

ELEVENTH AIR NAVIGATION CONFERENCE

Montreal, 22 September to 3 October 2003

Agenda Item 1: Introduction and assessment of a global air traffic management (ATM) operational concept

**1.4 The role of airborne collision avoidance systems (ACAS) technologies
:**

THE EUROPEAN EXPERIENCE IN THE IMPLEMENTATION OF ACAS II

(Presented by European Organisation for the Safety of Air Navigation
(EUROCONTROL) on behalf of its Member States and those of ECAC¹)

SUMMARY

¹ The ECAC Member States are: **Albania**, Armenia, **Austria**, Azerbaijan, **Belgium**, Bosnia and Herzegovina, **Bulgaria**, **Croatia**, **Cyprus**, **the Czech Republic**, **Denmark**, Estonia, **Finland**, **France**, **Germany**, **Greece**, **Hungary**, Iceland, **Ireland**, **Italy**, Latvia, Lithuania, **Luxembourg**, **Malta**, **Moldova**, **Monaco**, **the Netherlands**, **Norway**, Poland, **Portugal**, **Romania**, Serbia and Montenegro, **the Slovak Republic**, **Slovenia**, **Spain**, **Sweden**, **Switzerland**, **The former Yugoslav Republic of Macedonia**, **Turkey**, Ukraine **and the United Kingdom**).

The 31 Member States of EUROCONTROL appear in **bold**.

* French, Spanish and Russian versions provided by EUROCONTROL.

The EUROCONTROL Organisation, in cooperation with the European Civil Aviation Conference (ECAC) Member States, is implementing, a commonly agreed ACAS Policy and ACAS II Implementation schedule. Some significant implementation issues were experienced. However, ACAS II plays a central role in the resolution of encounters between aircraft, where there is a risk of collision.

ACAS Safety studies and operational experience have revealed that the widespread carriage and correct operation of ACAS II provides a significant safety benefit, but that failure to follow Resolution Advisories (RAs) seriously degrades the available safety benefit.

Action should be taken to ensure that the safety benefit available from ACAS II is maximised.

Suggested action by the Conference is in paragraph 9.

1. INTRODUCTION

1.1 Following the Fourth meeting of European Civil Aviation Conference (ECAC) Ministers on the Air Traffic System in Europe (MATSE/4) in 1994, EUROCONTROL was requested to develop an ACAS policy for the ECAC Member States.

1.2 An EUROCONTROL Task Force was established to recommend ACAS policy. The Task Force examined the results of safety studies reported by ICAO, and of safety analysis specific to part of the European airspace environment, which revealed that a significant safety benefit could be expected from widespread carriage and operation of an ACAS II. Consequently, the Task Force recommended a comprehensive ACAS policy requiring the mandatory carriage and operation of ACAS II, together with an aggressive ACAS II implementation schedule.

1.3 In 1995, the Member States of ECAC and EUROCONTROL agreed a common ACAS policy for the mandatory carriage and operation of ACAS II for flight in their airspace. To achieve this policy, an ACAS II implementation schedule, in two phases, was also agreed:

- a) Phase 1. With effect from 1 January 2000, all civil fixed-wing turbine-engined aircraft having a maximum certificated take-off mass exceeding 15,000 kg, or a maximum approved passenger seating configuration of more than 30, will be required to be equipped with ACAS II; and
- b) Phase 2. With effect from 1 January 2005, all civil fixed-wing turbine-engined aircraft having a maximum take-off mass exceeding 5,700 kg, or a maximum approved passenger seating configuration of more than 19, will be required to be equipped with ACAS II.

1.4 The responsibility for undertaking and co-ordinating the diverse work items required to achieve the ACAS II implementation in Europe was entrusted to the EUROCONTROL Agency, which established the specialist ACAS Programme to progress the task.

1.5 The ACAS policy and implementation schedule agreed by the Member States was also agreed by the ICAO European Air Navigation Planning Group (EANPG). The ACAS requirements were included in ICAO Doc 7030, European Regional Supplementary Procedures. Thus the ACAS implementation within Europe complied with the ICAO recommendation that ACAS implementations should be on the basis of Regional Air Navigation agreements. Subsequently, ICAO also established a standard, included in Annex 6, Part 1, to require the mandatory carriage and operation of ACAS II in two Phases, 1 January 2003, and 1 January 2005 respectively.

1.6 Phase 1 of the ACAS II implementation by the Member States is now complete, and action is underway to achieve Phase 2.

2. ACAS II IMPLEMENTATION – PRACTICAL ISSUES

2.1 At the time of the agreement by the Member States of the ACAS policy and ACAS II implementation schedule, the only operational airborne collision avoidance system providing collision avoidance advice was the Traffic Alert and Collision Avoidance System (TCAS) II. However, the version available was not compliant with the ICAO ACAS II SARPs, nor had minimum operational performance specifications (MOPS) for a new version of TCAS II, compliant with the ACAS II SARPs, yet been agreed by the RTCA. There is no European Organisation for Civil Aviation Equipment (EUROCAE) MOPS for an ACAS.

2.2 Nevertheless, MOPS and certification work for the new generation TCAS II equipment which would be ACAS II SARPs compliant – TCAS II Version 7 – was expected to be completed, and production boxes available, by no later than mid-1997. This situation was clearly understood during the ACAS policy and ACAS II implementation schedule decision - making process. Indeed, it was one of the important factors taken into account when determining the ACAS II Phase 1 implementation date of 1 January 2000.

2.3 In the event, production TCAS II Version 7 equipment did not start to become readily available to the aircraft manufacturers, maintenance facilities, and aircraft operators until mid-1999. Therefore, the ACAS II Phase 1 implementation date could not be achieved by the aircraft operators.

2.4 In retrospect, it is quite clear that an implementation programme, involving avionics equipment development, and aircraft avionics modifications or installation, should not, **wherever possible**, determine mandatory dates before the publication of all the relevant technical standards for the equipment in question.

3. ACAS II IMPLEMENTATION TRANSITIONAL ARRANGEMENTS

3.1 Transitional arrangements, managed and coordinated by the EUROCONTROL Agency for the EUROCONTROL/and ECAC Member States, were established to meet the delays caused by the non-availability of ACAS II compliant equipment. These arrangements included the provision of ACAS II exemptions, assessed on an individual airframe basis, and for a specific approved duration. This exemption system also provided the ability to track the implementation progress in affected aircraft fleets.

3.2 A major issue encountered was the failure of aircraft operators from one part of the ICAO EUR Region to respond to the implications of the promulgated ACAS II mandatory requirement. As a result, despite encouragement through extended ACAS II exemption concessions, which were finally terminated in September 2001, these operators were eventually unable to fly many of their aircraft in the airspace of ECAC/EUROCONTROL Member States due to failure to install ACAS II equipment.

4. ACAS II SAFETY STUDIES

4.1 The EUROCONTROL Agency recently carried out two ACAS Safety Studies, specifically addressing the performance of ACAS II in the European airspace environment, including Reduced Vertical Separation Minima (RVSM). These were the ACAS Analysis (ACASA) Project study on the “Safety of ACAS II in Europe” (supported by the European Commission) and the study of the “Safety Benefit of ACAS II Phase 1 and Phase 2 in the new European Airspace environment”.

4.2 These studies showed that, following Phase 1 of the ACAS II implementation in European airspace, the risk of collision that would exist without ACAS II equipage is estimated to be reduced by at least a factor of 3. When Phase 2 is implemented in 2005, the risk of collision is expected to be reduced by more than a factor of 4.

4.3 It was confirmed that, in RVSM airspace, TCAS II Version 7 (which is compliant with ACAS II SARPs) would perform efficiently, and that TCAS II Version 6.04A would be operationally incompatible (but not unsafe). No ACAS safety issues were identified related to the introduction of RVSM in Europe.

4.4 However, these studies also revealed that not following ACAS II Resolution Advisories (RAs) debases the safety benefits brought about by ACAS. The need to follow RAs correctly is emphasised.

4.5 Therefore, in order to maximise the reduction in the risk of collision available from ACAS II, its widespread installation and correct use should be promoted vigorously.

5. ACAS OPERATIONAL MONITORING

5.1 ACAS II can have a significant effect on ATC operations. Therefore, it is important that the performance of ACAS II in the ATC environment should be monitored to ensure that trends in ACAS encounters can be identified and appropriate action taken, as necessary. European ACAS operational monitoring and analysis is carried out by the EUROCONTROL Agency (as well as by some individual Member States’ authorities). This monitoring is undertaken on a confidential basis, using reports from pilots and controllers and, when available, correlated radar data. Analysis of each event is detailed, using ACAS analysis tools developed specifically for the purpose. Direct feedback is then given to the aircraft operators involved and to the ATC and civil aviation authorities as appropriate. In addition, an annual ACAS Monitoring Report is published, providing extensive statistical information.

5.2 ACAS operational monitoring is able to identify some areas of airspace where ACAS II RA events can be identified to occur frequently, producing a cluster of RA events over a period of time. These

are known as “RA hotspots”. The existence of a RA hotspot, where ACAS II has frequently calculated that there is a risk of collision, could indicate the existence of a potential endemic safety problem due to airspace design or procedure.

6. EUROPEAN MAINTENANCE OF TCAS II VERSION 7 (EMOTION 7 PROJECT)

6.1 The ACAS II implementation by the ECAC and EUROCONTROL Member States was the first widespread operational implementation of TCAS II Version 7 (which is compliant with ICAO ACAS II SARPs) to take place. This version of TCAS II represented a major update in performance to that available from previous TCAS II equipment. Therefore, the EUROCONTROL Agency established the EMOTION 7 project, to provide an appropriate framework to minimise the risks associated with potential TCAS II Version 7 safety, technical and operational issues which were related to the extensive changes within the collision avoidance system logic itself.

6.2 Focussed operational monitoring enabled the identification of several issues. Following severity and probability assessment, a detailed analysis was performed for some issues potentially affecting safety and operations. This was followed by development of specific rectification proposals which included:

- a) a change proposal to rectify a specific collision avoidance system logic issue;
- b) a procedural airspace solution to reduce actual and potential disruption to ATM caused by frequent RAs, in specific identified locations, where aircraft were climbing or descending to a level separated from other traffic by 1 000 ft. (This solution has already been successfully implemented in one major European TMA.); and
- c) Recommendations to minimise the incidence of incorrect altitude reports by aircraft, which can cause inappropriate RAs to be generated. Appropriate corrective actions are being addressed with regulatory authorities.

6.3 The EMOTION 7 project was very successful and terminated at the end of 2002. However, following EMOTION 7 work, analysing TCAS II performance in some recent serious incidents and particularly in the mid-air collision which took place on 1 July 2002, some further work is being undertaken to address some specific performance issues within the collision avoidance system logic.

7. OPERATIONAL EXPERIENCE

7.1 As a result of ACAS II implementation in Europe and in other regions, it is clear that ACAS II now plays a central role in the resolution of encounters between aircraft where there is a risk of collision. However, it has been underlined by the recent ACAS safety studies, and by operational experience, that **the effectiveness of ACAS II in assisting pilots in the avoidance of potential collisions is dependent on the correct response to RAs by pilots.**

7.2 Consistent and accurate response to RAs depends upon flight crew training – this is a crucial factor in achieving the expected safety benefit from ACAS II implementation. Currently, it is clear that there is not a consistent approach to ACAS training for flight crews. Some aircraft operators have very comprehensive ACAS training requirements, whilst others appear to treat it in a rather superficial fashion. ACAS training, including recurrent training, needs to be provided to flight crew to an established minimum acceptable standard, which, normally should include the use of a flight simulator to assess pilot understanding of ACAS manoeuvre training. Appropriate training material and guidance is provided by ICAO in “Proposed ACAS Performance-Based Training Objectives”, as well as by the Joint Aviation Authorities (JAA), by the EUROCONTROL Agency, and by some State authorities.

7.3 In order to maximise consistency in the operation of ACAS II, in particular relating to appropriate and accurate responses to RAs, it is essential that States’ ensure that their aircraft operators’ ACAS training programmes, for flight crews, take account of Amendment 12 to ICAO PANS-OPS, Doc 8168 which includes reinforced ACAS provisions, and a new Attachment providing ACAS training guidelines for flight crews.

7.4 ACAS training needs to be provided to controllers to an established minimum acceptable standard. At present, the extent and nature of ACAS training provided by Air Navigation Service Providers (ANSPs) to their controllers is not consistent. Appropriate training material and guidance is provided by ICAO, by the EUROCONTROL Agency, and by some State authorities.

7.5 In addition, it is important that the controller’s understanding of the airborne situation should be maximised. The controller does not know when ACAS II issues a RA(s), and could unknowingly issue instructions that are contrary to RA indications. The provision of RA downlink to the controller’s work position (CWP) could provide a system to automatically notify the posting of a RA. If provided in a timely manner, this could aid the controller’s understanding of the airborne situation during a RA event. The EUROCONTROL Agency, and some Member State authorities, are progressing actions to determine the technical feasibility issues, potential operational benefits, and operational implications of the provision of RA information to the CWP.

7.6 It is proposed that the ACAS provisions in ICAO PANS-ATM, Doc 4444, are reviewed, and that ACAS training guidelines for controllers are included as an Attachment to the document.

7.7 In order to improve the understanding of ACAS operations in the context of ATM, the EUROCONTROL Agency, has also developed, in cooperation with one Member State, a new version of the computer-based ACAS training tool, Replay Interface for TCAS Alerts (RITA2). This is designed for the ACAS training of air traffic controllers and also for use as an additional, but highly desirable, source of information to reinforce the ACAS training syllabus of flight crews.

7.8 Following recent serious accidents and incidents, the EUROCONTROL Organisation established a High-level Group to examine existing procedures and standards with a view to improving European ATM safety (see separate paper). This High-Level Action Group on European Aviation Safety (AGAS) has included specific ACAS-related items in an Action Plan, which include:

- a) development of an ACAS training syllabus standard for controllers;

- b) study the feasibility and potential operational benefit of ACAS II RA information downlinked to the controllers' working positions;
- c) maintenance of work to improve the performance of some specific areas of the TCAS II collision avoidance system logic;
- d) maintenance of ACAS operational monitoring, and inclusion within an overall pan-European safety monitoring system; and
- e) recommendation that ACAS II RA 'hot-spots' in the European region, identified through ACAS operational monitoring, should be examined by CAAs/ANSPs to ascertain whether this could indicate a potential safety issue relating to airspace design or procedures.

8. CONCLUSIONS

8.1 ACAS II now plays a central role in the resolution of encounters between aircraft where there is a risk of collision. ACAS safety studies and operational experience have confirmed the significant safety benefit provided by ACAS II, but have also revealed that it is seriously degraded by a deficient response to RAs.

8.2 European experience has shown that it is essential, during the global implementation of ACAS II, for operational monitoring systems and ACAS technical expertise to be maintained. This will enable any safety-critical operational and technical ACAS issues to be identified, and if necessary addressed and rectified in a timely manner.

8.3 The EUROCONTROL Organisation believes that it is vital for actions to be taken to maximise the safety benefit available from ACAS II. ACAS II should be operated at all times, and the need for flight crew to follow RAs should be reinforced. In addition, to improve further the performance of the ACAS safety net within ATC, the controller's understanding of the airborne situation should be maximised. A high standard of ACAS training is indispensable for flight crews and for controllers.

8.4 In particular, the EUROCONTROL Organisation supports the action taken by ICAO to revise and reinforce ACAS provisions in ICAO Annex 6, Part 1, in the Procedures for Air Navigation Services – Operations, Doc 8168, Vol 1, and in other related documentation. In addition, there is a need to review the ACAS provisions in PANS-ATM, Doc 4444, and to include ACAS training guidelines for controllers as an Attachment to the document.

9. ACTION BY THE CONFERENCE

9.1 The conference is invited to:

- a) urge States to take action to implement in appropriate national documentation and procedures, as soon as possible, the amendments concerning the ACAS provisions

contained in Amendment 28 to ICAO Annex 6, Part 1, and in Amendment 12 to Procedures for Air Navigation Services – Operations, Doc 8168, Vol 1²; and

- b) request ICAO to review the ACAS provisions in PANS-ATM, Doc 4444, and to include ACAS training guidelines for controllers as an Attachment to the document.

— END —

² The relevant amendments will become applicable on 27 November 2003.