



NOTICE OF PROPOSED AMENDMENT (NPA) No 2010-03

**DRAFT OPINION OF THE EUROPEAN AVIATION SAFETY AGENCY FOR A COMMISSION REGULATION
ESTABLISHING IMPLEMENTING RULES PERTAINING TO AIRSPACE USAGE REQUIREMENTS**

AND

**DRAFT DECISIONS OF THE EXECUTIVE DIRECTOR OF THE EUROPEAN AVIATION SAFETY AGENCY ON
ACCEPTABLE MEANS OF COMPLIANCE GUIDANCE MATERIAL RELATED TO THE DRAFT IMPLEMENTING
RULES FOR AIRSPACE USER REQUIREMENTS**

AND

**DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE EUROPEAN AVIATION SAFETY AGENCY
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 »)**

“Introduction of ACAS II software version 7.1”

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A. Explanatory Note

I. General

1. The purpose of this Notice of Proposed Amendment (NPA) is to develop an Opinion on the Implementing Rule for the mandated carriage of ACAS II with collision avoidance logic version 7.1 and a Decision on related Acceptable Means of Compliance (AMC). The scope of this rulemaking activity is outlined in Terms of Reference (ToR) ATM/ANS.002 and is described in more detail below.
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 Regulation¹ 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 2010. It implements the rulemaking task ATM.002a and ATM.002b Introduction of TCAS II software version 7.1
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.

II. Consultation

6. To achieve optimal consultation, the Agency is publishing the draft opinion and decisions of the Executive Director on its internet site. Comments should be provided **within 6 weeks** in accordance with Article 6(5) of the Rulemaking Procedure. Comments on this proposal should be submitted by one of the following methods:

CRT: Send your comments using the Comment-Response Tool (CRT) available at <http://hub.easa.europa.eu/crt/>

E-mail: In case the use of CRT is prevented by technical problems these should be reported to the [CRT webmaster](mailto:CRT_webmaster@easa.europa.eu) and comments sent by email to NPA@easa.europa.eu.

Correspondence: If you do not have access to internet or e-mail you can send your comment by mail to:
Process Support
Rulemaking Directorate
EASA
Postfach 10 12 53
D-50452 Cologne
Germany

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, Regulation (EC) No 1592/2002 and Directive 2004/36/EC as last amended by Regulation (EC) 1108/2009 (OJ L 79, 19.03.2008, p. 1, 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.

Comments should be submitted **by 7 May 2010**. If received after this deadline they might not be taken into account.

III. Comment response document

7. 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 opinion and decision

8. Following the adoption of Regulation (EC) 1108/2009³ amending Regulation (EC) 216/2008, referred to as the Basic Regulation (BR), the Agency has assumed responsibility for the safety regulations applicable to the airspace in which the Treaty applies in accordance with Article 4.3c. Thus enabling the Agency in accordance with Article 8b.7 (e) to react to the causes of accidents and incidents.
9. This NPA introduces a draft Agency opinion for a Commission Regulation based on the Agency's rule structure for the "Total System Approach" (see Figure 1), for the requirements applicable to airspace usage. The purpose of such a rule is to mandate carriage of ACAS II with collision avoidance logic version 7.1 for all turbine-powered aeroplanes having a maximum certificated take-off mass exceeding 5700 kg or authorised to carry more than 19 passengers operating within European airspace.
10. The requirements specified in this NPA are applicable to the same population of aeroplanes as per the existing ICAO requirement for the carriage of ACAS II (i.e. ACAS II with collision avoidance logic version 7.0).
11. In NPA 2009-02(b), *Implementing Rules for Air Operations of Community Operators*, a draft requirement for applicable operators to carry ACAS II was established in OPS.GEN.460. The introduction of this NPA makes the requirement in OPS.GEN.460 obsolete, as the high level carriage and operational requirement will no longer be defined in OPS.GEN, but as general requirement to all applicable aircraft undertaking operations in EU airspace. Thus, in order to avoid multiplying IRs pertaining to the same requirement, the Agency will delete from its proposals for OPS.GEN the requirements for the carriage of ACAS II and related generic operational requirements. In deleting the requirements from OPS.GEN, the requirements as specified in this NPA take into account the applicable comments received to NPA 2009-2(b).

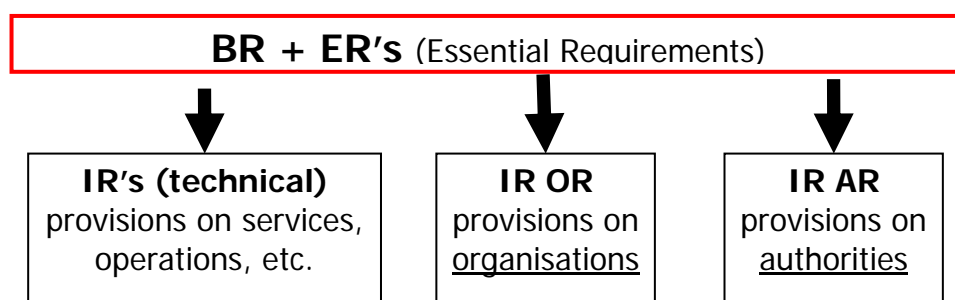


Figure 1 – Agency Implementing Rule structure – Total System

³ Regulation (EC) No 1108/2009 of the European Parliament and of the Council of 21 October 2009 amending Regulation (EC) No 216/2008 in the field of aerodromes, air traffic management and air navigation services and repealing Directive 2006/23/EC (OJ L 309, 24.11.2009, p. 51).

12. This NPA also introduces a Draft Decision for an Acceptable Means of Compliance related to the implementing rules for Airspace User Requirements that support the requirements as proposed in the Agency's opinion. This AMC material is based on ICAO Doc 8168 (PANS-OPS) volume 1, Part III, chapter 3.
13. Also introduced by this NPA is a Draft Decisions for a new Acceptable Means of Compliance, AMC 20-15 Airworthiness Certification Considerations for the Airborne Collision Avoidance System (ACAS II), based on the former JAA Technical Guidance Leaflet (TGL) number 8, to support the requirement as proposed in the Agency's opinion.
14. This NPA is part of a series of actions initiated by the Agency to address the issues associated with identified deficiencies with the current ACAS II collision avoidance logic. These actions also include:
 - issue of Safety Information Bulletin (SIB) 2009/16;
 - issue of revised ETSO-C119c.

V. Regulatory Impact Assessment

See Section C.

B. Draft Opinion and 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 Opinion Implementing Rule – AIRSPACE USAGE REQUIREMENTS (AUR)

Article 1

Applicability

This Regulation lays down common requirements and procedures for users of the airspace to which the Treaty applies.

Article 2

Definitions

For the purpose of this regulation the following definitions apply:

ACAS II means an airborne collision avoidance system based on secondary surveillance radar transponder signals which operates independently of ground-based equipment that provides vertical resolution advisories in addition to traffic advisories.

Resolution Advisory (RA) means a warning to the flight crew of an imminent collision threat, combined with commands for the crew to use in avoiding an airborne collision.

Traffic Advisory (TA) means a caution to the flight crew that an aircraft has become a potential collision threat.

Article 3

Airspace Usage

Users of the airspace as defined in Article 1 shall comply with the requirements as specified in Annex 1.

Article 4

Entry into force

1. This Regulation shall enter into force on the 1 March 2012.
2. Notwithstanding 1, this Regulation shall only apply to aeroplanes with an individual certificate of airworthiness issued before 1 March 2012, after 1 March 2014.

This Regulation shall be binding in its entirety and directly applicable on all Member States.

ANNEX 1
PART AUR

SUBPART ACAS– Airborne Collision Avoidance Systems (ACAS) II

Section I - General Requirements

AUR.ACAS.001 SCOPE

This subpart establishes the specific requirements for the carriage of ACAS II equipment to be met by all operators undertaking flights within the airspace above the territory of the Member States.

Section II – Equipment

AUR.ACAS.100 Performance Requirement

ACAS II, with collision avoidance logic version 7.1, shall be carried by all turbine-powered aeroplanes which:

- (a) have a maximum certificated take-off mass exceeding 5700 kg
or
- (b) are authorised to carry more than 19 passengers
or
- (c) any other aeroplane equipped with ACAS II.

Section III –Operations

AUR.ACAS.200 Use of ACAS II

- (a) ACAS II shall be used in normal conditions during flight in a mode that enables Resolution Advisories (RAs) to be produced for the flight crew when undue proximity to another aircraft is detected.
- (b) When an RA is produced by ACAS II,
 - 1. the pilot flying shall immediately take the corrective action indicated by the RA, even if this conflicts with an Air Traffic Control (ATC) instruction, unless doing so would jeopardise the safety of the aeroplane,
and
 - 2. when clear of conflict is enunciated, the aeroplane shall be promptly returned to the terms of the acknowledged ATC instruction or clearance.
- (c) ACAS II training programmes shall be established so that the flight crew:
 - 1. are appropriately trained in the avoidance of collisions,
and
 - 2. are competent in the use of ACAS II equipment.

II Draft Decision Acceptable Means of Compliance

AMC.AUR.ACAS.200 Use of Airborne Collision Avoidance System (ACAS) II

1. ACAS II OVERVIEW

- 1.1 The information provided by ACAS II is intended to assist flight crew in the safe operation of an aeroplane by providing advice on appropriate action to reduce the risk of collision. This is achieved through Resolution Advisories (RAs), which propose manoeuvres, and through Traffic Advisories (TAs), which are intended to prompt visual acquisition and to act as a warning that an RA may follow. TAs indicate the approximate positions of intruding aircraft that may later cause an RA. RAs that propose manoeuvres in the vertical plain are predicted to increase or maintain separation from the threatening aircraft.
- 1.2 ACAS II indications should be used by the flight crew in the avoidance of potential collisions, the enhancement of situational awareness and the active search for and visual acquisition of, conflicting traffic.
- 1.3 Nothing in the procedures specified in 2 hereunder shall prevent flight crew from exercising their best judgement and full authority in the choice of the best course of action to resolve a traffic conflict or avert a potential collision.

Note 1: The ability of ACAS II to fulfil its role of assisting flight crew in the avoidance of potential collisions is dependent on the correct and timely response by the flight crew to ACAS II indications. Operational experience has shown that the correct response by flight crew is dependent on the effectiveness of the initial and recurrent training in ACAS II procedures.

Note 2: The normal operating mode of ACAS II is TA/RA. The TA only mode of operation is used in certain aeroplane performance limiting conditions caused by in-flight failures or as otherwise promulgated by the Competent Authority.

2. USE OF ACAS INDICATORS

- 2.1 The indications generated by ACAS II should be used by the flight crew in conformity with the following safety considerations:

a) flight crew should not manoeuvre their aeroplane in response to TAs only;

Note 1: TAs are intended to alert flight crew to the possibility of an RA, to enhance situational awareness, and to assist in visual acquisition of conflicting traffic. However, visually acquired traffic may not be the same traffic causing a TA. Visual perception of an encounter may be misleading, particularly at night.

Note 2: The above restriction in the use of TAs is due to the limited bearing accuracy and to the difficulty in interpreting altitude rate from displayed traffic information.

b) on receipt of a TA, flight crew should use all available information to prepare for appropriate action if an RA occurs;

and

- c) in the event of an RA, flight crew should:
- 1) respond immediately by following the RA as indicated, unless doing so would jeopardise the safety of the aeroplane;
- Note 1: Stall warning, wind shear, and ground proximity warning system alerts have precedence over ACAS II.
- Note 2: Visually acquired traffic may not be the same traffic causing an RA. Visual perception of an encounter may be misleading, particularly at night.
- 2) follow the RA even if there is a conflict between the RA and an Air Traffic Control (ATC) instruction to manoeuvre;
 - 3) not manoeuvre in the opposite sense to an RA;
- Note: In the case of an ACAS II-ACAS II coordinated encounter, the RAs complement each other in order to reduce the potential for collision. Manoeuvres or lack of manoeuvres that result in vertical rates opposite to the sense of an RA could result in a collision with the intruder aeroplane.
- 4) as soon as possible and as permitted by flight crew workload, notify the appropriate ATC unit of RA's which required a deviation from the current ATC instruction or clearance;
- Note: Unless informed by the flight crew, ATC may not know when ACAS II issues an RA. It is possible for ATC to issue instructions that are unknowingly contrary to ACAS II RA instructions. Therefore, it is important that ATC be notified when an ATC instruction or clearance is not being followed because it conflicts with an RA.
- 5) promptly comply with any modified RAs;
 - 6) limit the alterations of the flight path to the minimum extent necessary to comply with the RAs;
 - 7) promptly return to the terms of the ATC instruction or clearance when the conflict is resolved;
- and
- 8) notify ATC when returning to the current clearance.

3. HIGH VERTICAL RATE (HVR) ENCOUNTERS

- 3.1 Flight crew should use appropriate procedures by which an aeroplane climbing or descending to an assigned altitude or flight level, especially with an autopilot engaged, may do so at a rate less than 8 m/s (1 500 ft/min) throughout the last 300 m (1 000 ft) of climb or descent to the assigned altitude or flight level. This should be accomplished when the flight crew are made aware of another aircraft at or approaching an adjacent altitude or flight level, unless otherwise instructed by ATC. These procedures are intended to avoid unnecessary ACAS II RAs in aeroplanes at or approaching adjacent altitudes or flight levels.

III Draft Decision AMC 20-15**AMC 20-15****AMC 20-15: Airworthiness Certification Considerations for the Airborne Collision Avoidance System (ACAS II)****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. It is issued to support the operational requirement that requires the carriage of ACAS II.

An applicant may elect to use an alternative means of compliance. However, those alternative means of compliance must meet safety objectives that are acceptable to the Agency. Compliance with this AMC is not mandatory. Use of the terms *shall* and *must* apply only to an applicant who elects to comply with this AMC in order to obtain airworthiness approval.

2 REFERENCE MATERIAL**2.1 EU/EASA**

EU OPS⁴ 1.160, 1.668, 1.1045, 1.398

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

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

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

ETSO-C113 Airborne Multipurpose Electronic Displays

ETSO-C119c Traffic Alert and Collision Avoidance System (TCAS) Airborne Equipment, TCAS II.

ETSO-2C112() Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment

2.2 Other documents

EUROCAE ED-143, Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance Systems (TCAS) Airborne Equipment.

3 MINIMUM EQUIPMENT QUALIFICATION

3.1 An acceptable minimum certification standard for the ACAS II equipment is EASA ETSO-C119c.

3.2 An acceptable minimum certification standard for the associated Mode S transponder is EASA ETSO-2C112()

⁴ 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 (O L J 377, 27.12.2006, p. 1).

AMC 20-15**4 SAFETY OBJECTIVES**

The applicant shall perform a Functional Hazard Assessment (FHA) and System Safety Assessment (SSA) to establish the ACAS II criticality and hazards associated with the proposed installation. The reliability level of the system must be commensurate with the following probabilities:

- 4.1 The probability of failure of the installed system to perform its intended function from a reliability and availability perspective must be shown to be no greater than 1×10^{-3} per flight hour.
- 4.2 The probability of failure of the system to provide the required aural and visual alerting functions without a failure indication must be shown to be no greater than 1×10^{-4} per flight hour.
- 4.3 The probability of false or misleading alerts due to a failure of the system when no collision threat exists must be shown to be no greater than 1×10^{-4} per flight hour in the terminal environment and 1×10^{-5} per flight hour in the en-route environment.
- 4.4 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.

5 HARDWARE AND INSTALLATION**5.1 General Considerations:**

The installation shall include as a minimum a single ACAS II system and a single Mode S Transponder that meet the requirements of paragraph 3.

5.2 Aural Alerts:

- (a) TA and RA aural alerts will need to be presented by the prescribed voice announcements via loudspeakers.
- (b) Consideration should be given to presenting voice announcements via headsets at a preset level, particularly where active noise-reducing headsets are used.
- (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. Altitude callout advisories which occur simultaneously with ACAS II cautions and warnings 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.

5.3 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.

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- (c) Resolution Advisory guidance must be presented 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 must be located in each pilot's primary field of view.
An Instantaneous Vertical Speed Indicator (IVSI) with a lighted red arc or an electronic attitude display with an alphanumeric message may be acceptable instead of a discrete warning enunciator.
- (e) A means to display traffic information to both pilots must 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 prevent Resolution Advisories should be provided.
- (i) An indication that the ACAS II system is operating in TA mode only should be provided.
- (j) The adequacy of display visibility needs to be demonstrated.

5.4 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.

5.5 Antennas:

- (a) Either a directional antenna and an omni-directional antenna, or two directional antennas may be installed.
- (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 must also ensure that propellers do not interfere with system operation, if applicable. ACAS II antennas may be installed with an angular offset from the aeroplane centreline not exceeding 5 degrees.

5.6 Interfaces:

- (a) Pressure altitude information will need to be obtained from the sensor source that supplies the Mode S Transponder and which is the most accurate source available on the aeroplane. This source should supply information (with appropriate segregation) to the flight deck altitude display(s). The air data sensor should supply pressure altitude information in either databus or synchro format.

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Note:1 Either a databus or synchro source is the preferred interface as it avoids the altitude jump risk inherent in ICAO Gray (Gillham) format encoders.

Note 2 Where a databus or a synchro source is not available, an acceptable alternative is two independent altitude encoders supplying altitude information in ICAO Gray (Gillham) format together with a comparator capable of detecting and responding to encoder malfunctions. A resolution of 100ft is provided by an ICAO Gray (Gillham) format encoder as used for transponder altitude reporting. The ICAO Gray (Gillham) altitude encoding format is defined in the appendix to Chapter 3 of ICAO Annex 10, Volume IV.

- (b) An interface to a radio altimeter sensor should be provided.
- (c) Inhibit logic selected for input to the ACAS II to take account the aeroplane performance limitations will need to be evaluated and justified unless accepted for an earlier ACAS II standard.
- (d) Other interfacing for discrete data shall be provided, as required.
- (e) The ACAS II installation must provide an interface with the flight recorder(s).
- (f) Recording of the "ACAS vertical data word" on the flight recorder is required unless it can be shown, to the satisfaction of the Agency, to be impractical, in which case at least the RA discrete should be recorded.

Note: The operator of the aeroplane will need to update the document which contains information necessary to retrieve and convert the stored data into engineering units.

- (g) Interfaces between systems should be analysed to show no unwanted interaction under normal or fault conditions.

6 CERTIFICATION TESTING

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

- 6.1** The bulk of testing for a modification to install ACAS II can be achieved by ground testing that verifies system operation, interfaces between affected aeroplane systems, correct warning prioritisation, and freedom from unwanted interaction.
- 6.2** The ground tests should include a verification check of the ICAO 24 bit airframe address. If altitude information supplied to the transponder is in ICAO Gray (Gillham) code format a check for correct operation of the altitude comparator should also be included.
- 6.3** Flight testing of an initial installation should evaluate overall operation, surveillance range, target azimuth reasonableness, freedom from unwanted interference, and to assess, during adverse flight conditions, instrument visibility, display lighting, sound levels and intelligibility of aural messages, and the effects of electrical transients.
- 6.4** Flight testing to demonstrate RA performance in a planned encounter between aeroplanes 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 responsible Competent Authorities.

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- 6.5** To minimise the certification effort for ACAS II follow-on installations, the applicant may claim credit, for applicable certification and flight test data obtained from equivalent aeroplane installations, including testing performed for TCAS version 6.04A. Flight Testing of ACAS II will not normally be required where acceptable evidence exists relating to the previous certification standard of TCAS. This assumes the introduction ACAS II involves equipment replacements only.

7 MAINTENANCE

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

- 7.1** Maintenance instructions for on-aeroplane ACAS II testing including the precautions of Appendix 1.
- 7.2** 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.

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

- 8.1** Limitations Section: The following Limitations will need 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).
- (b) Manoeuvres must not be based solely on information presented on the traffic display.

- 8.2** Emergency Procedures Section: none.

- 8.3** 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 co-ordinated manoeuvre by the intruder aircraft, advice that vertical speed should be accurately adjusted to comply with the RA.
- (b) For a crossing RA, a warning that 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, commanded manoeuvres may significantly reduce stall margins with the need to respect the stall warnings.
- (d) Advice that evasive manoeuvring should be made with the autopilot and autothrottle disengaged, and limited to the minimum required to comply with the RA.
- (e) When a Climb RA is given with the aeroplane in landing configuration, a normal go-around procedure should be initiated.

AMC 20-15**9 MINIMUM EQUIPMENT LIST**

The operator's Minimum Equipment List (MEL) will have to be amended in accordance with the MMEL requirements of the Agency.

10 AVAILABILITY OF DOCUMENTS

EASA documents may be obtained from EASA (European Aviation Safety Agency), 101253, D50452 Köln Germany or via the Website: http://www.easa.europa.eu/ws_prod/g/rg_certspecs.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.

**AMC 20-15
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 problem of 'nuisance' ACAS II warnings is more noticeable when ground testing of transponders takes place at facilities located beneath Terminal Control Areas or in the vicinity of Control Areas and Zones where air traffic movements are likely to be numerous. The following information provides guidelines 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.
- The use of a ground station to simulate an airborne intruder should not be attempted other than with the agreement of the Agency and the Competent Authority.
- 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, 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 less. This will minimise the possibility of ACAS II warning to airfield and over flying aeroplanes.
- When testing is complete select the transponder(s) to 'OFF' or 'Standby'.

**AMC 20-15
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
EUROCAE	European Organization 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
MMEL	Master Minimum Equipment List
ORCAM	Originating Region Code Allocation Method
RA	Resolution Advisory
SSA	System Safety Assessment
TA	Traffic Advisory
TCAS	Traffic Collision Avoidance System
WXR	Weather Radar

C. Appendices

I. Impact Assessment.

1.0 Introduction

Following a series of mid-air encounters in which safety margins have been lost, including two accidents (Yaizu 2001 and Überlingen 2002), EUROCONTROL sponsored the SIRE team to undertake a series of safety studies. These studies revealed two major reasons for the loss of separation:

- failure of ACAS II to reverse some Resolution Advisories (RAs) when a reversal is required to resolve the threat of collision;
- frequent instances of flight crew unintentional incorrect manoeuvres in the wrong direction to the "Adjust Vertical Speed" RA.

These studies have been further evaluated by EUROCAE and RTCA and were defined as safety issues SA01 and SA-AVSA. Revised Minimum Operational Performance Standards (MOPS) (ED-143 and DO-185B) that address these safety issues have been published. Following publication of the revised standards, the Agency has adopted the EUROCAE ED-143 standard as the requirement for all new equipment approvals⁵.

Further studies⁶ also concluded that:

- due to the combination of these two safety issues (SA01 and SA-AVSA) aeroplanes equipped with ACAS II (i.e. with collision avoidance logic version 7.0) face a mid-air collision risk of 2.7×10^{-8} per flight hour;
- the estimated probability is considered to be an unacceptable safety risk and regulatory action should be initiated to introduce ACAS II with collision avoidance logic version 7.1 as soon as practically possible to all aeroplanes already equipped with ACAS II.

Note: The use of the terms ACAS II and TCAS II may lead to confusion. ACAS II is defined as a TCAS II system that operates with Change 7 software version and is compliant with the minimum performance level as that specified in ICAO Annex 10, Volume IV, Chapter 4.

2.0 Description of the ACAS II Logic Changes

2.1 Safety Issue SA01

The design principles of ACAS II allow only one sense reversal once the relative position of the aeroplanes and their trajectories are certain. Notably, reversing the ongoing RA is not permitted while aeroplanes are manoeuvring in the vertical dimension and are at the same altitude. This can lead to delaying the decision to reverse if both aeroplanes are climbing or descending at similar vertical speeds. In the extreme, no sense reversal will be issued, although it would be required to ensure adequate separation. This problem can occur between an unequipped aeroplane and an ACAS II equipped aeroplane or in ACAS II -ACAS II encounters.

This issue has subsequently been observed during European monitoring efforts. Analysis indicates that the SA01 issue was a contributing factor to the two major mid-air collision events: the Yaizu (Japan) accident in 2001 and the Überlingen in 2002. Also within a 5-year period, 8 other occurrences have been observed in European airspace. Each of these

⁵ Decision No 2009/015/R of the Executive Director of the European Aviation Safety Agency of 01/12/2009 - ETSO-C119c.

⁶ EUROCONTROL document – Decision criteria for regulatory measures on TCAS II version 7.1 Safety Issue Rectification Extension Plus Project (SIRE+ Project), ACAS/08-103 dated 25 July 2008.

events resulted in a severe loss of separation where collision was only avoided by chance. These severe incidents were only identified when actual occurrences of safety issue SA01 were actively tracked.

Safety issue SA01 can occur when two aeroplanes are flying at the same Flight Level (FL) and are converging in range. A very late Air Traffic Control (ATC) instruction then induces the intruder to manoeuvre, thwarting the initial RA. Figure 1 and Figure 2 illustrate this issue for two aeroplanes at FL110, and the behaviour expected from ACAS II.

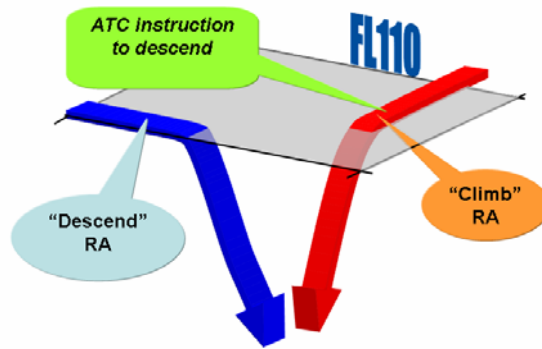


Figure 1 Current behaviour due to issue SA01

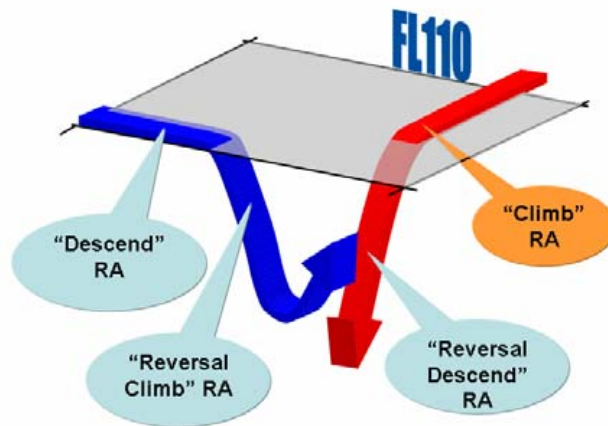


Figure 2 Expected behaviour

2.2 Safety Issue SA-AVSA

Monitoring of ACAS II performance by airlines and EUROCONTROL has highlighted several instances where flight crew responded unintentionally in the opposite direction to that specified by the RA particularly when an initial Adjust Vertical Speed Adjust (AVSA) RA was issued. The proper response to an AVSA RA is a reduction in vertical speed (i.e. a manoeuvre towards level flight). When flight crew manoeuvre in the opposite direction to an AVSA RA, the aeroplane is probably manoeuvring towards the intruder and thus increases the risk of collision.

Several causes have been identified that can explain an unintentional opposite reaction to an AVSA RA, including a lack of training for this type of RA. However, the main factor identified remains the design of the AVSA RA. First, the aural annunciation associated with the AVSA RA (i.e., "Adjust Vertical Speed, Adjust") does not give explicit instructions on the required manoeuvre.

Some ACAS II displays have also been shown to be difficult to interpret when AVSA RAs are posted. This is due to the position of the green arc on the vertical speed displays that can be misleading for flight crew who react to the RA according to the position of the green area relatively to the 0 fpm indicator. This can be illustrated by Figure 3 which shows a number of RAs as they are displayed on a typical vertical speed tape and the requested reaction to these RAs. A correct behaviour when faced with positive RAs (e.g., "Climb" or "Descend" RAs) leads to opposite reactions to AVSA RAs requesting.

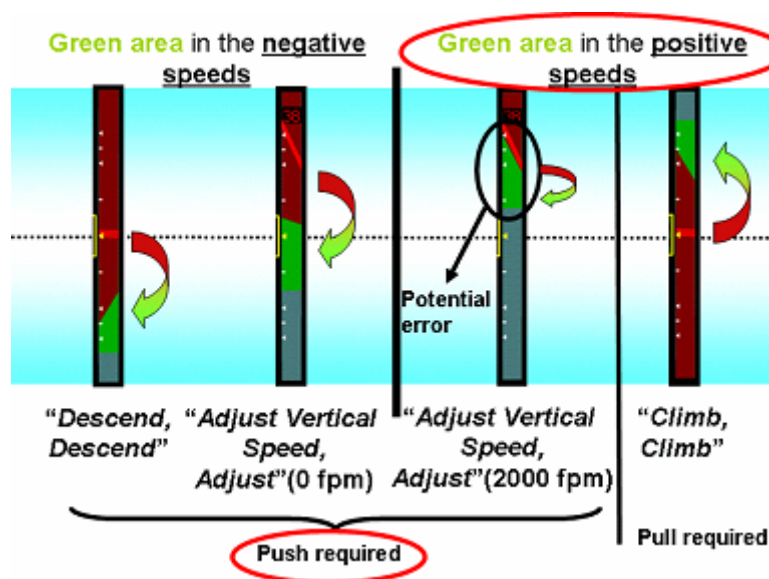


Figure 3

To illustrate this effect further, an event that occurred in French airspace⁷ in 2003 is shown in Figure 4, and it involved an Airbus A320 level at FL270, heading South (shown in blue), and a second Airbus A320 cleared to climb to FL260, heading North (shown in red). The second aeroplane's rate of climb was about 3300 fpm.

When passing through FL253, the second aeroplane's ACAS II triggered an initial AVSA RA requiring a reduction in the rate of climb to 1000 fpm. However, the flight crew misinterpreted the RA and reacted opposite to it: the rate of climb was instead increased to more than 6000 fpm.

The closure rate increased between the two aeroplanes and the initial AVSA RA was strengthened to a "Descend" RA. The flight crew followed this second RA but the manoeuvre took some time to be effective.

As a result of this opposite reaction to the initial AVSA RA, the climbing Airbus A320 busted its flight level by 1200 ft and the level Airbus A320 received a "Climb" RA requesting a 1500 fpm rate of climb. Even though the flight crew correctly followed this last RA, the aeroplanes were only separated by 300 ft vertically and 0.8 Nautical Miles (NM) horizontally at their point of closest approach.

⁷ BEA report f-mf030323 and f-qa030323

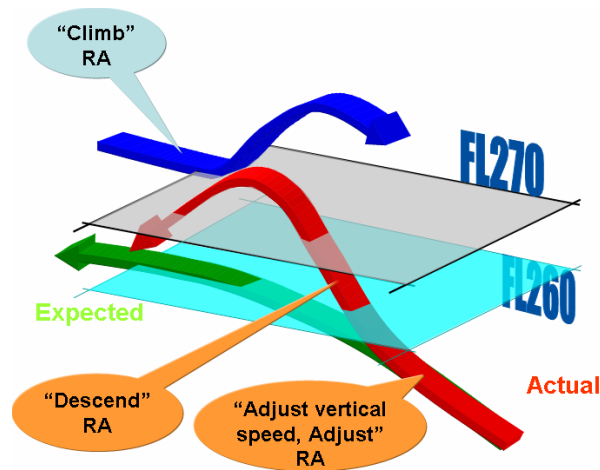


Figure 4

3.0 Considerations

The estimated probability of a mid-air collision of 2.7×10^{-8} per flight hour due to the identified deficiencies within the current collision avoidance logic version 7.0 is considered to be an unacceptable safety risk for a catastrophic event.

This probability equates to a frequency of one catastrophic accident in European airspace every three years due to ACAS II contributing factors. Although this has not been observed, the number of serious incidents identified and analysed indicate that the risk is real. Such an accident only appears to have been avoided by providence.

As part of the EUROCONTROL sponsored study a number of possible equipage policy scenarios were identified and analysed with respect to the safety benefits that could be obtained. It was concluded that a 'voluntary' or 'forward fit only' policy will bring very limited safety benefits in the long term and an aggressive carriage policy should be adopted. The study therefore recommended that in order to ensure that the full safety benefit via the use of the ACAS II with collision avoidance logic version 7.1 are achieved, all the aeroplanes operating within European airspace, in accordance with the current equipage requirements, should comply with the version 7.1 standard.

4.0 Actions proposed by the Agency

The Agency has identified 2 basic options, these being:

- Do Nothing
- Mandated Carriage

4.1 Do Nothing

The adoption of this option will not address the identified deficiencies with the use of the current ACAS II standard and will only bring limited safety benefit in the long term. Thus this option is considered too be inappropriate to address the identified safety risk associated with such a catastrophic event.

4.2 Mandated Carriage of Version 7.1

The estimated probability of 2.7×10^{-8} per flight hour for a mid-air collision as a result of the deficiencies identified with the ACAS II collision avoidance software is considered to be an unacceptable risk for such a catastrophic event. Thus the mandated carriage of

ACAS II with collision avoidance logic version 7.1 should be pursued, thus reducing the risk to an acceptable level.

To mandate the carriage of ACAS II with collision avoidance logic version 7.1, a number of options were identified, these being:

- issue an Airworthiness Directive;
- an Implementing Rule issued in accordance with the Regulation (EC) 216/2008 as amended by Regulation (EC)1108/2009;
- a Safety Directive following adoption of the option that would result from NPA 2009-01.

4.2.1 Airworthiness Directive (AD)

This option was considered not to be a practical solution for the following main reasons:

- justification of the unsafe airworthiness condition, and
- difficulties linked to issuing an AD to non-EU products.

An AD is used to correct an identified unsafe condition and to return the aeroplane a standard appropriate to the certification basis. As the current version of ACAS II is operating as per the requirement applicable at the time of certification, i.e. is in accordance with the certification basis, an unsafe condition with the current ACAS II standard cannot be justified.

As Europe is not the "state of design" for the majority of ACAS II systems, any AD issued by the Agency is unlikely to be fully adopted by all third countries, in particular the USA who have indicated that they have no plans to mandate the carriage of ACAS II collision avoidance logic version 7.1 within US airspace. Thus, any AD issued by the Agency will only be applicable to those aeroplanes registered within the EU Member States. This therefore results in not all users of European airspace being equipped the version 7.1. As this would result in a partial implementation of the total population of aeroplanes operating within European airspace at any time, it would only have a limited benefit in improving the overall safety of the airspace associated with the deficiencies identified with the current ACAS II standard.

It was therefore considered not to be the appropriate method to use to obtain the maximum safety benefits.

4.2.2 Implementing Rule (IR)

The use of such an appropriate IR will require all the airspace users, including third country operators, operating the applicable aeroplane types in European airspace, to be equipped with the correct version of ACAS II. The greatest improvement in the airspace safety associated with the elimination of the identified deficiencies with version 7.0 would result from the use of this option.

4.2.3 Safety Directive (SD)

The issue of SD in accordance with the proposed new paragraph 21A.3C, as introduced by NPA 2009-01 could be undertaken. Application of an SD would require the applicable aeroplanes to be upgraded to the ACAS II collision avoidance logic version 7.1 standard. The applicable aeroplanes in this case, similar to the AD case, would only be those aeroplanes registered in EU Member States.

The consultation phase for NPA 2009-01 that introduces the possible use of an SD finished on 30 June 2009 and it is anticipated that the adoption of the resulting opinion would not occur until 2012. Thus, an SD cannot be issued by the Agency

until 2012 at the earliest, assuming that the NPA for ACAS II is issued concurrently with the CRD to NPA 2009-01.

This option would also result in a partial implementation of the total population of aeroplanes operating within European airspace at any time and would therefore only have a limited benefit in improving the overall safety of the airspace associated with the deficiencies identified with ACAS II and the possible late application of the rule. It was therefore considered not to be the appropriate method to use to obtain the maximum safety benefits.

4.3 The preferred option selected

The use of an IR is therefore the preferred option and can be progressed in a timely manner. The use of this option will require all airspace users, including third country operators, operating the applicable aeroplane type to ensure that they are equipped with the correct version of ACAS II. This will result in the greatest improvement in airspace safety associated with the elimination of the identified deficiencies with version 7.0.

4.4 Sectors concerned

The proposed IR will affect all aeroplane operators that are operating within EU Member States airspace whose aeroplanes have an MTOW of 5700kg or are authorised to carry more than 19 passengers. It is estimated that approximately 8300 aeroplanes meeting the equipage requirement and registered in EU Member States are affected by this proposal. It is also estimated that an additional 2500-3000 aeroplanes registered in non EU Member States and operating with European airspace are also affected.

Information from suppliers of ACAS II equipment indicates that in the majority of cases and in particular for those aeroplanes equipped with ACAS II (TCAS II Version 7.0), only a software change is required to the existing hardware. The estimated cost of the equipment⁸ from a number of manufacturers is provided in Table 1. These estimated costs are the equipment costs from the manufacturer and do not include those associated with the installation, i.e. design costs, additional aircraft down time and additional man-hours. The additional maintenance down time, if planned properly, should be kept to a minimum and dependent upon the equipment supplier this may be accomplished on the aeroplane. Assuming the change is only software change, the installation and the associated tests should not result in a significant number of additional man-hours (estimated to be 6-10 man-hours) required to carry out the change.

However, regardless of the equipment supplier, operators will need to introduce additional crew training (or awareness programmes) due to the different call outs and to ensure that crews are aware of the equipment standard installed on individual aeroplanes during the transition phase.

It has also been identified that there are no interoperability problems between the existing 7.0 and 7.1 versions when operating in a mix airspace environment.

⁸ Ref ICAO Aeronautical Surveillance Panel (ASP) 7th meeting working paper ASP07-23 20/09/09.

	Manufacturer A	Manufacturer B	Manufacturer C
TCAS v7.1 new installations ⁹	€150,000	€150,000	€150,000
TCAS v7.1 retrofit	€7,500 ~ 10,000 (up to €75 for older aeroplanes)	€7,500~10,000	€7,500~55,000 (some units require change)

Table 1 Equipment Costs

The application of an IR to all operators operating within EU Member States airspace will ensure that the full safety benefits are achieved without unfair application of the associated cost.

5.0 Conclusion

Adopting the preferred option for the mandatory carriage of ACAS II with collision avoidance logic version 7.1 will bring additional safety benefits in minimising those risk identified with the current ACAS II collision avoidance logic.

⁹ or aeroplanes for which no retrofit solution is available.