

**RTCA Special Committee 186, Working Group 3
EUROCAE WG-51, SG-1**

ADS-B 1090ES MOPS Maintenance

Meeting #26

**RTCA Headquarters, Washington DC
31 March – 3 April 2009**

**Response to Action Item 25-05
Clarification of Fail/Warn Declaration
to the Flight Crew for ADS-B OUT**

**Jessie Turner
Boeing**

Summary
This Working Paper is in response to Action Item 25-05. The Working Paper addresses ADS-B Fail/Warn declaration to the flight crew and addresses whether wording changes to DO-260A, §2.2.11.2.1 and §2.2.11.5.1 are required to clarify the “monitoring” function and the setting of a Fail/Warn declaration.

Clarification of Fail/Warn Declaration to the Flight Crew for ADS-B Out

Background/Discussion

Working Paper 24-10 from Boeing discussed the declaration of Fail/Warn to the flight crew based on input failures, or loss of input buses, into the ADS-B transmitter. Extensive discussion at Meeting #24 in Brussels and during a March 10, 2009 telecon concluded that the only input data failure that is worthy of consideration is the failure or loss of all sources of aircraft position (i.e. all GPS, IRS, and FMS position inputs).

From a Functional Hazard Assessment (FHA) perspective, FAA NPRM 07-15 for ADS-B Out does not specifically state a hazard classification for the loss of the ability to transmit aircraft position. The NPRM does address corruption of position data (which is deemed a Major hazard class). In addition, loss of the ATC transponder function is considered a Minor hazard class.

Based on conservative estimates, loss or failure of a GPS input source into the ADS-B transmitter is on the order of $1.0E-04$ (which is equivalent to a 10,000 hr MTBF), and loss or failure of an IRS or FMS input source is on the order of $1.0E-04$. Therefore, loss of two position sources is on the order of $(1.0E-04 \times 1.0E-04) = 1.0E-08$. Thus, the probability of losing all sources of position data into the ADS-B transmitter is extremely remote ($<1.0E-07$). This low fault probability does not justify having a flight deck failure annunciation when the hazard class for loss of the ability to transmit aircraft position is considered Minor ($<1.0E-03$), or at most Major ($<1.0E-05$). It should also be considered that if the ADS-B transmitter lost all sources of position data, ground controllers would still receive all other ADS-B data. Thus, the fault would still be detectable by ground controllers, who would notify the flight crew of the loss of position data.

It is also important to note that in order to have an ADS-B failure annunciation in the flight deck to support loss or failure of all position input sources, some aircraft architectures would require a dedicated ADS-B failure indicator (e.g. on the ATC/TCAS control panel). Due to the extremely remote probability of the fault, and the fact that the fault is still detectable by ground controllers, the safety and cost benefit of having an ADS-B failure annunciation for this failure condition is very low. Therefore, it is recommended that a flight deck failure annunciation not be provided for loss or failure of any input data into the ADS-B transmitter, including loss or failure of all position input sources.

Proposed Wording Changes to §2.2.11.2.1 and §2.2.11.5.1

To clarify what is monitored during “fault monitoring”, Boeing took the action (AI 25-05) to propose revised and additional wording to clarify the MOPS requirements.

This portion of the working paper reviews MOPS §2.2.11.2.1 and §2.2.11.5.1, and provides clarification regarding the ADS-B transmitter monitoring function and the setting of the Fail/Warn declaration.

Proposed wording changes are in italicized bold BLUE below.

2.2.11.2 Broadcast Monitoring

2.2.11.2.1 Transponder-Based Equipment

If the ADS-B Transmitting Subsystem is implemented as a non-broadcast only equipment installation, then a squitter monitor **shall** be provided to verify that DF=17 transmissions are generated at the rates specified in §2.2.3.3 through §2.2.3.3.2.10. If any of the DF=17 message types for which the equipment is certified is not transmitted at the specified rates, then the equipment **shall** be considered as failed and the appropriate “Fail/Warn” indicators **shall** be set to the “Fail/Warn” state.

Clarification of Fail/Warn Declaration to the Flight Crew for ADS-B Out

No change to §2.2.11.2.1 above is required, since this section specifically addresses the squitter monitor only (i.e. verifies that the DF-17 transmissions are generated at the correct rates).

2.2.11.5 Failure Annunciation

2.2.11.5.1 ADS-B Transmission Device Failure Annunciation

An output **shall** be provided to indicate the validity/non-validity of the ADS-B Transmitting Subsystem. Failure to generate ADS-B Messages at a nominal rate, a failure detected by self-test (*per §2.2.11.1*) or the monitoring function (*per §2.2.11.2*), or failure of the address verification (*per §2.2.11.3*) **shall** cause the output to assume the invalid state. Momentary power interrupts **shall** not cause the output to assume the invalid state. The status of the ADS-B Transmitting Subsystem **shall** be enunciated to the flight crew where applicable.

NOTE: The term “a failure detected by self-test or the monitoring function” is interpreted to mean an internal failure detected within the ADS-B transmitter equipment as stated in §2.2.11.1 and §2.2.11.2, and does NOT include monitor of input bus data going to the ADS-B transmitter equipment. Loss or failure of input bus data will NOT result in a failure annunciation to the flight crew, but will result in maintenance fault messages being generated so that maintenance personnel can resolve the specific input bus fault.