International Civil Aviation Organization

Thirteenth Meeting of the APANPIRG
ATS/AIS/SAR Sub-Group (ATS/AIS/SAR/SG/13)

Bangkok, Thailand 23 – 27 June 2003

Agenda Item 4: Consider problems and make specific recommendations concerning the provision of ATS/AIS/SAR in the Asia/Pacific Region

AUTOMATIC DEPENDENT SURVEILLANCE BROADCAST (ADS-B) FOR AIR TO GROUND SURVEILLANCE

(Presented by Australia)

SUMMARY

This paper discusses the deployment of ADS-B for air to ground surveillance purposes and discusses the synergy of combining ADS-B fitment with European and FAA mandates.

1. Background

1.1 ADS-B technology has been developing quickly in recent years. European and North American states have, for some time, been examining the relative advantages and disadvantages of different link technologies to support an array of ADS-B applications. Unfortunately the standardisation process has been slow and has resulted in the development of a number of ICAO standards which are not interoperable. However, general consensus has emerged on the use of Mode S extended squitter for Air Transport Aircraft for the next 10 years at least.

1.2 Some states, without comprehensive radar coverage, see the potential of near term benefits using ADS-B as an alternative to radar without the need for other applications to support the cost-benefit argument. In particular, deployment of ADS-B air-ground surveillance alone can bring almost immediate benefits. Quick adoption of this technology would particularly assist developing states and other states which cannot afford expensive radar infrastructure.

2. Airservices Australia Operational deployment of an ADS-B systems

2.1 Airservices Australia has initiated a project to conduct an operational trial of ADS-B for ATC surveillance in a region near Bundaberg, Queensland. The project has installed a single ADS-B ground station, and equipped a number of aircraft with ADS-B avionics, and has modified an operational air traffic management system to process and display ADS-B tracks. The safety case has been submitted to the regulator and it is expected to be used operationally using a 5Nm radar like separation standard.

2.2 The performance being achieved in the Australian environment has exceeded expectations. Coverage performance has been excellent and has exceeded the performance that may normally be expected from a radar installed on the same site (see

figure 3). Manoeuvre performance is better than radar and identity data is reliably received. See attached sample plots at Figures 1&2.

2.3 Encouraged by the achieved performance, Airservices Australia has proposed to its customers that it deploy 20 ADS-B ground stations across Australia to provide nationwide coverage at Flight Level 300. (See attached coverage diagram at Figure 4).

2.4 Furthermore, Airservices Australia is considering the introduction of ATC procedures to give priority to ADS-B equipped aircraft. A draft AIP including the following wording is under review: "an ADS-B equipped aircraft will be given priority when by so doing an operational advantage is presented to ATC"

3. Potential for ADS-B in Asia-Pacific

3.1 Existing radar coverage in Asia Pacific is far from complete. ADS-B has the potential to provide coverage in areas where there is no surveillance today, at a very low cost. The attached diagram (Figure 5) shows both existing radars in South East Asia plus additional ADS-B ground stations that could be deployed for approximately $20 Million USD.

4. Safety and ADS-B

4.1 ADS-B provides significant safety benefits when used for air to ground surveillance, when compared to ATC without radar surveillance. Automated safety tools using ADS-B data such as short term conflict alert, cleared level adherence warning, route adherence warning, danger area infringement warning increase the safety and security and safety of airspace. Air traffic controller situational awareness is significantly improved with surveillance. Discontinuities in management of flights across sector and FIR boundaries are significantly improved when high update, high integrity positional and altitude data is provided. Mismatches between controller expectations and reality are identified earlier.

5. ICAO separation standards

5.1 Work is well advanced in the ICAO Separation and Airspace Safety Panel (SASP) regarding the development of ICAO ADS-B separation minima. This work has centred on the use of the proven 5NM radar separation minima for services where ADS-B is used as the surveillance medium. It is anticipated that the associated amendments to Doc 4444 PANSATM will be finalised by SASP in late 2004, with final publication by ICAO in late 2005. SASP is developing these standards by comparing the characteristics of ADS-B to a reference radar system in accordance with the comparative assessment methodology detailed in ICAO document 9689-AN/953.

6. Datalink choice and avionics

6.1 The extended debate on ADS-B link technology seems to have concluded. General consensus has been reached that for the next 10 years, Mode S extended squitter is the appropriate technology for Air Transport aircraft. It is recognised that other links may be required in the future.

6.2 This position has been adopted by many organisations including the following:

6.2.1 The United States FAA
6.2.2 IATA
6.2.3 CANSO
6.2.4 Association of European Airlines (AEA)
6.2.5 Airservices Australia
6.2.6 ICAO APANPIRG ADS-B Task Force
6.2.7 ICAO's SCRSP
6.2.8 The Eurocontrol ATM/CNS Consultative Group (ACG)

6.3 In addition, aircraft manufacturers Boeing and Airbus have released service bulletins which include ADS-B out using Mode S extended squitter. Airbus offer "ADS-B out" at no cost on new aircraft. Airbus has indicated that it will not offer VDL Mode 4 on its aircraft.

6.4 General aviation category transponders are also available, such as the product used by Airservices Australia in the Burnett Basin trial. Development of even lower cost products has also commenced.

7. APANPIRG ADS_B Task Force

7.1 The APANPIRG ADS-B Task Force met in March 2003 to consider the use of ADS-B in the Asia Pacific region. The meeting, fifty-three experts from Australia, China, Hong Kong China, Fiji, India, Japan, New Zealand, Pakistan, Singapore, Thailand, United States, IATA, IFALPA and SITA unanimously "supported the use of Mode S Extended squitter datalink for ADS-B in the Asia Pacific region, for Air Transport category aircraft".

7.2 Furthermore the meeting concluded that "early implementation of "ADS-B out" supports ground based surveillance immediately" and that "this can be regarded as an appropriate first step and that target implementation of "ADS-B out" for ground-based surveillance services in Asia Pacific commence January 2006".

8. ADS-B out fitment together with other transponder changes

8.1 Mode S transponders on many aircraft are currently being upgraded to meet the Elementary and Enhanced surveillance requirements of the European states. These changes include the ability of the transponder to provide callsign, bank angle, selected altitude and other aircraft parameters to interrogating radars. ATC systems may then increase safety. The changes are mandatory in Europe before end March 2005. The AIC from the German DFS is attached for information.

8.2 Most avionics manufacturers are providing an option to include ADS-B out capabilities at the same time since once Elementary and Enhanced surveillance is provided on an airframe, the addition of ADS-B comprises another software function in the same transponder. Aircraft manufacturer service bulletins include ADS-B extended squitter ADS-B out capability in their service bulletins for Elementary and Enhanced surveillance.

8.3 Appropriate avionics and ICAO standards already exist for both ADS-B out using extended squitter and Elementary and Enhanced surveillance.

8.4 The FAA has issued a Notice of Proposed Rulemaking (number 03-02) to change the operation of transponders when the "Unlawful Interference code" is entered. The FAA proposes these changes as mandatory by end March 2005

8.5 The opportunity exists for Asia Pacific to mandate or encourage the fitment of "ADS-B out" capability at the same time as the European and FAA mandates. Such an action would achieve fitment of ADS-B out at negligible cost.

8.6 In addition, some states using ModeS radar sensors, for example in terminal areas, could also gain the benefits of Elementary and Enhanced surveillance. These include earlier prediction of potential level "bust", less reliance and management of 4 digit octal codes, and improved tracker and safety net performance.

9. Timeliness of deployment

9.1 A critical issue in the implementation of any new system or technology is the timeliness of its introduction. If debate continues too long, the achievable benefits are lost for a period and the technological assumptions and economics of deployment change, invalidating earlier work.

9.2 "ADS-B out" using Mode S extended squitter, is already good enough to deploy for air-ground surveillance. Enough appropriate technical standards exist in ICAO, RTCA, Eurocae and AEEC to use Mode S extended squitter.

9.3 Any delay to the introduction of "ADS-B out" deprives Airlines and States of the economic and particularly the safety advantages that can be gained through introduction. Early deployment of "ADS-B out", before air-air surveillance capabilities mature, would provide benefits at a small incremental cost, for a significant period.

10. Conclusion

10.1 Australia considers that deployment of ADS-B technology using Mode S extended squitter at the same time as the European Enhanced surveillance mandate (March 2005) is a cost effective, efficient and responsible course of action.

10.2 Doing so, will allow many states to provide effective ATC radar like surveillance where there is no surveillance today increasing efficiency and making significant improvements to safety.

10.3 In the case of Australia, this technology brings the possibility of cost effective surveillance being provided over the whole continent, as it is today for VHF voice communication. Safety and commercial benefits will result when compared with the inefficiencies of today's procedural control in these areas.

11. Recommendations

11.1 It is recommended that:

11.1.1 The meeting note the conduct of the Australian ADS-B pilot deployment.
11.1.2 The meeting note the proposed deployment of ADS-B across Australia.
11.1.3 The meeting note the recommendation of the APANPIRG ADS-B Task Force to deploy ADS-B commencing January 2006.
11.1.4 The meeting encourage the fitment of "ADS-B out" capabilities in line with the European and FAA mandates of March 2005.

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Figure 1: Two ADS-B aircraft 60Nm from the ground station

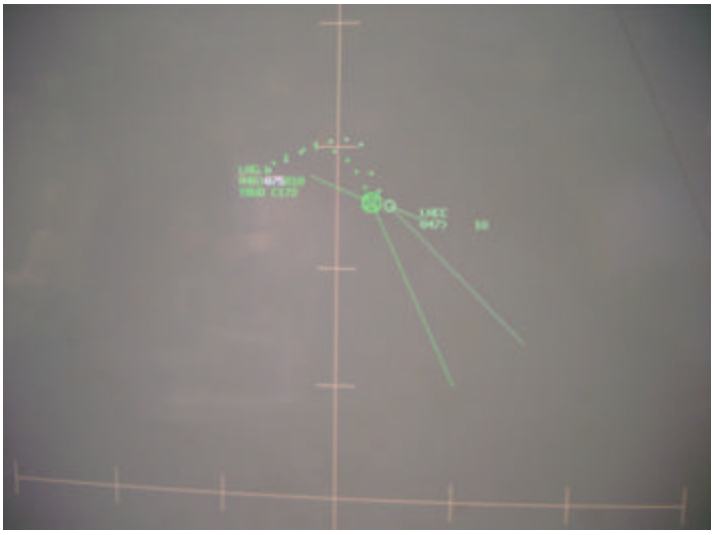

Figure 2: The display of an ADS-B track and a radar track for the same aircraft illustrating the improved velocity vector of the ADS-B track compared to radar.

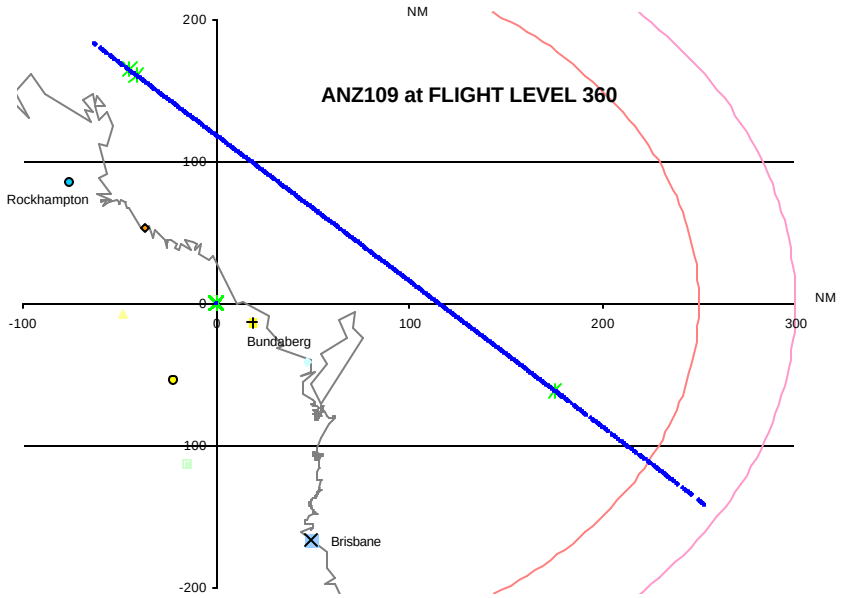

Figure 3: Illustrating coverage obtained from a single ground station. At Flight level 360 this aircraft was tracked beyond 260 nautical miles.

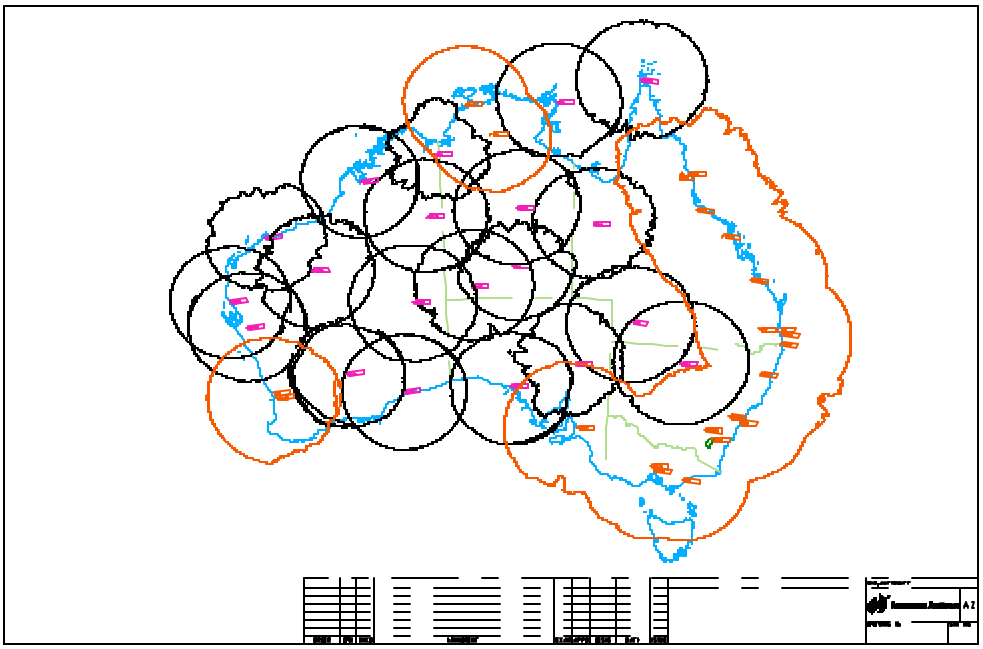

Figure 4: Proposed composite radar and ADSB coverage at FL300 after deployment of 19 ADSB sites.

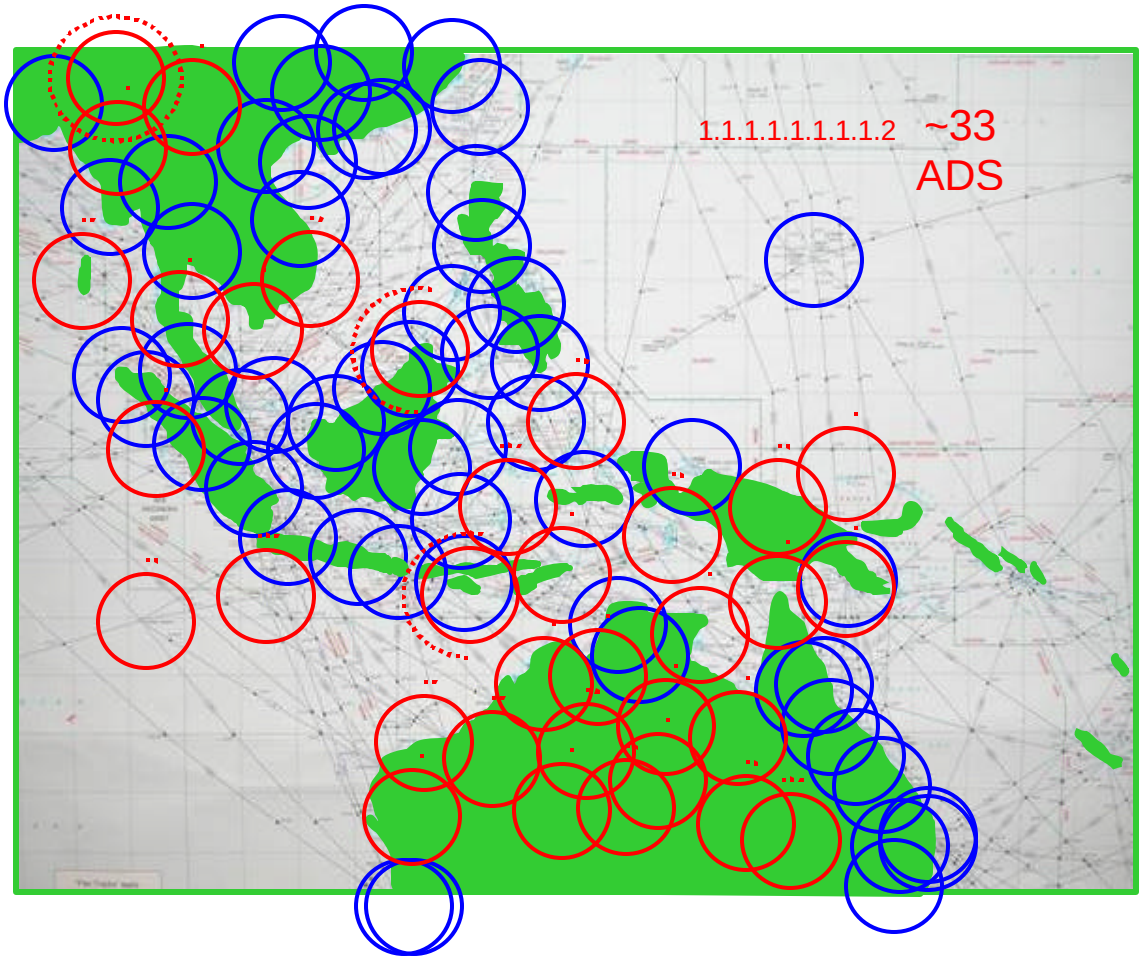

Figure 5: ADS-B Ground stations can be deployed at existing VHF sites, DME sites and data linked to appropriate ATC systems. This diagram shows the coverage that could be achieved for approximately $20M USD – substantially less than equivalent radar deployments.

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SSR-Mode S Enhanced Surveillance (EHS)

1. GENERAL

1.1 The purpose of this Circular is to present comprehensive information on the current planning of the EUROCONTROL Member States and other States in the ICAO EUR Region concerning the requirements for the airborne carriage and operation of SSR Mode S equipment and more specifically the detailed requirements for the Mode S Enhanced Surveillance functionality. It shall be read in conjunction with State regulations concerning Mode S Elementary Surveillance and ICAO Regional Supplementary Procedures Doc 7030, EUR Part 1.

1.2 Due to the rescheduling in the European Mode S programme combined with practical implementation difficulties of the aviation industry, involving supply, installation and certification of Mode S equipment , there is a need to correct the formerly published dates, taking into accounts the decisions and recommendations made by the EUROCONTROL Provisional Council.

1.3 This Circular supersedes German AICs IFR 13/98 and IFR 15/00 which provided initial information on the regulations governing the carriage and operation of SSR Mode-S transponders.

2. AIRBORNE EQUIPMENT REGULATION

2.1 The carriage and operation of Mode S airborne equipment with Enhanced Surveillance (EHS) functionality shall be mandatory within Mode S airspace designated by the appropriate ATS authorities as follows:
for all IFR flights, as General Air Traffic (GAT) with a maximum take-off mass exceeding 5,700kg, or a maximum true airspeed in excess of 250 kts with effect from 31 MAR 2005.

2.2 For the purpose of this Regulation, the Mode S Enhanced Surveillance Functionality shall constitute the data formats for Ground Initiated Comm-B (GICB) Protocols as defined in the ICAO Annex 10 Vol. III, Attachment A to Chapter 5 and the ICAO Manual of Mode S Specific Services (Doc. 9688-AN952) for:

i) BDS 60hex Heading and Speed Report
ii) BDS 50hex Track and Turn Report
iii) BDS 40hex Selected Vertical Intention

2.3 The functionality of Mode S transponders shall comply, as a minimum, with the provisions of ICAO Annex 10, especially Volume III and Volume IV, as standardised in Amendment 77 and the appropriate technical standards.

2.4 To accomplish the mandate it is not sufficient to install the appropriate Mode S transponder on board the aircraft, but it is also required to connect this transponder with the appropriate data sources on board the aircraft (e.g. as described in ARINC 718A).

2.5 In anticipation of further expansion of Mode S surveillance services, consideration needs to be given to the downlink of additional aircraft parameters for inclusion in the further development of Mode S Enhanced Surveillance. The required Mode S Level 2 transponder, as a minimum, has the ability to transmit data stored in up to 251 registers for downlink aircraft parameters (DAP) and additional DAPs which include e.g. those relating to the aircraft position, aircraft derived weather information or the aircraft trajectory are currently under evaluation. Detailed technical definitions of all these parameters as well as potential additional parameters for future use are described in the ICAO Annex 10 Vol. III, Attachment A to Chapter 5 and the ICAO Manual on Mode S Specific Services (Doc 9688).

2.6 New Mode S transponders, compliant with ICAO Annex 10 SARPS will provide also Mode S extended squitter, a technique that combines the capabilities of the SSR Mode S system with those of Automatic Dependent Surveillance-Broadcast (ADS-B). This is accomplished by broad-

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casting aircraft derived data from the aircraft to airborne or ground users to serve various future applications. Aircraft operators should note that whilst new Mode S transponders may be delivered with extended squitter functionality, future requirements for ADS-B operations in ECAC airspace, and the transmission media to be employed, have yet to be determined. Nevertheless, new Mode S transponders are expected to be able to use this technique for future applications.

3. COORDINATED POLICY AND EXEMPTION ARRANGEMENTS

3.1 The granting of exemptions from the requirements for the carriage and operation of Mode S airborne equipment have been coordinated, in accordance with the provisions of ICAO Doc 7030, in the interests of regional harmonisation. Therefore States will endeavour to comply with the exemption application principles set out below, subject to specific flight safety considerations and any significant penalty which might otherwise be incurred. Additionally, it is also planned to make every effort, within the airspace under national jurisdiction, to accommodate, in that airspace, aircraft which have been granted an exemption by another State participating in the Mode S programme. Aircraft operators who are granted exemptions should be advised that it will not be possible to provide the same level of ATM service as that applied to aircraft which comply with the Mode S Enhanced Surveillance carriage and operation requirements.

3.2 The coordinated Policy will encourage fitment of Mode S Enhanced Surveillance in aircraft whilst being realistic about the equipage time scales and the delivery of Mode S in ground systems. The principles of the coordinated policy will, where appropriate, be applied to both civil and military aircraft operators and will also take into account, and be consistent with, the Mode S Elementary Surveillance and ACAS mandates.

3.3 A transition period of 2 years (until 31 MAR 2007) has been agreed by the participating States during which the exemptions as defined below will be applied. During this 2-year period any exemption will be on a case-by-case basis and temporary in nature. Aircraft operators (private, commercial, or state/military) will be required to provide evidence that plans have been made to equip their aircraft with the relevant Mode S functionality as soon as possible. At the end of this period the coordinated exemption policies will be reviewed and redefined as necessary.

3.3.1 Exemptions will be granted only for aircraft supporting the Mode S Elementary Surveillance functionality as a minimum.

3.3.2 During the transition period, the EUROCONTROL Regulatory Unit shall manage, on behalf of those States mandating Mode S Enhanced Surveillance, a cell for the monitoring and coordination of exemptions, such as that employed for the ACAS programme, to support the exemptions process. During this period, all requests for the granting of exemptions (concerning both aircraft and service providers) shall be submitted to this Mode S EHS Exemption Coordination cell.

3.4 The following exemptions for aircraft operators (private, commercial, or state/military) have been coordinated between all participating states:

3.4.1 Exemptions will be granted to aircraft operators that can show a clear intent to equip their aircraft with the required Mode S functionality, but cannot achieve the target date March 2005 due to genuine technical issues or supply problems.

Note: 'clear intent' means that the aircraft operator will be required to provide the appropriate documents and implementation schedules together with their request for an exemption.

3.4.2 Exemptions may be granted to aircraft operators for aircraft which are equipped with Mode S transponders but where the avionics do not permit the extraction and transmission of the full set of prescribed DAPs. In his request for exemption the operator shall detail which specific parameters of the data set cannot be supported by the aircraft installation. The assessment of applications for exemptions will also take into account the estimated annual flying hours of the individual aircraft in the relevant airspace, together with the impact that non-compliance will have on the safety and capacity benefits that Mode S provides.

3.4.3 Exemptions will be granted to aircraft operators for IFR flights to occasionally operate as GAT, where a Mode S transponder with the Elementary Surveillance functionality is provided and the aircraft requires only occasional access to the Mode S airspace.

Note: In this context 'occasionally' is normally considered to be an average total flying time of 30 hours annually per airframe in the airspace subject to the mandatory carriage and operation of Mode S transponders with Enhanced Surveillance functionality. Aircraft operators should note that this figure is a guideline only and will be negotiated on a case-by-case basis.

3.4.4 Exemptions will be granted to aircraft operators for IFR flights conducted for the purposes of flight testing, delivery and for transit into and out of maintenance bases, subject to existing arrangements agreed with the appropriate authorities.

3.4.5 Exemptions will be granted to aircraft operators of older aircraft where the remaining airframe lifetime is considered to be less than 2 years from 31 MAR 2005.

4. Further information or guidance may be obtained from:

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