th>
<th>Comments</th>
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Guidance Materials on Monitoring and Analysis of ADS-B Avionics Performance

1. Introduction

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

Conclusion 24/45 - Exchange ADS-B Performance Monitoring Result

“That, States be encouraged to exchange findings/result of their ADS-B performance monitoring including experience gained in conducting the required performance monitoring.”

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

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

2. Problem Reporting and Feedback

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

(a) Air Navigation Service Providers (ANSPs) – upon detection of any unacceptable ADS-B reports from an aircraft, report the observed problem to the performance monitoring agent(s), if any, and the Aircraft Operators for investigation. In addition, ANSPs should take all actions to avoid using the ADS-B reports from the aircraft until the problem is rectified (e.g. black listing the aircraft), if usage of such reports could compromise safety.

(b) Regulators – to initiate any appropriate regulatory action or enforcement.

(c) Aircraft Operators – to allow avionics specialists to examine the causes and as customers of the avionics manufacturers ensure that corrective action will take place.
Appendix 2

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

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

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

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

3. Problem Categorisation

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

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

4. Managing the Problem

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

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

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

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

5.1 **Reporting Deficiencies**

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

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

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

5.1.1 **ATC Reported Deficiencies**

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

(a) ATC request for the pilot to select the alternate transponder; and

(b) ATC to adequately record the circumstances including Flight ID, ICAO Aircraft Address (if readily available) accurate time, Flight plan, and pilot provided information.

5.1.2 **Non ATC reported deficiencies**

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

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

(a) NUC of each ADS-B reported position is smaller than required for service delivery for more than 5% of total number of ADS-B updates;

(b) NIC, NAC, SIL are smaller than required for service delivery for more than 5% of total number of ADS-B updates;

(c) ICAO Aircraft Address (i.e. I021/080) is inconsistent with the flight planned registration (REG) based on each state’s ICAO Aircraft Address allocation methodology;

(d) Flight ID entered via cockpit interface and downlinked in ADS-B data (i.e. I021/170 in Asterix CAT 21) is a mismatch with aircraft callsign in the ATS Flight Plan;

(e) Inconsistent vertical rate compared to flight level change; and

(f) Inconsistency of position reports and presence of "jumps.

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1 A missing Flight ID, or a Flight ID with only “spaces” should not be considered a mismatch.
5.1.2.3 Overlapping radar coverage: For States that have overlapping radar coverage, a systematic means to monitor and analyze ADS-B could be considered in addition to relying on ATC to report the problem, or utilising the evaluation criteria in 5.1.2.2 above. This can be achieved by comparing radar information with ADS-B reported position, velocity, flight level and vertical rate change data as well as examining the ADS-B quality indicators and Flight Identification (FLTID) contained in the ADS-B reports.

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

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

5.2 Managing and Processing Deficiencies

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

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

\(^2\) For example, the deviation between ADS-B and radar tracks could be set to 1NM in accordance with ICAO Circular 326 defining position integrity (0.5NM < HPL < 1NM) for 3NM aircraft separation use, on assumption that radar targets are close to actual aircraft position. The values of ADS-B quality indicators (NUC, NAC, SIL, NIC) could be chosen based on the definition in ICAO Circular 326 on Position Accuracy and Position Integrity for 3NM aircraft separation minimum. A threshold of 5\% is initially set to exclude aircraft only exhibiting occasional problems during their flight journey. The above criteria should be made configurable to allow fine-turning in future. Evaluation of ADS-B vs radar may alternatively expose radar calibration issues requiring further investigation.
(b) Systematic technical analysis of each detected issue using ADS-B recorded data, to ensure that all detected issues are examined and addressed. Typically this will need:
- systems to record ADS-B data, replay ADS-B data and analyze ADS-B data
- staff and procedures to analyze each report
- A database system to manage the status of each event and to store the results of each analysis

(c) Procedures to support engagement with operators (domestic & foreign), regulators, other ANSPs, Airframe OEMs and avionics vendors to ensure that each issue is investigated adequately and maximize the probability that the root cause of the event is determined. The procedures could include:
- Data collection procedures;
- Telephone & email contact details; and
- Mechanisms for reporting, as appropriate, to the Asia Pacific ADS-B Avionics Problem Reporting Database (APRD)
### Attachment A – List of known ADS-B avionics problems

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Problem</th>
<th>Cause</th>
<th>Safety Implications to ATC (Yes / No)</th>
<th>Recommendations</th>
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<tbody>
<tr>
<td>1.</td>
<td>Track Jumping problem with Rockwell Collins TPR901 (See Figure1)</td>
<td>Software issue with TPR901 transponder initially only affecting Boeing aircraft. Does not occur in all aircraft with this transponder. Subsequent investigation by Rockwell Collins has found that the particular transponder, common to all of the aircraft where the position jumps had been observed, had an issue when crossing ±180 degrees longitude. On some crossings (10% probability), errors are introduced into the position longitude before encoding. These errors are not self-correcting and can only be removed by a power reset of the transponder. The problem, once triggered can last days, since many transponders are not routinely powered down.</td>
<td>Yes. Will present as a few wild/large positional jumps. Nearly all reports are tagged as low quality (NUC=0) and are discarded, however, some occasional non zero reports get through. Problem is very “obvious”. Could result in incorrect longitudinal position of Flight Data Record track. Can trigger RAM alerts.</td>
<td>Rockwell Collins has successfully introduced a Service Bulletin that solves the problem in Boeing aircraft. The problem is known to exist on Airbus aircraft. Rockwell has advised that a solution will not be available in the near future because of their commitment to DO260B development. Rockwell Collins may not have a fix for some time. Workaround solutions are being examined by Airbus, Operators and Airservices Australia. The only workaround identified at this time is to power down the transponders before flight to states using ADS-B – after crossing longitude 180. It can be noted that in Airbus aircraft it is not possible to safely power down the transponder in flight. Airbus have prepared a procedure to support power down before flight. Airservices Australia have negotiated with 2 airlines to enact this procedure prior to flights to Australia.</td>
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<td>2.</td>
<td>Rockwell Collins TDR94 Old version. The pattern of erroneous positional data is very distinctive of the problem. (See Figure 2)</td>
<td>Old software typically before version -108. The design was completed before the ADS-B standards were established and the message definitions are different to the current DO260. Rockwell has recommended that ADS-B be disabled on these models.</td>
<td>Yes. Will present as a few wild positional jumps. Nearly all reports are tagged as low quality (NUC=0) and are discarded, however, some occasional non zero reports get through. Also causes incorrect altitude reports. Problem is very “obvious”.</td>
<td>An additional partial workaround is: to ensure that procedures exist for ATC to ask the pilot to changeover transponders if the problem is observed. Since there is a 10% chance of the problem occurring on each crossing of ±180 degrees longitude, the chance that both transponders being affected is 1%. There is no complete workaround available for flights that operate across 180 degrees longitude directly to destination without replacing the transponder. Airbus advise that a new TPR901 transponder compliant with DO260B will be available in 2014. This new transponder will not exhibit the problem. Problem well known. Particularly affects Gulfstream aircraft which unfortunately leave the factory with ADS-B enabled from this transponder model. Rockwell has issued a service bulletin recommending that ADS-B be disabled for aircraft with this transponder software. See Service Information Letter 1-05 July 19, 2005. It is easy to disable the transmission.</td>
</tr>
<tr>
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<td>3.</td>
<td>Litton GPS with proper RAIM processing</td>
<td>Litton GNSSU (GPS) Mark 1 design problem. (Does not apply to Litton Mark II). GPS does not output correct messages to transponder.</td>
<td>No.</td>
<td>If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.</td>
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<td>Perceived GPS integrity changes seemingly randomly. With the GPS satellite constellation working properly, the position data is good. However the reported integrity is inconsistent and hence the data is sometimes/often discarded by the ATC system. The affected is perceived extremely poor “coverage”. The data is not properly ‘protected’ against erroneous satellite ranging signals – although this cannot be “seen” by ATC unless there is a rare satellite problem.</td>
<td></td>
<td>This GPS is installed in some older, typically Airbus, fleets. Data appears “Correct” but integrity value can vary. Performance under “bad” satellite conditions is a problem. Correction involves replacing the GNSSU (GPS) which is expensive. If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.</td>
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| 4.   | SIL programming error for DO260A avionics             | Installers of ADS-B avionics using the newer DO260A standard mis program “SIL”.  

a) This problem appears for DO260A transponders, with SIL incorrectly set to 0 or 1 (instead of 2 or 3)  
b) As the aircraft enters | No.                                   | Would NOT be included in a “black list”.  

Aircraft with “Dynon avionics” exhibit this behavior. They do not have a certified GPS and hence always set SIL = 0. This is actually correct but hence they do not get treated as ADS-B equipped. |
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<td>coverage, the ADS-B ground station correctly assumes DO260 until it receives the version number.</td>
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<td>c) The transmitted NIC (DO260A) is interpreted as a good NUC (DO260) value, because no SIL message has yet been received. The data is presented to ATC.</td>
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<td>5.</td>
<td>Garmin “N” Flight ID problem (See Figure 3)</td>
<td>Installers of Garmin transponder incorrectly set “Callsign”/Flight ID. This is caused by poor human factors and design that assumes that GA aircraft are US registered.</td>
<td>Yes. Flight ID appears as “N”. Inhibits proper coupling.</td>
<td>Can be corrected by installer manipulation of front panel. Does not warrant “black list” activity.</td>
</tr>
<tr>
<td>6.</td>
<td>Flight ID corruption issue 1 – trailing “U”</td>
<td>TPR901 software problem interfacing with Flight ID source. Results in constantly changing Flight ID with some reports having an extra “U” character.</td>
<td>Yes. Flight ID changes during flight inhibits proper coupling or causes decoupling.</td>
<td>Affects mainly B747 aircraft. Boeing SB is available for Rockwell transponders and B744 aircraft. Rockwell Collins have SB 503 which upgrades faulty -003 transponder to -005 standard. If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.</td>
</tr>
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<td>7.</td>
<td>Flight ID corruption issue 2</td>
<td>ACSS software problem results in constantly changing Flight ID. Applies to ACSS XS950 transponder Pn 7517800-110006 and Honeywell FMC (pn 4052508 952). ACSS fix was available in Sept 2007.</td>
<td>Yes.</td>
<td>Software upgrade available. If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.</td>
</tr>
<tr>
<td>8.</td>
<td>No Flight ID transmitted</td>
<td>Various causes</td>
<td>No.</td>
<td>Aircraft could “fail to couple with Flight Data Record”. Not strictly misleading – but could cause controller distraction.</td>
</tr>
<tr>
<td>9.</td>
<td>ACSS Transponder 10005/6 without Mod A reports NUC based on HFOM.</td>
<td></td>
<td>Yes.</td>
<td>Not approved and hence not compliant with CASA regulations. If known could be added to black list. Configuration is not permitted by regulation.</td>
</tr>
<tr>
<td>10.</td>
<td>Occasional small position jump backwards (See Figure 4)</td>
<td>For some older Airbus aircraft, an occasional report may exhibit a small “jump back” of less than 0.1 nm. Root cause not known</td>
<td>No.</td>
<td>ATC ground system processing can eliminate these.</td>
</tr>
<tr>
<td>11.</td>
<td>Older ACSS transponders report integrity too</td>
<td>Design error reports integrity one value worse than reality</td>
<td>No.</td>
<td>Can be treated in the same manner as a loss of transponder capability.</td>
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<td>12.</td>
<td>Intermittent wiring GPS transponder</td>
<td>ADS-B transmissions switch intermittently between INS position and GPS position.</td>
<td>Yes. Normally the integrity data goes to zero when INS is broadcast, but sometimes during transition between INS and GPS, an INS position or two can be broadcast with “good” NUC value. Disturbing small positional jump.</td>
<td>If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.</td>
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<td>13.</td>
<td>Wrong 24 bit code</td>
<td>Installation error</td>
<td>No. No direct ATC impact unless a rare duplicate is detected.</td>
<td>This is not a direct ADS-B problem, but relates to a Mode S transponder issue that can put TCAS at risk. Cannot be fixed by black list entry. Needs to be passed to regulator for resolution.</td>
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<td>14.</td>
<td>Toggling between high and low NUC (See Figure 5)</td>
<td>Faulty GPS receiver/ADS-B transponder</td>
<td>No. ATC will see tracks appear and disappear discretely. No safety implications to ATC.</td>
<td>While it is normal for NUC value to switch between a high and low figure based on the geometry of GPS satellites available, it is of the view that more should be done to examine this phenomenon. It is observed that such switching between high and low NUC occurs on certain airframe and</td>
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<td>15.</td>
<td>Consistent Low NUC (See Figure 6)</td>
<td>GNSS receivers are not connected to the ADS-B transponders.</td>
<td>No. Data shall be filtered out by the system and not detectable in ATC</td>
<td>Not considered a safety problem but a common phenomenon in the Region – the concerned aircraft will be treated equivalent to “aircraft not equipped with ADS-B”. While it is normal for aircraft to transmit low NUC, it is of the view that “consistent low NUC” could be due to the avionics problem (e.g. GNSS receiver is not connected to the ADS-B transponder). It is recognised that operators may not be aware that their aircraft are transmitting unexpected low NUC / NIC values, due to equipment malfunction. Hence, it is desirable for States to inform the operators when unexpected low NUC...</td>
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<tr>
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<td>16.</td>
<td>ADS-B position report with good integrity (i.e. NUC &gt;= “4”) but ADS-B position data are actually bad as compared with radar (met criteria 5.2(a))</td>
<td>Faulty ADS-B avionics</td>
<td>Yes.</td>
<td>The problem should be immediately reported to the concerned CAA/operators for problem diagnosis including digging out the root causes, avionics/GPS types etc., and ensure problem rectification before the ADS-B data could be used by ATC. Consider to “blacklist” the aircraft before the problem is rectified.</td>
</tr>
<tr>
<td>17.</td>
<td>FLTID transmitted by ADS-B aircraft does not match with callsign in flight plan (see Figures 7a – 7d)</td>
<td>Human errors</td>
<td>Yes.</td>
<td>Issue regulations/letters to concerned operators urging them to set FLTID exactly match with callsign in flight plan.</td>
</tr>
<tr>
<td>18.</td>
<td>B787 position error with</td>
<td>Software issue - surveillance</td>
<td>Yes.</td>
<td>Problem identified and fix will be</td>
</tr>
<tr>
<td>Ref.</td>
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<td>14</td>
<td>good NUC</td>
<td>system inappropriately “coasts” the position when data received by the transponder is split across multiple messages. System seems to self correct after some time. Can be corrected by surveillance system power off.</td>
<td>Misleading position presentation which is typically detected by ATC observing aircraft “off track” when in fact it is “on-track”.</td>
<td>provided by Boeing at the same time as the availability of DO260B upgrade – late 2015.</td>
</tr>
<tr>
<td>19</td>
<td>A number of airlines have reported or experienced ADS-B outages for complete flight sectors in A330 aircraft. Appears as low reliability ADS-B and has afflicted both A &amp; B side at same time.</td>
<td>Being actively investigated. One airline has implemented on-board recording which confirms that the MMRs are not providing HIL/HPL to the transponder whilst continuing to provide HFOM, GPS alt etc</td>
<td>No. Equivalent to a failed transponder.</td>
<td>Aircraft must be managed procedurally if outside radar coverage.</td>
</tr>
<tr>
<td>20</td>
<td>A380 flight ID lost after landing</td>
<td>For the A380 fleet, it has been confirmed that for some seconds after landing, the flight ID is set as invalid by FMS to AESS. Consequently, the current AESS design uses, as per design, the Aircraft Registration Number as a back-up source for A/C flight identification field in ADS-B broadcast messages.</td>
<td>No.</td>
<td>The correction to this logic is planned for next AESS standard release; planned for 2017.”. Only a problem for arriving aircraft on surface surveillance systems.</td>
</tr>
</tbody>
</table>
Figure 1 - Track Jumping problem with TPR901

Figure 3 - Garmin “N” Flight ID problem

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

Figure 4 - Occasional small position jump backwards
Figure 5 - NUC value toggling

Figure 6 – Consistent low NUC
Figure 7a - Additional zero inserted

Figure 7b - ICAO Airline Designator Code dropped

Figure 7c - Wrong numerical codes entered

Figure 7d - IATA Airline Designator Code used
Attachment B - Sample screen shot of a system to monitor and analyse performance of ADS-B avionics
A Template for ADS-B Mandate/Regulations for Aircraft Avionics

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

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

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

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

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

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

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

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(a) ^1 This paragraph ensures all aircraft operating in the airspace, if equipped with ADS-B, are compliant to standards.
(b) ^2 This paragraph provides mandate requirements within certain parts of the airspace.
An Example of Advice to Operators Concerning Inconsistency Between ADS-B Flight Planning and Surveillance Capability

1. Background

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

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

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

2. Flight Planning Requirements for Transponder and ADS-B

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

Surveillance Equipment
N if no surveillance equipment for the route to be flown is carried, or the equipment is unserviceable
OR
INSERT one or more of the following descriptors, to a maximum of 20 characters, to describe the serviceable surveillance equipment and/or capabilities on board:

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

SSR Mode S
E Transponder — Mode S, including aircraft identification, pressure-altitude and extended squitter (ADS-B) capability
H Transponder — Mode S, including aircraft identification, pressure-altitude and enhanced surveillance capability
I Transponder — Mode S, including aircraft identification, but no pressure-altitude capability
L Transponder — Mode S, including aircraft identification, pressure-altitude, extended squitter (ADS-B) and enhanced surveillance capability

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

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

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

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

**ADS-B**

B1 ADS-B with dedicated 1 090 MHz ADS-B “out” capability\(^1\)

B2 ADS-B with dedicated 1 090 MHz ADS-B “out” and “in” capability\(^1\)

U1 ADS-B “out” capability using UAT

U2 ADS-B “out” and “in” capability using UAT

V1 ADS-B “out” capability using VDL Mode 4

V2 ADS-B “out” and “in” capability using VDL Mode 4

### 3. Additional information

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

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

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

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

Less common configurations in General Aviation will include:

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

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\(^1\) Based on current version of ICAO Doc 4444
I, P or X – Most Mode S transponders will support Flight ID and pressure altitude, so these configurations are not common.

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

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

Planning designations not to be used in Asia Pacific:

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

**Remember:**

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