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TWELFTH AIR NAVIGATION CONFERENCE

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Agenda Item 4: Optimum capacity and efficiency – through global collaborative ATM
4.1: Efficient management of airspace and improved flow performance through collaborative decision-making (CDM)

OPERATIONAL AND SAFETY BENEFITS BROUGHT BY NEW AIRBORNE COLLISION AVOIDANCE SYSTEM (ACAS) FEATURES

(Presented by the Secretariat)

1. INTRODUCTION

1.1 As described in AN-Conf/12-WP/12 related to airborne collision avoidance systems (ACAS) and ground-based safety nets, ACAS provides global safety benefits as a last resort safety net for flight crew. With the latest logic improvements known as Version 7.1, ACAS provides enhanced protection and functionality through the monitoring of an aircraft's vertical rate and improved resolution advisory (RA) annunciations. The reader is reminded that this version will be required for all aircraft as early as 1 January 2014 (new installations) and no later than 31 December 2017 (all installations subject to ACAS carriage).

1.2 AN-Conf/12-WP/12 provides information on optional additional features to ACAS which can bring significant operational and safety benefits. It mentions that performance and protection are further enhanced by a new altitude capture law that drastically reduces the number of nuisance alerts and by a new RA mode which is coupled to the auto-pilot/flight director to ensure accurate responses to the RAs. Both options rely on the coupling of automatic flight guidance and control system (AFGCS) and ACAS. This information paper provides more comprehensive details on these features, including implementation and certification aspects.

2. OPTIONAL ADDITIONAL FEATURES

2.1 New altitude capture law

2.1.1 During 1 000 ft level-off encounters, ACAS II triggers unnecessary RAs, which are caused by the ACAS II predicting a risk of collision, when high vertical rates of climb or descent are maintained.

2.1.2 At the Eleventh Air Navigation Conference in 2003 (AN-Conf/11), this issue was resolved with the introduction of recommendations for reduced vertical rates when approaching the cleared flight level. The *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS, Doc 8168) now recommends a vertical rate of less than 8 m/s (1 500 ft/min) throughout the last 300 m (1 000 ft) of climb or descent to the cleared flight level. However, it only applies when the flight crew is made aware of another aircraft at or approaching an adjacent altitude or flight level.

2.1.3 At the AN-Conf/11, ICAO has also recommended that an automatic and technical solution, which consists of implementing new altitude capture laws taking into account ACAS II thresholds, should also be studied. Some States and international organizations evaluated such a solution in 2010 and 2011 for the European airspace.

Note.– Since 2009, the United States has been evaluating the potential for both improving current ACAS and developing a future collision avoidance capability. As a result of this study (see RTCA DO-337 published in March 2012), the United States has decided to pursue a future collision avoidance system in order to reduce unnecessary alert rates, improve interoperability with current and future airspace procedures and to extend collision avoidance capabilities to new user classes such as General Aviation and Unmanned Aircraft Systems (This future collision avoidance system is described in B2-101: New collision avoidance system).

2.1.4 In compliance with the PANS-OPS recommendation, these new altitude capture laws consist of an automatic reduction in the vertical rate when approaching the selected flight level in the presence of nearby traffic. In other words, when the ACAS detects other traffic, a traffic advisory (TA) is generated and the AFGCS adopts the new altitude capture law and reduces the vertical rate when approaching the selected flight level.

2.1.5 The validation was conducted using the encounter model methodology with operationally realistic assumptions in terms of proportion of aircraft equipped with ACAS II and with these new altitude capture laws, as well as the types of pilot behaviour when RAs are triggered. The validation was made computing key performance indicators on two encounter models (i.e. “safety” and “ATM”) and for several configurations of the new altitude capture laws. These key performance indicators are grouped in four different areas: safety, pilot acceptance, compatibility with air traffic control (ATC) and trajectory modification.

2.1.6 Assuming an RA is currently triggered every 800 flight hours in the European airspace, and 50 per cent of RAs is triggered in a 1 000 ft level-off encounter, we can assume that the current situation in Europe is one operationally undesired RA triggered every 1 600 flight hours. On the other hand, with the new altitude capture law, the likelihood of receiving an undesired RA during a 1 000 ft level-off encounter would be dramatically reduced, roughly once every 50 000 flight hours.

2.1.7 Another way to express the results is related to equipage: with a theoretical 100 per cent equipage in Europe, the likelihood of receiving an RA during a 1 000 ft level-off encounter is reduced by 97 per cent for RAs in a level-off encounter; for 50 per cent equipage, the likelihood is reduced by 50 per cent. It is noted that in Europe, more than half of the RAs are issued during a level-off encounter and this is a clear improvement in ATM compatibility.

2.1.8 The evaluation has shown that the new altitude capture laws would bring significant operational and safety benefits in the European environment.

2.2 Auto-pilot/flight director TCAS RA mode

2.2.1 Since ACAS II was mandated for all civil turbine-engined aircraft capable of carrying more than nineteen passengers or weighing more than 5 700 kg in 2005, it has demonstrated its effectiveness in reducing the risk of mid-air collision. However, the pilots do not always respond to the triggered RAs exactly as expected by ACAS II and this negatively affects ACAS II safety benefits and compatibility with ATC operations.

2.2.2 A solution to this issue would be to link ACAS with the autopilot so that the aircraft would automatically respond to the RAs but at the same time, when necessary, flight crew could select a manual response to the RAs. One of manufacturers has already developed, certified and implemented this solution on some aircraft.

2.2.3 In addition, in February 2012, the European Aviation Safety Agency (EASA) certified Rockwell-Collins ACAS on EUROCOPTER long-range helicopters (EC225 Super Puma) for which resolution advisories are automatically flown by autopilot.

2.2.4 Some States and international organizations evaluated in 2010/2011 the impact of implementing automatic response to RAs for all ACAS-equipped aircraft types. The validation was built on the model-based methodology that has been used in ACAS II studies conducted in Europe for more than ten years.

2.2.5 The validation has shown that the automatic responses to RAs bring significant additional safety and operational benefits to ACAS II performance, whatever the assumption in terms of equipage and compliance rate to RAs.

2.2.6 The results are expressed in risk ratios which is the key safety metric indicator for ACAS equipage. Risk ratio = (risk of collision with ACAS)/(risk of collision without ACAS): with a theoretical 100 per cent equipage, the risk ratio is reduced from 33 per cent (current situation) to 15.5 per cent.

3. IMPLEMENTATION AND CERTIFICATION ASPECTS

3.1 Based on evaluation results, industry standards are being developed by EUROCAE WG75 describing these optional features for ACAS installations in the form of the minimum operational performance standards (MOPS) for AFGCS coupled to TCAS which address:

a) automatic guidance (autopilot) and/or display cues to support pilot guidance (Flight Director) upon resolution advisories; and

b) automatic vertical speed reduction near altitude or flight level target when aware of nearby traffic at or approaching an adjacent altitude or flight level.

3.2 These MOPS are expected to be approved by the end of 2012 or early 2013.

Note.– *The* Minimum Operational Performance Standards (MOPS) for Automatic Flight Guidance and Control System and Equipment *published by RTCA (DO-325) includes some installation guidance for Autopilot/Flight Director/Auto-thrust coupled to TCAS in its Appendix C.*

3.3 Airbus has already developed, evaluated and certified an automatic guidance function on A380. Airbus has developed and evaluated an automatic vertical speed reduction (when appropriate) function on A380. Certification is expected by the end of 2012.

3.4 These dates are compatible with the ICAO mandate for ACAS v7.1 and implementation of these additional features can be achieved when complying with the ICAO mandate, as early as 1 January 2014 for new installations and no later than 31 December 2017 for all installations.

4. CONCLUSION

4.1 The Conference is invited to note the above information in relation with B0-101: ACAS improvements.

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