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ATCRBS / Mode S Transponder MOPS Maintenance

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Proposal for Changes to Clarify the Usage of TCS to Control Extended Squitter Broadcasts

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SUMMARY

This Working Paper is in response to an inquiry from manufacturers which indicate that clarification needs to be made in DO-181D/ED-73C regarding the extent to which setting the TCS parameter to 1 or 2 should control the broadcast of the Surface Position Message, as well as the other 1090ES ADS-B Messages when in the on-the-ground condition.

1.0 MOPS Change to Inhibit Unnecessary Replies from Surface Aircraft

With the implementation of multilateration, ADS-B and surface applications, procedures will be prevalent to keep transponders active (not in Standby or Off) while on the airport surface. Aircraft without an automatic means for surface determination will remain in airborne status and be a source of additional unwanted RF activity from Mode A/C replies and Mode S replies to All-Calls. This will reduce the probabilities for surveillance detection and successful addressed transactions, and could become a safety issue at major airports. Aircraft on the surface and reporting airborne will also not be able to participate in surface applications.

The original proposed change to address this problem would have accomplished unnecessary reply inhibition by directly permitting commands in the TCS field to control the transponder on-the-ground (OTG) state. When this proposed change was reviewed by RTCA/EUROCAE during an April 2010 teleconference, the proposal was not acceptable to the TCAS manufacturers because of safety concerns for TCAS. An error in ground control of the OTG state could render an aircraft invisible to TCAS.

At the Paris 2010 RTCA/EUROCAE meeting, a change to the Mode S MOPS was approved to inhibit transponder replies to ATCRBS and Mode S All-Call interrogations through commands in the TCS field. Instead of directly controlling the OTG status to achieve inhibition of the unwanted replies, the alternative approach is to modify the TCS commands sent by the ground to only add the requirement to inhibit replies to Mode S All-Call and Mode A/C interrogations when commanded to report the surface format. This will satisfy the intent of the ground control of unwanted interference from surface aircraft but makes no change to the vertical status reported to ACAS.

2.0 MOPS Change to Clarify Surface ES Broadcast when Controlled by TCS Commands

Subsequent to the Paris meeting, questions have been raised on the 1090ES message formats to be broadcast when commanded to report the “surface position type” by a command in the TCS field. A review of the existing relevant MOPS text for the TCS commands revealed that it was not modified from the original version of ES that (initially) had only an Airborne Position Message (the Airborne Velocity Message was a later addition). More recently there is a requirement to broadcast the Aircraft Operational Status Message, Subtype 0 for the airborne case, and Subtype 1 for the surface case.

The goal of the ground control via the TCS field is to have aircraft without an automatic means to set the surface condition broadcast the same ES formats on the surface as those with an automatic means. To reflect this, the text must be revised to state that the TCS surface command requires the transponder to broadcast the Surface Position and the Aircraft Operational Status Subtype 1 Messages and to inhibit the broadcast of the Airborne Position, Airborne Velocity, Aircraft Operational Status Subtype 0 Messages and Target State and Status Messages.

3.0 Proposed MOPS Change

The tracked changes in the following paragraphs include revisions to implement both of the above capabilities.

2.2.18.2.6 Acquisition Squitter Protocols

c. Conditions for Acquisition Squitter Transmission – The following applies to transponders transmitting Extended Squitters. When commanded to report the surface ~~position~~ type formats by TCS commands (see §2.2.23.1.7), aircraft without automatic means of determining the on-the-ground condition, and aircraft with such means that are reporting airborne state, **shall** transmit acquisition squitters in addition to the surface ~~position~~ Extended Squitter formats unless acquisition squitter transmission has been inhibited (subparagraph d.).

2.2.23.1.5.2 Ground Controlled Format Selection

Aircraft without such automatic means **shall** report the airborne type ~~messages~~formats. Aircraft with or without such automatic on-the-ground determination **shall** report the surface type formats ~~use position message types~~ as commanded by control codes in the TCS subfield (see §2.2.23.1.7). After timeout of the TCS commands, control of airborne/ surface formats **shall** revert to the means described above.

Note 1: *Extended squitter ground stations determine aircraft airborne or on-the-ground state by monitoring aircraft position, altitude and ground speed. Aircraft determined to be on-the-ground that are not reporting the surface ~~position message~~type formats may be commanded to report the surface ~~format~~ type formats via the TCS subfield. The normal return to the airborne ~~position messages~~type formats is via a ground command to report the airborne type ~~messages~~formats. To guard against loss of communications after takeoff, commands to report the surface ~~position message~~type formats automatically timeout.*

When commanded to report the surface type formats by TCS commands, aircraft without automatic means of determining the on-the-ground condition, and aircraft with such means that are reporting airborne state, **shall** transmit acquisition squitters as specified in §2.2.18.2.6.a.

Note 2: *Transmission of the acquisition squitter will provide for TCAS acquisition in the event that an airborne aircraft is commanded to report the surface type. In this case, the CA field of the acquisition and Extended Squitters will continue to show that the aircraft is airborne, or is unable to determine its on-the-ground state.*

2.2.23.1.7 Subfields in SD for Extended Squitter

The SD field contains the following information if the DI code is 2:

TCS, the 3-bit (bits 21 – 23) Type Control Subfield in SD **shall** control the ~~position~~ format types reported by the transponder and its response to ATCRBS and Mode S All-Call interrogations. These commands **shall** only affect the format types reported, they **shall not** change the aircraft determination of its on-the-ground condition. The commands for codes 1 and 2 **shall** be able to refreshed for a new period before timeout of the prior period.

Note 1: *Thus aircraft without the means to set the on-the-ground condition will continue to report code 6 in the CA field, and an aircraft with the means to set the on-the-ground condition that has determined that it is in the airborne state will continue to set code 5, independent of the Extended Squitter format that is emitted.*

The following TCS codes have been assigned:

TCS Codes	Description
0	No ~~position~~ surface format type or reply inhibit command
1	Use surface ~~position~~ format types and inhibit replies to ATCRBS and Mode S All-Call interrogations for the next 15 seconds
2	Use surface ~~position~~ format types and inhibit replies to ATCRBS and Mode S All-Call interrogations for the next 60 seconds
3	Cancel surface format type and reply inhibit commands
4 – 7	Not assigned

When commanded to report the Extended Squitter surface type formats, the transponder **shall** broadcast the surface format Extended Squitter Messages and inhibit the airborne format Extended Squitter Messages. When commanded to report the surface formats, unless under command to transmit the low surface rate by the RCS subfield, the high surface rate **shall** apply.

RCS, the 3-bit (bits 24 – 26) Rate Control Subfield in SD **shall** control the squitter rate of the transponder when it is reporting the Extended Squitter surface type formats. This subfield **shall** have no effect on the transponder squitter rate when it is reporting the airborne ~~position~~ type formats~~of Extended Squitter~~.

Note 2: *Aircraft without the means of determining on-the-ground state or aircraft with such means that are declaring the airborne state must be commanded to transmit the surface format (via TCS) before they can be controlled by this subfield. Both of these commands may be sent in the same interrogation.*

Note 3: *Both TCS and RCS have specific timeout periods. If the surface format command times out first, the aircraft will resume broadcasting the airborne format (unless it is now declaring the on-the-ground state or the surface format is selected in accordance with the requirements of RTCA DO-260B/EUROCAE ED-102A §2.2.3.2.1.2 (3)) even if the squitter suppression command has not timed out (since the squitter suppression command has no effect on the transmission of the airborne format). If the squitter suppression command times out first, the aircraft will resume the transmission of surface squitters.*

The following RCS codes have been assigned:

RCS Codes	Description
0	No surface Extended squitter rate command
1	Report high surface Extended squitter rate for 60 seconds
2	Report low surface Extended squitter rate for 60 seconds
3	Suppress all surface Extended squitters for 60 seconds
4	Suppress all surface Extended squitters for 120 seconds
5 – 7	Not assigned

Acquisition squitters **shall** be emitted during the time period when Extended Squitters are inhibited as specified in §2.2.18.2.6.c.

Note 4: *The definition of high and low squitter rate is given in §2.2.23.1.3 and applies to the Surface Position, Aircraft Identification and Category, and the Operational Status Messages.*

Note 5: *As stated in §2.2.18.2.6.b.4, Acquisition squitters are transmitted when Surface Extended Squitters are suppressed by using RCS=3 or 4.*

2.2.23.1.3 Extended Squitter Rate

g. Aircraft Operational Status Squitter Rate. The Aircraft Operational Status squitter shall be transmitted at the rates as specified in §2.2.3.3.1.4.2 of RTCA DO-260B/EUROCAE ED-102A, with the exceptions as specified in subparagraph "i". When transmitting the surface formats, the rate depends on whether the high or low squitter rate has been selected (see §2.2.23.1.6).