

## **CONSULTATION DOCUMENT**

### **PROPOSAL FOR AN INCREMENTAL EXPANSION OF THE USE OF SECONDARY SURVEILLANCE RADAR MODE SELECT TRANSPONDERS IN UK AIRSPACE**

**Version 1.0**

**31 January 2008**

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## EXECUTIVE SUMMARY

This consultation document and associated annexes set out proposals for a further expansion in the use of Secondary Surveillance Radar (SSR) Mode Select (Mode S) transponders in UK airspace, as part of the CAA's initiative to improve interoperability of aircraft with ATC radar and collision avoidance safety systems. **However, it should be noted that the proposals contained herein do not seek to take forward the previous all encompassing proposals for Mode S transponder carriage on all aircraft in all airspace.**

Levels of air traffic in the UK have grown significantly in the last three decades. This growth is set to continue and current EUROCONTROL long-term growth forecasts for Instrument Flight Rules (IFR) flight movements projects that the number of flights per year in UK airspace could increase by between 50% and 90% by 2025. This growth is highly beneficial to the nation in terms of economic prosperity, employment, tourism, exports and the social benefits of access to affordable air travel. In 2003 the Government set out in its White Paper, 'The Future of Air Transport', how it seeks to ensure that the forecast growth in air traffic can be accommodated by UK airports and the associated Air Traffic Control (ATC) system.

The 2003 White Paper also acknowledged that the benefits of traffic growth must be balanced with the environmental consequences of aircraft emissions. The Civil Aviation Authority (CAA) believes that the challenge of increasing capacity while simultaneously addressing environmental considerations and maintaining target levels of safety could be achieved through a variety of initiatives. These may include:

- More efficient handling and routing of flights within the Air Traffic Management (ATM) system;
- Greater technical interoperability of all classes of aircraft with the safety layers provided by anti-collision systems and ATC radars;
- A more modern ATC radar surveillance system;
- Measures to try and reduce numbers of airspace infringements and minimise the adverse consequences if they occur.
- Changes to controlled airspace, together with maximum efficiency in the use of controlled airspace;
- Optimal climb-out routes from airports and more direct routing of commercial aircraft between airports;
- Greater use of continuous descent approaches and less holding of commercial aircraft in the terminal phases of flight.

The consequences of these initiatives are likely to affect all airspace users in the UK to a lesser or greater extent, particularly through changes to the amount and structure of controlled airspace that may be required. Therefore, the CAA considers that greater interoperability between all categories of airspace user will be needed to protect freedom of movement and access to airspace. Moreover, the current SSR system used by air traffic control, which is the primary basis for anti-collision safety systems, needs to be updated to cope with increasing air traffic.

In March 2005, the CAA started the introduction of new SSR technology when it implemented a requirement for the use of Mode S within the very high density controlled airspace around major UK airports and along the major UK air routes. At the time of the consultation for that implementation, the CAA also stated its intention to propose further expansion of the use of Mode S into the remaining UK airspace from March 2008. However, coupled with the proposed technology update, the CAA also proposed that the number of

aircraft that are equipped with SSR technology should be increased in order to achieve improved technical interoperability and the accompanying safety benefits.

A public consultation on the proposed expansion of transponder carriage and Mode S was launched in June 2006. This resulted in a significant level of concern and opposition to the policy from the sporting and recreational flying community. As a result of the feedback from that consultation, the CAA has decided that a more gradual, phased approach to improved technical interoperability will need to be employed to address those concerns, and further consultation will be needed on some elements of the proposed policy.

Recommendations were recently sent to Government to phase out the use of the old Mode A/C transponder technology on aircraft operating in airspace where SSR transponders are currently mandatory. These have been approved and so Mode S will become the required means of compliance for transponder carriage in all the mandatory circumstances with effect from 31 March 2008. Nevertheless, operators of aircraft with existing Mode A/C installations will have until 31 March 2012 to upgrade them to Mode S if they want to continue to operate in mandatory transponder carriage airspace.

**However, the CAA has four other key priority areas in the use of SSR transponders that it considers should be adopted in the next phase of any expansion in the use of Mode S. This consultation document is being published to set out, and elicit feedback on, the following four implementation options, which could be introduced with effect from 31 March 2009 with a three-year Transition Period until 2012:**

- **Option 1: Mandate the carriage and operation of Mode S transponders on all aircraft operating within controlled airspace of classification A to E.** The aim is to create an environment where the position and altitude of all aircraft within all controlled airspace in the UK is 'known' to ATC and anti-collision safety systems. This measure would improve safety levels and the efficiency of ATC within the busiest portions of UK airspace and it is, therefore, an enabler for wider efforts to realise the significant economic benefits that were set out in 'The Future of Air Transport' White Paper. It also contributes towards improved access to controlled airspace for all users, as initial identification and subsequent maintenance of identity of all aircraft will be easier for controllers. In recognition of the particular challenges of equipping some light aircraft with SSR transponders, the existing regulatory arrangements whereby ATC units can authorise non-equipped aircraft to operate within controlled airspace, where safety and efficiency requirements would not be compromised, would remain. This would, ideally, be through standing Letters of Agreement, as it is likely that obtaining short-notice clearances will become increasingly more difficult as commercial traffic levels rise. The estimated total Present Value cost of Option 1 between 2009 and 2025 is £15.7M to £37.2M. Around 80% of these costs would be incurred by 2012.
- **Option 2: Implement a formal process to support applications for 'Transponder Mandatory Zones' (TMZs) outside of controlled airspace.** The CAA already has the regulatory authority to introduce these zones but, to date, this has been used only sparingly. However, it is considered likely that more TMZs will have to be established in the future to address pressing risks, such as airspace infringements. Therefore, the aim is to adopt and promulgate a standardised mechanism to support any applications from stakeholders for the establishment of TMZs. This will provide a clear process for applicants and stakeholders and it will ensure consistency in the rationale and evidence required to establish TMZs.
- **Option 3: Include gliders in the SSR transponder carriage regulations.** Gliders are not currently technically interoperable with ATC radars or SSR-based anti-collision safety systems. Moreover, gliding activity does not normally take place in segregated airspace. This option would improve safety levels and the efficiency of ATC within the busiest portions of UK airspace by making the transponder carriage regulations apply to all aircraft categories. This would help to enable wider efforts to realise the significant

economic benefits that were set out in 'The Future of Air Transport' White Paper. It also contributes towards improved access to controlled airspace for gliders. In recognition of the particular challenges of equipping gliders with SSR transponders, the existing regulatory arrangements whereby ATC units can authorise non-equipped aircraft to operate within controlled airspace, where safety and efficiency requirements would not be compromised, would remain. This would, ideally, be through standing Letters of Agreement, as it is likely that obtaining short-notice ATC clearances will become increasingly more difficult as commercial traffic levels rise. Moreover, based on levels of commercial and military aircraft activity, and proximity to controlled airspace, specific areas between Flight Level 100 and 195 could be designated and notified as non-mandatory transponder carriage airspace for gliding activity. The estimated total Present Value cost of Option 3 between 2009 and 2025 is £3.2M to £7M. Around 80% of these costs would be incurred by 2012.

- **Option 4: Mandate the carriage and operation of Mode S transponders on all powered aircraft conducting international flights.** The UK would need to adopt this requirement to become compliant with international standards. However, this option proposes that any implementation would need to be co-ordinated with neighbouring European States. It is considered that Option 1 above would cover the majority of aircraft impacted by Option 4 and the costs for these aircraft would be the same as for Option 1. Nevertheless, the residual number of aircraft that fly internationally but do not access controlled airspace needs to be quantified and it is hoped that the public consultation will help to provide this information.

These four options could be implemented individually or in combination with each other and any final recommendation to Government will depend on information and feedback received from stakeholders in response to this consultation. The total Present Value cost of implementing Options 1 to 4 together is currently estimated to be £19M to £44.2M between 2009 and 2025 at a discount rate of 3.5%, with most of these costs being incurred by 2012.

**The CAA would welcome feedback from interested parties on these proposals. The consultation on the four specific options ends on 31 May 2008.**

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## 1 Introduction

- 1.1 The UK Civil Aviation Authority (CAA) is conducting a consultation on the next stage of its proposals to improve the technical interoperability between different classes of aircraft operating in UK airspace. The overall policy comprises the replacement of existing Secondary Surveillance Radar (SSR) Mode A/C transponders with new Mode Select (Mode S) technology and an aspiration to widen the circumstances where aircraft have to carry and operate transponders.
- 1.2 This consultation document provides supporting information to accompany Impact Assessments on this next stage of the CAA's proposals and it invites feedback from stakeholders. Responses on the proposals can be submitted to the CAA by the following methods:
- A web-based response form is available at: <http://www.caa.co.uk/consultations>;
  - Electronic responses should be emailed to: [modesconsultation@caa.co.uk](mailto:modesconsultation@caa.co.uk);
  - Written responses should be sent to the point of contact listed in Annex L.
- 1.3 All comments should be submitted by 1700 hours on 31 May 2008. **Responses to the specific questions that are embedded within this consultation document would be particularly welcome.**

## 2 How the proposals have been revised since the 2006 interoperability consultation

- 2.1 Following the 2006 consultation on the technical interoperability of aircraft in UK airspace, the CAA is proposing a phased approach to the increase in Mode S transponder carriage. The phases have been designed to address the concerns of the General Aviation community about costs and technical challenges. A Phase 1 has now been approved by Government and it will require the use of Mode S from 31 March 2008 in all the circumstances where transponder carriage is currently required.
- 2.2 Proposed options for a Phase 2 of Mode S expansion are set out in this consultation document. These options are summarised in Section 3 below and they represent the minimum next steps that the CAA believes are essential to address key priority areas. However, consultation is being conducted to elicit information and feedback on the potential impact of these options before recommendations are made to Government.
- 2.3 **It should be noted from the outset that, unlike the 2006 consultation, this consultation on Phase 2 does not propose that all aircraft should carry Mode S transponders in all UK airspace.**

## 3 Options being considered for a proposed Mode S Phase 2 expansion

- 3.1 The overall objective of the Phase 2 proposals under this consultation is to implement an incremental expansion of the use of Mode S transponders in the UK. The following four options are proposed for consideration and feedback:
- **Option 1:** Mandate the carriage and operation of Mode S transponders on all aircraft operating within controlled airspace of classification A to E;
  - **Option 2:** Implement a formal process to support applications for 'Transponder Mandatory Zones' (TMZs) outside of controlled airspace;
  - **Option 3:** Include gliders in the SSR transponder carriage regulations;

- **Option 4:** Mandate the carriage and operation of Mode S transponders on all powered aircraft conducting international flights.
- 3.2 These four options for Phase 2, which are explained in more detail at Section 14, could be implemented individually or in combination with each other. Any final recommendation to Government will depend on information and feedback received from stakeholders in response to this consultation.
- 3.3 For transparency, a further two potential options are presented at Section 15. These options were 'Do Nothing' and 'Implement Advisory SSR Areas'. However, after consideration, the CAA has decided not to take them forward.

## 4 Why change is necessary

- 4.1 In 2003, the Government White Paper, 'The Future of Air Transport', set out an approach that provides a strategic framework for the development of air travel in the UK over the next 30 years<sup>1</sup>. It acknowledges that air travel is essential to the UK economy and continued prosperity in terms of business, tourism, exports, employment and the social benefits to UK citizens from having access to affordable air travel. A growing commercial air transport industry provides significant benefits for the whole of the UK, not just for the airlines operating commercial aircraft.
- 4.2 However, there has already been a five-fold increase in air travel over the last 3 decades, with almost a 50% growth in the number of commercial air transport movements at UK airports since 1996. This trend is forecast to continue, with the level of air traffic movements in UK airspace expected to rise by at least a further 50% by 2025 when compared to 2005 in the lowest forecast growth scenario, and by almost double in the highest forecast growth scenario<sup>2</sup>. **The currently available traffic growth data and forecasts are set out in Annex A to this document.** This growth presents considerable challenges in terms of protecting the environment, accommodating the increasing traffic levels within the UK air traffic system, and maintaining the required levels of safety.
- 4.3 The Government's 2003 White Paper also acknowledges that for any additional airport capacity to be utilised effectively, this would need to be matched by a corresponding increase in airspace capacity in the UK. The CAA considers that increased commercial demand and pressure to reduce the adverse environmental consequences of aviation can be managed through the redesign of airspace, more efficient use of airspace and the introduction of new supporting air traffic management technology. Measures will need to include an increased throughput of flights within the air traffic system, an optimisation of the 'track miles' flown by aircraft and the introduction of a more modern air traffic radar surveillance system that can cope with more densely populated airspace. Initiatives in new airspace design will need to incorporate: enhancements to all types of controlled airspace; more direct routing of aircraft between airports; less holding of aircraft in the terminal phases of flight; optimal climb-out routes from airports; and greater use of continuous descent approaches.
- 4.4 The Government is looking to the CAA to make progress in these areas with a view to a phased implementation of changes to eliminate capacity constraints and permit the

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<sup>1</sup> DfT White Paper "The Future of Air Transport", December 2003 is available at: <http://www.dft.gov.uk/about/strategy/whitepapers/air/thefutureofairtransportwhite5694>. An associated 'The Future of Air Transport Progress Report' was also subsequently published by DfT in December 2006.

<sup>2</sup> Source: EUROCONTROL Long-Term Forecast: IFR Flight Movements 2006-2025.

integration of the forecast increases in aircraft movements<sup>3</sup>. The CAA considers that a key technology enabler to help meet these challenges is the improvement of the current SSR infrastructure. This is necessary in order to be able to adequately and safely cope with more flights within UK airspace and improve interoperability between aircraft from disparate sectors, but particularly between commercial and military activity and sporting and recreational users. Improved interoperability will help to protect freedom of movement and access to airspace for all aircraft operators, it will permit efficient airspace design and use, and it will maintain or further increase safety levels as traffic levels continue to rise.

4.5 The Government also sees growth in the use of regional airports across the country as an essential element for accommodating overall air traffic demand. Since 2002, movements per year at airports outside of those located within the London terminal airspace have increased by nearly 250,000, which is an overall growth of 23%<sup>4</sup>. Some of the individual regional airports have seen growth of commercial air traffic movements of over 50% during this period. In order to accommodate continued growth at regional airports, controlled airspace might have to be established and/or extended to join up with the main UK air route structure. This may be necessary to afford appropriate protection to passenger and freight carrying aircraft and to permit more environmentally efficient flight profiles. Without greater technical interoperability between all classes of aircraft in terms of improved visibility of all aircraft to collision avoidance safety systems and Air Traffic Control (ATC) radars, non-commercial aviation activity may have to be increasingly confined to unconnected, segregated and smaller operating areas.

4.6 Figure 1 below shows the growth in the lateral, two-dimensional area of controlled airspace in the UK between 1997 and 2006 (i.e. does not take height into account), which was reported in the 'Strategic Review of General Aviation' in 2006. The figure shows a 68% overall increase of controlled airspace since 1997, most of which is in the London Flight Information Region (FIR). In 1997, around 13% (by area) of the UK FIR was controlled airspace and this had risen to 22% by 2006. During this same period there was a 50% growth in commercial air transport movements at UK airports. As commercial air traffic is forecast to grow by at least a further 50% by 2025 compared to 2005, the CAA considers that greater interoperability, rather than increased segregation, will best serve the interests of all airspace users for protecting freedom of movement, and it would facilitate a more efficient overall design and use of UK airspace structures. Furthermore, in this regard the CAA is charged by Government under the Transport Act 2000 to:

- Secure the most efficient use of airspace consistent with the safe operation of aircraft and the expeditious flow of air traffic;
- Satisfy the requirements of operators and owners of all classes of aircraft;
- Take account of the interests of any person (other than an operator or owner of an aircraft) in relation to the use of any particular airspace or the use of airspace generally.

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<sup>3</sup> "The Future of Air Transport" White Paper, Paragraph 12.26.

<sup>4</sup> Source: CAA UK Airport Statistics available on the CAA website at <http://www.caa.co.uk/default.aspx?categoryid=80&pagetype=88&pageid=3&sglid=3>

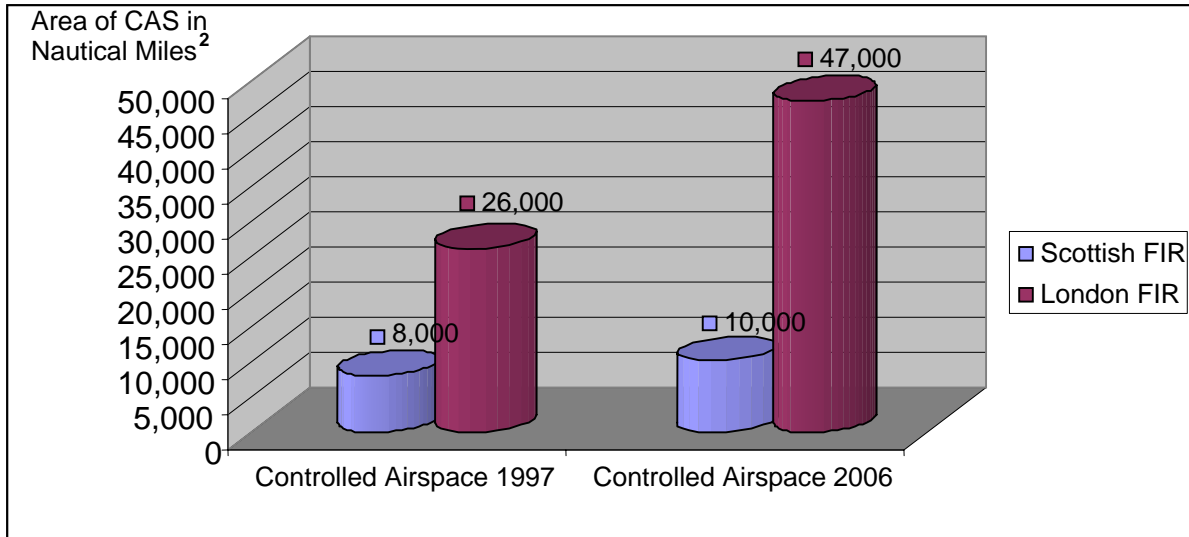


Figure 1: Growth of Controlled Airspace 1997-2006

## 5 How safe separation of aircraft is achieved in UK airspace

- 5.1 In order to prevent collisions between aircraft operating **in controlled airspace**, a number of systems and procedures are employed, which form a set of 'layered safety barriers'. Firstly, ATC rules and procedures are used, which normally involve controllers observing the positions and heights of aircraft on radar displays, and then providing instructions to aircraft under their control to separate them from conflicting traffic. If these procedures break down, a second layer of safety can be provided by conflict alert tools, which use radar information to automatically warn controllers of potential collisions. If this layer fails, a third comes into play that relies on 'last ditch' electronic collision avoidance systems fitted to aircraft, known as Traffic Alert and Collision Avoidance Systems (TCAS). If a potential collision is still not detected, then providence comes into play.
- 5.2 The first three safety 'barriers' generally rely on SSR systems to provide the relevant position and height information of aircraft and, consequently, rely on aircraft being equipped with SSR transponders. Where aircraft are not equipped with transponders and ATC procedures break down, there are no further safety barriers preventing a collision. Therefore, there would be immediate safety improvements from this layered approach if all aircraft within controlled airspace carried SSR transponders.
- 5.3 **Outside of controlled airspace**, the main method of aircraft separation is known as 'See and Avoid', which relies on pilots detecting conflicts visually. However, the layered approach can still apply in areas where some form of Air Traffic Service is being provided; for example, the Lower Airspace Radar Service (LARS). Many military units and some civil units also provide what is currently termed Air Traffic Services Outside of Controlled Airspace (ATSOCAS). In a mixed civil and military environment, with high performance aircraft (such as military fast jets and civil airliners) and low performance aircraft (such as gliders, microlights), 'See and Avoid' is not always effective in encounters between these disparate groups. Therefore, passenger carrying commercial air traffic operates primarily within controlled airspace to ensure that safety levels can be maintained to the maximum extent possible using the layered approach.

## 6 Why the existing SSR infrastructure needs to be replaced

- 6.1 The major anti-collision safety layers employing ATC radars, ground-based conflict alert tools and airborne collision avoidance systems, share a common, baseline technology, known as SSR. Conventional Mode A/C SSR has served the aviation industry well but, over the last three decades, the significant increase in traffic levels within UK and core European airspace has highlighted the inherent limitations of this outdated technology and has stretched the capacity and capability of the system to its limits. In particular, it is prone to interference, especially where many aircraft are operating in the same volume of airspace. **A more detailed explanation of the problems associated with existing Mode A/C technology is at Annex B to this document.**
- 6.2 Unless a more advanced system is introduced in the near future, the current SSR system will become unacceptably overloaded. Traffic growth cannot continue to be safely sustained, inside or outside of controlled airspace, using this old technology. Increasingly, the information displayed on ATC radar screens will be compromised leading to increased controller workload, meaning that less traffic can be handled. Furthermore, as traffic levels increase, SSR-based collision avoidance systems will be degraded due to radio frequency congestion.
- 6.3 If the SSR system is not replaced, levels of safety could only be assured by artificially limiting the capacity of the ATC system. Such a measure would have serious economic consequences both at a national and regional level. NATS, the UK's primary ATC provider, has recognised this problem and is committed to a programme for replacing all its conventional Mode A/C systems throughout the UK with Mode S radars by 2012; many of these new radars are now operational.

## 7 Why Mode S is the best solution to replace Mode A/C

- 7.1 Mode S takes conventional SSR to new levels of effectiveness and it is already in widespread use within Europe. It is an evolutionary improvement on conventional SSR and provides the necessary improved surveillance capability and capacity to handle future levels of air traffic. It significantly reduces or eliminates all the problems with conventional Mode A/C. Mode S uses the radio frequency spectrum much more efficiently and reduces the risk of interference. This reduced radio frequency congestion enables more aircraft to be handled by the radar. Consequently, Mode S is an enabler for increased capacity and reduced delays by helping to maintain or improve current levels of safety.
- 7.2 Mode S is also fully backwards compatible with conventional SSR and is fully interoperable with the current safety layers described in Section 5 above. This allows for a safe and gradual transition from conventional SSR to a complete Mode S environment. **A more detailed explanation of Mode S is at Annex C to this document.**

## 8 Why the CAA wants more aircraft to carry SSR transponders

- 8.1 The CAA considers that its overall aspiration of maximising the carriage of Mode S transponders in UK airspace is necessary to improve the opportunities for air traffic radar systems and anti-collision systems to detect more aircraft and help decrease collision risks. This is based on ensuring all layers of the safety 'barrier' approach explained in Section 5 above can be employed in controlled airspace, and, also, in other airspace where specific risks need to be addressed. Carriage of SSR transponders by all aircraft also increases the opportunities to allow aircraft from

different sectors, commercial and recreational, to share airspace rather than having to keep them segregated, thereby optimising airspace efficiency.

- 8.2 Currently, unless aircraft are equipped with a suitable SSR transponder that provides information on the height of the aircraft, ATC SSR radar systems, ground-based conflict alert and airborne collision avoidance systems are effectively 'blind' to the presence of these aircraft. Maximum safety benefits from such systems can, therefore, only be achieved if aircraft are equipped with SSR transponders that provide height data. For the reasons mentioned in Sections 6 and 7 above, any increase in the use of transponders will need to be based on Mode S technology and not conventional Mode A/C.

## **9 Why the General Aviation sector needs to be included**

- 9.1 The General Aviation sector is diverse, covering a wide range of activities. The sector includes recreational and sporting activity, personal transport and business aviation. General Aviation operations vary from balloons, gliders, hang gliders, microlights, gyroplanes and small helicopters, up to corporate jets. Between these extremes are many variants of light aircraft, including amateur-built aeroplanes, mass-produced touring aircraft and ex-military aircraft.

- 9.2 Of the 27,000 aircraft on the UK register, around 96% are assessed to be within the General Aviation sector. The 2006 'Strategic Review of General Aviation' noted that General Aviation activity is currently finding it increasingly difficult to access airspace. Of particular relevance to these proposals are the following extracts from the report of the Review:

*"Increases in controlled airspace can limit the GA sector's freedom to fly where it chooses. Some increase in controlled airspace is inevitable in order to accommodate a greater density of traffic safely within the airspace system, and the economic value of CAT and the associated public benefit make it desirable that CAT operations be facilitated. However, all stakeholders should strive for an outcome that allows all users to enjoy the maximum use of airspace consistent with safe operation."*

*"GA makes use of all types of airspace, and can under certain conditions transit through controlled airspace. However, GA mainly uses uncontrolled airspace, and the biggest airspace issue is the extent to which controlled airspace is growing at the expense of uncontrolled."*

*"Gliders face particular issues in transiting to higher altitudes for soaring. Microlights and amateur-built aircraft have the additional problem of planning their flights to avoid flying over built-up areas."*

*"The increasing demand for more CAS to protect the operation of large passenger aircraft, and the decline in unfettered access for GA users is unwelcome, from the perspective of GA and some other airspace users. From the opposing perspective, however, the protection offered by CAS and a 'known' air traffic environment is considered essential for the safe operation of commercial passenger aircraft and mixing operations with other users is considered undesirable, even untenable. Currently, great concern is being expressed in the aviation industry, and particularly by the air traffic management elements within it, about the increases in numbers of commercial air transport (CAT) flights from airports not protected by CAS and not connected to the air route structure. Technological advances may help address concerns surrounding CAT operations in uncontrolled airspace. The CAA is working closely with all users and providers to address the concerns raised by these operations, and their interaction with both military and GA activity, to ensure that the UK's excellent flight safety record is maintained."*

- 9.3 The impact of the CAA's proposals for this consultation is complex. The proposals are based around an expansion in the use of existing technology to improve safety and to facilitate access to airspace for all users, which are highly relevant to the issues highlighted above. However, it is clear that the cost and regulatory burden for aircraft equipage will fall chiefly on businesses, charities, voluntary organisations and private individuals within, and associated with, the General Aviation sector. Comments received during the 2006 interoperability consultation revealed that the vast majority of sporting and recreational respondents did not accept that they would realise significant improvements to safety and access to airspace from increased Mode S transponder carriage, or they considered that the degree to which the benefits would be realised did not justify the regulatory and cost burden that would be imposed on the sector.
- 9.4 The CAA understands that there are genuine difficulties with fitting transponders to some light aircraft and gliders due to issues with limited space, power generation, antenna placement, weight limits and the proportionality of costs. **The CAA will continue to work with the General Aviation community, primarily through ongoing liaison with the representative associations, to help identify measures to accommodate these aircraft and maximise their freedom of movement without compromising the overall safety and efficiency benefits that are required by 'The Future of Air Transport' White Paper and that these proposals seek to support.**

## 10 Related research that has been undertaken

- 10.1 Ongoing assessment of the current and predicted future interference levels on the SSR radio frequency environment is conducted under the auspices of the 'National Identification Friend or Foe (IFF)/SSR Committee'. **A summary of the most recently available computer modelling results conducted to support the CAA's interoperability proposals are at Annex D to this document.** This modelling has considered the effects on TCAS and ground radar performance. Overall, the CAA is content that the results of this modelling were as expected and they raise no issues that indicate increased carriage of Mode S transponders would be intolerable.
- 10.2 Relevant trials have also been conducted in France to assess the performance of TCAS when encountering 'clusters' of aircraft. **A summary of these trials is also at Annex D to this document.** Overall, it was considered that the trials involving Mode S transponders were successful and proved the worth of fitting them to light aircraft.
- 10.3 The Health Protection Agency has published a report<sup>5</sup> on the potential radiological effects of Mode S transponders entitled 'Exposure to EMFs from Lightweight Aviation Transponders'. A generic computer model of an 80 Watt transponder with typical antenna was developed for the study. Results showed that for a typical worst case duty cycle, the International Commission on Non-Ionizing Radiation Protection public exposure reference levels were not exceeded outside a separation distance of 5.4 cm from the human body. The CAA is satisfied that the results of this independent study address the main concerns raised by stakeholders during the 2006 interoperability consultation. The report was funded by the CAA and can be viewed at:  
[http://www.hpa.org.uk/radiation/publications/hpa\\_rpd\\_reports/2007/hpa\\_rpd\\_031.htm](http://www.hpa.org.uk/radiation/publications/hpa_rpd_reports/2007/hpa_rpd_031.htm)  
It provides details on the technical aspects of Mode S transponders, information on the various guidelines and technical standards relating to exposure to non-ionizing

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<sup>5</sup> Reference: HPA-RPD-031 (ISBN 978-0-85951-605-1).

radiation, field strength calculations for a generic transponder model and a review of the literature on localised specific absorption rate.

- 10.4 The CAA is also currently conducting other studies on related issues, such as:
- SSR antenna design and siting;
  - SSR transponder power and range;
  - Projected effects of traffic growth on the SSR radio frequency environment;
  - Effects of military systems that share the SSR radio frequency environment.

## **11 Why a different technology solution for General Aviation would not be suitable**

- 11.1 There was a common view in many responses to the 2006 interoperability consultation, and in recent impact assessment workshops with the main General Aviation representative associations, that light aircraft should be equipped with different technology to commercial aircraft, which was less costly and based on satellite positioning signals. The position taken was that Mode S was disproportionately expensive for the benefits that private pilots would gain and it was not technically suitable for many aircraft without an engine driven electrical system capable of continuously powering a transponder.
- 11.2 Satellite based air traffic surveillance technology does not require radars on the ground to interrogate aircraft transponders, and there are plans to introduce it in Australia and the USA for General Aviation aircraft in the form of 'Automatic Dependent Surveillance – Broadcast' (ADS-B) from around 2014 to 2020. It should be noted that the Federal Aviation Administration consultation document for ADS-B states: *"Implementation of an ADS-B system would not completely replace the primary radar or SSR at this time. In addition, ADS-B does not replace the requirement for transponders. Transponders are still necessary for SSR, which is the FAA's backup strategy in case of ADS-B failure."*
- 11.3 There are currently no firm plans for any widespread European implementation of ADS-B but it is included as a pillar in the European air traffic surveillance roadmap. Furthermore, the TCAS conflict avoidance algorithms will not interact with aircraft that are only equipped with ADS-B technology, because it needs to independently interrogate 'threat' aircraft. The CAA believes that it would take many years for an ADS-B only solution for General Aviation aircraft to be fully interoperable with the required safety 'barriers' described in Section 5 above. The CAA needs to resolve interoperability issues in a much shorter timeframe to manage traffic growth, while balancing environmental requirements and preserving freedom of movement for recreational flyers. Furthermore, the current cost of implementing ADS-B in General Aviation aircraft in Australia<sup>6</sup> and the USA<sup>7</sup> appears to be broadly comparable with the cost of installing available Mode S transponder products.
- 11.4 Mode S transponder products can now be purchased with a built-in capability to transmit ADS-B data via the Mode S reply frequency. This is known as the 1090 MHz 'Extended Squitter' (1090ES) capability. The CAA strongly recommends that light aircraft operators consider purchasing Mode S transponders that also have an

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<sup>6</sup> Australian Joint Consultation Paper on ADS-B, July 2007, states: "Provision of ADS-B OUT capability, including installation, is expected to cost less than \$10,000 for a typical GA VFR aircraft. Provision of ADS-B OUT and 'solemeans' GNSS navigation, including installation, is expected to cost less than \$15,000 for a typical GA IFR aircraft."

<sup>7</sup> FAA NPRM, Docket No. FAA-2007-29305; [Notice No. 07-15], states that aircraft unit costs for General Aviation aircraft, including equipment and installation, will be between \$4,238 and \$17,283.

approved<sup>8</sup> '1090ES' capability, as it should allow for the aircraft to be more easily upgraded to work with the currently foreseen European ADS-B applications.

11.5 Satellite positioning is also used as supporting technology for a commercial collision warning product, known as 'FLARM', which has been designed specifically for use by gliders. FLARM is becoming a popular commercial product in some other European States, Australia and South Africa to reduce the risk of collisions between equipped gliders. There is a view in the General Aviation community that this technology could be adapted for widespread use by light aircraft in UK airspace to overcome the lack of interoperability between General Aviation aircraft and commercial air transport. However, the CAA believes that a number of significant issues would arise from trying to use this technology as a generic collision avoidance system. These include:

- Range performance limitations;
- Use of unregulated radio spectrum;
- Lack of international standards and certification material;
- Effectiveness against high speed aircraft and multiple threats;
- Inability to independently interrogate threat aircraft to obtain relative positions;
- Unlike TCAS II, the system was designed primarily to enhance 'See and Avoid' rather than provide a last ditch collision avoidance system.

## 12 Assessment of Risks

12.1 Over the last 4 decades, a number of reports have been produced that try to assess the risk of mid-air collision and the benefits of TCAS in reducing this risk. These reports identify the difficulties of determining accurate estimates of actual safety levels, together with the broad and questionable assumptions that have to be made where actual numbers of collisions are historically low. They also acknowledge the challenges of accurately quantifying the beneficial effect that safety barriers, such as controller actions, automatic conflict alert tools and airborne collision avoidance systems, have on reducing the risk of collision.

12.2 However, a consistent theme of the available literature surrounds the positive net safety benefit of TCAS and associated SSR transponder carriage. To date, the CAA has not found any reports that contradict this view. The studies examined have generally focussed on the proportional reduction in risk where TCAS is present rather than on absolute changes to actual levels of safety being achieved. In particular, work by QinetiQ Ltd<sup>9</sup> and Professor Peter Brooker of Cranfield University<sup>10</sup> has been noted by the CAA in developing its interoperability proposals. Although the context of some of these studies is not always directly related to the scenarios covered by this consultation document, they do provide useful summaries of the challenges and issues involved in assessing the benefits of transponder carriage.

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<sup>8</sup> The transponders must currently be approved in accordance with European Technical Standard Order (ETSO)-2C112b.

<sup>9</sup> QinetiQ 'ACAS Safety Studies', 4 Feb 2004. Available at <http://www.eurocontrol.int/msa/gallery/content/public/documents/Safety/ACAS%20Safety%20Studies.pdf>.

<sup>10</sup> 'Future Air Traffic Management: Quantitative En Route Safety Assessment Part 2 – New Approaches', Peter Brooker, The Journal of Navigation (2002), 55, 363-379 and 'The Risk of Mid-Air Collision to Commercial Air Transport Aircraft Receiving a Radar Advisory Service in Class F/G Airspace', Peter Brooker, The Journal of Navigation (2003), 56, 277-289.

- 12.3 In terms of the interoperability proposals discussed in this consultation document, the CAA considers that broad assumptions in the following areas up to at least 2025 would need to be made in order to attempt to produce related Risk Assessments:
- Future commercial air traffic growth;
  - Future flight profiles of commercial aircraft;
  - Future airspace design;
  - Degree of effectiveness of different collision avoidance safety layers in given scenarios;
  - Future General Aviation aircraft activity levels and profiles;
  - Potential effects of other, related and unrelated safety initiatives.
- 12.4 Logic dictates that increased opportunities for ATC radars, automatic conflict alert tools and airborne collision avoidance systems to detect aircraft in a given volume of airspace must result in a reduced risk of collisions; and this is entirely consistent with the studies discussed above. However, due to the need for the aforementioned broad assumptions, any numerical estimates of the degree to which actual risk would be reduced in future scenarios of increased transponder carriage may not be sufficiently reliable for use in meaningful Cost Benefit Analyses.
- 12.5 The CAA is not convinced that the historical low rate of actual mid-air collisions between General Aviation aircraft and commercial or military aircraft justifies maintaining the status quo in the face of future traffic growth. The CAA must also consider and, where appropriate, act upon relevant reports and recommendations from bodies such as the Air Accident Investigation Branch (AAIB) and the UK Airprox Board (UKAB). **Some recent examples of discussions, comments and recommendations from these bodies on the use of SSR transponders are included at Annex E to this document.** Moreover, the UKAB has previously advised the CAA that it fully supports the proposals to mandate the equipage of Mode S transponders on all aircraft operating in the UK FIR to the maximum extent possible as permitted by available technology.
- 12.6 Given the obligations placed on the CAA by the Government in Ministerial Directions and in 'The Future of Air Transport' White Paper, and mindful of the current and forecast widespread use of ATC radars, conflict alert tools and airborne collision avoidance systems, the CAA considers that opportunities to reduce collision risks by improving the 'electronic visibility' of aircraft to the various aforementioned safety barriers should be maximised. Furthermore, when assessing risk, consideration must be given to the 'impact' as well the 'probability' of an event occurring. A single fatal collision between a recreational aircraft and an airliner could undermine public confidence in aviation significantly. Such an incident may have far reaching ramifications in terms of access to airspace for all users and the subsequent efficiency of the Air Traffic Management system.

### **13 How Mode S has been introduced in the UK to date**

- 13.1 In March 2005, new Mode S transponder technology was mandated on aircraft operating within the very high traffic density controlled airspace around major UK airports and along the major UK air routes. Mode S has now been introduced successfully by NATS in the airspace surrounding the major London airports; and the use of Mode S should be expanded to the Manchester and Scottish major terminal areas by 2009. As a result of this initial implementation, around 94% of aircraft on the UK register having a maximum take-off mass of 5,700 kg or greater are now equipped with Mode S transponders.

13.2 At the time of the consultation for this initial implementation of Mode S, the CAA also stated its intention to propose a further expansion of the use of the system on aircraft operating in the remaining UK airspace from March 2008. That proposal was then subject to a public consultation and Partial Regulatory Impact Assessment process during 2006. As a result of the analysis of the responses received during the 2006 consultation, the Government has now approved a CAA proposal that, from 31 March 2008, the use of Mode S should replace Mode A/C transponders in all circumstances where their use is currently mandatory. This was considered to be the minimum next step that should be taken towards phasing out the use of conventional Mode A/C in UK airspace and sought to take into account the majority of the concerns raised during the public consultation by private pilots. A transition period until 31 March 2012 is being provided to permit time for owners of affected aircraft to have them upgraded to Mode S capability. **Voluntary carriage of transponders remains unaffected by the new Mode S regulations.**

## 14 Proposed options to further extend Mode S transponder carriage

### 14.1 Option 1 – Mandatory Transponder Carriage Within All Controlled Airspace

14.1.1 Aircraft operating under Visual Flight Rules (VFR) within controlled airspace below Flight Level 100 do not currently need to carry and operate an SSR transponder. In terms of interoperability with commercial traffic and ATC, these flights are effectively 'invisible' to TCAS and the ground-based conflict alert systems. Furthermore, visibility of these flights to controllers relies on detection by Primary Surveillance Radars, which can be problematic with very light aircraft that have a small 'radar cross section' because these radar systems rely on radio energy reflecting off aircraft and being received back at the radar.

14.1.2 Even where aircraft are detected using Primary Surveillance Radars, the situational awareness of controllers is reduced compared to SSR because aircraft identity and altitude information is not provided and cannot, therefore, be displayed on ATC workstations. This absence of data increases controller workload when trying to maintain three-dimensional situational awareness about all aircraft operating within the controlled airspace, and it can make the sequencing and separation of aircraft under their control much less efficient. Many VFR pilots also frequently report difficulty in gaining clearance to access controlled airspace and in obtaining Air Traffic Services when they are not providing SSR data from transponders. This is generally due to the high controller workload involved in handling non-transponder equipped aircraft.

14.1.3 A proposed option is to introduce a regulatory requirement for all aircraft operating under VFR within controlled airspace (classification A to E) to carry a Mode S transponder capable of providing a minimum of Elementary Surveillance<sup>11</sup>. The aim will be to create an environment where the position and altitude of all aircraft within all controlled airspace in the UK is 'known'. The CAA considers that this option is not dependent on the availability of a Low Power SSR Transponder (LPST) but recognises that the equipage of some light aircraft with ICAO compliant transponders still presents challenges, particularly with regard to installation, electrical supply and cost proportionality. Therefore, the CAA will continue in its efforts to support the development of low cost, low power transponders in Europe. However, under existing regulatory provisions non-transponder equipped aircraft could still be able to access controlled airspace if authorised by a responsible ATC unit. This authorisation could be in the form of a standing Letter of Agreement (LoA) or via specially agreed and

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<sup>11</sup> More information on Mode S Elementary Surveillance is provided in Annex C to this consultation document.

notified transit routes/corridors. Exceptionally, temporary ATC clearances to access controlled airspace without a Mode S transponder could also still be sought under existing arrangements. However, short-notice clearances of this nature are likely to become increasingly more difficult as commercial traffic levels rise.

14.1.4 A summary of the benefits and costs (see Annex F to this document for the detailed cost calculations) of Option 1 are set out in Table 1 below.

<u>Benefits and Advantages:</u>	<u>Costs and Disadvantages:</u>
<ul style="list-style-type: none"> <li>• Increases the number of aircraft that are electronically visible to airborne and ground-based collision avoidance systems operating within and in support of controlled airspace. This will improve safety levels.</li> <li>• Provides ATC with improved 3D situational awareness through the creation of 'known' traffic environments in controlled airspace volumes. This will improve safety and efficiency of ATC.</li> <li>• Contributes towards the aim to accommodate the predicted growth in air traffic movements, thus helping to realise the significant economic benefits of air travel that were set out in 'The Future of Air Transport' White Paper.</li> <li>• Contributes towards improved access to controlled airspace for all users, as initial identification and subsequent maintenance of identity of all aircraft will be easier for controllers.</li> </ul>	<ul style="list-style-type: none"> <li>• Estimated average one-off equipage costs between 2009 and 2012 of £4.2M to £11M per year.</li> <li>• Estimated average on-going cost between 2009 and 2025 of £259K to £421K per year.</li> <li>• Estimated total Present Value cost between 2009 and 2025 of £15.7M to £37.2M at a discount rate of 3.5%.</li> <li>• Cost impact falls on the General Aviation community, particularly private pilots.</li> <li>• Larger businesses may be able to absorb the policy costs easier than SMEs.</li> </ul>

**Table 1: Summary of the Benefits and Costs of Option 1**

**[Q1: What other advantages and disadvantages could there be under Option 1 if all aircraft operating within controlled airspace used SSR?]**

**[Q2: Has the cost impact of Option 1 been accurately estimated? When considering your response, please provide supporting data where available.]**

**[Q3: What would be the impact of Option 1 on small businesses? When considering your response, please provide supporting data where available.]**

## 14.2 Option 2 – Implement a Formal Process to Establish Transponder Mandatory Zones

14.2.1 The CAA has existing regulatory powers to establish TMZs, which effectively allow specific, notified volumes of airspace to be created where all aircraft have to carry and operate SSR transponders. These would be in addition to the general SSR carriage regulations. To date, these powers have been used sparingly and the only current TMZ in the UK is in the Scottish TMA between 6,000 feet (altitude) and Flight Level 100. TMZs have started to be introduced in Germany and The Netherlands, and in the USA they are known as 'Mode C veils'.

14.2.2 The aim of this option is to put in place a formal mechanism for processing applications to establish TMZs. Current CAA thinking is that the process should be a subset of the existing Airspace Change Process that is set out in the Airspace Charter<sup>12</sup> and in CAA Publication (CAP) 725. However, it is considered that the elements of the ACP relevant to TMZ establishment would need to be scaleable to ensure that the burden on applicants is not disproportionate. It is intended that once a

<sup>12</sup> CAA Publication 724, Appendix F.

process has been developed and promulgated, it would be effective immediately. In the interim, in the interests of safety and efficiency, it is recognised that applications for TMZs will still need to be considered by the CAA under existing arrangements. **It should be noted that no specific TMZs are being proposed as part of this consultation. The CAA just wishes to seek the views of stakeholders on what overall future mechanism should be used to process applications for TMZs.**

14.2.3 TMZ applicants would need to consider and make provision for the needs of all airspace users affected by a proposed TMZ. TMZ applicants would also need to provide all appropriate supporting material prior to commencing consultation, and they would be expected to hold consultation meetings at locations that are mutually convenient to all parties. Where possible, the CAA would also seek to ensure that TMZ applicants take reasonable steps to minimise the overall burden and workload on affected parties. **Further details on the issues surrounding a process to establish TMZs are set out in Annex G to this document.**

14.2.4 A summary of the advantages and disadvantages of Option 2 are set out in Table 2 below.

<b><u>Benefits and Advantages:</u></b>	<b><u>Costs and Disadvantages:</u></b>
<ul style="list-style-type: none"> <li>• Provides a formal process to support existing regulation.</li> <li>• Allows the CAA to ‘fast-track’ urgent implementations to address pressing safety risks.</li> <li>• Process could utilise an established and proven airspace change mechanism as its basis.</li> <li>• Provides a clear process for applicants and stakeholders.</li> <li>• Will ensure consistency in the rationale and evidence required to establish TMZs.</li> <li>• Provides a transparent mechanism for addressing specific safety and airspace efficiency risks, such as airspace infringements (<b>see Annex H to this document</b>).</li> <li>• Robust requirements for applicants will ensure that TMZ applications will be minimised to only those absolutely necessary.</li> <li>• Applications can be considered on a case-by-case basis rather than having to apply inflexible criteria.</li> <li>• Ensures that the impact of specific TMZs will be assessed rigorously.</li> <li>• Workload for consultees will be minimised as far as practicable.</li> </ul>	<ul style="list-style-type: none"> <li>• Consultation workload and expense for stakeholders, particularly General Aviation organisations.</li> <li>• Workload and expense for applicants, particularly NATS and independent airport operators.</li> <li>• Burden may deter applications that could realise important benefits.</li> <li>• Cumulative workload from multiple simultaneous applications may prove difficult to manage.</li> <li>• De-confliction and co-ordination of multiple simultaneous applications may not be possible where risks urgently need to be overcome.</li> </ul>

**Table 2: Summary of the Benefits and Costs of Option 2**

***[Q4: What other issues should be taken into account within a mechanism to process and consider applications for TMZs?]***

***[Q5: What could be the cost to businesses and General Aviation representative associations of participating in a process for considering the establishment of a TMZ? When considering your response, please provide supporting data where available.]***

### **14.3 Option 3 – Include Gliders in all SSR Transponder Carriage Regulations**

- 14.3.1 Under present legislation, gliders are only required to carry and operate an SSR transponder when flying above Flight Level 195 outside of 'Temporary Reserved Airspace for Gliders', known as TRA(G). Consequently, gliders are not currently interoperable with ATC radars or anti-collision safety systems, and collision risk mitigation is not generally provided through segregation of gliding activity. However, some high volume gliding activity is notified.
- 14.3.2 In terms of interoperability with other airspace users, gliders and other non-powered aircraft have different flight profiles and limited electrical capacity compared to powered aircraft. The flight profiles of non-powered aircraft are particularly dependent on local meteorological conditions and topography. The performance and capability of gliders, from an ATC and aircraft separation viewpoint, is also very different than for other General Aviation activity.
- 14.3.3 To date, the main collision risk for gliders in the UK is with other gliders, mainly because of the need to turn in thermals, often in close proximity to other gliders. The gliding community considers this to be a much bigger priority that needs to be addressed by the CAA. While the CAA accepts that the collision risk in this scenario is historically greater, the effect of a 'glider-on-glider' collision on public confidence in aviation and the requirements of the 'The Future of Air Transport' White Paper is much less than the adverse consequences that would ensue from a glider collision with an airliner. Moreover, as UK airspace becomes busier and commercial aircraft need to reduce 'track miles', it is possible that collision risks between gliders and commercial aircraft could increase unless gliding activity is increasingly segregated or technical interoperability is improved. These proposals are specifically aimed at supporting the requirements of the 2003 White Paper and the 'glider-on-glider' collision risk will need to be addressed through other measures. To this end, the CAA has been assisting the gliding community with efforts to arrange for the UK radio regulations to permit the 'FLARM' system to use the radio spectrum in which it operates.
- 14.3.4 The CAA considers that this option is not dependent on the availability of a Low Power SSR Transponder (LPST). However, the CAA recognises that the equipage of gliders with ICAO compliant transponders still presents challenges, particularly with regard to installation, electrical supply and cost proportionality. Nevertheless, the CAA has been informed by other aviation regulators that gliders are now being equipped with Mode S transponders in other European States, particularly in Germany where the transponder is often only operated when crossing areas of airspace where its use is mandatory. Also, under existing regulatory provisions, the use of specific arrangements could provide means for enabling access to some volumes of mandatory transponder carriage airspace where the risks of non-detection by safety systems can be mitigated. These arrangements can include: LoAs with ATC units to set up standing clearances to access controlled airspace; and/or specifically agreed and notified non-transponder transit corridors/routes in controlled airspace and TMZs. Exceptionally, temporary ATC clearances to access controlled airspace without a Mode S transponder could also still be sought. However, short-notice clearances of this nature are likely to become increasingly more difficult as commercial traffic levels rise.
- 14.3.5 Moreover, specific areas of airspace between Flight Level 100 and 195 could, potentially, be identified as 'non-transponder airspace' for gliding activity. These areas would need to be determined on the basis of levels of commercial and military aircraft activity, and proximity to controlled airspace. Additionally, connectivity to TRA(G)s will need to be taken into account. The CAA would work with the British Gliding Association to identify what volumes of airspace could feasibly be included

within this principle. Furthermore, organised events, such as competitions, could be managed through existing alternative airspace management arrangements, if required, to provide parity for all participants in terms of available routings.

- 14.3.6 Therefore, as an initial step towards improving the interoperability of gliding activity with other airspace users and ATC surveillance systems, a regulatory option is proposed to extend the general SSR transponder carriage regulatory requirements to gliders unless they are otherwise authorised by responsible ATC units.
- 14.3.7 A summary of the benefits and costs (**see Annex F to this document for the detailed cost calculations**) of Option 3 are set out in Table 3 below.

<b><u>Benefits and Advantages:</u></b>	<b><u>Costs and Disadvantages:</u></b>
<ul style="list-style-type: none"> <li>• Ensures all gliders are electronically visible to airborne and ground-based collision avoidance safety systems operating within and in support of mandatory transponder carriage airspace. This will improve safety levels.</li> <li>• Provides ATC with improved 3D situational awareness through the creation of 'known' traffic environments in mandatory transponder carriage airspace volumes. This will improve safety and efficiency of ATC.</li> <li>• Contributes towards the aim to accommodate the predicted growth in air traffic movements, thus helping to realise the significant economic benefits of air travel that were set out in 'The Future of Air Transport' White Paper.</li> <li>• Contributes towards improved access to controlled airspace for gliders, as initial identification and subsequent maintenance of identity of all aircraft will be easier for controllers.</li> <li>• Allows flexibility for non-equipped gliders to enter controlled airspace when ATC units can safely accommodate them without unduly affecting other airspace users.</li> <li>• Potential mitigations could be used to address the non-uniform risk of gliding activity across UK airspace.</li> </ul>	<ul style="list-style-type: none"> <li>• Estimated average one-off equipage costs between 2009 and 2012 of £771K to £1.85M per year.</li> <li>• Estimated average on-going cost between 2009 and 2025 of £75.8K to £123K per year.</li> <li>• Estimated total Present Value cost between 2009 and 2025 of £3.2M to £7M at a discount rate of 3.5%.</li> <li>• Larger gliding related businesses and clubs may be able to absorb the policy costs easier than smaller ones, which could be financially vulnerable.</li> <li>• Cumulative burden (with other UK and European aviation regulations) may reduce the accessibility of gliding and adversely affect the viability of gliding clubs and private owners, particularly where the cost of equipage is a significant proportion of the value of the glider.</li> <li>• May not be possible to negotiate ATC authorisation for non-equipped gliders in many airspace volumes.</li> </ul>

**Table 3: Summary of the Benefits and Costs of Option 3**

**[Q6: What other advantages and disadvantages could arise if gliders were brought within the SSR transponder carriage regulations?]**

**[Q7: Has the cost impact of Option 3 been accurately estimated? When considering your response, please provide supporting data where available.]**

**[Q8: What would be the impact of Option 3 on small businesses? When considering your response, please provide supporting data where available.]**

#### **14.4 Option 4 - Meet International Obligations on SSR Transponder Carriage**

14.4.1 The UK is a contracting signatory to the Convention on International Civil Aviation (Chicago, 1944). The Standards and Recommended Practices (SARPs) for this

Convention are managed and published by the International Civil Aviation Organisation (ICAO). As a signatory, it is UK policy that ICAO SARPs are always adopted into UK legislation unless to do so would compromise safety or if they would be contrary to the national interests associated with operating a joint and integrated approach to national airspace arrangements. Where the UK notifies a temporary 'Difference' with ICAO SARPs, it is generally associated with an undertaking to comply as soon as practicable.

- 14.4.2 Current ICAO SARPs within Annex 6 to the Chicago Convention specify the need for all aeroplanes and helicopters (i.e. powered aircraft) conducting international flights to carry and operate pressure-altitude reporting SSR transponders, irrespective of the airspace in which they operate, with effect from 1 January 2003. The aim of these SARPs is to overcome the lack of interoperability between SSR and non-SSR equipped aircraft, with the resultant inefficiency and safety issues that this causes for ATC units and aircraft equipped with collision avoidance systems.
- 14.4.3 The CAA has currently notified a 'Difference' with these particular Annex 6 SARPs because it could mean that a significant increase in the carriage of SSR transponders was required. If these transponders were based on conventional Mode A/C technology, there is a risk that the integrity of the SSR radio frequency used for replies by transponders could be intolerably degraded. However, the CAA fully supports the rationale behind these international obligations and, therefore, proposes to enact the Annex 6 SARPs into UK legislation as part of this particular proposal by employing the new Mode S technology. The aim would be to work with neighbouring States to set up bilateral application of the Annex 6 requirements across mutual international airspace boundaries. The use of promulgated VFR corridors for non-transponder equipped aircraft could also be considered as a possible method of mitigation.
- 14.4.4 However, the CAA wishes to consult on this proposal to help assess the likely impact on stakeholders of complying with the Annex 6 SARPs and to try and quantify the number of UK-registered or UK-based aircraft that would be affected.
- 14.4.5 A summary of the benefits and costs of Option 4 are set out in Table 4 below.

<b><u>Benefits and Advantages:</u></b>	<b><u>Costs and Disadvantages:</u></b>
<ul style="list-style-type: none"> <li>• Improves the interaction of all international flights made by powered aircraft with collision avoidance safety systems and SSR-based surveillance systems supporting ATC.</li> <li>• UK could meet its obligation to withdraw its current 'Difference' from these SARPs.</li> </ul>	<ul style="list-style-type: none"> <li>• It is considered that Option 1 would cover the majority of aircraft impacted by Option 4 and the costs for these aircraft would be the same as for Option 1. Nevertheless, the residual number of aircraft that fly internationally but do not access controlled airspace needs to be quantified and it is hoped that the public consultation will help to provide this information.</li> <li>• Potential for confusion on routes with those neighbouring European States that have not yet decided to implement the ICAO Annex 6 requirements.</li> </ul>

**Table 4: Summary of the Benefits and Costs of Option 4**

- [Q9: Would the cost impact of Option 4 fall within the estimates for Option 1?]**
- [Q10: Has the number of UK aircraft affected by Option 4 been accurately estimated? When considering your response, please provide supporting data where available.]**
- [Q11: What other issues should be taken into account by the CAA when considering whether or not to continue to notify a 'Difference' with the ICAO Annex 6 international obligations?]**

## 15 Other potential options that have been discounted by the CAA

### 15.1 Do Nothing and Maintain the Status Quo

Under this discounted option, the CAA considered the merits of no further expansion in the use of Mode S in the UK and no expansion of the circumstances in which aircraft would have to be equipped with SSR transponder technology. Only aircraft operating at and above Flight Level 100, or operating under Instrument Flight Rules (IFR) in controlled airspace below this level, or operating for the purposes of public transport, would need to be equipped with a Mode S capable transponder. The current SSR transponder carriage requirements would also continue to not be applied to gliders. A summary of the advantages and disadvantages of this option are set out in Table 5 below.

<u>Benefits and Advantages:</u>	<u>Costs and Disadvantages:</u>
<ul style="list-style-type: none"> <li>• Stakeholders would not have to meet any new aircraft equipage costs, associated administrative costs, or an increase in costs associated with periodic checking and certification of SSR transponders.</li> <li>• Operators who choose not to equip with SSR transponders would not have to route around any new airspace where carriage was mandatory.</li> </ul>	<ul style="list-style-type: none"> <li>• No aircraft equipage costs for operators.</li> <li>• Indirect disbenefits if, as a result, the air traffic surveillance infrastructure and airspace capacity becomes incapable of safely supporting increased traffic levels to match future airport capacity. These disbenefits would accrue from the continued lack of interoperability of many aircraft with collision avoidance safety systems and the SSR-based radar used for ATC.</li> <li>• The economic benefits set out in ‘The Future of Air Transport’ White Paper might not be fully realised. Restrictions could have to be placed on the number of flights that are handled by the air traffic system, resulting in increased departure delays at airports and less environmentally efficient aircraft routing and flight profiles. Scarce capacity would adversely affect businesses in the UK regions that rely on access to the extensive route networks available at the major South East and other main regional airports. Unmet demand might also result in some connecting air traffic relocating to airport hubs in Continental Europe.</li> <li>• As levels of commercial traffic grow, the existing protective controlled airspace will become busier and will need to continue to be expanded. A lack of interoperability in non-transponder equipped aircraft would mean that access to this controlled airspace and to Air Traffic Services could become increasingly more difficult for operators of these aircraft.</li> <li>• Potential mitigation to reduce the extent of the growth in controlled airspace would not be available if a lack of interoperability to improve safety and efficiency continues to exist.</li> <li>• Freedom of movement and availability of sufficient contiguous areas outside of controlled airspace in which to conduct required flight profiles for general, sporting and recreational aviation could also reduce.</li> </ul>

**Table 5: Summary of the Benefits and Costs of Doing Nothing**

***[Q12: What would be the impact of maintaining the current status quo on your main activity?]***

**15.2 Implement ‘Advisory’ SSR Transponder Carriage Areas**

Under this discounted option, the CAA considered the merits of a non-regulatory approach as an alternative to Options 1 and 2, whereby volumes of airspace would be promulgated as ‘Advisory SSR Areas’. The carriage of SSR transponders would not be mandatory within these areas but would be used to try and encourage transponder equipage. It was considered that ‘Advisory SSR Areas’ would generally be associated with airspace volumes outside of controlled airspace below Flight Level 100. They would be marked on aeronautical charts and formally notified in the Aeronautical Information Publication to highlight the benefits to safety and access to Air Traffic Services arising from the use of SSR transponders in the airspace. A summary of the advantages and disadvantages of this option are set out in Table 6 below.

<b><u>Benefits and Advantages:</u></b>	<b><u>Costs and Disadvantages:</u></b>
<ul style="list-style-type: none"> <li>• Raises awareness among operators of the safety and efficiency benefits of SSR transponder carriage.</li> <li>• Could result in an increase in the number of aircraft carrying SSR transponders.</li> <li>• May encourage aircraft operators to turn on their SSR transponders outside of controlled airspace.</li> <li>• May deter some non-interoperable aircraft from being operated in the advisory areas.</li> <li>• No mandatory requirement for aircraft operators to meet equipage costs.</li> <li>• Could be introduced quickly, as no changes to the Air Navigation Order would be required.</li> </ul>	<ul style="list-style-type: none"> <li>• No mandatory aircraft equipage costs for operators.</li> <li>• Not enforceable and so benefits are not guaranteed as non-interoperable aircraft would still continue to operate within the areas.</li> <li>• Adds another layer of complexity to aeronautical charts.</li> <li>• Would require a significant education and awareness campaign to publicise these new areas to stakeholders.</li> <li>• Would not provide completely ‘known’ traffic environments.</li> </ul>

**Table 6: Summary of the Benefits and Costs of ‘Advisory’ Transponder Carriage Areas**

**16 Stakeholders likely to be affected by the proposals**

The sectors and groups potentially affected by Options 1 to 4 **are set out in Annex I to this document.**

**17 Implementation arrangements and dates**

17.1 The CAA proposes that the amended transponder carriage regulations would take effect from 31 March 2009 with a three-year transition period until 31 March 2012 to allow aircraft operators with Mode A/C transponders sufficient time to upgrade their aircraft with Mode S capability. This is aligned with the implementation of Mode S in the ground-based radars and ATC systems by NATS, which is due to be completed in 2012. **The proposed rules and procedures for exemption arrangements to support these proposals are at Annex J to this document for information.**

17.2 The requirements for the carriage and operation of SSR transponders are contained within Article 20(2) and Schedule 5 of the Air Navigation Order 2005 and in Part 6 of the Air Navigation (General) Regulations 2006. Therefore, Options 1, 3 and 4 would require the preparation of a suitable amending Statutory Instrument. The aim would be to lay an Impact Assessment and associated draft regulatory amendments before Parliament by December 2008. **A draft amendment to Schedule 5 of the Air**

**Navigation Order, which incorporates Options 1, 3 and 4, is at Annex K to this document for information.**

## **18 Code of Practice on Consultation**

This consultation document has been produced in accordance with the principles of the Government's "Code of Practice on Consultation", which all government departments are encouraged to follow. **The six consultation criteria are included at Annex L.** Although the CAA is a Non-Departmental Public Body that regulates in compliance with a statutory responsibility, it has nevertheless sought to comply with the 'Code of Practice' as far as practicable.

