European Aviation Safety Agency *16 Nov 2012*

NOTICE OF PROPOSED AMENDMENT (NPA) 2012-19

DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE EUROPEAN AVIATION SAFETY AGENCY

on Certification Specifications, Acceptable means of Compliance, and Guidance Material on Airborne Communications Navigation and Surveillance

(CS ACNS)

for Mode A/C, Mode S Elementary, Mode S Enhanced Surveillance, and ADS-B Out 1090 MHz Extended Squitter

and

Amending Decision No 2003/12/RM of the Executive Director of the European Aviation Safety Agency of 5 November 2003 on Acceptable Means of Compliance for airworthiness of products, parts and appliances

'AMC-20'

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

and

for AMC 20-24 Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHZ Extended Squitter

EXECUTIVE SUMMARY

This NPA contains a draft Decision for new Certification Specifications for Airborne Communication Navigation and Surveillance (CS ACSN) that comprises of information related to the airworthiness and interoperability standards in support of airspace applications. In particular, the intent of this NPA is to provide clear standards and Guidance Material to ensure safe operations and to demonstrate compliance with Commission Regulation (EU) No 1206/2011 and Commission Regulation (EU) No 1207/2011 for the following:

a. Mode A/C surveillance;

b. Mode S Elementary Surveillance;

c. Mode S Enhanced Surveillance;

d. ADS-B Out 1090 MHz Extended Squitter.

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A. Explanatory Note

I. General

1. The purpose of this Notice of Proposed Amendment (NPA) is to propose airworthiness and interoperability standards for Mode A/C surveillance, Mode S Elementary Surveillance, Mode S Enhanced Surveillance, and ADS-B Out 1090 MHz Extended Squitter. These standards would form Subpart D Section 1 to 4 of the Airborne Communication Navigation and Surveillance Certification Specification (CS ACNS).

2. The European Aviation Safety Agency (hereinafter referred to as the 'Agency') is directly involved in the rule-shaping process. It assists the Commission in its executive tasks by preparing draft regulations, and amendments thereof, for the implementation of the Basic Regulation[1] which are adopted as 'Opinions' (Article 19(1)). It also adopts Certification Specifications, Acceptable Means of Compliance and Guidance Material to be used in the certification process (Article 19(2)).

3. When developing rules, the Agency is bound to follow a structured process as required by Article 52(1) of the Basic Regulation. Such process has been adopted by the Agency's Management Board and is referred to as 'The Rulemaking Procedure'[2].

4. This rulemaking activity is included in the Agency's Rulemaking Programme for 2012-2015. It implements part of rulemaking task RMT.0559 (20.016) as further explained in section IV of this NPA.

5. The text of this NPA has been developed by the Agency. It is submitted for consultation of all interested parties in accordance with Article 52 of the Basic Regulation and Articles 5(3) and 6 of the Rulemaking Procedure.

6. The proposed rule has taken into account the development of European Union and International law (ICAO), and the harmonisation with the rules of other authorities of the European Union main partners as set out in the objectives of Article 2 of the Basic Regulation.

II. Consultation

7. To achieve optimal consultation, the Agency is publishing the draft Decision of the Executive Director on its internet site. Comments should be provided within **6 weeks** in accordance with Article 6(4) of the Rulemaking Procedure.

8. Please submit your comments using the **automated Comment-Response Tool (CRT)** available at **http://hub.easa.europa.eu/crt/**.[3]

9. The deadline for the submission of comments is **14 January 2013.**

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[1] Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Commission Regulation (EC) No 1592/2002 and Directive 2004/36/EC (OJ L 79, 19.03.2008, p. 1). Regulation as last amended by Regulation (EC) No1108/2009 of the European Parliament and of the Council of 21 October 2009 (OJ L 309, 24.11.2009, p. 51).

[2] Management Board decision concerning the procedure to be applied by the Agency for the issuing of opinions, certification specifications and guidance material (Rulemaking Procedure), EASA MB 08-2007, 13.6.2007.

[3] In case the use of the Comment-Response Tool is prevented by technical problems please report them to the CRT webmaster (crt@easa.europa.eu).

III. Comment-Response Document (CRD)

10. All comments received in time will be responded to and incorporated in a Comment-Response Document (CRD). The CRD will be available on the Agency's website and in the Comment-Response Tool (CRT).

IV. Content of the draft Decision

Summary

11. The purpose of this NPA is to introduce new Certification Specifications applicable to all aircraft, which will ultimately contain all communication, navigation and surveillance airworthiness, and interoperability standards in support of airspace applications.

12. This NPA contains the standards for surveillance within sections of Subpart D of the Certification Specification (CS ACNS).

13. Subpart D contains four sections covering the airworthiness requirements for Mode A/C surveillance (CS ACNS.AC), Mode S Elementary Surveillance (CS ACNS.ELS), Mode S Enhanced Surveillance (CS ACNS.EHS) and ADS-B Out 1090 MHz Extended Squitter (CS ACNS.ADS). For completeness, the section CS ACNS.AC has been included for aircraft seeking certification for operations in airspace where surveillance is based only on Mode A/C. This application will be limited to very few installations in aircraft that are not operating IFR flights in Europe.

14. The sections CS ACNS.ELS, CS ACNS.EHS and CS ACNS.ADS ensure airborne surveillance installations are in compliance with the interoperability Commission Regulation (EU) No 1207/2011[4] for aircraft that are subject to that regulation.

15. Commission Regulation (EU) No 1207/2011 mandates:

- Mode S Elementary Surveillance (ELS) capability for all aircraft flying IFR GAT;
- ADS-B Out 1090 MHz Extended Squitter (ADS) capability for all aircraft flying IFR GAT and having a maximum take-off mass exceeding 5 700 kg or having a maximum cruising true airspeed capability greater than 250 knots; and
- Mode S Enhanced Surveillance (EHS) capability for all aeroplanes flying IFR GAT and having a maximum take-off mass exceeding 5700 kg or having a maximum cruising true airspeed capability greater than 250 knots.

16. The interoperability regulation was developed in the framework of the Single European Sky interoperability Commission Regulation (EC) No 552/2004[5] under which the conformity assessment of EATMN systems and constituents is required. In this context, manufacturers are required to provide an EC declaration of conformity or suitability for use for constituents. Air Navigation Service providers will need to submit an EC declaration of verification of systems to their NSA for the EATMN systems that they put into service.

17. To avoid any unnecessary burden for aircraft and avionics manufacturers, Article 6(a) of the interoperability Regulation introduces an alternative verification of compliance on the basis of certificates issued by EASA providing that they include a demonstration of

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[4] Commission Implementing Regulation (EU) No 1207/2011 of 22 November 2011 laying down requirements for the performance and the interoperability of surveillance for the single European sky (OJ L 305, 23.11.2011, p. 35).

[5] Regulation (EC) No 552/2004 of the European Parliament and of the Council of 10 March 2004 on the interoperability of the European Air Traffic Management network (the interoperability Regulation) (OJ L 96, 31.3.2004, p. 26) as last amended by Regulation (EC) No 1070/2009 of the European Parliament and of the Council of 21 October 2009 (OJ L 300, 14.11.2009, p. 34).

compliance with the essential requirements of the interoperability Regulation and the relevant Implementing Rules for interoperability.

18. In order to provide visibility that CS ACNS is in compliance with the interoperability Commission Regulation (EU) No 1207/2011, a cross reference matrix is provided in chapter C of this NPA

19. Thus, certificates issued in accordance with Regulation (EC) No 216/2008 on the basis of this Certification Specification shall be considered as an EC declaration of conformity, and a declaration of suitability for use or declaration of verification.

Summary of structure

20. The creation of this new Certification Specification applicable to the installation airborne communications, navigation and surveillance systems consists of two books: Book 1 covers the airworthiness and interoperability standards and Book 2 provides the relevant GM material.

21. Each book contains:

- Subpart A which captures the general elements and the references to the relevant CNS related Implementing Rules, as applicable to which the airworthiness and interoperability standards should comply;
- Subpart B which will cover communication systems. It will be developed at a later stage;
- Subpart C which will cover navigation systems. It will be developed at a later stage;
- Subpart D which covers surveillance systems. Within this subpart, four surveillance capabilities have been introduced as part of this NPA; and
- Subpart E which will contain other airborne systems such as TAWS. It will be developed at a later stage.

22. The four sections of Subpart D which are introduced in this NPA are:

- Section 1: Mode A/C only surveillance (CS ACNS.AC);
- Section 2: Mode S Elementary Surveillance (CS ACNS.ELS) ;
- Section 3: Mode S Enhanced Surveillance (CS ACNS.EHS) ; and
- Section 4: ADS-B Out 1090 MHz Extended Squitter (CS ACNS.ADS).

Current regulatory context

23. The current regulatory context for the certification of airborne surveillance equipment consists of JAA TGL 13, AMC 20-13, and AMC 20-24.

24. Aircraft previously compliant with JAA TGL 13 **are not considered compliant** with the requirements as specified in Commission Regulation (EU) No 1207/2011 for the Mode S Elementary Surveillance. CS ACNS.ELS provides the new Certification Specifications and Guidance Material that will ensure compliance of aircraft subject to Commission Regulation (EU) No 1207/2011 for the Mode-S Elementary Surveillance capability. It will, therefore, supersede JAA TGL 13. The differences between CS ACNS.ELS and JAA TGL 13 are listed in Appendix D of Subpart D.

25. Aircraft previously compliant with AMC 20-13 **are also not considered compliant** with the requirements as specified in Commission Regulation (EU) No 1207/2011 for the Modes S Enhanced Surveillance; for example, AMC 20-13 does not include the requirement for the Barometric Pressure setting parameter. CS ACNS.EHS provides the new Certification Specifications and Guidance Material that will ensure compliance of

aircraft subject to Commission Regulation (EU) No 1207/2011 for the Mode-S Enhanced Surveillance capability. It will, therefore, supersede AMC 20-13. The differences between the more demanding CS ACNS.EHS and AMC 20-13 are listed in Appendix E of Subpart D.

26. The requirements of CS-ACNS.ADS fully cover (and exceed) the standards of AMC 20-24 (Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHz Extended Squitter) and are for operations equivalent to a radar environment. It will, therefore, supersede AMC 20-24.

27. Differences between CS-ACNS.ADS and FAA AC 20-165 are listed in Appendix J of Subpart D Book 2.

28. In addition to the above regulatory context description, Commission Regulation (EU) No 1206/2011[6] mandates the use of the aircraft identification information by ATC as the primary means of flight identification. This identification information is transmitted by Modes S ELS or ADS-B 1090 MHz Extended Squitter. New standards have been introduced into this Certification Specification to ensure when necessary, the availability of flight deck controls to configure valid aircraft identification information for the purpose of Article 9(3) of the regulation.

29. There is currently no EASA guidance on GNSS installations to be used as GNSS based position sources of ADS-B installations. Further rulemaking tasks 0519 and 0520 will ensure that such guidance is developed.

Review of events and lessons learnt from early implementation:

30. The initial implementation of Mode S Elementary Surveillance has shown that Aircraft Identification is not always entered correctly before aircraft departure (e.g.: in 2012, 2 to 3 % of flights depart with incorrect Aircraft Identification). This has shown a clear and explicit need to require the capability to change the aircraft identification in-flight when notified by ATC in order to correct such preflight miss-configurations. This need has been addressed when developing this new certification standard which is in line with the provisions of ICAO Annex 10 (see CS ACNS.ELS.2030(a)(3)).
The transmission of incorrect information or invalid data to be processed by ANSP operational ground surveillance systems can lead to incorrect aircraft identification resulting in an increased workload for ATC personnel with a potential safety risk to the aircraft and other nearby aircraft. To mitigate these risks, the transmission of all parameters should be adequately validated during the certification process. It is possible for some ELS installations to transmit EHS parameters, therefore, the certification requirements for ELS installations have been extended to ensure that those EHS parameters transmitted are also validated. (See CS ACNS.ELS 1000)

31. To avoid the possibility that surveillance systems make use of invalid data, all equipment supporting the ADS-B Extended Squitter capability are required to transmit valid data. As it is possible for some ELS installations to transmit parameters over the extended squitter, the certification requirements for ELS installations have been extended to ensure that these additional parameters transmitted are also validated. (See CS ACNS.ELS 2010 (b))

[6] Commission Implementing Regulation (EU) No 1206/2011 of 22 November 2011 laying down requirements on aircraft identification for surveillance for the single European sky (OJ L 305, 23.11.2011, p. 23).

V. Regulatory Impact Assessment

(a) Process and consultation

In accordance with the Rulemaking Procedure, the Agency needs to conduct a Regulatory Impact Assessment (RIA) of each proposed rule by analysing some potential and suitable options for rulemaking, and comparing them in terms of their safety, environment, economic, social, and regulatory harmonisation impacts.

Therefore, the aim of the RIA is to support the Agency and the decision makers to identify the best option to achieve the objective of this rulemaking activity as defined by the Terms of Reference for RMT.0559 (20.016) dated 10 December 2010.

This RIA was developed by the Agency during the preparation of the draft Decision and the resulting draft Decision takes into account the lessons learned from the current Mode S ELS, EHS and initial ADS-B deployment programmes.

(b) Issue analysis and risk assessment

(1) What is the issue and the current regulatory framework?

The issue of this RIA is based on the need to establish requirements that permits the airborne community to comply with airspace operational requirements. In particular, the issue is to permit simultaneously compliance with the two separate regulatory processes associated with Commission Regulation (EU) 748/2012[7] and Commission Regulation (EC) 552/2004, thus alleviating the requirement for multiple approvals, certificates, and EC declarations constituents and installations.

The issue is to address the certification of the on-board surveillance installations and ensures compliance with Commission Regulation (EU) No 1207/2011 for aircraft that are subject to that regulation.

(2) Who is affected?

Aircraft and avionics manufacturers, Design Organisations and aircraft operators developing or installing Mode A/C, Mode S ELS, Mode S EHS or ADS-B Out 1090 MHz Extended Squitter secondary surveillance radar systems.

(3) What are the risks (probability and severity)?

If the current situation remains as it is, it will be difficult to apply the provisions of Article 6a of the interoperability Regulation without a standard that has been demonstrated to comply with the requirement of interoperability implementing rule. This has the possibility to delay compliance with Commission Regulation (EU) No 1207/2011 and implementation of Article 9(3) of Commission Regulation (EU) No 1206/2011. Furthermore the non-availability of the Certification Specification that include all airworthiness and interoperability requirements may result in aircraft not be fully interoperable with the subsequent safety risks that are attributed to the incorrect identification of an aircraft and its location and proximity to other aircraft. This will prevent the delivery of expected benefits from deployments of ELS, EHS and ADS-B applications.

(c) Objectives

The overall objectives of the Agency are defined in Article 2 of Regulation (EC) No 216/2008 (the Basic Regulation): maintain a high and uniform aviation safety level with cost-efficient rules.

[7] Commission Regulation (EU) No 748/2012 of 3 August 2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations (OJ L 224, 21.8.2012, p. 1).

The specific objectives are:

- To establish standards that permit the airborne community to comply with airspace operational requirements related to the installation of Mode S ELS, Mode S EHS and ADS-B Out extended squitter installations requirements that can be used to ensure compliance with the European airspace regulation as specified in (EU) No 1207/2011 Article 2(2).
- To alleviate the requirement for multiple approvals, certificates and EC declarations for parts and appliances and installation.

(d) Options identified

Option 0: Do nothing.

Option 1: Application of a Special Condition (SC) on aircraft surveillance equipment installations to be notified to the applicant only on receipt of an approval request.

Option 2: The provision of an appropriate Certification Specification. for Mode A/C, Mode S ELS, Mode S EHS, and ADS-B Out extended squitter installations requirements that can be used to ensure compliance with the European airspace regulation as specified in Commission Regulation (EU) No 1207/2011 Article 2(2)

(e) Analysis of the impacts

(1) Safety impacts

Option 0, based on existing airworthiness certification material, will not ensure that the requirements as specified in Commission Regulation (EU) No 1207/2011 are met. In particular, no suitable certification material currently exists for ADS-B Out in support of both European and global applications for the use of ADS-B-Out surveillance in radar controlled areas.

Option 1 and 2 will improve safety by ensuring that the requirements as specified in Commission Regulation (EU) No 1207/2011 and requirements that permit global operations in radar controlled areas are met. Furthermore Option 3 ensures a harmonised airworthiness certification process.

(2) Environmental impacts

There is no environmental impact difference between options 0, 1, and 2.

(3) Social impacts

There is no social impact difference between options 0, 1, and 2.

(4) Economic impacts

The economic impact associated with the requirement to install Mode S and ADS-B Out capability has been quantified and accepted through the publication of Commission Regulation (EU) No 1207/2011 and is outside the scope of this NPA. However, with respect to demonstrating compliance,

Option 0: This will require multiple certificates to be issued with the potential to increase the administrative burden and associated costs;

Option 1: Notification of the certification standard only on receipt of an approval request has the potential to increase certification cost as a redesign may be required and will add time to the process of delivering the certificate; and

Option 2: This will provide transparency with respect to the required certification standard, so the avionics manufacturers and integrators will not lose time during the certification process, thus reducing the cost with respect to options 0 and 1.

Proportionality issues

The three options provide the same assurance of equity and fairness among all concerned sectors.

(5) Impact on regulatory coordination and harmonisation

Option 0 does not allow compliance with Commission Regulation (EU) No 1207/2011 to be demonstrated as a result of a certificate issued by EASA. Furthermore, it does not ensure a strong regulatory coordination or harmonisation of surveillance system certification requirements.

Option 1 is considered as an intermediate approach to satisfy both SES and EASA regulatory frameworks. However, this approach could generate confusion for the applicants of airworthiness certification as the required certification standard is not known.

Option 2 provides a simplified and unique approach that satisfies both regulatory frameworks. Furthermore, it integrates lessons learned from Mode S ELS, Mode S EHS, and initial ADS-B deployments.

(f) Conclusion and preferred option

(1) Comparison of the positive and negative impacts for each option evaluated.

Option 0 does not allow compliance with Commission Regulation (EU) No 1207/2011 to be demonstrated via the application of a single process.

Option 1 will create a situation where avionics manufacturer and aircraft manufacturer will depend on intermediate certification processes which is not justifiable on the basis of the given applicability timeframe of Commission Regulation (EU) No 1207/2011.

Option 2 option ensures a simplified and coherent approach to the aircraft surveillance equipment required by Commission Regulation (EU) No 1207/2011 and globally through the application of a single system.

(2) Final assessment and recommendation of a preferred option:

The Agency concludes that Option 2 is the preferred option.

B. Draft Decision

The text of the amendment is arranged to show deleted text, new text, or new paragraph as shown below:

1. deleted text is shown with a strike through: ~~deleted~~
2. new text is highlighted with grey shading: new
3. '…' indicates that remaining text is unchanged in front of or following the reflected amendment.

I. Draft Decision on Certification Specifications, Acceptable Means of Compliance, and Guidance material for Communication Navigation and Surveillance — CS ACNS Book 1 and Book 2

Certification Specifications
and
Acceptable Means of Compliance

for

Airborne Communications, Navigation and Surveillance

CS ACNS

Initial Issue

Dd Month 2012

CONTENTS

CS ACNS - Airborne Communications, Navigation and Surveillance

Preamble

CS-ACNS — Initial issue

CS-ACNS

Book 1

Certification Specifications

Subpart A — General

CS ACNS.GEN.1000 Applicability

These Certification Specifications are applicable to all aircraft for the purpose of compliance with airspace equipage requirements with respect to on-board Communication, Navigation and Surveillance systems. Furthermore, compliance with the appropriate section of these Certification Specifications ensures compliance with the following European regulations:

(a) Commission Regulation (EU) No 1207/2011, of 22 November 2011 laying down requirements for the performance and the interoperability for surveillance for the single European sky; and

(b) Commission Regulation (EU) No 1206/2011, of 22 November 2011 laying down requirements on aircraft identification for surveillance for the single European sky.

CS ACNS.GEN.1010 Definitions

This section contains the definitions of terms used in these Certification Specifications and not defined in CS-definitions.

24-bit Aircraft Address means a technical address used by Mode S protocols to identify the transponder on the 1030/1090 Mhz RF network. Each aircraft uses a unique 24-bit aircraft address allocated by their state of registry. This address may also be used by other types of avionics equipment for other purpose.

ADS-B means automatic dependent surveillance - broadcast, a surveillance technique in which aircraft automatically provide, via a data link, data derived from on-board navigation and position-fixing systems. It refers to a surveillance technology where ADS-B Out equipped aircraft broadcast position, altitude, velocity, and other information in support of both air-to-ground and air-to-air surveillance applications.

ADS-B Device Failure refers to a condition enunciated to the flight crew whereby the ADS-B transmit unit is unable to transmit ADS-B messages.

ADS-B Function Failure refers to a condition enunciated to the flight crew whereby the position source(s) or interconnecting avionics fail to provide horizontal position data to the ADS-B transmit unit.

ADS-B Out system refers to the overall set of avionics that generate, transport, process, and transmit ADS-B data.

ADS-B Transmit Unit refers to that part of the ADS-B Out system that transmits 1090 MHz ES ADS-B data, including the data processing within that system;

Aircraft Identification means an alphanumeric chain that contains information allowing operational identification of individual flights. It contains either the Aircraft Identification as registered in item 7 of the flight plan or the aircraft registration if no flight plan has been filed.

Airship means a power-driven lighter-than-air aircraft.

Barometric Altitude Rate means the rate of climb estimated by using the difference of pressure.

Barometric Pressure Setting means the barometric pressure setting used by the pilot when flying the aircraft using a QNH reference.

Comm-B: A 112-bit Mode S reply containing a 56-bit MB message field containing the extracted transponder register.

Data Quality Indicator refers to integrity and/or accuracy quality metrics that are associated with some of the ADS-B Out surveillance data, in particular with the horizontal position.

FMS Selected Altitude: The altitude to which the FMS will level the aircraft.

Ground speed. The speed of an aircraft relative to the surface.

Global Navigation Satellite System (GNSS). A worldwide position and time determination system that includes one or more satellite constellations, aircraft receivers and system integrity monitoring, augmented as necessary, to support the required navigation performance for the intended operation.

Horizontal Velocity refers to the ground speed vector information.

Inertial Vertical Velocity means the rate of climb measure along the axis estimated using different sources including inertial reference.

Magnetic Heading means the angle between the aircraft centreline and magnetic North (angle between the direction to which the aircraft nose is pointing and the magnetic North).

MCP/FCU Selected Altitude means the altitude selected by the flight crew on the flight control panel of the aircraft. This corresponds to the altitude the auto-pilot will not transgress.

Mode S Elementary Surveillance refers to the use of Mode S surveillance data to downlink aircraft identification from airborne installations.

Mode S Enhanced Surveillance refers to the use of other airborne information in addition to data used for Elementary Surveillance.

Transponder means a device that transmits airborne surveillance data spontaneously or when requested. The transmissions are performed on 1090 MHz RF band and the interrogations are received on 1030 MHz RF band using Mode S protocols. It is also named Secondary Surveillance Radar transponder.

Roll Angle means the angle of wings compared to horizon representing the angle of rotation around the roll axis going along the centreline of the aircraft.

Track Angle Rate means the rate of change of the track angle rate.

Transmit refers to the provision of surveillance data by the transponder.

Transponder level means an indication of which Mode S data-link protocols are supported by a transponder. There are 5 transponder levels defined by ICAO.

Transponder register means a transponder data buffer containing different pieces of information. It has 56 bits which are split in different fields. The definition of the transponder registers can be found in ICAO Doc 9871 edition 2 and in transponder MOPS ED-73E with the ICAO document being the reference document in case of conflict. Transponder registers are numbered in hexadecimal (00hex to FFhex). The register number is also known as the BDS code (Comm-B data selector). In this documentation a register is named: register XY_{16} or register addressed by BDS code X,Y. Outside this document, it is also often referenced as just BDS X,Y.

True Track angle means the angle between the track (course over ground or path) of the aircraft and true north.

CS ACNS.GEN.1020 Instructions for continued airworthiness

(See AMC1 ACNS.AC.2000)

Instructions for continued airworthiness for each system, part or appliance as specified in this CS ACNS and any information related to the interface of those systems, parts or appliances with the aircraft are to be provided.

Subpart B — Communications (COM)

(Reserved)

Subpart C — Navigation (NAV)

(Reserved)

Subpart D — Surveillance (SUR)

Section 1 — Mode A/C only surveillance

GENERAL

CS ACNS.AC.1000 Applicability

This section provides standards for Mode A/C only airborne surveillance installations.

SYSTEM FUNCTIONAL REQUIREMENTS

CS ACNS.AC.2000 Transponder characteristics

(See AMC1 ACNS.AC.2000)

(a) The transponder is approved and has Mode A and Mode C capability.

(b) The transponder replies with Mode A and Mode C replies to Mode A/C interrogations, to Mode A/C-only all-call interrogations, and to Mode A/C/S all-call interrogations.

(c) The peak pulse power available at the antenna end of the transmission line of the transponder is more than 21 dBW and not more than 27 dBW for aircraft that operate at altitudes exceeding 4 570m (15 000 ft) or with a maximum cruising speed exceeding 324 km/h (175 knots).

(d) The peak pulse power available at the antenna end of the transmission line of the transponder is more than 18.5 dBW and not more than 27 dBW for aircraft operating at or below 4 570m (15 000 ft) with a maximum cruising airspeed of 324 km/h (175 knots) or less.

CS ACNS.AC.2010 Data transmission

The surveillance system provides the following data in the replies:

(a) The Mode A identity code in the range 0000 to 7777 (Octal).

(b) The pressure altitude corresponding to within plus or minus 38.1 m (125 ft), on a 95 % probability basis, with the pressure-altitude information (referenced to the standard pressure setting of 1013.25 hectopascals),used on board the aircraft to adhere to the assigned flight profile. The pressure altitude should range from minus 1 000 ft to the maximum certificated altitude of aircraft plus 5 000 ft

(c) Special Position Indication (SPI) for 15 to 30 seconds.

CS ACNS.AC.2020 Altitude source

(See AMC1 ACNS.AC.2020)

(a) The reported pressure altitude is obtained from an approved source with appropriate resolution.

(b) The altitude resolution and integrity is commensurate with the intended operation.

CS ACNS.AC.2030 Flight deck interface

(See AMC1 ACNS.AC.2030)

A means is provided to:

(a) select Mode A Code including emergency codes;

(b) initiate the IDENT (SPI) feature;

(c) notify the flight crew when the transmission of pressure altitude information has been inhibited;

(d) select the transponder to the 'standby' or 'OFF' condition;

(e) indicate the non-operational status or failure of the transponder system without undue delay;

(f) display the selected Mode A code to the flight crew; and

(g) select the pressure altitude source to be connected to the active transponder.

SYSTEM PERFORMANCE REQUIREMENTS

CS ACNS.AC.3000 Design assurance

The Mode A/C only airborne surveillance system is designed commensurate with a minor failure condition (see AMC 25.1309 section 7).

CS ACNS.AC.3010 Continuity

The probability of the loss of Mode A/C only airborne surveillance system transponder function is better than or equal to probable (see AMC 25.1309 section 7).

INSTALLATION REQUIREMENTS

CS-ACNS.AC.4000 Dual/multiple transponder installation

(See AMC1 ACNS.AC.4000)

If more than one transponder is installed, simultaneous operation of the transponders is prevented.

CS-ACNS.AC.4020 Antenna installation

(See AMC1 ACNS.AC.4020)

The installed antenna(s) has (have) a radiation pattern which is vertically polarised, omnidirectional in the horizontal plane, and has sufficient vertical beam width to ensure proper system operation during normal aircraft manoeuvres.

Section 2 — Mode S elementary surveillance

GENERAL

CS-ACNS.ELS.1000 Applicability

(See AMC1 ACNS.ELS.1000)

This section provides the standards for Mode S Elementary Surveillance installations.

SYSTEM FUNCTIONAL REQUIREMENTS

CS ACNS.ELS.2000 Transponder characteristics

(See AMC1 ACNS.ELS.2000)

(a) The transponder(s) is (are) an approved level 2 or greater Mode S transponder(s) with Elementary Surveillance and Surveillance Identifier (SI) capability.

(b) The transponder(s) of aircraft that have ACAS II installed is (are) ACAS compatible

(c) The peak pulse power available at the antenna end of the transmission line of the transponder is more than 21 dBW and not more than 27 dBW for aircraft that operate at altitudes exceeding 4 570 m (15 000 ft) or with a maximum cruising speed exceeding 324 km/h (175 knots).

(d) The peak pulse power available at the antenna end of the transmission line of the transponder is more than 18.5 dBW and not more than 27 dBW for aircraft operating at or below 4 570 m (15 000 ft) with a maximum cruising airspeed of 324 km/h (175 knots) or less.

CS ACNS.ELS.2010 Data transmission

(See AMC1 ACNS.ELS.2010)

(a) The surveillance system provides the following data in the Mode S replies:

(1) The Mode A Code in the range 0000 to 7777 (Octal);

(2) The pressure altitude corresponding to within plus or minus 38.1 m (125 ft), on a 95 per cent probability basis, with the pressure-altitude information (referenced to the standard pressure setting of 1013.25 hectopascals), used on board the aircraft to adhere to the assigned flight profile. The pressure altitude should range from minus 1 000 ft to the maximum certificated altitude of aircraft plus 5 000 ft;

(3) On-the-ground status information;

(4) The Aircraft Identification as specified in Item 7 of the ICAO flight plan or the aircraft registration;

(5) Special Position Indication (SPI);

(6) Emergency status (Emergency, Radio communication failure, Unlawful interference);

(7) The data link capability report;

(8) The common usage GICB capability report;

(9) The ICAO 24-bit aircraft address; and

(10) Aircraft that have ACAS II installed provide the ACAS active resolution advisory report.

(b) All other data transmitted is verified.

(1) If the system transmits one or more additional downlink airborne parameters in addition to those listed in paragraph (a), then the relevant sub specifications of CS ACNS.EHS.2010 are also complied with.

(2) If the system transmits additional parameters on the extended squitter and if their full compliance with CS ACNS.ADS has not been verified, as a minimum the aircraft identification, pressure altitude, ICAO 24-bit aircraft address is identical to those transmitted in the Mode S replies. Additionally the position and velocity quality indicators reports the lowest quality.

CS ACNS.ELS.2018 On-the-ground status determination

(See AMC1 ACNS.ELS.2018)

(a) The on-the-ground status is not set by a manual action.

(b) If automatically determination of the On-the-ground status is not available, the On-the ground status is set to airborne.

CS ACNS.ELS.2020 Altitude source

(See AMC1 ACNS.ELS.2020)

(a) The reported pressure altitude is obtained from an approved source with the appropriate resolution.

(b) The altitude resolution and integrity is commensurate with the intended operation.

CS ACNS.ELS.2030 Flight deck interface

(See AMC1 ACNS.ELS.2030)

(a) A means is provided :

(1) to select Mode A Code, including emergency codes;

(2) to initiate the IDENT (SPI) feature;

(3) for a aircraft identification to be inserted or amended by the flight crew if the aircraft uses variable aircraft identification;.

(4) to notify the flight crew when the transmission of pressure altitude information has been inhibited;

(5) to select the transponder to the 'standby' or 'OFF' condition;

(6) to indicate the non-operational status or failure of the transponder system without undue delay;

(7) to display the selected Mode A code to the flight crew;

(8) to display the aircraft identification to the flight crew; and

(9) to select the pressure altitude source that is connected to the active transponder.

(b) Input which is not intended to be operated in flight, is not readily accessible to the flight crew.

SYSTEM PERFORMANCE REQUIREMENTS

CS ACNS.ELS.300 Design assurance

The Mode S ELS airborne surveillance system is designed commensurate with a minor failure condition (see AMC 25.1309 section 7).

CS ACNS.ELS.3010 Continuity

The Mode S ELS airborne surveillance system is designed to an allowable qualitative probability of $2x10^{-4}$.

INSTALLATION REQUIREMENTS

CS ACNS.ELS.4000 Dual/multiple transponder installation

(See AMC1 ACNS.ELS.4000)

If more than one transponder is installed, simultaneous operation of transponders is prevented.

CS ACNS.ELS.4010 ICAO 24-bit Aircraft address

The ICAO 24-bit aircraft address assigned by the competent authority is correctly implemented on each transponder.

CS ACNS.ELS.4020 Antenna installation

(See AMC1 ACNS.ELS.4020)

(a) The installed antenna(s) has (have) a resulting radiation pattern which is (are) vertically polarised, omnidirectional in the horizontal plane, and has (have) sufficient vertical beam width to ensure proper system operation during normal aircraft manoeuvres.

(b) Antenna(s) is/are located such that the resulting far field radiation is not obscured by the aircraft structure.

CS ACNS.ELS.4030 Antenna diversity

(See AMC1 ACNS.ELS.4030,)

Aircraft with a maximum certified take-off mass in excess of 5700 kg or a maximum cruising true airspeed capability, under ISA conditions, in excess of 463 km/h (250 knots) operates with an antenna diversity installation.

Section 3 — Mode S Enhanced Surveillance

GENERAL

CS ACNS.EHS.1000 Applicability

(See AMC1 ACNS.EHS.1000)

(a) This section provides standards for airborne Mode S EHS installations which provide on request (through Mode S replies elicited by Mode S interrogations) airborne parameters in addition to parameters provided by ELS installations compliant with Section 2.

Note: The criteria that are applicable to airborne installations providing spontaneously (through ADS-B Extended Squitters) airborne parameters are specified in Section 4.

(b) This certification specification is applied together with Mode S Elementary Surveillance certification specification defined in Section 2.

SYSTEM FUNCTIONAL REQUIREMENTS

CS ACNS.EHS.2000 Transponder characteristics

(See AMC1 ACNS.EHS.2000)

The transponder is an approved Mode S transponder with EHS capability.

CS ACNS.EHS.2010 Data transmission

(See AMC1 ACNS.EHS.2010)

The surveillance system provides in the Mode S reply the following downlink aircraft parameters in addition to those specified in CS ACNS.ELS.2010:

(a) MCP/FCU Selected Altitude;

(b) Roll Angle;

(c) True Track Angle;

(d) Ground Speed;

(e) Magnetic Heading;

(f) Indicated Airspeed or Mach No ;

(g) Vertical rate: Barometric Altitude rate or Inertial vertical Velocity. When barometric altitude rate field is provided, it is derived solely from barometric measurement;

(h) Barometric Pressure Setting in use minus 800 hectopascal; and

(i) Track Angle Rate or True Airspeed.

SYSTEM PERFORMANCE REQUIREMENTS

CS ACNS.EHS.3000 Design assurance

The Mode S EHS airborne surveillance system is designed commensurate with a minor failure condition.

CS ACNS.EHS.3010 Continuity

The Mode S EHS airborne surveillance system is designed to an allowable qualitative probability of probable

Section 4 — 1090 MHz Extended Squitter ADS-B

GENERAL

CS ACNS.ADS.1000 Applicability

(See GM1 ACNS.ADS.1000)

This section provides standards for 1090 MHz Extended Squitter (ES) ADS-B Out installations.

SYSTEM FUNCTIONAL REQUIREMENTS

CS ACNS.ADS.2000 ADS-B Out system approval

(See AMC1 ACNS.ADS.2000)

The equipment contributing to the ADS-B Out function is approved.

ADS-B OUT DATA

CS ACNS.ADS.2005 ADS-B Out Data Parameters

(See AMC1 ACNS.ADS.2005(a-b))

(a) The ADS-B Out system provides the following minimum set of data parameters:

- (1) Aircraft Identification;
- (2) Mode A Code;
- (3) ICAO 24-bit aircraft address;
- (4a) Airborne Horizontal Position — Latitude and Longitude;
- (4b) Airborne Horizontal Position Quality: NIC;
- (4c) Horizontal Position Quality: NACp;
- (4d) Horizontal Position Quality: SIL;
- (4e) Horizontal Position Quality: SDA;
- (5) Pressure Altitude (incl. NICbaro);
- (6) Special Position Identification (SPI);
- (7a) Emergency Status;
- (7b) Emergency Indication;
- (8) 1090 ES Version Number;
- (9a) Airborne velocity over Ground — (East/West and North/South);
- (9b) Horizontal Velocity Quality: NACv;
- (10) Emitter Category;
- (11) Vertical Rate;
- (12a) Surface Horizontal Position — Latitude and Longitude;
- (12b) Surface Horizontal Position Quality: NIC;
- (13) Surface Ground Track;
- (14) Movement (surface ground speed);

(15) Length/width of Aircraft;

(16) GPS Antenna Offset;

(17a) Geometric Altitude; and

(17b) Geometric Altitude Quality: GVA.

(b) Where available in a suitable format, the ADS-B Out system provides the following data parameters:

(1) Selected Altitude;

(2) Barometric Pressure Setting;

(3a) ACAS Operational; and

(3b) ACAS Resolution Advisory.

CS ACNS.ADS.2008 Provision of Data

(See AMC1 ACNS.ADS.2008(a)(c))

(a) All data provided by the ADS-B Out system comes from approved sources.

(b) The data transmitted by the ADS-B Out system originates from the same data source as used in the transponder replies to Mode S interrogations.

(c) When a data quality indication is required, it is provided to the ADS-B transmit unit together with the associated data parameter and it expresses the actual quality of the respective data as valid at the time of applicability of the measurement.

ADS-B TRANSMIT UNIT

CS ACNS.ADS.2010 ADS-B Transmit Unit Approval

(See AMC1 ACNS.ADS.2010)

The ADS-B transmit unit is approved and it is integrated in the Mode S transponder.

CS ACNS.ADS.2011 ICAO 24-bit Aircraft address

The ICAO 24 bit aircraft address is implemented as specified in CS ACNS.ELS.4010.

CS ACNS.ADS.2012 Antenna diversity

(See AMC1 ACNS.ADS.2012)

The ADS-B transmit unit deploys antenna diversity as specified in CS ACNS.ELS.4030.

CS ACNS.ELS.2013 Antenna installation

The antenna is installed as specified in CS ACNS.ELS.4020.

CS ACNS.ADS.2014 Transmit power

The ADS-B transmit unit has a peak transmit power as specified in CS ACNS.ELS. 2000(c);(d).

CS ACNS.ADS.2016 Simultaneous operation of ADS-B transmit units

(See AMC1 ACNS.ADS.2016)

If more than one ADS-B transmit unit is installed, simultaneous operation of the transmit systems is prevented.

CS ACNS.ADS.2018 On-the-ground status determination

(See AMC1 ACNS.ADS.2018)

(a) The on-the-ground status is determined and validated by the ADS-B Out system.

(b) The on-the-ground status is not set by a manual action.

HORIZONTAL POSITION AND VELOCITY DATA SOURCES

CS ACNS.ADS.2020 Horizontal Position and Velocity Data Sources

(See AMC1 ACNS.ADS.2020)

(a) The horizontal position is derived from GNSS data.

(b) The GNSS receiver based horizontal position and velocity data source is approved and performs, as a minimum, horizontal position receiver autonomous integrity monitoring (RAIM) and fault detection and exclusion (FDE).

(c) Horizontal velocity data stems from the same source as horizontal position data.

OTHER DATA SOURCES

CS ACNS.ADS.2030 Data Sources as defined by Mode S Elementary and Enhanced Surveillance

(See AMC1 ACNS.ADS.2030)

The data source requirements as defined for in section 2 and 3 of this subpart, are also applicable.

CS ACNS.ADS.2034 Geometric Altitude

(See AMC1 ACNS.ADS.2034)

(a) Geometric Altitude is provided by the horizontal position and velocity source (see CS ACNS.ADS.2020).

(b) Geometric Altitude is transmitted as height above WGS-84 ellipsoid.

FLIGHT DECK CONTROL AND INDICATION CAPABILITIES

CS ACNS.ADS.2040 Flight deck interface

(See AMC1 ACNS.ADS.2040(a) and **AMC1 ACNS.ADS.2040(b)**)

(a) The control and display of surveillance data items is as per CS ACNS.ELS.2030.

(b) A means is provided to indicate the non-operational status or failure of the ADS-B Out system without undue delay.

SYSTEM PERFORMANCE REQUIREMENTS

CS ACNS.ADS.3000 Design assurance

(a) The ADS-B Out system is designed commensurate with a major failure condition for the transmission of the following parameters:

(1) ICAO 24-bit aircraft address;

(2) Airborne Horizontal Position — Latitude and Longitude;

(3) Airborne Horizontal Position Quality: NIC;

(4) Horizontal Position Quality: NACp;

(5) Horizontal Position Quality: SIL;

(6) Horizontal Position Quality: SDA;

(7) 1090 ES Version Number;

(8) Airborne velocity over Ground — East/West and North/South;

(9) Horizontal Velocity Quality: NACv;

(10) Emitter Category;

(11) Surface Horizontal Position — Latitude and Longitude;

(12) Surface Horizontal Position Quality: NIC;

(13) Surface Ground Track;

(14) Movement (surface ground speed);

(15) Length/width of Aircraft;

(16) GPS Antenna Offset;

(17) Geometric Altitude;

(18) Geometric Altitude Quality: GVA;

(b) The ADS-B Out system is designed commensurate with a minor failure condition for the transmission of other parameters.

CS ACNS.ADS.3010…Continuity

The ADS-B Out system is designed to an allowable qualitative probability of remote.

HORIZONTAL POSITION AND VELOCITY DATA REFRESH RATE AND LATENCY

CS ACNS.ADS.3020…Horizontal Position and Velocity Data Refresh Rate

A horizontal position and velocity source calculates position and velocity data with a rate of at least 1 Hertz.

CS ACNS.ADS.3022…Horizontal Position and Velocity Total Latency

(See AMC1 ACNS.ADS.3022 and 3024)

Measured from the time of applicability within the source, the total latency of the horizontal position and horizontal velocity data introduced by the ADS-B Out system does not exceed 1.5 second.

CS ACNS.ADS.3024…Horizontal Position Uncompensated Latency

(See AMC1 ACNS.ADS.3022 and 3024)

The uncompensated latency of the horizontal position data introduced by the ADS-B Out System does not exceed 0.6 second.

Subpart E – Others

Reserved

CS-ACNS

Book 2

Guidance Material

(a) GENERAL

Book 2 contains Acceptable Means of Compliance (AMC) and Guidance Material (GM).

(b) PRESENTATION

(1) The Acceptable Means of Compliance and Guidance Material are presented in full page.

(2) A numbering system has been used in which the Acceptable Means of Compliance and Guidance Material use the same number as the paragraph in Book 1 to which they are related. The number is introduced by the letters AMC (Acceptable Means of Compliance) or GM (Guidance Material) to distinguish the material from Book 1. Reference to the Acceptable Means of Compliance is included in the heading of each Book 1 paragraph

(3) Explanatory Notes, not forming part of the AMC text, appear in italic typeface.

(4) The units of measurement used in this document are in accordance with the International System of Units (SI) specified in Annex 5 to the Convention on International Civil Aviation. Non-SI units are shown in parentheses following the base units. Where two sets of units are quoted, it should not be assumed that the pairs of values are equal and interchangeable. It may be inferred, however, that an equivalent level of safety is achieved when either set of units is used exclusively.

Subpart A – General

AMC1 ACNS.GEN.102 Instructions for Continued Airworthiness

(a) Transponder testing

The Instructions for Continued Airworthiness should include the following measures and precautions in order to minimise the possibility of causing nuisance warnings to ACAS equipped aircraft.

(1) When not required, ensure all transponders are selected to 'OFF' or 'Standby'.

(2) Before starting any test, contact the local Air Traffic Control Unit and advise them of your intention to conduct transponder testing. Advise the Air Traffic Unit of your start time and test duration. Also inform them of the altitude(s) at which you will be testing, your intended Aircraft Identification (Flight Id) and your intended Mode A code. See §6.4.2.2c and d.

Note: Certain altitudes may not be possible due to over flying aircraft.

(3) Set the Mode A code to 7776 (or other Mode A code agreed with Air Traffic Control Unit).

Note: The Mode A code 7776 is assigned as a test code by the ORCAM Users Group, specifically for the testing of transponders.

(4) Set the Aircraft Identification (Flight Id) with the first 8 characters of the company name. This is the name of the company conducting the tests.

(5) Set the on-the-ground status for all Mode S replies, except when an airborne reply is required (e.g. for altitude testing).

(6) Where possible, perform the testing inside a hangar to take advantage of any shielding properties it may provide.

(7) As a precaution, use antenna transmission covers whether or not testing is performed inside or outside.

(8) When testing the altitude (Mode C or S) parameter, radiate directly into the ramp test set via the prescribed attenuator.

(9) In between testing, i.e., to transition from one altitude to another, select the transponder to 'standby' mode.

(10) If testing transponder parameters other than 'altitude', set altitude to -1 000 feet (minus 1 000 feet) or over 60 000 feet. This will minimise the possibility of ACAS warning to airfield and overflying aircraft.

(11) When testing is complete, select the transponder(s) to 'OFF' or 'Standby'.

Subpart B — Communications (COM)

Reserved

Subpart C — Navigation (NAV)

Reserved

Subpart D — Surveillance (SUR)

Section 1 — Mode A/C only Surveillance

AMC1 ACNS.AC.2000 Transponder characteristics

(a) Transponder capabilities.

(1) The Mode A/C only transponder should hold an EASA equipment authorisation in accordance with European Technical Standard Order ETSO-C74d, or an equivalent standard that is consistent with applicable ICAO SARPS, and which is acceptable to EASA.

(2) The Mode A/C only transponder should be a class 2 as defined in ETSO-C74d.

Note 1: ETSO-C74d Class 2 equipment meets EUROCAE Document 1/WG9 (1971) with amendment 1 and 2. Amendment 2 contains the requirements and tests to show that the transponder correctly replies to Mode A/C-only all call interrogations and to Mode A/C/S all-call interrogations used by Mode S radars.

Note 2: RTCA DO-144 does not include requirement to reply to Mode A/C/S All-Call and Mode A/C-Only All-Call interrogations and is, therefore, not sufficient to prove the compliance. RTCA DO-144A contains the requirements for the equipment to reply to Mode A/C/S All-Call and Mode A/C-Only All-Call interrogations.

(b) Minimum reply rate

(1) Mode A/C only transponders should be capable of continuously generating at least 500 replies per second for a 15-pulse coded reply.

(2) Transponder installations used solely below 4 500 m (15 000 ft), or below a lesser altitude established by the appropriate authority or by regional air navigation agreement, and in aircraft with a maximum cruising true airspeed not exceeding 175 knots (324 km/h) should be capable of generating at least 1 000 15-pulse coded replies per second for a duration of 100 milliseconds.

Note: The rate of 1 000 replies per second for a limited duration of 100ms is an acceptable deviation to ETSO-C74d.

(3) Transponder installations operated above 4 500 m (15 000 ft) or in aircraft with a maximum cruising true airspeed in excess of 175 knots (324 km/h) should be capable of generating at least 1 200 15-pulse coded replies per second for a duration of 100 milliseconds.

Note 1: A 15-pulse reply includes 2 framing pulses, 12 information pulses, and the SPI pulse.

Note 2: The transponder should be capable of replying to this short-term burst rate, even though the transponder may not be capable of sustaining this rate.

Note 3: The rate of 1 200 replies per second for a limited duration of 100ms is an acceptable deviation to ETSO-C74d.

(c) Minimum output power level

The transponder power output capability should be verified as follows depending on the aircraft capability:

(1) For aircraft that operate at altitudes exceeding 4 570 m (15 000 ft) or with maximum cruising speed exceeding 324 km/h (175 knots), the class of the transponder declared in the transponder DDP should be Class A.

(2) For aircraft operating at or below 4 570m (15 000 ft) with a maximum cruising airspeed of 324 km/h (175 knots) or less, the class of the transponder declared in the transponder DDP should be Class A or Class B.

AMC1 ACNS.AC.2020 Altitude source

(a) Altimeters compliant with JAA TGL No 6 are an acceptable means of compliance for the altitude source.

(b) Altimeters with a pressure altitude resolution lower than or equal to 25 ft is an acceptable means of compliance.

Note: Altitude source resolution of 25 ft or better is required for aeroplanes intended to be used for international air transport as defined in ICAO Annex 6 Part 1 — 6.19.

(c) An altimeter with a pressure altitude resolution lower than or equal to 100 ft and greater than 25 ft is an acceptable means of compliance for aircraft provided that the flight deck interface provides a means to inhibit the transmission of pressure altitude information for aircraft equipped with Gillham encoded altitude

Note: It is not recommended to install altimeters with a Gillham altitude encoder interface.

AMC1 ACNS.AC.2030 Flight deck interface

Where available the pressure altitude source connected to the active transponder should be the one which is being used to control the aircraft.

Note: Systems not utilising Gillham interfaces may or may not provide a means to inhibit the transmission of pressure altitude.

AMC1 ACNS.AC.4000 Dual/multiple transponder installation

When dual or multiple transponders are installed on an aircraft, it is highly recommended to use a common control interface/panel to ensure that only one transponder is active at a given time.

AMC1 ACNS.AC.4020 Antenna Installation

(a) Antenna locations recommended by the aircraft manufacturer do not need to be revalidated.

(b) Antenna performance for new locations may be validated in flight, by ground measurements or simulation modelling.

Section 2 — Mode S Elementary Surveillance

AMC1 ACNS.ELS.1000 Applicability

For installations previously compliant with JAA TGL 13 Rev 1, further demonstration should be performed for each of the differences listed in Appendix D in order to demonstrate compliance of the installation with subsection D Section 2

Note 1: A list of Mode S ELS related documents is provided in Book 2 Subpart D Appendix *B section (b).*

Note 2: More information on how the ELS information will be extracted and used by ground surveillance is available in Book 2 Subpart D Appendix *B section (c).*

AMC1 ACNS.ELS.2000 Transponder characteristics

(a) Transponder capabilities.

(1) The Mode S transponder should hold an EASA equipment authorisation in accordance with European Technical Standard Order ETSO-C112d, or an equivalent standard that is consistent with applicable ICAO SARPS and which is acceptable to the responsible certification authority

Note: ETSO-C112d requires compliance with EUROCAE ED-73E.

(2) The transponder class can be verified by checking that the transponder DDP declares the transponder level as .**'2', '3', '4', or '5'**.

Note: The definition of a level 2 transponder and associated functions can be found in EUROCAE ED-73E paragraph 1.4.2.1, 3.22 and 3.23.

(3) The SI code capability can be verified by checking that the transponder DDP indicates the letter '**s**' in the transponder capability declaration.

Note 1: The DDP indicates those requirements of ED-73E (or later version) with which the transponder is not compliant with.

Note 2: The transponder SI code capability can be found in EUROCAE ED-73E paragraph 3.18.4.34. SI codes have been allocated to Mode S radars used in Europe and it is, therefore, an important capability to ensure correct detection of the aircraft.

(4) The Elementary Surveillance functionality can be verified by checking that the transponder DDP indicates the letter '**l**' for ELS or '**n**' for EHS in the transponder capability declaration.

Note: Such transponders meet the requirements specified in EUROCAE ED-73E 3.29. According to ED-73E, a transponder with the Enhanced Surveillance capability has also the Elementary Surveillance capability.

(5) ACAS compatibility can be verified by checking that the transponder DDP indicates the letter 'a' in the transponder capability declaration.

Note: Necessary capabilities to be an ACAS-compatible Mode S transponder are described in section 3.27 of EUROCAE ED-73E.

(b) Minimum output power level: The transponder power output capability should be verified as follows, depending on the aircraft capability:

(1) For aircraft that operate at altitudes exceeding 4 570m (15 000ft) or with maximum cruising speed exceeding 324 km/h (175 knots), the class of the transponder declared in the transponder DDP should be **Class 1**.

(2) For aircraft operating at or below 4570m (15 000ft) with a maximum cruising airspeed of 324 km/h (175 knots) or less, the class of the transponder declared in the transponder DDP should be Class 1 or Class 2.

Note: Classes of equipment are defined in EUROCAE ED-73E 1.4.2.4. Power characteristic is defined in ICAO Annex 10 Volume IV 3.1.1.7.11.

AMC1 ACNS.ELS.2010 Data transmission

Data transmission verifications

(a) Table 1 below provides the parameters that should be verified for Mode S Elementary Surveillance.

Table 1 — List of parameters to be verified on an ELS installation

Item	Parameters	Message/register	Remark
1	Mode A code and Emergency status	DF5 and DF21	
2	Pressure altitude	DF4 and DF20	See 0
3	On-the-ground status	DF4/5/20/21	
4	Aircraft Identification	Register 20_{16}	See 0
5	SPI	DF4/5/20/21	See 0
6	Data-link and common usage GICB capability reports	CA field in DF11Register 10_{16} Register 17_{16}	
7	24 bit aircraft address	DF11	
8	RA report	Register 30_{16} + announcement in DF4/5/20/21	Only for ACAS installation see 0

Note 1: Information about how Mode S ELS data are used by Mode S ground system can be found in Book 2 Appendix B *to this CS.*

Note 2: Downlink Formats (DF) are defined in ICAO Annex 10 Volume IV and EUROCAE ED-73E. A summary can also be found in Book 2 Appendix *B.*

Note 3: It is not recommended to have 2 transponders installed without a common control panel.

(b) Pressure Altitude

(1) The consistency of the altitude reported in Mode C replies and Mode S replies should be checked.

Note: An incorrect installation of altimeters using Gillham encoding may result in altitude transmitted in Mode C replies and no altitude transmitted in Mode S replies.

(2) For aircraft transmitting parameters via the Extended Squitter, for which compliance with Subpart D section 4 is not required, the pressure altitude data should be checked in the Extended Squitter register for airborne position (register 0516).

(c) Pressure altitude resolution transmission

(1) The resolution of the transmitted pressure altitude should be 25 ft for aircraft equipped with a pressure altitude source having a resolution better than 25 ft for all altitudes except those above 50 187.5 ft.

(2) Aircraft equipped with altimeters that have a resolution greater than 25 ft (e.g. 100 ft) should report their altitude in 100 ft encoding.

(3) Verify that the encoding of the altitude is appropriate to the altimeter resolution as defined in paragraphs 1 and 2 above.

(4) For aircraft transmitting parameters via the Extended Squitter, for which compliance with Subpart D section 4 is not required, the pressure altitude resolution data should be checked in the Extended Squitter register for airborne position (register 05_{16}).

(d) Aircraft Identification

For aircraft transmitting parameters via the Extended Squitter, for which compliance with Subpart D section 4 is not required, the Aircraft Identification received via the Extended Squitter should be checked to ensure that it is identical to the information transmitted in register 08_{16}.

(e) Special Position Indication (SPI)

The FS field should report FS = 4 or 5 for 18 seconds (+/-1 second) when SPI is manually activated in replies DF4, DF5, DF20 or DF21.

Note: Flight Status values can be found in ICAO Annex 10, Vol IV, paragraph 3.1.2.6.5.1.

(f) ACAS active Resolution Advisory report

For aircraft that have ACAS II installed, post a Resolution Advisory report. No undue RA report should be announced (DR field never set to 2, 3, 6 or 7) within 5 minutes.

(g) Transmission of other parameters

When one or more other airborne data items are transmitted, they should be verified as proposed in AMC1 ACNS.EHS.2010.

Note 1: The minimum data transmission verification of transponder also having ADS-B ES capabilities has been defined above. Transponders that are transmitting parameters other than the minimum tested above, are encouraged to demonstrate compliance with Subpart D section 4.

Note 2: The implementation of registers E316 and E416 is recommended.

AMC1 ACNS.ELS.2018 On-the-ground status determination

The automatic determination of the on-the-ground status should be obtained from:

(a) Weight On Wheel (WOW) sensor: When the aircraft is equipped with an automatic sensor to determine if the aircraft is on the ground (i.e. Weight On Wheel sensor), this sensor should be used as the on-the-ground status source of the transponder; or

Note: Attention is drawn on the wiring of the WOW to the right pins of the transponder.

(b) automatic algorithm: If ground speed, radio altitude, or airspeed parameters are being used in the algorithm and the 'on-the-ground' condition is being reported or if the on-the-ground status has been commanded via the TCS subfield, the on-the-ground status is to be overridden and changed to 'airborne' if :

Ground Speed OR Airspeed > X or Radio height > 50 ft.

Note 1: Care should be taken to ensure that the chosen threshold values of X are such that the aircraft can never report 'on ground' status when in the air, and should be based on the aircraft nominal performance.

Note 2: Systems that able to support Enhanced Surveillance and ADS-B might use available airborne parameters in their automatic algorithm to determine if they are on the ground. More information can be found in Subpart D section 4.

AMC1 ACNS.ELS.2020 Altitude source

(a) Altimeters compliant with JAA TGL No 6 are an Acceptable Means of Compliance for the altitude source.

(b) Altimeters with a pressure altitude resolution lower than or equal to 25 ft are an Acceptable Means of Compliance.

Note: Altitude source resolution of 25 ft or better is required for aeroplanes intended to be used for international air transport as defined in ICAO Annex 6 Part 1 — 6.19.

(c) An altimeter with a pressure altitude resolution lower than or equal to 100 ft and greater than 25 ft is an Acceptable Means of Compliance for aircraft provided that the following provisions are implemented:

(1) There is no conversion of Gillham encoded data to another format before inputting to the transponder unless failure detection can be provided, and the resolution (quantisation) is set in the transmitted data to indicate 100 ft;

Note 1: It is not recommended to install altimeters with a Gillham altitude encoder interface as it supports a resolution of only 100 ft.

Note 2: Losses or errors of pressure altitude have an impact on the provision of separation by ATC. It is, therefore, important to design the altitude pressure source to minimise the loss of this data or the provision of erroneous data.

Note 3: Further guidance on altitude measurement and coding systems may be found in EUROCAE document ED-26.

(2) Altitude source comparison;

(3) For aircraft equipped with ACAS II where the available source of pressure altitude information is only in Gillham encoded format, detection of an altitude source or encoder failure can be satisfied by means of dual independent altitude corrected sensors together with an altitude data comparator (which may be incorporated and enabled in the transponder). Similar provision is also acceptable for alternative altitude information sources that do not signal erroneous data.

(4) The flight deck interface should provide a means to inhibit the transmission of pressure altitude information for aircraft equipped with a Gillham encoded altitude interface.

AMC1 ACNS.ELS.2030 Flight deck interface

The pressure altitude source connected to the active transponder should be, by default, the one which is being used to control the aircraft.

AMC1 ACNS.ELS.4000 Dual/multiple transponder installation

When dual or multiple transponders are installed on an aircraft, a common control interface/panel should be provided to ensure that only one transponder is active at a given time, and to ensure that the Mode A code and Aircraft Identification changes are applied to the active transponder.

AMC1 ACNS.ELS.4020 Antenna Installation

(a) Antenna locations recommended by the aircraft manufacturer do not need to be revalidated.

(b) Antenna performance for new locations should be validated in flight by ground measurements or simulation modelling.

(c) The distance between L-band antennas should be at least 40 cm and the distance between other antennas (e.g. ACAS, DME) should satisfy the appropriate isolation and longitudinal separation limits.

(d) When the Mode S ELS surveillance installation is using two antennas, the horizontal distance between the two antennas should be less than 7.6m

AMC1 ACNS.ELS.4030 Antenna Diversity

(a) The aircraft maximum cruising true airspeed may be determined using one of the 3 following options:

(1) Where the Aircraft Flight Manual or Pilot's Operating Handbook gives more than one table of true airspeed values for a range of temperatures, the table which gives the maximum true airspeed, should be used;

(2) For some aircraft, the maximum cruising true airspeed is not obtained at the maximum operating altitude. In those cases, the maximum true airspeed has to be considered and not the true airspeed at maximum operating altitude;

(3) Aircraft which do not state the maximum cruising true airspeed under ISA conditions in their Aircraft Flight Manual or Pilot's Operating Handbook, may use the following alternative method to calculate maximum cruising true airspeed:

i. Use the maximum operating values of altitude and airspeed (i.e. VNO, or VMO/MMO as applicable) quoted in the Limitations section of the Aircraft Flight Manual or Pilot's Operating Handbook to calculate the maximum cruising true airspeed of the aircraft. If the aircraft is unpressurised, an altitude of 8 000 feet may be used as the maximum 'normal' operating altitude.

ii. For example, using a maximum 'normal' operating altitude of 8 000 feet for an unpressurised aircraft, and a maximum operating airspeed of 215 knots, (as stated in the Aircraft Flight Manual or Pilot's Operating Handbook, e.g. VNO = 215 knots) then the aircraft has an equivalent TAS capability of 250 knots in the ICAO Standard atmosphere. The calculation may be made using a pilot's TAS computer.

(b) For airships, the applicant should demonstrate the need or otherwise for antenna diversity. The demonstration should be based on the construction techniques and size of the airship.

(c) The transponder DDP should indicate the letter **'**d**'** in the transponder capability declaration to indicate antenna diversity capability.

Section 3 — Mode S Enhanced Surveillance

AMC1 ACNS.EHS.1000 Applicability

Previous compliance declarations with EASA AMC 20-13 (Certification of Mode S Transponder Systems for Enhanced Surveillance) is another Acceptable Means of Compliance for existing installations, provided that differences listed in Appendix E have been addressed.

AMC1 ACNS.EHS.2000 Transponder characteristics

(a) The means of compliance defined in AMC1 ACNS.ELS.2000 should be followed, with the exception that the transponder DDP should indicate a label 'n' in the transponder capability declaration to reflect ELS and EHS capabilities.

Note: Such transponders meet the requirements specified in EUROCAE ED-73E section 3.30 for EHS capabilities. If the transponder is compliant with EUROCAE ED-73E, it provides register format corresponding to a Mode S subnetwork version 5.

(b) The Mode S subnetwork format should be 3 or above.

Note : The use of the highest Mode S Subnetwork version format is recommended.

AMC1 ACNS.EHS.2010 Data transmission

(a) The compliance verification should include a list of transponder registers supported by the installation, including the parameters that are available in each register. The list should contain the registers that are indicated as available in the Mode Specific Capability reports (18_{16} to $1C_{16}$), except the following registers:

(1) registers managed by the transponder to support the Mode S airborne initiated protocol (02_{16}, 03_{16}, 04_{16});

(2) registers containing extended squitters information (05_{16}, 06_{16}, 07_{16}, 08_{16}, 09_{16}, $0A_{16}$);

(3) aircraft capability reporting (10_{16} to $1F_{16}$);

(4) Aircraft Identification (20_{16});

(5) ACAS RA report (30_{16}); and

(6) transponder dependant information ($5F_{16}$, $E3_{16}$, $E4_{16}$, $E7_{16}$, EA_{16}).

Note 1: An example of a minimum list of registers to support EHS is provided in Subpart D Appendix C.

Note 2: An example of other registers and parameters is provided in Subpart D Appendix C.

(b) Verification of operation

(1) All the transponder registers containing data as defined in (a) should be verified to ensure correct data is transmitted by the Mode S transponder.

Note: Format and resolution of airborne parameters can be found in ED-73E Volume 2 or in ICAO Doc 9871 Edition 2.

(2) Where a register is declared available but a parameter within that register is not available, it is necessary to verify that the status of the parameter is declared invalid in the corresponding aircraft register.

Note 1:Some parameters are particularly difficult to measure statically. To ensure that these parameters (e.g. Roll Angle, Track Angle Rate, Inertial Vertical Velocity) are correctly received from the sensor and transmitted by the transponder, it is acceptable to test that the correct transponder register is transmitted (by the transponder), that the value of the parameter status bit is valid (status bit = 1),

and the value of the parameter field is set to zero when aircraft is not moving on the ground.

Note 2: Due to the limitations of the static tests, it is recommended to perform a flight and record the content of the different transponder registers to verify that all parameters listed in (a) are changing in accordance with pilot input and aircraft attitude and manoeuvre.

Note 3: To minimise the certification effort for transponder follow-on installations, the applicant may claim from the responsible authority credit for applicable certification and flight test data obtained from equivalent aircraft installations. This is acceptable only if all equipment connected to the transponders are of the same type and same software revision number.

(c) Aircraft parameters

(1) Selected Altitude

i. MCP/FCU Selected Altitude

The MCP/FCU Selected Altitude provided should correspond to the altitude selected by the flight crew. Normally this corresponds to the cleared flight level provided by the controller.

In case there is no MCP/FCU Selected Altitude function, it is accepted to use the information provided by an altitude alerter.

ii. FMS Selected Altitude

When available, it is recommended that the FMS Selected altitude field is provided. The FMS selected altitude is the selected altitude used by the FMS to manage the vertical profile of the aircraft.

Note: This will allow the reporting of the intermediate selected altitudes during applications (e.g. RNAV1) when aircraft is flown using FMS.

iii. MCP/FCU mode bits

When data is available, it is recommended (optional) to provide information on autopilot mode which is selected by the flight crew.

Note: It is accepted to set this bit to zero rather than providing wrong information.

iv. Target Altitude source bits

The target altitude source bits are used to indicate the source (e.g. FCU/MCP, FMS) which provides the next level at which the aircraft will level off. This is also referred to as the Target Altitude. However, the necessary data may be inconsistent or not accessible. In this case, the status of target altitude source bits should indicate no source information provided (set to zero).

Note: It is also acceptable that status of target altitude source bits is set to valid and target altitude source is set to 00 to indicate unknown.

(2) Vertical Rate

The Barometric Altitude Rate should contain value solely derived from barometric measurement.

When different sources are available, the Inertial Vertical Velocity should contain data coming from the most accurate and steady source.

Note 1: The vertical rate can be provided in the Barometric Altitude Rate and/or the Inertial Vertical Velocity fields of register 60_{16}. Both the Barometric Altitude Rate and the Inertial Vertical Velocity can be transmitted simultaneously.

Note 2: The Barometric Altitude Rate is usually very unsteady.

Note 3: The Inertial Vertical Velocity (derived from IRS, AHRS and/or GPS) information is more filtered and smoothed.

(3) Barometric Pressure Setting

If operating with reference to the standard pressure setting, the Barometric Pressure Setting field should indicate standard pressure value equivalent to 1 013.25 hPa.

(4) Track Angle Rate or True Airspeed

If Track Angle Rate data cannot be readily provided due to the aircraft configuration, True Airspeed data should be substituted.

(d) Sensor Selection

Particular attention should be given to the interface between data sources and transponders when multiple transponders and multiple sensors are employed. In this context, 'sensors' refers to FMS, IRS, AHRS, ADS, GPS, or Data Concentrator (or other) systems used to provide data to the transponder.

In an installation where sensor selection capability for the active transponder is provided on the flight deck, the crew should be aware, at all times, which sensors (captain's or co-pilot's side) are providing information to the active transponder. The sensor selected for the active transponder should be relevant to the aircraft flight profile.

In an installation, where sensor selection for the active transponder is **not** provided, the captain's side transponder should utilise the captain's side sensors, and the co-pilot's side transponder should utilise the co-pilot's side sensors.

Data parameters from different sensors of the same type should not be mixed.

Note: For example, Mode-C or Mode-S altitude reporting information from ADC source #1 should not be mixed with reporting of TAS, Baro Vertical Rate, Mach from ADC source #2. In this case, partially blocking of data output from either ADC source #1 or #2 will cause uncorrelated results. This could result in problems with ATC ground processing of the data.

Where only single sensors are available (i.e. single FMS), it is permissible to connect the single sensor to multiple transponders. It should be noted that this may result in reduced operational availability should the single sensor fail.

Section 4 — 1090 MHz Extended Squitter ADS-B Out

GM1 ACNS.ADS.1000 Applicability

With respect to 1 090 MHz ES ADS-B Out installations, the material in this section is to a large degree in line with the corresponding FAA AC 20-165 material. Differences between the two documents are listed in Appendix J . This guidance may be of use when showing of compliance with both documents is required.

The approval of on-board systems receiving and processing ADS-B messages in support of air-to-air applications is outside the scope of Subpart D section 4.

AMC1 ACNS.ADS.2000 ADS-B Out system approval

Equipment Qualification

For equipment qualification, refer to AMC1 ACNS.ADS.2010 through to AMC1 ACNS.ADS.2040.

AMC1 ACNS.ADS.2005(a-b) ADS-B Out data parameters

During ADS-B Out system installation testing, all the parameters that are broadcast should be demonstrated to be correct for each installed ADS-B transmit unit, i.e. the transmitted data should be in line with the respective source data.

The Emitter Category, Aircraft Length and Width and GPS Antenna Offset parameters might be either configured as a fixed value during ADS-B Out system installation, or provided via a variable data interface. In both cases, during installation, the respective settings should be verified to be correctly set.

Additional guidance material on the required surveillance data parameters are provided in Appendix H ,Part 1 and Part 2.

Appendix H Part 6 provides matrices of the so-called BDS register fields as used by the 1090 ES ADS-B transmit unit to broadcast the ADS-B Out parameters. These matrices detail the ADS-B Out data requirements at data field level for general understanding and in support of integration testing, as appropriate.

If installations transmit ADS-B Out data that do not meet some requirements of the Subpart D Section 4, the respective data should only be transmitted with a 'zero' quality indication (if a quality indication is defined in the ADS-B Out transmit system).

AMC1 ACNS.ADS.2008(a) Provision of data — Approved sources

(a) See AMC1 ACNS.ADS.2020-2040 for details on the approval of the respective data sources.

(b) For transmission of optional data items, the following provisions should be considered:

(1) Airspeed

In case of a loss of GNSS horizontal velocity data, the ADS-B transmit unit normally switches to broadcast airspeed information (using subtypes 3 and 4 of register 09_{16}).

Therefore, if airspeed data is provided to the ADS-B transmit unit, it should be provided by an approved airspeed source that is providing data intended for use by the flight crew. An air data computer meeting the minimum performance requirements of ETSO-C106 (JTSO-C106) is an acceptable source.

(2) Heading

In case of a loss GNSS ground track and if heading is provided to the ADS-B transmit unit, the heading source should meet the minimum performance requirements of ETSO-C5e (JTSO-C5e) or any revision of ETSO-C6d (JTSO-C6d).

(3) Other Data Parameters

The Intent Change Flag should be set as appropriate to indicate the availability of information in the Mode S registers 40_{16} to 42_{16}.

If available, Selected Heading information should come from approved data sources.

The 1090 ES IN capability field should be set correctly.

AMC1 ACNS.ADS.2008(c) Provision of data – Data quality indication and associated data

Data quality indications for the horizontal position containment bound (NIC) and horizontal position accuracy bound (NACp) should be provided to the ADS-B transmit unit together with the corresponding horizontal position information within the same data set.

Data quality indications for the horizontal position source integrity level (SIL) and system design assurance level (SDA) may be preset at installation. Systems that utilise multiple position sources with different design assurance levels, should be capable of adjusting the SDA and SIL quality indications to match the position source that is employed at the time of transmission.

The horizontal velocity accuracy bound (NACv) and vertical geometric altitude accuracy bound (GVA) should be dynamically provided to the ADS-B transmit unit together with the corresponding velocity and geometric altitude information within the same data set. However, NACv and GVA may be also preset at installation.

For further guidance on the ADS-B data quality indicators, refer to AMC1 ACNS.ADS.2020(a).

AMC1 ACNS.ADS.2010 ADS-B Transmit unit installation

The ADS-B transmit unit should be compliant with ETSO-C166b and ETSO-C112d, including any additional requirements as required to comply with the provision of the AMC's to Subpart D section 4 (e.g. On-the-ground status determination and maximum NIC encoding). Where such additional requirements apply, it is expected that the ADS-B transmit unit manufacturer supplies compliance information through a Declaration of Design and Performance (DDP), or an equivalent document

If using earlier versions of ETSO-C112( ), it should to be demonstrated that all applicable requirements from EUROCAE ED-102A have been implemented. This can be achieved by a positive deviation of compliance to previous versions of EUROCAE ED-73 that have been documented in the Declaration of Design and Performance (DDP).

AMC1 ACNS.ADS.2012 Antenna Diversity

The 1090 ES data protocol includes a bit to indicate if antenna diversity has been installed or not. The corresponding parameter for the Single Antenna bit is contained in register 65_{16} (message element bit '30') and should be set to the appropriate value.

Note 1: For detailed guidance on the required antenna diversity as a function of aircraft maximum cruising true airspeed capability, refer to AMC1 ACNS.ELS.4030.

Note 2: For further guidance on antenna installations, see CS ACNS.ELS.4020, CS ACNS.ELS.4030, AMC1 ACNS.ELS.4020 and AMC1 ACNS.ELS.4030.

AMC1 ACNS.ADS.2016 Simultaneous operation of ADS-B transmit units

Manual switching between transmitters is considered acceptable.

Note: The requirement applies to ADS-B transmit units broadcasting on the same data link. It does not preclude simultaneous operation of dual link installations.

AMC1 ACNS.ADS.2018 On-the-ground status Determination

For aircraft with retractable landing gear, the on-the-ground status determination is typically provided through a landing gear weight-on-wheels switch. For aircraft that have fixed-gear, the ADS-B Out system should be able to determine the air-ground status of the aircraft using other means.

Installations that provide a means to automatically determine on-the-ground status based on input from other aircraft sensors are acceptable if they are demonstrated to accurately detect the status. Otherwise, ground status validation algorithms should be implemented, using speed thresholds that match the typical aircraft's rotation speed as closely as possible.

It is noted that for the validation of a directly determined on-the-ground status that is not validated outside the ADS-B transmit function, validation against the aircraft's typical rotation speed (rather than a fixed value of 100 knots) might not have been tested in accordance with ETSO-C166b. If that is the case, it is expected that the ADS-B transmit unit manufacturer supplies compliance information through a Declaration of Design and Performance (DDP), or an equivalent document.

Detailed guidance material is provided in Appendix I.

AMC1 ACNS.ADS.2020 Horizontal Position and Velocity Data Sources

(a) GNSS Standards

(1) Basic GNSS System Approval

The horizontal position and velocity data source should be approved in accordance with either ETSO-C129a, or ETSO-C196, or ETSO-C145/ETSO-C146, including the additional qualification requirements as specified in paragraph (2) below.

(2) Additional GNSS Receiver Qualification Requirements

In order to fully address the standard associated with ADS-B Out, an ETSO authorisation alone may not be sufficient to ensure ADS-B compatibility. The position and velocity source should also comply with the following requirements (i) to (vi).

It is expected that compliance with these requirements is demonstrated by the equipment manufacturer and documented in the Declaration of Design and Performance (DDP), or an equivalent document. Detailed guidance material on the qualification requirements is provided in Appendix H Part 5.

i. The horizontal position integrity containment should have been qualified as per Appendix H Part 5 paragraph 1;

ii. The maximum time to alert for the indication of a signal-in-space data integrity failure should be 10 seconds as per Appendix H in Part 5 paragraph 1;

iii. Navigation modes that would force the NIC value temporarily to 'zero' whilst the actual horizontal position integrity containment bound would meet the NIC requirements in Appendix H Part 3 Table 20, should not be installed.

iv. The horizontal position source accuracy output should have been qualified as per Appendix H Part 5 paragraph 2;

v. The horizontal position source latency and timing characteristics should have been documented (see Appendix H Part 5 paragraph 3);

vi. The horizontal velocity accuracy output should have been qualified. If a dynamic horizontal velocity accuracy output is not provided, the transmitted

horizontal velocity accuracy should be based on a worst case accuracy. If a dynamic horizontal velocity accuracy output is provided, the source should have been qualified for this quality indication accordingly as per Appendix H Part 5 paragraph 4.

In addition, a means should be provided to establish the condition when the horizontal velocity track angle accuracy exceeds plus/minus 'eight' degrees as per Appendix H Part 5 paragraph 4.

(3) Interface Interoperability Aspects

It should be verified that the position and velocity information (including their respective quality indicators) received from the source are correctly interpreted by the ADS-B equipment.

(i) Horizontal Position Integrity Containment Bound

If the horizontal position sources outputs a horizontal position integrity containment bounds of less than 75 meters the transmit unit should limit the NIC value to 'eight'

It is expected that the ADS-B transmit unit manufacturer supplies compliance information through a Declaration of Design and Performance (DDP), or an equivalent document.

(ii) Horizontal Velocity Format

The position and velocity source manufacturer should provide information describing how the horizontal velocity information is output (i.e., in a ground speed/track angle format versus north/east velocity format) and the protocols used.

(4) Data Quality Indicator Testing

By design and under nominal GNSS satellite constellation conditions, an ADS-B Out system that is compliant with CS ACNS.ADS.2020 should meet the required values of the horizontal position NIC, NACp, SIL and horizontal velocity NACv quality indicators (refer to Appendix H Part 3 Table 20).

(b) Installation Guidance

The GNSS based position sources should be installed in accordance with FAA AC 20-138B (or later).

Note: EASA is developing GNSS installation guidance, once published, should be used instead of the FAA material.

(c) Multiple Position and Velocity Data Sources

(1) Multiple Source Approval

Any position and velocity source that is interfaced to the ADS-B transmit unit, should meet the requirements of CS ACNS.ADS.2020.

(2) Source Priority

If multiple horizontal position data sources are interfaced with the ADS-B transmit unit, priority should be given to the source that provides the best ADS-B performance with respect to the horizontal position integrity containment bound (NIC)..

A change of the selection between sources should only take place when the not selected source has exceeded the NIC performance of the selected source for several seconds.

(d) Interconnecting Avionics

Interconnecting avionics between a horizontal position and velocity data source and the ADS-B transmit unit are not recommended.

If installed, interconnecting avionics should:

(1) not output horizontal position and velocity data that has been blended with data from other sources;

(2) use GNSS horizontal velocity data to extrapolate the horizontal position data if extrapolation is deployed; and

(3) maintain full source resolution of the horizontal position and velocity data.

Interconnecting avionics that do not comply with the above may dilute the horizontal position accuracy achieved with GNSS-based sources, with detrimental effects on the usability of the ADS-B Out system.

Note: closely coupled GPS/IRS systems are not considered as interconnecting avionics.

AMC1 ACNS.ADS.2030 Data Sources as defined by Mode S Elementary and Enhanced Surveillance

(a) General Requirements

For the requirements and general guidance on the data sources providing the Mode S Elementary and Enhanced surveillance parameters, the following references to CS ACNS.ELS and CS ACNS.EHS apply:

(1) Aircraft Identification: CS ACNS.ELS.2030(a)(9);

(2) Mode A Code: CS ACNS.ELS.2030(a)(1) and (8) ;

(3) SPI: CS ACNS.ELS.2030(a)(2);

(4) Emergency Mode/Status: CS ACNS.ELS.2030(a)(1);

(5) Pressure Altitude: CS ACNS.ELS.2020, CS ACNS.ELS.2030(a)(4) and (10);

(6) Vertical Rate: AMC1 ACNS.EHS.2010;

(7) MCP/FCU Selected Altitude: : AMC1 ACNS.EHS.2010 (c)(1);

(8) Barometric Pressure Setting:AMC1 ACNS.EHS.2010;

(9) ACAS Operational/Resolution Advisory: AMC1 ACNS.ELS.2010; and

(10) ICAO 24 bit Address: CS ACNS.ELS.4000,

(b) Emergency Status

When transmitting the Mode A emergency status codes, the additional specific bits should be set (see Appendix H , Part 1, Definition 10).

(c) Pressure Altitude — NICbaro

For aircraft with an approved, non-Gillham altitude source, the Barometric Altitude Integrity Code 'NICbaro' should be set to 'one'.

For aircraft where the pressure altitude that is based on a Gillham coded input that has not been cross-checked against another source of pressure altitude, the 'NICbaro' should be set to 'zero'. Otherwise, the 'NICbaro' should be set to 'one'.

For general guidance on the ADS-B 'NICbaro' indicator that is associated with Pressure Altitude information, refer to Appendix H , Part 1, Definition 9.

(d) Vertical Rate

The Vertical Rate information should come from the most accurate and steady source.

Vertical Rate from an inertial sensor that is not blended with barometric altitude should not be transmitted. Neither should ADS-B transmit units derive a barometric altitude rate by sampling barometric altitude measurements.

The source bit for vertical rate (1090 ES register 09_{16}, message bit '36') should be coded as barometric when utilising barometric rate from an air data computer, or when using a blended or hybrid vertical rate. The source bit for vertical rate should only be coded as geometric when using vertical rate from a GNSS source.

Note: due to differences in the respective transmit formats, the above source prioritisation differs in some parts with the guidance applicable to Mode S Enhanced Surveillance as provided in AMC ACNS.EHS.2010.2.5.7.

For general guidance on Vertical Rate data sources, refer to Appendix H , Part 1, Definition 14.

(e) Selected Altitude (and related Modes)

With respect to the various status and mode fields contained in register 62_{16} (subtype 1), the respective provisions of AMC1 ACNS.EHS.2010 (c)(1) apply to the Selected Altitude Type, Status of MCP/FCU Mode Bits, VNAV Mode Engaged, Altitude Hold Mode, and Approach Mode information.

The population of the additional Autopilot Engaged and LNAV Mode Engaged fields status bits are optional but should be populated where the data is available.

AMC1 ACNS.ADS.2034 Geometric Altitude

(a) Geometric Altitude data source

The position source should output a vertical position accuracy metric to support the encoding of the Geometric Altitude GVA quality indicator.

GNSS position sources should provide the geometric altitude accuracy through the vertical figure of merit (VFOM). If that is the case, the vertical position source accuracy output by a GNSS receiver should have been qualified as per Appendix H Part 5 paragraph 5.

If the position source does not output a qualified vertical accuracy metric, the GVA parameter should be set to 'zero'.

For general guidance on the GVA encoding, refer to Definition 20 in Appendix H of Subpart D.

(b) Geometric Altitude Reference

A GNSS position source compliant with CS ACNS.ADS.2020 provides Geometric Altitude, in its native format, as geocentric height above the earth's ellipsoid shape. Height Above Ellipsoid (HAE) is described by the WGS-84 format.

Another altitude reference is described by the earth's geoid, a surface on which the gravitational potential is constant and which approximates the (local) mean levels of all the earth's seas. The difference between the mathematically idealised smooth ellipsoid and irregular geoid surfaces varies between +106m to -85m across the earth. The related Mean Sea Level (MSL) altitude is then established as the sum of the HAE altitude and those local differences (using look-up tables). MSL is sometimes also referred to as Height-Above-Geoid (HAG).

A position source that only provides HAG or MSL altitude (ARINC label 076) but not HAE (ARINC label 370) should, therefore, not be interfaced to the ADS-B transmit unit unless the ADS-B transmit unit can properly convert HAG/MSL to HAE, using the same HAG/MSL model as the position source (typically NATO STANAG Appendix 6). This should be based on position source installation instructions that specify a deterministic method to perform conversion to HAE, and be demonstrated during ADS-B transmit unit design approval. It

is expected that the respective compliance information is supplied by the position and velocity source, and ADS-B transmit unit manufacturers through a Declaration of Design and Performance (DDP) or an equivalent document.

Note: Horizontal position sources compliant with Class 3 equipment approved under ETSO-C145c/C146c are required to output HAE altitude. The requirement has been implemented from revision C of RTCA/DO-229 onwards.

(c) Geometric Altitude Accuracy Quality Indicator Testing

If a qualified vertical accuracy metric is available, under nominal GNSS satellite constellation and visibility conditions, the transmitted GVA value should be a minimum of 'one'.

AMC1 ACNS.ADS.2040(a) Flight Deck Interface

(a) Installations

(1) Data Transmission and Display Consistency

The data transmitted by the active ADS-B transmit unit with the data displayed to the flight crew should be consistent.

Note: The horizontal position data displayed to the flight crew might be based on data from more than the position source than that used for ADS-B transmissions.

(2) Single Point of Flight Crew Entry

Installations that do not provide a single point of flight crew entry for the transponder and the ADS-B transmit unit should be evaluated to ensure that dual entry of the Mode A code, SPI, and emergency status does not lead to the transmission by the active ADS-B transmit unit of inconsistent data, particularly when communicating an aircraft emergency.

(b) ADS-B Off Switch

If control is provided to enable or disable the ADS-B transmit unit, then the status of the active ADS-B transmit unit should clearly be indicated to the flight crew from their normal seated position.

The respective controls should be located such that inadvertent disabling is prevented.

AMC1 ACNS.ADS.2040(b) Flight Deck Interface

ADS-B Out system failures should be indicated in amber without undue delay, i.e. a response time within the order of one second.

ADS-B Out system failures may be indicated independently of each other; however, detailed operating instructions should be developed to describe the means to interpret indications.

The ADS-B Out system failure indication should not be confused with an ACAS or Mode S system failure annunciations.

In case the ADS-B Out system function failure is linked to the unavailability of horizontal position information, it is expected that the transponder should continue to support the ACAS and Mode S functions.

The proper indications of the ADS-B Out system failures should be tested.

AMC1 ACNS.ADS.3022 and 3024 Horizontal Position and Velocity Total and Uncompensated Latency

(a) Time of Applicability

With respect to the latency requirements in CS ACNS.ADS.3022 and CS ACNS.ADS.3024, the initial time of applicability (ITOA) is the time of validity of the position or velocity solution. Hence, the latency between the time of signal in space measurement (TOM) and this time of validity is excluded from the total latency budget.

The transmit time of applicability (TTOA) equals the initial time of applicability plus the amount of compensated latency (CL), as valid at the time at which the ADS-B transmit unit broadcasts the position (or velocity) information (TOT).

(b) Compliance Demonstration

Total latency (TL) is the difference between time of transmission (TOT) and initial time of applicability (ITOA). The analysis of total latency includes the maximum asynchronous delay caused by the time difference of position (or velocity) updates arriving at the ADS-B transmit unit and of transmitting the information. It is noted that for ADS-B transmit units compliant with AMC1 ACNS.ADS.2010, this asynchronous delay can be up to 1.1 second.

Uncompensated latency (UL, or more generically a latency compensation error) is the difference between total latency (TL) and amount of compensated latency (CL) thereof. Therefore, uncompensated latency determines the transmit time of applicability (TTOA). The GNSS time mark if provided to the transmit system, can be used by the ADS-B transmit unit to reduce uncompensated latency. It is possible for compensation algorithms to overcompensate for the effects of latency, also as a result of the desired attempt to account for latency external to the ADS-B transmit unit. This might lead to transmitting a position that is out in front of the actual aircraft position rather than behind the actual aircraft position. This is acceptable as long as the transmitted position is not further ahead than 200 ms.

The various latency related parameters are summarised in Figure 1.

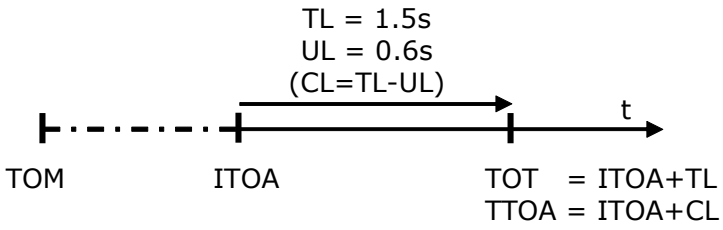


Figure 1: Latency Parameters

Latency should be addressed through analysis rather than testing. Total and uncompensated latency information should be generated by the respective manufacturers of the position source, ADS-B transmit unit and any interconnecting avionics and should be included as part of the latency analysis.

The latency analysis should determine the latency applicable to each component of the ADS-B Out system. The total of all of the individual component latencies should be established as the sum of their maximum latencies.

ADS-B Out systems whereby the transmit equipment compliant with AMC1 ACNS.ADS.2010 is directly connected to a position source compliant with AMC1 ACNS.ADS.2020, should meet the total latency and uncompensated latency requirements without further analysis.

For other ADS-B Out systems, the applicant should perform a detailed position and velocity latency analysis. This includes systems where ADS-B Out system components are interfaced through a highly integrated architecture.

For detailed guidance on horizontal position and velocity source latency qualification, refer to Appendix H Part 5.

It is expected that this compliance information is supplied by the position and velocity source manufacturer through a Declaration of Design and Performance (DDP) or an equivalent document.

(c) ADS-B Quality Indicator Change Latency

The ADS-B Quality Indicator change latency requirements are driven by the maximum time to alert for the indication of a data integrity failure with respect to exceeding integrity containment bound (CS ACNS.ADS.2020 and related AMC guidance).

For detailed guidance on time to alert qualification, refer to Appendix H Part 5.

(d) Horizontal Position Latency Compensation

The ADS-B transmit unit may compensate for horizontal position latency incurred outside the ADS-B transmit unit (see sub-paragraph 2 above). If such is implemented, a verifiable estimation of the delay between the time of applicability of the position measurement, and the provision of that measurement to the ADS-B transmit unit data interface should be performed

Appendix A — Background information for Mode A/C surveillance system

(a) General

This appendix provides additional references, background information, and guidance for maintenance testing, as appropriate to Mode A/C surveillance installations.

(b) Related References

(1) EASA

ETSO-C74d**,** Minimum Performance Standards for Airborne ATC Transponder Equipment.

(2) ICAO

i. ICAO Annex 10, Volume IV, Aeronautical Communications (Surveillance Radar and Collision Avoidance Systems) — Amd. 85;

ii. ICAO Document 8168-OPS/611 Volume I, Procedures for Air Navigation Services, Aircraft Operations;

iii. ICAO Document 4444-ATM/501, Procedures for Air Navigation Service, Air Traffic Management; and

iv. ICAO EUR Regional Air Navigation Plan, Part IV CNS Supplement SSR Code Allocation List for the EUR region, current edition.

(3) EUROCAE

i. ED-43, Minimum Operational Performance Requirements for SSR Transponder and Alticoder; and

ii. ED-26, Minimum Performance Specification for Airborne Altitude Measurement and Coding Systems.

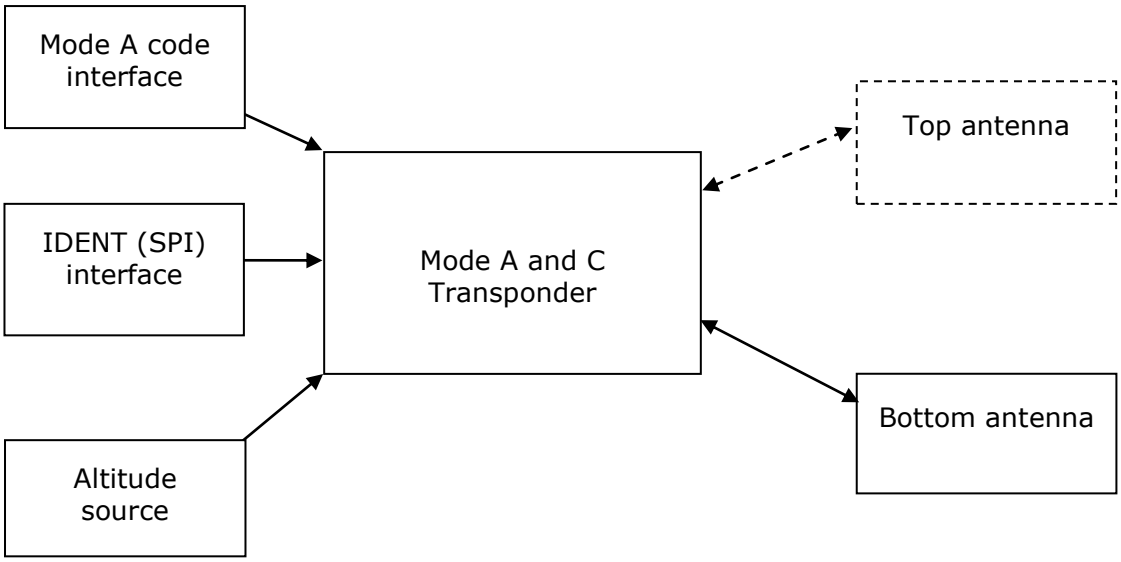
(4) RTCA

i. DO-144A Minimum Operational Performance Standards (MOPS) for Air traffic Control Radar Beacon Systems (ATCRBS) Airborne Equipment

(c) Background Information

Airborne surveillance system

The following diagram presents the Mode A and C transponder and its main functional interfaces.


Mode A code interface
IDENT (SPI) interface
Altitude source
Mode A and C Transponder
Top antenna
Bottom antenna

Appendix B — Background information on Mode S ELS

(a) General

This appendix provides background information on Elementary Surveillance (ELS) useful to understand ELS airborne surveillance system defined in the CS-ACNS.ELS and its associated AMCs.

(b) Related Material

(1) EASA

ETSO-C112d**,** Minimum Operational Performance Specification for SSR Mode S Transponders. (Based on EUROCAE ED-73E).

(2) ICAO

i. ICAO Annex 10, Volume IV, Amd. 85, Aeronautical Communications (Surveillance Radar and Collision Avoidance Systems);

ii. ICAO Document 9871 Edition 2 (transponder register formats);

iii. ICAO Document 8168-OPS/611 Volume I (Procedures for Air Navigation Services); and

iv. ICAO Document Doc 4444-RAC/501 Procedures for Air Navigation Service, Air Traffic Management.

(3) EUROCAE

i. ED-73E Minimum Operational Performance Specification for Secondary Surveillance Radar Mode S Transponders; and

ii. ED-26 Minimum Performance Specification for Airborne Altitude Measurement and Coding Systems.

(4) RTCA

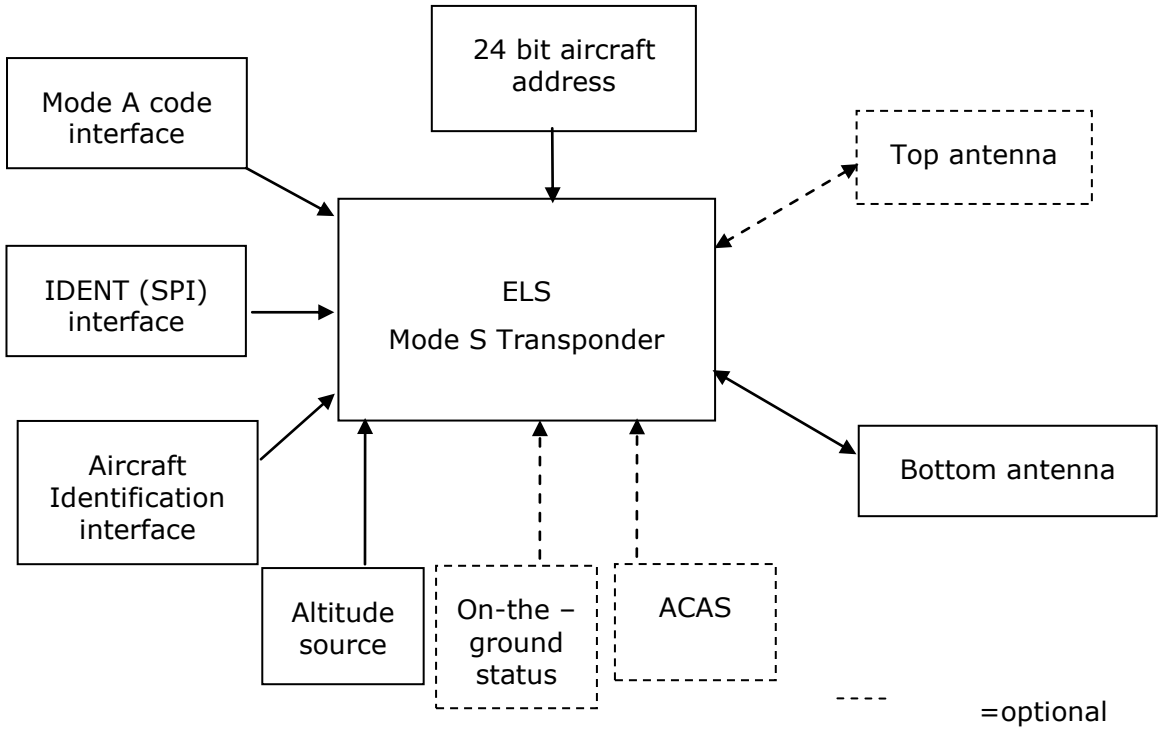
RTCA DO-181E.Minimum Operational Performance Specification for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment

(c) Background Information

Airborne surveillance system description

This section describes the ELS system including transponder, interfaces, and antenna.

The following diagram represents the Mode S Transponder and its main functional interfaces.



(1) Acquisition of aircraft position by Mode S ELS radar

Aircraft entering the coverage of a Mode S radar is first acquired by All Call interrogations to which the transponder will reply if it is not on the ground. Therefore, it is important to test that the airborne surveillance system correctly takes into account the on-the-ground information. The on-the-ground status is also used by the ACAS systems to select aircraft which will be tracked.

During this acquisition phase the radar will acquire the Horizontal position and the 24-bit aircraft address corresponding to the aircraft technical address on the RF network.

The position and the aircraft address will be subsequently used to selectively interrogate the aircraft during the rest of its trajectory through the radar coverage.

Selective interrogations will be used:

i. to update the horizontal position of the aircraft;

ii. to request the aircraft to not reply to the All Call interrogations specifically transmitted by the radar. This is known as lockout command;

iii. to request additional information such as Mode A code and altitude;and

iv. to request further information to be downlinked from specific aircraft transponder registers such as the Aircraft Identification.

(2) Determination of the aircraft surveillance system capability

Ground surveillance system will need to establish the capabilities of the aircraft surveillance system to extract information only if it is available in the aircraft surveillance system. If this is not done, it could result in a situation where the aircraft would no longer reply to the interrogations used by the radar, and, therefore, the position of the aircraft could be lost. Hence, there is a need to have correct reporting of the aircraft surveillance system capability.

This process starts by determining whether the transponder is level 2 or above by checking the CA field of the Mode S All Call replies. The CA field is encoded with either 4,5,6,7 to indicate that the transponder is a level 2.

If the transponder is a level 2 or above transponder, the second step of the process is the verification of the data-link capability provided in register 10_{16}, the 'Data link capability report'. It contains different information about the data link capability of the airborne surveillance system

Elementary Surveillance System will use important information from this register, including:

(i) Aircraft Identification capability (bit 33 of register 1016) to determine the availability of the register containing the Aircraft Identification;

(ii) Surveillance Identifier code (bit 35 of register 10_{16}) which indicates if SI protocol can be used to lockout the transponder; and

(iii) the Mode S Specific Services capability (bit 25 of register 10_{16}) which indicates that Mode S specific services; including additional registers used for enhanced surveillance; are supported; and that the particular capability reports should be checked.

If the 'Mode S Specific Services' bit is set in register $10_{16,}$ the availability of other registers will be checked by extracting register 17_{16}.

(3) Extraction of Aircraft Identification using Mode S protocol

Aircraft equipped with Mode S having an aircraft identification feature transmits its Aircraft Identification as specified in Item 7 of the ICAO flight plan, or when no flight plan has been filed, the aircraft registration.

Aircraft Identification information will be obtained by Mode S radar by extracting the transponder register 20_{16} at the track initialisation.

The Aircraft Identification is variable when it changes from one flight to another flight. It is, therefore, possible that input errors may occur. Whenever it is observed on the ground situation display that the Aircraft Identification transmitted by a Mode S-equipped aircraft is different from that expected from the aircraft, the flight crew will be requested to confirm and, if necessary, re-enter the correct Aircraft Identification.

When Aircraft Identification is modified, the transponder will indicate this change for 18s in its selective replies. This is done using the Mode S Comm-B Broadcast protocol (ICAO Annex 10 Volume IV 3.1.2.6.11.4). The Mode S ground station will extract the Comm–B Broadcast message to obtain the new value of the Aircraft Identification.

(4) Extraction of Mode A code using Mode S protocol

Ground Mode S surveillance system will extract Mode A code at track initialisation.

If the Mode A code is modified, the transponder will indicate this change for 18s in its selective replies. This is done by raising an alert bit which is set for 18s after the change. Once this alert is detected, the Mode S ground stations will extract the new Mode A code.

It is, therefore important, that the change of the Mode A code happens on the active transponder which is announcing the change for 18s.

Note: ED-73E contains additional requirement requiring the announcement of a Mode A code change when a transponder becomes active. This is not necessarily available on older Mode S transponders in which it may be necessary to follow a specified procedure on installations with no common control interface. In some

instances, a ground system workaround, consisting of periodically extracting the Mode A code, has also been implemented.

(5) ACAS Resolution Advisory (RA) report extraction

When a resolution advisory has been produced, the transponder announces the presence of a 'RA report' for the time that the RA is active until 18s after it has ceased. The Mode S ground stations will extract the register 30_{16} to obtain the information

(6) Summary of registers used for ELS

Register 10_{16} to obtain information on data link capability of the airborne surveillance system.

Register 17_{16} to obtain information on additional services available. For ELS, it is possible that register 17_{16} is empty (=0).

Register 20_{16} to obtain the Aircraft Identification.

Register 30_{16} to obtain the RA Report

(7) Information on Mode S replies used to support ELS

The following Mode S reply types are used to track the aircraft and obtain additional data:

DF11: Mode S All Call replies containing the 24-bit Aircraft Address and the CA field indicating whether the transponder is level 2 or greater and whether the aircraft is on the ground or airborne. DF11 can also be spontaneously transmitted as acquisition squitters. These replies are used for aircraft acquisition.

DF4: Short Mode S reply containing Altitude information.

DF5: Short Mode S reply containing the selected Mode A code.

DF20: Long Mode S reply containing the Altitude information and the content of the transponder register requested.

DF21: Long Mode S reply containing the Mode A code and the content of the transponder register requested.

(d) Existing Installed Transponders

A number of service bulletins have been issued to rectify some observed deficiencies and have already been addressed by the equipment manufacturers. Therefore, the installed transponders should have all published corrective transponder equipment service bulletins (SB) relating to the correct operation of the Elementary functionality embodied.

Appendix C — Background information on Mode S EHS

(a) Introduction

This appendix provides background information on Enhanced Surveillance (EHS) useful to understand EHS airborne surveillance system defined in the CS-ACNS.EHS and its associated AMCs.

(b) Related Material

(1) EASA

ETSO-C112d, Minimum Operational Performance Specification for SSR Mode S Transponders. (Based on EUROCAE ED-73E).

(2) EUROCONTROL

i. The Concept of Operations - Mode S in Europe, document SUR.ET2.ST02.1000-CNP-01-00, Edition 2, Nov 1996:

ii. Operational Hazard Assessment of Elementary and Enhanced Surveillance, Edition 1.1, EATMP Infocentre Reference: 04/04/07-01, 07.04.2004; and

iii. Preliminary System Safety Analysis for the Controller Access Parameter service delivered by Mode S Enhanced Surveillance, Edition 1.1, EATMP Infocentre Reference: 04/04/07-02, 07.04.2004

(3) ICAO

i. ICAO Annex 10, Volume IV, Amd. 85, Aeronautical Communications (Surveillance Radar and Collision Avoidance Systems);

ii. ICAO Document 9871 Edition 2;

iii. ICAO Document 8168-OPS/611 Volume I (Procedures for Air Navigation Services); and

iv. ICAO Document Doc 4444-RAC/501 Procedures for Air Navigation Service, Air Traffic Management.

(4) EUROCAE

i. ED-73E Minimum Operational Performance Specification for Secondary Surveillance Radar Mode S Transponders;

ii. ED-26 Minimum Performance Specification for Airborne Altitude Measurement and Coding Systems; and

iii. ED-12C Software Considerations in Airborne Systems and Equipment Certification.

(5) RTCA

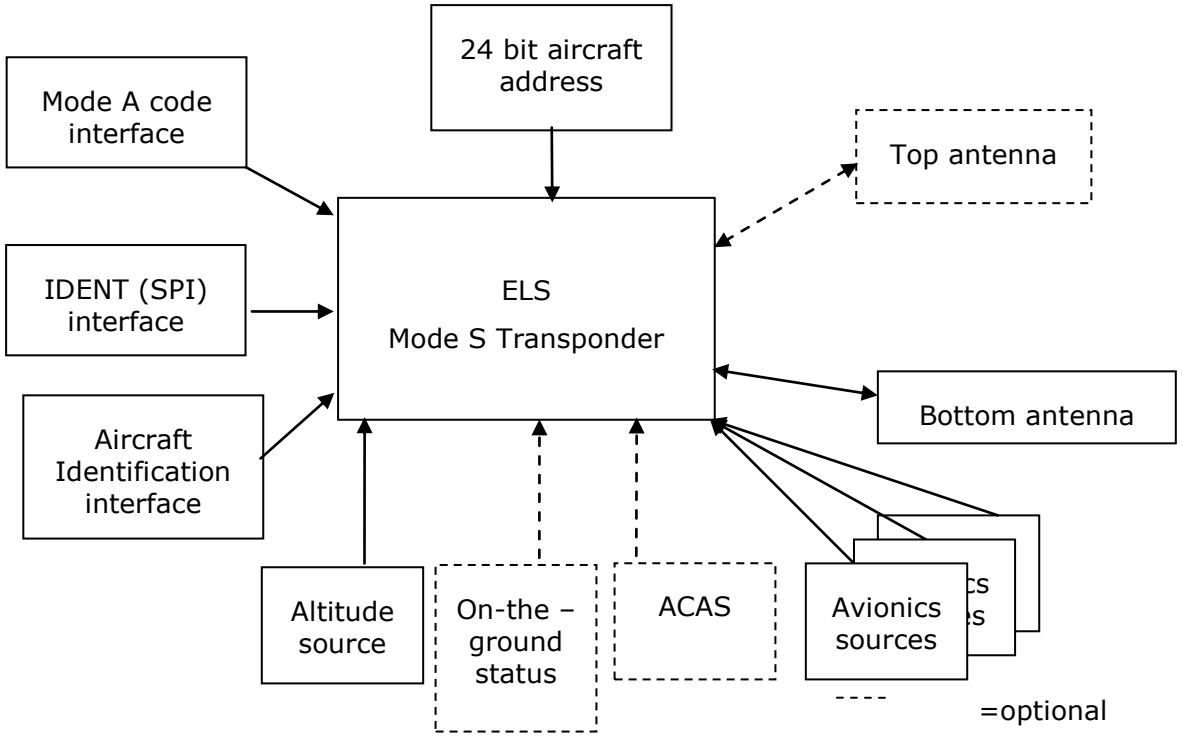
DO-181E Minimum Operational Performance Specification for Air Traffic Control Radar Beacon System/ Mode Select (ATCRBS/Mode S) Airborne Equipment.

(c) Background Information

(1) Airborne surveillance system description

This section describes the EHS system including transponder, interfaces, and antenna.

The following diagram represents the Mode S Transponder, and its main functional interfaces. It is to be noted that different interfaces coming from different parts of the avionics may need to be connected to the transponder to support EHS.



(2) Registers used to support EHS capability

i. Capability

In addition to the registers already used for ELS capability establishment, the EHS capability of the aircraft will be established using register 17_{16} and $1D_{16}$.

Register 17_{16} will indicate which other registers (e.g. 40_{16},50_{16},60_{16}) are currently supported by the airborne surveillance system.

Ground systems could also use register 18_{16} to $1C_{16}$ to determine which registers are installed if those register are not included in register 17_{16}.

Register $1D_{16}$ is used to determine if Dataflash specific MSP is installed. Dataflash is an application allowing the transmission of registers to the ground only when they have changed, and, therefore, removing the need for periodic extraction of registers. Dataflash is not expected to be installed, however, some Mode S ground stations have been developed to take benefit of the dataflash application when available on aircraft.

Mode S ground stations can also use Mode S sub network version to filter old systems not correctly supporting EHS.

ii. Basic Data

Example of a basic list of registers and parameters to use to support the declaration of registers and parameters supported by an EHS installation is provided in Table 2 below.

Table 2 - Example of basic list of EHS registers and parameters

Register number	***Assignment***	**Capability reporting in register 18_{16} to $1C_{16}$**	**parameters**	**EHS req**
40_{16}	Selected vertical intention	Reg. 19_{16} Bit 49	MCP/FCU Selected Altitude	Yes
			FMS Selected Altitude	No
			Barometric Pressure Setting	Yes
			MCP/FCU Mode bits	No
			Target altitude source bits	No
50_{16}	Track and turn report	Reg. 19_{16} Bit 33	Roll Angle	Yes
			True Track angle	Yes
			Ground speed	Yes
			Track Angle Rate	Yes
			True Airspeed	Yes
60_{16}	Heading and speed report	Reg. 19_{16} Bit 17	Magnetic Heading	Yes
			Indicated Airspeed	Yes
			Mach	Yes
			Barometric Altitude Rate	Yes
			Inertial Vertical Velocity	Yes

(3) Other data

Mode S ground stations can extract other data when available. It is, therefore, important that all data provided are verified.

The Table 3 provides more data to facilitate the declaration of other registers and parameters which may be supported and which may need to be added to the basic list provided above.

Table 3 - Example of extended list of Transponder registers and supported parameters

Register number	**Assignment**	**Capability reporting in register 18_{16} to $1C_{16}$**	**parameters**	**EHS req**
$0B_{16}$	Air/air information 1 (aircraft state)	Reg. 18_{16} Bit 46	True Air Speed	No
			heading	No
			True track angle	No
			Ground speed	No
$0C_{16}$	Air/air information 2 (aircraft intent)	Reg. 18_{16} Bit 45	Level Off Altitude	No
			Next Course	No

Register number	Assignment	Capability reporting in register 18_{16} to $1C_{16}$	parameters	EHS req
			Time to Next Waypoint	No
			Vertical Velocity	No
			Roll Angle	No
21_{16}	Aircraft and airline registration markings	Reg. 18_{16} Bit 24	Aircraft registration number	No
			ICAO airline registration marking	No
22_{16}	Antenna positions	Reg. 18_{16} Bit 23		No
2_6	Aircraft type	Reg. 18_{16} Bit 20		No
41_{16}	Next waypoint identifier	Reg. 19_{16} Bit 48	-	No
42_{16}	Next waypoint position	Reg. 19_{16} Bit 47	Waypoint latitude	No
			Waypoint Longitude	No
			Waypoint Crossing Altitude	No
43_{16}	Next waypoint information	Reg. 19_{16} Bit 46	Bearing to waypoint	No
			Time To Go	No
			Distance To Go	No
44_{16}	Meteorological routine air report	Reg. 19_{16} Bit 45	Wind Speed and Direction	No
			Average Static Pressure	No
			Turbulence	No
			Humidity	No
45_{16}	Meteorological hazard report	Reg. 19_{16} Bit 44	Turbulence	No
			Wind Shear	No
			Microburst	No
			Icing	No
			Wake vortex	No
			Static Air temperature	No
			Average Static Pressure	No
			Radio Height	No
48_{16}	VHF channel report	Reg. 19_{16} Bit 41	VHF1	No
			VHF2	No
			VHF3	No

Register number	Assignment	Capability reporting in register 18_{16} to $1C_{16}$	parameters	EHS req
51_{16}	Position report coarse	Reg. 19_{16} Bit 32	Latitude and Longitude and Pressure altitude	No
52_{16}	Position report fine	Reg. 19_{16} Bit 31	Latitude fine and Longitude Fine and Pressure altitude or GNSS Height	No
53_{16}	Air-referenced state vector	Reg. 19_{16} Bit 30	Magnetic Heading	No
			Indicated Airspeed	No
			Mach Number	No
			True Airspeed	No
			Altitude Rate	No
54_{16}	Waypoint 1	Reg. 19_{16} Bit 29	-	No
55_{16}	Waypoint 2	Reg. 19_{16} Bit 28	-	No
56_{16}	Waypoint 3	Reg. 19_{16} Bit 17	-	No
$E5_{16}$	ACAS unit part number	Reg. $1C_{16}$ Bit 52	-	No
$E6_{16}$	ACAS unit software revision number	Reg. $1C_{16}$ Bit 51	-	No
$F1_{16}$	Military applications	Reg. $1C_{16}$ Bit 40	-	No
$F2_{16}$	Military applications	Reg. $1C_{16}$ Bit 39	-	No

Note 1: When different fields are defined with their own status, each field will be listed in the table. In this case, it is possible to indicate the provision of the associated parameter by checking the value of the associated status bit.

Note 2: For more information about the content of the registers see Doc 9871 Edition 2 or above.

(d) Existing Installed Transponders

A number of service bulletins have been issued to rectify some observed deficiencies and have already been addressed by the equipment manufacturers Therefore, the installed transponders should have all published corrective transponder equipment service bulletins (SB) relating to the correct operation of the elementary functionality embodied .

Appendix D — Differences between CS ACNS.ELS and JAA TGL 13 Rev1

To demonstrate compliance with CS-ACNS Elementary Surveillance requirements, the following additional points need to be addressed for aircraft previously compliant with JAA TGL 13 Rev1:

(a) Verification of consistency between the Aircraft identification and that sent in Extended Squitter messages and in the Mode S replies, (See CS ACNS.ELS.2010);

(b) Verification of consistency between the pressure altitude provided in Extended Squitter messages and in Mode S replies if the installation sends Extended Squitter but it is not compliant with Subpart D section 4 (See CS ACNS.ELS.2010 (b));

(c) The ability to change the Aircraft Identification in flight if the aircraft uses variable aircraft identification (See CS ACNS.ELS.2030 (a)); and

(d) Other parameters provided by the airborne surveillance system are verified. (See CS ACNS.ELS.2010 (b)).

Note. The tests of the other parameters transmitted by the system allow certification of aircraft not subject to full EHS mandate but capable of transmitting some of the parameters which can be used by the operational systems.

Appendix E — Differences between CS-ACNS.EHS and EASA AMC 20-13

To demonstrate compliance with CS-ACNS Enhanced Surveillance requirements, the following additional points need to be addressed for aircraft previously compliant with EASA AMC 20-13:

(a) A list of all registers and parameters transmitted by the system is provided (See AMC1 ACNS.EHS.2010 (a)) with a confirmation of good operation;

(b) All parameters/registers are tested to ensure correct data is transmitted by the Mode S transponder (See CS ACNS.ELS.2010 (b) (3)); and

(c) Barometric pressure setting is provided and corresponds to 1013.25 when standard pressure is used to fly the aircraft (See CS ACNS.ELS.2010 (c) (3))

Appendix F — Example of Flight Manual Supplement for ELS/EHS

This Flight Manual is EASA approved under Approval Number P-EASA.xxxxx

Flight Manual [*or POH as appropriate*] Reference _____

(Company Name)

FLIGHT MANUAL SUPPLEMENT

Aircraft Model: _____

Serial Number: ____

SSR MODE S Elementary/Enhanced Surveillance

Modification Number _____

The limitations and information contained herein either supplement or, in the case of conflict, override those in the flight manual.

GENERAL

The installed transponder system is able to respond to interrogations in Modes A, C and S and is fully compliant with the requirements of CS ACNS.ELS/EHS (Mode S Elementary/Enhanced Surveillance). A detailed description of the transponder operation can be found in the _____, P/N _____, Rev. _____ or subsequent revisions.

LIMITATIONS

None

EMERGENCY PROCEDURES

No change to Approved Aircraft Flight Manual

NORMAL/ ABNORMAL PROCEDURES

Normal/Abnormal transponder operating procedures are described in the _____, P/N _____, Rev. _____ or subsequent revisions.

The procedure to change Aircraft Identification in flight is described in _____.

PERFORMANCE

No change to Approved Aircraft Flight Manual.

To be inserted in the flight manual and record sheet amended accordingly.

Page (__) of (__) **Authority/DOA Approval:_____Date:_____**

Issue:_____ **Signature:_____**

Appendix G - Example of Flight Manual Supplement for ADB-S out

(*Aircraft Type*) Flight Manual [or POH as appropriate] Reference (*XXXX*)

(Company Name)

FLIGHT MANUAL SUPPLEMENT *(1)* ISSUE *(1)*

Aircraft Model: _____

Serial Number: ___

ADS-B Out

Modification Number _____

ADDITIONAL LIMITATIONS AND INFORMATION

The limitations and information contained herein either supplement or, in the case of conflict, override those in the flight manual.

GENERAL

The installed ADS-B system is fully compliant with the requirements of CS ACNS.ADS (1090 MHz Extended Squitter ADS-B Out). A detailed description of the system operation can be found in the _____, P/N _____, Rev. _____ or subsequent revisions.

LIMITATIONS

None

EMERGENCY PROCEDURES

No change to Approved Aircraft Flight Manual

NORMAL/ ABNORMAL PROCEDURES

Normal/Abnormal operating procedures are described in the _____, P/N _____, Rev. _____ or subsequent revisions.

The procedure to change Aircraft Identification in flight is described in _____.

PERFORMANCE

No change to Approved Aircraft Flight Manual

To be inserted in the flight manual and record sheet amended accordingly.

Page (__) of (__) **Authority/DOA Approval:_____Date:_____**

Issue:_____ **Signature:_____**

Appendix H – Guidance on 1090 MHz Extended Squitter ADS-B Out

Part 1 – ADS-B Out Data Parameters (AMC ACNS.ADS.2005(a))

Part 1 of this Appendix provides guidance to the aircraft integrator on the minimum ADS-B Out surveillance data requirements (Table 5 and associated Definitions).

In addition, guidance is given for the overall understanding of the ADS-B Out system, in support of equipment configuration and ADS-B Out data parameter testing, as appropriate. This includes the presentation of data encodings related to the so-called BDS registers (Table 4), as extracted from ED-102A. The content of the various BDS registers are loaded into the 56-bit ADS-B message (ME) field of the Mode S Downlink Format 17 (DF17, bits 33-88), in line with their respective transmission rates.

Table 5 below makes reference to the BDS registers that contain the various ADS-B Out data parameters. When Table 5 states Same source as for Mode S replies, reference is made to the requirement that the content of ADS-B broadcasts and Mode S replies that carry the same information need to come from the same source (CS ACNS.ADS.2008(b)).

The reference to the BDS registers is provided in order to facilitate a detailed understanding and traceability of ADS-B Out requirements at ADS-B transmit unit level, also in support of integration testing, as appropriate.

The relationship between the BDS registers and the ADS-B message Type Codes (first 5 bits in the 56-bit ADS-B message field) is thereby as shown in Table 4. The Type Code is used to differentiate between ADS-B message types (i.e. BDS registers). In addition, for Airborne and Surface Position Messages, the Type Code is used to encode the horizontal position integrity containment bounds (NIC). The Subtype Code is used to further differentiate between ADS-B messages of a certain type (e.g. Operational Status Message).

A number of service bulletins have been issued to rectify some observed deficiencies and have already been addressed by the equipment manufacturers Therefore, the installed transponders should have all published corrective transponder equipment service bulletins (SB) relating to the correct operation of the ADS-B functionality embodied.

Table 4: BDS Register Overview

BDS Register	Type Code(s)	Subtype Code
05_{16} – Airborne Position Message	0, 9-18, 20-22	n/a
06_{16} – Surface Position Message	0, 5-8	n/a
08_{16} - Aircraft Identification and Category Message	1	n/a
09_{16} - Airborne Velocity Message Velocity over Ground (Normal/Supersonic)	19	1+2
61_{16} - Aircraft Status Message Emergency Status and Mode A Code	28	1
61_{16} - Aircraft Status Message ACAS RA Broadcast	28	2
62_{16} - Target State and Status Message	29	1
65_{16} – Aircraft Operational Status Message While Airborne	31	0
65_{16} – Aircraft Operational Status Message On the Surface	31	1

Table 5: Minimum ADS-B Out Surveillance Data Transmission Requirements

Item	Parameter	Requirements	BDS Register	Remarks
1	Aircraft Identification	See Definition 1	08_{16}	Same source as for Mode S replies
2	Mode A Code	See Definition 2	61_{16}	Same source as for Mode S replies Broadcast suppressed for conspicuity code '1000'
3	ICAO 24-bit aircraft address	Transmit ICAO 24-bit aircraft address	All BDS (AA field of DF17, bits 9-32)	Unique 24 bit aircraft address needs to be assigned by the responsible authority
4a	Airborne Horizontal Position – Latitude and Longitude	See Definition 3	05_{16}	
4b	Airborne Horizontal Position Quality: NIC	See Definition 4 and 5	05_{16} Type Codes	Incl. NIC Supplements A (65_{16}) and B (05_{16})
4c	Horizontal Position Quality: NACp	See Definition 4 and 6	62_{16} and 65_{16}	
4d	Horizontal Position Quality: SIL	See Definition 4 and 7	62_{16} and 65_{16}	Incl. SIL Supplement.
4e	Horizontal Position Quality: SDA	See Definition 4 and 8	65_{16}	
5	Pressure Altitude	See Definition 9	05_{16}	Same source as for Mode S replies Data associated with 'NICbaro' integrity indicator
6	Special Position Identification (SPI)	Setting as per ED-73E §2.5	05_{16}	Same source as for Mode S replies
7a	Emergency Status	See Definition 10	61_{16} (subtype 1)	Same source as for Mode S replies (where defined for SSR)
7b	Emergency Indication	Setting as per ED-73E §2.5	05_{16}	Same source as for Mode S replies
8	1090 ES Version Number	To be set to 2 for ED-102A/DO-260B systems.	65_{16}	Value is fixed at the time the ADS-B transmit unit is manufactured.

Item	Parameter	Requirements	BDS Register	Remarks
9a	Airborne Horizontal Velocity (Ground Speed) - east/west and north/south	See Definition 11	09_{16} (subtypes 1and2)	Same source as for SSR EHS replies
9b	Horizontal Velocity Quality: NACv	See Definition 12	09_{16} (airborne) and 65_{16} (subtype 1, surface)	
10	Emitter Category	See Definition 13	08_{16}	
11	Vertical Rate	See Definition 14	09_{16} (subtypes 1and2)	Selected source is indicated in 09_{16} source indication
12a	Surface Horizontal Position – Latitude and Longitude	Source see AMC ACNS.ADS.2020 See Definition 3	06_{16}	Quality indicators NACp, SIL, SDA: same encodings as for airborne horizontal position
12b	Surface Horizontal Position Quality: NIC	See Definition 15	06_{16} Type Codes	Incl. NIC Supplements A and C (both 65_{16})
13	Heading/Ground Track	See Definition 16	06_{16}	Heading preferred source
14	Movement (surface ground speed)	See Definitions 11 and 12	06_{16}	NACv: same as for airborne ground velocity (see 9b)
15	Length/width of Aircraft	See Definition 17	65_{16} (subtype 1)	
16	GPS Antenna Offset	See Definition 18	65_{16} (subtype 1)	Lateral and longitudinal
17a	Geometric Altitude	See Definition 19	09_{16} (05_{16})	In 09_{16} reported as difference from Pressure Altitude
17b	Geometric Altitude Quality: GVA	See Definition 20	65_{16} (subtype 0)	

Definition 1: Aircraft Identification Data Sources

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

A flight management system; or

A pilot control panel; or

For aircraft, which always operate with the same aircraft identification (e.g. using registration as the aircraft identification), it may be programmed into equipment at installation.

In case no ICAO flight plan is filed, the Aircraft Registration is provided to the ADS-B transmit unit.

Definition 2: Mode A Code

Refer to AMC1 ACNS.ELS.2010.2.3 for general guidance.

When the ADS-B transmit unit receives a Mode A Code containing the Mode S conspicuity code (1000), the broadcast of Mode A code information, other than for emergency codes, is stopped.

Note: The broadcast of the Mode A Code is provided as a transitional feature, e.g. to aid operation of legacy ATC automation systems that use Mode A Code for Flight Plan correlation. Entry of the Mode A Code of 1000 will disable the transmission of the Mode A Code, and, hence, reduce the overall 1090 ES transmission rate.

Definition 3: Horizontal Position Information

The Mode S Extended Squitter position format uses the Compact Position Reporting (CPR) algorithm to encode latitude and longitude efficiently into messages. The resulting messages are compact in the sense that several higher order bits which are normally constant for long periods of time, are not transmitted in every message.

The CPR technique enables a receiving system to unambiguously determine the location of the aircraft, and, hence ,reconstruct the original information provided by the source. If required for integration testing purposes, detailed guidance on the CPR algorithm is provided in ED-102A/DO-260B.

A horizontal position data source provides position information for both the airborne and surface horizontal position data formats (i.e. registers 05_{16} or 06_{16}, respectively), accordingly encoded by the ADS-B transmit unit depending on the aircraft airborne/surface state.

Definition 4: Horizontal Position Quality – NIC and NACp

The encoding of the NIC and NACp horizontal position quality indicators should be directly derived from the corresponding integrity and accuracy information as being reported by the selected horizontal position source (refer also to CS-ACNS.ADS.2008(c)).

In case a measurement integrity failure has been indicated by the selected horizontal position source (e.g. bit 11 of ARINC label 130 for ARINC 743A compliant sources), both the NIC and NACp quality indicators will be set to invalid (zero), regardless of the indicated integrity containment bound (e.g. HPL).

Definition 5: NIC

NIC is reported so that surveillance applications, such as by ATC or other aircraft, may determine whether the reported horizontal position has an acceptable level of measurement integrity for the intended use. (Note that the NIC parameter is closely associated with the SIL quality metric.)

The NIC (and SIL) values are associated with a possible failure condition of the position measurement function and the detection thereof. For most ADS-B applications, the NIC (and

SIL) values are the key horizontal position quality metrics on which the horizontal position data is determined to be of sufficient quality for its intended use. The NIC value is encoded on the respective horizontal position integrity containment radius as provided by the source.

The NIC values, including the NIC Supplements values, are encoded for airborne position messages as follows (Rc is the horizontal position integrity containment bound, typically HPL/HIL for GNSS systems):

Table 6: Airborne NIC Encoding

NIC Value	Radius of Containment (R_C)	Airborne		
		Airborne Position TYPE Code	NIC Supplement Codes	
			A	B
0	R_C unknown or $R_C \geq 20$ NM	0, 18 or 22	0	0
1	$R_C < 20$ NM (37.04 km)	17	0	0
2	$R_C < 8$ NM (14.816 km)	16	0	0
3	$R_C < 4$ NM (7.408 km)	16	1	1
4	$R_C < 2$ NM (3.704 km)	15	0	0
5	$R_C < 1$ NM (1852 m)	14	0	0
6	$R_C < 0.6$ NM (1111.2 m)	13	1	1
	$R_C < 0.5$ NM (926 m)	13	0	0
	$R_C < 0.3$ NM (555.6 m)	13	0	1
7	$R_C < 0.2$ NM (370.4 m)	12	0	0
8	$R_C < 0.1$ NM (185.2 m)	11	0	0
9	$R_C < 75$ m	11	1	1
10	$R_C < 25$ m	10 or 21	0	0
11	$R_C < 7.5$ m	9 or 20	0	0

Note: The minimum NIC values required for the ADS-B-RAD application can be found in Table 20*, in Part 3 of AMC ACNS.ADS Appendix A. They are met through the horizontal position source requirements defined in CS-ACNS.ADS.2020.*

Definition 6: NACp

NACp specifies the 95% radial accuracy of the aircraft's horizontal position information (latitude and longitude) derived from the position source's accuracy output, typically the HFOM metric from GNSS based sources.

Whereas the NIC value is associated with a possible failure condition of the position measurement function, the NACp value describes the nominal performance of the measurement function in terms of horizontal position accuracy as provided by the source.

The NACp value is encoded as follows:

Table 7: NACp Encoding

Coding	95% Horizontal Accuracy Bound
0	EPU ≥ 18.52 km (≥10 NM)
1	EPU < 18.52 km (10 NM)
2	EPU < 7.408 km (4 NM)
3	EPU < 3.704 km (2 NM)
4	EPU < 1852 m (1 NM)
5	EPU < 926 m (0.5 NM)
6	EPU < 555.6 m (0.3 NM)
7	EPU < 185.2 m (0.1 NM)
8	EPU < 92.6 m (0.05 NM)
9	EPU < 30 m
10	EPU < 10 m
11	EPU < 3 m

Note: The minimum NACp values required for the ADS-B-RAD application can be found in Table 20*, in Part 3 of AMC ACNS.ADS Appendix A. This value is met through the horizontal position source requirements defined in CS-ACNS.ADS.2020.*

The NACp encoding is the same for airborne position messages and surface position messages.

Definition 7: SIL

The encoding of the horizontal position source integrity level (SIL) is based on the probability of the reported horizontal position exceeding the radius of containment defined by the NIC, without alerting, assuming no avionics faults. The SIL value is set as follows:

Table 8: SIL Encoding

SIL value	Probability of Exceeding the NIC Containment Radius
0	Unknown or $> 1 \times 10^{-3}$ per flight hour or per sample
1	$\leq 1 \times 10^{-3}$ per flight hour or per sample
2	$\leq 1 \times 10^{-5}$ per flight hour or per sample
3	$\leq 1 \times 10^{-7}$ per flight hour or per sample

Note: The minimum SIL value required for the ADS-B-RAD application can be found in Table 20*, in Part 3 of AMC ACNS.ADS Appendix A. This value is met through the horizontal position source requirements defined in CS-ACNS.ADS.2020 (see also related AMC guidance).*

Whereas SIL assumes that there are no system integrity failures, the SIL should consider the effects of a faulted signal-in-space.

For horizontal position sources compliant with CS-ACNS.ADS.2020, the probability of exceeding a NIC radius of containment without alerting is based on a per hour rate. Hence, the SIL Supplement should be set to 'zero'. If based on per sample, the SIL Supplement would be set to 'one'.

The SIL encoding is the same for airborne position messages and surface position messages.

Definition 8: SDA

The encoding of the system design assurance level (SDA) is based on the failure condition that the entire ADS-B Out system, with respect to the horizontal position data and associated quality indicators, is designed to support.

The SDA value is encoded as follows:

Table 9: SDA Encoding

SIL value	Probability of Exceeding the NIC Containment Radius
0	Unknown or $> 1 \times 10^{-3}$ per flight hour or per sample
1	$\leq 1 \times 10^{-3}$ per flight hour or per sample
2	$\leq 1 \times 10^{-5}$ per flight hour or per sample
3	$\leq 1 \times 10^{-7}$ per flight hour or per sample

Note 1: Software Design Assurance per EUROCAE ED-12B (RTCA DO-178B). Airborne Electronic Hardware Design Assurance per EUROCAE ED-80 (RTCA DO-254).

Note 2 In line with the ADS-B-RAD requirements, the minimum value required for the horizontal position source is SDA=2 (refer to AMC ACNS.ADS.3000*).*

The SDA encoding is the same for airborne position messages and surface position messages.

Definition 9: Pressure Altitude Data Sources

Refer to AMC1 ACNS.ELS.2010.2.4 for guidance.

The ADS-B NICbaro quality indicator is encoded as follows:

Table 10: NICbaro Encoding

Coding	Meaning
0	The barometric altitude is based on a Gillham coded input that has not been cross-checked against another source of pressure altitude.
1	The barometric altitude is either based on a Gillham code input that has been cross-checked against another source of pressure altitude and verified as being consistent, or is based on a non-Gillham coded source.

Definition 10: Emergency Status

The provision of the Emergency Status values that do not have a corresponding Mode A Code value (see CS ACNS.ELS.2010) denoting the other emergency conditions defined in 61_{16}, is optional. This applies to the decimal values 2, 3, 6 and 7 in Table 11.

Table 11: Emergency Status Encoding

Coding		**Meaning**
(Binary)	(Decimal)	
000	0	No Emergency
001	1	General Emergency
010	2	Lifeguard/medical Emergency
011	3	Minimum Fuel
100	4	No Communications
101	5	Unlawful Interference
110	6	Downed Aircraft
111	7	Reserved

Definition 11: Horizontal Velocity (Ground Velocity)

The horizontal velocity provides the rate at which an aircraft changes its horizontal position with a clearly stated direction.

Velocity data sources provide ground velocity vector information for both the airborne and surface velocity data transmit formats, allowing for the transmission of east/west and north/south velocity information (09_{16}), or velocity scalar (06_{16}, movement) and possibly ground track information[8] (06_{16}), respectively.

In case of a failure of the provision of ground velocity data, the ADS-B transmit unit will attempt to broadcast airspeed (and heading) information instead (using subtypes 3 or 4 of register 09_{16}.

8. Refer to Definition 16.

Definition 12: Horizontal Velocity Quality Indicator NACv

The NACv is an estimate of the accuracy of the horizontal geometric velocity data.

The NACv value is encoded as follows:

Table 12: NACv Encoding

Navigation Accuracy Category for Velocity NACv		
Coding		**Horizontal Velocity Error (95%)**
(Binary)	**(Decimal)**	
000	0	Unknown or $\geq$ 10 m/s
001	1	< 10 m/s
010	2	< 3 m/s
011	3	< 1 m/s
100	4	< 0.3 m/s

The NACv encoding is the same for airborne position messages and surface position messages.

Definition 13: Emitter Category

Emitter Category settings describe the size and performance of an aircraft, primarily expressed with respect to its maximum take-off weight.

The Emitter Category value is encoded as follows:

Table 13: Emitter Category Encoding

ADS-B Emitter Category Set "A"	
Coding	**Meaning**
0	No ADS-B Emitter Category Information
1	Light (<15 500 lbs)
2	ll (15 500 to 75 000 lbs)
3	Large (75 000 to 300 000 lbs)
4	High-Vortex Large (aircraft such as B-757)
5	Heavy (> 300 000 lbs)
6	h Performance (>5g acceleration and > 400 knots)
7	Rotorcraft

ADS-B Emitter Category Set "B"	
Coding	**Meaning**
0	No ADS-B Emitter Category Information
1	Glider / Sailplane
2	Lighter-than-Air
3	Parachutist / Skydiver
4	Ultralight / hang-glider / paraglider
5	Reserved
6	Unmanned Aerial Vehicle
7	Space / Trans-atmospheric vehicle

ADS-B Emitter Category Set "C"	
Coding	**Meaning**
0	No ADS-B Emitter Category Information
1	Surface Vehicle - Emergency Vehicle
2	Surface Vehicle - Service Vehicle
3	Point Obstacle (includes tethered balloons)
4	Cluster Obstacle
5	Line Obstacle
6 - 7	Reserved

ADS-B Emitter Category Set "D"	
Coding	**Meaning**
0	No ADS-B Emitter Category Information
1 - 7	Reserved

The ADS-B Emitter Category Sets A, B, C or D are identified by the Message Format TYPE Codes 4, 3, 2, and 1 respectively.

Note 1: A coding of '0' within an Emitter Category Set is not allowed.

Note 2: The Emitter Category codes 1 to 5 in category set A are intended to advise other aircraft of the transmitting aircraft's wake vortex characteristics, and not necessarily the transmitting aircraft's actual maximum take-off weight. In case of doubt, the next higher aircraft category code should be used

Definition 14: Vertical Rate

Vertical Rate is either the barometric or geometric rate at which the aircraft is climbing or descending, measured in feet per minute. The vertical rate is typically generated by an air data computer or GNSS position source, or equipment which blends barometric vertical rate with inertial vertical rate and/or GNSS vertical rate.

As the geometric vertical rate can be readily derived from the ADS-B Out position source, it is classified as a minimum requirement rather than an (effectively Mode S Enhanced Surveillance) conditional requirement.

Definition 15: Surface NIC Value

The Surface NIC value, including the NIC Supplement A and C values, is encoded as follows:

Table 14: Surface NIC Encoding

NIC Value	Radius of Containment (R_C)	Surface		
		Surface Position TYPE Code	NIC Supplement Codes	
			A	C
0	R_C unknown	0, 8	0	0
6	R_C < 0.6 NM (1111.2 m)	8	0	1
	R_C < 0.3 NM (555.6 m)	8	1	0
7	R_C < 0.2 NM (370.4 m)	8	1	1
8	R_C < 0.1 NM (185.2 m)	7	0	0
9	R_C < 75m	7	1	0
10	R_C < 25m	6	0	0
11	R_C < 7.5m	5	0	0

Definition 16: Surface Heading/Ground Track

Aircraft Heading indicates the direction in which the nose of the aircraft is pointing. It should be used as the primary source and be expressed (in ME bit 54 in 65_{16}) as either true north ('0', preferred) or magnetic north ('1').

If an approved heading source is not available (or failed during operation), the Ground Track angle information from the selected ground velocity data source will be used instead by the ADS-B transmit unit for the determination of the direction of the horizontal velocity vector.

If the position source ground track is used and inaccurate below a certain ground speed, and the position source does not inhibit output of the ground track at these slower speeds, the installer should ensure that the ADS-B transmit unit has the capability to invalidate the ground track when the GNSS ground speed falls below a threshold specified by the position source manufacturer (e.g. 7 knots).

Definition 17: Aircraft Length and Width

Aircraft Length and Width settings describe the aircraft dimensions by the width and length of a rectangle that is aligned parallel to the aircraft's heading. The aircraft's length is to be measured along its axis of symmetry (i.e. from nose to tail). The aircraft's width is to be measured from wing-tip to wing-tip.

The Aircraft Length and Width values are encoded as shown in Table 15 to be less than or equal to a respective upper bound length and width as expressed in the two right-side columns. The Length and Width Codes are based on a combined encoding of the actual length **and** width whereby the largest respective upper bound prevails. If the Aircraft or Vehicle is longer than 85 meters, or wider than 90 meters, then decimal Aircraft/Vehicle Length/Width Code 15 is used.

Table 15: Aircraft Length/Width Encoding

A/V - L/W Code (Decimal)	Length Code			Width Code	Upper-Bound Length and Width for Each Length/Width Code	
	'ME' Bit 21	'ME' Bit 22	'ME' Bit 23	'ME' Bit 24	Length (meters)	Width (meters)
0	0	0	0	0	No Data or Unknown	
1	0	0	0	1	15	23
2	0	0	1	0	25	28.5
3				1		34
4	0	1	0	0	35	33
5				1		38
6	0	1	1	0	45	39.5
7				1		45
8	1	0	0	0	55	45
9				1		52
10	1	0	1	0	65	59.5
11				1		67
12	1	1	0	0	75	72.5
13				1		80
14	1	1	1	0	85	80
15				1		90

Example: a powered glider with an overall length of 24 meters and wingspan of 50 meters would, normally, have a length code of '001'. However, since the wingspan exceeds 34 meters, it does not qualify for either Width subcategory of length category '001'. In line with its actual width, such an aircraft would be assigned a length code of '100' and width code of '1', meaning length less than 55 meters and width less than 52 meters.

Definition 18: GPS Antenna Offset (lateral and longitudinal)

GPS Antenna Offset information provides the position offset of the GNSS antenna used for the provision of horizontal position information.

Both a lateral distance of the GPS Antenna (from the longitudinal axis of the aircraft) and a longitudinal distance of the GPS Antenna (from the nose of the aircraft) are provided.

The accuracy of the information should be better than 2 meters, consistent with the data resolution.

The lateral and longitudinal GPS Antenna Offset values are encoded as follows:

Table 16: Lateral Axis GPS Antenna Offset Encoding

'ME' Bit (Message Bit)			**Upper Bound of the GPS Antenna Offset Along Lateral (Pitch) Axis Left or Right of Longitudinal (Roll) Axis**	
33 (65)	**34** (66)	**35** (67)		
0 = left 1 = right	**Encoding**			
	Bit 1	**Bit 0**	**Direction**	**(meters)**
0	0	0	**LEFT**	**NO DATA**
	0	1		2
	1	0		4
	1	1		6
1	0	0	**RIGHT**	0
	0	1		2
	1	0		4
	1	1		6

Supplementary Notes

Maximum distance left or right of aircraft longitudinal (roll) axis is 6 meters or 19.685 feet. If the distance is greater than 6 meters, then the encoding should be set to 6 meters.

The No Data case is indicated by encoding of 000 as above, while the ZERO offset case is represented by encoding of 100 as above.

Table 17: Longitudinal Axis GPS Antenna Offset Encoding

'ME' Bit (Message Bit)					**Upper Bound of the GPS Antenna Offset Along Longitudinal (Roll) Axis Aft From Aircraft Nose**
36 (68)	**37** (69)	**38** (70)	**39** (71)	**40** (72)	
Encoding					
Bit 4	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**	**(meters)**
10	0	0	0	0	**NO DATA**
0	0	0	0	1	Position Offset Applied by Sensor *(see also Notes)*
0	0	0	1	0	2
0	0	0	1	1	4
0	0	1	0	0	6
*	*	*	*	*	***
1	1	1	1	1	60

Supplementary Notes:

If the distance is greater than 60 meters, the encoding should be set to 60 meters.

Position Offset Applied by the Sensor applies to future cases where the antenna offset is compensated by the horizontal position source to the centre of the rectangle describing the aircraft's length and width (refer to Definition 17).

The encoding of the values from decimal '2' (only bit 1 one set to '1') to '31' (all five bits set to '1') is as follows: encoded binary value = offset [m]) / 2 + 1 (e.g. an offset of 4 meters leads to a binary value of (4/2 + 1 = 3), i.e. Bits 0-1 equal '1' and Bits 2-4 equal '0').

Definition 19: Geometric Altitude

The geometric altitude is a measure of the aircraft's height above a geometric reference and is provided by a GNSS-based position source.

Both within 05_{16} and 09_{16}, Geometric Altitude is provided as height above ellipsoid (HAE) in accordance with the WGS 84 coordinate system (AMC1 ACNS.ADS.2034(b)).

Definition 20: Geometric altitude quality indicator information (GVA)

The GVA parameter expresses the actual performance of the geometric altitude data source as valid at the time of applicability of the measurement.

The GVA value is encoded as follows:

Table 18: GVA Encoding

GVA Encoding (decimal)	**95% Accuracy** (meters)
0	Unknown or > 150 meters
1	≤ 150 meters
2	$\underline{<}$ 45 meters
3	Reserved

Appendix H

Part 2 – ADS-B Out Surveillance Data Parameters (AMC1 ACNS.ADS.2005(b))

Table 19 below makes reference to the BDS register(s) that contain the various ADS-B Out surveillance data parameters. When Table 19 states Same source as for Mode S replies, reference is made to the requirement that the content of ADS-B broadcasts and Mode S replies that carry the same information and need to come from the same source (CS-ACNS.ADS.2008(b)).

Guidance on the content of the various BDS registers and their relationship with the ADS-B message Type Codes is provided in Table 4 in part 1 of AMC1 ACNS.ADS Appendix A.

Table 19: ADS-B-ADD Surveillance Data Transmission Requirements

Item	Parameter	Requirements	BDS Register	Remarks
1	Selected Altitude	See Definition 21.	62_{16}	Same source as for Mode S replies
2	Barometric Pressure Setting		62_{16}	
3a	ACAS Operational	See Definition 22.	62_{16} and 65_{16}	
3b	Resolution Advisory (RA)		61_{16} (subtype 2)	

Definition 21: Selected Altitude/Barometric Pressure Setting

Refer to AMC1 ACNS.EHS.2010.2.5.1 for detailed guidance.

Definition 22: ACAS Operational /Resolution Advisory (RA)

Refer to AMC1 ACNS.EHS.2010.2.5.8 for detailed guidance.

The data is populated from ACAS II systems if installed on the aircraft. Both parameters should be preset to 'zero' if an ACAS II system is not installed (refer to ADS-B transmit unit manufacturer instructions).

Appendix H

Part 3 – ADS-B Out Minimum Horizontal Position and Velocity Data Requirements

Table 20 provides a summary of the minimum horizontal position data requirements as specified in the defining ADS-B-RAD Safety and Performance Requirements/Interoperability document (ED-161).

Table 20: Minimum Horizontal Position and Velocity Data Quality Requirements

Quality Parameter	Requirement
Position Accuracy (NACp)	NACp<=0.1NM (i.e. NACp>=7) for both 3 NM and 5 NM separation
Position Integrity Containment Radius (NIC)	3 NM Sep: NIC<=0.6 NM (i.e. NIC>=6) 5 NM Sep: NIC<=1 NM (i.e. NIC>=5)
Source Integrity Level (SIL)	SIL=3: 10^{-7}/flight-hour
System Design Assurance (SDA)	SDA=2: 10^{-5}/flight-hour - allowable probability level REMOTE (MAJOR failure condition, LEVEL C software and design assurance level)
Velocity Accuracy (NACp)	NACv<=10 m/s (i.e. NACv>=1)

Note 1: The requirement of NACp<=0.1NM in support of 3NM separation is based on the arguments produced in Annex B to ED-161 (ADS-B-RAD Safety and Performance Requirements*/Interoperability Requirements Document).*

Note 2: The SDA encoding of '2' (10-5/fight-hour) applies to individual components of the ADS-B Out system, i.e. 10-5/fight-hour for the ADS-B transmit unit and 10-5/flight-hour for the horizontal position and velocity source.

Note 3: ADS-B transmit units interfaced with a GNSS position source that is compliant with CS ACNS.ADS.2020 (and the related AMC guidance) should preset the SIL Supplement to 'zero'.

Note 4: If set as fixed value, NACv should be always 'one'. For quality indications that are dynamically provided by the velocity source, NACv should be 'one' or 'two'. There is currently no established guidance on establishing a NACv performance of 'three' or better.

Appendix H.

Part 4 – ADS-B Out Integrity and Continuity Requirements

The tables in AMC1 ACNS.ADS.3000 and AMC1 ACNS.ADS.3010 summarise, per mandatory data parameter, the integrity and continuity probability levels applicable to the ADS-B Out system.

In the first place, the ADS-B Out System installed in the aircraft needs to deliver data that satisfy the ADS-B-RAD airborne domain system safety and performance requirements in line with Section 3.4 of the ADS-B-RAD Safety and Performance Requirements/Interoperability standard ED-161.

As, for the purpose of framing the ADS-B-RAD operational safety assessment, the ADS-B-RAD airborne domain only comprises the horizontal position data source and the ADS-B transmit unit, including the interconnecting avionics, the data sources providing surveillance information other than horizontal position and velocity are assumed to operate as within today's SSR environment. Hence, in line with CS-ACNS.ADS.2030, the related Mode S Elementary and Enhanced Surveillance requirements apply.

It is noted that the respective Mode S Elementary and Enhanced Surveillance requirements have to be understood within their given context, in particular taking into account applicable procedural mitigation means (e.g. as currently performed by means of the ICAO required controller-pilot verification procedure for pressure altitude reporting).

The ADS-B Out data parameters other than the ones addressed in the preceding paragraphs, need to satisfy comparable ADS-B-RAD requirements.

The specified integrity levels are required to adequately protect against the corruption of ADS-B Out surveillance data causing false or misleading information to be transmitted.

Although the direct effects to an aircraft of an ADS-B Out failure may be minor, the ADS-B Out information will be used by ATC and other ADS-B equipped aircraft, thus provisions that would allow for a reduction in failure probabilities and design assurance level, do not apply to the ADS-B Out system.

Appendix H

Part 5 – GNSS Position and Velocity Source Qualification

This part 5 of AMC ACNS.ADS Appendix H provides guidance to GNSS equipment manufacturers on how to establish a qualification for these ADS-B specific requirements, i.e. beyond the demonstration of compliance to ETSO requirements. In the following, as appropriate, reference is made to the respective:

- ETSO material: ETSO-C129a (JTSO-C129a), ETSO-C196a, ETSO-C145()/146()
- EUROCAE/RTCA MOPS material: ED-72A, DO-208, DO-229D, DO-316 as well as DO-235B; and
- FAA AC material (AC 20-138B).

Note: ETSO-C145 refers to RTCA DO-229A, ETSO-C146 refers to RTCA DO-229B, ETSO-C145c/146c refers to RTCA DO-229D, and ETSO-C145()/146() refers to any of those revisions.

In addition to the ETSO minimum requirements, the requirements of this part need to be demonstrated unless this has been demonstrated as a declared non-ETSO function. It is expected that the required compliance demonstration is supplied by the position and velocity source manufacturer through a Declaration of Design and Performance (DDP), or an equivalent document.

(a) Horizontal Position Integrity (HPL)

Horizontal Position Integrity — AMC1 ACNS.ADS.2020(a).1.2(a)

Applicability: ETSO-C129a (JTSO-C129a)

GNSS equipment manufacturers should provide substantiation data showing that the equipment outputs a 10^{-7}/hr Horizontal Protection Limit (HPL, or equivalent) based on the RAIM algorithm meeting the ETSO-C129a (JTSO-C129a) Class A1, A2, B1, B2, C1, or C2 RAIM requirements.

Integrity Fault – Time to Alert — AMC ACNS.ADS.2020(a).1.2(b)

Applicability: ETSO-C129a (JTSO-C129a)

For the horizontal position sources compliant with AMC ACNS.ADS.2020, it should to be demonstrated, that a non-isolated GNSS satellite fault detected by the position source is properly passed to the ADS-B transmit unit within the allowable time to alert of 10 seconds, at any time.

With reference to the mode dependent time to alert in Table 3-5 of EUROCAE ED-72A section 3.2.1 (Table 2-1 of RTCA DO-208 Section 2.2.1.13.1), GNSS equipment manufacturers should provide information describing the equipment integrity fault output latency, along with interface instructions and/or any limitations for meeting the 10-second latency requirement of AMC1 ACNS.ADS.2020(a).1.2(b).

Note 1: The latency of reporting nominal ADS-B Quality Indicator changes, such as in response to changing GNSS satellite constellations or due to switching between position sources, is bounded by CS ACNS.ADS.2020(a).1.2(c) as well.

Note 2: ED-72A allows a provision to extend the Time to Alarm up to 30 seconds during en route phases of flight while for terminal and Non-Precision Approach the 10-second limit is applicable. For ADS-B Out, a time to alert of 10 seconds applies to any phases of flight.

Mode Output — AMC1 ACNS.ADS.2020(a).1.3

Applicability: ETSO-C129a (JTSO-C129a), ETSO-C196a, ETSO-C145()/146()

GNSS equipment manufacturers should provide instructions describing any equipment modes affecting the interpretation of horizontal position integrity output and how the position source outputs the mode indication.

As the minimum horizontal position integrity containment bound provided by non-augmented, as well as some specific augmented GNSS source, equipment is limited to 0.1 NM by design, the GNSS equipment manufacturer should present substantiation data whether the HPL output is limited or not, and provide proper instructions for the ADS-B Out system integration. If the GNSS source equipment does not limit the HPL, the ADS-B transmit unit limits the encoded NIC value to be equal to or less than 'eight'.

(b) Horizontal Position Accuracy (HFOM) — AMC ACNS.ADS.2020(a).1.2(d)

Applicability: ETSO-C129a, ETSO-C145, and ETSO-C146

Note: Compliance with RTCA/DO-229D is required by ETSO-C145c-C146c. ETSO-C145/-C146 may be acceptable by applications of a positive deviation.

GNSS equipment manufacturers should provide substantiation data showing the equipment computes and outputs HFOM. The following criteria for an acceptable horizontal position output and its associated HFOM accuracy metric are recommended to be applied:

(1) The horizontal position output should be calculated using the general least squares position solution of DO-229D Appendix J.1 (or any mathematically equivalent linear combination of range measurements). There is no restriction on the choice of the weight matrix W including non-weighted solutions; the use of the LNAV/VNAV, LP, LPV approach weight ($w_i = 1/\sigma_i^2$) is optional.

(2) The horizontal position accuracy should be tested using the procedure of DO-229D Section 2.5.8.3. The σ_i^2 used to compute the variance d^2_{major} should be greater or equal to the ones listed in DO-229D Appendix J when the equipment uses SBAS-provided integrity and greater or equal to the ones listed as an acceptable means for FDE-provided integrity in section DO-229D 2.1.2.2.2.2 when the equipment does not use SBAS-provided integrity. A fixed sigma of 33.3 m is considered a sufficient over-bound when using FDE-provided integrity. For equipment that uses SBAS-provided integrity, testing only in the highest mode attainable for its declared Operational Class as specified in the test itself is acceptable.

(3) The accuracy metric should be greater or equal to 1.96 $\text{sqrt}(d^2_{east} + d^2_{north})$ or 2.45 d_{major} where d_{major}, d_{east}, and d_{north} are computed using the same σ_i employed during the horizontal accuracy test procedure. General certification substantiation data that the equipment meets this requirement is sufficient; no specific test is required.

Note 1: The scaling factors for the horizontal position accuracy metrics were rounded to 2 decimal places; there is no intention to prohibit the use of a more accurate number.

Note 2: The horizontal position accuracy metrics listed above are the standard metrics used to provide a minimum of 95% containment (varying from 95% to approximately 98.5% for the horizontal metrics) under the assumption that a Gaussian distribution with a sigma of σ_i over- bounds the error of the range measurements. The use of a general least squares position solution (or mathematically equivalent) results in a joint Gaussian distribution for the components (North, East, Up) of the position error. Any accuracy metric that can be mathematically demonstrated to provide a minimum 95% containment in the position domain under the Gaussian assumption is also acceptable.

(c) Horizontal Position Latency — AMC1 ACNS.ADS.2020(a).1.2(e)

Time of Measurement to Time of Applicability

Applicability: ETSO-C129a (JTSO-C129a)

The intent of this qualification is to ensure that position and related quality indicator information are related to the same time of applicability in a consistent manner.

Based on the particular receiver design, GNSS equipment manufacturers should use a manufacturer-defined test, and/or analysis to determine the latency between the time satellite measurements are collated for processing and the time the equipment calculates a filtered (impulse response) position solution. The equipment should meet a 500-millisecond time of measurement to time of applicability requirement and account for the impulse response of the position solution.

Note: Whilst CS ACNS.ADS does not establish requirements on the time of measurement, the above qualification has been incorporated to ensure consistency with FAA AC 20-165.

Time of Applicability to Time of Output

Applicability: ETSO-C129a (JTSO-C129a)

The GNSS equipment manufacturer should document the position source latency from time of applicability to time of position output. If this latency exceeds 0.4 seconds, it may not support the 1.5-second total ADS-B transmission latency at the aircraft level (refer also to AMC1 ACNS.ADS.3022.2).

Time Mark

Applicability: ETSO-C129a (JTSO-C129a), ETSO-C196a, ETSO-C145()/C146()

If the use of the time mark to reduce latency is implemented in the ADS-B Out system, GNSS equipment manufacturers must provide installation instructions describing how the time mark relates to the time of applicability of the position, velocity, and related quality indicator information.

(d) Horizontal Velocity Accuracy — AMC1 ACNS.ADS.2020(a).1.2(f)

Environmental Noise Test Conditions:

Applicability: ETSO-C129a, ETSO-C145( )/C146( ) (JTSO-C145/C146)

For equipment that was not required to meet the environmental noise standard prescribed by DO-235B, the velocity tests in AC 20-138B, Appendix 4 use environmental noise test conditions that may cause the equipment to stop functioning, i.e. to lose satellite acquisition and tracking capability that causes the equipment to stop outputting velocity. Whilst this contributes to an ADS-B availability issue for operators, this loss of function will not prevent the equipment from being used as an ADS-B velocity input, provided:

(1) the equipment does not output misleading velocity information at or after the onset of the triggering interference levels; and

Note:A method to accomplish this is first running the test at the higher noise level to ensure there is no misleading velocity information at loss of function before running the complete test at the lower noise level.

(2) the equipment manufacturer documents the interference levels that cause the equipment to lose function.

If the above conditions are met, the velocity tests in Appendix 4 of AC 20-138B (see below for NACv=1 and NACv=2 cases) can be run using an interference level that does not cause the equipment to lose acquisition and tracking.

ADS-B Out system installations intending to support NACv = 1:

Applicability: ETSO-C129a (JTSO-C129a), ETSO-C196a, ETSO-C145()/146()

The GNSS equipment manufacturer should perform the velocity tests in Appendix 4 of AC 20-138B associated with NACv = 1 to substantiate the equipment's velocity output.

The GNSS equipment manufacturer should indicate that the equipment satisfies the requirements for NACv =1 in the instructions for the ADS-B integration.

ADS-B Out system installations intending to support NACv = 2:

Applicability: ETSO-C129a (JTSO-C129a), ETSO-C196a, ETSO-C145()/146()

The GNSS equipment manufacturer should perform the velocity tests in Appendix 4 of AC 20-138B associated with NACv = 1 and NACv = 2 to substantiate the equipment's velocity output.

The GNSS equipment manufacturer should indicate that the equipment satisfies the requirements for NACv = 2 in the instructions for ADS-B Out system integration.

Track Angle Validity:

Applicability: ETSO-C129a (JTSO-C129a), ETSO-C196a, ETSO-C145()/146()

Using test and/or analysis for substantiation data, GNSS manufacturers should provide instructions for the ADS-B Out system integrator indicating when the track angle 95 % accuracy, when derived from north/east velocity, exceeds plus/minus 'eight' degrees. It is acceptable for the instructions to state that the track angle does not meet the required accuracy below a specified speed.

Note 1: Track Angle Validity is only an issue at taxiing speeds. Thereby, only along-track acceleration (0.58g) and jerk (0.25g/sec) are assumed to apply.

Note 2: Use should be made of the test environment specified in Appendix 4 of AC 20-138B. The interference levels used to demonstrate velocity accuracy compliance can be used for true track angle validity testing as well.

(e) Geometric Altitude Accuracy (VFOM) — AMC ACNS.ADS.2034

Applicability: ETSO-C129a (JTSO-C129a), ETSO-C196a, ETSO-C145()/146()

GNSS equipment manufacturers should provide substantiation data showing if and how the equipment computes and outputs VFOM. If VFOM is output, the following criteria for an acceptable HAE-referenced geometric altitude output and its associated VFOM accuracy metric are recommended to be applied:

(1) The HAE output should be calculated using the general least squares position solution of DO-229D Appendix J.1 (or any mathematically equivalent linear combination of range measurements). There is no restriction on the choice of the weight matrix W including non-weighted solutions; the use of the LNAV/VNAV, LP, LPV approach weight ($w_i = 1/\sigma_i^2$) is optional.

(2) The HAE accuracy should be tested using the procedure of DO-229D Section 2.5.8.3. The σ_i^2 used to compute the variance d_U^2 should be greater or equal to the ones listed in DO-229D Appendix J when the equipment uses SBAS-provided integrity and greater or equal to the ones listed as an acceptable means for FDE-provided integrity in section 2.1.2.2.2.2 when the equipment does not use SBAS-provided integrity. A fixed sigma of 33.3 m is considered a sufficient over-bound when using FDE-provided integrity. For equipment that uses SBAS-provided integrity, testing only in the highest mode attainable for its declared Operational Class as specified in the test itself is acceptable.

(3) The accuracy metric should be greater or equal to 1.96 d_U where d_U is computed using the same σ_i employed during the HAE accuracy test procedure. General certification substantiation data that the equipment meets this requirement is sufficient; no specific test is required.

Note: The Notes 1 and 2 in Section 3 above apply to the guidance in this section as well (by replacing horizontal with vertical).

Appendix H

Part 6 – Compliance Matrix BDS Register Fields

This part of Appendix H lists compliance matrices of the BDS register fields transmitted by the 1090 ES ADS-B transmit unit, with respect to the population of the 1090 ES data fields with data from approved sources (CS ACNS.ADS.2008(a) applies).

Omitted in the tables are fields containing the subtype codes (for these, refer to Part 1 of this Appendix) and reserved fields.

Reference to ADS-B Out item numbers is made in line with Part 1 of this Appendix respectively. Reference to Definitions is made in line with Part 1 of this Appendix.

Within the requirements (Req't) column, 'M' expresses a mandatory requirement, i.e. the respective fields are populated with data from approved sources. 'O' expresses an optional requirement, 'NA' expresses non-applicability.

Register 05_{16} – Airborne Position Message

ME Bits	Field	Req't	Remark
6-7	Surveillance Status	M	= '0', no condition information = '1', Item 7a, Definition 10 = '2', Mode A code change = '3', Item 6
8	NIC Supplement-B	M	Item 4b, Definition 4 and 5
9-20	Altitude	M	Item 5, Definition 9
21	Time (T)	M	"GNSS time mark coupled" ('0' no, '1' yes), Item 4a, Definition 3
22	CPR Format (F)	M	Compact Position Reporting (CPR) format type ('0' even, '1' odd) , Item 4a, Definition 3
23-39	CPR Encoded Latitude	M	Item 4a, Definition 3
40-56	CPR Encoded Longitude	M	

Register 06_{16} – Surface Position Message

ME Bits	Field	Req't	Remark
6-12	Movement	M	Item 14, Definitions 11 and 12
13	Heading/Ground Track Status	M	Item 13, Definition 15
14-20	Heading/Ground Track	M	
21	Time (T)	M	'GNSS time mark coupled' ('0' no, '1' yes), Item 4a, Definition 3
22	CPR Format (F)	M	Compact Position Reporting (CPR) format type ('0' even, '1' odd) , Item 4a, Definition 3
23-39	CPR Encoded Latitude	M	Item 4a, Definition 3

Register 08_{16} - Aircraft Identification and Category Message

ME Bits	Field	Req't	Remark
6-8	ADS-B Emitter Category	M	Item 10, Definition 13
9-56	Identification Characters #1-#8	M	6 bits per character, Item 1, Definition 1

Register 09_{16} - Airborne Velocity Message - Velocity over Ground (Subtypes 1and2, Normal/Supersonic)

ME Bits	Field	Req't	Remark
6-8	Subtype	M	'0' normal, '1' supersonic
9	Intent Change Flag	O	Mode S protocol support, indication of new information in GICB registers 40_{16} to 42_{16}
11-13	NAC_V	M	Item 9b, Definition 12
14	E/W Direction Bit	M	Item 9a, Definition 11
15-24	E/W Velocity	M	
25	N/S Direction Bit	M	
26-35	N/S Velocity	M	
36	Vertical Rate Source	M	Item 11, Definition 14
37	Vertical Rate Sign	M	
38-46	Vertical Rate	M	
49	Difference from Barometric Altitude Sign	M	Item 17a, Definition 19

Register 09_{16} - Airborne Velocity Message - Airspeed (Subtypes 3 and 4, Normal/Supersonic)

ME Bits	Field	Req't	Remark
6-8	Subtype	M	'0' normal, '1' supersonic
9	Intent Change Flag	O	Mode S protocol support, indication of new information in GICB registers 40_{16} to 42_{16}
11-13	NAC_V	O	Item 9b, Definition 12
14	Heading Status Bit	O	Item 9a, Definition 11
15-24	Heading	O	
25	Airspeed Type	O	
26-35	Airspeed	O	
36	Vertical Rate Source	M	Item 11, Definition 14
37	Vertical Rate Sign	M	
38-46	Vertical Rate	M	
49	Difference from	M	Item 17a, Definition 19

ME Bits	Field	Req't	Remark
	Barometric Altitude Sign		
50-56	Difference from Barometric Altitude	M	

Register 61_{16} - Aircraft Status Message - Emergency Status and Mode A Code

ME Bits	Field	Req't	Remark
6-8	Subtype	M	='1'
9-11	Emergency/Priority Status	M	Mandatory codes: '0', '1', '4' and '5', Item 7a, Definition 10
12-24	Mode A Code	M	Item 2, Definition 2

Register 61_{16} - Aircraft Status Message - ACAS RA Broadcast

ME Bits	Field	Req't	Remark
5-8	Subtype	M	='2'
9-22	Active Resolution Advisories	M	Item 20b, Definition 22
23-26	RACs Record	M	
27	RA Terminated	M	
28	Multiple Threat Encounter	M	
29-30	Threat Type Indicator	M	
31-56	Threat Identity Data	M	

Register 62_{16} - Target State and Status Message

ME Bits	**Field**	**Req't**	**Remark**
6-7	Subtype	M	= '1'
8	SIL Supplement	M	Item 4d, Definition 4 and 7
9	Selected Altitude Type	M	Where available in a suitable format Item 18, Definition 21
10-20	MCP/FCU Selected Altitude ***or*** FMS Selected Altitude	M	
21-29	Barometric Pressure Setting	M	Where available in a suitable format Minus 800 millibars.
30	Selected Heading Status	O	not required by Commission Regulation (EU) No 1207/2011
31	Selected Heading Sign	O	
32-39	Selected Heading	O	
40-43	Navigation Accuracy Category Position (NAC_P)	M	Item 4c, Definition 4 and 6
44	Navigation Integrity Category Baro	M	Item 5, Definition 9
45-46	Source Integrity Level	M	Item 4d, Definition 4 and 7
47	Status of MCP/FCU Mode Bits	M	Item 18, Definition 21
48	Autopilot Engaged	O	
49	VNAV Mode Engaged	O	
50	Altitude Hold Mode	O	
52	Approach Mode	O	
53	TCAS Operational	M	Item 20a, Definition 22
54	LNAV Mode Engaged	O	Item 18, Definition 21

Register 65_{16} – Aircraft Operational Status Message - While Airborne

ME Bits	**Field**	**Req't**	**Remark**
6-7	Subtype	M	= '1'
8	SIL Supplement	M	Item 4d, Definition 4 and 7
9	Selected Altitude Type	M	Where available in a suitable format Item 18, Definition 21
10-20	MCP/FCU Selected Altitude ***or*** FMS Selected Altitude	M	
21-29	Barometric Pressure Setting	M	Where available in a suitable format Minus 800 millibars.
30	Selected Heading Status	O	not required by Commission Regulation (EU) No 1207/2011
31	Selected Heading Sign	O	
32-39	Selected Heading	O	
40-43	Navigation Accuracy Category Position (NAC_P)	M	Item 4c, Definition 4 and 6
44	Navigation Integrity Category Baro	M	Item 5, Definition 9
45-46	Source Integrity Level	M	Item 4d, Definition 4 and 7
47	Status of MCP/FCU Mode Bits	M	Item 18, Definition 21
48	Autopilot Engaged	O	
49	VNAV Mode Engaged	O	
50	Altitude Hold Mode	O	
52	Approach Mode	O	
53	TCAS Operational	M	Item 20a, Definition 22
54	LNAV Mode Engaged	O	Item 18, Definition 21

Register 65_{16} – Aircraft Operational Status Message - On the Surface

ME Bits	Field	Req't	Remark
6-8	Subtype	M	= '1' (Surface)
9-10	Surface Capability Class Subtype	M	= '0,0'
12	1090 ES IN	O	not required by Commission Regulation (EU) No 1207/2011
15	B2 Low	NA	not applicable (targeting at class B2 equipment, e.g. ground vehicles)
16	UAT IN	O	not required by Commission Regulation (EU) No 1207/2011
17-19	NACv	M	Item 9b, Definition 12
20	NIC Supplement C	M	Item 12b, Definition 15
21-24	Length/Width Codes	M	Item 15, Definition 17
25-26	Surface Operational Mode Subtype	M	= '0,0'
27	TCAS RA Active	M	Item 20b, Definition 22
28	IDENT Switch Active	M	Item 6
30	Single Antenna Flag	M	= '0', see CS-ACNS.ADS.2012
31-32	System Design Assurance	M	Item 4e, Definition 4 and 8
33-40	GPS Antenna Offset	M	Item 16, Definition 18
41-43	MOPS Version Number	M	= '2'
44	NIC Supplement-A	M	Item 12b, Definition 15
45-48	NAC_P	M	Item 4c, Definition 4 and 6
51-52	Source Integrity Level	M	Item 4d, Definition 4 and 7
53	Track Angle/Heading	M	Item 9a, Definition 11
54	Horizontal Reference Direction (HRD)	M	'0' true north, '1' magnetic north Item 13, Definition 15
55	SIL Supplement	M	Item 4d, Definition 4 and 7

Appendix I — On-the-ground status Test and Validation Guidance for Aeroplanes

The following tests provide guidance to the aircraft integrator for the verification of the ADS-B Out system installation, as appropriate. Separate cases are presented depending on the need to validate the status within the ADS-B transmit unit.

(a) Directly determined On-the-ground status being validated outside the ADS-B transmit function:

Modern aircraft with integrated avionics suites commonly contain sophisticated algorithms for determining the On-the-ground status based on multiple aircraft sensors. These algorithms are customised to the airframe and designed to overcome individual sensor failures. These algorithms are an acceptable means to determine the On-the-ground status and do not require additional validation.

(b) Validation of directly determined On-the-ground status not being validated outside the ADS-B transmit function:

If ground speed **or** airspeed is larger than the aeroplane's typical rotation speed, then the On-the-ground status is (changed to) airborne and the airborne position message is broadcast irrespective of the directly determined On-the-ground status (i.e. as indicated to the ADS-B transmit function).

(c) Indirectly determined On-the-ground status validation within the ADS-B transmit unit:

If an aircraft is not equipped with a means, such as a weight-on-wheels switch, to determine whether it is airborne or on the ground, then the following tests should be performed to determine whether to broadcast the Airborne or Surface Position Messages.

(1) If the aircraft's radio height (RH) parameter is available, and RH is less than 50 feet, and at least ground speed (GS) or airspeed (AS) is available, and the GS or the AS are less than 100 knots, then that aircraft broadcasts the surface position message.

If all three parameters are available, the decision to broadcast the Airborne or Surface Position Messages is determined by the logical AND of all three parameters.

(2) If radio height (RH) is not available, and if the aircraft's ground speed (GS) and airspeed (AS) are available, and GS<50 knots and AS<50 knots, then that aircraft broadcasts the surface position message.

Otherwise, the aircraft broadcasts the Airborne Position Message.

On-the-ground status Test and Validation Guidance for Helicopters, Lighter-than-Air Vehicles and Fixed-under-Carriage Aeroplanes

For helicopters, lighter-than-air vehicles, and fixed-under-carriage aeroplanes, the On-the-ground status should be airborne unless an automatic means of determining On-the-ground status is available.

Appendix J — Comparison between EASA CS ACNS.ADS and FAA AC 20-165 Requirements

CS ACNS.ADS Reference	Comparison
CS ACNS.ADS.1000 Applicability	CS refers to Commission Regulation (EU) No 1207/2011, AC to FAA 14 CFR § 91.227.
CS ACNS.ADS.2000 ADS-B Out System Installation	CS addresses 1090 ES as the only ADS-B Out data link, AC UAT as well.
CS ACNS.ADS.2005 ADS-B Out Data Parameters	Parameters required by CS, optional for AC: Vertical Rate, GPS Antenna Offset and Selected Altitude. Parameters required by CS, not addressed by AC: Barometric Pressure Setting. Parameters not required by CS, required by AC: ADS-B In Capability. Parameters not addressed by CS, optional for AC: Selected Heading. All other parameters are required by both the CS and AC.
CS ACNS.ADS.2008 Provision of Data	No difference.
CS ACNS.ADS.2010 ADS-B Transmit Unit Installation	No difference.
CS ACNS.ADS.2012 Antenna Diversity	CS requires antenna diversity (as applicable to Commission Regulation (EU) No 1207/2011 aircraft). Within AC, single bottom-mounted antenna installations are allowed for ETSO-C166b classes A1S and B1S.
CS ACNS.ADS.2014 Transmit Power	No difference.
CS ACNS.ADS.2016 Simultaneous Operation of ADS-B Transmit Units	No difference.
CS ACNS.ADS.2018 On-the-ground Status Determination	No difference.
CS ACNS.ADS.2020 Horizontal Position and Velocity Data Sources	No difference overall. However, CS specifies ETSO-C129a as a minimum requirement (in line with Commission Regulation (EU) No 1207/2011).
CS ACNS.ADS.2030 Other Data Sources	No difference, as applicable to the common data parameters (see also 'CS ACNS.ADS.2005').
CS ACNS.ADS.2032	No difference.

CS ACNS.ADS Reference	Comparison
Heading	
CS ACNS.ADS.2034 Geometric Altitude	No difference.
CS ACNS.ADS.2040 Flight Deck Interface	No difference.
CS ACNS.ADS.3000 Integrity	No difference, however, CS details requirements per data parameter.
CS ACNS.ADS.3010 Continuity	No requirement expressed in AC.
CS ACNS.ADS.3020 Horizontal Position and Velocity Data Refresh Rate	No difference.
CS ACNS.ADS.3022 Horizontal Position and Velocity Total Latency	CS uses time of applicability as a reference, AC time of measurement. In line with the AC recommendation that the difference between the two references should be less than or equal to 500ms, the total latency requirements are effectively the same (CS: 1.5s, AC 2.0s).
CS ACNS.ADS.3024 Horizontal Position Uncompensated Latency	No difference.
AMC ACNS.ADS.2000.4.2 Flight Test	AC requires a flight test, for any set of component part numbers of the ADS-B Out system on a given aircraft type.

Subpart E – Others

Reserved

II Draft Decision amending Decision No 2003/12/RM of the Executive Director of the European Aviation Safety Agency of 5 November 2003 on Acceptable Means of Compliance for airworthiness of products, parts and appliances ('AMC-20')

The following AMC 20 standards are deleted from the table of contents.

CONTENTS

AMC-20

GENERAL ACCEPTABLE MEANS OF COMPLIANCE FOR AIRWORTHINESS OF PRODUCTS, PARTS AND APPLIANCES

…

~~AMC 20-13 Certification of Mode S Transponder Systems for Enhanced Surveillance.~~
Cancelled

…

~~AMC 20-24 CERTIFICATION CONSIDERATIONS FOR THE ENHANCED ATS IN NON-RADAR AREAS USING ADS-B SURVEILLANCE (ADS-B-NRA) APPLICATION VIA 1090 MHZ EXTENDED SQUITTER~~ Cancelled

…

C. Cross reference with interoperability Regulation

As implementing rules for interoperability refine the essential requirements of the interoperability Regulation, the below material traces Articles and Annexes of Commission Regulation (EU) No 1207/2011 to the Subpart D Sections 2-4 Book 1 of CS-ACNS requirements.

Each numbered article of the regulation is reproduced in the first column of the table below, followed by a second column cross-referencing to the corresponding Subpart D Sections 2-4 Book 1 requirement(s). A third column provides explanatory notes.

Text of 1207/2011	Applicability and CS-ACNS SUR Book 1 Reference	Notes
Article 1 Subject matter		
This Regulation lays down requirements on the systems contributing to the provision of surveillance data, their constituents and associated procedures in order to ensure the harmonisation of performance, the interoperability and the efficiency of these systems within the European air traffic management network (EATMN) and for the purpose of civil-military coordination.	CS-ACNS.GEN.1000	The CS-ACNS ELS, EHS and ADS Book 1 requirements will ensure interoperability of the aircraft constituents with the other constituents of the surveillance chain.
Article 2 Scope		
1. This Regulation shall apply to the surveillance chain constituted of:		
(a) airborne surveillance systems, their constituents and associated procedures;	CS-ACNS.GEN.1000	The CS-ACNS ELS, EHS and ADS Book 1 requirements will ensure interoperability of the aircraft constituents with the other constituents of the surveillance chain.
(b) ground-based surveillance systems, their constituents and associated procedures;		Not relevant (applicable to ground constituents)
(c) surveillance data processing systems, their constituents and associated procedures;		Not relevant (applicable to ground constituents)
(d) ground-to-ground communications systems used for distribution of surveillance data, their constituents and associated procedures.		Not relevant (applicable to ground constituents)

Text of 1207/2011	Applicability and CS-ACNS SUR Book 1 Reference	Notes
2. This Regulation shall apply to all flights operating as general air traffic in accordance with instrument flight rules within the airspace provided for in Article 1(3) of Regulation (EC) No 551/2004 of the European Parliament and of the Council [3] with the exception of Articles 7(3) and 7(4) which shall apply to all flights operating as general air traffic.		Airspace and flight operation are outside the scope of the CS-ACNS (ELS, EHS, ADS).
3. This Regulation shall apply to air traffic service providers which provide air traffic control services based on surveillance data, and to communication, navigation or surveillance service providers which operate systems laid down in paragraph 1.		Not relevant (applicable to air traffic service provider)
Article 3 Definitions		Definitions have been reused
Article 4 Performance requirements		
1. Air navigation service providers shall ensure seamless operations within the airspace under their responsibility and at the boundary with adjacent airspaces by applying appropriate minimum requirements for the separation of aircraft.		Not relevant (applicable to air navigation service providers)
2. Air navigation service providers shall ensure that systems referred to in points (b), (c) and (d) of Article 2(1) are deployed as necessary to support the minimum requirements for the separation of aircraft applied in accordance with paragraph 1.		Not relevant (applicable to air navigation service providers)
3. Air navigation service providers shall ensure that the output of the surveillance chain referred to in Article 2(1) complies with the performance requirements set out in Annex I provided that the airborne constituent functions used are compliant with the requirements set out in Annex II.		Not relevant (whole surveillance chain provided that airborne constituents are compliant with requirements addressed in this CS)

Text of 1207/2011	Applicability and CS-ACNS SUR Book 1 Reference	Notes
4. If an air navigation service provider identifies an aircraft whose avionics exhibit a functional anomaly, he shall inform the operator of the flight of the deviation from the performance requirements. The operator shall investigate the matter before the next flight is initiated and any rectification necessary shall be introduced in line with normal maintenance and corrective procedures for the aircraft and its avionics.		Not relevant (applicable to air navigation service providers and aircraft operators)
Article 5 Interoperability requirements		
1. Air navigation service providers shall ensure that all surveillance data transferred from their systems identified in points (b) and (c) of Article 2(1) to other navigation service providers complies with the requirements set out in Annex III.		Not relevant (applicable to air navigation service providers)
2. Air navigation service providers when transferring surveillance data from their systems identified in points (b) and (c) of Article 2(1) to other air navigation service providers, shall establish formal arrangements with them for the exchange of the data in accordance with the requirements set out in Annex IV.		Not relevant (applicable to air navigation service providers)
3. Air navigation service providers shall ensure that, by 2 January 2020 at the latest, the cooperative surveillance chain has the necessary capability to allow them to establish individual aircraft identification using downlinked aircraft identification made available by aircraft equipped in accordance with Annex II.		Not relevant (applicable to air navigation service providers)
4. Operators shall ensure that:		
(a) aircraft operating flights referred to in Article 2(2) with an individual certificate of airworthiness first issued on or after 8 January 2015 are equipped with secondary surveillance radar transponders having the capabilities set out in Part A of Annex II;		See traceability of Annex II Part A

Text of 1207/2011	Applicability and CS-ACNS SUR Book 1 Reference	Notes
(b) aircraft with a maximum certified take-off mass exceeding 5700 kg or having a maximum cruising true airspeed capability greater than 250 knots, operating flights referred to in Article 2(2), with an individual certificate of airworthiness first issued on or after 8 January 2015 are equipped with secondary surveillance radar transponders having, in addition to the capabilities set out in Part A of Annex II, the capabilities set out in Part B of that Annex;		See traceability of Annex II Part B
(c) fixed wing aircraft with a maximum certified take-off mass exceeding 5 700 kg or having a maximum cruising true airspeed capability greater than 250 knots, operating flights referred to in Article 2(2), with an individual certificate of airworthiness first issued on or after 8 January 2015 are equipped with secondary surveillance radar transponders having, in addition to the capabilities set out in Part A of Annex II, the capabilities set out in Part C of that Annex.		See traceability of Annex II Part C
5. Operators shall ensure that by 7 December 2017 at the latest:		
(a) aircraft operating flights referred to in Article 2(2), with an individual certificate of airworthiness first issued before 8 January 2015, are equipped with secondary surveillance radar transponders having the capabilities set out in Part A of Annex II;		See traceability of Annex II Part A
(b) aircraft with a maximum certified take-off mass exceeding 5700 kg or having a maximum cruising true airspeed capability greater than 250 knots, operating flights referred to in Article 2(2), with an individual certificate of airworthiness first issued before 8 January 2015 are equipped with secondary surveillance radar transponders having, in addition to the capabilities set out in Part A of Annex II, the capabilities set out in Part B of that Annex;		See traceability of Annex II Part B

Text of 1207/2011	Applicability and CS-ACNS SUR Book 1 Reference	Notes
(c) fixed wing aircraft with a maximum certified take-off mass exceeding 5700 kg or having a maximum cruising true airspeed capability greater than 250 knots, operating flights referred to in Article 2(2), with an individual certificate of airworthiness first issued before 8 January 2015 are equipped with secondary surveillance radar transponders having, in addition to the capabilities set out in Part A of Annex II, the capabilities set out in Part C of that Annex.		See traceability of Annex II Part C
6. Operators shall ensure that aircraft equipped in accordance with paragraphs 4 and 5 and having a maximum certified take-off mass exceeding 5700 kg or having a maximum cruising true airspeed capability greater than 250 knots operate with antenna diversity as prescribed in paragraph 3.1.2.10.4 of Annex 10 to the Chicago Convention, Volume IV, Fourth Edition including all amendments up to No 85.	CS-ACNS.ELS.4030 (b) CS-ACNS.ADS.2012	
7. Member States may impose carriage requirements in accordance with point (b) of paragraph 4 and point (b) of paragraph 5 to all aircraft operating flights referred to in Article 2(2) in areas where surveillance services using the surveillance data identified in Part B of Annex II are provided by air navigation service providers.		Not relevant (applicable to Member States)
8. Air navigation service providers shall ensure that, before putting into service the systems referred to in points (b), (c) and (d) of Article 2(1), they are implementing the most efficient deployment solutions taking into account the local operating environments, constraints and needs as well as airspace users capabilities.		Not relevant (applicable to air navigation service providers)
Article 6 Spectrum protection		Not relevant (applicable to Member States)

Text of 1207/2011	Applicability and CS-ACNS SUR Book 1 Reference	Notes
1. By 5 February 2015 at the latest Member States shall ensure that a secondary surveillance radar transponder on board any aircraft flying over a Member State is not subject to excessive interrogations that are transmitted by ground-based surveillance interrogators and which either elicit replies or whilst not eliciting a reply are of sufficient power to exceed the minimum threshold level of the receiver of the secondary surveillance radar transponder.		
2. For the purpose of paragraph 1, the sum of such interrogations shall not cause the secondary surveillance radar transponder to exceed the rates of reply per second, excluding any squitter transmissions, specified in paragraph 3.1.1.7.9.1 for Mode A/C replies and in paragraph 3.1.2.10.3.7.3 for Mode S replies of Annex 10 to the Chicago Convention, Volume IV, Fourth Edition.		
3. By 5 February 2015 at the latest Member States shall ensure that the use of a ground based transmitter operated in a Member State does not produce harmful interference on other surveillance systems.		
4. In the event of disagreement between Member States regarding the measures detailed in paragraphs 1 and 3 the Member States concerned shall bring the matter to the Commission for action.		
Article 7 Associated procedures		
1. Air navigation service providers shall assess the level of performance of ground based surveillance chain before putting them into service as well as regularly during the service, in accordance with the requirements set out in Annex V.		Not relevant (applicable to air navigation service providers)

Text of 1207/2011	Applicability and CS-ACNS SUR Book 1 Reference	Notes
2. Operators shall ensure that a check is performed at least every two years, and, whenever an anomaly is detected on a specific aircraft, so that the data items set out in point 3 of Part A of Annex II, in point 3 of Part B of Annex II and in point 2 of Part C of Annex II, if applicable, are correctly provided at the output of secondary surveillance radar transponders installed on board their aircraft. If any of the data items are not correctly provided then the operator shall investigate the matter before the next flight is initiated and any rectification necessary shall be introduced in line with normal maintenance and corrective procedures for the aircraft and its avionics.		Not relevant (applicable to periodic checks whilst aircraft is operated)
3. Member States shall ensure that the assignment of 24-bit ICAO aircraft addresses to aircraft equipped with a Mode S transponder complies with Chapter 9 and its appendix of Annex 10 to the Chicago Convention, Volume III, Second Edition including all amendments up to No 85.		Not relevant (applicable to Member States)
4. Operators shall ensure that on board the aircraft they are operating, any Mode S transponder operates with a 24-bit ICAO aircraft address that corresponds to the registration that has been assigned by the State in which the aircraft is registered.	CS-ACNS.ELS.4010 CS-ACNS.ADS.2011	
Article 8 State aircraft		State aircraft may be certified against this CS
1. Member States shall ensure that, by 7 December 2017 at the latest, State aircraft operating in accordance with Article 2(2) are equipped with secondary surveillance radar transponders having the capability set out in Part A of Annex II.		See traceability of Annex II Part A

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2. Member States shall ensure that, by 1 January 2019 at the latest, transport-type State aircraft with a maximum certified take-off mass exceeding 5700 kg or having a maximum cruising true airspeed capability greater than 250 knots, operating in accordance with Article 2(2) are equipped with secondary surveillance radar transponders having in addition to the capability set out in Part A of Annex II, the capability set out in Part B and Part C of that Annex.		See traceability of Annex II Part B
3. Member States shall communicate to the Commission by 1 July 2016 at the latest the list of State aircraft that cannot be equipped with secondary surveillance radar transponders that comply with the requirements set out in Part A of Annex II, together with the justification for non-equipage.		See traceability of Annex II Part C
Member States shall communicate to the Commission by 1 July 2018 at the latest the list of transport-type State aircraft with a maximum certified take-off mass exceeding 5700 kg or having a maximum cruising true airspeed capability greater than 250 knots, that cannot be equipped with secondary surveillance radar transponders that comply with the requirements set out in Part B and Part C of Annex II, together with the justification for non-equipage.		Not relevant (applicable to Member States)
The justification for non-equipage shall be one of the following:		
(a) compelling technical reasons;		
(b) State aircraft operating in accordance with Article 2(2) that will be out of operational service by 1 January 2020 at the latest;		
(c) procurement constraints.		

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4. Where State aircraft cannot be equipped with secondary surveillance radar transponders as specified by paragraphs 1 or 2 for the reason set out in point (c) of paragraph 3 Member States shall include in the justification their procurement plans regarding these aircraft.		Not relevant (applicable to Member States)
5. Air traffic service providers shall ensure that the State aircraft identified in paragraph 3 can be accommodated, provided that they can be safely handled within the capacity of the air traffic management system.		Not relevant (applicable to ANSP)
6. Member States shall publish the procedures for the handling of State aircraft which are not equipped in accordance with paragraphs 1 or 2 in national aeronautical information publications.		Not relevant (applicable to Member States)
7. Air traffic service providers shall communicate on an annual basis to the Member State that has designated them their plans for the handling of State aircraft which are not equipped according with paragraphs 1 or 2. Those plans shall be defined by taking into account the capacity limits associated with the procedures referred to in paragraph 6.		Not relevant (applicable to ANSP)
Article 9 Safety requirements		Not relevant (ground systems only)
1. Member States shall ensure that, by 5 February 2015 at the latest, a safety assessment is conducted by the parties concerned for all existing systems referred to in points (b), (c) and (d) of Article 2(1).		
2. Member States shall ensure that any changes to the existing systems referred to in points (b), (c) and (d) of Article 2(1) or the introduction of new systems are preceded by a safety assessment, including hazard identification, risk assessment and mitigation, conducted by the parties concerned.		

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3. During the assessments identified in paragraphs 1 and 2, the requirements set out in Annex VI shall be taken into consideration as a minimum.		
Article 10 Conformity or suitability for use of constituents		
Before issuing an EC declaration of conformity or suitability for use provided in Article 5 of Commission Regulation (EC) No 552/2004, manufacturers of constituents of the systems referred to in Article 2(1) of this Regulation or their authorised representatives established in the Union, shall assess the conformity or suitability for use of those constituents in compliance with the requirements set out in Annex VII.		Not relevant
However, certification processes complying with Regulation (EC) No 216/2008 of the European Parliament and of the Council [4], shall be considered as acceptable procedures for the conformity assessment of constituents if they include the demonstration of compliance with the applicable interoperability, performance and safety requirements of this Regulation.		This traceability material demonstrates the compliance of the CS-ACNS Subpart D Sections 2-4 to the Commission Regulation (EU) No 1207/2011.
Article 11 Verification of systems		
1. Air navigation service providers which can demonstrate or have demonstrated that they fulfil the conditions set out in Annex VIII shall conduct a verification of the systems referred to in points (b), (c) and (d) of Article 2(1) in compliance with the requirements set out in Part A of Annex IX.		Not relevant (applicable to ANSP)
2. Air navigation service providers which cannot demonstrate that they fulfil the conditions set out in Annex VIII shall subcontract to a notified body a verification of the systems referred to in points (b), (c) and (d) of Article 2(1). This verification shall be conducted in compliance with the requirements set out in Part B of Annex IX.		Not relevant (applicable to ANSP)

Text of 1207/2011	Applicability and CS-ACNS SUR Book 1 Reference	Notes
3. Certification processes complying with Regulation (EC) No 216/2008 shall be considered as acceptable procedures for the verification of systems if they include the demonstration of compliance with the applicable interoperability, performance and safety requirements of this Regulation.		This traceability material demonstrates the compliance of the CS-ACNS Subpart D Sections 2-4 to the Commission Regulation (EU) No 1207/2011.
Article 12 Additional requirements		Not relevant (not applicable to aircraft constituents)
1. Air navigation service providers shall ensure that all personnel concerned are made duly aware of the requirements laid down in this Regulation and that they are adequately trained for their job functions.		
2. Air navigation service providers shall:		
(a) develop and maintain operations manuals containing the necessary instructions and information to enable all personnel concerned to apply this Regulation;		
(b) ensure that the manuals referred to in point (a) are accessible and kept up to date and that their update and distribution are subject to appropriate quality and documentation configuration management;		
(c) ensure that the working methods and operating procedures comply with this Regulation.		
3. Operators shall take the necessary measures to ensure that the personnel operating and maintaining surveillance equipment are made duly aware of the relevant provisions of this Regulation, that they are adequately trained for their job functions, and that instructions about how to use this equipment are available in the cockpit where feasible.		
4. Member States shall ensure compliance with this Regulation including the publication of the relevant information on surveillance equipment in the national aeronautical information publications.		

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Article 13 Exemptions on the cooperative surveillance chain		
1. For the specific case of approach areas where air traffic services are provided by military units or under military supervision and when procurement constraints prevent compliance with Article 5(3), Member States shall communicate to the Commission by 31 December 2017 at the latest, the date of compliance of the cooperative surveillance chain that shall not be later than 2 January 2025.		Not relevant (applicable to Member State)
2. Following consultation with the Network Manager and not later than 31 December 2018, the Commission may review the exemptions communicated under paragraph 1 that could have a significant impact on the EATMN.		Not relevant (applicable to European Commission)
Article 14 Exemptions on aircraft		Not relevant (exemption conditions against regulation)
1. Aircraft of specific types with a first certificate of airworthiness issued before 8 January 2015 that have a maximum take off mass exceeding 5700 kg or a maximum cruising true airspeed greater than 250 knots that do not have the complete set of parameters detailed in Part C of Annex II available on a digital bus on-board the aircraft may be exempted from complying with the requirements of point (c) of Article 5(5).		
2. Aircraft of specific types with a first certificate of airworthiness issued before 1 January 1990 that have a maximum take off mass exceeding 5700 kg or a maximum cruising true airspeed greater than 250 knots may be exempted from complying with the requirements of Article 5(6).		
3. The Member States concerned shall communicate to the Commission by 1 July 2017 at the latest, detailed information justifying the need for granting exemptions to these specific aircraft types based on the criteria of paragraph 5.		

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4. The Commission shall examine the requests for exemption referred to in paragraph 3, and, following consultation with the parties concerned, shall adopt a decision.		
5. The criteria referred to in paragraph 3 shall include the following:		
(a) specific aircraft types reaching the end of their production life;		
(b) specific aircraft types being produced in limited numbers;		
(c) disproportionate re-engineering costs.		
Article 15 Entry into force and application		Not relevant
This Regulation shall enter into force on the 20th day following its publication in the Official Journal of the European Union.		
Article 4, Article 5(1) and (2) and Article 7(1) shall apply from 13 December 2013.		
This Regulation shall be binding in its entirety and directly applicable in all Member States.		
ANNEX I Performance requirements referred to in Article 4(3)		Not relevant (whole surveillance chain provided that airborne constituents are compliant with requirements addressed in this CS)
ANNEX II Part A: Secondary surveillance radar transponder capabilities referred to in Article 4(3), Article 5(4)(a) and (5)(a), Article 7(2), Article 8(1) and (2)		
1. The minimum capability for the secondary surveillance transponder shall be Mode S Level 2 certified in accordance with paragraphs 2.1.5.1.2, 2.1.5.1.7 and 3.1.2.10 of Annex 10 to the Chicago Convention, Volume IV, Fourth Edition including all amendments up to No 85.	CS-ACNS.ELS.2000 (a)	
2. Each implemented transponder register shall be compliant with the corresponding section of ICAO document 9871 (2nd edition).	CS-ACNS.ELS.2010 (b)	

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3. The following data items shall be made available to the transponder and be transmitted by the transponder via the Mode S protocol and in accordance with the formats specified in ICAO document 9871 (2nd edition):		
(a) 24-bit ICAO aircraft address;	CS-ACNS.ELS.2010 (a) (9)	
(b) Mode A code;	CS-ACNS.ELS.2010 (a) (1)	
(c) pressure altitude;	CS-ACNS.ELS.2010 (a) (2)	
(d) flight status (on the ground or airborne);	CS-ACNS.ELS.2010 (a) (3)	
(e) data link capability report;	CS-ACNS.ELS.2010 (a) (7)	
- airborne collision avoidance system (ACAS) capability,		
- Mode S specific services capability,		
- aircraft identification capability,		
- squitter capability,		
- surveillance identifier capability,		
- common usage Ground Initiated Comms.-B (GICB) capability report (indication of change),		
- Mode S subnetwork version number;		
(f) common usage GICB capability report;	CS-ACNS.ELS.2010 (a) (8)	
(g) aircraft identification;	CS-ACNS.ELS.2010 (a) (4)	
(h) special position indication (SPI);	CS-ACNS.ELS.2010 (a) (5)	
(i) emergency status (general emergency, no communications, unlawful interference) including the use of specific Mode A codes to indicate different emergency states;	CS-ACNS.ELS.2010 (a) (6)	
(j) ACAS active resolution advisories when the aircraft is equipped with Traffic alert and collision avoidance system II (TCAS II).	CS-ACNS.ELS.2010 (a) (10)	

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4. Other data items may be made available to the transponder.		Option
5. The data items referred to in point 4 shall only be transmitted by the transponder via the Mode S protocol if the aircraft and equipment certification process covers the transmission of these data items via the Mode S protocol.	CS-ACNS.ELS.2010 (b)	For optional data items
6. The continuity of transponder functionality supporting the Mode S protocol shall be equal to or less than 2. 10-4 per flight hour (i.e. mean time between failure equal to or greater than 5000 flight hours).		
Part B: Secondary surveillance radar transponder capabilities referred to in Article 4(3), Article 5(4)(b), (5)(b) and (7), Article 7(2) and Article 8(3)		
1. The minimum capability for the secondary surveillance transponder shall be Mode S Level 2 certified in accordance with paragraphs 2.1.5.1.2, 2.1.5.1.6, 2.1.5.1.7 and 3.1.2.10 of Annex 10 to the Chicago Convention, Volume IV, Fourth Edition including all amendments up to No 85.	CS-ACNS.ADS.2010	
2. Each implemented transponder register shall be compliant with the corresponding section of ICAO document 9871 (2nd edition).	CS-ACNS.ADS.2010	
3. The following data items shall be made available to the transponder and be transmitted by the transponder via Version 2 of the extended squitter (ES) ADS-B protocol in accordance with the formats specified in ICAO document 9871 (2nd edition):	CS-ACNS.ADS.2005 (a)	
(a) 24-bit ICAO aircraft address;	CS-ACNS.ADS.2005 (a) Item 3	
(b) aircraft identification;	CS-ACNS.ADS.2005 (a) Item 1	
(c) Mode A code;	CS-ACNS.ADS.2005 (a) Item 2	

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(d) special position indication (SPI) using the same source as for the same parameter specified in Part A;	CS-ACNS.ADS.2005 (a) Item 6 CS-ACNS.ADS.2008 (b) CS-ACNS.ADS.2030	
(e) emergency status (general emergency, no communications, unlawful interference) using the same source as for the same parameter specified in Part A;	CS-ACNS.ADS.2005 (a) Item 7a and 7b CS-ACNS.ADS.2008 (b) CS-ACNS.ADS.2030	
(f) ADS-B version number (equal to 2);	CS-ACNS.ADS.2005 (a) Item 8	
(g) ADS-B emitter category;	CS-ACNS.ADS.2005 (a) Item 10	
(h) geodetic horizontal position in accordance with the world geodetic system revision 1984 (WGS84) latitude and longitude, both while airborne or on the ground;	CS-ACNS.ADS.2005 (a) Items 4a and 12a	
(i) geodetic horizontal position quality indicators (corresponding to the integrity containment bound (NIC), 95 % navigation accuracy category for position (NACp), source integrity level (SIL) and system design assurance level (SDA));	CS-ACNS.ADS.2005 (a) Items 4b, 4c, 4d, 4e and 12b	
(j) pressure altitude using the same source as for the same parameter specified in Part A;	CS-ACNS.ADS.2005 (a) Item 5 CS-ACNS.ADS.2008 (b) CS-ACNS.ADS.2030	
(k) geometric altitude in accordance with the world geodetic system revision 1984 (WGS84), provided in addition and encoded as a difference to pressure altitude;	CS-ACNS.ADS.2005 (a) Item 17a	
(l) geometric vertical accuracy (GVA);	CS-ACNS.ADS.2005 (a) Item 17b	
(m) velocity over ground, both while airborne (east/west and north/south airborne velocity over ground) or on the ground (surface heading/ground track and movement);	CS-ACNS.ADS.2005 (a) Items 9a, 13 and 14	
(n) velocity quality indicator corresponding to navigation accuracy category for velocity (NACv);	CS-ACNS.ADS.2005 (a) Item 9b	

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(o) coded aircraft length and width;	CS-ACNS.ADS.2005 (a) Item 15	
(p) global navigation satellite system (GNSS) antenna offset;	CS-ACNS.ADS.2005 (a) Item 16	
(q) vertical rate: barometric vertical rate using the same source as for the same parameter specified in the data item in point 2 (g) of Part C when the aircraft is required and capable to transmit this data item via the Mode S protocol, or Global Navigation Satellite System (GNSS) vertical rate;	CS-ACNS.ADS.2005 (a) Item 11 CS-ACNS.ADS.2008 (b) CS-ACNS.ADS.2030	
(r) mode control panel/flight control unit (MCP/FCU) selected altitude using the same source as for the same parameter specified in Part C when the aircraft is required and capable to transmit this data item via the Mode S protocol;	CS-ACNS.ADS.2005 (b) Item 1 CS-ACNS.ADS.2008 (b) CS-ACNS.ADS.2030	
(s) barometric pressure setting (minus 800 hectoPascals) using the same source as for the same parameter specified in Part C when the aircraft is required and capable to transmit this data item via the Mode S protocol;	CS-ACNS.ADS.2005 (b) Item 2 CS-ACNS.ADS.2008 (b) CS-ACNS.ADS.2030	
(t) ACAS active resolution advisories when the aircraft is equipped with TCAS II using the same source as for the same parameter specified in Part A.	CS-ACNS.ADS.2005 (b) Item 3a and 3b CS-ACNS.ADS.2008 (b) CS-ACNS.ADS.2030	
4. Surveillance data items (the data items in point 3(h), (k) and (m)) and their quality indicator data items (the data items in point 3(i), (l) and (n)) shall be provided to the transponders on the same physical interface.	CS-ACNS.ADS.2008 (c) CS-ACNS.ADS.2020 (b)	
5. The data source connected to the transponder and providing the data items in point 3(h) and (i) shall meet the following data integrity requirements:		
(a) horizontal position (data item in point 3(h)) source integrity level (SIL, expressed with respect to NIC) shall be equal to or less than 10-7 per flight-hour;	CS-ACNS.ADS.2008 (a) CS-ACNS.ADS.2020 (a)	Refer to AMC ACNS.ADS.2020 for compliance with data integrity requirement specified in the Rule.

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(b) horizontal position (data item in point 3(h)) integrity time to alert (leading to a change of the NIC quality indicator), if on-board monitoring is required to meet the horizontal position source integrity level, shall be equal to or less than 10 seconds.	CS-ACNS.ADS.2008 (a) CS-ACNS.ADS.2020 (a)	Refer to AMC ACNS.ADS.2020 for compliance with data integrity time to alert requirement specified in the Rule.
6. The primary data source providing the data items in point 3(h) and (i) shall be at least compatible with GNSS receivers that perform receiver autonomous integrity monitoring (RAIM) and fault detection and exclusion (FDE), along with the output of corresponding measurement status information, as well as integrity containment bound and 95 % accuracy bound indications.	CS-ACNS.ADS.2020 (a)	Refer to AMC ACNS.ADS.2020 for compliance with data integrity requirement specified in the Rule.
7. The system integrity level of the data sources providing the data items in point 3(f), (g), (k) to (p) shall be equal to or less than 10-5 per flight-hour.	CS-ACNS.ADS.3000	Refer to AMC ACNS.ADS.3000 for detailed compliance with the system integrity requirement specified in the Rule.
8. The quality indicator information (NIC, NACp, SIL, SDA, NACv and GVA) (the data items in point 3(i), (l) and (n)) shall express the actual performance of the selected data source as valid at the time of applicability of the measurement of the data items in point 3(h), (k) and (m)).	CS-ACNS.ADS.2008(c)	
9. With respect to the processing of the data items in point 3(a) to (t), the transponder system integrity level for the extended squitter ADS-B protocol, including any interconnecting avionics to the transponder, shall be equal to or less than 10-5 per flight-hour.	CS-ACNS.ADS.3000 (a)	
10. The total latency of the horizontal position data (the data items in point 3(h) and (i)) shall be equal to or less than 1,5 second in 95 % of all transmissions.	CS-ACNS.ADS.3022	
11. The uncompensated latency of the horizontal position data (data item in point 3(h)) shall be equal to or less than 0,6 second in 95 % of the cases and shall be equal to or less than 1,0 second in 99,9 % of all transmissions.	CS-ACNS.ADS.3024	

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12. The total latency of the ground speed data items (the data items in point 3(m) and (n)) shall be equal to or less than 1,5 second in 95 % of all transmissions.	CS-ACNS.ADS.3022	
13. If the transponder is set to use a Mode A conspicuity code of 1000 then the broadcast of Mode A code information via the extended squitter ADS-B protocol shall be inhibited.	CS-ACNS.ADS.2010	Refer to AMC ACNS.ADS.2010 for related ETSO compliance with the requirement specified in the Rule.
14. Other data items may be made available to the transponder.	n/a	See Item 15, Annex II, Part B (and below).
15. Except for military reserved formats, the data items referred to in point 14 shall only be transmitted by the transponder via the extended squitter ADS-B protocol if the aircraft and equipment certification process covers the transmission of these data items via the extended squitter ADS-B protocol.	CS-ACNS.ADS.2008 (a)	This also covers optional data items.
16. The continuity of transponder functionality supporting the ADS-B protocol shall be equal to or less than 2. 10-4 per flight hour (i.e. mean time between failure equal to or greater than 5000 flight hours).	CS-ACNS.ADS.3010	Refer to AMC ACNS.ADS.3010 for compliance with system continuity requirement specified in the Rule.
Part C: Secondary surveillance radar transponder additional surveillance data capability referred to in Article 4(3), Article 5(4)(c) and (5)(c), Article 7(2), Article 8(3) and Article 14(1)		
1. Each transponder register that is implemented shall be compliant with the corresponding section of ICAO document 9871 (2nd edition).	CS-ACNS.EHS.2010	Through reference to CS-ACNS.ELS.2010
2. The following data items shall be made available to the transponder and be transmitted by the transponder as requested by the ground-based surveillance chain, via the Mode S protocol and in accordance with the formats specified in ICAO document 9871 (2nd edition):		
(a) MCP/FCU selected altitude;	CS-ACNS.EHS.2010 (a)	
(b) roll angle;	CS-ACNS.EHS.2010 (b)	

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(c) true track angle;	CS-ACNS.EHS.2010 (c)	
(d) ground speed;	CS-ACNS.EHS.2010 (d)	
(e) magnetic heading;	CS-ACNS.EHS.2010 (e)	
(f) indicated airspeed (IAS) or mach number;	CS-ACNS.EHS.2010 (f)	
(g) vertical rate (barometric or baro-inertial);	CS-ACNS.EHS.2010 (g)	
(h) barometric pressure setting (minus 800 hectoPascals);	CS-ACNS.EHS.2010 (h)	
(i) track angle rate or true airspeed if track angle rate is not available.	CS-ACNS.EHS.2010 (i)	
3. Other data items may be made available to the transponder.		Option
4. The data items referred to in point 3 shall only be transmitted by the transponder via the Mode S protocol if the aircraft and equipment certification process covers the transmission of these data items via the Mode S protocol.	CS-ACNS.EHS.2010	Through reference to CS-ACNS.ELS.2010
ANNEX III Surveillance data exchange requirements referred to in Article 5(1)		Not relevant (ground systems only)
ANNEX IV Requirements for the establishment of formal arrangements referred to in Article 5(2)		Not relevant (ground systems only)
ANNEX V Requirements for the assessment of the level of performance of surveillance chains referred to in Article 7(1)		Not relevant (ground systems only)
ANNEX VI Requirements referred to in Article 9		Not relevant (ground systems only)
ANNEX VII Requirements for the assessment of the conformity or suitability for use of constituents referred to in Article 10		Not relevant (Article 10 Not relevant))
ANNEX VIII Conditions referred to in Article 11(1) and (2)		Not relevant (ground systems only)
ANNEX IX Part A: Requirements for the verification of systems referred to in Article 11(1)		Not relevant (ground systems only)

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Part B: Requirements for the verification of systems referred to in Article 11(2)		Not relevant (ground systems only)