Australian Government

Civil Aviation Safety Authority

ADVISORY CIRCULAR

AC 21-45
Airworthiness approval of airborne automatic dependent surveillance broadcast equipment

v2.2 – June 2015

Advisory Circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.

Advisory Circulars should always be read in conjunction with the relevant regulations.

Audience

This AC is applicable to all Australian aircraft and visiting foreign aircraft transmitting ADS-B information in Australia in accordance with current legislation. Requirements to transmit ADS-B information are found in either Civil Aviation Order (CAO) 20.18 or 82.1.

This Advisory Circular (AC) applies to:

- Subpart 21.M authorised persons
- Subpart 21.J approved design organisations

Purpose

This AC is intended to define the airborne component of the 1090 Megahertz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) data link use in Australia, and provide guidance and advice for the airworthiness approval for the installation of the aircraft equipment proposed to support that use.

For further information

For further information on this AC, contact CASA's Airworthiness and Engineering Standards Branch (telephone 131 757).

Unless specified otherwise, all subregulations, regulations, divisions, subparts and parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

Status

This version of the AC is approved by the Executive Manager, Standards Division.

Version	Date	Details
(0)	April 2007	Initial issue of this AC
(1)	February 2012	This is the second issue of this AC and replaces AC 21-45(0) issued in April 2007.
v2.1	April 2014	The following changes have been made to the document: • Addition of greater range of suitable pressure altitude data source devices at Section 8.6, Appendix A and C. • Added that Appendix A will not be subject to further update and will be kept for historical record at Section 9.4 and Appendix A.
v2.2	June 2015	The following changes have been made to the document: • Converted document to new format • Updated Appendix D - Acceptable equipment combinations • Updated reference list • Inserted definition table

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1 Reference material

1.1 Acronyms

The acronyms and abbreviations used in this AC are listed in the table below.

Acronym	Description
AC	Advisory Circular
ADS-B	Automatic Dependent Surveillance - Broadcast
AEEC	Airlines Electronic Engineering Committee
AFM	Aircraft Flight Manual
ARINC	Aeronautical Radio, Inc
ATC	Air Traffic Control
ATSO	Australian Technical Standard Order
BARO	Barometric sourced data
CAO	Civil Aviation Order
CAR	*Civil Aviation Regulations 1988*
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
EASA	European Aviation Safety Agency
ETSO	EASA Technical Standard Order
EUROCAE	European Organisation for Civil Aviation Equipment
FAA	Federal Aviation Administration of the United States of America
FDE	Fault Detection and Exclusion
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HAE	Height Above Ellipsoid
HFOM	Horizontal Figure of Merit
HIL	Horizontal Integrity Limit
HPL	Horizontal Protection Limit
ICAO	International Civil Aviation Organization
JAA	Joint Aviation Authority of Europe
JTSO	JAA Technical Standard Order
MASPS	Minimum Aviation System Performance Standards
MEL	Minimum Equipment List

Acronym	Description
MMR	Multi Mode Receiver
MODE S	Mode Select (a transponder format to allow discrete interrogation and data link capability/ selective interrogation mode of SSR
MOPS	Minimum Operational Performance Standards
MSL	Mean Sea Level
NAC	Navigation Accuracy Category
NAC^P	Navigation Accuracy Category for Position
NIC	Navigation Integrity Category
NUC	Navigation Uncertainty Category
POH	Pilot Operating Handbook
RAAO	Recreational Aviation Administration Organisation that is recognised by CASA
RTCA	RTCA, Inc (formerly Radio Technical Committee for Aeronautics)
SA	Selective Awareness
SIL	Surveillance Integrity Level
SPI	Special Position Identification
SSR	Secondary Surveillance Radar
TSOA	FAA Technical Standard Order Authorisation
TSO	FAA Technical Standard Order

1.2 Definitions

Terms that have specific meaning within this AC are defined in the table below.

Term	Definition
ADS-B Out	A function on an aircraft or vehicle that periodically broadcasts its state vector (position and velocity) and other information derived from on-board systems in a format suitable for ADS-B IN capable receivers
ADS-B System	A collection of ADS-B subsystems wherein ADS-B messages are broadcast and received by appropriately equipped participant subsystems
Aircraft address	The term 'address' is used to indicate the information field in an ADS-B message that identifies the ADS-B unit that issued the message
Barometric Altitude	Geopotential altitude in the earth's atmosphere above mean standard sea level pressure datum surface, measured by a pressure (barometric) altimeter
Mode A	Transponder function that transmits a 4-digit octal identification code for an aircraft when interrogated by an SSR, the code having been assigned to the aircraft by ATC for the relevant flight sector

Term	Definition
Mode C	Transponder function that transmits a 4-digit octal code for an aircraft's pressure altitude when interrogated by an SSR
Mode S	Monopulse radar interrogation technique that improves the accuracy of the azimuth and range information of an aircraft, and uses a unique aircraft address to selectively call individual aircraft
Navigation Uncertainty Category	Uncertainty categories for the state vector navigation variables are characterized by a NUC data set provided in the ADS-B sending system. The NUC includes both position and velocity uncertainties
Position Uncertainty Category	The position uncertainty category (PUC) is needed for surveillance applications to determine whether the reported position has an acceptable level of position uncertainty
Resolution	The smallest increment reported in an ADS-B message field. The representation of the least significant bit in an ADS-B message field
Surveillance radar	Radar equipment used to determine the position of an aircraft in range and azimuth

1.3 References

Regulations

Regulations are available on the ComLaw website http://www.comlaw.gov.au/Home

Document	Title
CASA regulations	
CASR Part 21	Certification and airworthiness requirements for aircraft and parts
CASR Subpart 21M	Designs of modifications of, and repairs to, aircraft, aircraft engines, propellers and appliances
CAO 20.18	Aircraft Equipment – Basic Operational Requirements
ATSO-C1004	Airborne Mode A/C Transponder Equipment with Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) Transmit Only Equipment
ATSO-C1005	Airborne Stand-Alone Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) Transmission Capability
FAA TSOs	
TSO-C112	TSO for Mode S Extended Squitter
TSO-C145	Airborne Navigation Sensors using GPS Augmented by Satellite Based Augmentation System
TSO-C146	Stand Alone Airborne Navigation Equipment using GPS Augmented by Satellite Based Augmentation System
TSO-C196	Airborne Supplemental Navigation Sensors using GPS Augmented by Satellite Based Augmentation System
TSO-C166	Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B) and Traffic Information Service - Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz)
TSO-C10	TSO for Altimeter, Pressure Actuated, Sensitive Type
TSO-C106	TSO for Air Data Computer
TSO-C88	TSO for Automatic Pressure Altitude Reporting Code–Generating Equipment
EASA TSOs	
ETSO-2C112a formerly JTSO-2C112a	MOPS for SSR Mode S Transponders (Adopts EUROCAE ED-73A). Note: This JTSO is being updated to version B based on EUROCAE document ED-73B.
ETSO-C10	ETSO for Altimeter, Pressure Actuated, Sensitive Type
ETSO-C106	ETSO for Air Data Computer
ETSO-C88	ETSO for Automatic Pressure Altitude Reporting Code–Generating Equipment

Advisory material

Advisory Circulars are available at http://www.casa.gov.au/AC

Civil Aviation Advisory Publications are available at http://www.casa.gov.au/CAAP

FAA advisory circulars are available at http://rgl.faa.gov/

EASA guidance material is available at http://easa.europa.eu/certification-specifications/amc-20-general-acceptable-means-compliance-airworthiness-products-parts

ICAO publications are available at http://www.icao.int/publications/Pages/default.aspx

RTCA Inc, standards are available at http://www.rtca.org/Files/ListofAvailableDocsMarch2013.pdf

EUROCAE standards are available at https://www.eurocae.net/publications/search/

Document	Title
CASA advisory circulars	
AC 21-15	Supplemental Type Certificate - Certification
AC 21-36	Global Navigation Satellite System (GNSS) Equipment: Airworthiness Guidelines
AC 21-601	Australian Technical Standard Order Authorisation
FAA advisory circulars	
AC 20-140B	Guidelines for Design Approval of Aircraft Data communications
AC 20-165A	Airworthiness Approval of Automatic Dependent Surveillance Broadcast (ADS-B) Out Systems
AC 90-114	Automatic Dependent Surveillance-Broadcast (ADS-B) Operations
EASA guidance material	
AMC 20-24	Acceptable Means of Compliance
ICAO publications	
ICAO Annex 10 Volume III	Aeronautical Communications (Digital Data Communication Systems)
ICAO Annex 10 Volume IV	Aeronautical Communications (Surveillance Radar and Collision Avoidance Systems)
ICAO Doc 9924	Aeronautical Surveillance Manual
ICAO Doc 9684	Manual of the Secondary Surveillance Radar System (SSR)
ICAO Doc 4444	Procedures for Air Traffic Services - Air Traffic Management (PANS-ATM)
RTCA Inc, and EUROCAE standards	
RTCA/DO-229D	MOPS for Global Positioning System/Wide Area Augmentation System Airborne Equipment
EUROCAE/ED-78A RTCA/DO-264	Guidelines for Approval of the Provision and Use of Air Traffic Services Supported by data communications
EUROCAE/ED-75C RTCA/DO-236C	MASPS for Required Navigation Performance (RNP) Area Navigation
RTCA/DO-242A	MASPS for ADS-B

Document	Title
Change 1 to RTCA/DO-242A	
RTCA/DO-317A EUROCAE/ED-102A	MOPS for Aircraft Surveillance Applications (ASA) System
EUROCAE/ED-73E	MOPS for Secondary Surveillance Radar Mode S Transponders
RTCA/DO-289 Change 1 to RTCA/DO-289	MASPS for Aircraft Surveillance Applications (ASA)
RTCA/DO-181E	MOPS for Air Traffic Control Radar Beacon System/ Mode Select (ATCRBS/Mode S) Airborne Equipment
RTCA/DO-302	MASPS for Surveillance Transmit Processing (STP)
RTCA/DO-303 EUROCAE/ED-126	Safety, Performance and Inter-operability Requirements Document for the ADS-B Non-Radar-Airspace (NRA) Applications
RTCA/DO-316	MOPS for Global Positioning System/Aircraft Based Augmentation System Airborne Equipment

2 Background

ADS-B is a surveillance application that periodically transmits aircraft parameters, such as identification, pressure altitude, position and position integrity, via a broadcast data link that is available to any receiver, either airborne or ground-based, within range of the transmitter.

ADS-B information is broadcast without any knowledge of which users may be receiving it and without the expectation of an acknowledgement or reply. As an automatic system, ADS-B requires no flight crew or controller action for the information to be transmitted. The surveillance-type information broadcast is dependent on the aircraft's navigation system and the broadcast capability of the source emitter.

An ADS-B 'out' system consists of the following components:

- a transmitting subsystem that includes message generation and transmission functions at the source aircraft
- the data link broadcast medium.

The sources of the transmitted information, as well as the user applications, are not considered to be part of the ADS-B system, but their performance needs to be considered when defining overall ADS-B system performance.

3 Functional requirement

3.1 ADS-B avionics

3.1.1 For an aircraft to be ADS-B capable it requires:

- appropriate data sources
- an ADS-B transmitter to broadcast the data in a predetermined standard format.

3.2 ADS-B transmitter

3.2.1 The ADS-B transmitter needs to comply with the minimum performance standards detailed in RTCA/DO-260, DO-260A or DO-260B Paragraph 2.2 as appropriate for the aircraft type.

3.2.2 For ADS-B data to be universally usable it needs to be transmitted in the formats and characteristics defined in the following standards:

- Annex 10 to Chicago Convention, Volumes III and IV, Amendment 85
- RTCA/DO-260 Change 2 (systems compliant with earlier versions may continue to use HFOM in abnormal situations as described in Paragraph 8.2.10)
- RTCA/DO-260A Change 2
- RTCA/DO-260B.

3.2.3 Compliance with RTCA/DO-260B is preferred – noting that this is the requirement being implemented in the United States of America (USA) and Europe.

3.2.4 To be useable for Air Traffic Control (ATC) surveillance in a 'radar like' manner, ADS-B transmitters must transmit the following minimum data set:

- **Position** (in extended squitter surface position message and in extended squitter airborne position message)
- **Position Integrity Information** (e.g. NUC or NIC value transmitted in the 'TYPE' code in extended squitter surface position message and in extended squitter airborne position message)
- **Pressure Altitude** (in extended squitter airborne position message, GNSS height may also be transmitted in this message when barometric altitude is not available)
- **Aircraft Identification** (in extended squitter identity and category message)
- **Version Number**, SIL and NACP in aircraft operational status message, if the avionics equipment is RTCA/DO-260A or RTCA/DO-260B compliant.

3.2.5 To provide a more comprehensive data set to other stations, transmission of the following data is highly desirable, as it is used by the Australian ATC system:

- **SPI Indication** (in Surveillance Status Subfield of ADS-B airborne position messages)
- **Emergency Flag** (in Surveillance Status Subfield of ADS-B airborne position messages)

- **Emergency Priority Status Information** (may be broadcast in Extended Squitter Aircraft Status Message, RTCA/DO-260 or RTCA/DO-260A, or the Target State and Status Message RTCA/DO-260A or RTCA/DO-260B)
- **Velocity Information** (Extended Squitter Velocity Message or Surface Position Message)
- **GNSS height** (GNSS Altitude Difference From Barometric Altitude in Extended Squitter Velocity Message)
- **Vertical rate** (in Extended Squitter Velocity Message)
- **Aircraft category** (ensure the parameter is correctly set in the extended squitter and category message).

3.2.6 Additional ADS-B data, defined in ICAO Annex 10, Volumes III and Volume IV, Amendment 85 or RTCA/DO-260 or RTCA/DO-260A may also be transmitted.

3.2.7 Operators installing systems compliant with RTCA/DO-260B are urged to configure their systems to transmit all available parameters. Utilisation of the failure annunciation output is recommended - refer RTCA/DO-260B Paragraph 2.2.11.5.

3.2.8 Equipment marked as compliant with ATSO-C1004(a), ATSO-C1005(a) or TSO-C166, are considered capable of transmitting data described above in the correct formats. Later versions of these TSOs are acceptable.

3.2.9 Transponders marked as compliant with the following standards:

- AEEC – ARINC 718A
- TSO-C112
- EUROCAE ED-73B
- JTSO-2C112a
- ETSO-2C112a

may be capable of transmitting this information in the correct formats. Functional testing of the installation would be required to confirm compliance.

3.2.10 RTCA/DO-260 compliant ADS-B transmitters use the HPL/HIL data from the GNSS receiver as the highest priority data source for determination of NUC.

3.2.11 ADS-B transmitters compliant with pre RTCA/DO-260 Change 2 may continue to use HFOM data from the GNSS receiver during periods of HPL non-availability due to operational reasons (e.g. satellite geometry etc.); however, this is considered to be an abnormal situation.

3.2.12 For RTCA/DO-260A and RTCA/DO-260B compliant transmitters, HPL is used for determination of NIC and HFOM is used for determination of NAC.

3.2.13 It is desirable but not essential that the flight crew have the ability to disable the ADS-B function on instruction from ATC without disabling the operation of the ATC transponder function.

3.2.14 It is desirable that the flight crew are able to initiate emergency messages and 'ident' functions.

3.2.15 Transmitter antenna installation, including the need for antenna diversity, needs to comply with the manufacturer’s installation instructions for ATC transponders to ensure

satisfactory functioning. This is particularly relevant to aircraft above 5700 kg, or with a maximum cruising speed greater than 463 km/h (250 knots).

3.3 ADS-B data sources (essential)

3.3.1 The following section describes the minimum data necessary for ADS-B transmitters to function in the ATC environment (for more detailed requirements including references see the Appendices of this AC). Each category is essential to ensure the message being transmitted has all the relevant data necessary to enable separation to be calculated. Failure to comply may render the prospective operator unable to obtain the benefits of ADS-B separation.

3.4 Positional data

3.4.1 Accurate positional data is essential for the ADS-B system to operate in a 'radar like manner' and be the basis for the allocation of separation between aircraft. Valid GNSS data input provides an acceptable accuracy and integrity for separation purposes with the delivery of position information at a periodic but randomised interval of less than or equal to one second.

3.4.2 GNSS equipment compliant with TSO-C145, TSO-C146, TSO-C196, or an equivalent standard acceptable to the Civil Aviation Safety Authority (CASA), are suitable for use with ADS-B. Later versions of these TSOs are acceptable.

3.4.3 Particular navigation packages that do not have a TSOA, but can be demonstrated to achieve the accuracy and integrity values required, may be acceptable to CASA. In assessing the suitability of GNSS avionics that do not have a TSO-C145/146/196 authorisation, CASA may consider the system differences to the standards documented in RTCA/DO-229C or RTCA/DO-316 (or later versions), with particular regard to the following criteria:

- The system is capable of delivering position information with a periodic interval of at least one second
- The system can continuously output the HPL value to the ADS-B transmitter
- The system has a FDE capability as described in CAO 20.18 Appendix XI Part B 3 (c)(ii)(A)
- The system addresses selective availability (SA) as described in CAO 20.18 Appendix XI Part B 3 (c)(ii)(C).

3.5 Positional integrity data

3.5.1 HPL integrity data needs to be provided to the ADS-B transmitter from the GNSS receiver on the same interface as the positional data. This data is typically available as ARINC 429 label 130.

3.5.2 HFOM data will be provided to the transponder on the same interface as the HPL data. HFOM typically uses ARINC 429 label 247.

3.5.3 A RTCA/DO-260A or RTCA/DO-260B compliant installation will use the HFOM value to calculate NAC.

3.5.4 In some cases, such as during rare periods of inadequate satellites, HPL may not be delivered to the interface. In this case a RTCA/DO-260 compliant installation may use the HFOM value to generate NUC during the period of HPL non-availability; however, this is considered an abnormal situation.

3.5.5 In the case of RTCA/DO-260A or RTCA/DO-260B compliant installations the SIL is intended to reflect the integrity of the navigation source of the position information broadcast. Where position integrity is based on HPL, and the SIL cannot be unambiguously determined and set dynamically, CASA recommends that value should be set to 2 (two) or the value recommended by the equipment manufacturer. During periods where HPL is not available the NIC should be set to 0 (zero), and the NAC should reflect the accuracy of the broadcast position.

3.6 Pressure altitude

3.6.1 Pressure altitude provided to transponders is to be in accordance with existing requirements for ATC transponders. It is preferable that 7.62 metre (25 feet) altitude encoding is used. This data is typically available on ARINC 429 label 203.

3.6.2 Suitable pressure altitude data source may be provided by:

- a barometric encoder (FAA TSO-C88 or later version)
- a barometric altimeter (FAA TSO-C10 or later version)
- an air data computer (FAA TSO-C106 or later version)
- EASA equivalent versions of above TSO standards.

3.7 Identity

3.7.1 Identity information, that is the aircraft flight identification (Flight ID) or aircraft registration mark, is to be provided to the transponder so that the information is identical to the filed flight plan. This information is normally entered by the flight crew prior to each flight utilising either:

- a flight management system
- a pilot control panel.

3.7.2 For aircraft which always operate with the same Flight ID (e.g. using the aircraft registration mark as a callsign) this may be programmed into equipment at installation.

3.8 ADS-B data sources (desirable)

3.8.1 **GNSS altitude**. GNSS altitude should be provided from an approved GNSS receiver to the ADS-B transmitter. Typically this data is available as HAE, ARINC 429 label 370 or MSL, ARINC 429 label 076.

3.8.2 **Vertical rate (GNSS or Barometric).** Vertical rate may be provided from either a GNSS receiver or from a pressure source:

- GNSS vertical rate should be provided from an approved GNSS receiver, and is typically available as ARINC 429 label 165

– **Barometric vertical rate.** Barometric (BARO) vertical rate is typically available as ARINC 429 label 212.

Note: The most accurate source should be used.

3.8.3 **Velocity Information**. Ground speed from an approved GNSS receiver in the form of East/West Velocity and North/South Velocity should be provided. This would be typically available as ARINC 429 label 174.

3.8.4 **SPI Indication**. For ATC transponders, the SPI capability is integrated into the transponder functionality and is controlled from the transponder control panel. For non transponder implementations a discrete input or a control panel may be provided to trigger the SPI indication.

3.8.5 **Emergency indicator**. For ATC transponders the emergency declaration capability is integrated into the transponder functionality and is controlled from the transponder control panel. For non transponder implementations a discrete input or a control panel may be provided to trigger the emergency and/or to indicate the type of emergency.

4 Design, development and approval of aircraft modifications

4.1 Legislative basis for acceptable aircraft configurations

4.1.1 CAO 20.18 Paragraph 9B together with CAO 20.18 Appendix XI detail the legislated technical and operational requirements that are to be met by aircraft operating in Australian airspace and wishing to take advantage of the benefits of ADS-B separation. This covers both the preferred methods together with an alternative standard based on existing international requirements.

4.2 Compliance

4.2.1 When utilising this guidance material for the approval of an ADS-B installation, in accordance with either Subpart 21.M or a Supplemental Type Certificate under Subpart 21.E of the Civil Aviation Safety Regulations 1998 (CASR 1998), the following need to be considered:

- The applicant will need to submit a compliance statement to CASA that shows how the criteria of this guidance material has been satisfied, together with evidence resulting from the activities described in this section.
- Compliance with the airworthiness requirements for intended function and safety may be demonstrated by equipment qualification, safety analysis of the interface between the ADS-B equipment and data sources, equipment cooling verification and ground tests. To support the approval application, design data will need to be submitted showing that the requirements for ADS-B operation have been complied with.
- The safety analysis of the interface between the ADS-B system and its data sources should show no unwanted interaction under normal or fault conditions.

4.2.2 The Federal Aviation Administration of the USA (FAA) AC 120-86 and AC 20-165 provide additional guidance by providing general information and acceptable methods of compliance for the certification, airworthiness, and operational approval of certain aircraft surveillance systems and selected associated aviation applications.

4.2.3 A self-evaluation checklist intended to assist in determining compliance is included at Appendix B of this AC.

4.3 Functional testing

4.3.1 Testing of the installed system either on ground or in flight, is intended to confirm:

- system operation
- that the aircraft derived data in the transmitted messages, including integrity data, is correct
- correct functioning of installed system fault detectors.

4.3.2 Whilst some of the functionality for ADS-B out applications may be demonstrated by ground testing, thorough validation of the installed equipment combination may need a mix of ground and flight tests.

4.3.3 When a particular ADS-B equipment combination is being fitted to an aircraft the following issues need to be addressed:

- If the equipment combination installation is in accordance with an existing proven design (i.e. OEM fit, approved STC or CASR 21M approved engineering order) then the aircraft may only require transponder test set confirmation and the normal post maintenance check flight to confirm correct function of the installed equipment and overall aircraft operation. Coordination with local ATC may also be required.
- If the proposed equipment combination has not been implemented previously, but sufficient documentary evidence is submitted to prove compliance of the system integration with the performance standards as detailed, then paragraph 9.3.1 of this AC would also apply.
- If the proposed equipment combination installation has not been implemented previously and there is insufficient supporting evidence to show compliance with the published standards, comprehensive use of an ADS-B capable transponder test set to verify operation all data fields is required. Subsequently, coordination may be required with local ATC to allow a one off trial period during which time the ADS-B data transmitted by the aircraft is gathered and analysed to confirm correct functioning of the equipment combination. This would be in addition to the requirements of paragraph 9.3.1 of this AC.

4.4 Acceptable configurations

4.4.1 Schedules 1 and 2 of Appendix C to this AC provide listings of the currently accepted equipment combinations. These combinations were submitted by operators as part of their application for ADS-B based services and subsequently verified by Airservices Australia. These combinations are not exhaustive, and are a historical record and not subject to further update.

4.4.2 Recent legislative changes have required a technical review of the performance of existing equipment combinations. Appendix C, Schedule 3 of this AC lists those combinations that are no longer acceptable for use in Australia. This list is not exhaustive and is a historical record and not subject to further update.

4.5 Flight manual

4.5.1 The AFM or the POH, whichever is applicable, should provide at least a statement that the transponder system(s) complies with the criteria of ICAO Annex 10 Volumes III and IV, Amendment 85 regarding extended squitter and any necessary procedures for expected operations (e.g. the need to enter Identity/Call Sign also known as Flight ID) for use with ATC.

4.5.2 Crew Operating Instructions for the ADS-B system should emphasise the need to use the ICAO format, as defined in ICAO Doc 4444, for entry of the Flight ID or Registration Mark as applicable to the flight. The shortened format commonly used by airlines (a

format used by the International Air Transport Association) is not compatible with the ground systems of the air traffic services.

4.6 Minimum equipment list (MEL)

4.6.1 The mandatory requirements detailed in paragraph 9B.8 of CAO 20.18 regarding the serviceability of the ADS-B equipment fitted are to be noted in the MEL.

4.7 Maintenance

4.7.1 Maintenance tests should include a periodic verification check of aircraft ADS-B data including the ICAO 24-bit aircraft address (also known as the Mode S address) using suitable ramp test equipment. A check of the ICAO 24-bit aircraft address should be made in the event of a change of the registration mark of the aircraft (this is always necessary following change in State of registration) or whenever a transponder is replaced.

Note: Australian aircraft are allocated a 24-bit address by the Registrar of Aircraft or relevant RAAO at time of registration.

4.7.2 Where possible, maintenance tests should check the correct functioning of system fault detectors.

4.7.3 The maximum period between ADS-B maintenance tests of the ADS-B transmitter should be the same as for ATC transponders and all transponders fitted to the aircraft should be checked.

5 Foreign based operators

5.1.1 Paragraph 5.8 of CAO 82.1 , paragraph 10.8 of CAO 82.3 and paragraph 10.8 of CAO 82.5 detail the requirements for ADS-B that foreign registered aircraft must comply with if intending to utilise ADS-B services operations within Australian FIR.

Appendix A

ADS-B 'Out' data

Table 1: Required characteristics of essential ADS-B Out data

Item	Parameter	Range	Minimum Resolution	Accuracy Limits	Maximum Data Age at Transmission	Remarks ADS-B transmitter specification
1	Identity/Call Sign	8 characters	N/A	N/A	60 seconds	ICAO Annex 10, Vol IV, para 3.1.2.9
2	Position	Any latitude and longitude on earth		-	2 seconds	ICAO Annex 10, Vol IV, para 3.1.2.8.6.6 & Vol III, Part I, App to Chap 5 para 2.3.2.3
3	Pressure Altitude	-1000 ft to maximum certificated altitude of aircraft plus 5000 ft	100 ft (Gillham's code) or 25 ft as provided by the source.	As the installed sensor.	2 seconds	ICAO Annex 10, Vol IV, para 3.1.2.6.5.4. referenced to 1013.25 hPa & Vol III, Part I, App to Chap 5 para 2.3.2.4. Note: Minimum resolution of 25 ft is preferred.
4	Integrity Value	Value 0-9	1	N/A	2 seconds	ICAO Annex 10, Vol III, Part I, App to Chap 5 para .2.3.1

Table 2: Required characteristics of desirable ADS-B Out data

Item	Parameter	Range	Minimum Resolution	Accuracy Limits	Maximum Data Age at Transmission	Remarks ADS-B transmitter specification
1	SPI Indication					
2	Emergency Flag					
3	Emergency Type Indicator					
4	Velocity Information		-	-	2 seconds	ICAO Annex 10, Vol IV, para 3.1.2.8.6.6 & Vol III, Part I, App to Chap 5 para 2.3.5
5	GNSS Height					
6	Vertical rate (GNSS/BARO)					

Appendix B

Self-evaluation checklist

Table 3: Self-evaluation checklist

Self-evaluation checklist	
ADS-B Transmitter Manufacturer & Model number	
GNSS positional source Manufacturer & Model number	
GNSS receiver TSO	TSO C145a or later version TSO C146a or later version TSO-C196 or later version Other
If not TSO C145(), TSO C146() or TSO C196() compliant	Fault Detection and Exclusion YES/NO Selective Availability aware YES/NO Confirm outputs HPL or HIL Is BARO aiding provided to GNSS receiver?
Transmitter Message formats compliant with (Circle one)	ICAO Annex 10, Volume III and IV Amendment 85 or DO-260 or DO-260A or TSO C166 or TSO-C166a DO-260B or TSO C166b
Transmitter characteristics compliant with (Circle one)	ATSO-C1004b ATSO-1C74c TSO-C112d and compliant with RTCA/DO-181e or ETSO-C112b or ED73B or DO-181e ATSO-C1005b
HPL is provided to ADS-B transmitter on same interface as GNSS positional data and tested	YES/NO
Suitable pressure altitude data source provided to transmitter and tested?	YES/NO TSO-C10b or ETSO-C10b TSO-C106 or ETSO-C106 TSO-C88b or ETSO-C88b
Uses ship's ATC transponder antenna?	YES/NO
If not using ship's ATC antenna, has antenna been mounted in accord with transponder mounting rules?	YES/NO
Flight ID source installed and tested? (Circle one)	Programmed/ pilot entry panel/ Flight Management System interface
Optional data supported & tested (circle those verified)	SPI indication Emergency flag Ground track / Ground speed Velocity vector Emergency type indicator GNSS height GNSS Vertical rate BARO vertical rate

Appendix C

Acceptable equipment combinations

C.1 Introduction

C.1.1 The equipment combinations listed in Schedules 1 and 2 are not exhaustive, and are a historical record and not subject to further update. The lists were compiled from data obtained from individual applications to Airservices Australia by operators wishing to be included in the ADS-B separation services.

C.1.2 Following legislative changes and technical review of the performance of existing transponder combinations Schedule 3 lists those combinations that are no longer acceptable for use in Australia. This list is not exhaustive, and is a historical record and not subject to further update.

C.1.3 Aviation Communication & Surveillance Systems (ACSS) XS-950 transponders are not acceptable unless software modification A is incorporated.

Schedule 1 - ATC transponder and MMR/GPS receiver combinations from multiple manufacturers

Transponder manufacturer and model	Transponder part number	MMR/GPS receiver manufacturer and model	MMR/GPS receiver part number
ACSS XS-950 (with software mod A)	7517800-10005	Honeywell GR-550	HG2021GA03
			HG2021GC02
		Honeywell RMA-55B	066-50029-1161
		Rockwell Collins GLU-920	822-1152-001
			822-1152-002
			822-1152-121
			822-1152-130
			822-1152-131
			822-1152-220
		Rockwell Collins GLU-925	822-1821-430
	7517800-10007	Rockwell Collins GLU-920	822-1152-001
			822-1152-002
			822-1152-121
			822-1152-130
			822-1152-220
		Rockwell Collins GLU-925	822-1821-001
	7517800-10009	Rockwell Collins GLU-920	822-1152-001
			822-1152-002
			822-1152-121

Transponder manufacturer and model	Transponder part number	MMR/GPS receiver manufacturer and model	MMR/GPS receiver part number
			822-1152-130
			822-1152-220
	7517800-10100	Rockwell Collins GLU-925	822-1821-430
Transponder Manufacture and Model	Transponder Part Number	MMR/GPS Receiver Manufacturer and Model	MMR/GPS Receiver Part Number
ACSS XS-950 (with software mod A)	7517800-11006	Honeywell GR-550	HG2021GC02
		Honeywell RMA-55B	066-50029-1201
		Rockwell Collins GLU-920	822-1152-002
		Rockwell Collins GLU-925	822-1821-001
	7517800-11009	Honeywell GR-550	HG2021GC01
			HG2021GC02
		Honeywell RMA-55B	066-50029-1201
		Rockwell Collins GLU-920	822-1152-001
			822-1152-002
		Rockwell Collins GLU-925	822-1821-001
Honeywell TRA-67A	066-01127-1301	Honeywell GR-550	HG2021GP01
		Rockwell Collins GLU-920	822-1152-002
	066-01127-1402	Honeywell RMA-55B	066-50029-1161
		Rockwell Collins GLU-920	822-1152-121
			822-1152-130
			822-1152-131
		Thales TLS755	TLS755-01-0101B
			TLS755-01-0102A
	066-01127-1601	Honeywell GR-550	HG2021GC01
		Honeywell RMA-55B	066-50029-1101
		Rockwell Collins GLU-920	822-1152-002
	066-01127-1602	Honeywell GR-550	HG2021GC01
			HG2021GC02
			HG2021GP01
		Honeywell GR-551	HG2021GP02
Transponder	Transponder	MMR/GPS Receiver	MMR/GPS Receiver

Transponder manufacturer and model	Transponder part number	MMR/GPS receiver manufacturer and model	MMR/GPS receiver part number
Manufacture and Model	Part Number	Manufacturer and Model	Part Number
Honeywell TRA-67A	066-01127-1602	Honeywell RMA-55B	066-50029-1101
			066-50029-1201
		Litton LTN2001Mk2	466200-0104
		Rockwell Collins GLU-920	822-1152-002
			822-1152-003
		Rockwell Collins GLU-925	822-1821-001
			822-1821-330
		Thales TLS755	TLS755-01-5101A
Honeywell ISP-80A	965-1694-001	Rockwell Collins GLU-925	822-1821-131
			822-1821-430
Honeywell XS-858A	7517401-960	CMC Electronics CMA-2024-1 (This a modular unit normally located in a higher assembly)	245-604067-100
Rockwell Collins TDR-94	622-9352-108	Rockwell Collins GPS-4000S	822-2189-001
	622-9352-409		822-2189-002
	622-9210-409		
Rockwell Collins TDR-94D	622-9210-108	Honeywell GR-550	HG2021GD02
		Rockwell Collins GPS-4000S	822-2189-001
Rockwell Collins TDR-94D	622-9210-409	FreeFlight Systems 1203	84327-01-0303
			84327-02-100A
		Universal Avionics Systems UNS-1Lw	3116-42-1116
Transponder Manufacture and Model	Transponder Part Number	MMR/GPS Receiver Manufacturer and Model	MMR/GPS Receiver Part Number
Rockwell Collins TPR-901	822-1338-003	Free Flight Systems 1203	84327-50-200A
		Free Flight Systems 1203C	84327-50-200B
		Honeywell GR-550	HG2021GC02
			HG2021GP01
		Honeywell RMA-55B	066-50029-1101

Transponder manufacturer and model	Transponder part number	MMR/GPS receiver manufacturer and model	MMR/GPS receiver part number
			066-50029-1201
		Rockwell Collins GLU-920	822-1152-002
			822-1152-005
		Rockwell Collins GLU-925	822-1821-001
			822-1821-330
	822-1338-020	Rockwell Collins GLU-920	822-1152-121
	822-1338-021	Rockwell Collins GLU-920	822-1152-121
			822-1152-131
		Rockwell Collins GLU-925	822-1152-130
			822-1821-430

Schedule 2 - ATC transponder and GPS receiver combinations manufactured by Garmin International

Table 4: Transponders - panel mounted

Model	Part Number	Notes
GTX330	011-00455-60	(1) (2)
GTX330	011-00455-80	(1) (2)
GTX330D	011-00455-70	(1) (2)
GTX330D	011-00455-90	(1) (2)

Table 5: Transponders - G1000 avionics suite

Model	Part Number	Notes
GTX33	011-00779-20	(1) (2)
GTX33	011-00779-30	(1) (2)
GTX33D	011-00779-21	(1) (2)

Table 6: GPS receivers - GPS/NAV/COMM 400W/500W series equipment

Model	Part Number	Notes
GNS530AW TAWS	011-01067-XX	(2) (3) (4)
GNS530AW	011-01066-XX	(2) (3) (4)
GNS530W TAWS	011-01065-XX	(2) (3) (4)
GNS530W	011-01064-XX	(2) (3) (4)
GNS500W TAWS	011-01063-XX	(2) (3) (4)
GPS500W	011-01062-XX	(2) (3) (4)
GNS430AW	011-01061-XX	(2) (3) (4)
GNS430W	011-01060-XX	(2) (3) (4)
GNC420AW	011-01059-XX	(2) (3) (4)
GNC420W	011-01058-XX	(2) (3) (4)
GPS400W	011-01057-XX	(2) (3) (4)

Table 7: GPS receivers - G1000 avionics suite

Model	Part Number	Notes
GIA 63W	011-01105-00	(2) (5) (6)
GIA 63W A2/B2	011-01105-01	(2) (5) (6)
GIA 63W	011-01105-20	(2) (5) (6)

Table 8: Table 5: GPS receivers - GPS/NAV/COM 600/700 series equipment

Model	Part Number	Notes
GTN650	011-02256-00	

Notes (applicable to Schedule 2 Tables):

1. Software version 6.11 or later required (Garmin Service Bulletin 0935 refers).
2. Any transponder or GPS can be used in combination as they all support the Garmin RS-232 serial interface that allows GPS position and integrity information to be supplied to the transponder. Generally the G1000 transponders will be combined with the G1000 GPS units, similarly for the non-G1000 transponders and GPS.
3. -XX denotes any numbered suffix. All part numbers in each model range are suitable for providing GPS data that can be used for ADS-B.
4. Software version 3.20 or later required.
5. The unit part number shown in Table 4 matches the part number printed on the nameplate or tag on the equipment itself.
6. Software version 5.80 or later required.

Schedule 3 - Review of currently approved combinations

Table 9: Non-compliant ATC transponder and MMR/GPS receiver combinations – not recommended for any new installations but may remain in service

Transponder manufacturer and model	Transponder part number	MMR/GPS receiver manufacturer and model	MMR/GPS receiver part number
Honeywell KT-73	066-01164-0101	Honeywell KLN 94	069-01034-0101
			069-01034-0102
		Honeywell KLN 900	066-04034-0102
			066-04034-0104
		Honeywell KMH 820	066-01175-2101
			066-01175-2102

Notes:

1. The ongoing acceptability of these combinations may be determined by future legislation. Operators utilising these equipment configurations are urged to update.
2. The KT-73 transponder does not utilise the HPL but uses RAIM flags and as such is non-compliant to the minimum standards described in this AC. This non-compliance results in the KT-73 having a lower ADS-B service availability.

Table 10: Non-compliant ATC transponder and MMR/GPS receiver combinations – not acceptable for continued use

Transponder manufacturer and model	Transponder part number	MMR/GPS receiver manufacturer and model	MMR/GPS receiver part number
ACSS XS-950 Does not use HPL for calculation of NUC. ACSS have a Service bulletin to upgrade to Mod A.	7517800-1005/6	Any	
ACSS RCZ-852 Pre modification 'AT'	7510700-951 with product software 7517419-108	Any	
Any		Litton LTN2001Mk1 Does not properly transmit HPL	465205-0302-0303 465205-0402-0303 465205-0502-0304
Rockwell Collins TDR-94/94D pre -108 Rockwell advises that ADS-B should be		Any	

Transponder manufacturer and model	Transponder part number	MMR/GPS receiver manufacturer and model	MMR/GPS receiver part number
disabled for these transponders by grounding discrete input P1-59			
STPR901 Fitted to Boeing 747-400 generates incorrect Flight ID with a trailing 'U' character. SB 503 is available to rectify.	822-1338-003	Any	