



Causal Factor Analysis of Airspace Infringements in the United Kingdom

1 January – 31 December 2017

A report by the Causal Factor Working Group, a sub-group of the CAA's Airspace Infringement Working Group

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Introduction

An airspace infringement is the unauthorised entry of an aircraft into notified airspace. This includes flight in controlled airspace (Control Areas, Control Zones and Terminal Manoeuvring Areas), Prohibited or Restricted airspace (either permanent or temporary in establishment), active danger areas, aerodrome traffic zones (ATZ), radio mandatory zones (RMZ) or transponder mandatory zones (TMZ).

Any airspace infringement has the potential to be a serious safety incident which may result in a mid-air collision or AIRPROX. In 2017 there were a total on 1165 airspace infringements reported through Mandatory Occurrence Report (MOR) or Alleged Breach of Air Navigation Legislation (ABANL) reports. Of these, 307 were investigated by the CAA's Infringement Coordination Group for one or more of the following reasons:

1. The airspace infringement resulted in a loss of standard separation between air traffic operating within notified airspace and an infringing aircraft;
2. The airspace infringement resulted in a controlling action being initiated to establish or maintain standard separation between air traffic operating/intending to operate within controlled airspace and an infringing aircraft. Historically this has been known as 'service disruption'. It should be noted that this action is taken as a safety measure to prevent point 1 above from occurring. This may include one or more of the following actions:
 - a) Avoiding action;
 - b) Airborne holding instructions or tactical vectors;
 - c) A cessation/suspension of planned departures or modification of a departure route.
3. The airspace infringement was carried out in an aircraft where the registration and or callsign (if different) has been recorded as having previously infringed.

In all cases above, the pilot will, where known, be contacted and asked to submit a report. This report may take the form of a pilot-initiated MOR, the use of the Post-infringement Questionnaire (found at <https://airspacesafety.com/infringement/infringement-form/>) or via free text emails or letters. The CAA has no regulatory powers to make a pilot submit such a report. These reports serve 2 purposes: they form a supplementary report to the MOR/ABANL and are used by the Infringement Coordination Group in its investigation and handling process of airspace infringements; and they are analysed annually by the Airspace Infringement Working Group (AIWG) to identify causal factors and trends. The latter plays a vital role in allowing the CAA to identify work streams and focal areas that will

enable cross industry groups to work towards reducing the number and consequences of airspace infringements.

This report was carried out by the 3-member Causal Factor Working Group (part of the AIWG). The Group comprised 3 experienced General Aviation pilots with a span of operations over several areas of aviation; one of the members was also a PhD student Factors who is researching their role in airspace infringements in particular and pilot error generally. The report is not to serve as a download of statistical data; relevant statistics on monthly and annual airspace infringements may be found on the Airspace and Safety Initiative website at (<https://airspacesafety.com/facts-stats-and-incidents/>). Some data relating to airspace infringements from 1 January 2017 to 31 December 2017 can be found at appendix 1.

Analysis and Findings

In 2017, of the 1165 reported airspace infringement MORs, only 215 reports were received from pilots. Whilst this number (at circa 18.5%) is lower than desired, the Working Group (WG) found that it had sufficient data to formulate some significant findings. This report comprises findings from 209 of those MOR reports relating to infringements and the associated pilot reports. The remaining 6 were either deemed, on investigation, not to be an actual airspace infringement or the quality of the pilot report offered too little information to provide any definite causal factors.

With the agreement of the AIWG, the WG assessed these reports against four mitigation measures that could potentially have helped to prevent the infringement (or mitigated the impact of an infringement on other traffic or controllers.):

1. Use of Moving Maps with an airspace warning.
2. Use of a Frequency Monitoring Code (FMC) or other service where FMC was not available or appropriate.
3. Recognition of/dealing with overload, fixation and distraction.
4. Better familiarity with aircraft and equipment.

The following findings are worded such that had the measure been applied, implemented or use improved, of the 209 analysed airspace infringements the stated percentage of airspace infringements would possibly have been avoided. It is impossible to say that the mitigation would have been totally effective as other mitigation methods may not have been implemented effectively.

Mitigation Methods

Correct use of a moving map with alert

Possibly effective in 85% of cases

A device to give the pilot an alert to make them aware that the aircraft is approaching notified airspace and that a decision is due to prevent an infringement. In doing the analysis, the WG's "model" device was SkyDemon; the WG is effectively reporting on the proportion of infringements that would have been prevented had SkyDemon been properly used. It must be noted that other software is available that offers a similar functionality.

The reasons leading to an alert of potential infringement include:

1. Poor pre-flight planning (several instances of not noting a particular piece of airspace or airspace level)
2. Distraction by other cockpit tasks or passengers
3. Ad hoc change of plan often shortly before departure.

Most subject aircraft were not carrying such devices, and, of those that did, in many cases the pilot apparently either did not know that the alerts were available, chose not to use them or chose to turn the device off. Many aircraft were fitted with a GPS which was either not used, or not able to give useful alerts. (See: Better familiarity with aircraft and equipment).

However, there is evidence of pilots deliberately ignoring warnings when they know they are close to airspace, particularly, for example, on the approach to an airfield close to controlled airspace. This can create "Alarm Fatigue" because there are circumstances where the alarm needs to be ignored, and so is ignored when it is needed. There is also an element in a number of cases of "Inattentional Deafness", where the alarm goes off, but the pilot is overloaded by other distractions (in one case the distraction was fire) Therefore, there may be a case for greater "intelligence" in warnings; thorough and comprehensive research would be needed to work this scenario through.

Using an FMC (Listening Squawk)

Possibly effective in 65% of cases

The FMC is a discrete Mode 3A SSR code that be may selected when flying in the vicinity of controlled airspace. The code is specific to an airspace structure/airport's airspace and correlates with a radio frequency that the pilot will select and monitor. Air traffic controllers may then transmit warnings to an aircraft as it infringes or, subject to controller workload and capacity, defensively prior to an aircraft infringing. FMCs are also referred to as 'Listening Squawks'.

Many pilots did not mention FMC at all in their post-infringement reports, so the WG assumed that they were not aware of it. However, a number did note that had they used it they may have avoided the infringement. One pilot stated that he was going to stop using FMC because it has no purpose in helping him avoid infringements, only to identify him for action to be taken. Another misunderstanding noted on a number of occasions was pilots squawking the correct FMC, but not listening out on the correct frequency.

Recognition of/dealing with overload, fixation and distraction

Possibly effective in 43% of cases

Several instances were related to passenger distraction, often with low-hour pilots. In addition, the time spent looking for landmarks nominated by passengers emerged on several occasions. Other distractions included weather, equipment and aircraft failure, communications failures and cockpit workload.

Better familiarity with aircraft and equipment

Possibly effective in 24% of cases

A lack of familiarity with the aircraft or equipment led to problems ranging from being surprised by climb performance leading to vertical infringements to not using equipment installed, e.g. GPS, because the pilot was not familiar with its operation. In some cases, unfamiliarity combined with distraction led to overload and the resulting infringement.

Findings

Although very few pilots could be considered too casual about the importance of pre-flight planning and accurate in-flight navigation, the majority within the investigated reports made genuine mistakes, rather than had a poor approach to their responsibilities.

However, there were a few reports of pilots knowingly infringing to avoid other risks, such as traffic warnings or deteriorating weather; this could suggest a lack of airmanship

There were some navigation errors, such as mistaking a waypoint or setting up an incorrect heading. These were often associated with low-hours pilots. There were some instances of incorrect altimeter setting procedures and errors in entering the correct pressures. Examples of the latter include using RPS or Standard Pressure when beneath controlled airspace and continuing en-route with QFE set.

Most pilots had planned their flight thoroughly, but many infringements took place in the pilot's local area. There were infringements as a result of the pilot not noticing a piece of airspace, usually a small fillet, or the vertical extent, during the planning stage.

Some pilots misread charts in complex airspace, with some criticism of labelling.

One major infringement involving five separate aircraft appears to be the result of non-UK based pilots believing that there was a temporary change to Stansted's airspace to allow easier access to Duxford for an airshow. It is not known how that belief arose as there was no published notification of changes to existing airspace structures or rules.

There were several instances where the pilot had not allowed sufficient margin between their planned /actual flight path and the boundary of controlled airspace. In these cases, a small vertical or horizontal error led to the infringement. A similar cause was aircraft not allowing sufficient time to descend when planning to fly under a CTA from a higher cruising level.

Mitigations

The four possible mitigation measures may have helped prevent the vast majority of the occurrences reviewed. None of the measures are new to General Aviation flying activity, but it is apparent that the pilots involved were not making the best use of them.

Moving Map Displays

Without doubt the most help to avoid infringements comes from a GPS enabled moving map with airspace warning systems and pilot alerts. In some of the cases reviewed, the pilot had such a device but didn't use it to its full capability. Had they done so, their infringement would probably not have occurred. It is the WG's view that if the CAA and the ANSPs are serious about reducing infringements, they should be setting policy which results in greater use of these devices and training in their use.

This could include

1. Basic training, which in many schools still emphasises Dead Reckoning over GPS.
2. Making it be known that the use of GPS will, in line with a be noted and, where appropriate, considered in post- infringement action
3. Financial assistance in procuring such a system.
4. Ongoing or refresher training of current pilots

Capacity

All pilots will have a captaincy capacity limit. The actual limit will vary from person to person, but if a pilot recognises there is a limit and takes measures to stay within it then the instances of infringement due to overload should reduce. For example, a low-hour pilot taking a passenger for the first time should plan to fly further away from controlled airspace so that if, as in several instances, the passenger is unwell and/or causes a distraction, any resulting inaccuracy in flight is less likely to lead to an airspace infringement. Training in Human Factors, both at ab initio and recurrent level could, and should, be improved.

Training and Preparation

Pilots should be completely conversant with the use of any equipment in the aircraft. If the aircraft is flown under 'self-hire', it must be recognised that time spent on the ground understanding the equipment will help to get the most benefit from it and reduce distraction in the air. For example, there was a case of a pilot who didn't understand how to use the GPS in the hired aircraft, which may have helped him to not infringe Southampton had he

been confident in its operation to use it, and another where an unfamiliar radio layout led to both distraction and communication difficulties.

Flight Planning

The two flight planning improvements that would have made the most difference are:

1. Planning to stay a safe distance from controlled airspace so that an inflight inaccuracy won't lead to an infringement. ([Take Two](#))
2. Planning to change levels well ahead of the airspace boundary to avoid infringing during a climb or descent.

Communication

Pilots should take the help available by:

1. Making use of FMCs to make the aircraft visible and contactable by ATC; pilots of non-transponder equipped aircraft should also be encouraged to monitor the relevant frequency if an air traffic service is not required as ATC may transmit to pilots of unknown non-squawking aircraft.
2. Communicating with ATC where there is no FMC
3. Listening out at all times for help from ATC.

FMC (Listening Squawks)

The WG believed, from reading the reports, that ATSU's vary in their use of FMC. Some use it to make timely warnings to approaching aircraft, others only to respond following infringement. We suggest that the CAA and ANSPs agree a standard as to the use and purpose of FMCs; are they for prevention or mitigation? Once that is established, pilots need to be educated as what they can expect from FMCs.

Appendix 1: 2017 Airspace Infringement Statistical Data

Total number of reported airspace infringements	1165
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Percentage by aircraft category:	
Aeroplane	59%
Helicopter	12%
Ultralight/Microlight	5%
Sailplane/Hang-glider/Paraglider	2%
Balloon	less than 1%
Military aeroplane/helicopter	4%
Unknown aircraft	18%

Number by airspace type:	
Control Zones (CTR)	240
Control Areas (CTA) (inc airways)	299
Terminal Manoeuvring Areas	111
Restricted/Prohibited/Danger Areas	81
Radio Mandatory Zone (RMZ)	115
Transponder Mandatory Zone (TMZ)	48
Aerodrome Traffic Zone (ATZ)	96
Other/Not stated in report	175

Number by airspace location:	
Stansted (CTR/CTA/TMZ)	103
Southampton CTR/Solent CTA	103
Manchester CTR/CTA/TMA	68
Luton CTR/CTA	67
Birmingham CTR/CTA	34
Gatwick CTR/CTA	36
London CTR	37
Liverpool CTR/CTA	33
Doncaster/Sheffield CTR/CTA	23
London City CTR/CTA	12
Other UK airspace	659