

**AMC 20-15 Effective: 30/03/2011**

Annex II to ED Decision 2011/001/R of 23/03/2011

**AMC 20-15: Airworthiness Certification Considerations for the Airborne Collision Avoidance System (ACAS II) with optional Hybrid Surveillance****1 PREAMBLE**

This Acceptable Means of Compliance (AMC) provides a means that can be used to obtain an airworthiness approval for the installation of ACAS II equipment which may include optional hybrid surveillance. It is issued to support the operational requirement that requires the carriage of ACAS II.

Hybrid Surveillance is an optional feature that allows ACAS II to use a combination of active surveillance, i.e. actively interrogating the Mode-S Transponders of surrounding aircraft, and passive surveillance, i.e. use of ADS-B position and altitude data (extended squitter), to update an ACAS II track.

An applicant may elect to use an alternative means of compliance. However, those alternative means of compliance must meet the relevant requirements and ensure a safety objectives as defined in paragraph 5 are met. Compliance with this AMC is not mandatory.

**2 RELEVANT REQUIREMENTS**

The provisions to which this AMC applies are:

CS 25.1301, 1302, 1309, 1322, 1333, 1431, 1459, 1529 and 1581.

CS 23.1301, 1309, 1322, 1431, 1459, 1529 and 1581.

CS 27.1301, 1309, 1322, 1459, 1529 and 1581

CS 29.1301, 1309, 1322, 1333, 1431, 1459, 1529 and 1581

**3 REFERENCE MATERIAL**

EU OPS<sup>1</sup> 1.160, 1.668, 1.1045, 1.398

AMC 25.1302, AMC 25.1309, AMC 25.1322 and AMC 25-11.

ETSO-C113	Airborne Multipurpose Electronic Displays
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ETSO-C119c	Traffic Alert and Collision Avoidance System (TCAS) Airborne Equipment, TCAS II.
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ETSO-2C112()	Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment
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EUROCAE ED-143 including change 1	Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance Systems (TCAS) Airborne Equipment.
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<sup>1</sup> Council Regulation (EEC) No 3922/91 on the harmonisation of technical requirements and administrative procedures in the field of civil aviation. Regulation as last amended by Regulation (EC) No 1899/2006 of the European Parliament and of the Council of 12 December 2006 (OJ L 377, 27.12.2006, p. 1).

EUROCAE ED-112	Minimum Operational Performance Specification for Crash Protected Airborne Recorder Systems
RTCA DO-300 including change 1	Minimum Operational Performance Standards (MOPS) for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid surveillance.

**4 MINIMUM EQUIPMENT QUALIFICATION**

- 4.1 An acceptable minimum certification standard for the ACAS II equipment including optional hybrid surveillance is EASA ETSO-C119c.
- 4.2 An acceptable minimum certification standard for the associated Mode S transponder is EASA ETSO-2C112().

**5 SAFETY OBJECTIVES**

The applicant should perform a Functional Hazard Assessment (FHA) and System Safety Assessment (SSA) for the proposed ACAS II installation. For the purposes of this AMC, a system includes all airborne devices contributing to the ACAS II function. Guidance is provided in AMC 25.1309 or FAA AC 23-1309-1() or AC 27-1B or AC 29-2C. Acceptable probability levels for functionality and alerts are given below:

- 5.1 The probability of failure of the installed system to perform its intended function from a reliability and availability perspective should be shown to be no greater than  $1 \times 10^{-3}$  per flight hour.
- 5.2 The probability of failure of the system to provide the required RA aural or visual alert, when required, without a failure indication should be shown to be no greater than  $1 \times 10^{-4}$  per flight hour in the terminal environment and  $1 \times 10^{-5}$  per flight hour in the en-route environment. See note 1.
- 5.3 The probability of a false or misleading RA aural and visual alert due to a failure of the system should be shown to be no greater than  $1 \times 10^{-4}$  per flight hour in the terminal environment and  $1 \times 10^{-5}$  per flight hour in the en-route environment. See note 1.

Note: The definition of a 'misleading alert' is when an RA condition exists, and an RA is issued, but the RA gives incorrect guidance. The definition of a 'false alert' is when an RA is issued, but an RA condition does not exist.

- 5.4 Failure of the installed ACAS II must not degrade the integrity of any essential or critical system which has an interface with the ACAS II.

The use of Hybrid Surveillance including transitions from active to passive surveillance and vice versa, using a system that complies with the requirements of RTCA DO-300 including Change 1, is assumed not to compromise the safety of ACAS II.

Note 1: In terminal airspace the frequency of encounters, where another aircraft could be present, may be assumed to be once every 10 hours. In en-route airspace the frequency of encounters, where another aircraft could be present, may be assumed to be once every 200 hours. Different frequencies may be used if supported by operational data.

## 6 HARDWARE AND INSTALLATION

### 6.1 General Considerations:

The installation should include as a minimum a single ACAS II system and a single Mode S Transponder that meet the requirements of paragraph 4.

### 6.2 Aural Alerts:

- (a) TA and RA aural alerts should be presented by the prescribed voice announcements via flight deck loudspeakers.
- (b) Consideration should be given to presenting ACAS II voice announcements via headsets at a preset level.
- (c) A means for the pilot to cancel active voice announcements and visual indicators is permitted but should not be necessary where voice announcements have a specific duration.
- (d) The ACAS II voice announcements should be consistent with the general philosophy of other flight deck aural alerting systems. In particular, the prioritisation and compatibility of alerts and voice announcements from different warning systems should be consistent with each other. The alert priorities should be wind shear, TAWS and then ACAS II. Altitude callout advisories which occur simultaneously with ACAS II advisories are permitted, but the audibility of each voice alert will need to be understandable.
- (e) The adequacy of aural levels will need to be demonstrated.

Note: For rotorcraft, TA and RA aural alerts should be presented via headsets at a preset level

### 6.3 Displays & Indications

- (a) Warning and Caution alerts should comply with the guidance provided in AMC 25.1322 unless otherwise stated in this AMC.
- (b) The display of Traffic and Resolution Advisory information should be consistent with the guidance provided in AMC 25.1322 and with paragraph 5.4 of AMC 25.1302.
- (c) Resolution Advisory guidance should be presented at each pilot station in the pilot's primary field of view.  
Resolution Advisories may be presented on EFIS or IVSI displays provided their primary functions are not compromised.
- (d) A discrete red warning Resolution Advisory enunciator or an Instantaneous Vertical Speed Indicator (IVSI) with a lighted red indication or Primary Flight Display (PFD) with a lighted red indication or an electronic attitude display with an alphanumeric message should be located in each pilot's primary field of view.
- (e) A means to display traffic information to each flight crew member should be provided. Traffic information may be provided on weather radar (WXR), Electronic Flight Instrument System (EFIS), Instantaneous Vertical Speed Indicator (IVSI) or other compatible display screen which has been demonstrated to meet the guidance of AMC 25-11, provided their primary functions are not compromised. A separate dedicated traffic display,

readily visible to both pilots, is an acceptable alternative. In case a Multi Function Display is used, the display should meet the requirements of ETSO-C113.

- (f) Discrete TA caution lights are optional.
- (g) ACAS II Resolution and Traffic Advisories which trigger the Master Warning System will not be accepted.
- (h) An indication of ACAS II system and sensor failures which prevents correct operation should be provided.
- (i) An indication that the ACAS II system is operating in TA mode should be provided.
- (j) ACAS II should be automatically switched to TA mode, if ACAS II and wind shear voice or ACAS II and TAWS voice announcements occur simultaneously.
- (k) The adequacy of display visibility needs to be demonstrated.
- (l) The flight crew should be aware, at all times, of the operational state of the ACAS II system. Any change of the operational state of the ACAS II system is to be enunciated to the flight crew via suitable means.

#### 6.4 ACAS II Controls:

- (a) Control of the ACAS II should be readily accessible to the flight crew.
- (b) A means to initiate the ACAS II Self Test function should be provided.

#### 6.5 Antennas:

- (a) Either a directional antenna and an omni-directional antenna, or two directional antennas may be installed.  
Note: when installing a directional antenna and an omni-directional antenna the omni-directional antenna should be the lower antenna.
- (b) The physical locations of the transponder antennas and the ACAS II antennas will need to satisfy isolation and longitudinal separation limits. The physical location should also ensure that propellers or rotors do not interfere with system operation, if applicable. ACAS II antennas may be installed with an angular offset from the aircraft centreline not exceeding 5 degrees.

#### 6.6 Interfaces:

- (a) Pressure altitude information will need to be obtained from the same sensor source that supplies the Mode S Transponder(s) and the flight deck altitude display(s). This source should be the most accurate source available on the aircraft. Altitude information should be provided via a digital data bus. ICAO Gray (Gillham) code should not be used.
- (b) An interface to a radio altimeter sensor should be provided.
- (c) Inhibit logic selected for input to the ACAS II to take account of the aircraft performance limitations will need to be evaluated and justified unless accepted for an earlier ACAS II standard.
- (d) Other interfacing for discrete data should be provided, as required.

- (e) The ACAS II installation should provide an interface with the flight recorder(s).
- (f) Recording of ACAS II data should be accomplished in accordance with EUROCAE ED-112.  
 Note: Information necessary to retrieve and convert the stored data into engineering units should be provided.
- (g) Interfaces between systems should be analysed to show no unwanted interaction under normal or fault conditions.

## 7 CERTIFICATION TESTING

Ground testing will need to be performed with due consideration of the possible risk of nuisance advisories in operating aircraft. The precautions provided in Appendix 1 should be followed.

- 7.1 The bulk of testing for a modification to install ACAS II can be achieved by ground testing that verifies system operation and interfaces with aircraft systems.
- 7.2 The ground tests should include:
  - (a) verification check of the ICAO 24 bit airframe address.;
  - (b) bearing accuracy check of intruder. A maximum error of  $\pm 15$  degrees in azimuth should be demonstrated for each quadrant. Larger errors may be acceptable in the tail area of the aircraft;
  - (c) failure of sensors which are interfaced to ACAS II. A test should be performed to ensure that the effect on ACAS II agrees with the predicted results;
  - (d) correct warning prioritisation. The alert priorities should be wind shear, TAWS and then ACAS II;
  - (e) electromagnetic interference evaluation to ensure that ACAS II does not cause interference with other aircraft systems;
  - (f) the correct operation of any aircraft configurations which result in, by design, the inhibition of RAs.
- 7.3 Flight testing of an initial installation should evaluate overall operation including:
  - (a) surveillance range;  
 Note: Surveillance range may vary depending on airspace conditions.
  - (b) target azimuth reasonableness.
  - (c) freedom from unwanted interference;
  - (d) assessment, during adverse flight conditions, of instrument visibility, display lighting, sound levels and intelligibility of aural messages;
  - (e) the effects of electrical transients;
  - (f) validity and usability of Traffic information when the aircraft is subject to attitude changes of  $\pm 15$  degrees in pitch and  $\pm 30$  degrees in roll;
  - (g) the correct operation of any aircraft configurations which result in, by design, the inhibition of RAs;  
 Note: these tests may be considered to be a subset of the ground tests performed in paragraph 7.2 (f). Only those aircraft configurations which are practical to perform in an airborne environment need to be assessed.
  - (h) electromagnetic interference evaluation to ensure that ACAS II does not cause interference with other aircraft systems.

- 7.4 Flight testing to demonstrate RA performance in a planned encounter between aircraft will not normally be required for an ACAS II – Mode S equipment combination, previously demonstrated as performing correctly. Planned encounter flight testing should not be attempted without the agreement of the Agency.
- 7.5 To minimise the certification effort for ACAS II for additional aircraft types listed in the type certificate, the applicant may claim credit, for applicable certification and flight test data obtained from equivalent aircraft installations, including testing performed for ACAS II version 6.04A or 7.0. Flight Testing of ACAS II will not normally be required where acceptable evidence exists relating to the previous certification standard of ACAS II. This assumes the introduction ACAS II involves equipment replacements only.
- 7.6 Equipment that meets the acceptable minimum certification standard for the ACAS II equipment (see paragraph 4.1) has demonstrated that hybrid surveillance function does not degrade the performance of the ACAS II active surveillance. Therefore, when the optional hybrid surveillance function is enabled, specific installation testing of this function is not required.

## **8 MAINTENANCE**

The Instructions for Continued Airworthiness (ICA) should include the following:

- 8.1 Maintenance instructions for on aircraft ACAS II testing including the precautions of Appendix 1.
- 8.2 Maintenance instructions for the removal and installation of any directional antenna should include instructions to verify the correct display of ACAS II traffic in all four quadrants.

## **9 AIRCRAFT FLIGHT MANUAL/PILOT OPERATING HANDBOOK**

The Aircraft Flight Manual (AFM) or the Pilots Operating Handbook (POH) should provide at least the following limited set of information. This limited set assumes that a detailed description of the installed system and related operating instructions are available in other operating or training manuals.

Note: Aircraft malfunctions which would prevent the aircraft from following ACAS II climb indication, and which do not automatically inhibit the ACAS II climb indication, should be addressed (e.g. as a cautionary note) in the AFM/POH.

- 9.1 Limitations Section: The following Limitations should to be included:
- (a) Deviation from the ATC assigned altitude is authorised only to the extent necessary to comply with an ACAS II Resolution Advisory (RA).
- 9.2 Emergency Procedures Section: none.
- 9.3 Normal Procedures Section: The ACAS II flight procedures should address the following:
- (a) For a non-crossing RA, to avoid negating the effectiveness of a coordinated manoeuvre by the intruder aircraft, advice that vertical speed should be accurately adjusted to comply with the RA.

- (b) Non-compliance by one aircraft can result in reduced vertical separation with the need to achieve safe horizontal separation by visual means.
- (c) A caution that under certain conditions, indicated manoeuvres may significantly reduce stall margins with the need to respect the stall warnings.
- (d) Advice that evasive manoeuvring should be limited to the minimum required to comply with the RA.
- (e) When a Climb RA is given with the aircraft in landing configuration, a normal go-around procedure should be initiated.

## 10 AVAILABILITY OF DOCUMENTS

EASA documents may be obtained from EASA (European Aviation Safety Agency), 101253, D50452 Koln Germany or via the Website:  
[http://www.easa.europa.eu/ws\\_prod/g/rg\\_certspeccs.php](http://www.easa.europa.eu/ws_prod/g/rg_certspeccs.php).

EUROCAE documents may be purchased from EUROCAE, 102 rue Etienne Dolet, 92240 Malakoff, France, (Fax: +33 1 46 55 62 65), or website: [www.eurocae.net](http://www.eurocae.net).

RTCA documents may be obtained from RTCA Inc, 1828 L Street, NW., Suite 805, Washington, DC 20036, USA, (Tel.: +1 202 833 9339; Fax: +1 202 833 9434). Website: [www.rtca.org](http://www.rtca.org).

FAA documents may be obtained from Superintendent of Documents, Government Printing Office, Washington DC, 20402-9325, USA. Website: [www.faa.gov](http://www.faa.gov).

## Appendix 1

**APPENDIX 1: ACAS II/Mode S Transponder Ground Testing Precautions:**

Transponder/ACAS II system testing is a known source of 'nuisance' ACAS II warnings. The following information provides guidance which should be followed to minimise this risk:

- When not required, ensure all transponders are selected to 'OFF' or 'Standby'.
- Before starting any test, contact the local Air Navigation Service Provider (ANSP) or Air Traffic Service (ATS) and advise them of your intention to conduct transponder testing. Advise 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.
- 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.

- 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.
- Where possible, perform the testing inside a hangar to take advantage of any shielding properties it may provide.
- As a precaution, where practicable, use antenna transmission covers whether or not testing is performed inside or outside.
- When testing the altitude (Mode C or S) parameter, radiate directly into the ramp test set via the prescribed attenuator.
- In between testing, i.e. to transition from one altitude to another, select the transponder to 'standby' mode.
- If testing transponder/ACAS II system parameters that do not require 'altitude', set altitude to – 1000 feet (minus 1000 feet) or greater than 60,000 feet. This will minimise the possibility of ACAS II warning to airfield and over flying aircraft.
- When testing is complete select the transponder(s) to 'OFF' or 'Standby'.



## Appendix 2

**APPENDIX 2: List of Acronyms**

ACAS	Airborne Collision Avoidance System
AMC	Acceptable Means of Compliance
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATCRBS	Air Traffic Control Radar Beacon System
ATS	Air Traffic Service
CS	Certification Specifications
EASA	European Aviation Safety Agency
EFIS	Electronic Flight Instrument System
ETSO	European Technical Standard Order
EU	European Union
EUROCAE	European Organisation for Civil Aviation Equipment
FHA	Failure Hazard Analysis
ICA	Instructions for Continued Airworthiness
ICAO	International Civil Aviation Organization
IVSI	Instantaneous Vertical Speed Indicator
MEL	Minimum Equipment List
ORCAM	Originating Region Code Allocation Method
RA	Resolution Advisory
SSA	System Safety Assessment
TA	Traffic Advisory
TCAS	Traffic Alert and Collision Avoidance System
WXR	Weather Radar