AIRSPACE & SAFETY INITIATIVE

Airspace Infringement Working Group

Report from Causal Factors Working Group 2019

The Causal Factors Working Group is a sub-group of the Civil Aviation Authority's Airspace Infringement Working Group (AIWG). It includes three people, all independent of the UK Civil Aviation Authority: two industry experts whose experience covers microlight flying and instruction, higher performance commercial and IFR flying and instruction alongside a third member with experience in SEP flying and PhD level work in causal factors.

The members of the Causal Factors Working Group are:

- T Nathan, PPL/IR Board member, ATPL holder and Instrument Rating Instructor
- G Weighell, Chief Executive BMAA
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The Airspace & Safety Initiative is a joint CAA, NATS, AOA, GA and MoD initiative to tackle major safety risks in UK airspace: airspacesafety.com

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Introduction

An airspace infringement is the unauthorised entry of an aircraft into notified airspace. This includes controlled, prohibited or restricted airspace, active danger areas, aerodrome traffic zones, radio mandatory zones or transponder mandatory zones.

This sub-group of the AIWG meets annually to analyse and discuss the previous year's infringements and are subject to Non-Disclosure Agreements. The Group had access to 437 MORs said to contain pilot reports. They were also helped in their work that the vast majority of pilot reports were in a common format, that of the report that pilots are asked by the CAA and ANSP to make online.

Of these 437 occurrences, 28 could not be analysed because either there was no pilot report, or it was lacking in sufficient detail and no conclusions were drawn. Six reports were deemed by the team not to be infringements; they were either misfiled, misreported or, when reviewed by the CAA under CAP1404, previously closed as not being an airspace infringement.

The Group was left with 403 properly reported and confirmed infringements. The Group consider this to be a fair representation of the whole and so, this year for the first time, will not be adding caveats about statistical uncertainty. The Group thanked the CAA safety reporting group for all their work in making this possible.

It is often suggested that many pilots who are reported as infringing claim that they were outside controlled airspace and that the altitude readout on their transponder is at fault. However, only 23 (5.7%) of those studied made that claim and offered varying levels of evidence from stating "it was probably an incorrect Mode C" to an engineer's report, with most at the "probably" end of the scale. Where the CAA accepts that the transponder was faulty, following an engineer's report, it is not treated as an infringement.

Only after the analysis was complete was the question raised of the match between the Group's assessment of causal factors and the conclusions drawn by the Airspace Infringement Coordination Group. It would be useful to know the correlation, and include that analysis in future years.

The Group discusses some contributions to infringements that may fall under the heading 'human factors'. The role of such factors in accidents and infringements is well established but needs to be properly understood if we are to reduce the number of incidents.

These include the role of alarm fatigue as contributing to the failure by some pilots to respond to moving map alerts of impending airspace, whereby low-hour pilots and pilots operating with an increased workload may become close to capacity. As a result, they become fixated on the task in hand and simply do not register the alarm.

Distraction is also a significant factor leading to pilot error. Many pilots understand distraction to mean something like worsening weather, dropping a pen in the cockpit or a passenger asking a question. But distraction can, and does, go much further. Distraction, which leads to a break in the flow of activities, does not only involve immediate attentional failures. It can start hours or even days before the flight, but effectively adds to workload and leads to stress. Indeed, anything that disturbs the normal functioning of the individual, including time pressures and tiredness, can be considered to be a distraction.

Statistics

The Group was asked by the AIWG to address some very specific questions, the following are some statistics by way of an introduction:

Licence held

Students	28	(6.9%)
PPL/LAPL/NPPL	305	(75.7%)
CPL/ATPL	70	(17.4%)
Instructors	56	(13.9%)

The majority of professional licence holders were engaged in instruction or examination. Only 18 (4.4% of the total) were professional pilots not engaged in training and most of these were engaged in non-commercial operations.

Concerns about instructional flights are discussed later, but instructors on instructional flights remain a large cohort of infringers.

Type of flight

Recreational/other	295	(73.2%)
Commercial	13	(3.2%)
Instructional	57	(14.1%)
Student Solo	28	(6.9%)
Unknown	10	(2.5%)

Appropriate Moving Map

The Group had some difficulty determining what should be considered as a Moving Map appropriate for avoiding airspace infringement. The conclusion was made that purely IFR units, such as the GNS 430, although capable of giving some pictorial representation and alerts, fall below the threshold of usability required. Therefore, the Group generally recorded tablets and phones running apps such as SkyDemon and RunwayHD, and portable units such as the Garmin Aera range, as meeting the criteria to be included.

We were surprised by the number of pilots who reported that apps such as SkyDemon and RunwayHD do not provide airspace alerting functionality (to the extent that we contacted the manufacturers of RunwayHD to reassure ourselves that it really does). In many cases the question "*Was the aircraft equipped with a GPS or airspace warning device that issues an audible or visual alert when proximate to controlled airspace?*" was answered "no" when the pilot had also reported that they had SkyDemon or RunwayHD. The analysis classified those that reported that the functionality was not available together with those who had switched off alerting accidentally.

The Group was gratified that 289 (71.7%) had an appropriate moving map but were rather puzzled as why they still infringed. Very often this detail was not reported but we were able to establish the following statistics. In these cases, percentages are based on only the number of aircraft with a moving map available (289)

Alerts

Not available on the unit	72	(24.9%)
Deliberately switched off	25	(8.7%)
Accidentally off/not aware they exist	105	(36.3%)
No information	87	(30.1%)

In 16 (5.5%) of cases, the moving map was out of sight, typically in a pocket either of the pilot or the aircraft. In 28 (9.7%) cases the moving map was present but not used. These were for a variety of reasons from "I don't need it in my local area" to it being too big for the aircraft or stowed for aerobatics.

In 11 (3.8%) cases the alert was not understood by the pilot.

One anecdote we wanted to test was that moving maps are not used by instructors "to give a good example" to students who "should learn to navigate properly". In fact, this was only mentioned in 3 (1%) cases.

ATC

Another aspect that historically was possibly causing infringements, and was exacerbating the issues caused by infringements, was pilots not being in contact with radar units.

264 (65.5%) infringing aircraft were in contact with a radar unit and squawking (where the type of service was mentioned, it was almost exclusively Basic Service), and

28 (6.9%) were using the FMC system.

There were many reports where "the day was saved" by the fact that the aircraft was immediately contactable. Farnborough LARS in particular got many infringers out of airspace before the airspace operators noticed that they were there.

Planning and Threat and Error Management (TEM)

Another area that particularly the instructors and examiners on the AIWG were concerned about was whether pilots were properly planning and applying Threat and Error Management.

This data was therefore extracted from the pilot reports. To some extent this is subjective and a matter of opinion, but the three members of the Group were very consistent in the analysis of the reports, so we are reasonably confident in the outcome.

The Group differentiated between pilots who made a plan (albeit often not taking threats into account) and those who effectively did not make any plan. An example of the former would be planning to fly close to controlled airspace, an example of the latter would be an instructor who transits to and operates in the same training area on a regular basis, but was faced with unusual circumstances such as strong winds or distraction.

These percentages are across the total 403 analysed, many falling into several categories.

Category	No.	% of 403
Lack of any planning	90	(22.3%)
Planning error	49	(12.2%)
Planning to fly too close to CAS	147	(36.6%)
In general	125	(31%)
In turbulence	22	(5.5%)

Deviation from plan	284	(70.5%)
Deliberate	66	(16.4%)
Accidental	218	(54.1%)
Lack of flexibility when plan not working	37	(9.2%)
Failure to recognise threat	278	(69%)
Inadequate weather briefing	14	(3.5%)

It is worth pointing out that the 147 infringements that were planned too close to airspace constitute 47% of all infringements where some planning was carried out. That indicates that if pilots could be persuaded to "Take 2", the number of infringements would be decreased significantly.

Although there is clearly an element of lack of planning, it's dwarfed by those having a well formulated plan but accidentally deviating from it. Examples of accidental deviation are altitude deviation while performing other tasks or distraction, and, to a lesser extent, misidentifying ground features (usually towns).

Examples of deliberate deviation include, to avoid weather, to avoid traffic, to respond to a passenger's request to overfly their house, changing level without sufficient planning and change of runway direction.

Failure to recognise the threat is also very salient. This was typically not a general lack of understanding of the threat of infringing, but more a lack of awareness of a particular, localised threat.

Distraction

It could be said that nearly all infringements have distraction as a causal factor, so it is unnecessary to provide more statistics on the general question, but the Group was tasked by the AIWG to look into some particular areas of concern and causes of distraction. 260 (64.5%) of the 403 we looked at had one of these distractions as a causal factor. The percentages below are of those 260, then of the total 403. In many cases there were multiple factors, so the percentages may add to more than 100%.

Cause of distraction	No.	% of 260	% of 403
Passenger	25	(9.6%)	(6.2%)
Weather	62	(23.8%)	(15.4%)
Mech/Tech failure	49	(18.8%)	(12.2%)
Change of plan			
ATC Considerations	22	(8.5%)	(5.5%)
Weather	26	(10%)	(6.5%)
Change of intention	20	(7.7%)	(5%)
Requirements of training task	27	(10.4%)	(6.7%)
Student's hands on controls	34	(13.1%)	(8.4%)
Allowing Student error to develop	9	(3.4%)	(2.2%)
Unfamiliarity with aircraft or equipment	19	(7.3%)	(4.7%)
Traffic	24	(9.2%)	(6%)
Others	61	(23.5%)	(15.1%)

'Others' included pilots conducting air tests, infringing while adjusting radio or altimeter settings and trying to contact ATC on a busy frequency.

Subjective observations

Moving on from hard statistics, the Group members were all struck by a very similar set of observations and concerns from the reports.

Moving map

Although most (70%) infringing aircraft have a VFR GNSS with Moving Map on board, the pilots are still infringing. This left the Group a little bewildered, but members came to the conclusion that very few platforms seemed to have been properly used as a tool for airspace avoidance, but rather as a way to steer a way through airspace, and were soon forgotten when the pilot was distracted. The Group recommends that going forward, more detailed questions can be asked of pilots as to why the Moving Map did not work for them.

The aural warning seems to be unheard either because of overload (hearing is known to become degraded under pressure) or because of cockpit noise, and none seem to have the warning sounding in their headsets. Group members don't know whether this is possible, but it warrants investigation.

The Group was surprised at the number of infringing pilots who were clearly unaware that their MM produces warnings. Moving Maps (SkyDemon and RunwayHD, etc.) are configured on installation to produce warnings, and indeed in some programs the warnings cannot be switched off, so it could not be understood how so many pilots (36% of users) could be blind to them.

Visible warnings are normally configured but, perhaps due to the positioning of the Moving Map, alarm fatigue, saturation or just because the pilot hasn't planned to pay attention to them, they go unheeded.

Some infringements occurred when the pilot was deliberately not using a Moving Map as they wanted to practise using the chart and dead reckoning.

A few pilots had Moving Map and alerting but still infringed, but did not say in their responses why the impending infringement had not been signalled. It was recommended that this particular question should be asked in a redesigned questionnaire.

There was some mention of Alarm Fatigue. Pilots flying in constrained airspace, around London or Manchester in particular, will constantly see alerts and simply stop noticing them or cancel them without checking.

The Group also noted that some Moving Maps were switched off due to complacency or training task. Most often this is instructors not using Moving Maps even though they carry them – usually because they are familiar with the training area and feel certain that they will remain clear.

Constricted airspace

A number of infringements derive from

- the Manchester Low Level Route, especially at the entry and exit points
- the ATZs embedded in CTRs, especially White Waltham, Redhill, Denham and Fairoaks and
- where an airfield is hemmed in horizontally and vertically, such as North Weald.

Many of these are because pilots are concerned about the potential to meet other traffic in a restricted area of airspace, or indeed by conflicting traffic in sight. This is both a distraction and may lead pilots to take action to avoid a mid-air collision such as flying closer to airspace than they usually would, as the lesser of two evils.

Another problem is energy and flight management. By the time they have settled down after take-off, they have already infringed.

Where there is a low base of controlled airspace, such as the Manchester low level route, east of Redhill and North Weald, pilots don't want to "Take 2", they want to maximise their altitude to increase safety margins.

Saturation

Task Saturation is an issue in two groups of pilots:

- Those with low hours make errors because they have reached saturation point, not always from distraction but because handling the aircraft takes all their attention.
- Instructors and examiners are more prone to saturation than other pilots because their primary focus is to train pilots, but they are also responsible for record keeping and note taking, as well as traffic, airspace, fuel, mechanical and technical issues.

Recency is an issue. Pilots, particularly low hour pilots and those who have not flown for some time, should recognise the importance of easing back into flying gradually. This is of particular concern in 2020 when the start of the flying season coincided with lockdown and GA restrictions, meaning that many pilots have not flown for up to eight months.

In our opinion, instructors need to be encouraged to plan to operate further away from CAS, as they have enough to do without having to worry about infringing. This is particularly salient when they are close to CAS with the student's hands on the controls. They should also be strongly encouraged to use MM even if they are familiar with their local area.

Too close to airspace

Planning to fly too close to CAS remains a problem in a lot (36%) of cases.

It is most commonly manifested vertically, where pilots have planned to fly at 100 feet below CAS, and then gain altitude when doing other tasks such as looking for traffic or tuning a radio.

The Group therefore recommend even more focus on Take 2 (though it was acknowledged that a lot of effort has gone into this, the 2019 data set is somewhat historical.)

Many infringements were related to flying too close to CAS, but some were in areas where the options were limited (e.g. Redhill with the 1500 ft base)

Where turbulence/strong thermal activity featured in responses, it was more of a problem for microlights and very light aircraft.

Skills/Overconfidence

Group members had concerns about skills and training, with many pilots not seeming to understand basic pilot knowledge. Many infringements were by low hour pilots who do not sufficiently recognise their limitations.

These pilots may have been the subject of overconfidence/optimism bias (that causes someone to believe that they themselves are less likely than other pilots to experience a negative event). Pilots are recognised to be generally goal-oriented and this may drive some to push their skills envelope too early rather than adopt a more cautious approach.

There were a number of incidents where qualified pilots seemed to show a lack of competence or understanding. For example, one did not understand the word SFC and thought it meant that he should climb above the base of Class A airspace, another flew through and around the ATZ of one of the busiest GA airfields at circuit altitude, opposite to circuit direction, squawking a code from a nearby unit, apparently with no understanding of how the circuit worked or of R/T calls. Though there were few, they did raise questions about training and skills.

Altimetry

Altimetry is not a huge issue, though it does arise from time to time.

There were a few examples of pilots taking off with QFE and forgetting to set QNH when leaving the aerodrome circuit.

There is, among some pilots, a weak understanding of RPS. They do not equate the fact that RPS is deliberately biased towards terrain safety to equally increase altitude towards the base of airspace. RPS was a causal factor in five infringements.

Misunderstanding role and scope of Flight Information Services

There were examples of pilots misunderstanding of LARS' role or misplaced expectations. For example, thinking being in contact with LARS will lead to a warning about an impending infringement. This may be a complacency issue but training in the scope of LARS (and other services) could also be a problem.

There were a number of misunderstandings of the nature of the service offered, for example:

- London/Scottish FIS were thought to be able to issue clearances
- Being in touch with London FIS was thought to permit Hawarden RMZ transit
- LARS knowing that the transponder was inoperative was thought to permit Stansted TMZ crossing, without specific request or clearance.

Change of Plan

Some infringements happened when pilots faced an unexpected change of plan (e.g. change in weather, destination airfield closed, temp. closure of airspace) and they were thinking in real time about what to do, without an alternative plan.

Instructional and Student Flights

Infringements on instructional flights seemed to be the result of focus on the student

In 2019's data set there were 28 infringements by solo students (7% of the total infringements). They were not the result of poor planning, but gross errors, such as flying the wrong heading or misidentifying surface features (usually small towns.)

Noticeably, some instructors did not use MM, even though they were carrying them – usually because they considered themselves sufficiently familiar with the training area.

It was also noted that some instructors infringed towards the end of a long flying day and it was considered whether fatigue and loss of concentration are an issue.

Both these issues warrant more careful analysis in future years.

Misreading chart

There seemed to us to be more instances of pilots misreading charts – usually the vertical constraints of airspace. They would be convinced in the air that they were outside airspace but could see once back on the ground that they were not.

This is, to some extent, a planning issue, but the complexity of airspace and the marking of charts was also considered to be relevant.

Clearances

There were examples of expected late clearances that were not forthcoming, either because the controller has said "you can expect a clearance" or because the pilot "always gets a clearance". There were a couple of examples of pilots not being able to get a word in on frequency and continuing nonetheless.

Perhaps controllers could be encouraged to consider such requests sooner, where possible, and agree or deny clearance as part of their risk management.

Summary

The working group analysed ATC and Pilot reports of 403 airspace infringements that had occurred during 2019 to establish causal factors that had led to the infringement.

It became clear from the analysis that although it might be expected that the pilots involved would be among the less experienced, even experienced pilots do infringe. 17.4% held professional licences and 13.9% were instructors.

In a significant number of cases, pre-flight planning was undertaken, but that planning did not take into account the potential threats and errors that could affect the flight, and that lack of Threat and Error Management contributed to around 70% of all infringements studied.

Failure to recognise a potential threat, such as a complex airspace structure, not obtaining a CAS clearance or unexpected weather on the planned route, left some pilots without a plan B and an infringement resulted. A recent publication by ASI has highlighted the importance of Threat and Error Management (TEM), including at the time of planning.

The use of a GPS enabled moving map with an airspace warning has been encouraged by the AIWG as mitigation against an infringement. The Group found that, although many infringers carried such devices, they had not prevented the incident. It was concluded that some pilots were unaware of the warning capability of the device, and, in many instances, the warning was not heard or seen. Our findings suggest that more emphasis on the proper use of these devices would be beneficial.

Distraction as the result of a variety of causes is still a significant contributor to airspace infringements. Many reports suggest that the pilot was already operating at the limit of their capacity, and a distraction became overload, leading to a loss of spatial awareness resulting in an infringement. These instances might be reduced by pilots having a better understanding of the role distraction plays in infringements as well as of their own capabilities, and planning flights accordingly.

Mistakes and errors will always happen at any level and the cause of some infringements can be put down to just making a momentary misjudgement. This is human nature and will never be eliminated. But one can reduce the opportunity for errors.

Among the actions to limit the opportunity for errors which lead to an infringement it is suggested that key areas for action are promotion of:

- Good planning,
- Understanding how to identify potential threats and mitigate them,
- Using all the aids and assistance available, and
- Knowing one's own limitations.

Appendix 1:
Reasons for Investigation of Airspace Infringements

The CAA's Infringement Coordination Group investigated 527 airspace infringements that occurred during 2019.

These infringements were selected because:

1. The airspace infringement resulted in a loss of standard separation between air traffic operating within notified airspace and an infringing aircraft;

   or

2. The airspace infringement resulted in a safety implementation measure (controlling action) being initiated to establish or maintain standard separation between air traffic operating/intending to operate within controlled airspace and an infringing aircraft. 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. Suspension of planned departures or modification of a departure route.

   or

3. The airspace infringement was carried out by a pilot who has been recorded as having previously infringed notified airspace.

Appendix 2:
2019 Airspace Infringement Statistical Data

Total number of reported airspace infringements	1275

Percentage by aircraft category:	
Aeroplane	71.5%
Helicopter	11.1%
Ultralight/Microlight	4.9%
Sailplane/Hang-glider/Paraglider	1.6%
Balloon	0.4%
Military aeroplane/helicopter	2.4%
Unknown aircraft	7.9%

Number by airspace type:	
Control Zones (CTR)	288
Control Areas (CTA) (inc airways)	422
Control Areas (TMA)	296
Restricted/Prohibited/Danger Areas (including temporary)	73
Radio Mandatory Zone (RMZ)	42
Transponder Mandatory Zone (TMZ)	53
Aerodrome Traffic Zone (ATZ)	101

Number by airspace location:	
Stansted (CTR/CTA/TMZ)	128
Southampton CTR/Solent CTA	99
Manchester CTR/CTA/TMA	85
Luton CTR/CTA	44
Birmingham CTR/CTA	47
Gatwick CTR/CTA	78
London CTR	51
Liverpool CTR/CTA	11
Doncaster/Sheffield CTR/CTA	18
London City CTR/CTA	16
Other UK airspace	698