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Subject: a) sustainability of the 1 030/1 090 MHz RF environment; b) incorrect SSR practices by some military authorities; and c) guidance on ground testing of SSR transponders

Action required: a) consider Attachment A in planning and implementation of air navigation services; and b) forward Attachments B and C to military authorities and aircraft operators respectively for this action

Sir/Madam,


1. I have the honour to invite your attention to guidance material developed by the Aeronautical Surveillance Panel and to inform you that the Air Navigation Commission, at the fifth meeting of its 181st Session held on 9 June 2009, considered the material and agreed that it be sent to States and international organizations. The material relates to the following subjects:

- a) measures needed to ensure the sustainability of the 1 030/1 090 MHz radio frequency environment that is serving a number of surveillance systems as well as the airborne collision avoidance system (ACAS);
- b) advice to be provided to military authorities concerning adverse effects of some incorrect secondary surveillance radar (SSR) practices on civil aviation; and
- c) advice to aircraft operators on the correct method of ground testing of SSR transponders to avoid potential adverse effects on ACAS of aircraft in flight.

2. May I request that you consider the guidance material in Attachment A in your activities relating to the planning and implementation of surveillance systems and ACAS; and, forward to and follow up with your military authorities and aircraft operators the material in Attachments B and C.

3. The use of this material by States in the planning and implementation activities will ensure long-term sustainability and correct operation of surveillance and collision avoidance systems.

Accept, Sir/Madam, the assurances of my highest consideration.



Raymond Benjamin
Secretary General

Enclosures:

- A — Measures to protect the 1 030/1 090 MHz RF environment
- B — Issues related to the use of SSR by military authorities
- C — Guidance on transponder ground testing

**MEASURES TO PROTECT THE 1 030/1 090 MHZ
RADIO FREQUENCY (RF) ENVIRONMENT**

The following measures are needed to ensure the sustainability of the radio frequency (RF) environment:

- a) to the extent possible, ground secondary surveillance radars (SSRs) (Mode A/C) that use sliding window technique should be upgraded to monopulse or Mode S. New sliding window interrogators should not be deployed in high density environments. This is critical to sustain the performance of all systems that operate on 1 030/1 090 MHz;
- b) regarding ground radars (and multilateration systems), better regional coordination should be put in place to minimize interrogation rates and transmission power as well as use of appropriate antenna patterns. Moreover, in any given region, Mode S radars must be operated with an appropriate installed monopulse antenna and should be clustered as much as possible, and the use of different interrogator codes should be minimized;
- c) better coordination should be performed between civil and military authorities specifically regarding the 1 030/1 090 MHz RF environment;
- d) as much as feasible, airborne Mode A/C transponders should be replaced with Mode S transponders. This will significantly reduce FRUIT generated by ground and airborne interrogations; and
- e) it should be ensured that only properly tested and maintained airborne equipment are operated on aircraft.

ISSUES RELATED TO THE USE OF SSR BY MILITARY AUTHORITIES

1. INTRODUCTION

1.1 It has been observed that certain military authorities have been using some rather incorrect practices in their implementation and operation of secondary surveillance radars (SSRs). Those practices are described below:

X pulse in the SSR Mode A reply

1.1.1 The X pulse in SSR Mode A replies is being used to distinguish an unmanned aircraft system (UAS) from a manned aircraft. As stated in Annex 10, Volume IV, Chapter 3 and the *Manual of the Secondary Surveillance Radar (SSR) Systems* (Doc 9684), the X pulse was foreseen for future expansion of the systems and not for any use within the existing system. The aforementioned provisions also state that it has finally been decided that such expansion would be achieved using Mode S. The X pulse should therefore not be used today and it is not foreseen to be used in the future.

1.1.2 There are operational consequences to aeronautical surveillance if the X pulse is used to distinguish a UAS from a manned aircraft. The presence of a pulse in the X pulse position has the effect of invalidating Mode A replies in systems used by some States. Any air vehicle transmitting the X pulse, including a UAS, may therefore not be visible to air traffic control if this method of operation is adopted. This is a flight safety issue.

1.1.3 If requested by States, ICAO will be able to establish a procedure for the identification of UASs as part of the Mode S acquisition.

Use of IC Codes by Mobile Interrogators

1.1.4 By default, any mobile Mode S interrogator (mainly used by military) should not be allocated a distinct interrogator code. They should use a special mode of target acquisition using interrogator code II=0, defined in Annex 10, Volume IV. Alternative means are possible to acquire targets passively, such as using the acquisition squitter and an angle of arrival antenna, or the extended squitter with an omni-antenna to determine the azimuth angle and address of aircraft, removing the need for mobile interrogators to use the lockout protocol.

1.1.5 In any case, Mode S operations using other interrogator codes, even at sea, without prior coordination with air navigation service providers should be prohibited as it could severely impact the operation of other ground Mode S surveillance systems used for civil aviation and/or air defence systems.

Requirement for monopulse for Mode S scanning beam interrogators

1.1.6 Some military Mode A/C interrogators are being upgraded to Mode S capability without the use of the monopulse technique. In Mode A/C operation, an interrogation elicits replies from all equipped aircraft in the antenna main beam. Azimuth is determined by center marking of eight or more consecutive replies from each detected aircraft using a technique known as "beam splitting." Mode S has

been developed to provide azimuth information based on a single reply using monopulse processing which determines the off-boresight angle of the received reply. Monopulse is also used in the processing of Mode S and Mode A/C replies to improve correct decoding in the presence of interference.

1.1.7 Since Mode S is based on the use of an addressed interrogation to a specific aircraft, implementing a Mode S interrogator without monopulse processing results in each Mode S aircraft being interrogated eight or more times during beam passage in order to support beam splitting. This approach dramatically increases the 1 030/1 090 MHz channel occupancy (also called RF pollution).

1.1.8 Operating a Mode S interrogator without monopulse capability in high density environments will cause excessive channel occupancy that will result in degraded performance of all other systems using 1 030/1 090 MHz (e.g. Mode S, ACAS and extended squitter). Therefore such improper implementation should be prohibited.

GUIDANCE ON TRANSPONDER GROUND TESTING

To avoid the generation of airborne collision avoidance system (ACAS) traffic advisories (TAs) and resolution advisories (RAs), special precautions and appropriate procedures described below are required during transponder testing and maintenance:

- a) when not required, ensure that all transponders are set to “OFF” or “Standby”;
- b) before starting any test, contact the local air traffic control (ATC) unit and advise them of your intention to conduct transponder testing and indicate the planned start time and test duration. Also inform them of your intended Mode A code (see subparagraph c) below) and your intended aircraft identification (Flight ID, see subparagraph d) below);
- c) prior to “switch-on” or with the transponder in “standby” mode, set the Mode A code to a value that is regionally agreed to be used for transponder testing;

Note. — Mode A code 7 776 is assigned as a reserved code in Europe, specifically for the testing of transponders. Australia requires the use of Mode A code 2 100 for transponder testing.

- d) for a Mode S transponder, set the aircraft identification (Flight ID) to the first eight characters of the name of the company that is conducting the tests (or something to that effect);
- e) set the on-the-ground status for all Mode S replies, except when an airborne reply is required (e.g. for altitude testing);
- f) where possible, perform the testing inside a hanger to take advantage of any shielding properties it may provide;
- g) as a precaution, use antenna transmission covers whether or not testing is performed inside or outside;
- h) when testing the altitude parameter of a Mode A/C or Mode S transponder, radiate directly into the ramp test set via the prescribed attenuator;
- i) manually set the altitude to an unrealistically high value (i.e. over 60 000 feet);
- j) in between testing, i.e. to transition from one altitude to another, or changing the Mode A code, set the transponder to “Standby” mode before changing the altitude input;
- k) when testing is complete, immediately set the transponder(s) to “OFF” or “Standby”;

- l) simulation of ACAS operation must not be carried out by radiating from an antenna located on, or remotely based, from a workshop; and
- m) finally, it should be noted that the current practices of testing transponders with different altitudes using Gilham encoders may no longer be required for aircraft using altitude encoders with serial output.

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