



**Airspace4All GA Airfields ATS ADS-B  
Traffic Display Trial**

**Safety Case Report**

Version 1.0

Approved

12/10/2018

## Executive Summary

Under the auspices of the CAA Electronic Conspicuity Working Group (ECWG), in July 2017 FASVIG published a document to the ECWG entitled "FASVIG GA Airfield Pseudo Radar Trial" outlining a proposed trial of low-cost ADS-B traffic display technology by GA airfields ATS units. This was endorsed by the CAA in a public statement on 16<sup>th</sup> August 2017 [12].

FASVIG Limited was renamed as Airspace4All Ltd on 1<sup>st</sup> September 2018.

For the Airspace4All GA Airfield ADS-B Traffic Display Trial, a number of general aviation aircraft based at three GA airfields (the "Trial Airfields") will be equipped with Automatic Dependent Surveillance Broadcast (ADS-B) devices. The trial will take place during a six month window commencing in 2018.

The proposed Trial Airfields are:

- City Airport – Manchester Barton (ATS licensed to provide AFIS)
- Chichester/Goodwood (Goodwood) (ATS licensed to provide AFIS)
- Gloucester (ATS licensed to provide RADAR)

The Trial Airfields will be equipped with real-time flight tracking equipment that provides a situational awareness tool (which is not to be used to provide any form of Air Traffic Control service).

The data transmitted by General Aviation aircraft during the trial is not assured, and has been treated as such in the safety assessment.

The Safety assessment for the airfields will follow the CAP 760 process, and the results will be contained in this Safety Case Report.

This version of the Safety Case Report is modelled on a previous Safety Case Report developed by NATS/CAA/Redhill for an equivalent GA Airfield ADS-B trial. The outputs of this previous Safety Case (the "*Model Safety Case*") form the starting point for reviewing and developing the Safety Case for the Airspace4All GA Airfield ADS-B Traffic Display Trial. The adapted outputs of the Model Safety Case are documented in this Draft Report.

The Safety Case Report has been further developed to take account of discussions with the Trial Airfields and also a meeting with and subsequent feedback from CAA ATM Regional Office staff.

On 17<sup>th</sup> September 2018 the CAA published a consultation on FISO Licensing [15] that formally proposes a licensing change that could permit use of surveillance tools by FISOs.



*Airspace for All*

## **Airspace4All GA Airfields ATS ADS-B Traffic Display Trial**

### **Safety Case Report**

---

The Model Safety Case identified the following:

The potentially induced hazards that could occur as a result of the trial were as follows:

- Trial Airfield ATS Staff Provides Unsafe Instruction/Advice.
- Trial Airfield Aircraft Penetrates Controlled Airspace without an ATC Clearance;

The potential causal factors can be summarised as incorrect use of the ADS-B equipment, and plot integrity issues. Several safety requirements have been derived to address these issues, and will be implemented before the trial goes live.

The residual risk for both hazards was found to be Acceptable in accordance with the CAP 760 risk scheme. The residual risk was also assessed to be As Low As Reasonably Practical (ALARP).

Interference with Air-Air Safety Nets and Ground Surveillance Infrastructure was considered. Sufficient evidence has been collated to conclude that this is not an issue.

The aim is to collect safety related data during the trial which will be reviewed towards the end of it. A final report will also be produced once the trial completes.

The data collected during the trial will be used to validate the analysis provided in this assessment.

Therefore this report will be up issued, and may be used as a best practice guide for future ADS-B trials at other airports.

## Publication History

Issue	Month/Year	Change Requests in this issue
0.1 Draft	February 2018	First Issue – DRAFT for comment
0.2 Draft	June 2018	Second Issue – DRAFT for comment
0.3 Draft	July 2018	Third Issue – DRAFT for comment Amended to address comments from CAA ATC Inspectors.
0.4 Draft	September 2018	Fourth Issue – DRAFT for comment Amended to address comments from CAA ATC Inspectors.
1.0 Approved	October 2018	Final version approved by CAA

## Reviewed and Agreed

Name	Role
	Airspace4All Electronic Conspicuity Lead & Trial Project Manager
	CAA Future Systems Coordinator

## Additional Distribution

Name	Role
	CAA, Manager, Future Airspace
	Gloucestershire
	City Airport – Manchester Barton
	City Airport – Manchester Barton
	Goodwood

## Referenced Documents

Title	Reference	Issue, Date
[1]. ATS Safety Requirements	CAP 670	3 Inc. Amdt. 1/2014
[2]. Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases: For Aerodrome Operators and Air Traffic Service Providers	CAP 760	1st Edition Inc. Amdt. 2010/01
[3]. FASVIG GA Airfield 'Pseudo Radar' Trial	-	Version 1 30 <sup>th</sup> June 2017
[4]. (Deleted)	-	-
[5]. Flight Information Services	CAP774	Version 2.3
[6]. (Deleted)	-	-
[7]. (Deleted)	-	-
[8a]. Letter of Agreement between Airspace4All and Barton Airfield	Trial Safety Plan Appendix A	V1.0 October 2018
[8b]. Letter of Agreement between Airspace4All and Gloucester Airfield	Trial Safety Plan Appendix A	V1.0 October 2018
[8c]. Letter of Agreement between Airspace4All and Goodwood Airfield	Trial Safety Plan Appendix A	V1.0 October 2018
[9]. uAvionix Website - Sky Echo	<a href="#">uAvionix Website</a>	N/A
[10]. Airspace4All GA Airfield ADS-B Traffic Display Trial Safety Plan	-	V1.0 October 2018
[11]. Electronic Conspicuity Devices	<a href="#">CAP1391</a>	December 2016
[12]. ADS-B can help reduce airspace infringements and mid-air collisions, says CAA	<a href="#">CAA Website</a>	Accessed February 2018
[13]. QinetiQ (2014) Low Power ADS-B Transceiver (LPAT) RF Environment Modelling Study - Phase 2	QINETIQ/14/01558	2014
[14]. Modelling Request: Impact of General Aviation Electronic Conspicuity on TCAS	QINETIQ/15/02265	Issue 1, November 2015
[15]. Review of CAA Policy on the Training, Qualification and Licensing of Flight Information Service Officers	CAP1669 ( <a href="https://consultations.caa.co.uk/future-safety/fiso-training-qualification-licensing-review/">https://consultations.caa.co.uk/future-safety/fiso-training-qualification-licensing-review/</a> )	17 <sup>th</sup> September 2018



Airspace for All

# Airspace4All GA Airfields ATS ADS-B Traffic Display Trial

## Safety Case Report

### Acronyms and Abbreviations

Acronym	Definition
ADS-B	Automatic Dependent Surveillance Broadcast
AFIS	Aerodrome Flight Information Service
AIC	Aeronautical Information Circular
ALARP	As Low as Reasonably Practical
ATC	Air Traffic Control
ATS	Air Traffic Services
CAP	Civil Aviation Publication
FISO	Flight Information Service Officer
GA	General Aviation
GPS	Global Position System
IFF	Identification Friend/Foe
IFR	Instrument Flight Rules
LFA	Low Flying Area
LOS	Loss of Separation
LTC	London Terminal Control
MFD	Multi Function Display
MHz	Mega Hertz
MLAT	Multi Lateration
NISC	National IFF/SSR Committee
Nms	Nautical Miles
pCAIT	Primary Radar Controlled Airspace Infringement Tool
RAIM	Receiver Autonomous Integrity Monitoring
SA	Situational Awareness
SBAS	Satellite Based Augmentation System
sCAIT	Secondary Radar Controlled Airspace Infringement Tool
SR	Safety Requirement
SSR	Secondary Surveillance Radar
STANAG	Standardisation Agreement
TOI	Temporary Operating Instruction
UTP	Unit Training Plan
VFR	Visual Flight Rules

## **1 Introduction**

A number of General Aviation aircraft based at the Trial Airfields will be equipped with Automatic Dependent Surveillance Broadcast (ADS-B) devices as part of a trial. The trial will take place during a six month window commencing 2018<sup>1</sup>. The Trial Airfields will be equipped with real-time flight tracking equipment that provides a situational awareness tool (which is not to be used to provide any form of Air Traffic Control service).

This Safety Case Report has been produced in accordance with CAP 760 and provides the assurance for the trial.

A separate Safety Plan [10] has been produced, which details the scope, agreements, applicable standards, activities, responsibilities and dependencies.

### **1.1 Objectives**

#### **1.1.1 ADS-B Trial Objectives**

The objectives of the trial are as follows [10]:

- Gather information to allow the CAA to assess and potentially authorise the use of ADS-B Traffic Displays at GA airfields.
- Reduce the probability of mid-air collisions.
- Provide increased situational awareness, potentially resulting in a reduction of aircraft infringing CAS, i.e. penetrating controlled airspace without an ATC clearance.

Upon completion of the trial, the results will be evaluated and a trial report written.

#### **1.1.2 Safety Case Objectives**

The objectives of this Safety Case are as follows:

- To record all hazards associated with the trial, and maintain a hazard status.
- To record all assumptions, shortcomings, mitigations and Safety Requirements.
- To justify that all Safety Requirements have been adequately addressed.

### **1.2 Assessment Scope**

This Safety Case provides assurance for the ADS-B trial that will take place at the Trial Airfields, which will run for up to 6 months. The scope of the safety assessment is as follows:

Within Scope

- Aircraft operations in the vicinity of the Trial Airfields only.

---

<sup>1</sup> Dates to be determined.



*Airspace for All*

## **Airspace4All GA Airfields ATS ADS-B Traffic Display Trial**

### **Safety Case Report**

- 
- ATS operational aspects resulting from using the ADS-B system.
  - Safe use of ADS-B display (including position plots with no integrity)

#### Outside of Scope

- Any third party devices that are connected to the airborne ADS-B unit (e.g. iPad with moving map).
- Air-to-air links, as that requires additional airborne equipment (i.e. cockpit display device).
- Integrity of cloud based data.
- Equipment assurance for airborne and ground based equipment, meaning:
  - Equipment integrity.
  - Software assurance.
  - Electro Magnetic Interference (EMI) and interference with other systems and equipment<sup>2</sup>.
  - Health and Safety at Work aspects, or project and financial risks.

---

<sup>2</sup> Although EMI is not within the scope of this assessment, evidence has been sought to show that there will be no interference with Air-Air Safety Nets and Ground Surveillance Infrastructure. See Section 3.3.2 for details.

## 2 System Description

### 2.1 ADS-B Network Overview

Automatic Dependent Surveillance Broadcast is a surveillance technology in which an aircraft determines its position via Global Positioning System (GPS), and continually broadcasts it, which enables it to be tracked. The ADS-B system does not wait to be interrogated, like a conventional transponder. It can also receive position data from other aircraft.

ADS-B is "automatic" in that it requires no pilot or external input, and is "dependent" in that it depends on data from other aircraft systems.

### 2.2 Airborne Equipment

'ADS-B Out' provides the broadcasting function of the system. An aircraft equipped with 'ADS-B Out' capability will continuously transmit aircraft data, such as airspeed, altitude, and location, to other ADSB receivers, which may be airborne or ground based.

The trial will be based on the Sky Echo [9], which is able to function as a standalone unit. It incorporates a Satellite Based Augmentation System (SBAS) and Receiver Autonomous Integrity Monitoring (RAIM) enabled GPS that transmits 1090 MHz position data. The transmitter has a 20 Watt nominal output.

The SkyEcho also supports 'ADS-B In' functionality, which provides the receiver function of the system. 'ADS-B In' equipment allows aircraft to receive and interpret the signals from other aircraft's 'ADS-B Out' data. Traffic information may be displayed to the pilot on installed equipment, such as a multifunction display (MFD). However, any external devices are not within the scope of this assessment. According to CAP 1391[11], Electronic Conspicuity devices capable of 1090MHz extended squitter do not require specific approval by the National IFF/SSR Committee (NISC) to operate, providing they comply with the requirements of Annex 10 to the Convention on International Civil Aviation Volume IV, or Standardisation Agreement (STANAG) 4193, as appropriate. The Sky Echo unit is CAP1391 approved [9].

### 2.3 The Trial Airfields

The Trial Airfields have a range of commercial aviation activities, ranging from helicopter and fixed wing charter services, to flying training and aircraft maintenance. The aerodromes are also home to a number of private aircraft.

The Barton ATZ abuts the Manchester CTR, and is wholly in Class G under the Manchester CTA (2000ft). Barton ATS is licensed to provide an Aerodrome Flight Information Service (AFIS).





*Airspace for All*

## **Airspace4All GA Airfields ATS ADS-B Traffic Display Trial**

### **Safety Case Report**

---

The Gloucester ATZ is wholly within Class G with no overlying CAS to impact circuit traffic. Gloucester ATS is licensed to provide an Air Traffic Control Service. Gloucester air traffic services are TOWER, APPROACH, RADAR and INFORMATION (ATIS). Gloucester has an existing Radar Aerodrome Traffic Monitor.

The Goodwood ATZ is wholly within Class G, under the London TMA (FL65) which does not have any impact on circuit traffic. Goodwood ATS is licensed to provide an Aerodrome Flight Information Service (AFIS).

Detailed aerodrome information is available in the Aeronautical Information Publication (AIP).

During the trial the participating airfields will use a standalone pingStation receiver from uAvionix which provides real time data with no built-in delay. The system does not support MLAT, and does not provide a view of Mode A, C or S traffic. The data will be presented on a PC running Virtual Radar Server.

The ADS-B service will be provided in the vicinity of the aerodrome, where vicinity is defined as being coincident with the unit's Designated Operational Coverage for RT purposes (typically 10nm radius and up to 3000ft or the base of controlled airspace, whichever is lower).

### **2.4 Potential Safety Benefits**

In the context of the trial, the overall purpose of ADS-B is to increase pilot and ATS Staff Situational Awareness (SA). In this context, this leads to the following potential safety benefits:

#### **1. Reduced Chance of a Mid-air Collision**

GA aerodromes can be busy, and are often used by inexperienced pilots, such as students. An ADS-B display provides the ATS Staff with more complete information to base traffic advisories on.

#### **2. Reduced Chance of Airspace Infringement**

This is of particular importance for airfields in close proximity to controlled airspace and danger areas.

#### **3. Better Assistance to Pilots Uncertain of their Position**

ATS units could provide better assistance to aircraft that are lost in the vicinity of the airfield. Presently non-radar units would have to either hand a lost aircraft off to a Radar unit to provide navigational assistance, or relay assistance from that unit to a lost aircraft. There is potential to advise aircraft of their position based on ADS-B derived location directly.

### **3 Hazard Assessment**

This section provides a detailed account of the Hazard Assessment from the Model Safety Case. The output of the Hazard Assessment is also recorded in the Hazard Log in Appendix B.

A number Safety Requirements were derived to reduce the residual risk to 'As Low As Reasonably Practical' (ALARP). Further Safety Requirements were derived outside of the CAP 760 process, which were based on ATS Staff and pilot judgement. These requirements relate to R/T terminology, trial termination procedures and the collection of in-service data.

Sections 3.1 and 3.2 below provide a full narrative of the hazards. Section 3.4 provides the complete lists of Safety Requirements applicable to the trial.

#### **3.1 Hazard 1: Barton Aircraft Penetrates Controlled Airspace without an ATC Clearance**

This Hazard relates to Barton only. The nearest CAS to Gloucester and to Goodwood are beyond the area of responsibility for Gloucester ATS and Goodwood ATS.

The Manchester and Barton runways are approximately 8 nms apart, and there is an existing hazard associated with Barton aircraft infringing the Manchester Control Zone.

The potential consequences of an aircraft infringing the Manchester Control Zone are as follows:

- Loss of Separation (LOS);
- Increased workload for the Manchester controllers;
- Increased workload for the Barton ATS Staff.

Due to the nature of the hazard, all three outcomes would be likely to occur simultaneously.

The potential consequences match the Consequence Severity 'Significant Event' in the CAP 760 scheme.

The number of in-service occurrences discussed in the Model Safety Case placed that operation in the 'Review' category<sup>3</sup>.

The Model Safety Case states that the deployment of ADS-B would improve this result since it increases ATS Staff (and subsequently pilot) situational awareness. However, the risk reduction was not quantified.

---

<sup>3</sup> CAP 760: The consequence and/or likelihood are of concern; measures to mitigate the risk to ALARP should be sought. Where the risk still lies within the 'Review' region after ALARP risk reduction has been undertaken, then the risk may be accepted provided that the risk is understood and has the endorsement of the individual ultimately accountable for safety within the organisation.



**ADS-B Trial and Effect on Manchester Infringement Risk**

The final responsibility for navigation in the Barton Airfield area of responsibility lies with the pilot and not the ATS Staff (Assumption C8). However, the Barton ATS Staff will take appropriate action if an aircraft appears to be infringing the Manchester Control Zone (Assumption A4). Although it was agreed that the increased Situational Awareness brought by the ADS-B system is likely to reduce the number of infringers, the potential for the ADS-B system causing an infringement was discussed (induced hazard).

This could occur if too much trust is placed on the ADS-B system, which provides unassured information, or if it is used incorrectly (for example, issuing a heading instruction based solely on the information being provided by the ADS-B system). The close proximity of Barton Airfield to Manchester Airport means that there is limited time to detect and reverse an incorrect instruction. The following causal factors were identified, which could lead to the ATS Staff failing to carry out a task when required (omission), or carrying out a task incorrectly (commission):

Table 2 - H1: Causal Factors and Mitigation

Ref.	Causal Factor	Mitigation
H1-1	Misidentification of Traffic Since not all aircraft will be visible on the ADS-B screen, the ADS-B picture may not match the visual picture. Therefore there is a potential for instructions being provided to the incorrect aircraft. Label clutter was also discussed, which could result in misidentification of traffic. This concerns the software package that will used to display data.	Unit Training Plan (UTP) and Temporary Operating Instruction (TOI) (SR01, SR02, SR03). This should include system set-up, to avoid label clutter (SR16).
H1-2	Incorrect Plot Position The ADS-B data is not assured, and may not be accurate. Position plots may be in the incorrect position, or show an incorrect track. The system limitations shall be stated in the Trial Airfield operating procedures (SR01, SR02).	Regular position reports shall be requested from aircraft in the trial, and correlated with the position plots on the ADS-B screen (SR05). Screen shots shall be taken of incorrect plots, and logged (SR06).
H1-3	Ground Equipment Failure This was only considered to be a safety issue should the ADS-B screen provide an erroneous picture or a frozen screen. Complete failure of the equipment was not considered to be a safety issue.	Unit Training Plan (UTP) and Temporary Operating Instruction (TOI) (SR03). This may include a procedure to adjust the range setting so that any non-moving plots become obvious (SR16).

As discussed above, infringement into the Manchester Control Zone was classified as a Significant Event based on the CAP 760 scheme. The Probability of the hazard consequences occurring was assessed as Remote before mitigation was accounted for. This low probability was based on the following:

- The current operation will not change significantly with the ADS-B system (Assumption A5). Therefore the ADS-B system on its own, which only serves to increase situational awareness, is unlikely to cause the hazard.
- Manchester will have visibility of most traffic in the trial (Assumption B1) and have Safety Nets, such as CAIT (Assumption B2). They also have a quick dial number to Barton Aerodrome (Assumption B3), and are able to relay radio calls via the Barton ATS (Assumption B4).



Airspace for All

## Airspace4All GA Airfields ATS ADS-B Traffic Display Trial

### Safety Case Report

- 
- The final responsibility for navigation lies with the pilot, that may query instructions taking them towards the Manchester Control Zone.
  - Briefing material is available to pilots who intend flying to/from Barton Airfield. The material addresses the aerodrome's proximity to Manchester Airport, and provides procedures for joins and circuit routings.

Although this results in an 'Acceptable' risk in accordance with the CAP 760 risk scheme, further means to reduce the risk to 'As Low As Reasonably Practical' (ALARP) were explored. This resulted in the mitigations in Table 2, above, that were derived against each causal factor.

Although a 3-6 month trial will not result in statistically significant data, it may provide an indication of change. Therefore Airspace4All will seek all relevant infringement data at the end of the trial, which will inform the final Trial Report (SR10). In addition, all cases where the ADS-B trial prevents infringements into the Manchester Control Zone shall be logged by the Barton ATS Staff (SR11).

Section 3.4 details the resulting Safety Requirements.

### 3.2 Hazard 2: Airfield ATS Staff Provides Unsafe Instruction/Advice

This Hazard relates to all airfields in the trial.

This hazard concerns traffic within the trial airfield ATS area of responsibility, such as in the traffic pattern, which causes a safety event. Since this hazard is based on the ATS Staff providing an incorrect instruction or advice, there is some overlap with Hazard 1 above.

Although it was agreed that the increased Situational Awareness brought by the ADS-B system is likely to reduce the likelihood of the trial airfield ATS Staff providing an unsafe instruction or unsafe advice, the potential for the ADS-B system causing this condition was discussed (induced hazard).

Traffic separation is a responsibility of the pilot. At airfields providing ATC, traffic separation is also a responsibility of Air Traffic Controllers. At airfields providing AFIS, traffic separation is also the responsibility of ATS Staff only for traffic on the ground (Assumption C7), however the ATS Staff will take appropriate action in case of unsafe proximity of traffic (Assumption A3).

The potential consequences of the ATS Staff providing an unsafe instruction or unsafe advice were identified as follows:

- Unsafe aircraft proximity;
- Increased workload for the Trial Airfield ATS Staff.

Due to the nature of the hazard, it was concluded that both outcomes would be likely to occur simultaneously.



The potential consequences matched the Consequence Severity 'Significant Event' in the CAP 760 scheme.

The following causal factors could lead to the ATS Staff failing to carry out a task when required (omission), or carrying out a task incorrectly (commission):

Table 3 - H2: Causal Factors and Mitigation

Table with 3 columns: Ref, Causal Factor, Mitigation. It lists five causal factors (H2-1 to H2-5) such as 'Over Reliance on ADS-B Data', 'Distraction', 'Boundary Creep', 'Misidentification of Traffic', and 'Incomplete set of Plots', each with a corresponding mitigation strategy.

The Probability of the hazard consequences occurring was assessed as Reasonably Probable before mitigation was accounted for. This was based on that pilots in the trial airfield area of responsibility are responsible for their own separation, and are generally continuously scanning for other traffic, particularly when in the vicinity of an aerodrome. This places the risk in the 'Review' category. Nevertheless, further means to reduce the risk were explored, which resulted in the mitigations in Table 3 above, which were derived against each causal factor. After accounting for mitigation, the Hazard Occurrence was reduced to Remote, resulting in an 'Acceptable' risk.

Section 3.4 details the resulting Safety Requirements.

3.3 Non-Interference

3.3.1 Interference with Air-Air Safety Nets and Ground Surveillance Infrastructure

Chapter 5 of CAP1391 [11] addresses the non-interference issue, and considers:

- a) Interference that compromises the performance of air-to-air safety nets such as TCAS.

This has been addressed through a 2015 study by QinetiQ [14] which states



---

that EC devices such as those envisaged will when operating at rates specified by international standards, have no effect on the operation of TCAS. They will be effectively invisible to TCAS.

- b) Interference that compromises the performance of the ground surveillance infrastructure.

According to CAP CAP1391 [11], there has already been work undertaken that shows that the introduction of significant numbers of ADS-B Out equipped GA aircraft would have minimal effect on the ability of ground surveillance systems to detect existing transponder-equipped aircraft.

This has also been addressed through a 2014 study by QinetiQ [13] which considered impacts on ground surveillance infrastructure.

### **3.3.2 Interference with Secondary Surveillance Radar (SSR)**

Section 2.1.1 of CAP 1391[11] states that the transmitter section of the EC device must be deactivated on aircraft that have a Mode S transponder to avoid possible interference due to non-synchronised transmissions, and duplication of information transmitted by the transponder and EC device.

As a result of this, uAvionix [9] webpage imposes the following operational limitation on the Sky Echo unit: "If you have an installed Mode S transponder in your aircraft, you will have to turn off the transmit function of the SkyEcho or the Mode S transponder."

On request by the CAA, this trial will be conducted with both types of devices running simultaneously.

It is essential that other Radar ATS units maintain visibility of trial. Therefore pilots participating in the Trial must be informed by the trial coordinator that they are required to keep both devices transmitting at all times (SR17).

It is noted that both ADS-B devices and transponders transmit on 1090 MHz in the UK, which raises the question of non-interference.

The Raytheon EMS Secondary RADAR utilised in support of the Swanwick operation features an advanced monopulse technique reply decoder. This is designed to separate overlapping replies from multiple aircraft on the same azimuth and also to separate the genuine replies from FRUIT<sup>4</sup> pulses polluting the environment.

This decoder utilises three characteristics of signals to separate them out:

- Phase – do the pulses arrive more strongly to the left side of the antenna array or the right?
- Time – do the pulses overlap?
- Amplitude – are these pulses the same size as those pulses?

---

<sup>4</sup> False Reply from Un-Interrogated Target/Un-synchronised In Time.



Any one of these elements is enough for the system to correctly distinguish two replies. In the case of an ADS-B transmitter and SSR transponder on the same aircraft and operating simultaneously the impact on each of the distinguishing characteristics will be as follows:

- Phase - as both signals are emanating from the same point in space and therefore their strength across the antenna array will be identical. Thus, this characteristic will be of no use in such cases.
Time - as the two devices are not coordinated it is possible that a reply will overlap with an ADS-B transmission. However both the ADS-B transmissions and the SSR interrogations are staggered, therefore whilst it is possible one reply will overlap such that it cannot be distinguished it is unlikely that multiple replies will in sequence. Within an antenna scan we would typically expect four replies for a Mode A/C plot and two replies for a Mode S plot. This characteristic may be of no use for one reply, but not all replies within a scan.
Amplitude - it is anticipated that the SSR transponder reply will be significantly stronger than the ADS-B transmission. It is therefore anticipated that this distinguishing characteristic remains viable. This may not however be the case if the SSR transponder has been poorly installed on an individual aircraft.

On this basis it is expected that it should generally be possible for the NATS En-Route RADAR network to distinguish SSR replies from transmissions being made by the low powered ADS-B device. Should ATS be advised of interference, the pilots will be required to deselect or recycle the ADS-B device if instructed to do so by ATS (SR19).

3.4 Safety Requirements

Based on the mitigations identified against each hazard, the following Safety Requirements have been derived:

Table 4 - ADS-B Trial Safety Requirements

Table with 4 columns: Ref, Requirement, Justification/Remarks, and Responsibility. It contains two rows of safety requirements (SR01 and SR02) detailing lateral/vertical limits and system limitations for the ADS-B service.

5 The SkyEcho transmitter has a 20 Watt nominal output. Transponders tend to have a nominal output range of 150-200 Watts.



Airspace for All

## Airspace4All GA Airfields ATS ADS-B Traffic Display Trial

### Safety Case Report

Ref	Requirement	Justification/Remarks	Responsibility
SR03	Procedures specific to the ADS-B trial shall be covered in the Trial Airfield UTP.	Hazard 1 Hazard 2 In the case of Gloucester, which already has an Aerodrome Traffic Monitor (ATM) in the VCR, the unit documentation will additionally state whether the ATM and ADS-B will both be used at the same time, and if so, how.	Trial Airfield
SR04	The ADS-B screen shall not be placed in an overly prominent position.	Hazard 2 The purpose is to prevent distraction and fixation on ADS-B display.	Trial Airfield
SR05	Regular position reports shall be requested from aircraft in the trial, and correlated with the position plots on the ADS-B screen.	Hazard 1 This is likely to occur in conjunction with aircraft passing VRPs.	Trial Airfield
SR06	Screen shots shall be taken of incorrect plots (subject to maintaining safety), and logged.	Hazard 1	Trial Airfield
SR07	The trial shall be terminated at a specific trial airfield if found to be unsafe by the airfield ATS Staff at that Trial airfield	Is not possible to estimate all scenarios that could be considered unsafe. Therefore this will be based on ATS Staff judgement.	Trial Airfield
SR08	The details of the trial shall be provided in an Aeronautical Information Circular (AIC).	-	CAA
SR09	Pilot position reporting procedures shall be provided in the AIC.	Pilots need to be aware of the importance of position report accuracy during the trial.	Trial Airfield
SR10	The number of Barton Infringers into the Manchester Control Zone will be monitored during the trial.	Hazard 1 A 3-6 month trial will not provide statistically significant data, but may set the lower bound.	Airspace4All
SR11	All cases of cases where the ADS-B trial prevents infringements into the Manchester Control Zone shall be logged by the Barton ATS Staff.	Hazard 1 Informs the trial report.	Barton
SR12	Phraseology for providing traffic information shall be reviewed.	Assumption A2	Trial Airfield
SR13	Phraseology for providing airspace advisories shall be reviewed.	Assumption A2	Trial Airfield
SR14	Phraseology for taking action in case of unsafe proximity of traffic within the Trial Airfield Area of Responsibility shall be reviewed.	Assumption A3	Trial Airfield
SR15	Phraseology for taking action in case of Barton traffic appearing to infringe the Manchester Control Zone shall be reviewed.	Assumption A4	Barton
SR16	System setup shall be covered in the Trial Airfield TOI.	Hazard 1 and 2 This includes settings to avoid label clutter. May also include range settings.	Trial Airfield





Airspace for All

## Airspace4All GA Airfields ATS ADS-B Traffic Display Trial

### Safety Case Report

Ref	Requirement	Justification/Remarks	Responsibility
SR17	Pilots shall be informed that they must operate both the ADS-B transponder and any Mode A/C/S transponder simultaneously during the trial.	Manufacturer's website [9] provides contradictory information by stating "if you have an installed Mode S transponder in your aircraft, you will have to turn off the transmit function of the SkyEcho or the Mode S transponder." May be addressed by SR08.	Airspace4All Trial Airfield
SR18	Manchester ATS Unit shall be informed of the trial before it commences.	Informs the Manchester operation.	Airspace4All
SR19	Pilots shall be aware that they may be asked to recycle or deselect the ADS-B device if instructed by ATS Staff.	In case of ADS-B device interference with transponder, the pilots may be asked to take action.	Airspace4All

The above Safety Requirements shall be reviewed during the 'Start-Up' Phase that will be conducted at the beginning of the trial (See Week One 'Start-Up' Phase in Safety Plan [10]).

## 4 Supporting Information

### 4.1 Assumptions

Table 5 - Assumptions

Topic	Ref.	Assumption	Validation	Remarks
A. Trial Airfield ATS	A1	The service will be provided in the vicinity of the Trial Airfield.	To Be Validated.	The boundary of the service is flexible but in general coincident with the unit's Designated Operational Coverage for RT purposes (typically 10nm radius and up to 3000ft or the base of controlled airspace, whichever is lower).
	A2	The Trial Airfield ATS Staff will provide traffic information and provide airspace advisories.	To Be Validated.	Review how standard phraseology shall be used (SR12 and SR13).
	A3	The Trial Airfield ATS Staff will take appropriate action in case of unsafe proximity of traffic.	To Be Validated. CAP 774 [5]	Review how standard phraseology shall be used (SR14).
	A4	The Trial Airfield ATS Staff will take appropriate action if an aircraft appears to be infringing other Controlled Airspace.	To Be Validated. CAP 774 [5]	Review how standard phraseology shall be used (SR15).
	A5	ATS to aircraft will not change significantly as a result of using ADS-B.	To Be Validated.	Temporary Operating Instruction (TOI) will be produced.
	A6	The Trial Airfield ATS Staff is able to detect gross lateral/vertical position errors of ADS-B plots.	To Be Validated.	Via RT with target aircraft, if on frequency.
	A7	Trial Airfield ATS Staff will have visibility of Mode S traffic through MLAT.	Not Valid. Model Safety Case	Ground based equipment does not have capability to show Mode A, C and S equipped traffic. MLAT was not accounted for in the hazard assessment.
	A8	The service will be available to IFR and VFR traffic.	To Be Validated.	Both IFR and VFR traffic operate out of Trial Airfields.
	A9	The service will only be available during trial airfield normal operating hours.	To Be Validated.	This means the service will primarily be offered during daylight hours.
B. Manchester	B1	Manchester Airport will be able to see the majority of Barton aircraft in trial on radar, since most will have transponders.	To Be Validated.	Also see assumptions B2, B3 and B4.
	B2	Manchester have safety nets, including: - Short Term Conflict Alert (STCA) - Controlled Airspace Infringement Tool (CAIT)	To Be Validated.	Also see Section 2.4.
	B3	Manchester have a quick dial number to Barton Airfield.	To Be Validated.	Barton maintains a log with all calls ground-ground to/from Manchester.
	B4	Manchester are able to relay calls to Barton traffic via Barton ATS.	To Be Validated.	Barton maintains a log with all calls ground-ground to/from Manchester.
C. Airborne Equipment and Pilot Operations	C1	All pilots participating in trial will be briefed ahead of the trial.	To Be Validated.	Contents of briefing to be determined.
	C2	The ADS-B unit works as a standalone unit - no pilot interaction is required.	Valid Model Safety Case	None



Topic	Ref.	Assumption	Validation	Remarks
	C3	The aircraft participating in the trial will be General Aviation aircraft, and may be fixed wing and helicopters.	Valid Airspace4All	None
	C4	Most aircraft in trial will also be equipped with a serviceable transponder (A/C/S).	To Be Validated	It cannot be guaranteed that all aircraft will be equipped.
	C5	The ADS-B output signal will not interfere with the transponder output signal.	Valid Section 3.3.2.	None
	C6	The ADS-B output signal will not interfere with the ground based surveillance infrastructure	Valid Section 3.3.1	Chapter 5 of CAP1391 [11] This will be further validated during the trial, as outlined on the CAA's ADS-B webpage [12].
	C7	The ADS-B output signal will not interfere with air-to-air safety nets (i.e. TCAS)	Valid Section 3.3.1 Chapter 5 of CAP1391 [11]	None
	C8	There may be other ADS-B equipped aircraft at the trial airfields that are not participants in the trial.	Valid  Airspace4All	None
	C9	Pilots will be of varying experience levels (Student, inexperienced, experienced).	Valid  Airspace4All	None
	C10	Pilots have the final responsibility for traffic separation in the vicinity of the trial airfields.	Valid ICAO Annex 2	None
	C11	Pilots have the final responsibility for navigation within the Trial Airfield area of responsibility	Valid ICAO Annex 2	None

### 4.2 Interfaces

- Aircraft 'ADS-B Out' 1090 MHz signal to ground based ADS-B receiver;
- Ground-ground between Barton Airfield and Manchester ATC.

### 4.3 Agreements

- Agreement between Airspace4All and Trial Airfields [8].

### 4.4 Standards and Processes

This full list of standards and processes that apply to this assessment are as follows:

- CAP 670 [1];
- CAP 760 [2];
- CAP 774 [5];
- CAP 1391 [11].



Airspace for All

# Airspace4All GA Airfields ATS ADS-B Traffic Display Trial

## Safety Case Report

### 4.5 CAP 760 Compliance Table

Table 6 - CAP 760 Compliance Table

CAP 760 Section	Compliance in the Safety Case
Step 1 - System Description	Section 2
Step 2 - Hazard and consequence identification	Sections 3.1 and 3.2 Appendix B.
Step 3 - Estimation of the severity of the consequences of the hazard occurring.	Sections 3.1 and 3.2 Appendix B.
Step 4 - Estimation/assessment of the likelihood of the hazard consequences occurring.	Sections 3.1 and 3.2 Appendix B.
Step 5 - Evaluation of the risk.	Sections 3.1 and 3.2 Appendix B.
Step 6 - Risk mitigation and safety requirements.	Sections 3.1, 3.2 and 3.3
Step 7 - Claims, arguments and evidence that the safety requirements have been met and documenting this in a safety case.	Appendix A. To be developed.

## 5 Conclusions

At this stage, this Draft Safety Case presents the risk associated with the trial, and derives applicable Safety Requirements.

The Model Safety Case concluded that the deployment of ADS-B would have an overall positive effect on the Trial Airfield operation since it increases ATS Staff situational awareness.

Despite that, it was necessary to consider the induced hazards that could be caused by the ADS-B trial. Two hazards were identified.

- Trial Airfield ATS Staff Provides Unsafe Instruction/Advice.
- Trial Airfield Aircraft Penetrates Controlled Airspace without an ATC Clearance;

In both cases, the potential causal factors can be summarised as incorrect use of the ADS-B equipment, and plot integrity issues.

When accounting for the Safety Requirements, the residual risk was assessed as Acceptable in accordance with the CAP 760 scheme. The risk was also concluded to be ALARP.

Further Safety Requirements were derived outside of the CAP 760 process, that were based on ATS Staff and pilot judgement. These requirements relate to R/T terminology, trial termination procedures and the collection of in-service data.

Interference with Air-Air Safety Nets and Ground Surveillance Infrastructure was considered. Sufficient evidence has been collated to conclude that this is not an issue.

A final version of this report may be released when the trial completes, and will then be validated by the trial results.

## **APPENDIX A Post-Trial Claims, Arguments and Evidence**

To be developed in a future version of this report after completion of the trial.

## APPENDIX B Hazard Log

This Hazard Log is the formal method that is used to document hazards identified for the Trial Airfield ADS-B Trial.

### B.1 Hazard 1 – Trial Airfield Aircraft Penetrates Controlled Airspace without an ATC Clearance

Table 7 - H1: Barton Aircraft Penetrates Controlled Airspace without an ATC Clearance

Topic	Consideration	Details
Tracking	Identified by	Model Safety Case
	Date Created	February 14, 2018
	Last Update Action	February 14, 2018
	Date of Last Update	February 14, 2018
Hazard Details	Hazard Description	Barton Aircraft Penetrates Controlled Airspace without an ATC Clearance Causal factors: H1-1: Misidentification of Traffic H1-2: Incorrect Plot Position H1-3: Ground Equipment Failure
	Hazard Category	Operational
Consequences	Hazard Consequence	a) Loss of Separation b) Increased workload (Manchester Controller) c) Increased Workload (Barton Airfield ATS Staff)
	This Hazard Probability (Qualitative and/or Quantitative)	Remote (pre and post mitigation)
	Severity	Significant Incident
Mitigations	Proposed Mitigation/Action	SR01: The lateral and vertical limits of the ADS-B service shall be established in the Barton operating procedures. SR02: The system limitations shall be stated in the Barton TOI. This includes: - Data is not assured - Data is not complete, i.e. non-ADS-B Out traffic will not be shown. - Plots may be inaccurate SR03: Procedures specific to the ADS-B trial shall be covered in the Barton UTP. SR04: The ADS-B screen shall not be placed in an overly prominent position. SR05: Regular position reports shall be requested from aircraft in the trial, and correlated with the position plots on the ADS-B screen. SR06: Screen shots shall be taken of incorrect plots, and logged. SR11: All cases of cases where the ADS-B trial prevents infringements into the Manchester Control Zone shall be logged by the Barton ATS Staff. SR16: System setup shall be covered in the Barton TOI
	Proposed by	Model Safety Case
	Actionee	Barton Airfield
	Planned Date	
	Mitigation Taken	
	Date of Action	
	Action Status	
Hazard Status	State of this hazard log entry	Assessed as Acceptable and ALARP in accordance with CAP 760 process.
	Date Closed	Open



Airspace for All

## Airspace4All GA Airfields ATS ADS-B Traffic Display Trial

### Safety Case Report

## B.2 Hazard 2 – Trial Airfield ATS Staff provides Unsafe Advice/Instruction

Table 8 - H2: Trial Airfield ATS Staff Provides Unsafe Advice/Instruction

Topic	Consideration	Details
Tracking	Identified by	Model Safety Case
	Date Created	February 14, 2018
	Last Update Action	October 24, 2017
	Date of Last Update	October 24, 2017
Hazard Details	Hazard Description	Trial Airfield ATS Staff Provides Unsafe Advice /Instruction
	Hazard Category	Operational
Consequences	Hazard Consequence	a) Unsafe Proximity of Traffic b) Increased ATS Staff Workload (Trial Airfield ATS Staff)
	This Hazard Probability (Qualitative and/or Quantitative)	Reasonably probable (Pre mitigation) Remote (Post mitigation)
	Severity	Significant Incident
Mitigations	Proposed Mitigation/Action	SR01: The lateral and vertical limits of the ADS-B service shall be established in the Trial Airfield operating procedures. SR02: The system limitations shall be stated in the Trial Airfield TOI. This includes: - Data is not assured - Data is not complete, i.e. non-ADS-B Out traffic will not be shown. - Plots may be inaccurate SR03: Procedures specific to the ADS-B trial shall be covered in the Trial Airfield UTP. SR04: The ADS-B screen shall not be placed in an overly prominent position. SR16: System setup shall be covered in the Trial Airfield TOI.
	Proposed by	Model Safety Case
	Actionee	Trial Airfield Airfield
	Planned Date	
	Mitigation Taken	
	Date of Action	
	Action Status	
Hazard Status	State of this hazard log entry	Assessed as Acceptable and ALARP in accordance with CAP 760 process.
	Date Closed	Open