MID-AIR COLLISIONS: AN EVIDENCE BASED ANALYSIS OF RISK 1975 to 2018

A Paper by Airspace4All

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(Page 3 - glider risk of collision % figures corrected)

Introduction

Mid-air collisions often have a high public profile but because they are relatively infrequent, occurrence statistics are not used directly for analysis of risk. Instead indicators such as airproxes, level busts, infringements and ACAS events are used to inform policy on the underlying risk of mid-air collision.

However, the CAA MOR database contains the record of every collision in the last 43 years providing a rich source of direct data. It enables us to analyse the nature and distribution of the risk itself to validate the indicators and inform airspace policy decisions. Unlike the indicators, it provides a direct framework of evidence against which to test potential safety policies such as electronic conspicuity options and airspace modernisation.

This paper assembles and analyses data on mid-air collisions within the UK FIR involving civil aircraft, including those operated by military personnel. The data was extracted from the CAA MORS and BGA accident databases and AAIB reports. Collisions solely between military registered aircraft are not included.

The analysis measures the distribution of collision risk by aircraft class, phase of flight and geographic position. It creates a mechanism to test safety policy options.

Aim

The aim of this paper is to inform policy on collision risk and improve future airspace safety particularly related to electronic conspicuity options and airspace modernisation.

Nature of The Data

For brevity, all civil aeroplanes and helicopters, including SLMGs operating under power, are referred to as powered aircraft. Civil registered aircraft operated by MOD are included as are military aircraft involved in collisions with civil aircraft. Collisions between military aircraft are not included.

Collision Data

An extract of the principle data is set out in Annex A covering all known collisions between 1975 and 2018 (43 years) by type of aircraft and phase of flight. A larger spreadsheet of interaction data is available separately on request. Summarising this data:

In the 43 years since 1975:

202 aircraft were involved in 101 collisions,
43 of which involved 83 fatalities.

Of the 202 aircraft involved:

- 82 were powered aircraft
- 108 were gliders
- 7 were glider tugs
- 5 were military aircraft.

The military aircraft were 2 Tornados, 1 Jaguar, 1 Tucano and 1 A-10

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Within the MOR data there is no record of a collision involving a commercial air transport aircraft in the UK FIR, there is no record of a collision involving an aircraft flying in IMC and there is no record of death or injury to third parties.

Powered Aircraft

82 powered aircraft were involved in 47 collisions resulting in 53 fatalities to the occupants.

The 82 powered aircraft collided with:

- 5 military aircraft in the cruise at low level
- 7 gliders
  - 3 over the launch site
  - 3 in the cruise
  - 1 where the powered aircraft was doing aerobatics
- 70 collided with each other
  - 40 in or close to the same airfield or circuit
  - 30 in the cruise

Analysis

For powered aircraft:

The risk of collision with military aircraft represents 6% of total collision risk and occurs away from the airfield in the cruise at low level, below 2000ft agl.

The risk of collision with gliders represents 8.5% of total risk but if powered aircraft do not overfly glider launch sites, that falls to 5% which occurs in the cruise.

The remaining and overwhelming 85% of risk to powered aircraft is from other powered aircraft. 43% of that risk occurs in the cruise and 57% in or close to the airfield or circuit making the latter the greatest risk area.

Geographic distribution follows general population density with few collisions in the north and west increasing in the midlands and south-east; see Annex B. Within that distribution, the principle areas of raised risk are associated with the higher traffic density near airfields.

Of the 20 powered aircraft collisions that occurred over or near an airfield

- 9 airfields offered an ATC service,
- 5 an AFIS and
- 6 an AGS or no service

Suggesting that the nature or existence of an ATS is not an obvious risk mitigation

With few radar ATS available, any mitigation that involves controller-in-the-loop is likely to be limited; pilot interpreted solutions that warn powered aircraft of each other are more likely to be effective. Those solutions that have sufficient definition to function in or near the airfield circuit and in a dynamic situation are likely to offer the greatest safety benefit.

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Gliders

108 gliders were involved in 61 collisions resulting in 26 fatalities to the occupants

The 108 gliders collided with:

- 7 powered aircraft
  - 3 over the launch site
  - 4 in the cruise
- 7 glider tugs near the launch site.
- 94 gliders collided with each other
  - 78 over or close to the launch site
  - 16 flying cross country

Analysis

For gliders:

The risk of collision with powered aircraft is 6.5% of total collision risk.

The risk of collision with glider tugs is 6.5% of total collision risk.

The remaining and overwhelming 87% collision risk to gliders is from other gliders. 17% of that risk occurs in the cruise and 83% over or close to the launch site making the latter by far the greatest risk.

There is no record of a glider colliding with a military registered aircraft.

With no ATS service available or practicable for gliders, pilot interpreted solutions that are effective in warning gliders of each other in close manoeuvring situations near the launch site are likely to offer the greatest safety benefit. The quiet cockpit in gliders makes audio cueing and warning effective.

Glider Tugs

The 7 glider tugs collided with:

- 7 gliders.

The 7 glider tugs collided with gliders in the vicinity of the launch point. Similar considerations to gliders apply to tugs and the same pilot interpreted solution could mitigate this risk whilst reducing the risk to gliders by a further 6.5%.

Military Aircraft

The 5 military aircraft collided with:

- 5 powered aircraft.

These collisions occurred at low level (<2000ft) in open areas. Because of the speed differential avoiding action by the powered aircraft is likely to be less effective than that by the military aircraft.

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With no ATS service available or practicable, pilot interpreted solutions that are effective in warning military aircraft of powered aircraft together with pre-notification or flight planning for low-level civil flight are likely to offer the greatest safety mitigation.

This paper deals only with collisions involving civil aircraft so cannot assess overall collision risk distribution faced by military aircraft. Although from the military aviation perspective, the risk of collision with a civil aircraft may be judged to be high, from the powered civil aircraft perspective, the risk of collision with military aircraft represents but 6% of total collision risk and may therefore be considered to be low.

Geographic Distribution

The collision records have been analysed to produce a lat/long position for each although some historic records do not contain specific locations. As part of the Airspace4All Ltd work on VFR Significant Areas, these have been transposed onto an electronic layer map enabling different categories of collision to be examined in relation to airspace and other geographic features. This model also overlays historic traffic data with heat maps depicting traffic flows and densities. This facility will be made available on-line as part of an Airspace4All/NATS project related to UAV but at the time of writing, it is available off-line and with some powered aircraft traffic flows yet to be populated.

An off-line model of collision and traffic data in the form of a KMZ file for Google Earth can be made available on request to Airspace4All.

Context

Between 2010 and 2017 on average in the UK there were:

- 700 reportable accidents per year
- Of which 4.3 were collisions

- 19 fatal accidents per year with 27 fatalities
- Of which 1.4 were fatal collisions with 2.2 fatalities

Collisions represent some 8% of fatal accident risk

Whilst collisions tend to have a high public profile, they represent only a small proportions of fatal accident risk.

Conclusion

Predominately, powered aircraft collide with other powered aircraft and gliders collide with other gliders. The majority of collisions between powered aircraft (57%) occurred near the airfield and the overwhelming majority of glider collisions (91%) occurred near the launch site.

Geographically, the highest risk to all aircraft is close to airfields and launch sites towards the south of England. The majority of collisions occur in areas of known high traffic density, so warnings or alerts need to be specific.

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Most collisions occur within classification groups so:

A solution that addresses collisions between gliders could mitigate 97% of glider collision risk.

A solution that addresses collisions between powered aircraft could mitigate 85% of powered aircraft collision risk.

A solution that addresses collisions between glider and powered aircraft could mitigate 3% of glider risk and 5% of powered aircraft risk.

If they are to be effective, electronic conspicuity solutions need to address the predominant risk for each category of aircraft:

For gliders, FLARM has been demonstrated to provide substantial mitigation of their predominant risk; there has been only one recorded collision between FLARM equipped gliders in the UK FIR. FLARM is widely deployed in Germany and is mandated for all gliders in the France; it is installed in a large proportion of UK gliders and in many powered aircraft. FLARM provides collision avoidance warning and cueing.

For powered aircraft, the generation of traffic alert devices based on transponder equipage does not mitigate their predominant risk at all. To be effective near an airfield a device would need to alert to a risk of imminent collision in a dynamic situation in the presence of multiple nearby traffic. In such circumstances, avoidance cueing is important.

The data set out in this paper and in the interactive model of geographical distribution provides a testbed for potential electronic conspicuity solutions. It offers a means to assess how they might have performed in reducing the incidence of collision in the groups and circumstances set out in the analysis.

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24 April 2019

Annexes:

A. Table of mid-Air Collisions in the UK FIR 1975 to 2018.

B. Distribution of Collisions in the UK FIR 1975 to 2018.

Note: an interactive model of the data in Annex A and B is available on request to Airspace4All Ltd

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ANNEX A

To MID-AIR COLLISIONS: AN EVIDENCE BASED ANALYSIS OF RISK 1975 to 2018

Dated 24 APRIL 2019

Table of mid-Air Collisions in the UK FIR 1975 to 2018

Date	Place	Airspace 1	Airspace 2	Type 1	Type 2	Fatalities	CAA Ref	BGA Ref
01/06/75	not known	G		glider	glider	0		1975049
06/12/76	Milltown	G	site	glider	glider	0		1977080
15/05/77	Biggin Hill	G	ATZ	Bell 206	Tiger Moth	5	197705291	
25/11/78	Biggin Hill	G	ATZ	MS Rallye	C-150	1	197804825	
31/07/79	nr Lasham	G	site	glider	glider	0		1979144
27/08/79	Long Mynd	G	site	glider	glider	0		1979163
08/09/79	Nr Chinnor	G		PA-38	Robin	0	197903729	
05/04/80	Wattisham	G	site	glider	glider	0		1980045
08/03/81	Cranwell	G	ATZ	Rallye	Glider	2	198100616	1981167
30/04/81	Hamble	G	ATZ	PA-28	PA-28	2	198101260	
26/08/81	Camphill	G	site	SF25 Falke	Glider	2	198102703	1981144
06/10/81	M Wallop	G	ATZ	Bell 47	Scout	0	198103249	
18/04/82	Lasham	G	site	PA-18	glider	0	198200978	1982036
21/08/82	not known	G		glider	glider	2		1982170
20/11/83	Chipping	G		Glider	Glider	1	198307001	1983006
29/02/84	Tyrellswood	G		C-150	A-10	1	198400484	
12/05/84	Upton	G		Glider	Rockwell	1	198401216	1984183
13/05/84	Walney	G		glider	glider	1	198407002	1984107
23/06/84	Lasham	G	site	glider	glider	0		1984089
17/08/84	nr Lasham	G		glider	glider	0		1984152
05/04/85	Portmoak	G	site	glider	glider	0		1985032
26/05/85	Woburn	G	site	Microlight	Microlight	0	198502415	
07/09/85	nr Rattlesden	G		glider	glider	0		1985166
10/11/85	Cambridge	G		PA-28	C-152	0	198503872	
05/02/86	Tudley	G		Bell 47	Hughes 329	0	198600302	
29/08/86	Lasham	G	site	Rallye	glider	0	198602877	1986159
07/09/86	Booker	G	site	glider	glider	0		1986158
25/02/87	Cranfield	G	ATZ	Firefly	C-152	0	198700319	
10/08/87	Newtonard	G		PA-28	PA-29	0	198702017	
16/08/87	Sutton Bank	G	site	glider	glider	2	198702157	1987127
01/06/88	Tibenham	G	site	glider	glider	0		1988066
04/09/88	Crosland	G	site	DG-400	CAP 21	0	198802988	
22/01/89	Wycombe	G	ATZ	C-182	C-152	0	198900101	
10/02/89	Shobdon	G	ATZ	microlight	C-152	1	198900343	
03/05/90	Chadlington	G		Grob-109	Robin	2	199001807	
19/05/90	Reigate	G		PA-28	Tiger Moth	4	199002070	

14/07/90	Newbury	G	G	glider	glider	0		1990128
20/07/91	Lasham	G	site	glider	glider	0		1991124
08/08/91	nr Portmoak	G	site	glider	glider	0		1991120
29/08/91	Carno	G		Jaguar	C-152	2	199103079	
17/05/92	Ringmer	G	site	glider	glider	2	199201676	1992057
27/06/92	Elstree	G	ATZ	PA-28	AA5	0	199202442	
23/06/93	Kendal	G		Bell 206	Tornado	2	199302014	
28/08/93	Pocklington	G	site	glider	glider	0		1993137
23/07/94	Farnborough	G	ATZ	C-152	Glider	0	199403032	1994090
26/08/94	Lasham	G	site	glider	glider	0		1994139
02/07/95	Nr Goodwood	G		Jungman	microlight	0	199502614	
05/08/95	Sealand	G		Viking	Viking	2	NA	
05/05/96	Wescott	G		AA5	glider	1	199601590	1996042
21/08/96	Aston Down	G		glider	glider	1	199603659	1996117
26/10/96	Dover	G		Robin	Robin	2	199604849	
12/08/97	York	G		SA 355	DA 20	0	199704177	
10/09/97	Wookey	G		Tucano	SA 355 h	0	199704740	
01/10/97	nr Aboyne	G		glider	glider	0		1998008
02/05/98	Seighford	G	site	glider	glider	2	199802193	1998041
10/07/98	Mildenhall	G		glider	glider	1	199803868	1998083
27/07/98	Bidford	G		glider	glider	1	199804242	1998093
21/01/99	Mattersey	G		C-152	Tornado	4	199900274	
08/05/99	Long Mynd	G	site	glider	glider	0		1999034
31/05/99	Gt Hucklow	G	site	glider	glider	3	199903250	1999036
19/04/00	North Weald	G	ATZ	C-150	Yak	3	200002631	
31/05/00	Oxford	G	ATZ	PA-28	PA-29	0	200003619	
30/06/00	Lasham	G	site	PA-18	glider	0	200004738	2000091
10/09/00	Sackville Farm	G	site	glider	glider	0		2000152
08/10/00	Bembridge	G	ATZ	Piper L-21	glider	0	200007420	2001008
05/05/01	Winthorpe	G	site	glider	glider	0		2001040
07/05/01	Gransden	G	site	glider	glider	0		2001077
15/07/01	Bidford	G	site	Glider	Tug	1	200104791	2001085
14/09/01	Aston Down	G	site	PA-25	Glider	2	200106390	2001145
13/04/02	North Hill	G	site	glider	glider	0		2002045
21/06/02	Barton	G	ATZ	PA-28	microlight	0	200204177	
26/07/02	Nr Cambridge	G		Socata TB9	microlight	0	200205241	
11/08/03	nr Didcot	G	G	glider	glider	0		2003130
04/09/03	nr Lasham	G	G	glider	glider	0		2003119
26/04/04	Lasham	G	site	glider	glider	1	200402545	2004025
06/07/04	Nr Hatfield	G		R22	microlight	2	200404406	
22/07/04	Lasham	G	site	glider	glider	0		2004088
26/07/05	Lasham	G	site	glider	glider	0		2005088
18/12/05	M in Marsh	G		C-152	microlight	1	200510308	
02/10/06	Sutton Bank	G		glider	glider	1	200608919	2007002
10/01/07	Tern Hill	G	ATZ	SA350	SA350	1	200700262	
14/07/07	Southam	G		glider	glider	0	200706528	2007082
16/12/07	Rugeley	G		Luscombe	PAC 750	2	200712294	
17/08/08	Coventry	G	ATZ	C-402	Microlight	5	200808844	
11/02/09	Porthcawl	G		Grob 115	Grob 115	4	NA	
14/06/09	Abingdon	G		Grob 115	glider	2	200905933	2009076

28/07/09	Nr Wittering	G		glider	glider	0	200907854	2009114
05/03/11	Yeovilton	G	ATZ	Starduster	Wasp	0	201102294	
04/07/11	Shoreham	G	ATZ	RV-6	DA40	1	201107467	
05/08/11	Lasham	G	site	glider	glider	0	201109116	2011114
18/12/11	Leicester	ATZ	ATZ	Taylorcraft	Pitts	1	201115471	
23/07/12	Gransden	G		glider	glider	0	201208400	2012113
18/05/14	Gransden	G		glider	glider	0	201406533	2014062
15/07/14	Portmoak	G		glider	glider	0	201409462	2014104
26/07/14	St Neots	G		glider	glider	0	201410268	2014111
01/09/14	Aboyne	G		glider	glider	0	201412336	2014137
23/09/14	St Neots	G		Kitfox	C177RG	1	201412989	
30/09/16	Elstree	G		PA-28	PA-28	0	201624802	
04/12/16	Mkt H'brough	G		glider	Cessna 150	1	201630353	2017014
17/11/17	Waddesdon	G		Cessna	R44	4	201728797	
09/06/18	Dunstable	G	site	glider	glider tug	0	201812813	2018082
TOTAL						83		

Annex B

Distribution of Collisions

This is a sample from the active KMZ mapping file which is available on request

Further detail and cross references to Annex A are available on the KMZ file