An Analysis of In-Flight Impairment and Incapacitation in Fatal General Aviation Accidents (1990-1998)

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AN ANALYSIS OF IN-FLIGHT IMPAIRMENT AND INCAPACITATION IN FATAL GENERAL AVIATION ACCIDENTS (1990-1998)

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In-flight impairment and incapacitation are defined as states wherein the pilot's ability to effectively control the aircraft is adversely affected. They are of special concern in general aviation given there may be no second pilot to take over the controls. The purpose of the present study was to examine the characteristics of fatal general aviation accidents associated with impairment and incapacitation. A comprehensive review of 2,696 fatal general aviation accidents from 1990-1998 using database records maintained by the NTSB and FAA yielded 216 accidents (8.01%) that had some form of impairment/incapacitation or physiological causes mentioned in the accident report. Impairment due to drugs (n = 88, 40.7%) and alcohol (n = 68, 31.5%) were the most common causes. Cardiovascular causes were cited in 12.03% (n = 26) of the cases. Significant relationships were observed between age and impairment/incapacitation due to alcohol, drugs, and cardiovascular causes. Some disparities were observed between the prevalence of alcohol in toxicology samples and alcohol impairment being cited in the accident report as a contributory factor. The analysis provides some insight into the possible causes of pilot impairment and incapacitation in general aviation. Education and risk management training may serve as effective interventions.

INTRODUCTION

In-flight incapacitation is characterized by any state that affects pilots' health during the performance of their duties, preventing them from performing normal operations and coping with emergency situations (Martin-Saint-Laurent, Lavernhe, Casano, & Simkoff, 1990). The issue of in-flight incapacitation has been the subject of intense interest to the aviation medical community and safety professionals, because of its potential to cause a fatal mishap in the air. Incapacitation in General Aviation (GA), where generally there is no copilot, poses a greater threat to flight safety compared to a multi-crew environment where the second pilot can take over controls in the event of impairment or incapacitation of the other pilot.

Frequently reported causes of in-flight sudden incapacitation in civil and military pilots are acute coronary events (Leighton-White, 1972; Manning, 1975; Mohler & Booze, 1978; Rayman, 1974), new onset idiopathic epilepsy and physiological conditions including spatial disorientation, hypoxia, and improper G-protection techniques (Rayman, 1973). A review of the literature reveals that the concern has been primarily limited to incapacitation subsequent to medical causes in general and cardiovascular causes in particular (Rayman & McNaughton, 1983; Booze, 1989). However, in-flight incapacitation subsequent to other physiological conditions or self-imposed stresses (such as alcohol and drugs) can all lead to the same outcome - a fatal aviation accident. It is therefore surprising that not much data exists on incapacitation in GA resulting from causes other than cardiovascular.

While incapacitation, obviously implies the inability of the pilot to control the aircraft, a seemingly less ominous manifestation, would be impairment. Although, not clearly defined in most databases, it presumably differs from incapacitation in the magnitude of deterioration in the ability of the pilot to control the aircraft. While impairment may not impact system safety in other work environments, it has almost similar connotations in aviation as incapacitation. No study has yet described the composite problem of impairment and incapacitation in GA and the possible outcomes after in-flight impairment/incapacitation.

The quantification of impairment and incapacitation in general aviation is much more difficult than commercial aviation. There may be no witnesses in the aircraft, no electronic aids such as Flight Data Recorder or Cockpit Voice Recorder, and the impact forces may damage the remains, especially of the occupant, beyond any utility value. Identifying incapacitation as a cause (or even discovering the occurrence of incapacitation) in such an accident can be very difficult and may only be surmised from the circumstances preceding the accident. This has been brought out in previous studies, given the fact that trauma, fire, and inattention to detail may mask medical or physiological causes involved in some accidents (Booze, 1989). The purpose of the present study, however, was to examine the causes and characteristics of fatal general aviation accidents that have been found to be associated, either directly or indirectly, with impairment and incapacitation.

MATERIAL AND METHODS

A comprehensive review of all fatal general aviation accidents from 1990-1998 was conducted using database records maintained by the National Transportation Safety Board (NTSB) and the Federal Aviation Administration (FAA). Those accidents attributable at least in part to the aircrew, in which the investigation was complete, and the cause of accident determined were included for analysis. A total of 2,696 fatal accidents met these criteria and of these 216 (8.01%) accidents had some form of impairment, incapacitation, physical impairment or physiological causes mentioned in the accident report.

Autopsy reports (where available) were also analyzed in cases where the NTSB investigators had cited heart attack/other cardiovascular (CVS) or physiological causes as cause of accident. These autopsy reports were obtained from the Medical Statistical Section, Civil Aerospace Medical Institute (CAMI), Federal Aviation Administration in Oklahoma City.

RESULTS

Impairment /incapacitation due to drugs was present in 40.7% (n = 88) of the 216 accidents, followed by alcohol in 31.5% (n = 68) of the accidents. Incapacitation/impairment due to heart attack/cardiovascular causes was present in 26 (12.03%) accidents. No cause for impairment/ incapacitation was mentioned in 17 (7.87%) accidents. There were 9 (4.16%) accidents involving impairment/incapacitation due to hypoxia in-flight, whereas 4 (1.85%) accidents had impairment/incapacitation due in-flight exposure to carbon monoxide. No description was available in 5 cases of impairment/incapacitation due to organic /other organic causes and 2 cases due to other toxic causes. Three cases of impairment /incapacitation occurred as a result of the pilot suffering a stroke in-flight. There were 4 cases of in-flight impairment due to visual deficiency. There were nine cases with physiological condition documented as the cause; however, the cause was not immediately obvious from the sequence of events or the "probable cause of the accident."

Of the 14 cases where only incapacitation was cited as a cause, the cause remained unknown /undetermined in 5 cases. Among the rest, one of the pilots had transmitted before the accident that "he was not feeling well and had blurred vision." Four of them appear to be cardiovascular in origin in the form of autopsy evidence of coronary atherosclerosis or myocarditis or a history of severe chest pain or taking medications for hypertension. One pilot had been incapacitated as a result of a bird strike on the windscreen.

NTSB accident reports were perused to look for possible causes in the narrative section in cases that had a physiological cause. While one of them obviously appears to be Insulin Dependent Diabetes Mellitus (IDDM) (presence of insulin bottles and syringes), two appear to be cases of hypertension on medications. There were two pilots in whom there was no description of what the physiological condition may have been, both however, occurred during aerial application.

Environmental Conditions and Operation of Flight

Majority of these flights (94.0%, n = 203) were being operated under CFR Part 91, whereas 3.2% (n = 7) were operating under CFR Part 137 at the time of accident. Almost a third (32.4%, n = 70) of these accidents occurred during maneuvering phase of flight, followed by the approach phase in 14.4% (n = 31) accidents. Accidents occurring during the cruise phase accounted for 13.0% (n = 28) cases, while accidents that occurred during take off and descent phases of flight each accounted for 10.2% (n = 22) cases.

Pilot Demographics

Pilots more than age 60 constitute the largest group (19.0%, n = 41), whereas pilots younger than 26 years constituted only 7.9% (n = 17). Approximately 40.7% (n = 88) of the pilots were more than 50 years of age. Information on age was not available in 2 cases. Almost a third (31.9%, n = 69) of the pilots had logged more than 2,000 hours of flying, whereas an almost similar percentage 30.6% (n = 66) had less than 500 hours of flying. The next highest group was pilots with flying experience between 501-1,000 hours (16.2%, n = 35). More than half of the pilots held a Private Pilot License (PPL) (53.7%, n = 116) with 20.8% (n = 45) holding a Commercial Pilot License (CPL). In 3.2% (n = 7) of the accidents, the pilot was not holding a valid pilot license.

Age and Cause of Impairment/Incapacitation

Figures 1, 2, and 3 show the relations between the three major causes of impairment /incapacitation and age. Impairment/ incapacitation due to cardiovascular causes shows a gradual increase beyond the age of 30, whereas alcohol and drugs predominate in the middle age groups (41-45 years). There was a statistically significant relation between age and impairment /incapacitation due to alcohol ($\chi2$ (n = 214, 8) = 21.264, p < 0.006), drugs ($\chi2$ (n = 214, 8) = 19.930, p < 0.01), and cardiovascular causes ($\chi2$ (n = 214, 8) = 20.376, p < 0.009).

Cardiovascular Impairment/Incapacitation and Autopsy Findings

Although autopsy reports were not available in almost half of the cases where heart attack or cardiovascular cause was annotated, those available provide sufficient insight. There were 5 autopsies available out of 12 cases of incapacitation due to heart attack. In four of these, the medical examiner conducting the autopsy considered blunt trauma as the primary mechanism of death. One had "cardiovascular" as the cause of death. Similar pattern is observed in cases where the NTSB cause was impairment (heart attack) or other CVS.

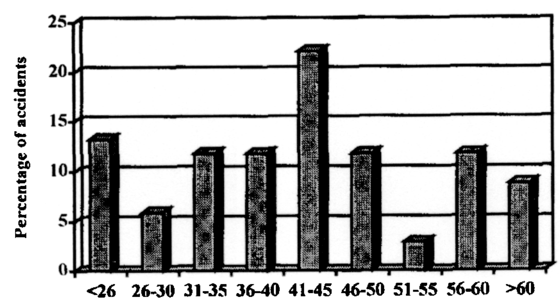

Figure 1. Impairment/incapacitation due to alcohol and age.

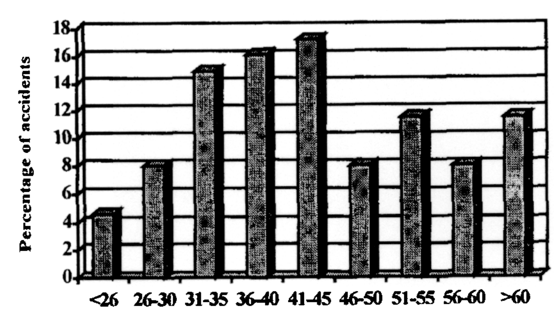

Figure 2. Impairment/incapacitation due to drugs and age.

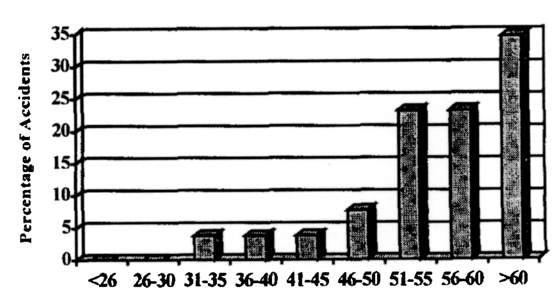

Figure 3. Impairment/incapacitation due to heart attack/cardiovascular causes and age.

Evidence of acute occlusion of the coronary blood vessels was present in only 4 out of the 10 autopsies, with findings of coronary disease in all but one. Autopsy findings suggest that the probable underlying cause in cases where "Other CVS" was mentioned could be coronary heart disease.

DISCUSSION

Despite the low incidence of in-flight incapacitation, the subject has been a cause for concern. Various researchers have used different databases and employed different denominators to estimate the magnitude of the problem of incapacitation in aviation. While Rayman (1973) reported the incidence of fatal accidents due to in-flight sudden incapacitation in the USAF to be about 0.5 per 1,000 pilots for every 1,000 hours of flying, with incidence due to coronary artery disease at 0.01 per 1,000 pilots for every 1,000 hours of flying (Rayman, 1974). Mohler and Booze (1978) provide cardiovascular incapacitation rate of 0.93% of documented fatal GA accidents. All the above, with miniscule numerators compared to enormous denominators belies the adverse potential and consequences of the event in a single pilot operation.

The effects of impairment and incapacitation due to alcohol have generally not been reported in literature. Alcohol at or above the legal limit of 0.04% has generally averaged around 7% of all fatal general aviation accidents (Canfield, Hordinsky, Millett, Endecott, & Smith, 2001). In the present study, alcohol and drugs constitute the most significant causes of impairment leading to fatal aviation accidents. Alcohol can affect attention and signal detection performance (Jansen, de Gier, & Slangen, 1985) besides causing prolongation of reaction time and lowering of a coordination performance (Tagawa, Kano, Okamura, Itoh, Sakurai, Watanabe, & Yanai, 2000). Although, the impairment may not be as catastrophic as other causes, the effect on flying performance can jeopardize flight safety, as has been evident from the data.

There appears to be a disparity between the NTSB investigators attributing alcohol /drug as a cause of impairment and the same being found in toxicology samples at or above the legal limits (0.04%). CAMI is required to conduct toxicological analyses on specimens from, and special pathologic studies on aircraft accident fatalities (Department of Transportation, 1985). Alcohol was found in 124 cases from 1994 to 1998, with 117 of these in pilots operating under CFR 91 (Canfield et al., 2001). In our data, impairment alcohol was mentioned in only 90 cases by the NTSB investigators. This disparity seems all the more glaring because evidence suggests (Cook, 1997) that aircrew performance may be impaired by alcohol consumption even after their blood alcohol concentration has returned to "zero" (i.e., < 5 mg/dl). Such disparities may possibly influence the causative sequences of various fatal accidents.

The significant relation of cardiovascular conditions with increasing age corroborates findings reported in the aviation literature (Booze, 1989) as well as those reported for the general population (Kannel & McGee, 1985). Analysis of autopsy reports in cases where heart attack and CVS was cited, presents some interesting features. A difference of opinion is possible between the NTSB investigators presumption of impairment due to cardiovascular cause and the medical examiner's opinion on the cause of death. This could be subsequent to the massive injuries sustained by the pilot due to impact forces, even if, there was in-flight incapacitation leading to loss of control. It may also be difficult at times for the medical examiner to attribute the cause of death as "cardiovascular" with the lack of definitive evidence of an acute occlusion/ myocardial infarction. It is also known that approximately 6% of all patients with acute myocardial infarction, and perhaps four time this percentage of patients with this diagnosis younger than the age of 35 years, do not have coronary atherosclerosis demonstrated by coronary angiography or at autopsy (DeWood, Spores, Notske, et al., 1980). On the other hand, there may be occasions, when the medical examiner documents cardiovascular as a cause of death but the NTSB investigator does not even consider that possibility. This has been bought out in an earlier report (Taneja & Wiegmann, 2001). Such ambiguities in attributing cardiovascular, as the cause of impairment/incapacitation would certainly affect the incidence/figures that have been so often quoted.

The relations between the major causes of impairment and incapacitation with age are interesting. Alcohol and drugs appear to follow similar patterns with peak in the middle ages. It is difficult to put forward any hypothesis for this, except that with some experience in aviation, there may be a complacency setting in, where one could feel that he or she is experienced enough to "experiment" with flying while intoxicated.

The present analysis provides some insight into the possible causes that may impair or incapacitate a pilot in-flight and thus affect the safety of flight. Alcohol and drugs have continued to be present in about 7% of fatal general aviation accidents and need to be considered in evaluating the total magnitude of the problem of in-flight impairment and incapacitation. Preventive activities, such as educating the pilots on the physiological mechanisms in flight and the effects of subtle illnesses on performance can go a long way in enhancing flight safety. Educating the pilot community on the epidemiology and etiology of cardiovascular illnesses can certainly lead to primary prevention of the disease and decrease the disease burden among the pilot population.

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Contents

Abbreviations

AAIB	Air Accidents Investigation Branch
AIC	Aeronautical Information Circular
ANO	Air Navigation Order
AOPA	The Aircraft Owners and Pilots Association
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
C of A	Certificate of Airworthiness
CFIT	Controlled Flight into Terrain
GA	General Aviation
GASIL	General Aviation Safety Information Leaflet
IMC	Instrument Meteorological Conditions
IR	Instrument Rating
JAA	Joint Aviation Authorities
JAR FCL	Joint Aviation Requirements – Flight Crew Licensing
LOC IMC	Loss of Control in Instrument Meteorological Conditions
LOC VMC	Loss of Control in Visual Meteorological Conditions
LOW/AERO	Low Flying/Aerobatics
NATMAC	National Air Traffic Management Advisory Committee
NOTAMs	Notices to Airmen
PPL	Private Pilot's Licence
SRG	Safety Regulation Group

1 INTRODUCTION

1.1 During 1987 there was a marked increase in the number of fatal accidents involving General Aviation (GA) aeroplanes when the rate rose to 3.7 per 100,000 flying hours compared with the average annual figure of 2.1 for the preceding five years. In response to public concern at the time, the then CAA Chairman established a Study Group to analyse the 1987 accidents and to determine whether there were:

- factors common to a number of accidents which might have contributed to the causes.
- regulatory or other measures which, if taken by the CAA, could be expected to reduce the number of accidents occurring without unreasonable detriment to the future growth and wellbeing of general aviation.

The review was published as CAP 542 – 'General Aviation Accident Review' in October 1988 and contained 13 recommendations. Most have been actioned or are awaiting progress through development of the Joint Aviation Requirements.

1.2 The Authority considered that a further review of General Aviation accidents should take place. Accordingly, in January 1995, a new Working Group was established with terms of reference as follows:

- to undertake a review of serious and fatal GA incidents and accidents with a view to focusing on their causal factors to help reduce such events in the future.
- to produce a report and make recommendations to Safety Regulation Group (SRG) management for appropriate consideration and action.

2 TERMINOLOGY

2.1 General Aviation

For the purpose of this report a General Aviation aircraft was considered to be a UK registered aeroplane or helicopter with a maximum take-off mass of 5700kg or less.

3 SCOPE OF THE REPORT

3.1 The Group decided that a review of all GA accidents (over 250 per year) and incidents was impracticable. There was a risk that some significant issues could be outweighed by relatively minor accidents such as landing gear collapses. It was agreed that the review would concentrate on fatal accidents to UK registered aeroplanes and helicopters of 5700kg maximum take-off mass and below which occurred in the UK and abroad during the 10 year period 1 January 1985 to 31 December 1994. Microlights, gyroplanes and gliders were excluded as they have different airworthiness codes and pilot licensing standards. This provided a manageable number of accidents (166) for analysis while it corresponded with the CAP 542 work (aeroplanes).

3.2 Fatal accidents where there was only third party involvement (e.g. people moving into rotating propellers or rotors) were included since these could have been affected by the operational environment.

3.3 The CAA's Mandatory Occurrence Reporting Scheme records all significant hazardous or potentially hazardous occurrences as well as accidents. For the purposes of this review, the occurrence computer database did not contain sufficient background material on the fatal accidents so Air Accidents Investigation Branch (AAIB) Bulletins, occurrence files and licensing records as well as other sources were used.

3.4 A number of accidents, 20 (12%), involved UK registered aircraft flying outside the UK and, thus, were investigated by foreign authorities. Very few had produced adequate reports and in spite of enquiries via Air Accidents Investigation Branch, very little has been forthcoming and, in most cases, it was not possible to allocate any causal factors. The 1987 accident review group also experienced this difficulty.

4 WORKING METHOD

4.1 The Group was aware that work of this sort was very subjective, so in order to maintain consistency the group independently read the relevant information on each accident and then met to reach a consensus view on the one type of accident and as few or many factors as necessary were allocated, all with equal weight. These were divided into four main groups:

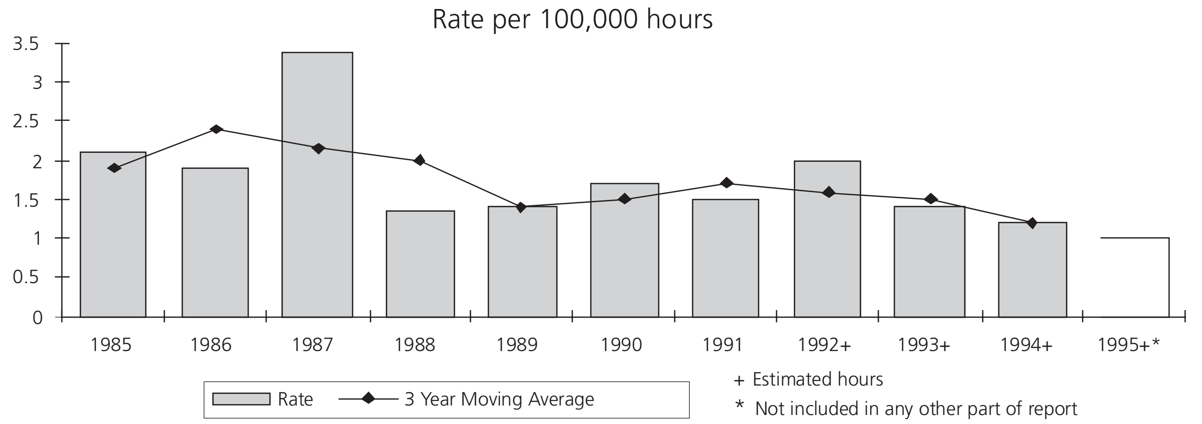
- pilot knowledge or skill;
- attitude, stretching the limits;
- pilot physiology;
- external factors.

4.2 The list of factors was extended as the task progressed. This method attempted to ensure a reasonable degree of consistency. A few of the types of accident also appeared as factors.

4.3 Statistical tests were performed to determine whether certain differences between groups were statistically significant. (The test selected was the Mann-Whitney U test for comparison of two independent samples.)

5 FATAL ACCIDENT RATE 1985 TO 1994 (See Appendix 1)

5.1 The 166 fatal accidents mentioned in para 3.1 above comprised 140 accidents involving aeroplanes and 26 involving helicopters. A total of 234 persons were killed in the aeroplane accidents and 46 in the helicopter accidents. This compared with the 158 persons killed during the same period in large aeroplane and large helicopter accidents. The fatal accident rate is measured as an accident rate per 100,000 flight hours. During the period of the report, the fatal accident rate for aeroplanes varied from a high of 3.7 in 1987 to a low of 1.0 in 1994. The corresponding figures for helicopters varied from a high of 3.6 in 1990 to a low of zero in 1985 and 1988. The numbers of accidents for both categories of aircraft were combined in the following graph to show rates per 100,000 hours: the 3 year moving average shows a generally favourable trend throughout the period under review.



5.2 The gradual improvement in the three year moving average may be due to a number of factors including:

- improvements in instructional standards and syllabus content.

- an improved safety culture in general over the last 10 years as demonstrated by the now common use of household smoke alarms, cyclists' crash helmets, motorists' airbags etc.

- the long-term effect of initiatives to promote safety within the general aviation community via the General Aviation Safety Information Leaflet (GASIL), Safety Evenings, Safety Sense Leaflets etc.

Nevertheless, because of a high incidence of pilot error and poor decision making/judgement it was clear that most of the recent fatal accidents could still be classified as avoidable. It could not be argued, therefore, that the accident rate was close to an irreducible minimum.

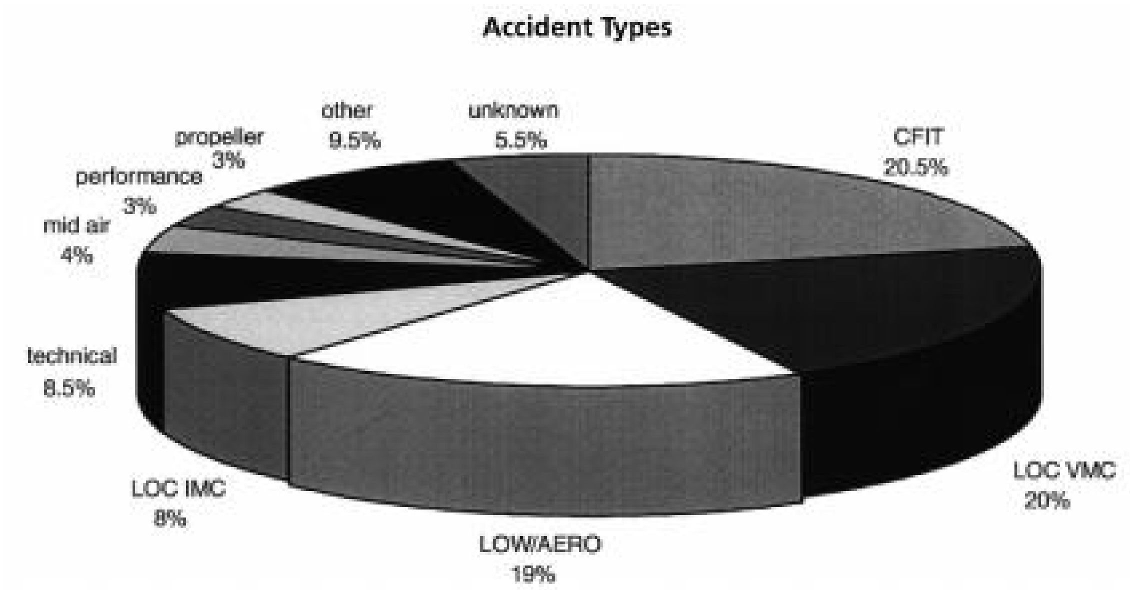
5.3 Most members of the group felt strongly that general aviation in the context of this report should not be regarded as purely recreational and that every effort should be made to help pilots of all levels to become more 'proficient'. The public has come to expect regular reductions in road fatalities brought about by a combination of education backed up by legislation and enforcement together with improved crashworthiness/occupant protection. This resulted in an approximate 5% per annum reduction in the fatal accident rate. Some of those measures may not be appropriate in the general aviation world. Nevertheless, as a target, a 5% per annum improvement in the aircraft accident rate was believed to be a realistic objective. This has almost been achieved in the UK, in terms of the 3 year moving average, over the last 10 years (1.8 per 100,000 hours down to 1.2).

5.4 Attempts were made to compare the UK situation with that in other countries. Unfortunately, it was not possible to make direct comparisons because of differing definitions of general aviation separation of helicopters, terrain, weather, licence requirements etc. In general terms the accident causes were very similar to the UK with loss of control, continued flight into adverse weather and controlled flight into terrain as major factors.

6 FINDINGS OF THE WORKING GROUP

6.1 Types of Accident

The pie-chart below shows the types of accident which occurred most often. Four of the major types – controlled flight into terrain (CFIT), loss of control in VMC (LOC VMC), low flying/aerobatics (LOW/AERO), and loss of control in IMC (LOC IMC) – are discussed in detail in Appendices 2 to 5.



Clearly the greatest benefits result from addressing the four major accident types since 67.5% of accidents were in these areas. Nevertheless the less frequent types must not be ignored. Discussion of the less frequent accidents is at Appendix 6. A summary of detail on all 166 accidents reviewed is at Appendix 8.

6.2 Controlled Flight into Terrain (CFIT) (See Appendix 2)

A CFIT accident was defined as an event where an aircraft strikes the ground during powered, controlled flight. The review has shown that in 20.5% of fatal accidents CFIT was a feature leading to 61 fatalities. Typically, the CFIT accident involved the more mature and experienced pilot who, despite his experience, seemed to be oblivious to the dangers of continuing the flight into deteriorating weather conditions. Eighty-two percent of pilots in CFIT accidents continued into bad or worsening weather or showed a lack of appreciation of the weather situation. In 74% of CFIT accidents, the safety altitude was apparently not observed by the pilots concerned or was not correctly calculated. In many cases, a descent was initiated to achieve visual conditions below cloud, with disastrous consequences. Usually, training for the Private Pilot's Licence (PPL) takes place in good weather and with the advent of more candidates training for the PPL overseas, this trend is likely to increase. The average PPL student has little if any exposure to adverse weather during training and, on obtaining his licence, is unlikely to understand how to assess weather conditions or be able to relate his own skills to a deteriorating weather situation. It was considered that PPL training should be subjected to a greater level of CAA oversight to ensure that the best information is made available to candidates particularly in the areas of weather appreciation, calculation of safety altitude, flight planning and diversion techniques.

6.3 Loss of Control in Visual Meteorological Conditions (LOC VMC)

(See Appendix 3)

6.3.1 This type of accident was defined as one where the pilot lost control of the aircraft while operating in accordance with normal aviation procedure, under the Visual Flight Rules, and not engaging in low level aerobatics. LOC VMC is associated more with inexperienced pilots and accounted for 20% of the accidents and 61 fatalities; two thirds of those involved in these accidents had less than 500 flying hours. This type of accident is the result of a lack of basic handling skills often associated with an unfamiliar or new situation. Loss of control of an aircraft in visual conditions is more likely to reflect weaknesses in basic handling skills brought about by poor initial training or inadequate refresher training. If initial training is poor, the standard of instruction is brought into question. Sound instructional standards are at the core of basic flying training. Currently there is no provision in civil requirements for training those who will train others to be flying instructors. This was seen as a fundamental weakness which will not be remedied in JAR-FCL. The majority of pilots take considerably more than the minimum syllabus hours to achieve a PPL. However, some applicants acquired the licence in only a few weeks and there is concern as to the ability of some of them to retain basic skills for very long. For instance, if a pilot is to be able to react correctly in an unusual situation the ability, for example, to identify the symptoms of an approaching stall needs to be frequently demonstrated and practised. The present PPL revalidation requirements are inadequate in this respect as they allow a licence holder to fly unsupervised and without a flight check for many years. For perhaps too long, general aviation flying has been considered by many as mainly a leisure activity, separate and different from commercial aviation. With the increasing complexities of aviation and the constraints on airspace, this view is no longer viable and there needs to be a progressive drive towards better and more professional training for the PPL holder. To this end it was considered that the CAA should play a more active part in overseeing the standards of the initial course for the PPL and in post-licence education and training.

6.3.2 In nearly half of the LOC VMC accidents, pilots were presented with unusual or unexpected circumstances which may have contributed to loss of control. Repetitive testing of basic skills could help to reduce this type of accident particularly since 4 out of the total of 21 accidents to multi-engine aeroplanes involved loss of control following engine failure. The high number of stall/spin accidents resulted in discussion of stall warning systems, natural buffet etc. It was considered that an audio warning was much better than a light which could be overlooked because of sunlight on the panel or because the pilot was keeping a lookout. For new aircraft being certificated to JAR 23, VLA etc, the need for audio warning had been adequately covered and new types of Permit to Fly aeroplanes are approved on an individual basis with the Popular Flying Association. Retrospective action on aircraft types already certificated and which had poor or no stall warning was discussed, however, it was felt that any measures would be an unjustified economic penalty on the owners. Furthermore, the growing use in general aviation aircraft of high quality headsets that resulted in the pilot failing to hear a stall (and other) audio warning was considered. As this was a problem currently under consideration for all aircraft, it was felt that in the short term the issue for general aviation was best covered by publicity via AICs or GASIL. It was felt that in the long term there would be an improvement in stall warning systems and that currently no action was justified.

6.4 **Low Flying/Aerobatics (LOW/AERO)** (See Appendix 4)

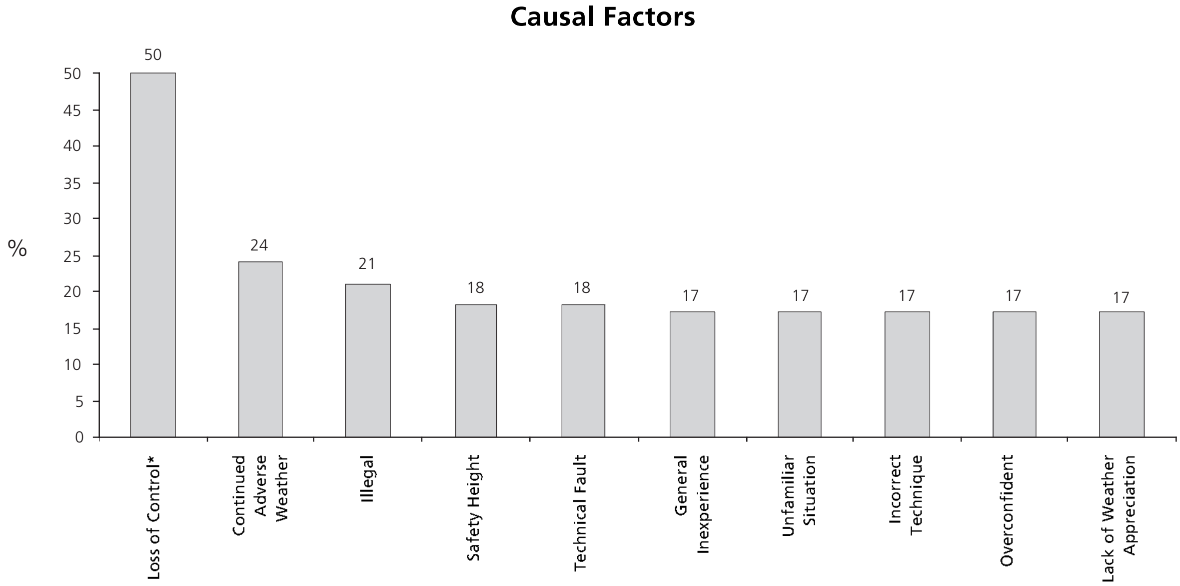
These were defined as accidents occurring at low level, or through the conduct of aerobatics by pilots at too low a level for safety. These accounted for 19% of accidents and 46 fatalities during the period of the review. There is no aerobatics rating in the UK and any pilot can 'have a go'. The present system fails to curb enthusiastic aerobatic attempts by untrained PPLs. The Aircraft Owners and Pilots Association (AOPA) 'Aerobatics Certificate' is available for those who choose to take the course of training and who achieve the necessary standard. JAR–FCL proposals do not address this issue. In over 50% of cases there was an 'audience' resulting in peer pressure.

6.5 **Loss of Control in Instrument Meteorological Conditions (LOC IMC)** (See Appendix 5)

This was defined as an accident where a pilot lost control of the aircraft in Instrument Meteorological Conditions (IMC). This was the fourth most common accident type, having been the cause of 8% of the accidents and 29 deaths. Three quarters of the pilots involved were attempting to fly in IMC when not qualified to do so. It was not possible to determine whether or not the accident aircraft were fitted with serviceable attitude indication equipment to assist the pilot in getting out of such weather conditions.

6.6 **Causal Factors**

The relevant information on each accident was reviewed and it was decided which of 62 causal factors (Appendix 7) were applicable to each accident. The 10 most frequently identified causal factors and percentages of all accidents where those factors applied were:



• Excludes asymmetric in a twin engine aircraft.

- It was not surprising that loss of control was predominant as this factor occurred in several of the types of accident, eg loss of control in Visual Meteorological Conditions, loss of control in Instrument Meteorological Conditions and in aerobatics/low flying accidents.

- The category 'Illegal' was only employed for those accidents where the legality of the flight had a direct bearing on the accident. For example, in a loss of control accident 'illegal' would not have been used had the Certificate of Airworthiness (C of A) been out of date. The number of accidents where illegality was a direct contributor was of concern.

6.7 **Other causal factors**

There were numerous other causal factors where the number of fatal accidents attributed to each was too small for useful in-depth study. However, three of these factors are particularly noteworthy:

- *Illegality.* In 21% of fatal general aviation accidents, the factor 'Illegal' was identified. In many cases the circumstances suggested that pilots were knowingly breaking the law. Education is likely to be more effective than further legislation or stricter enforcement.

- *Poor Clarity/Availability of Information.* For a flight to be legally and safely conducted, Article 38(a) of the Air Navigation Order (ANO) requires the commander to take into account the latest information on the route, aerodromes, weather etc. Lack of the appropriate information was a factor in a number of accidents. Although the availability of weather information is much improved, Notices to Airmen (NOTAMs) are frequently criticised by GA pilots on grounds of availability, clarity and presentation. A pilot needs to be able to readily find in the NOTAMs relevant information for his flight. In many respects the ANO is difficult to interpret and, unlike the Road Traffic Acts, there is nothing similar to the Highway Code. Some guidance is however given in CAP 85 'A guide to aviation law, flight rules and procedures for applicants for the Private Pilot's Licence'.

- *Human Factors.* The majority of causal factors had a Human Factors element. This aspect has been partly addressed by the introduction of the Human Performance and Limitations examination. The syllabus leading to the examination could usefully be reviewed in the light of this report.

7 CONCLUSIONS

7.1 The four most frequent causes of accidents studied in this review were Controlled Flight Into Terrain; Loss of Control in Visual Meteorological Conditions; Low Flying/Aerobatics and Loss of Control in Instrument Meteorological Conditions. CFIT accidents typically happen to mature pilots who, despite their experience, seem oblivious to the dangers of continuing a flight into bad or worsening weather. It was considered that a possible solution could be improved knowledge in the areas of weather appreciation, calculation of safety altitude, flight planning and diversion techniques. The LOC VMC accidents involved inexperienced pilots, generally with less than 500 hours, who may have been caught out by an unexpected event. It was noted that there are no civil requirements for training those who train flying instructors and that the present PPL revalidation requirements are inadequate. The LOW/AERO accidents occurred with relatively young, experienced pilots flying in demanding conditions or attempting manoeuvres too close to the ground and/or beyond their capabilities. The present system also fails to curb enthusiastic aerobatic attempts by untrained PPLs. There is a perceived need for some form of aerobatics certificate along the lines of the AOPA aerobatic certificate. Of the pilots involved in LOC IMC accidents more than two thirds were flying outside their licence privileges and almost a quarter took their aircraft outside its operating limits, often leading to a structural break up.

8 MAIN RECOMMENDATIONS

8.1 Having reviewed 166 fatal accidents, the Authority agreed the following main recommendations:

(a) Revalidation of a PPL should include a proficiency check with an authorised flying instructor every 24 months. JAR-FCL requirements for the PPL class rating for a single engine aircraft include either a proficiency check, with a class rating examiner in the last three months prior to rating expiry, or a recency requirement plus a flight with a flying instructor. This latter requirement could very well meet the need identified above, providing the flight is correctly structured to cover the areas of concern. It is recommended that a similar skill test be introduced as a requirement for the UK PPL as soon as possible.

(b) Resources should be devoted to the establishment of a CAA Approved Safety Training Module which pilots should attend during PPL training. This module should concentrate on weather appreciation, flight in poor visibility, calculation and application of safety altitude, stall/spin awareness, etc.

(c) Current licence holders should be encouraged to attend the Safety Training Module proposed in para (b) above in order to foster a culture of ongoing improvement so that the licence holder's skills, personal attitude, self-discipline and knowledge are improved throughout his/her term as a licence holder.

(d) The syllabus of training for flying instructors should be reviewed, particularly in respect of the navigation and weather training content. Additionally, the need for a short course to prepare instructors who provide flying instructor courses, should be considered.

(e) The desirability of introducing an aerobatics rating, coupled with a prohibition of solo aerobatics until the commander holds such a rating, should be discussed with the British Aerobatic Association and AOPA.

(f) A research project should be implemented to review availability, clarity and layout of all information necessary in the UK for safe and legal GA flying.

(g) A Safety Sense Leaflet should be produced on Human Factors to benefit those PPL pilots who have not taken the Human Performance and Limitations examination. There could be a parallel leaflet on human physiology, 'Fit to Fly'.

9 SECONDARY RECOMMENDATIONS

9.1 General

During analysis of the 166 fatal accidents, concerns were expressed in a number of areas that did not warrant a main recommendation. Attention to such additional findings could enhance overall safety by small improvements in a wide range of aspects. These secondary recommendations are detailed below, grouped into three broad areas.

9.2 Operations

(a) The Maximum Elevation Figures on UK topographical charts could be mistaken for Area Minimum Altitude/Safe Clearance Altitude as used on Jeppesen/Aerad Radio Navigation Charts etc.

It is recommended that the Director of Airspace Policy's Maps and Charts Working Group should review this matter.

(b) General aviation aircraft are being required to fly close to terrain or funnelled into corridors to remain outside controlled airspace.

It is recommended that this be reviewed by the National Air Traffic Management Advisory Committee (NATMAC).

(c) There were a number of fatal accidents where a timely diversion or precautionary landing could have avoided the accident. In the UK (and probably elsewhere) there is a 'culture' of pressing on and hoping for the best rather than accepting the inconvenience and cost of a diversion. This 'culture' needs to be changed, firstly by educating pilots and secondly by persuading aerodrome owners that there should be no charge for emergency landings or diversions. (There are some aerodromes that do not make a charge for an emergency landing.)

It is recommended that all aerodrome owners be persuaded to adopt a policy that there should be no charges for emergency landings or diversions by General Aviation aircraft.

(d) There are a variety of Route Planning Forms available, some of which do not have a column or space for safety altitude. These forms are produced by commercial organisations, clubs etc.

It is recommended that the need for safety altitude on Flight Planning forms should be emphasised in training programmes and users should be advised to obtain forms which have an appropriate column or space.

9.3 Licence and Training

(a) Both the existing UK requirements and the JAR-FCL proposals allow a pilot who has obtained his/her licence on a Cessna 152 to fly an advanced, retractable gear, variable pitch propeller aircraft (e.g. Piper Malibu) without any further formal training. In some countries this progression requires the issue of a rating. It was noted that over 10% of the accidents involved the more complex, faster aeroplanes where distraction and/or failing to keep up with the aeroplane may have been a factor.

It is recommended that a rating be introduced for pilots wishing to fly an aircraft of over 180HP fitted with variable pitch propeller and retractable landing gear.

(b) Having acquired a licence, many PPLs undertake little in the way of further training, other than when converting to another aircraft type.

It is recommended that clubs should be encouraged to offer 'Post Qualification' training that should include such items as:

- *gross weight performance and handling,*
- *unfamiliar situations, e.g. jammed throttle, control restriction,*
- *practice PANs (distress and urgency communications),*
- *side slipping.*

(c) There are a variety of CAA-approved PPL training syllabuses in the UK. It was felt that there ought to be standardisation via a specimen syllabus in the same way as the CAA has specimen flight manuals, operations manuals etc.

It is recommended that a specimen PPL training syllabus be produced.

(d) The number of accidents to twin engine aeroplanes due to loss of control after engine failure indicate a requirement for asymmetric flight training to be regularly practised. Aeroplanes of this group can carry a significant number of passengers.

It is recommended that the current requirement for the flight every 13 months to maintain the licence be amended to include 'and shall every 6 months have practised the procedures following simulated engine failure with an authorised instructor, examiner or line check pilot'.

9.4 **Aircraft**

9.4.1 (a) Although it was not possible to determine whether it was a factor in mid-air collisions, there was disquiet at the poor state of windshields and transparencies found on some aircraft, with dirty, crazed and scratched windshields being by no means rare.

It is recommended that an Appendix to Airworthiness Notice No 12 be issued making it clear that excessively scratched, opaque and crazed windshields and transparencies should be rejected by maintenance engineers during renewal of an aircraft's C of A, Permit to Fly or during annual inspection.

(b) In crashworthiness and occupant survival terms, it is well known that a full harness was much more effective than a lap and diagonal restraint.

It is recommended that pilots be reminded of the benefits of the extra protection from a full harness and that when fitted it should be used. Pilots should also be reminded of the need to use belts/upper torso restraint.

(c) The restricted field of vision from some current general aviation training and touring aircraft is also an issue which needs to be addressed. If anything is to be improved in the future, action needs to be taken now over new aircraft design, JAR 23.773 and JAR VLA.773 both use the general words 'sufficiently extensive, clear and undistorted view etc'.

Airworthiness authorities should review the necessity for improved visibility from general aviation aircraft when flown by pilots of varying stature.

(d) Performance 'write downs', either by fleet or to an individual aircraft, are only promulgated by a loose-leaf supplement in the Pilots Handbook or Flight Manual. This can easily be lost or overlooked.

It is recommended that aircraft owners take steps to ensure that all who fly their aircraft are made aware of any amendments to the published performance data.

Appendix 1 Statistical Summary

	1985	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*(1995)**	*TOTAL (Excluding 1995)*
AEROPLANES												
Number of Accidents	16	14	27	12	11	13	13	11	13	10	(12)	140
Rate per 100,000 hrs	2.4	2.0	3.7	1.4	1.2	1.4	1.6	1.4	1.4	1.0	(1.1)	–
Deaths	28	17	53	19	14	28	19	16	20	20	(29)	234
HELICOPTERS												
Number of Accidents	0	1	1	0	3	6	2	7	2	4	(1)	26
Rate per 100,000 hrs	0	1.0	0.95	0	2.0	3.6	1.3	5.0	1.2	2.2	(0.5)	–
Deaths	0	6	1	0	8	8	2	10	3	8	(1)	46
TOTAL ACCIDENTS	16	15	28	12	14	19	15	18	15	14	(13)	166
TOTAL DEATHS	28	23	54	19	22	36	21	26	23	28	(30)	280
TOTAL RATE	2.1	1.9	3.4	1.35	1.4	1.7	1.5	2.0	1.4	1.2	(1.0)	

* Data not included in any other part of report.

Fig 1 Fatal Accidents to UK-Registered Aeroplanes and Helicopters (MTOM 5700 kg and below)

- The rates use flying hours derived from 3 year C of A or Annual Permit to Fly returns, up to 1991. Estimated hours based on airport movements by club and private aircraft, published in CAPs, have been used subsequently.
- As the working group has concentrated on causal factors, data for aeroplane and helicopter accidents have been combined for that purpose. It was acknowledged that some causes such as 'loss of control during aerobatics' would not apply to helicopters nor would 'loss of control in Instrument Meteorological Conditions' apply fully as many helicopters are not equipped for such flight.

Type of Accident	*Number of Accidents*	*Number of Persons Killed*	*% of all accidents*
Controlled flight into terrain (CFIT)	34	61	20.5
Loss of control VFR (LOC VFR)	33	61	20
Low aerobatics/flying	32	46	19
Technical problems	14	22	8.5
Loss of control IMC (LOC IMC)	13	29	8
Mid air collision	7	13	4
Aeroplane performance	5	10	3
Third party into propeller/rotor	5	5	3
Fuel system mismanaged	4	6	2.5
Alcohol/suicide	3	4	2
Collision with ground objects	3	6	2
Glider and banner towing	2	2	2
Medical	2	2	1
Unknown	9	13	5.5
TOTAL	**166**	**280**	

Fig 2 Type of Accident

Appendix 2 Controlled Flight into Terrain (CFIT)

1 Definition of a CFIT Accident

- A Controlled Flight into Terrain accident is an event where an aircraft strikes the ground during powered, controlled flight. It is the single most common form of fatal accident in General Aviation Flying.

2 Pilot Characteristics in Fatal CFIT Accidents

- Pilots involved in fatal CFITs are significantly older than those in other accident types. Over half are more than fifty years old compared with less than a quarter in other accident types.

- Probably due to the fact that it was not introduced until 1987, later than most pilots of this age would have been trained, only 13% of them have passed a Navigation Flight Test (NFT) (although some would be exempt, eg helicopter pilots). However, of the four pilots who had passed the NFT, three were among those who made errors in Navigation.

- Approximately 35% were flying in their home base local area at the time of the accident.

- Half the pilots had more than 1000 hours of total flying experience; 11% had less than 100 hours. When flying hours on type are considered, 81% had at least 20 hours and almost a third had over 350 hours.

- 34% held a current Instrument Rating (IR) or IMC rating, this increases to 45% if CPL and ATPL holders are included.

- All were male.

Criteria	*CFIT*	*Other Accident Types*
Average Age	48	40
Average Total Hours	1787	1857
Average Hours on Type	333	375
Previous 90 days	48	57
Previous 28 days	20	23
% Aged 50+	55%	22%
% 1000 hours+	50%	41%
% 350 on type+	31%	20%

Fig 2.1 Summary of Pilot Characteristics in Fatal CFIT Accidents

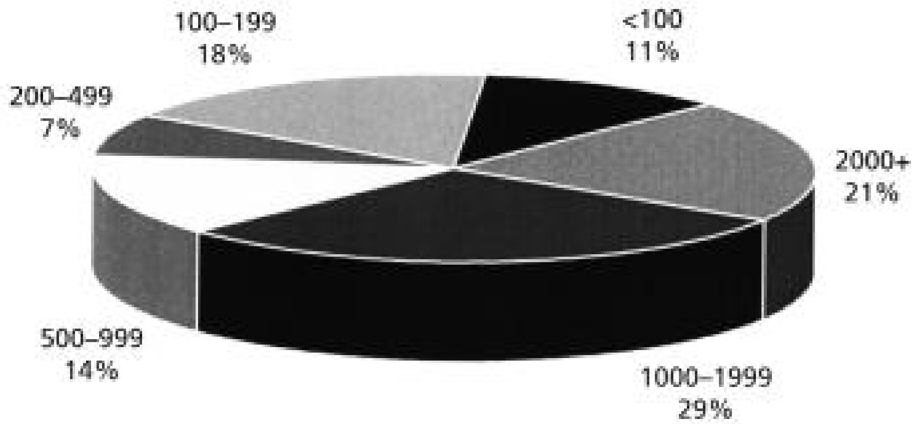


Fig 2.2 Total Hours Flying Experience of CFIT Commanders

3 Main Causal Factors in Fatal CFIT Accidents

- Figure 2.3 below shows the relative frequency of causal factors listed above. The final bar shows the two 'weather' related factors combined, ie accidents where one or both of 'continued into adverse weather' and 'lack of weather appreciation' were involved.

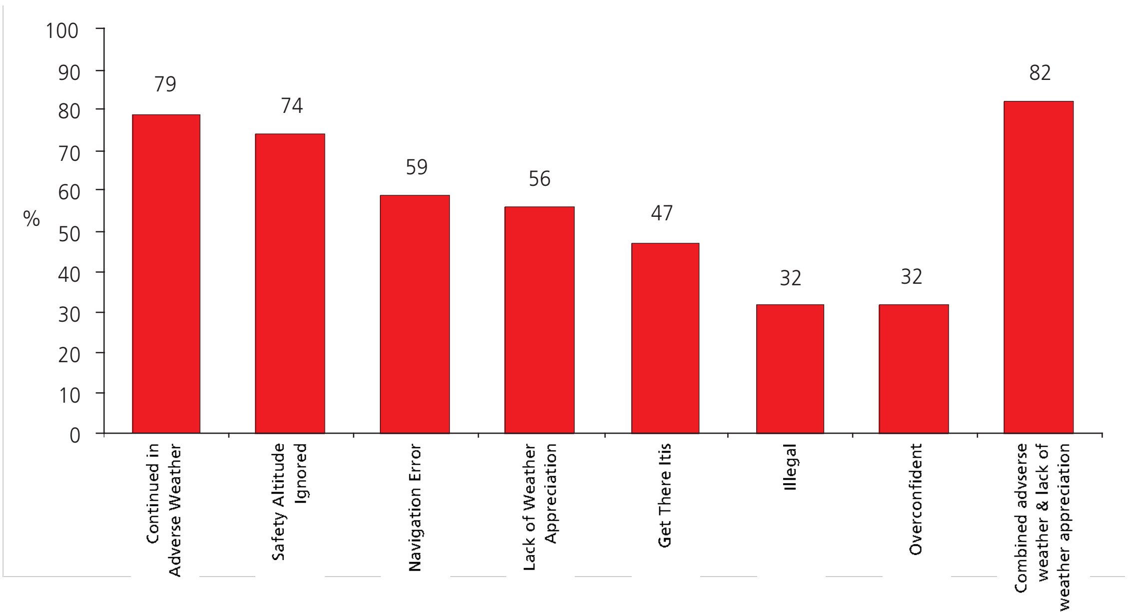


Fig 2.3 Most Frequent Causal Factors in CFIT

- The main observable factors appeared to be weather related (either continued into adverse weather or lack of weather appreciation) as well as disregard for safety altitude. It was noticed that at least one of these four factors was present in most accidents. Frequently, these factors were observed in combination. Three quarters of cases involved at least two of these main factors, and more than one third involved at least three.

- The map which follows shows that CFIT accidents are not confined to mountainous areas.

4 Location of CFIT Accidents in the UK (Fig 2.4)

The map shows that CFIT accidents are not exclusively confined to mountainous areas.

Numbers are reference numbers in Annex 8.

Fig 2.4

5 Portrait of a Fatal CFIT Accident

- The 'typical' CFIT pilot profile could be described as follows:
  - mature, experienced pilot continues a flight into deteriorating weather conditions
  - he ignores the correct safety altitude for the area
  - he may persist despite not holding a rating to fly in IMC
  - he may make a navigation error
  - he may attempt to descend into visual conditions. This might be either because he is unsure of his position and decides to seek visual references, or because he (wrongly) believes that he knows his position, and that the ground beneath him is lower than is actually the case
  - it may occur in his local area
  - he does not seek help
  - he may believe that *'he can make it'* especially if he has previously been confronted with similar circumstances and *'got away with it'*.

Appendix 3 Loss of Control in VMC (LOC VMC)

1 Definition of a Fatal LOC VMC Accident

- This is defined as a fatal accident where the pilot lost control of the aircraft while operating in accordance with normal aviation practice, under Visual Flight Rules, and **not attempting low flying, aerobatics or 'beat ups'.**

2 Pilot Characteristics in Fatal LOC VMC Accidents

- Pilots who lose control in VMC are close to the average age for pilots in other types of fatal accident. They have similar average levels of experience on aircraft type.

- Recency data on the number of hours flown in the previous 90 and 28 days was only available for a small proportion of cases (less than half) and therefore no statistical analysis was conducted. However, it may be of interest to note that the difference in averages may indicate a lower level of recency in accidents of this type.

- The most striking difference is in the total number of hours flown. It is not surprising that pilots who lose control in VMC are less experienced than those involved in other types of accident. It is interesting that it is total flying experience, but not experience on type, that shows this marked distinction.

- All but one were male.

Criteria	*LOC VMC*	*Other Accident Types*
Average Age	40	43
Average Total Hours	927	2115
Average Hours on Type	365	376
Previous 90 days	36	61
Previous 28 days	17	24
% Aged 50+	21%	31%
% 1000 hours+	21%	55%
% 350 on type+	12%	27%

Fig 3.1 Summary of Pilot Characteristics in LOC VMC Accidents

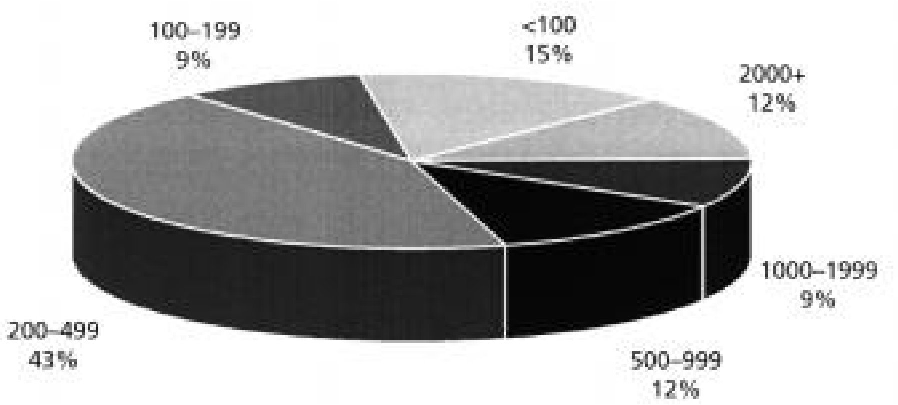


Fig 3.2 Total Hours Flying Experience of LOC VMC Commanders

3 Main Causal Factors in Fatal LOC VMC Accidents

- Some factors were clearly identified as common to a high proportion of LOC VMC Accidents. Results are summarised below:

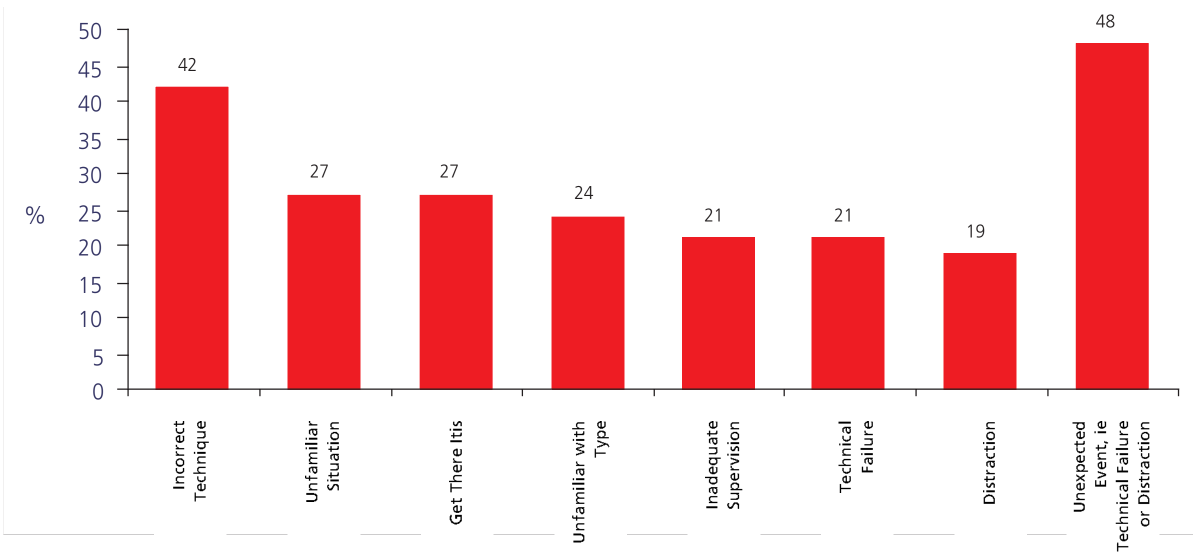


Fig 3.3 Most Frequent Causal Factors in LOC VMC

4 Portrait of a Fatal LOC VMC Accident

- These accidents appear to be the result of basic inexperience, since two thirds of pilots had less than 500 hours experience.
- Almost half involve an 'unexpected event' which may indicate that without greater overall experience, they were not adequately prepared for this.
- In view of the average flying hours, it may be that the pilot is just beginning to gain confidence and try a little more adventurous flying, or possibly he/she may have become a little complacent.
- With almost half of these accidents occurring to pilots with between 200–499 hours of total experience, this could be the time when they begin to believe that *'now they can fly'*.

Appendix 4 Low Flying and Aerobatics (LOW/AERO)

1 Definition of a Fatal LOW/AERO

- Aerobatics without sufficient height to recover from an unintentional or inadvertent manoeuvre, intentional low flying and 'beat ups'.

2 Pilot Characteristics in Fatal LOW/AERO Accidents

- Pilots involved in Low Flying and Aerobatic Accidents are more experienced and tend to be younger than pilots in other types of fatal accident.
- Only 14% of pilots were more than fifty years of age, yet almost two thirds had more than 1000 hours experience, whilst 29% had more than 5000 hours. Their hours on Type are similar to those in other types of accident.
- All were male.

Criteria	*LOW/AERO*	*Other Accident Types*
Average Age	38	43
Average Total Hours	2816	1608
Average Hours on Type	354	371
Previous 90 days	79	49
Previous 28 days	32	20
% Aged 50+	14%	32%
% 1000 hours+	64%	38%
% 350 on type+	18%	23%

Fig 4.1 Summary of Pilot Characteristics in Fatal LOW/AERO Accidents

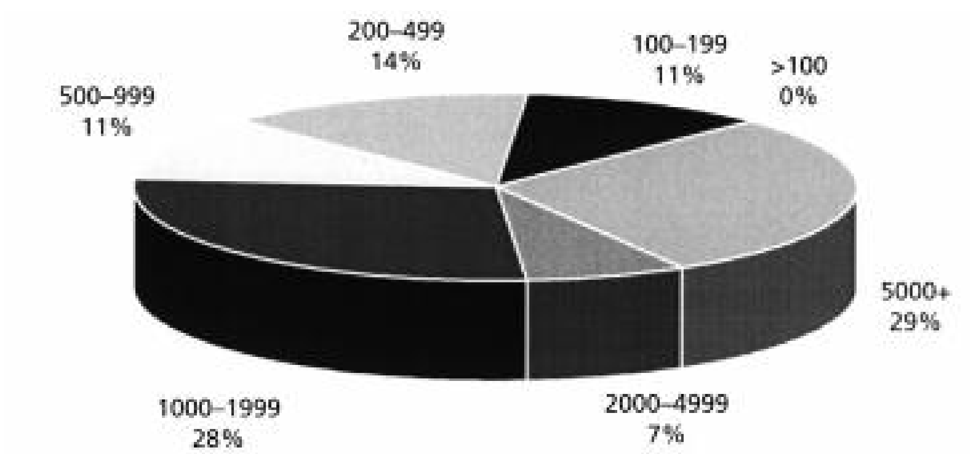


Fig 4.2 Total Hours Flying Experience of LOW/AERO Commanders

3 Main Causal Factors in Fatal LOW/AERO Accidents

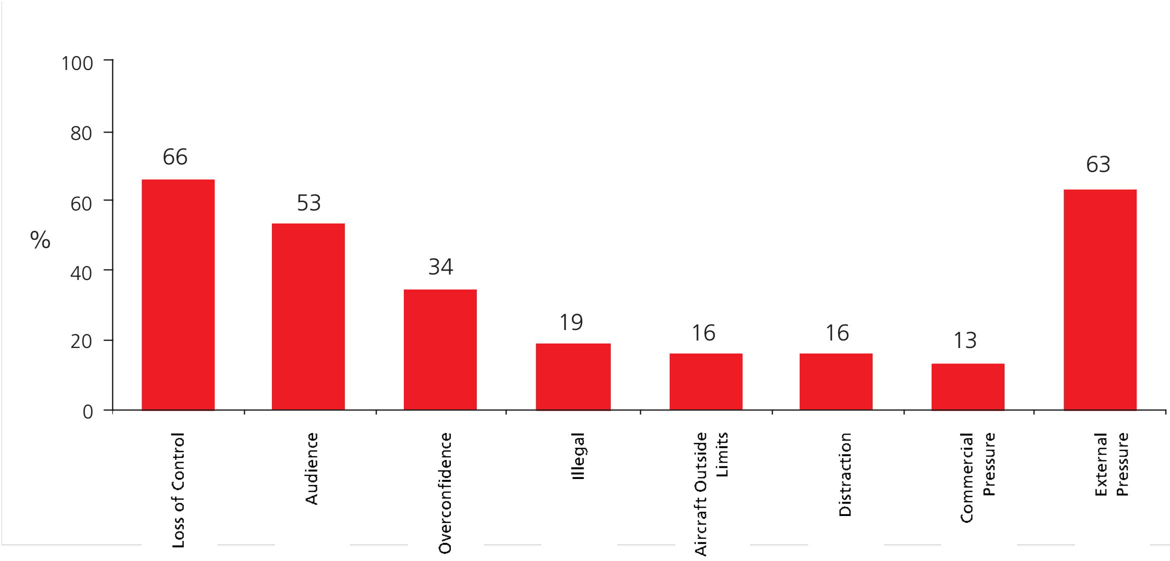


Fig 4.3 Most Frequent Causal Factors in LOW/AERO

- Two thirds involved Loss of Control. A combination of factors involving either or both of the elements 'Audience' and 'Commercial Pressure' – both possible external pressures to take risks – is also involved in almost two thirds (63%) of cases. More than a quarter (28%) involved either or both 'Illegal' (outside licence privileges) and 'Aircraft Outside Limits'.

4 Portrait of a Fatal LOW/AERO Accident

- Typically this type of accident occurs when a fairly young but highly experienced pilot is flying in demanding conditions. His trade-off between risk and safety may be adversely influenced by his confidence in his own ability (due to high hours) and external encouragement from an unofficial audience or employer. (Only one was at a UK Airshow. During much of the period under review the Air Display Authorisation system was in use.)

- He may believe that *'he can handle it'*.

Appendix 5 Loss of Control in IMC (LOC IMC)

1 Definition of a Fatal LOC IMC

- This is defined as a fatal accident where a pilot lost control of the aircraft in Instrument Meteorological Conditions.

2 Pilot Characteristics in LOC IMC Accidents

- Pilots involved in fatal LOC IMC accidents appear to be close to average age. The mean values for Total Hours and Hours on Type appear slightly lower than for other accident types but the difference is not statistically significant. Although recency data was too sparse to analyse, the averages do not suggest that this type of accident is particularly associated with being out of practice.

- All were flying in IMC yet more than three quarters had no Instrument Rating (IR) or IMC rating. (Only one pilot in this group had an IR.)

- All but one were male.

Criteria	*LOC IMC*	*Other Accident Types*
Average Age	42	38
Average Total Hours	1389	1718
Average Hours On Type	230	346
Previous 90 days	62	45
Previous 28 days	20	18
% Aged 50+	23%	27%
% 1000 hours+	23%	41%
% 350 on type+	31%	19%

Fig 5.1 Summary of Pilot Characteristics in LOC IMC Accidents

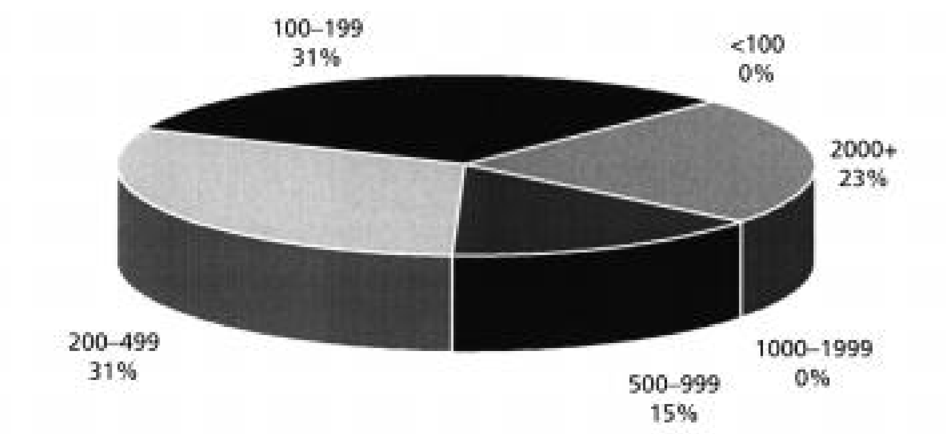


Fig 5.2 Total Hours Flying Experience of LOC IMC Commanders

3 Main Causal Factors in Fatal LOC IMC Accidents

- More than two thirds were flying outside their licence privileges and almost a quarter unwittingly took their aircraft outside limits, often leading to structural break up.
- Almost two thirds had continued a flight into adverse weather, and more than half were thought likely to have suffered from disorientation.
- Almost a quarter experienced some kind of technical failure, thus distraction was likely.
- Combination of 'weather' related factors shows that over two thirds (69%) of accidents involved either 'continued adverse weather' or 'lack of weather appreciation'.
- Combination of factors that involve 'transgression' shows that more than three quarters (77%) involved either 'illegal' or 'aircraft outside limits'.
- 85% of accidents involved one or both of these combined factors.
- Some factors were clearly identified as common to a high proportion of LOC IMC accidents. Results were as follows:

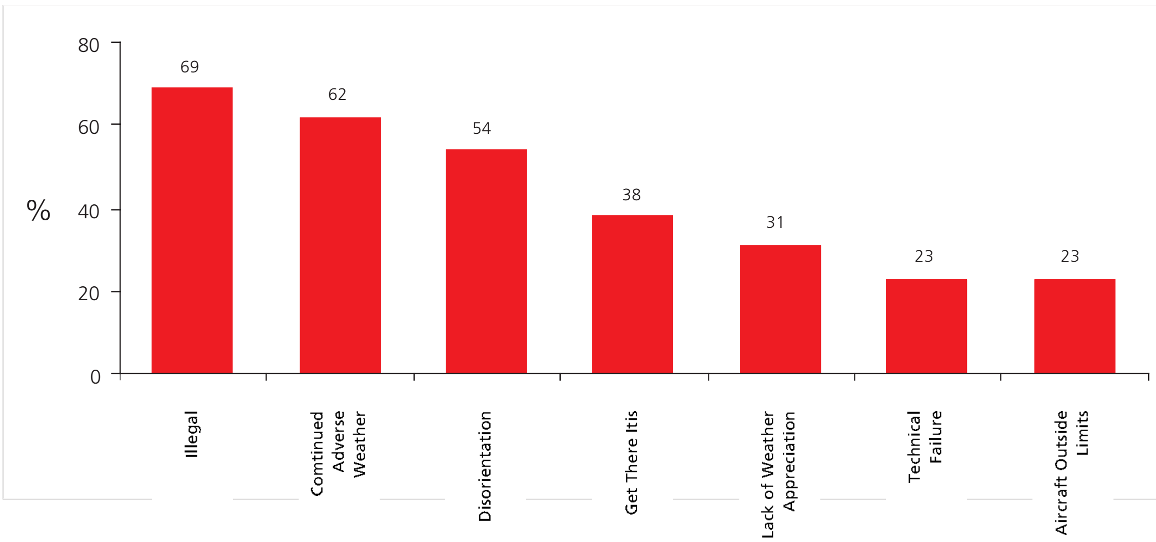


Fig 5.3 Most Frequent Causal Factors in LOC IMC

4 Portrait of a Fatal LOC IMC Accident

- This type of accident does not appear to be associated with pilots of any particular age or experience level.
- It is primarily associated with pilots who continue to fly in meteorological conditions that are either outside their licence privileges or, in some cases, their current state of practice.
- In some cases a technical failure is involved that might have finally stretched the capabilities of the pilot too far, if he was already fully engaged in controlling the aircraft in a demanding situation.
- The fact that more than three quarters were flying beyond their licence privileges, and almost two thirds continued a flight into adverse weather, suggests that many believe *'it'll be all right'*.

Appendix 6 Other Types of Accident – Discussion

There are several other types of accident where the numbers are too small for useful in-depth study but cannot, nevertheless, be ignored. Hence some discussion is provided on each one.

1 Technical Problems – 14 accidents (8%)

- Of the 14 accidents classified as technical problems, 9 of the aircraft had a Certificate of Airworthiness and 5 had a Permit to Fly.
- Four of the 14 accidents (29%) were to helicopters which account for approximately 11% of the hours flown by the UK general aviation fleet. There is thus a somewhat greater risk of an accident due to technical failure on a helicopter, not surprising in view of the greater complexity.
- Most of the accidents classified as technical failures, also contain human factors. Furthermore, technical faults were a causal factor in 10% of other types of accident.
- There were no predominant features in the technical failure accidents. However, there were 6 cases of fatal accidents due to engine stoppage, of which only 2 or possibly 3, in over 9 million flying hours, were the result of mechanical failure of the 'core' engine, all others included human factors ranging from maintenance to pilot procedures. One of the core engine failures involved a turbine engine, one was a piston engined Permit to Fly aeroplane, leaving possibly one accident on a certificated piston engine where sticking valves might have been a cause. There were many other instances of engine failures, where the aircraft landed safely. It might be argued that thorough training and correctly executed pilot procedures contributed to this satisfactory record.

2 Mid Air Collision – 7 accidents (4%)

- In two of these cases a military aircraft struck a general aviation aircraft from an angle which made detection by the general aviation aircraft impossible. The group were well aware that confliction with military aircraft is a current issue.
- The remaining five accidents were during a range of circumstances from a mock dog fight to one aircraft overtaking another. It appeared that most were in good visibility conditions and good lookout would probably have reduced the likelihood of the accident.

3 Third Party Struck by Propeller/Rotor – 5 accidents (3%)

- Four of these involved helicopters, of which three were ground personnel experienced in helicopter operations.
- Sadly, two accidents involved parachutists falling into propellers or rotors. The publication in February 1996 of CAP 660 'Parachuting' makes clear the need for procedures to ensure non-confliction in the air and on the ground.

4 **Take-off and Landing Performance – 5 accidents (3%)**

- These were accidents where the runway was not long enough either because the take-off weight was excessive for the take-off run available or through inadequate allowance for runway surface, slope, local obstructions.
- In four of these accidents incorrect technique was a factor. In two of them 'poor planning' contributed.
- The total flying hours of the pilots involved in these accidents ranged from 208 to 2050 with an average of 950. They could not therefore be regarded as inexperienced.

5 **Fuel Management – 4 accidents (3%)**

- Fatalities due to running out of fuel, either totally or in the tank being used, appeared to be connected with distraction or general inexperience. By comparison non-fatal accidents show the main factor is inadequate pre-flight visual check coupled with inaccurate fuel gauges.

6 **Alcohol/Suicide – 3 accidents (2%)**

- These have been amalgamated because flying under the influence of alcohol is tantamount to suicide.
- Sadly, very occasionally a pilot feels the need to take his/her own life by diving an aircraft into the ground. Only those cases where the pilot has left a 'note' or letter, have been classified as suicide. There have been several where there is 'hearsay' evidence only, these have been classed as unknown.

7 **Collision with Ground Objects – 3 accidents (2%)**

- These were accidents where the pilot was making a normal approach to an airfield, as opposed to a 'beat up' which was classified under low flying.
- One of the above may well have been a 'black hole' illusion during a night approach.

8 **Glider and Banner Towing – 2 accidents (1%)**

- This is a specialist task with a demanding operating technique. Accidents have only been placed in this category if the glider/banner was still attached to the tug aircraft when the accident started to happen.
- There have been several other fatal accidents to glider towing aircraft after the glider has been released, which have been classified in the appropriate group, eg loss of control VMC or out of fuel.

9 **Medical – 2 accidents (1%)**

- Probably as a result of the high medical standards required in the UK, the number of fatal accidents due to medical causes is comparatively low. In the microlighting and gliding worlds, where there is 'self certification', information from other sources shows that the percentage of accidents for medical reasons is much higher at 6% of all fatal accidents in both groups compared with 1% for the accidents considered in this review.

- Some may argue that in spite of all the checks, there have still been two fatal accidents, thus the checks are inadequate. Unlike aircraft, where non-destructive testing is usually satisfactory, with the human body the only wholly reliable method is 'destructive testing'!

10 'Other' Accident Types

- This data summarises pilot details for accidents that are not included within the four main types, and are not categorised as 'Unknown'.

Criteria	*'Other' Fatal Accidents*
Average Age	42
Average Total Hours	2092
Average Hours On Type	443
Previous 90 days	56
Previous 28 days	24
% Aged 50 +	27%
% 1000 hours+	48%
% 350 on type+	24%

Fig 6.1 Summary of Pilot Characteristics in 'Other' Accidents

Criteria	*'Unknown' Fatal Accidents*
Average Age	45
Average Total Hours	2358
Average Hours On Type	349
Previous 90 days	89
Previous 28 days	29
% Aged 50 +	38%
% 1000 hours+	63%
% 350 on type+	50%

Fig 6.2 Summary of Pilot Characteristics in Accidents Classified as 'Unknown'

Appendix 7 Discussion on Related Background Information

1 Pilot Characteristics, All Accident Types

- This data covers all types of accidents except those classified as unknown, and includes the four main types. For the total of 157 fatal accidents of known type, pilot characteristics are summarised as follows:

Criteria	*All Fatal Accidents*
Average Age	42
Average Total Hours	1843
Average Hours On Type	367
Previous 90 days	55
Previous 28 days	23
% Aged 50+	29%
% 1000 hours+	43%
% 350 on type+	22%

Fig 7.1 Summary of Pilot Characteristics in All Fatal Accidents of Known Type

- Recency data was not analysed further as it was only available in less than half of cases.

2 Causal Factors, All Accidents

Loss of Control	50%
Continued Adverse Weather	25%
Illegal	22%
Safety Height	19%
General Inexperience	18%
Unfamiliar Situation	18%
Incorrect Technique	18%
Overconfident	18%
Lack of Weather Appreciation	17%
Technical Failure	17%

Fig 7.2 Top Ten Causal Factors (see Fig 7.4 for full list) and the percentage of all fatal accidents of known type

- The percentages of all causal factors allocated to the four groups were:
  - Pilot Knowledge or Skill (31%)
  - Attitude – Stretching the Limits (44%)
  - Pilot Physiology (7%)
  - External Factors (18%)

- Less than 3% of fatal accidents were purely technical problems with no human factors involvement.

3 Gender

- For 'All' fatal accidents, 97.5% of pilots were male; 2.5% female, ie 4 were females.

- In the general pilot population, the data are available for the last three years only, these are as follows:
  - 1995: 6.1% of PPLs were female
    (Female = 1,602; Male = 24,694; Total = 26,296)
  - 1994: 6.0% of PPLs were female
    (Female = 1,539; Male = 24,053; Total = 25,592)
  - 1993: 5.2% of PPLs were female
    (Female = 1,893; Male = 34,332; Total = 36,225)

- This does show a trend of a changing proportion over time, so a direct statistical test would not be appropriate. However, to reach an average over the ten year period of 2.5%, (ie the percentage seen in the fatal accident statistics) the percentage of female pilots in 1984 would have to be less than zero.

4 Age of General Pilot Population

- Because the situation is continually changing, it is only possible to present a single 'snapshot in time' of the overall pilot population. Fig 7.3 below shows the data as it was on one day in 1994. It is presented to show the approximate numbers in each age group of the total PPL population, and also to give some impression of the number of hours flown, and accidents that occur, within each age group.

- It is important to recognise that, for example, although the accident rate per pilot increases with age, this must be balanced against the number of hours per annum typically flown by each age group.

Age Group	*Total PPLs (1994)*	*Average Hours per Annum (1994)*	*Fatal Accidents (1985-1994)*
17–26	2777	16	16
27–36	6772	27	37
37–46	7969	34	48
47–56	5217	44	34
57–66	2209	39	19
67–76	624	48	4
77–86	24	49	0

Fig 7.3 The PPL Population (1994)

5 Comparative Data

- This Section presents summary data comparing accident types.

Pilot Knowledge/Skill

In the 166 fatal accidents there were judged to be a total of 711 causal factors. The figure in brackets is the percentage of fatal accidents to which the factor applied.

Incorrect technique	29	(17%)	Procedures not followed	7	(4%)
Unfamiliar situation	29	(17%)	Lack of general technical knowledge	6	(4%)
General inexperience	29	(17%)	Lack of instrument practice	5	(3%)
Lack of appreciation of weather	29	(17%)	Lack of head protection	4	(3%)
Inadequate supervision	21	(13%)	Belt/harness ignored	4	(3%)
Unfamiliar with type	18	(11%)	Lack of training of commander	3	(2%)
Poor flight planning	11	(7%)	Lack of recency	2	(1%)
Instructor error	11	(7%)			
Poor lookout	9	(5%)	**TOTAL 217**		

Stretching the Limits

Loss of control	78	(50%)			
Continued into adverse weather	40	(24%)	Aircraft outside limits	14	(8%)
Illegal, contributing to accident	35	(21%)	Loss of control asymmetric	6	(4%)
Safety height ignored	30	(18%)	Fuel mismanagement	8	(5%)
Overconfident	28	(17%)	Poor checks	5	(3%)
Navigation error	25	(15%)	Poor flight planning	2	(1%)
Get there itis	24	(14%)			
Commercial pressure	16	(10%)	**TOTAL 311**		

Pilot Physiology

Distraction	20	(12%)	Fatigue	4	(2%)
Disorientation in IMC	11	(7%)	Pilot incapacitated	3	(2%)
Visual illusion	5	(3%)	Disorientation in VMC	1	(1%)
Possible medical problem	5	(3%)	**TOTAL 49**		

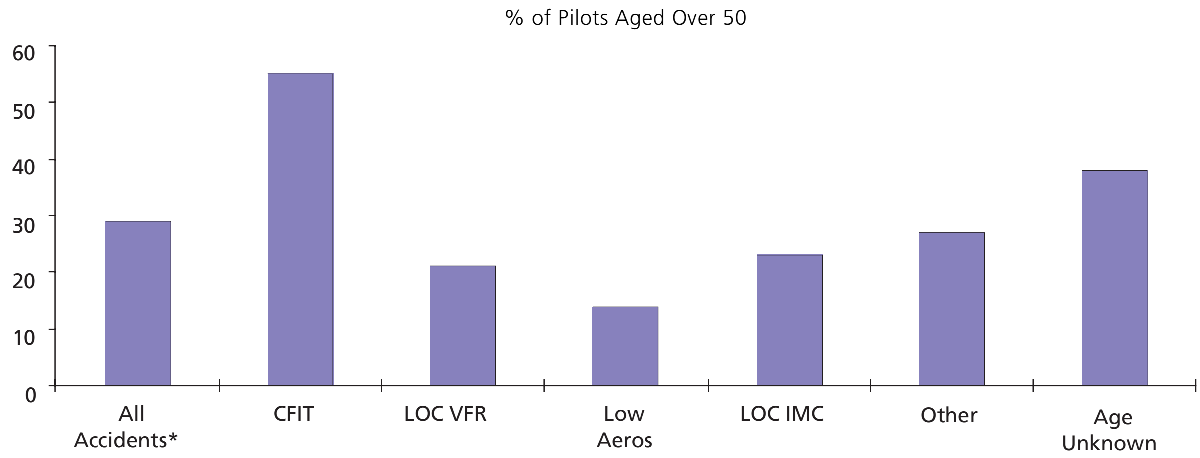
External Factors

Technical fault	30	(18%)	Unmarked obstruction near airfield	2	(1%)
Spectators	21	(13%)	Performance write down	2	(1%)
Design/build problem	13	(8%)	Poor stall warning	2	(1%)
Poor maintenance	12	(7%)	Military operations	2	(1%)
Possible engine icing	10	(6%)	Lack of weather information	1	(1%)
Ditching	5	(3%)	Inadequate passenger supervision	1	(1%)
Poor ATC	5	(3%)	Poor forms	1	(1%)
Survival equipment	5	(3%)	High ambient temperature	1	(1%)
Poor design	4	(2%)	Turbulence/down draft	1	(1%)
Inaccurate weather information	3	(2%)	Fuel unavailable	1	(1%)
Lack of navaids	3	(2%)	Airframe Icing	1	(1%)
Loose objects	3	(2%)	Wake turbulence	1	(1%)
Altimetry	2	(1%)			
Possible passenger involvement	2	(2%)	**TOTAL 134**		

Fig 7.4 Causal Factors

	Total Occurrences	Average Age	Average Total Hours	Average on Type	Previous 90 Days	Previous 28 Days	Souls On Board	Fatalities
CFIT	34	48.1	1787	333	48	20	84 (av. 2.5)	61 (av. 1.8)
LOC VMC	33	39.9	927	366	36	17	63 (av. 1.9)	61 (av. 1.9)
LOW AER	32	37.6	2816	354	79	32	61 (av. 1.9)	46 (av. 1.4)
LOC IMC	13	42.4	1389	230	61	20	29 (av. 2.2)	29 (av. 2.2)
Other	45	42.4	2092	443	56	24	119 (av. 2.6)	68 (av. 1.5)
Unknown	9	45.1	2358	349	89	30	13 (av. 1.4)	13 (av. 1.4)
All Known	157	42.1	1843	367	55	23	356 (av. 2.3)	265 (av. 1.7)
All Fatals Inclusive	166	42.2	1870	367	57	23	369 (av. 2.2)	278 (av. 1.7)

Fig 7.5 Comparative Data Summary



* Including accidents where causes were unknown

Fig 7.6 Pilot Age and Accident Types

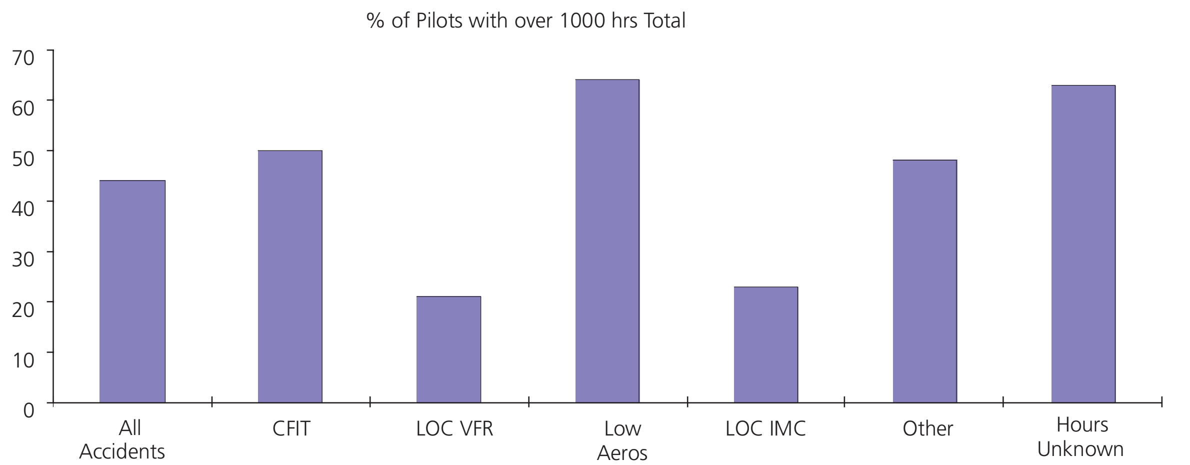


Fig 7.7 Pilot Total Experience and Accident Types

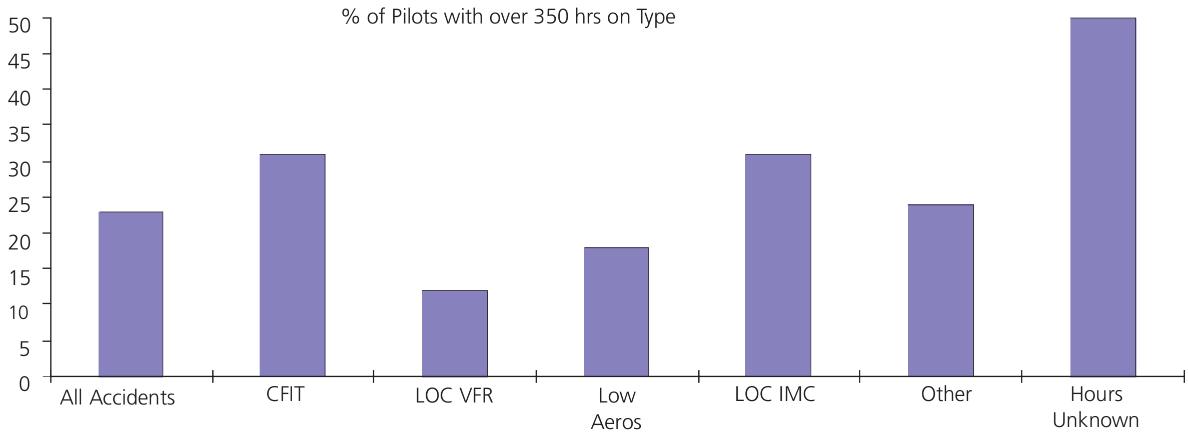


Fig 7.8 Pilot Total Experience and Accident Types

6 Aircraft Type

- Aircraft design may influence a number of accidents ranging from fuel system design to ease of lookout and, of course, handling qualities that may enable a pilot to recover from a marginal situation. A few types of accident, eg medical, suicide and alcohol have been excluded from the table below which only includes those aircraft types with 3 or more fatal accidents.

Aircraft Type	*Fatal Accidents*	*Estimated Total Flying Hours* 1985–1994*	*Fatal Accidents per 100,000 hours*
Cessna 150/152	9 +	1,702,000	0.52
(Cessna 172	2	486,900	0.41)
Cessna 182	5	81,700	6.10
Gulfstream AA5	3 ++	303,900	0.99
Jodels	4	93,800	4.30
Mooney M20	3	28,800	x
Piper PA18/19 Cub	3	57,300	5.20
Piper PA28 Cherokee	13 ++	1,554,000	0.84
Piper PA31 Navajo	3	169,700	1.80
Piper PA38 Tomahawk	3	413,200	0.73
Pitts S1 & S2	7	18,400	x
Slingsby T67	5	91,000	5.50
Socata TB Series	3	90,700	3.30
Steen Skybolt	3	1,100	x
Taylor Mono/Titch	3	3,700	x
Bell 206 Jet Ranger	9	273,300	3.30
Robinson R22	7	230,000	3.00

- ♦ In addition to the above, there were 14 aircraft types each of which had 2 fatal accidents and 49 with a single fatal accident. The Cessna 172 is included in the table for comparative purposes as it has flown a sizeable total of hours.

- ♦ It should be noted that human factors and style of operation are the cause of most of these fatal accidents. Aircraft technical defects are covered by Appendix 6, para 1.

- ♦ The differing fatal accident rates per 100,000 hours shows those aircraft types where perhaps extra training and a more responsible pilot attitude are required.

7 Registration Category

- ♦ The maintenance and equipment standards are dependent upon the category in which the aircraft is registered. These may, in some cases, have an effect upon an accident or its outcome. The certification category of the aircraft involved in fatal accidents is shown below.

Category	Number of Fatal Accidents	Estimated Total Flying Hours * 1985–1994	Fatal Accident Rate per 100,000 hours
Permit to Fly ø	34	339,000	10.0
Private	51	2,226,00	2.3
Transport	81	6,512,000	1.2
None	1	–	–
Total/Mean	167	9,077,000	1.8

Notes to paras 6 and 7:

Where the aircraft were UK general aviation involving fatalities, both types have been included in mid-air collisions.

\+ Each symbol represents an accident due to medical, suicide or alcohol, not included in rate for aircraft types.

* Flying hours taken from C of A and Permit to Fly renewal records 1985-1991, estimated from number of aircraft on register and utilisation for 1992-1994 for total aircraft in each category.

x Rate unreliable for aircraft with less than 50,000 hours.

ø Includes warbirds.

- ♦ Again it should be borne in mind that few of the above were accidents solely due to aircraft faults. Most were due to the way in which the pilot operated the aircraft.

8 Licence Held by Commander

- The type of licence held will reflect the commander's background, experience and level of training. The following percentages apply to the commander of aircraft involved in fatal accidents; they may not necessarily have been the handling pilot. It has not been possible to assess throughout the period the percentage of the pilot population in each group.

Student	2.4
PPL	63.8
BCPL/CPL and instructor rating	12.6
Student CPL	1.8
ATPL, including instructor rating	14.4
None	.6
Unknown	4.2

- The relatively high percentage of accidents where the commander held both a professional licence and an instructor rating is of concern.

9 Type of Operation

Type of Operation	*Number of Fatal Accidents*	*%*
AOC Holder, excluding police	14	8.4
Instructional flight for issue of licence or new category, includes students flying solo	18	10.8
Private, including business	117	70.0
Special activities, police, aerial work, parachute dropping, line inspection, glider or banner towing	14	8.4
Public flying display, excluding practice	4	2.4

Note: If the accident is a mid-air collision, where relevant, the type of operation of both civil aircraft has been included.

- The percentage of fatal accidents involving AOC Operators is notable. Some were during transit/ferry flights by AOC Operators, and other were during freight flights. Thus the number involving AOC passenger carrying flights was not excessive.

- The percentage of accidents during instructional flights, some of which were student solo flights is also of concern.

- The various Special Activities by their very nature are in unusual or high risk situations.

- In the period under review, fatal accidents at public flying displays (of which one was outside the UK) are comparatively rare and may now reflect the firm control exercised by the CAA. None of these accidents created any risk to the public.

- It has not been possible to determine the relative proportions of hours or flights in each category of Operation.

Appendix 8 Summary of Each Accident

(Type of Operation – A = AOC Operator, D = Display, I = Instruction, P = Private, S = Special ie Aerial work, glider and banner towing, pipeline, police, parachuting)

Ref No	*Date*	*Aircraft Type*	*No of Engines*	*Type of Operation*	*Location*	*On Board*	*Deaths*
1	10.02.85	Cessna 172N	1	P	Nr Alderney, CI	1	1
	Reportedly ditched in sea after engine problem. Wreckage not found. Subject of an insurance investigation.						
2	24.02.85	GA7 Cougar	2	P	Nr Ventnor, I of W	4	1
	Flying low over sea aircraft struck the water. One passenger drowned.						
3	25.04.85	PA32 Lance RT	1	P	Nr Fairoaks, Surrey	4	2
	After landing gear indication problem, the aircraft crashed into woods following engine stoppage due to lack of fuel in selected tank.						
4	15.05.85	Edgley Optica	1	S	Nr Ringwood, Hants	2	2
	Loss of control during a steep turn while on a police surveillance flight at low altitude.						
5	03.06.85	Cessna 150	1	P	Nr Market Rasen, Lincs	2	2
	Crashed in deteriorating weather on edge of Wolds. The aircraft was destroyed by fire.						
6	01.07.85	Monnett Moni	1	P	Tibenham, Norfolk	1	1
	Following a low flypast and steep climbing turn, a spin developed from which it failed to recover.						
7	02.07.85	Pitts S1D	1	P	Nr Bognor Regis, Sussex	1	1
	While performing aerobatics, the aircraft failed to recover before striking the sea.						
8	09.08.85	PA28-180 Archer	1	P	Nr Welford, Northants	1	1
	Aircraft seen to enter steep dive, pilot had suffered from a heart condition, CAA not informed.						
9	02.09.85	PA28-180R	1	P	Nr Annemasse, France	4	2
	After take-off the aircraft turned towards a high mountain, lost altitude and speed, attempted to force land on steep slope.						
10	07.09.85	Harvard	1	P	Bourn, Cambs	1	1
	During an air display routine with another Harvard the aircraft failed to recover from a rolling manoeuvre.						
11	08.09.85	Cessna 206	1	S	Nr Winterborne Zelston, Devon	2 (4)	2
	During climb to drop parachutists, control was lost after an aileron cable disconnected.						

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
12	08.09.85	Pitts S2	1	P	Wellesbourne Mountford, Warwickshire	2	2

While performing aerobatics, a spin developed at about 700ft, it struck the ground and burned.

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
13	17.09.85	Grumman AA5A	1	P	Le Touquet, France	4	4

Crashed into low hill approximately 1/2 mile from the airfield boundary in bad weather following go around from ILS approach.

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
14	01.10.85	Rockwell 112	1	I	Leicester Airport	1	1

During a solo flight to renew the pilot's night rating, the aircraft collided with power cables just over 1nm from the threshold.

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
15	08.11.85	PA28-180 Archer	1	P	Drumlanrig, Dumfries	2	2

The aircraft was taking off at maximum weight from the Castle driveway and clipped trees and crashed.

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
16	20.11.85	PA31 Navajo	2	P	Nr Rochester, Kent	3	3

During a second visual night approach, the aircraft struck the steep upper slopes of a hill 2 km from the aerodrome.

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
17	15.03.86	Pitts SID	1	P	London Colney, Herts	1	1

During aerobatic manoeuvres with another aircraft, the pilot lost control and crashed.

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
18	08.04.86	SA355 Twin Squirrel	2	A	Nr Banbury, Oxon	6	6

While flying at 2,500ft in IMC, the helicopter suffered a total loss of power. The most likely cause being slush forming in the intake.

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
19	29.04.86	Jodel 1050	1	P	Stapleford, Essex	3	3

Just before landing the left wing was seen to drop, the aircraft cartwheeled and caught fire.

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
20	05.05.86	Slingsby T67M	1	D	Cranfield, Beds	1	1

At the end of a display sequence the aircraft pulled up into a manoeuvre from which it descended in a nose down attitude until it struck the ground.

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
21	12.06.86	DHC6 Twin Otter	2	A	Nr Islay, Scotland	16	1

Struck hillside during visual approach in poor weather.

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
22	13.06.86	PA18-150 Super Cub	1	P	Eaglescott, Devon	1	1

Control was lost during a very steep right turn within the airfield boundary.

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
23	15.06.86	Rand KR2	1	P	Nr Swansea, Glamorgan	1	1

Control was lost while making a forced landing due to an engine problem.

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
24	03.07.86	AA5A	1	I	Denham, Bucks	2	1

During a touch and go the aircraft took off in a very nose high attitude, a wing dropped and it crashed into trees.

Ref No	*Date*	*Aircraft Type*	*No of Engines*	*Type of Operation*	*Location*	*On Board*	*Deaths*
25	04.08.86	Taylor JT1 Monoplane	1	P	Nr Holbeach, Lincs	1	1
	The aircraft crashed while making an emergency landing following an engine problem on the pilot's first flight on the single seat aircraft type.						
26	10.09.86	Cessna F150M	1	P	Norwich, Norfolk	1	1
	While practising for a forthcoming air display, during a pull up and spin manoeuvre, the aircraft failed to pull out of the ensuing dive.						
27	11.09.86	Grumman AA5A	1	P	Chandlers Ford, Hants	1	1
	The aircraft was seen to dive at high power vertically into the ground and was destroyed by fire, the inquest returned a verdict of suicide.						
28	14.09.86	BN3 Trislander	3	A	Nr Amsterdam, Schiphol	1	1
	The aircraft was on a night cargo flight from Stansted. After a discontinued ILS approach owing to wind and turbulence, the aircraft entered a spiral dive and crashed.						
29	03.10.86	Gardan GY80 Supercub	1	P	Nr Bethersden, Kent	2	2
	Loss of control after engine stopped due to being out of fuel.						
30	11.11.86	MS893 Rally 180	1	S	Manchester (Barton), Lancs	1	1
	Banner tow rope became trapped over tailplane causing loss of control.						
31	13.12.86	PA38 Tomahawk	1	P	Walthamstow, London	2	1
	Crashed in built up area during forced landing owing to smoke in cockpit from failed solid state 'alternator inoperative switch'.						
32	18.01.87	MS894A Rally Minerva	1	P	Honiton, Devon	3	3
	Crashed following loss of control due to severe airframe icing.						
33	23.01.87	Cessna FRA150	1	I	Perth, Scotland	1	1
	Loss of control in climb after touch and go landing into setting sun.						
34	22.03.87	Scheibe SF23	1	P	Nr Bellaghy, Co Londonderry	2	2
	After a prolonged take-off run the aircraft stalled when in a steep nose-high attitude.						
35	29.03.87	Slingsby T67A	1	P	Nr Brandesburton, N Humberside	2	2
	Loss of control during low level roll manoeuvre near a farmhouse.						
36	07.04.87	Cessna 310	2	P	Nr Tatsfield, Kent	2	2
	The aircraft crashed during a VOR/DME approach in poor visibility.						
37	10.10.87	Piper PA19 Super Cub	1	P	10 nm N of Dinard, France	2	2
	The engine stopped and the aircraft was ditched successfully. The bodies, wearing lifejackets, were recovered 3½ hours later.						

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
38	26.04.87	Cessna 441 Conquest	2	P	Blackbushe, Hants	1	1
	After a go-around due to unsafe main gear indication (defective microswitch) the aircraft turned until it crashed into trees semi inverted. An asymmetric power condition was most probable.						
39	10.05.87	Jodel D112	1	P	Nr Llangwnnadl, Aberdaron, Gwynedd	2	2
	Control was lost after the engine lost power due to a faulty fuel selector.						
40	17.05.87	Steen Skybolt	1	P	Brunton, Northumberland	2	2
	Loss of control during a low flypast possibly due to control obstruction from a bag on the passenger's lap.						
41	17.05.87	PA28 Arrow	1	P	Nr Nieuwkerken, Belgium	4	4
	Mid air collision at 1500ft with Belgian C185 parachuting aircraft (5 killed in C185).						
42	23.05.87	Supermarine S5 Replica	1	P	Nr Mylor, Cornwall	1	1
	The tail detached due to flutter on its first flight for 7 months.						
43	12.06.87	Slingsby T67A	1	P	Nr Effingham, Surrey	2	2
	Engine cut during a loop with insufficient height between bottom of TMA and ground for recovery.						
44	06.07.87	Partenavia P68	2	S	Faroe Isles, Denmark	3	3
	Crashed into cliff on small offshore island during approach in poor weather while on wildlife survey.						
45	12.07.87	Slingsby T67A	1	P	Alskike, Sweden	1	1
	Crashed during low level aerobatics.						
46	14.07.87	Grumman AA5	1	P	Nr Exeter, Devon	1	1
	Crashed into hill while attempting to follow a motorway in poor weather and low cloud base.						
47	31.07.87	D62 Condor	1	S	Brome, Suffolk	1	1
	After glider tow, pilot became lost, ran out of fuel and control was lost during forced landing.						
48	02.08.87	Stampe SV4	1	P	Nr Royston, Herts	2	2
	Crashed during aerobatics after left lower wing main spar tie-rod failed due to fatigue at threaded end.						
49	09.08.87	Enstrom F28	1	I	Thruxton, Hants	3	0 (1 Third Party)
	Parachutist fell into rotors – killed – helicopter destroyed.						
50	18.08.87	PA31 Navajo 2	2	P	Mt Beuvray, France	7	4
	Aircraft struck trees on high ground in thick fog.						

Ref No	*Date*	*Aircraft Type*	*No of Engines*	*Type of Operation*	*Location*	*On Board*	*Deaths*
51	06.09.87	Piel CP301 Emeraude	1	P	Perth, Scotland	2	2
	Aircraft stalled after take-off in a crosswind from short runway and crashed into trees.						
52	06.09.87	SF25 Falke B	1	I	Waldershare Park, Kent	2	1
	Engine failure during climb due to water in fuel, aircraft struck trees during forced landing.						
53	12.09.87	Beech 200 Super King Air	2	A	Rayleigh, Essex	1	1
	Loss of control after explosion and fire in left-hand engine – crashed into garage.						
54	22.09.87	Chipmunk	1	S	Husbands Bosworth, Leicestershire	2	2
	Aircraft crashed on final approach due to loss of control in steep turn.						
55	25.09.87	Cessna A150K	1	P	Tollesbury, Essex	2	2
	Aircraft crashed in field after performing low level aerobatics, alcohol involved.						
56	19.10.87	Beech 200 Super King Air	2	P	Otley, S Yorks	1	1
	Collision with hill during approach to Leeds-Bradford – altitude setting error.						
57	20.10.87	Cessna 421B Golden Eagle	2	P	Nr Stansted, Essex	6	6
	Left-hand engine problem – pilot tried to return but lost control and crashed inverted.						
58	29.11.87	PA32R-301T Saratoga	1	P	Bow Fell, Cumbria	1	1
	Aircraft flew into cloud covered mountain 150ft from summit.						
59	17.12.87	Rollason Beta	1	P	Wattisham, Suffolk	1	1
	On approach to landing, the aircraft spun into the ground.						
60	15.01.88	Cessna 150L	1	P	Teignmouth, Devon	1	1
	Aircraft crashed into a fog shrouded hill top.						
61	25.01.88	Beech 90 King Air	2	A	East Midlands Airport	1	1
	Stalled during attempted go-around in instrument conditions, with some power asymmetry.						
62	28.03.88	Jodel D120A	1	P	Cotgrave, Northants	1	1
	Wing failed due to overstressing during aerobatics not permitted on the type.						
63	23.04.88	Akro Z200	1	P	Tempsford, Beds	1	1
	Aircraft recovered from a spin but did not come out of a spin in the opposite direction.						
64	16.06.88	Piper PA28-161	1	P	Detling Hill, Kent	1	1
	The aircraft entered a spiral dive into the ground – believed spatial disorientation in cloud.						

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65	11.07.88	Pitts S1D	1	P	Chessington, Surrey	1	1
	Crashed during a go-around when control was lost in turn.						
66	18.07.88	PA38 Tomahawk	1	I	Longdon, Worcs	1	1
	Mid-air collision with another PA38 during unauthorised 'dog fight'.						
67	23.07.88	Mooney M20K	1	P	Southampton, Hants	2	2
	Crashed at high speed near airfield during attempt at visual approach in poor visibility.						
68	11.09.88	Cessna P210N	1	P	Turin, Italy	3	3
	Crashed into high ground about 30 miles from airport in poor weather.						
69	18.09.88	Jodel D120A	1	P	Slinfold, W Sussex	2	2
	Crashed into trees on approach when control was lost during turn on to short finals.						
70	21.10.88	Robin 400-180R	1	P	Drumochter, Scotland	3	3
	Loss of control in cloud after engine lost power.						
71	20.11.88	Slingsby T67C	1	I	Nr Aylesbury, Bucks	2	2
	The aircraft failed to recover from intentional spin.						
72	10.02.89	Cessna 152	1	I	Shobdon, Herefordshire	3	1
	Mid-air collision with microlight during climb out.						
73	11.03.89	BN2A Islander	2	S	Headcorn, Kent	2	1
	Parachutist on descent fell into prop of jump aircraft on ground.						
74	07.06.89	Grob G109B	1	P	Nr Alicante, Spain	1	1
	Crashed in mountain region (in area of known down-draughts).						
75	28.06.89	Bell 206B	1	S	Corfu, Greece	5	1
	Struck cliff face during low level filming.						
76	01.07.89	Spitfire VC	1	P	Hartley Whitney, Hants	1	1
	Crashed during attempted forced landing following engine crankshaft failure.						
77	08.07.89	PA28 200R	1	P	Nr Amberley, W Sussex	1	1
	Aircraft broke up in the air following loss of control in cloud.						
78	29.07.89	IS28 M2A	1	I	Woodford, Cheshire	2	2
	Aircraft stalled soon after take-off and spun into ground.						
79	07.08.89	Steen Skybolt	1	P	Nr Worksop, Notts	2	1
	Rudder controls jammed by loose object – aircraft spun into ground.						
80	23.08.89	Colibri MB2	1	P	Nr Basingstoke, Hants	1	1
	During unidentified manoeuvres the right-hand wing separated in flight due to overload.						
81	24.08.89	PA18-150	1	S	Portmoak, Scotland	2	2
	After releasing the glider, the aircraft spun during turn at low level.						

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82	09.09.89	Falco F8L	1	P	Strangford Lough, N Ireland	2	2
	Structural failure after empennage failure, possibly as a result of canopy detachment.						
83	02.12.89	Pitts S-2A	1	P	Insch, Scotland	1	1
	Failed to recover from a manoeuvre during low level aerobatics.						
84	06.12.89	Hughes 369HS	1	P	Nr Carlisle, Cumbria	2	2
	Loss of control and rotor RPM in IMC – reason undetermined.						
85	18.12.89	Bell 206B	1	A	Nr Biggin Hill, Kent	5	5
	Crashed following loss of control when attempting to return in poor weather.						
86	24.01.90	Bell 206A	1	S	Giffnock, Glasgow	4	1
	Engine flamed out in snow and reduced visibility during police operations. Helicopter struck building and crashed.						
87	09.02.90	Christen Eagle 2	1	P	Nr Chelmsford, Essex	1	1
	Failed to recover from a low level aerobatic manoeuvre.						
88	18.03.90	FNR RF5	1	P	Rattlesden, Suffolk	2	1
	Aircraft stalled and hit ground shortly after take-off.						
89	24.03.90	Cessna 150FM	1	P	Nr Mere, Wilts	2	2
	Aircraft stalled in low level turn during precision flying practice.						
90	28.03.90	Robinson R22B	1	P	Nr Chinnor, Oxfordshire	1	1
	Struck trees on rising ground when hill tops were cloud covered.						
91	13.04.90	Beech 33 Bonanza	1	P	Bayeux, France	4	4
	Loss of control in IMC and severe turbulence. Aircraft broke up in air.						
92	28.04.90	D62 Condor	1	S	Tibenham, Suffolk	1	1
	Tug engine problems – glider released. Wing struck ground during forced landing.						
93	03.05.90	Grob G109	1	P	Wolford Heath, Warwickshire	2	2
	Mid air collision with Robin. No injury to occupant of Robin.						
94	19.05.90	Tigermoth	1	P	Nr Reigate, Surrey	1	1
	During the climb mid air collision with PA28 (in which 3 persons killed).						
	19.05.90	Piper PA28-181	1	I		3	3
	While descending towards the aerodrome mid air collision with Tigermoth (in which 1 person was killed).						
95	21.05.90	Bell 206B	1	A	Nr Invervie, Scotland	1	0 (1 Third Party)
	Experienced ground handler inexplicably walked into tail rotor and sustained fatal injury.						

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96	27.05.90	Socata TB10	1	P	Stoneykirk, Scotland	4	4
	The aircraft took off with flaps retracted in a steep nose high attitude, struck bank, turned over and caught fire.						
97	27.06.90	Agusta A109	2	P	Nr Rocester, Staffs	6	2
	Helicopter struck power lines while low flying along a river valley and crashed.						
98	07.07.90	PA28-140	1	P	Cranfield, Beds	3	3
	The aircraft was turning to reposition correctly on finals when it stalled.						
99	13.07.90	Bell 206B	1	P	Stanley, Co Durham	2	2
	Struck power lines shortly after take-off from a hotel site and crashed.						
100	17.07.90	Cessna 150FL	1	P	Skegness, Lincs	2	2
	The aircraft failed to recover from a low level stall turn.						
101	31.08.90	Hughes 369HS	1	P	Felsted, Essex	1	1
	Attempted forced landing in field after engine rundown due to failure of PC line – lost rotor RPM.						
102	20.10.90	Partenavia P68B	2	A	Nr East Midlands Airport	1	1
	Crashed after take-off due to disorientation at night in poor weather. The single artificial horizon was in poor condition.						
103	20.11.90	PA28-161	1	P	Nr Dunbar, Scotland	1	1
	Struck high ground at night during approach to Edinburgh.						
104	27.12.90	Cessna 150FF	1	P	Nr Burlington Cross, Hants	2	2
	Aircraft short of fuel – control was lost during precautionary landing in field.						
105	10.03.91	Robinson R22B	1	P	Halifax, W Yorkshire	2	1
	Struck power cables on take-off.						
106	10.03.91	Cessna 175C	1	P	Nr Chilgrove, W Sussex	1	1
	Disorientation during go-around in bad weather after approach to Chichester – struck high ground.						
107	31.03.91	PA38 Tomahawk	1	P	Coventry, W Midlands	2	2
	Crashed after failing to recover from a formation pull-up and steep turn.						
108	18.04.91	PA28-181	1	P	Stanmore, Middlesex	1	1
	Aircraft ran out of fuel and crashed – pilot under influence of alcohol.						
109	15.05.91	Cessna 182Q	1	P	Nr Llangollen, N Wales	3	3
	Crashed into high ground 1500ft amsl.						
110	19.05.91	Provost T51	1	P	Aldermaston, Berks	1	1
	Crashed during a low level turn while practising for an air display.						

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111	20.05.91	Piper PA28-161	1	P	High Cross Moor, Nr Lancaster, Lancs	2	2
	Crashed at 850ft amsl in low cloud and hill fog.						
112	30.06.91	DH89 Dragon Rapide	2	D	Audley End, Essex	1	1
	The aircraft spun during low level slow flight display – probably due to control restriction after the control yoke caught in a loop on pilot's harness.						
113	06.07.91	Taylor Titch	1	P	Winterbourne, Nr Bristol, Avon	1	1
	Stalled in steep low level turn and struck ground.						
114	17.08.91	Christen Eagle 2	1	P	Nr Pangbourne, Berks	2	2
	Failed to recover from inverted spin during aerobatics.						
115	26.08.91	Bandeirante	2	S	Tilstock, Whitchurch, Shropshire	19	1
	Parachutist struck stabiliser on exit – killed. Aircraft not cleared for parachuting.						
116	29.08.91	Cessna 152	1	P	Carno, Wales	3	2
	Struck by RAF Jaguar while carrying out low-level photography – aircraft destroyed.						
117	08.09.91	Robinson R22B	1	I	Welford, Warwickshire	1	1
	Main rotor struck tail boom in flight – aircraft crashed.						
118	22.11.91	PA23 Aztec	2	P	Nr Venice, Italy	1	1
	Aircraft crashed in sea off Venice during night flight – accident circumstances not determined.						
119	16.12.91	Cessna P210N	1	P	Chichester, W Sussex	1	1
	Crash in fog conditions near touchdown point while attempting visual approach.						
120	13.02.92	PA28-200R Arrow	1	P	Skiddaw, Cumbria	1	1
	Entered adverse weather at night, crashed into high ground of 3055 amsl.						
121	23.02.92	Robinson R22M	1	P	Royton, Oldham, Lancs	2	2
	Engine lost power, rotor stopped and fell vertically to ground.						
122	28.03.92	Rotorway Exec	1	P	Coalport, Shropshire	1	1
	Main rotor blade failure due to disbonding – tail boom detached and helicopter fell into wooded area.						
123	03.04.92	Grob G115	1	I	Loch Muick, Ballater Scotland	2	2
	Loss of control in adverse weather – crashed into Loch.						
124	07.04.92	PA28-140 Cherokee	1	P	Consett, Co Durham	1	1
	Struck radio mast cable 1932ft amsl in poor weather – crashed on hillside.						

Ref No	Date	Aircraft Type	No of Engines	Type of Operation	Location	On Board	Deaths
125	18.04.92	Sikorsky S76A	2	A	Heather A Platform N Sea	9	0 (1 T/P)
	Main rotor blade struck and killed HLO on oil rig platform. The platform was rolling and pitching causing helicopter to move backwards.						
126	09.05.92	Pitts S-1T	1	D	Albenga, Italy	1	1
	Crashed after spin during flying display.						
127	29.05.92	Robinson R22B	1	P	Nr Latimer, Bucks	2	2
	Crashed following entry into poor weather at night. Possible distraction due to engine problem from carburettor icing or sticking exhaust valve.						
128	27.06.92	Spitfire XIV	1	D	Woodford, Nr Manchester	1	1
	Failed to recover from loop at flying display and struck ground.						
129	12.07.92	PA28-161 Warrior	1	I	Oxford Airport	2	2
	Loss of control on finals due to wake turbulence from hover-taxying helicopter – crashed just short of runway.						
130	15.07.92	Piper PA34-200T	2	P	Nr Bowland, Lancs	1	1
	Struck 1400ft high ground in poor weather and visibility.						
131	14.08.92	Bell 206B	1	A	Crowthorne, Berks	5	2
	Tail rotor drive disconnect after nut detached. Helicopter crashed into woodland.						
132	22.08.92	Socata TB20	1	P	Isle of Jura, Scotland	4	4
	Struck high ground in poor weather conditions while flying off intended track.						
133	17.09.92	Schweizer 269C	1	P	Gmunden, Austria	1	1
	Fell down hillside while attempting to land on sloping site.						
134	22.09.92	SA 365 Dauphin	2	A	Viking Bravo Oil Rig	2	0 (1 Third Party)
	Main rotor blade struck and killed deck hand.						
135	04.10.92	Cessna 172D	1	P	Sheepwash, Devon	4	1
	During the third attempt to take-off at maximum weight, struck hedge and crashed.						
136	17.11.92	Pitts S-2A	1	I	Chesham, Bucks	2	1
	The aircraft entered an unintentional spin following a badly executed aerobatic manoeuvre below TMA.						
137	06.12.92	Cessna 182N	1	P	Nr Wycombe, Bucks	2	2
	Crashed into trees during night visual approach with low cloud base.						
138	13.01.93	Bandeirante	2	A	Nr Sellafield, Cumbria	2	2
	Crashed on high ground in poor weather after diverting from planned track.						
139	28.01.93	Cessna 182N	1	P	Belfast Lough, N Ireland	1	1
	Crashed into water during night IMC approach to Belfast City Airport.						

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140	18.03.93	AS202 Bravo	1	I	Nr Maybole, Ayr, Scotland	2	2
	Entered spin and struck ground while flying low.						
141	21.03.93	Socata TB20	1	P	Nr Swindon, Wilts	3	3
	Control was lost attempting precautionary landing in poor weather after loss of electrical power.						
142	08.04.93	Wassmer 52	1	P	Nr Teignmouth, Devon	3	3
	Struck tree and crashed on high ground in bad weather.						
143	22.06.93	Taylor Titch	1	P	Haut Rine, France	1	1
	Struck high ground in poor weather.						
144	23.06.93	Bell 206B	1	S	Nr Kendal, Cumbria	2	2
	While on pipeline inspection, struck by RAF Tornado, severed tail rotor.						
145	20.07.93	Beech 33 Debonair C	1	P	Nr Ashford, Kent	2	2
	Stalled while low flying – crashed in field and destroyed.						
146	15.08.93	PA31 Navajo	2	A	Nr Guildford, Surrey	1	1
	Sudden descent into ground at very high speed – destroyed. Cause not determined.						
147	05.09.93	Pulsar	1	P	Co Clare, Ireland	1	1
	Stalled in tight turn and dived to ground during low flypast.						
148	15.09.93	PA28-161 Warrior	1	I	Nr Sanquhar, Ayrshire	1	1
	Struck high ground following PAN call 'entering cloud'.						
149	03.10.93	Stolph Starduster 2	1	P	Nr Bridport, Dorset	2	1
	Aircraft spun following wing distortion due to detached flying wires.						
150	15.11.93	Auster J1N	1	P	Nr Biggin Hill, Kent	2	2
	Crashed in garden of house 3nm from Biggin Hill while low flying involving steep manoeuvres.						
151	20.11.93	Robinson R22B	1	P	Nr Brecon, Wales	1	1
	Crashed on snow covered hillside in Brecon Beacons after diverting from planned route.						
152	28.12.93	Short Skyvan	2	S	Ampuriabrava, Spain	1	1
	Out of fuel at the end of a parachuting flight, control lost during an attempted go-around to avoid parachutists obstructing the runway.						
153	08.01.94	Mooney M20J	1	P	The Wrekin, Shropshire	2	2
	Hit top of isolated hill in poor weather.						

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154	15.01.94	Bell 206B	1	I	Luton, Beds	1	1
	Loss of control while practising hovering. Helicopter rolled over and parts of blade struck pilot.						
155	17.01.94	Cessna 182F	1	P	Nr Keswick, Cumbria	1	1
	Aircraft dived into ground at high speed from cruise at 4500ft. No cause established.						
156	20.01.94	PA34 Seneca 2	1	P	Nr Bloxwich, W Midlands	4	4
	Loss of control at 6000ft. Aircraft broke up during recovery from ensuing dive.						
157	06.04.94	Mooney M20J	1	P	Nr Grenoble, France	1	1
	Struck high ground in poor weather.						
158	22.05.94	Bell 206B	1	A	Nr Gwytherin, Clwyd	4	3
	Struck high ground in poor weather.						
159	08.06.94	Robinson R22B	1	I	Nr Martin, Hants	2	2
	Crashed in field after main rotor struck tail boom.						
160	25.06.94	Steen Skybolt	1	P	Nr Penzance, Cornwall	2	2
	Loss of control during aerobatics. Pilot may have been hit by unrestrained fire extinguisher.						
161	01.08.94	MS 733 Alcyon	1	P	Parham, Suffolk	2	2
	Stalled at 200ft after take-off and failed to recover from incipient spin.						
162	09.10.94	Grumman AA5B	1	P	Nr Binbrook, Lincs	1	1
	Hit ground when nearing destination. Possible heart attack.						
163	03.11.94	Cessna 180K	1	P	Nr Ballymena, N Ireland	2	1
	Crashed on hillside in poor weather while dropping food for gamebirds.						
164	20.11.94	Cessna 182Q	1	P	Nr Worthing, Sussex	3	2
	Struck high ground in poor weather while attempting to land at Shoreham.						
165	07.12.94	AS350 Ecuriel B2	1	S	Nr Ballachulish, Scotland	2	2
	While flying low, underslung load hook struck ground, flew up into tail rotor causing loss of control.						
166	26.12.94	Robin HR100	1	P	Nr Stapleford, Essex	4	4
	Struck power lines during a long flat approach.						