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Subject

Operational



AIRCRAFT TRANSPONDER FAILURE AND ATC OPERATIONS

1 Introduction

- 1.1 NATS in common with other UK and European Air Navigation Service Providers have implemented Mode S Secondary Surveillance RADAR (SSR) Systems. The correct functioning of these systems, and the interoperability of the airborne transponder equipment with them, is essential for the provision of the data necessary for safe separation and expeditious flow of air traffic. This is particularly the case in a modern ATC centre where extensive use of software tools is made.
- 1.2 The use of a Mode S interrogation pattern (Mode S MIP), as opposed to the older mixed Mode A/C and S interrogation pattern, allows the radar to provide additional information to Air Traffic Controllers with a higher level of quality whilst minimising the risk of overloading the frequency. This is also required by UK regulation [see National IFF/SSR Committee (NISC) letter Ref. 8AP/65/02/58_SS3/07/102].
- 1.3 Mode S MIP continues to support both Mode A/C and Mode S transponders (as a standards compliant Mode A/C transponder will respond Mode A/C to Mode S inter-mode interrogations). However those aircraft equipped with transponders which are faulty, or are not standards compliant, such that they fail to respond to this interrogation pattern will not be visible to NATS SSRs and such will be subject to a lowering of the safety margins and may be subjected to restrictions in the level of service they can be offered.

2 Secondary RADAR Interrogation Patterns Used in the UK

- 2.1 The Mode S MIP is fully compliant with the international standards and has been in use in the UK and across Europe for some years. All standards compliant transponders will be interoperable with Mode S MIP. In Mode S MIP the following repeating pattern of interrogations is used during the All-Call period:

S, As, S, Cs

The S (Mode S-Only All-Call) element within this pattern is defined by ICAO Annex 10, Vol. IV, 3.1.2.5.2 and the As and Cs (Mode A/C only All-Call) element is defined by ICAO Annex 10, Vol. IV, 3.1.2.1.5.1.2.

- 2.2 As defined by ICAO Annex 10, Vol. IV, Chapter 3 the following responses are expected from transponders during the all call period in response to Mode S MIP:

Interrogation Element	S	As	S	Cs
Mode S Transponder (during acquisition)	S (DF11)	Nil	S (DF11)	Nil
Mode S Transponder (once locked-out)	Nil	Nil	Nil	Nil
Legacy Mode A/C Transponder	Nil	A	Nil	C

Note: Mode S roll-call replies (DF4, 5, 20, 21) not shown as not in All-Call period.

3 Air Traffic Services for Aircraft Failing to Respond to SSR Interrogations

- 3.1 SSR transponder carriage is mandatory for all flights within Class A, B & C Airspace and all IFR flights within Class D & E Airspace (Para. 5.3, GEN 1.5 of UKAIP) and also within defined Transponder Mandatory Zones (TMZs). Within such airspace, aircraft failing to respond to Mode S MIP will be considered as having suffered a transponder failure. If detection cannot be recovered through changing to the alternate Transponder (where fitted) or through 'recycling', aircraft will be dealt with in accordance with Paragraph 2.4 of ENR 1.6 of UKAIP. As transponder failure events lead to a large increase in controller workload and prevent the correct operation of safety nets, this may include significant restrictions to clearances, or refusal of entry into Controlled Airspace (CAS).

3.2 Aircraft operating outside of airspace for which transponder carriage is mandatory and which fail to respond to Mode S MIP will be at increased risk in the event of infringement into controlled airspace and will be limited in their ability to receive certain Flight Information or LARS services. Ground based electronic 'safety nets' such as NATS' Controlled Airspace Intrusion Tool and Short Term Conflict Alert are severely impaired where a transponder is not functioning. Additionally some known transponder faults which preclude a response to Mode S MIP also prevent the transponder's correct interoperability with the Traffic Collision Avoidance System carried by most large aircraft.

4 Post Event Actions by Aircraft Operators

4.1 In the event that an airspace user is informed by ATC of a transponder system deficiency it is important that the failure be urgently reported to their aircraft maintenance facility. In all cases as per the recommendations contained in EASA Safety Information Bulletin 2011-15R2 the aircraft operator should "initiate an unscheduled maintenance action to arrange for any deficiencies to be corrected, at the earliest opportunity".

4.2 It should be noted that some failure modes can be intermittent in nature or affect only one of two antennas (if dual fitted) such cases may pass a basic bench test of the transponder. Depending on the specific installation, detection issues have been known to result from failures or degradations of any of the following units – transponder, antenna, antenna feeder cabling, antenna changeover switch or code selection panel. Aircraft maintainers are also advised to check for pertinent Service Bulletins, as a number of transponders have had modifications to resolve such issues. When undertaking ground transponder testing this should be undertaken in accordance with national rules, in the UK as described in Paragraph 2.2.3 of ENR 1.6 of UK AIP.

5 Why Aircraft Fail to Respond to SSR Interrogations

5.1 There are a number of reasons why a transponder might fail to respond to SSR:

- A design fault with a particular transponder type or antenna;
- A systematic fault with the way an aircraft manufacturer fitted a transponder to an aircraft type (e.g. crossed wires);
- A random fault which has occurred with a particular installation (e.g. a loose connection, damaged feeder cable, faulty weight on wheels switch or ageing components);
- The transponder is over-interrogated by ground-based SSR Systems beyond its processing capability (protective measures are in place to ensure this condition does not occur);
- The transponder is switched off.

5.2 The following Airworthiness Directives (ADs) and manufacturer's Service Bulletins have been published pertaining to some common non-detection issues and operators are encouraged to ensure that their aircraft are in compliance. Other ADs relating to incorrect data output have also been published and these may be viewed at <https://ad.easa.europa.eu/>.

Transponder	Airworthiness Directive	Service Bulletin/Letter
Filsler/Funkwerks/f.u.n.k.e TRT-800A and TRT-800H	EASA AD: 2008-0183	Service Bulletin TRT800-A-H-1/2008
	N/A	Service Letter SL-1/2010
	N/A	Service Bulletin TRT800-A-H-1/2018
Filsler TRT-600	EASA AD: 2008-0158R2	Service Letter SL-1/2008
Various with Gables ATC/TCAS Control Panels	EASA AD: 2011-0043	Service Information Letter (SIL) 85 dated 19 May 2009
Honeywell MST-67A	EASA AD: 2006-0269	Software Bulletin SWB MST 67A-SW2
NARCO Avionics AT-150	EASA AD: 2009-0200	Service Bulletins #1 and #6
Rockwell Collins TDR-94 and TDR-94D	EASA AD: 2010-0003R2	Service Information Letter 07-2 Rev 1 (ref. 523-0810069-101000)
Rockwell Collins TPR-720 and TPR-900	EASA AD: US-2014-05-27	Service Information Letter 13-1, Revision No. 1, 523-0821603-101000
Terra TRT-250 / TRT-250D	FAA AD: 95-01-01	N/A
Rockwell Collins ISS-2100 as integrated into Boeing 787	N/A	There are several service bulletins applicable to the B787 depending on age and operators are advised to confirm with Boeing which are applicable.