# RTCA Special Committee 209 and EUROCAE WG-49

## ATCRBS / Mode S Transponder MOPS Maintenance

## Meeting #12

## In Joint Session with EUROCAE WG–49
## EUROCAE Headquarters, Malakoff near Paris France
## 15 – 19 November 2010

## Review of EADS Proposal to Revise §5.5.8.13.3 of ED-73C

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**SUMMARY**

Working Paper SC209-WP11-10R1 was presented during the Joint Session of SC-209/WG-49 at RTCA in September 2010 as a review of comments submitted by EADS against EUROCAE ED-73C. One of those comments was regarding a test procedure detailed in ED-73C §5.5.8.13.3 [DO-181D, §2.5.4.13]. As a preliminary resolution to that specific comment during the September meeting, it was agreed that all transponder manufacturers would be asked to evaluate the proposed change and comment back during Meeting #12 at EUROCAE. After discussing the issue with several manufacturers, and coming to understand that an analysis of the proposed changes were out of the scope of understanding of most manufacturers, individuals at the MIT Lincoln Labs were asked to review the proposed change and comment, in light of their expertise in Mode S.

# Review of EADS Proposal to Revise §5.5.8.13.3 of ED-73C

## 1.0 Overview

The following is an excerpt from Working Paper SC209-WP11-10R1 for this specific proposed change. All comments apply equally to RTCA DO-181D, §2.5.4.13.

| | | | | |
|---|---|---|---|---|
| 5.5.8.13.3 | a. Transponder Not Locked Out to All-Calls | Definition of PR checking intervals is statistically wrong. The lower the required reply probability the higher is the chance for a wrong result with 100 interrogations only. The min-max-intervals could be maintained only by increasing the number of interrogations. Please refer to chapter 3 of this document. | **Proposed action**: Improvement to be considered by the meeting (see Appendix A justifying the changes) | SC209/WG49 asks Mfg to review this and provide feedback |

Before commenting on the proposed change, it is useful to review the use of data in the PR field of the Mode S-only all-call interrogation (UF=11).

## 2.0 Use of the PR Field

The PR field is provided to command a transponder to reply to a DF=11 interrogation with a reduced probability in order to handle the case of synchronous garble on acquisition. This is sometimes referred to as stochastic acquisition.

This garble is caused by two (or more) aircraft in the antenna beam not locked out to all-calls that are within 5 NM of each other in slant range. The overlap of all-call replies at the interrogator from these aircraft makes it impossible to decode the 24-bit aircraft addresses. The commanded reduced probability of reply means that the interrogator will eventually receive a reply from only one of the aircraft in the garbling set. The interrogator can then lock out this aircraft to further all-calls and then acquire the other aircraft using the same technique.

## 3.0 Interrogator Implementation of Stochastic Lockout

This technique is used by the interrogator in the following ways:

Initial target acquisition after a period of inactivity. When an interrogator comes on line after an outage, it must quickly acquire the entire set of aircraft in its operating area. This is

accomplished by starting all-call activity with the lowest value of probability for a number of scans. Aircraft 24-bit addresses that are received are used to immediately lock out those aircraft. Next the probability level is increased one step for several more scans and the process repeats until the probability is set to one. At this point the entire set of aircraft should be in track.

Detection of a garble event during normal all-call activity. During operation, synchronous garble of all-call replies is manifested by the detection of an all-call reply at a consistent range and azimuth that cannot be decoded because of too many bit errors. In this case, the interrogator will schedule stochastic all-call interrogations commanding reduced probability (e.g., 0.5) within the roll call period for the range and azimuth of the garble event.

## 4.0 Requirement for Accuracy of Transponder Reply Probability

The two uses of the reduced probability described above do not imply a requirement for a high accuracy in the transponder implementation of reduced probability. This needs to be considered in deciding what (if any) revision should be made to ED-73C, §5.5.8.13.3 [DO-181D, §2.5.4.13].

## 5.0 Alternatives

1. Accept the proposed change. The proposed change appears to be based on rigorous analysis and will make the test of the paragraph more "technically" correct.

2. Add a note to the paragraph to address the possibility of test failure. The current test is based on a small sample, so it is likely that in some cases of testing, statistical variation did cause a correctly implemented transponder to fail this test. In this case, it is equally likely that the test was rerun one or more times and was then successful. It might be useful to add a note to the paragraph to alert testers of this possibility.

3. Do not make any revision to ED-73C, §5.5.8.13.3 [DO-181D, §2.5.4.13]. Revisions are normally made to published standards to correct errors or misinterpretations that have lead to problems in testing or the operation of the equipment covered by the standard. Given, (a) the modest requirements for accuracy of transponder performance for reduced probability, and (b) that there do not appear to be any reports of problems in the many years since this paragraph was first published, it may be preferable to leave the paragraph as it is.

## 6.0 Recommendation

After considering the possible alternatives, it is proposed that no change be made to ED-73C, §5.5.8.13.3 [DO-181D, §2.5.4.13].