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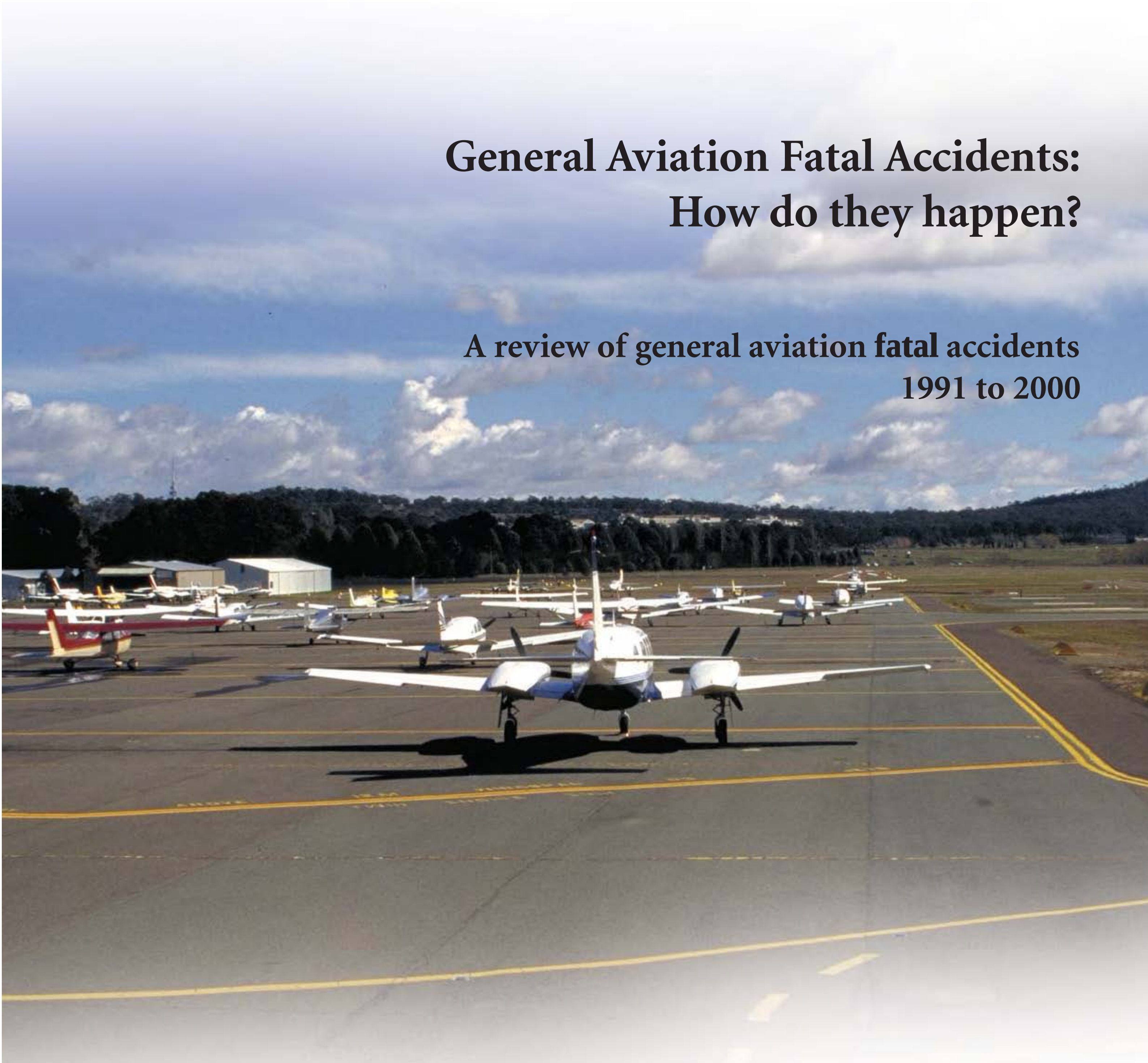
General Aviation Fatal Accidents: How do they happen?

A review of general aviation fatal accidents 1991 to 2000



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General aviation fatal accidents: How do they happen?

A review of general aviation fatal accidents 1991 to 2000

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Contents

EXECUTIVE SUMMARY

Australian aviation is, by world standards, extremely safe. Fatal accidents in regular public transport (RPT) operations are low and, since the late 1960s, have been confined to low capacity operations. Australia has not had a high capacity RPT fatal accident since 1968 and has not had a RPT jet fatal accident.

The vast majority of Australian civil fatal aircraft accidents occur in general aviation (GA) operations. This study examined Australian 'VH-registered' civil aircraft involved in GA fatal accidents for the period 1991 to 2000, and covers fatal accident numbers and rates by aircraft type and operational grouping, timing of accidents, injury levels, pilot demographics and fatal accident types.

Between 1991 and 2000 inclusive, there were 215 fatal accidents and 413 associated fatalities. Over the ten-year period there were 1.2 GA fatal accidents per 100,000 hours flown. The annual fatal accident rate decreased from 1.6 fatal accidents per 100,000 hours flown in 1991 to 0.9 in 2000. While this decrease was not statistically significant, subsequent data to the end of 2002 do indicate a statistically significant decrease. Statistically significant variations were identified at certain times of the day and week, indicating that occurrences were more likely to be fatal accidents at certain times. The rate of general aviation fatal accidents was found to be significantly higher during the evening between 1700 and 2059 than the rest of the day and the private/business fatal accident rate was found to be significantly higher over the weekend than during the week. Reasons for these findings could not be clearly identified.

The population of pilots involved in fatal accidents was compared with the present population of active general aviation pilots against certain demographic criteria.

The risk of a fatal accident per hour flown was greater for pilots who had between 50 and 1,000 hours aeronautical experience than pilots who had more than 1,000 hours experience. However, with the low number of pilots involved in fatal accidents, small changes in the demographics of pilots involved in fatal accidents can lead to large changes in the risk associated with different age and experience groupings.

The fatal accidents were grouped using a classification scheme developed within the ATSB so that a consistent and useful description of the accident types could be achieved. The re-classification and re-coding of the accidents enabled a more accurate description of the larger groupings of fatal accidents, which could provide a greater opportunity to accurately target specific risk areas in general aviation operations.

The majority of fatal accidents (82 per cent) fell into three main groups:

- controlled flight into terrain
- managed flight into terrain
- uncontrolled flight into terrain.

For the purpose of this report these accident types were defined as:

- Controlled flight into terrain (CFIT) - an event where an aircraft collided with obstacles, objects or terrain during powered, controlled flight with little or no awareness on the part of the pilot of the impending impact.
- Managed flight into terrain (MFIT) – an event where an aircraft collided with obstacles, objects or terrain while being flown under limited control or reduced performance, with insufficient height/performance to reach a designated landing area.
- Uncontrolled flight into terrain (UFIT) - an event where an aircraft collided with obstacles, objects or terrain after control of the aircraft was lost in-flight (includes cases where the pilot became incapacitated) but the aircraft structure did not change prior to impact.

UFIT fatal accidents were the most prevalent of the fatal accident types (46 per cent), followed by CFITs (30 per cent) and MFITs (6 per cent).

Accidents that did not fall into one of these three main groupings were categorised separately, but were not sub-categorised to the same extent.

The vast majority of low-level UFIT fatal accidents (approximately 90 per cent) could be described as accidents where the pilot's control inputs (or lack of inputs) initiated a loss of control. In almost a quarter of these cases, turbulence or windshear may have also contributed to the loss of control. In contrast, UFIT fatal accidents during 'normal' operations were more likely to have had an initiating factor such as a loss of engine power, loss of reference to the external environment, aircraft system or airframe problem, pilot incapacitation etc., with around 20 per cent being primarily the result of pilot action or inaction. This disparity suggests that many of the loss of control events during low-level operations could have been recovered had the aircraft been at a greater height. For fixed wing operations, a higher proportion of UFIT accidents were private/business operations (2/3), compared with MFIT or CFIT accidents (1/2).

The next largest fatal accident grouping was controlled flight into terrain accidents (CFITs). The majority of CFIT fatal accidents occurred during low-level operations, when the pilot could see the environment. Most of these accidents were wirestrikes. Pilots involved in CFIT fatal accidents who were flying aircraft unnecessarily low, accounted for a quarter of all the fatal CFITs and 42 per cent of fatal CFITs during low-level flying. The large majority of CFIT fatal accidents from 'normal' operations occurred when the pilot was not able to see the outside environment, whether operating under VFR or IFR.

The accident classifications used in this report promote greater understanding of the types of fatal accidents that have occurred by focusing on the state of the aircraft at the time it sustained damage or a person was fatally injured. The events or circumstances that precipitated the accident types highlight areas where it is possible to intervene in the sequence of events to avoid a fatal accident or reduce the severity of an accident.

The characteristics of each accident group were markedly different, and the sub-categorisation of accidents within each group was therefore also different. The majority of CFIT fatal accidents were initiated by an impact with an obstacle or terrain. In UFIT accidents the event that led to the situation becoming a fatal accident generally happened while the aircraft was still flying. MFIT accidents were generally fatal because of the nature of terrain encountered at the time of impact, rather than because of the nature of the event that precipitated the accident.

1. INTRODUCTION

Objective

The aim of the ATSB is 'Safe Transport'. The ATSB investigates aircraft occurrences (accidents and incidents), in order to identify the factors that contributed to an occurrence. This approach enables the ATSB to identify the factors that can reduce the likelihood of similar occurrences in the future. As part of its work, the ATSB maintains a database of aviation safety occurrences related to Australian registered aircraft (occurring both in Australia and overseas) and occurrences in Australia related to foreign-registered aircraft.

Aircraft accident numbers and rates have been published for many years by the ATSB and its predecessors. The objective of this study was to undertake a comprehensive examination of Australian civil general aviation fatal accidents between 1991 and 2000, with the intent of determining the types of fatal accidents that occurred, and the events and factors (where possible) that precipitated these fatal accidents. Part of the objective of this project involved the development of a classification scheme to define and describe the fatal accidents as completely as possible. The major task of the project then involved the re-classification and re-coding of fatal accidents, from investigation reports and other data sources, using the new classification framework.

The Civil Aviation Safety Authority (CASA) has participated in this project by providing de-identified data relating to the present population of licensed pilots with current medical certificates. These population data have been used to compare the demographic characteristics of pilots involved in fatal accidents, to determine if there are any groups at a greater risk of being involved in a fatal accident.

Relationship with ATSB 'Aviation Safety Indicators 2002' report and other published data

In November 2003 the ATSB released the 'Aviation Safety Indicators 2002' report. While there is some overlap in the data presented in the 'Aviation Safety Indicators 2002' report with data covered in this report, there are differences that should be noted when comparing the two reports.

The periods of time examined in these two reports are different. The 'Aviation Safety Indicators 2002' report covered the period 1993 to 2002 to include the most recent year for which activity data were available. In 2003, when the current project was initiated, the period to be examined was determined by selecting the most recent ten-year period where all investigations into general aviation fatal accidents were complete, to ensure that the most comprehensive information for each fatal accident was available. This resulted in the period 1991 to 2000 being selected for this report.

Just as the periods investigated in these two reports differ, the emphasis of each report is also different. One fatal aircraft accident in 1997 that was included in the 'Aviation Safety Indicators 2002' report involving an aeroplane was excluded from the dataset on which this report is based. This was because it had neither a certificate of airworthiness nor a permit to fly, which was considered important in this study.

The hours flown that were used as a denominator to calculate fatal accident rates in this report have been adjusted slightly from those used in the 'Aviation Safety Indicators 2002' report. As such, the fatal accident rate in 1995 has risen slightly from 1.2 to 1.3 fatal accidents per 100,000 hours flown. The fatal accident rate in 1997 remains at 0.9 fatal accidents per 100,000 hours flown, based on 16 fatal accidents and the adjusted flying hours.

During the period covered in this report, the decline in the general aviation fatal accident rate, from 1.6 fatal accidents per 100,000 hours flown in 1991 to 0.9 in 2000, was found to be not statistically significant. The 'Aviation Safety Indicators 2002' report covered the ten-year period ending 2002. The year 2002 saw the number of GA fatal accidents fall markedly to 10, and the decline in the fatal accident rate from 1.3 fatal accidents per 100,000 hours flown in 1993 to 0.6 in 2002 was found to be statistically significant.

As stated in both reports, the small number of fatal accidents and the tendency of these numbers to fluctuate make it difficult to ascertain long term trends. The considerable variation in the number of fatal accidents from year to year, in an environment of relatively stable activity, can arrest or reverse previously identified trends in the space of few years. The fluctuations can be seen in the years 1999, 2000, 2001 and 2002 when there were 21, 16, 21 and 10 fatal accidents respectively. In 2003 there was a total of 14 fatal accidents and so far in 2004 (to end May) there have been four fatal accidents.

When comparing aircraft accident numbers and rates between different reports or sources, differences in accident totals and rates can arise due to a number of factors. These include the time period investigated, operational types examined (general aviation, regular public transport operations, sport aviation or all operational types), the denominator used to calculate rates (hours flown, departures), or whether the dataset is confined to Australian-registered aircraft only or if accidents in Australia involving foreign registered aircraft are included in accident totals (although it is most unlikely they will be included in accident rates as the hours flown by foreign registered aircraft are unlikely to be known).

2. METHODOLOGY

Aviation safety occurrences (accidents and incidents) recorded on the ATSB aviation safety occurrence database were searched to isolate those fatal accidents that occurred in Australia or overseas, during the period 1991 to 2000, involving at least one VH-registered general aviation aircraft (and excluding aircraft with neither a certificate of airworthiness nor permit to fly).

Fatal accidents where there were no crew or passenger fatalities but a third party was fatally injured (e.g. accidents where third parties were fatally injured by moving rotors/propellers or via contact with other parts of the aircraft) were included since these accidents could have been affected by the operational environment.

Fatal collision accidents between general aviation aircraft and non-general aviation aircraft were included regardless of which aircraft's occupants were fatally injured. A fatal collision between an aeroplane and a glider, with fatalities on board the glider only could also have been affected by the general aviation operational environment.

Data sources

The ATSB aviation safety occurrence database contains data on aviation safety occurrences including fatal accidents. For the purpose of this report, the occurrence database and aircraft accident investigation files were used to aid in the classification of fatal accidents and consolidation of relevant data. On occasion these data were reinforced by interviews with those involved in the investigation.

The Civil Aviation Safety Authority (CASA) provided de-identified pilot data against which the population of fatal accident pilots was compared.

The number of hours flown by general aviation aircraft was provided by the Bureau of Transport and Regional Economics (BTRE), Department of Transport and Regional Services (DOTARS), to calculate fatal accident rates.

Data analysis

Fatal accidents and rates - Accident numbers and rates were calculated for fatal accidents, by aircraft type and operational grouping. Rates have been calculated using hours flown as the denominator to enable comparison between years, aircraft types and operational groupings.

Injuries – The dataset of persons injured consisted of crew members and passengers, of aircraft involved in the fatal accidents, who sustained fatal, serious, minor or nil injuries and other persons who sustained fatal, serious or minor injuries as a result of the fatal aircraft accidents.

Fatal accident rates by day-of-week and time-of-day - Where exposure data (i.e. hours flown) were not available, the number of general aviation occurrences recorded in the ATSB aviation safety occurrence database was used as the denominator. Not all aviation occurrences are reported to the ATSB but it has been assumed that the non-reporting of aviation occurrences is not related to the day of the week or the time of the day. Not all occurrences reported to the ATSB have the operational type included. Where occurrences have been split into commercial and non-commercial operations to use as the denominator to calculate accident rates for separate periods of the week, occurrences with an operational type of 'unknown' have been included in non-commercial operations as these occurrences are more likely to have been non-commercial than commercial operations.

Pilot demographics - The population of pilots involved in fatal accidents was compared with the present population of active general aviation pilots (as on a day in March 2004).

The demographic criteria for comparison were:

- age of the pilot
- age at which a pilot obtained their pilot qualification
- number of years that a pilot had held the pilot qualification
- aeronautical experience of the pilot.

It is not possible to obtain a homogeneous dataset of pilots undertaking general aviation flying from available data sources. De-identified records were provided by CASA, of all pilots with active medicals. Against each record, age, date of acquisition of first licence, total aeronautical experience, hours flown in the past six months and nature of flying operations as recorded on the last medical were also provided.

Airline pilots (pilots who stated on their last medical that they only flew multi-crew operations) were removed. Some airline pilots also fly single-crew aircraft, and some general aviation pilots only fly multi-crew operations. However, this approach produced the most accurate population of general aviation pilots that could be extracted from the available data. Some pilots approximate their aeronautical experience and activity on their medical documentation; however, in a large population such errors average out. To calculate the age of licence acquisition, the date that pilots obtained their private pilots licence (PPL) was used. Where the date of PPL acquisition was not available, the date that the general flight progress test was undertaken or date of student licence acquisition was used instead.

Types of fatal accidents - The classification scheme used to group the fatal accidents was developed within the ATSB and is detailed in Appendix A. Some classifications were developed that had not been used before. 'Managed Flight into Terrain' (MFIT) is such an example. Categorisation of accidents inevitably led to certain events being split up across different accident types. Significant questions, such as 'what happened after a loss of engine power', and 'what happened after a Visual Flight Rules (VFR) aircraft entered Instrument Meteorological Conditions (IMC)', were also looked at as groups in their own right.

3. GENERAL AVIATION FATAL ACCIDENT DATA

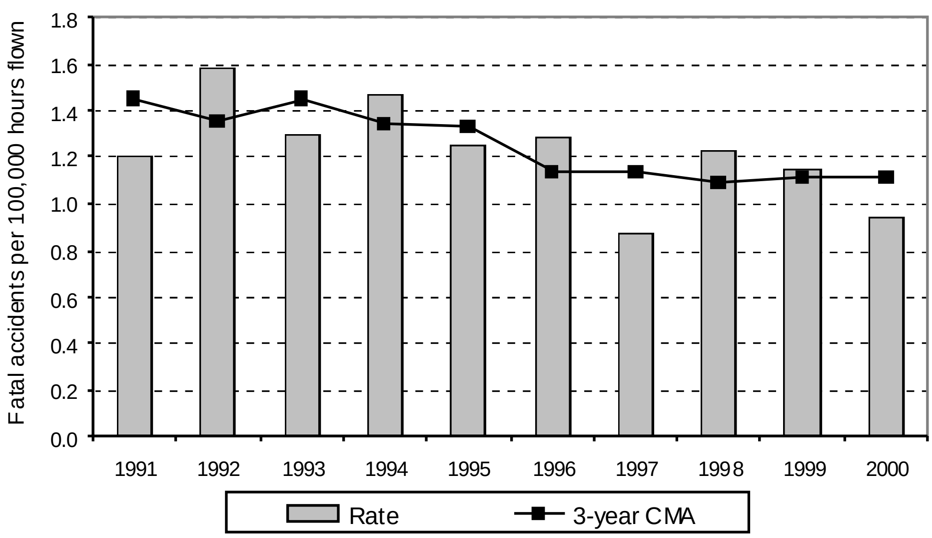
There were 215 fatal accidents, between 1991 and 2000 inclusive, involving at least one general aviation aircraft listed on the Australian civil aircraft register, according to the selection criteria used in this study.

Table 1 below shows the number of fatal accidents, the fatal accident rate (defined as the number of fatal accidents per 100,000 hours flown) and the fatal accident rate three-year central moving average. Figure 1 depicts the fatal accident rate and the associated three year central moving average (3-year CMA).

Table 1: General aviation fatal accidents and fatal accidents per 100,000 hours flown - 1991 to 2000

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	91-00
Fatal Accidents	21	26	22	25	22	23	16	23	21	16	215
Rate	1.2	1.6	1.3	1.5	1.3	1.3	0.9	1.2	1.1	0.9	1.2
3-year CMA	1.4	1.4	1.4	1.3	1.3	1.1	1.1	1.1	1.1	1.1	

Figure 1: General aviation fatal accidents per 100,000 hours flown - 1991 to 2000



The annual fatal accident rate varied from a high of 1.6 per 100,000 hours flown in 1992 to a low of 0.9 in both 1997 and 2000. For the ten-year period (1991-2000), there were 1.2 fatal accidents per 100,000 hours flown. The fatal accident rate three-year central moving average fell from 1.4 in 1991 to 1.1 in 1996 and remained at this level for the rest of the period examined. Although the fatal accident rate decreased by about four per cent per year from 1991 to 2000, the decrease was not statistically significant.[1] It should be noted though, that the small number of fatal accidents and the considerable variation in numbers from year to year make it difficult to identify trends.

All but two of the fatal accidents occurred within Australia. The two overseas accidents were a Cessna C210 Centurion accident in Indonesia and a Piper PA-28 Archer accident in France.

Seven of the fatal accidents involved collisions between two aircraft. One was a collision on a runway and the other six were mid-air collisions. The remaining 208 fatal accidents involved single aircraft.

[1] Poisson regression was used. Rate ratio = 0.96 per year, 95% CI 0.92, 1.01, p = 0.13.

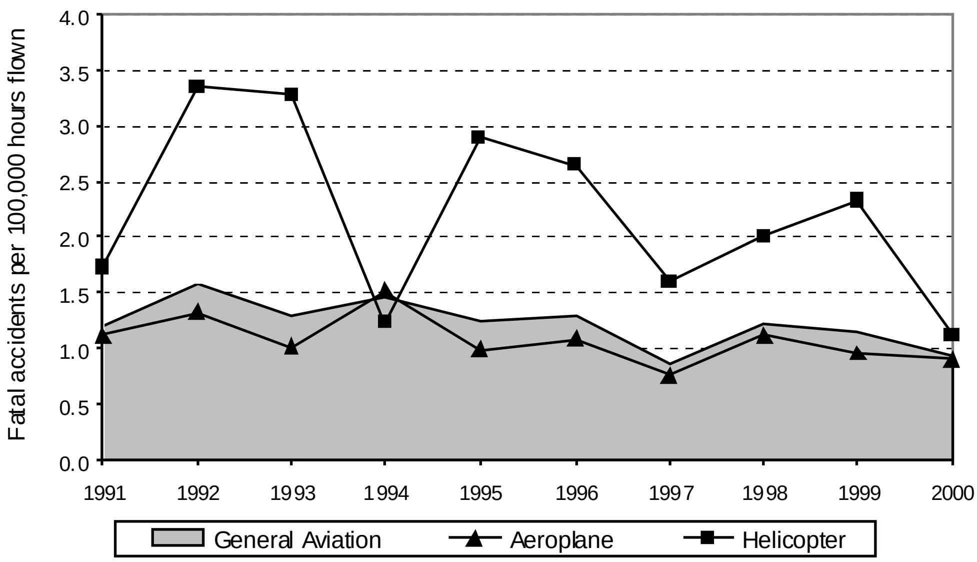
3.1. Types of aircraft

Table 2 shows the number of general aviation fatal accidents grouped by the type of general aviation aircraft involved and the associated fatal accident rates. Figure 2 depicts the fatal accident rates by type of general aviation aircraft involved, and the total general aviation fatal accident rate.

Table 2: General aviation fatal accidents and fatal accidents per 100,000 hours flown – 1991 to 2000 by type of aircraft involved

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	91-00
Aeroplane											
Fatal Accidents	17	19	15	22	15	17	12	18	15	13	163
Rate	1.1	1.3	1.0	1.5	1.0	1.1	0.8	1.1	1.0	0.9	1.1
Helicopter											
Fatal Accidents	4	7	7	3	7	6	4	5	6	3	52
Rate	1.7	3.3	3.3	1.2	2.9	2.6	1.6	2.0	2.3	1.1	2.2

Figure 2: General aviation fatal accidents per 100,000 hours flown - 1991 to 2000, aeroplane and helicopter



There were 163 general aviation fatal accidents involving at least one aeroplane[2] and 52 involving helicopters.

The number of fatal accidents per 100,000 hours flown involving aeroplanes varied from a high of 1.5 in 1994 to a low of 0.8 in 1997, and for fatal accidents involving helicopters, from a high of 3.3 in 1992 and 1993 to a low of 1.1 in 2000. Over the ten-year period, the fatal accident rate was 1.1 for aeroplanes and 2.2 for helicopters.

[2] There were seven fatal accidents involving more than one aircraft: one aeroplane/aeroplane runway collision; two aeroplane/aeroplane mid-air collisions; and four aeroplane/glider mid-air collisions. There were no fatal collisions between aircraft involving a helicopter.

Table 3: Number of aircraft involved in general aviation fatal accidents – 1991 to 2000

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	91-00
Aeroplane	18	19	15	22	15	17	12	19	16	13	166
Helicopter	4	7	7	3	7	6	4	5	6	3	52
Glider	0	2	1	0	0	0	0	0	1	0	4
Total	22	28	23	25	22	23	16	24	23	16	222

Table 3 shows that a total of 222 aircraft were involved in the 215 fatal accidents. The seven fatal accidents where two aircraft collided involved a total of ten aeroplanes and four gliders.

3.2. Operational grouping

Table 4: General aviation fatal accidents – 1991 to 2000 by operational grouping

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	91-00
Charter	2	2	4	6	3	6	4	2	3	3	35
Agriculture	1	3	1	4	2	4	5	2	0	3	25
Flying training	3[3]	1	0	2	1	0	0	1	2[4]	0	10
Other aerial work	1	2[5]	3	4	4	4	1	2	1	2	24
Private/business	14	18[6]	14[7]	9	12	9	6	16[8]	15[9]	8	121
Total	21	26	22	25	22	23	16	23	21	16	215

Table 4 shows the number of fatal accidents grouped by the operational type of the general aviation aircraft involved. The largest category of fatal accidents was the result of non-commercial operations flown by the private/business group, which accounted for 56 per cent of all fatal accidents. The remaining 94 fatal accidents involved aircraft undertaking commercial operations (i.e. charter, agriculture, other aerial work and flying training in decreasing order) which represented 44 per cent of fatal accidents. Table 5 shows the number of private and business fatal accidents separately.

Table 5: Breakdown of private and business fatal accidents - 1991 to 2000

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total
Business	1	0	1	0	3	2	1	3	2	0	13
Private	13	18	13	9	9	7	5	13	13	8	108

[3] Includes a mid-air collision between two aeroplanes, both undertaking flying training operations.
[4] Includes a runway collision between two aeroplanes, one undertaking flying training operations and the other private operations (counted in the flying training group as the fatality was on board this aircraft.)
[5] Includes a mid-air collision between an aeroplane undertaking other aerial work operations and a glider.
[6] Includes a mid-air collision between an aeroplane undertaking private operations and a glider.
[7] Includes a mid-air collision between an aeroplane undertaking private operations and a glider.
[8] Includes a mid-air collision between two aeroplanes, both undertaking private operations.
[9] Includes a mid-air collision between an aeroplane undertaking private operations and a glider.

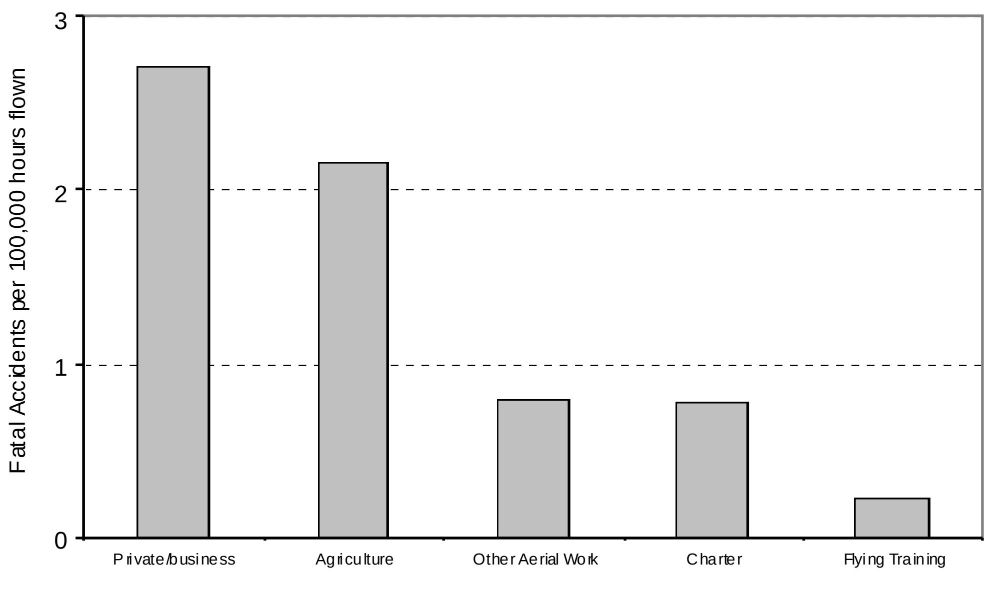
Table 6: General aviation fatal accidents per 100,000 hours flown – 1991 to 2000 by operational grouping

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	91-00
Commercial											
Charter	0.5	0.5	1.0	1.4	0.6	1.3	0.8	0.4	0.6	0.6	0.8
Agriculture	0.9	3.3	1.0	4.6	1.9	3.2	3.7	1.4	0.0	2.4	2.2
Flying Training	0.7	0.2	0.0	0.5	0.2	0.0	0.0	0.2	0.4	0.0	0.2
Other Aerial Work	0.3	0.8	1.0	1.3	1.3	1.4	0.3	0.6	0.3	0.7	0.8
Total commercial	0.5	0.6	0.7	1.3	0.8	1.1	0.7	0.5	0.4	0.6	0.7
Non-commercial											
Private/business	2.8	3.9	2.9	2.0	2.7	2.0	1.4	3.7	3.5	2.1	2.7
Total GA	**1.1**	**1.5**	**1.3**	**1.5**	**1.3**	**1.3**	**0.9**	**1.3**	**1.1**	**0.9**	**1.2**

Table 6 shows the number of fatal accidents per 100,000 hours flown for each operational group and for commercial and non-commercial operations. Non-commercial operations (private/business operational grouping) had the highest fatal accident rate over the period examined of 2.7 fatal accidents per 100,000 hours flown. Agriculture operations had the highest fatal accident rate (2.2) of the commercial operations and flying training the lowest (0.2). Over the period examined, commercial operations resulted in 0.7 fatal accidents per 100,000 hours flown compared with the non-commercial rate of 2.7.

Figure 3 depicts the number of fatal accidents per 100,000 hours flown for each operational grouping over the period 1991 to 2000.

Figure 3: General aviation fatal accidents per 100,000 hours flown - 1991 to 2000 by operational grouping



Figures 4 and 5 show the fatal accident rates by operational grouping and Figure 6 shows the commercial and non-commercial fatal accident rates.

Figure 4: General aviation fatal accidents per 100,000 hours flown – 1991 to 2000 by operational grouping

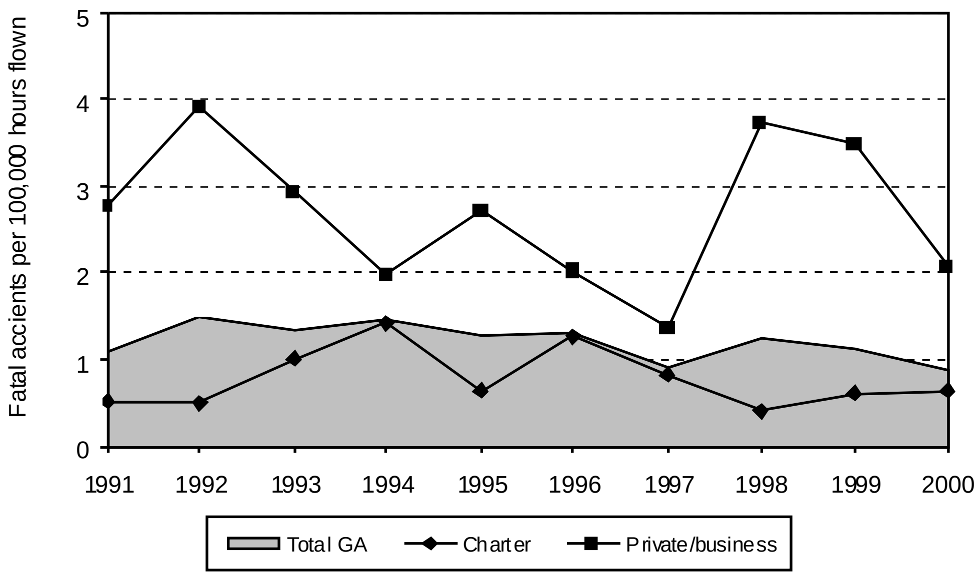


Figure 5: General aviation fatal accidents per 100,000 hours flown – 1991 to 2000 by operational grouping

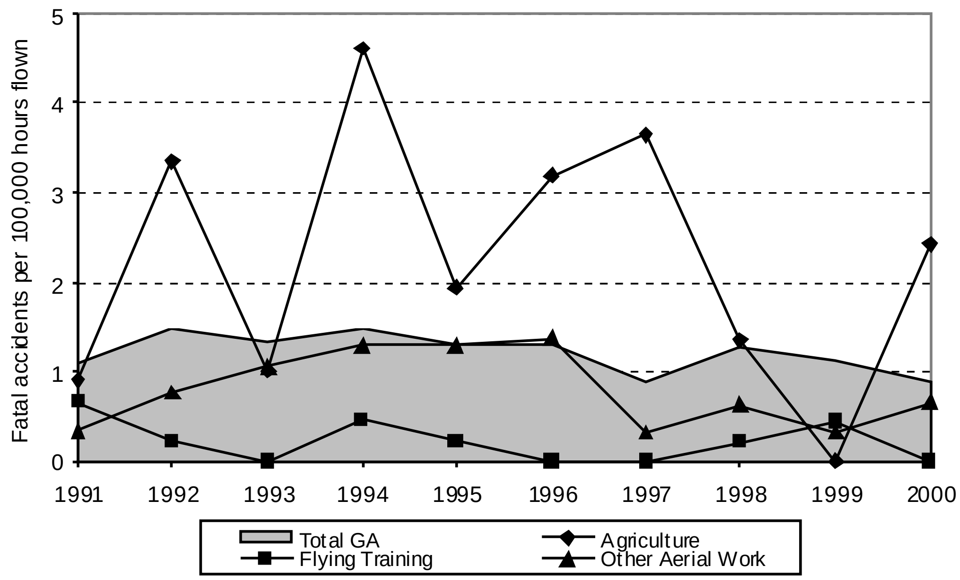
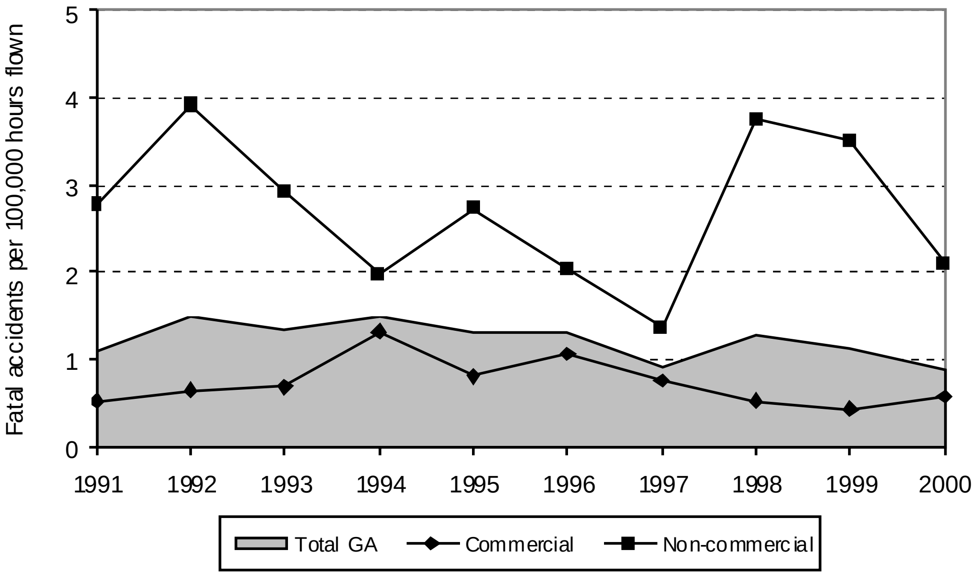


Figure 6: General aviation fatal accidents per 100,000 hours flown – 1991 to 2000 by commercial and non-commercial operations



3.3. Injuries

3.3.1. Fatalities

The 215 general aviation fatal accidents resulted in 413 fatalities. Table 7 shows the number of fatalities annually for crew members, passengers and third parties.

Table 7: General aviation fatalities – 1991 to 2000

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	91-00
Crew fatalities[10]	22	23	20	26	23	21	14	22	20	17	208
Passenger fatalities	23	26	25	25	14	22	12	24	20	12	203
Third party fatalities	0	1	1	0	0	0	0	0	0	0	2
Total fatalities	45	50	46	51	37	43	26	46	40	29	413

The highest number of fatalities (51) occurred in 1994 and the lowest number (26) in 1997.

Third party fatalities are those that were sustained by persons who were not crew members or passengers of aircraft. In 1992, a person was fatally injured when struck by the main rotor blades of a helicopter during refuelling operations, and in 1993 a human marker assisting in agriculture operations was fatally injured when struck by an aircraft conducting cotton spraying. Along with the two third-party deaths from 1991 to 2000, there were 411 other fatalities which were almost evenly divided between crew and passengers, with 208 pilots and 203 passengers receiving fatal injuries.

Table 8: General aviation fatalities – 1991 to 2000 by number of fatal injuries per fatal accident

Number of fatalities per accident	Number of fatal accidents	% of all fatal accidents	Fatalities
1	114	53.0%	114
2	58	27.0%	116
3	18	8.4%	54
4	11	5.1%	44
5	5	2.3%	25
6	6	2.8%	36
7	1	0.5%	7
8	1	0.5%	8
9	1	0.5%	9
Total	215	100%	413

Table 8 shows the frequency of fatal injuries in general aviation fatal accidents. Eighty per cent of fatal accidents resulted in either one or two fatalities. The highest number of fatalities in a single accident was nine.

[10] In 1992 and 1999 there were mid-air collisions between gliders and aeroplanes. The total crew fatalities for each of these years include a glider pilot fatality.

3.3.2. Fatalities by aircraft type

Table 9: General aviation fatalities – 1991 to 2000 by type of aircraft

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	91-00
Aeroplane											
Crew fatalities	18	18	13	24	17	17	12	17	14	12	162
Passenger fatalities	16	21	19	23	11	18	9	23	17	9	166
Third party/glider fatalities	0	1	1	0	0	0	0	0	1	0	3
Total aeroplane fatalities	34	40	33	47	28	35	21	40	32	21	331
Helicopter											
Crew fatalities	4	4	7	2	6	4	2	5	5	5	44
Passenger fatalities	7	5	6	2	3	4	3	1	3	3	37
Third party fatalities	0	1	0	0	0	0	0	0	0	0	1
Total helicopter fatalities	11	10	13	4	9	8	5	6	8	8	82

Table 9 shows the number of fatalities sorted by the type of general aviation aircraft involved in fatal accidents. The 163 fatal accidents involving aeroplanes resulted in 331 fatalities comprising 162 aeroplane crew members, 166 aeroplane passengers, two glider pilots (as a result of mid-air collisions between aeroplanes and gliders) and one third party; for the 52 helicopter fatal accidents there were 44 crew member, 37 passenger and one third party fatalities.

3.3.3. Fatalities by operational grouping

Table 10: General aviation fatalities – 1991 to 2000 by operational grouping[11]

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	91-00
Charter	3	2	8	22	8	13	8	7	10	11	92
Agriculture	2	3	1	4	2	4	6	2	0	3	27
Flying Training	4	2	0	4	1	0	0	1	2	0	14
Other Aerial Work	1	2	4	5	6	5	2	3	2	6	36
Private/business	35	41	33	16	20	21	10	33	26	9	244
Total general aviation	45	50	46	51	37	43	26	46	40	29	413

Table 10 shows the number of fatalities by operational grouping. The number of fatalities per operational grouping is a function of the activity level and relative risk of each operational grouping but it is also an indication of the nature of each operational type, as some types, such as agricultural operations, naturally have fewer people on board an accident aircraft than other types of operations such as charter flights.

[11] Agriculture fatalities in 1992 and 1993 both included a third party fatality. Other aerial work fatalities in 1992 include a glider pilot fatality. Private/business fatalities in 1999 include a glider pilot fatality

3.3.4. Survivors

In addition to the 413 fatalities there were 78 other people involved in general aviation fatal aircraft accidents who survived with varying degrees of injury.

3.3.4.1. Survivors in single aircraft general aviation fatal accidents

Single aircraft accidents are all accidents except those involving collisions between two aircraft.

A total of 404 people were fatally injured in the 208 single aircraft accidents and 72 other persons were involved.

Two single aircraft fatal accidents resulted in third party fatalities only (a human marker and a refueler), with no crew or passenger fatalities. The pilot of the aircraft in each case, who was the only other person involved, was not injured.

There were 81 single aircraft fatal accidents where the pilot, who was the only occupant on board the aircraft was fatally injured. One of these accidents resulted in two people on the ground being injured when an aircraft impacted a house. One occupant of the house was seriously injured while the other sustained minor injuries

There were 86 single aircraft fatal accidents with more than one person on board the aircraft, where all the crew and passengers (261 persons) were fatally injured.

The 39 remaining single aircraft fatal accidents involved aircraft with more than one crew member or passenger, where at least one person survived the fatal accident. A total of 60 people were fatally injured and 68 persons survived. In two instances a passenger was fatally injured while outside the aircraft. One passenger received fatal injuries as a result of walking into the tail rotor of a helicopter, and the pilot and three other passengers were not injured. In another helicopter accident, a passenger was fatally injured by the main rotor when the helicopter rolled over as he was unloading equipment. The pilot and the second passenger were uninjured.

The injury levels sustained by the 72 survivors of single aircraft accidents are shown in Table 11.

Table 11: Non-fatal injuries resulting from general aviation single aircraft fatal accidents – 1991 to 2000

	Serious	Minor	Nil	Total
Crew	10	4	7	21
Passenger	28	11	10	49
Third party	1	1	-	2
Total	**39**	**16**	**17**	**72**

To assess the survivability of single aircraft fatal accidents to those travelling on board the aircraft, the injuries sustained by the persons involved in the 123 fatal accidents where there was more than one person on board the aircraft at the time of the fatal accident are graphed in Figure 7. Single aircraft accidents where people were fatally injured while outside the aircraft and those with only one person on board the aircraft have been excluded.

Figure 7: Non-fatal injuries resulting from general aviation single aircraft fatal accidents with more than one occupant – 1991 to 2000 by injury level

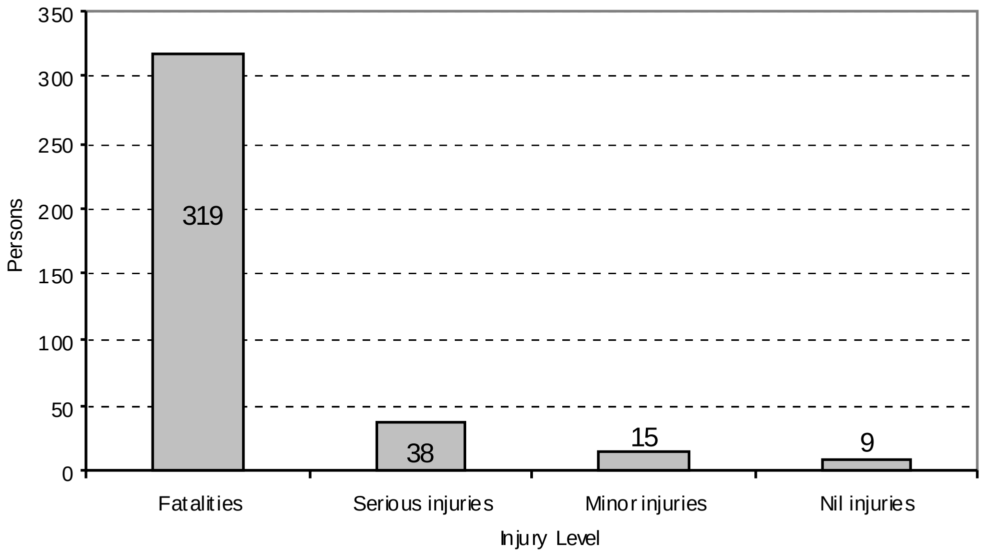
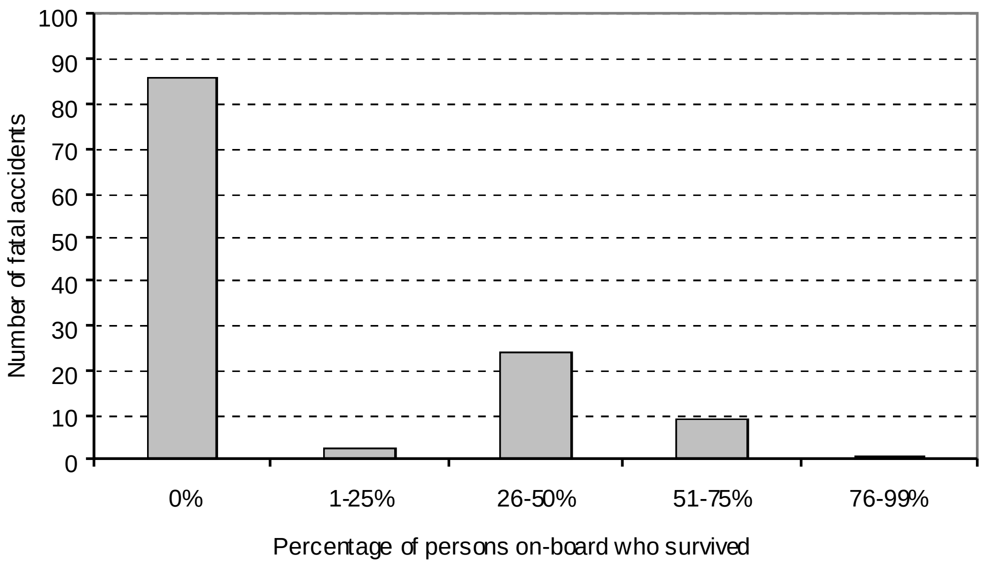


Figure 7 shows that the probability of coming out of a fatal accident unscathed is low. This is consistent with the higher energy dissipation in an aircraft accident, compared with many other forms of transport collision.

Figure 8 below depicts the percentage of survivors of single aircraft fatal accidents where there were multiple persons on board the aircraft at the time of the fatal accident (excluding accidents where a person outside the aircraft was fatally injured). Of the 123 fatal accidents, there were no survivors in 86 accidents; between 1 per cent and 25 per cent of persons survived in three accidents; between 26 per cent and 50 per cent of persons survived in 24 accidents; between 51 per cent and 75 per cent of persons survived in nine cases and more than 75 per cent of persons on board the aircraft survived in one accident.

Figure 8: Percentage of survivors in fatal accidents where there were multiple persons on board the aircraft – 1991 to 2000



3.3.4.2. Survivors in fatal accidents involving the collision of two aircraft

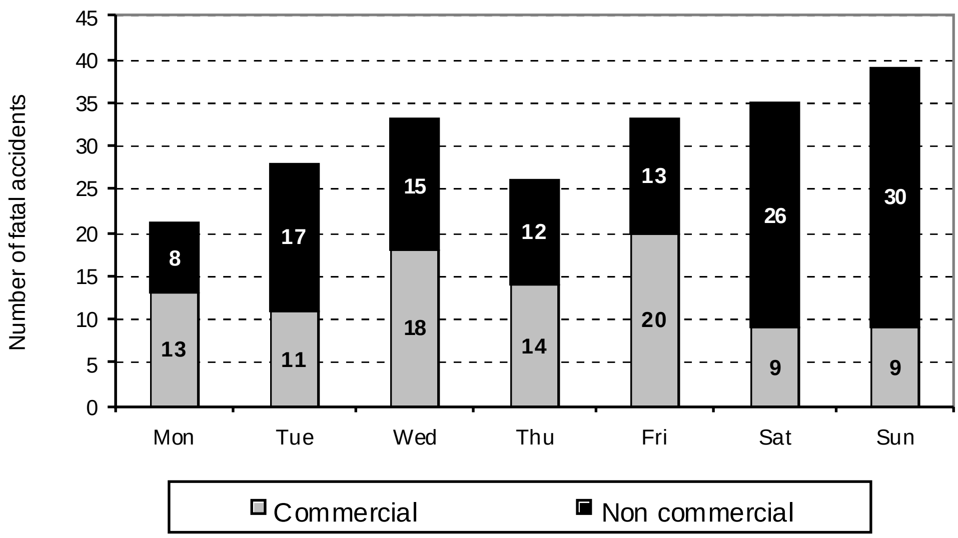
There were nine fatalities as a result of general aviation fatal accidents where two aircraft collided and six people survived these accidents. Of the six survivors, five were uninjured and one was seriously injured. Only one of these accidents resulted in the pilots of both aircraft being fatally injured (no passengers were carried on either aircraft). The six other accidents were such that the occupant/s of one aircraft in the collision was/were fatally injured, with the occupant of the other aircraft surviving with nil injury in five accidents and a serious injury in the other.

3.4. Fatal accident rates by day-of-week and time-of-day

3.4.1. Fatal accident rates by day-of-week

The fatal accidents were sorted by the day of the week on which the accidents occurred, for commercial and non-commercial operations. The results are shown in Figure 9.

Figure 9: General aviation fatal accidents -1991 to 2000, by day of week of fatal accident occurrence

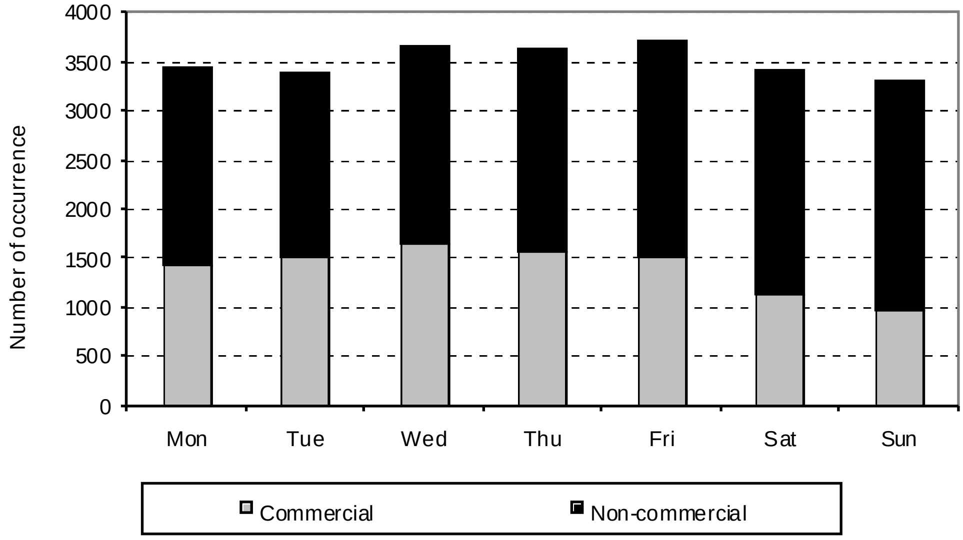


For four of the five weekdays (i.e. Monday to Friday), the number of fatal accidents involving aircraft doing commercial operations exceeded the number of fatal accidents involving non-commercial operations, with Tuesday being the exception.

For Saturday and Sunday, the ratio of non-commercial to commercial fatal accidents is approximately 3:1.

As there are no measures of exposure for commercial and non-commercial general aviation operations by day-of-week, the number of occurrences recorded in the ATSB aviation occurrence database involving general aviation aircraft was used to provide an indication of the level of flying activity occurring on each day of the week for commercial and non-commercial operations. These occurrences were sorted by the day of the week of occurrence and are in Figure 10.

Figure 10: General aviation occurrences recorded in the ATSB aviation occurrence database –1991 to 2000 by day of week of occurrence



The fatal accident rate (defined as fatal accidents per reported general aviation occurrences) was analysed for commercial and non-commercial operations.

For commercial operations there was no trend and no statistical difference in the fatal accident rate across all the days of the week from Monday to Sunday. For non-commercial operations the fatal accident rate increased, with the differences in the rate being statistically significant, across the days of the week from Monday to Sunday[12]. Most of the increase in the fatal accident rate trend is probably due to the differences in the rate between the weekday period (Monday to Friday) and the weekend.

From the graph of fatal accidents, grouped by day of week in Figure 9, there appeared to be a distinct demarcation for both commercial and non-commercial operations between the weekday and the weekend periods.

The fatal accident rates for commercial and non-commercial operations were analysed to compare the weekday period with the weekend period.

The fatal accident rate for commercial operations was lower during the weekend than the period during the week, but the difference was not statistically significant.

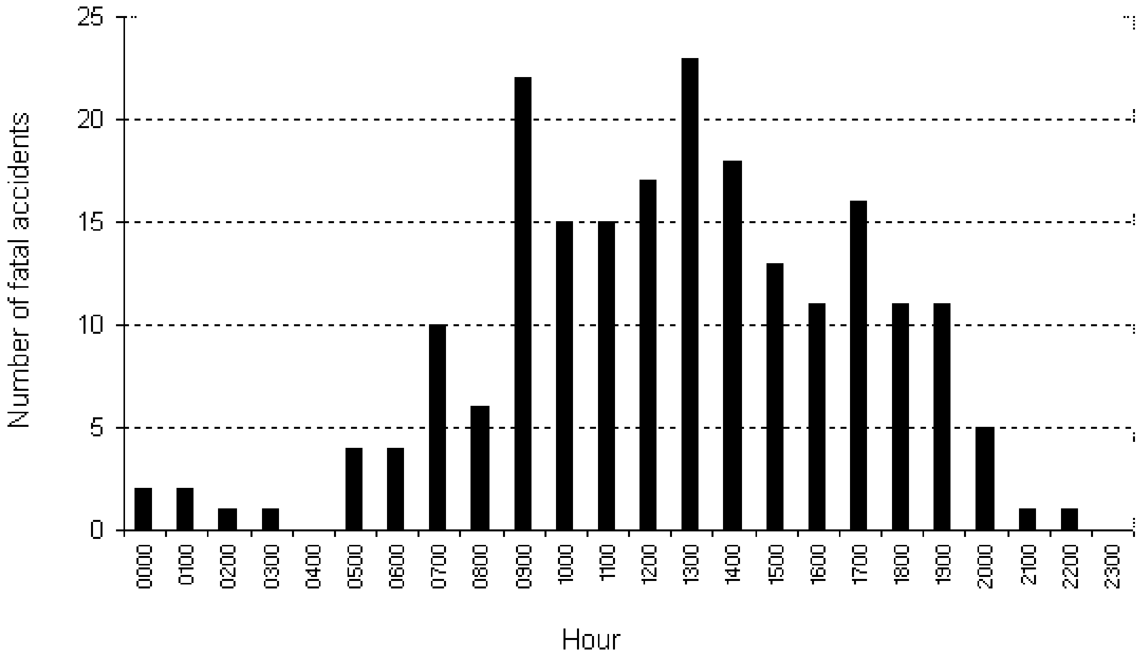
The fatal accident rate for non-commercial operations was found to be significantly higher during the weekend, compared with the weekday period, when pilots were 1.9 times more likely to be involved in a fatal accident (or alternatively, occurrences involving non-commercial operations were 1.9 times more likely to be fatal over the weekend than during the weekday period)[13].

[12] Poisson regression was used. Test statistic = 7.81, df = 6, p= 0.02.
[13] Poisson regression was used. Test statistic = 11.94, df = 1, p= 0.0005.

3.4.2. Fatal accident rates by time-of-day

The time that each fatal accident occurred was known for 209 of the 213 fatal accidents that occurred in Australia. Figure 11 shows the number of fatal accidents that occurred during each hour of the day.

Figure 11: General aviation fatal accidents – 1991 to 2000 by hour of accident occurrence

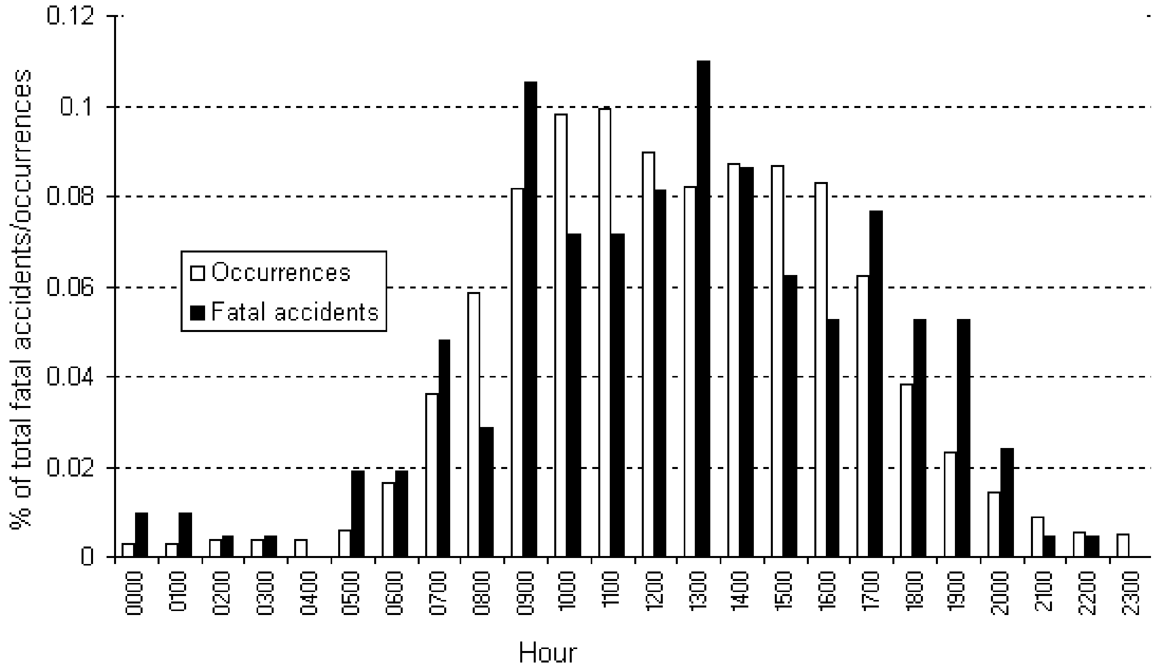


The number of fatal accidents showed peaks at 0700-0759, 0900-0959, 1300-1359 and 1700-1759.

To ascertain whether these hours of the day represent times of higher accident rates, the level of activity across each hour of the day would be required to calculate a fatal accident rate. As there are no measures of exposure of general aviation activity by hour, the occurrences involving general aviation aircraft recorded in the ATSB aviation occurrence database were used as an estimate for the level of general aviation activity occurring during each hour of the day.

Figure 12 shows the percentage of the 209 fatal accidents that occurred during each hour of the day along with the percentage of general aviation occurrences (1991 to 2000) that occurred during each hour of the day.

Figure 12: Percentage of general aviation fatal accidents and occurrences - 1991 to 2000 by hour of occurrence



The fatal accident rate (as a percentage of all general aviation occurrences) is low but displays statistically significant variation across the different hourly periods of the day.[14] Times of note over the 24-hour period include 0500 to 0559, 0700 to 0759, 0900 to 0959 and 1300 to 1359.

The period of time from 1700 to 2059 consists of four consecutive hours when the percentage of fatal accidents exceeds the percentage of recorded occurrences. If the rate of occurrence reporting is consistent for occurrences happening at different times of the day, then during this period of the evening pilots are 1.6 times more likely to be involved in a fatal accident than at other times of the day.[15] Alternatively, an occurrence is more likely to be fatal during this period.

[14] Poisson regression was used. Test statistic = 36.35, df = 23, p = 0.038
[15] Poisson regression was used. Test statistic = 7.19, df = 1, p = 0.005

3.5. Pilot Demographics

The ATSB collects data on pilots involved in fatal accidents as part of its normal business. The data were collated to provide the following data types:

- the age of the pilot at the time of the accident
- the age of the pilot involved when a pilot qualification was first obtained
- the number of years that a pilot qualification had been held at the time of the accident
- the total flying experience at the time of the accident.

The data from the active pilot population provided by CASA were collated to provide the same data types as had been collated from the population of pilots involved in fatal accidents. This enabled a comparison between the two datasets.

For each data type (age, age of licence acquisition, number of years pilot licence held and aeronautical experience) there is age or experience pilot grouping with a lower risk of fatal accident involvement. However, the data types are not independent and their influence should not be considered without considering the effects of the other data types.

There are four graphs for each of the data types described above:

- the population of fatal accident pilots against the data type
- the population of active pilots against the data type
- the ratio between the two populations against the data type
- the ratio between the two populations against the type of data, factored for the average number of hours flown in six months by the active pilot population, by the groupings in that data type.

The fourth graph provides the best indication of the relative risk per flying hour of being involved in a fatal accident, according to the data type.

It is important to note that the number of pilots involved in fatal accidents is low and when these pilots were sorted into groups (by age and experience) the number of pilots in each group is even lower. Hence, even small changes in the demographics of pilots involved in fatal accidents could dramatically change the risk associated with each age group or experience group.

Graphs ‘c’ and ‘d’ for Figures 13, 14, 15 and 16 do not give absolute figures, but a comparative ratio. They can only be used to compare the differences between the different groups in that data type.

3.5.1. Age of pilot

Figure 13a
Number of pilots involved in fatal accidents, sorted by age group

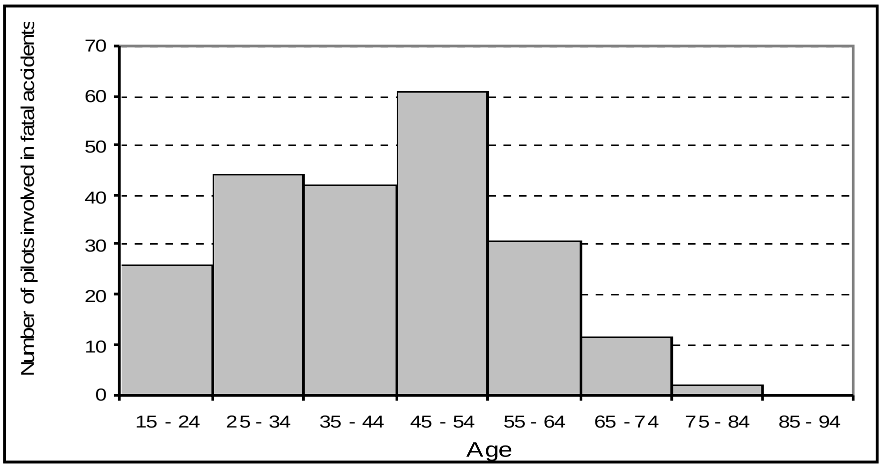


Figure 13b
Number of active general aviation pilots, sorted by age group

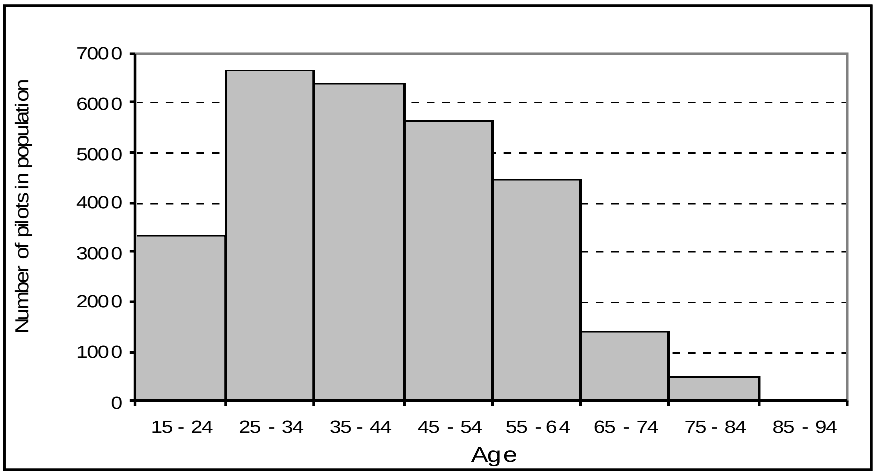


Figure 13c
Ratio of accident pilots to active general aviation pilots, sorted by age group

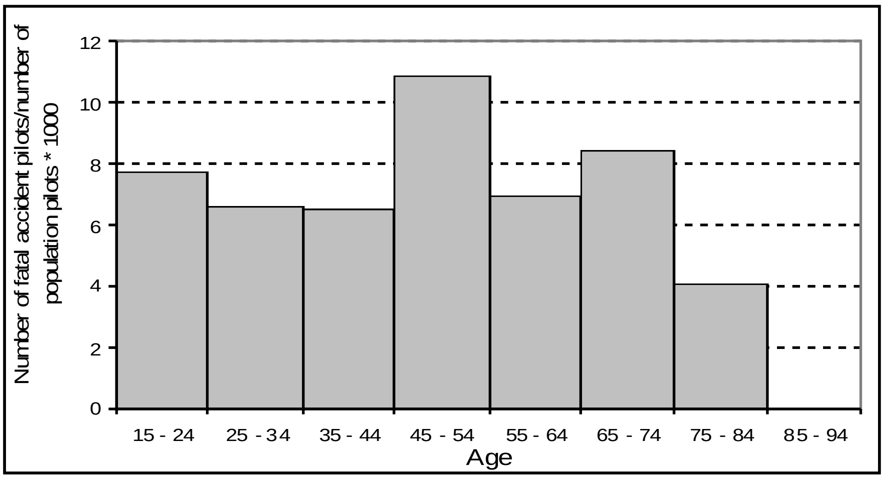


Figure 13d

Ratio of accident pilots to active general aviation pilots, sorted by age group, divided by that age group's active general aviation pilot population's average hours flown in the past six months. This gives a comparative risk of a fatal accident per hour flown by age group.

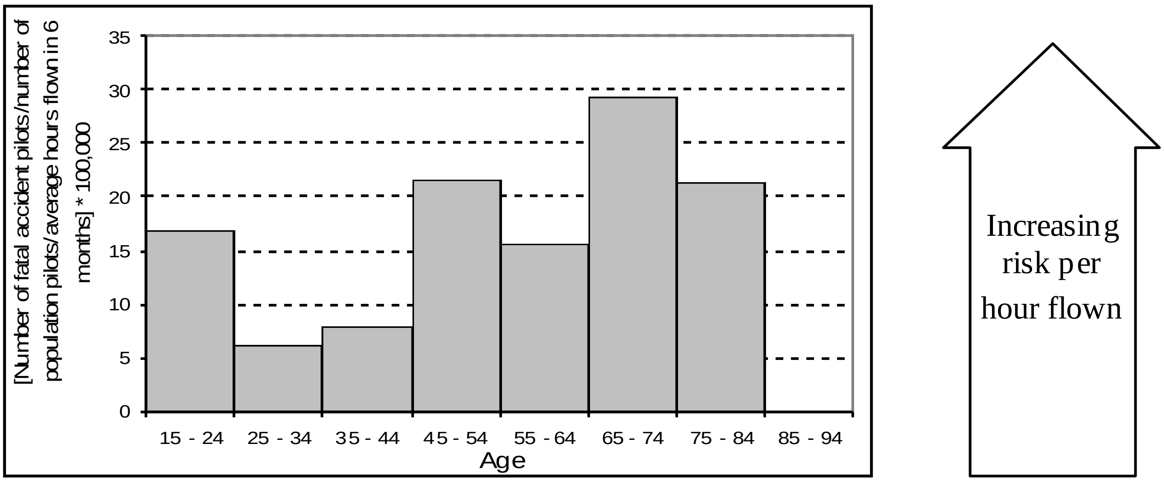


Figure 13d shows that the risk per hour flown for pilots aged 15-24 is relatively high. The risk then decreases dramatically, but increases for older pilots.

3.5.2. Age at which licence was acquired

Figure 14a
Number of pilots involved in fatal accidents, sorted by age when licence was acquired

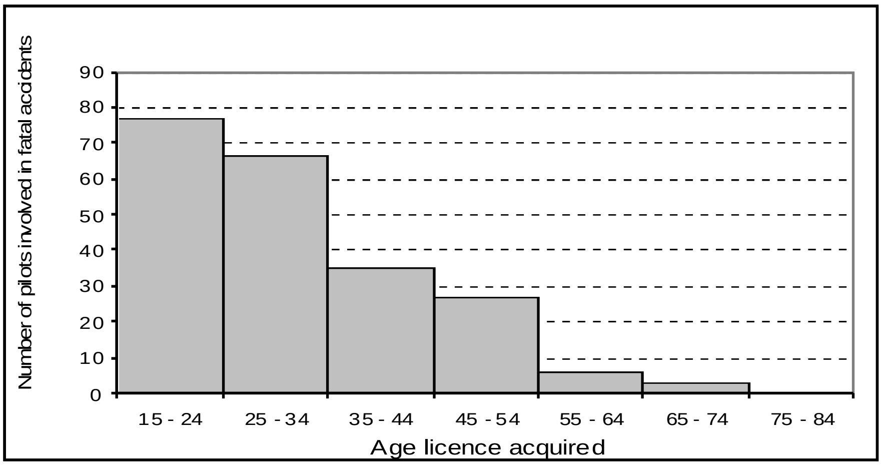


Figure 14b
Number of active general aviation pilots, sorted by age when licence was acquired

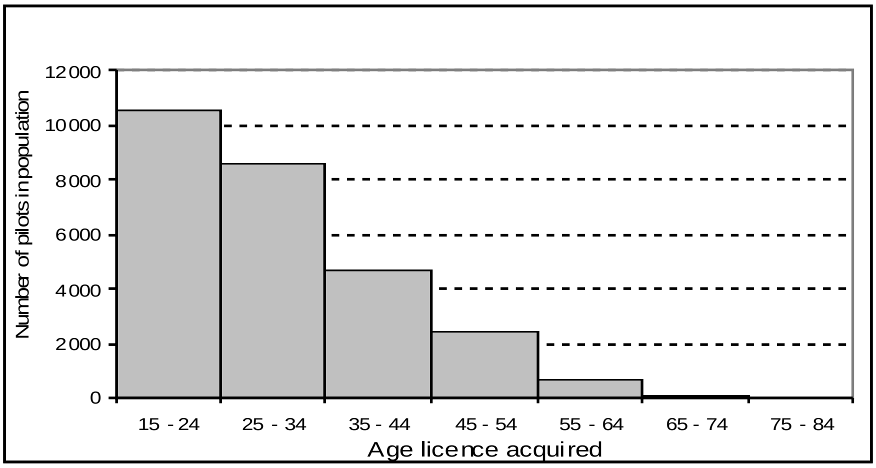


Figure 14c
Ratio of accident pilots to active general aviation pilots, sorted by age when licence was acquired

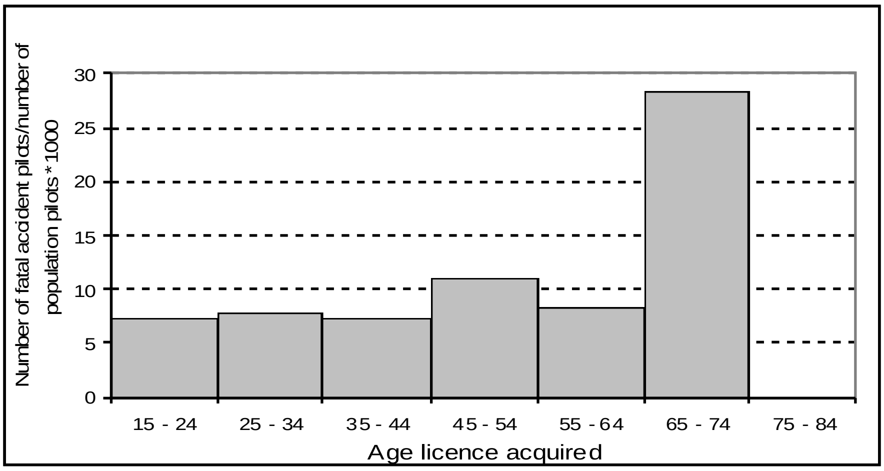
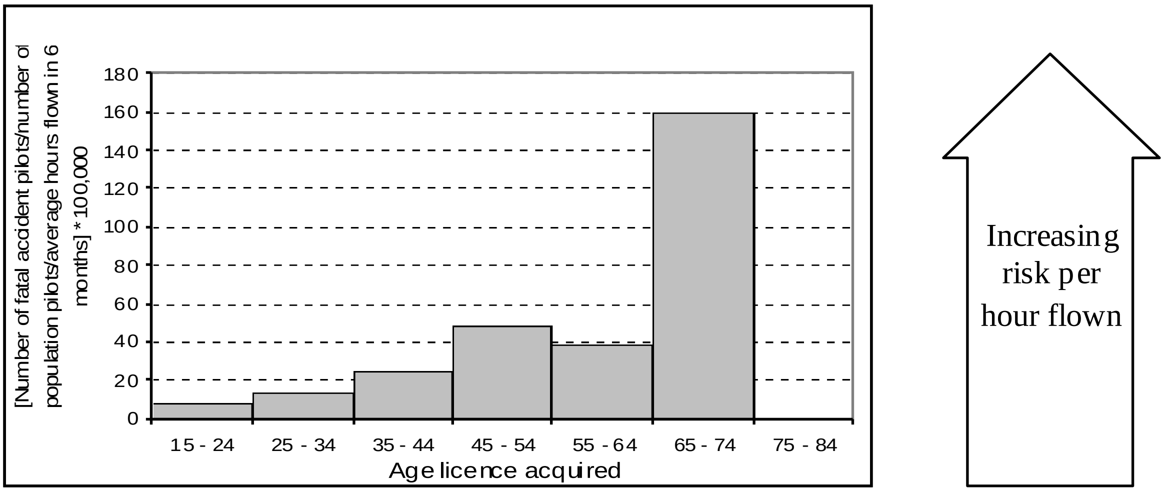


Figure 14d

Ratio of accident pilots to active general aviation pilots, sorted by age when licence was acquired, divided by that age group's active general aviation pilot population's average hours flown in the past six months. This gives a comparative risk of a fatal accident per hour flown by age when licence was acquired.



There is a general increase in risk of a fatal accident per hour flown as the age when the licence was acquired increases. Although there appears to be a dramatic increase in risk if the licence is acquired over the age of 65, Figure 14a shows that the population from which this number was derived was very small, and therefore it should not be considered as a conclusive indication of a high risk in this group. If the last two groups are aggregated into an age group 55-74, the relative risk indication for that age group in Figure 14d would be approximately 60.

3.5.3. Years that a licence had been held

Figure 15a
Number of pilots involved in fatal accidents, sorted by years that a licence had been held

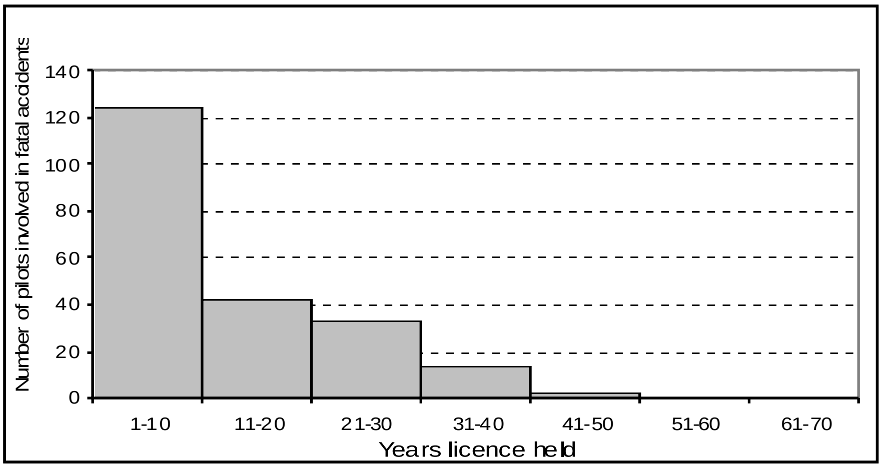


Figure 15b
Number of active general aviation pilots, sorted by years that a licence had been held

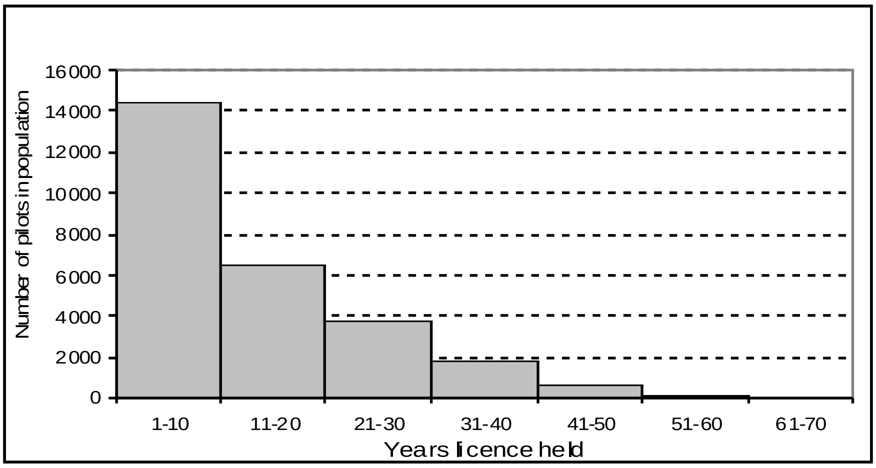


Figure 15c
Ratio of accident pilots to active general aviation pilots, sorted by years that a licence had been held

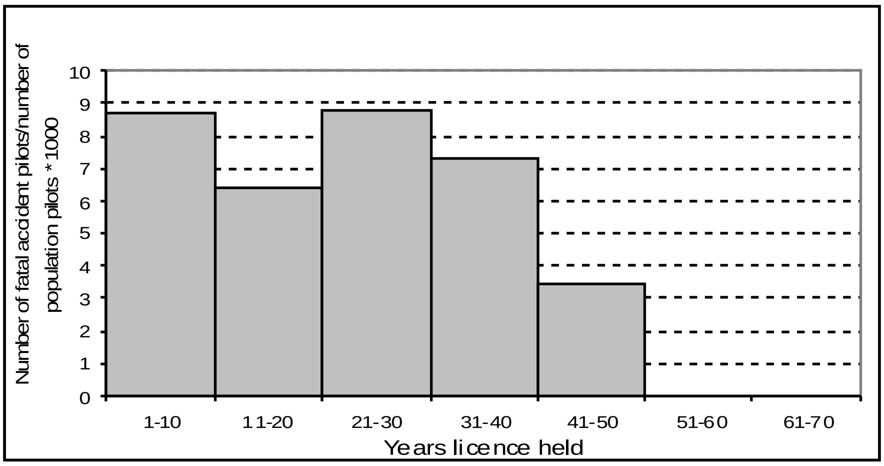
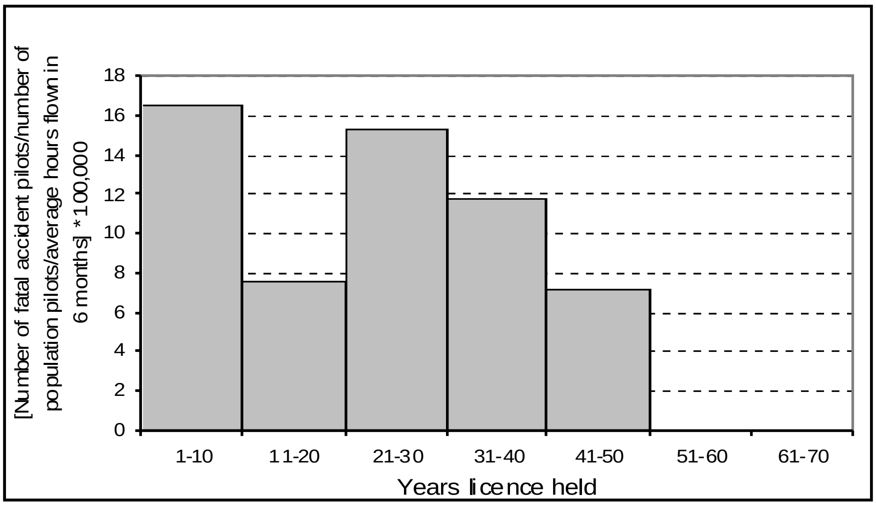
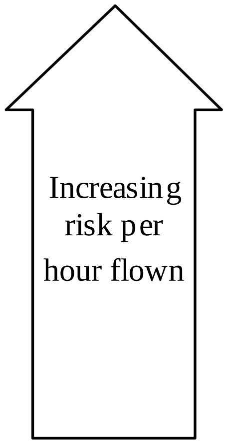


Figure 15d

Ratio of accident pilots to active general aviation pilots, sorted by years that a licence had been held, divided by that age group's active general aviation pilot population's average hours flown in the past six months. This gives a comparative risk of a fatal accident per hour flown by years that a licence had been held.





There is a gradual decrease in risk per hour flown, the longer a licence has been held. However, there is a larger decrease in risk for the group of pilots who have held a licence for 11 to 20 years.

3.5.4. Total flying experience

Figure 16a
Number of pilots involved in fatal accidents, sorted by total flying experience.

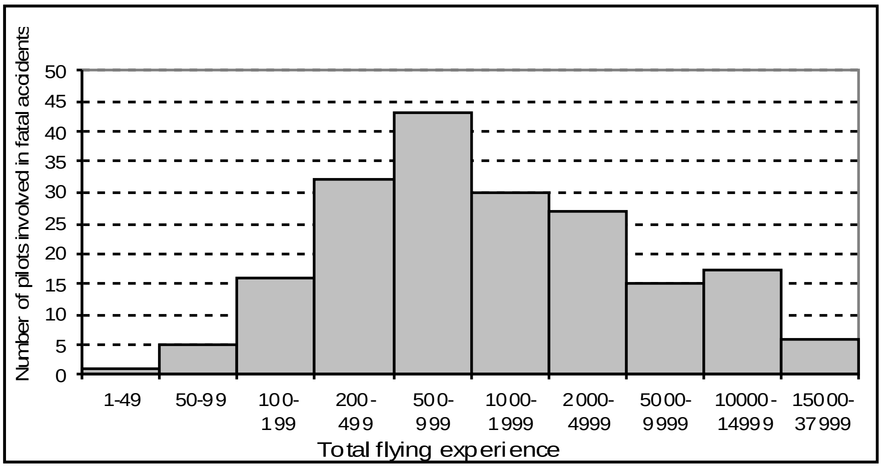


Figure 16b
Number of active general aviation pilots, sorted by total flying experience.

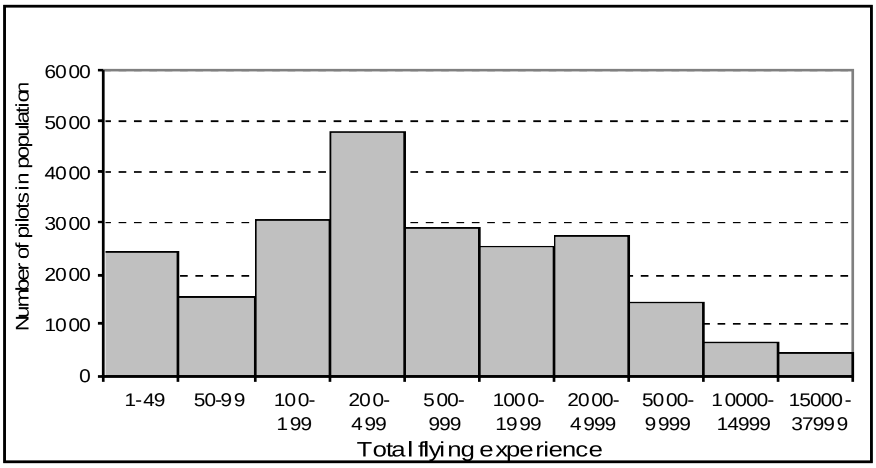


Figure 16c
Ratio of accident pilots to active general aviation pilots, sorted by total flying experience

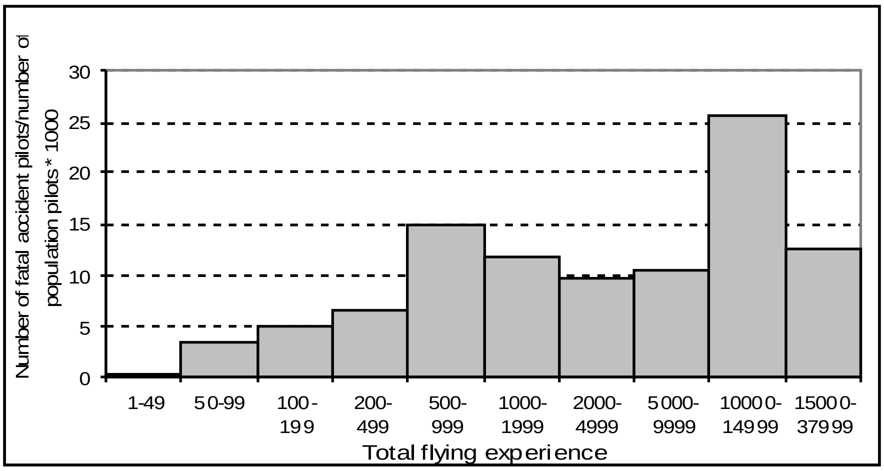
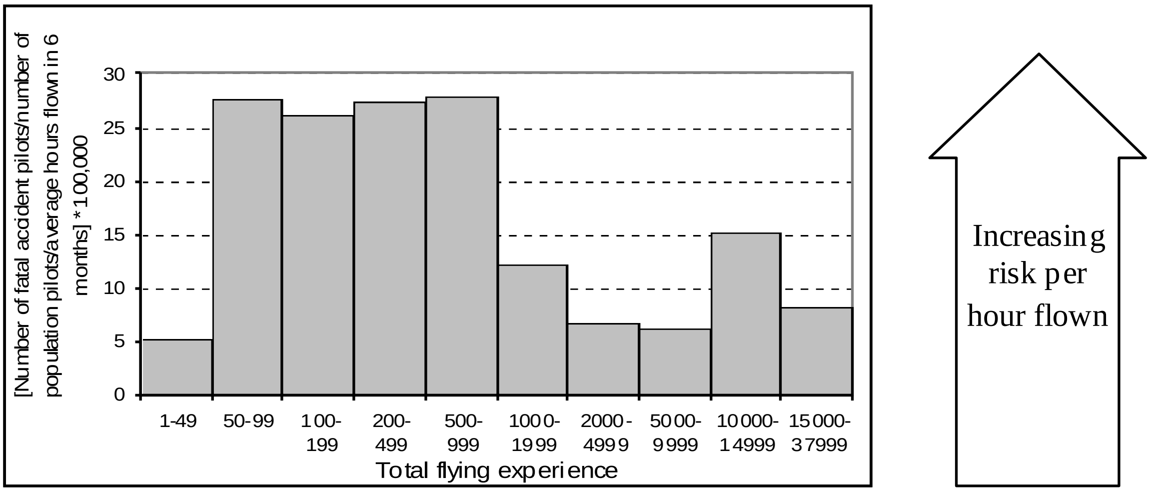


Figure 16d
Ratio of accident pilots to active general aviation pilots, sorted by total flying experience, divided by that age group's active general aviation pilot population's average hours flown in the past six months. This gives a comparative risk of a fatal accident per hour flown by total flying experience.



This graph shows a low risk per hour flown with a pilot experience of 1-49 hours. This is consistent with the period in a flying career when a pilot is normally flying under the auspices of a flying school. The risk of a fatal accident per hour flown is greater from 50 to 999 hours than from 1000 hours and upwards.

Analysis of the pilot data for those who had more than 49 hours aeronautical experience showed that those who had between 50 and 999 hours had 3.1 times the fatal accident rate of those pilots with 1,000 or more hours aeronautical experience[16].

[16] Poisson regression was used. Test statistic = 58.74, d f = 1, $p < 0.001$.

4. FATAL ACCIDENT TYPES

4.1. Categorisation of fatal accidents

Part of the aim of this project was to develop a coding framework for analysing accidents that allowed meaningful categorisation of fatal accidents. Some new classifications have been developed, as they have enabled accidents to be grouped more completely. The classifications used are listed below, and described in Appendix A.

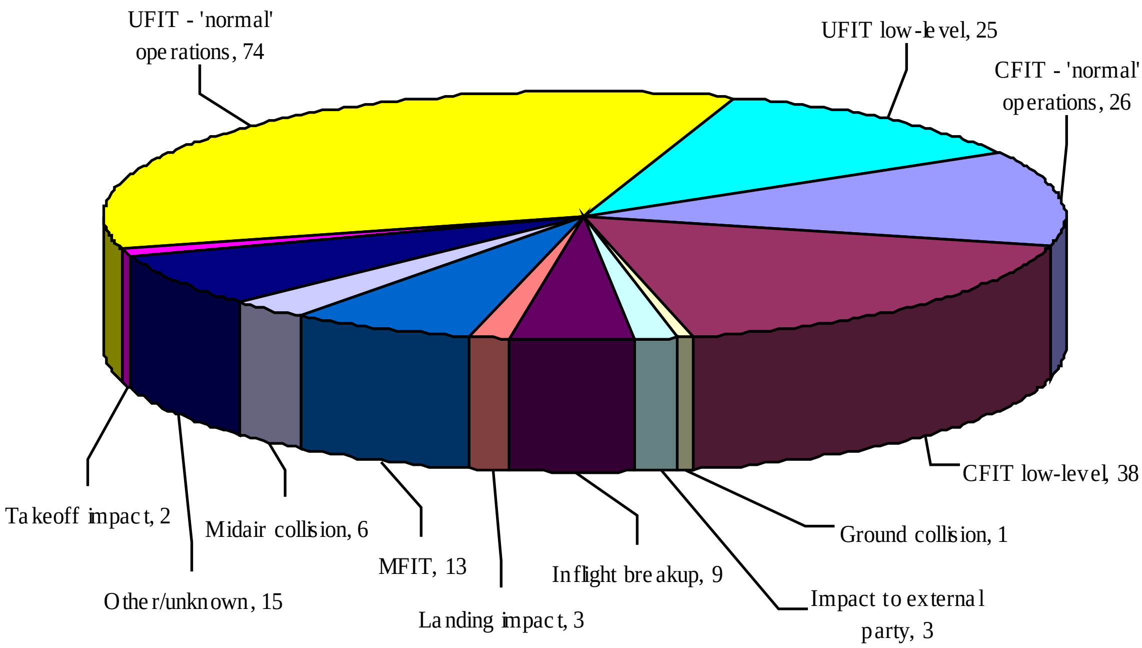
- Controlled flight into terrain (CFIT) – low-level operations
  – 'normal' operations
- Ground collision
- Impact to external party
- In-flight break-up
- Landing impact
- Managed flight into terrain (MFIT)
- Mid-air collision
- Other
- Take-off impact
- Uncontrolled flight into terrain (UFIT) – low-level operations
  – 'normal' operations
- Unknown

CFIT and UFIT accidents were sub-grouped according to the planned operating height of the aircraft. Hence, the fatal accident classification scheme separated CFITs and UFITs that occurred during planned low-level flying from the other CFITs and UFITs respectively. The CFIT and UFIT accidents that occurred during flight other than planned low flying were deemed to have occurred during 'normal' operations. The definitions of low-level operations and 'normal' operations are in Appendix A.

Grouping the accidents using this classification scheme allowed the accidents to be categorised into mutually exclusive groups which essentially described the state of the aircraft when it sustained damage or a person was fatally injured.

Figure 17 shows the types of fatal accidents that occurred between 1991 and 2000, in accordance with this report's definitions.

Figure 17: General aviation fatal accident types – 1991 to 2000



Approximately 82 percent of fatal accidents were in the controlled flight into terrain (CFIT), managed flight into terrain (MFIT) or uncontrolled flight into terrain (UFIT) groups. The analysis will therefore focus on these categories while describing the others.

The differing nature of these accident types leads to different analyses of these categories. In CFIT accidents, it is of interest to look at why the pilot was not aware of the impending impact. MFIT accidents related to events that were not necessarily associated with a fatal accident; however, the nature of the impact site was not conducive to survivability, such as impact with water or terrain with obstacles. This category described dangerous, but not necessarily lethal, sequences of events. UFIT accidents were sub-categorised differently, as it was of greater interest to identify why control had been lost, rather than what the aircraft hit at the time of the accident.

4.2. Controlled flight into terrain (CFIT) fatal accidents

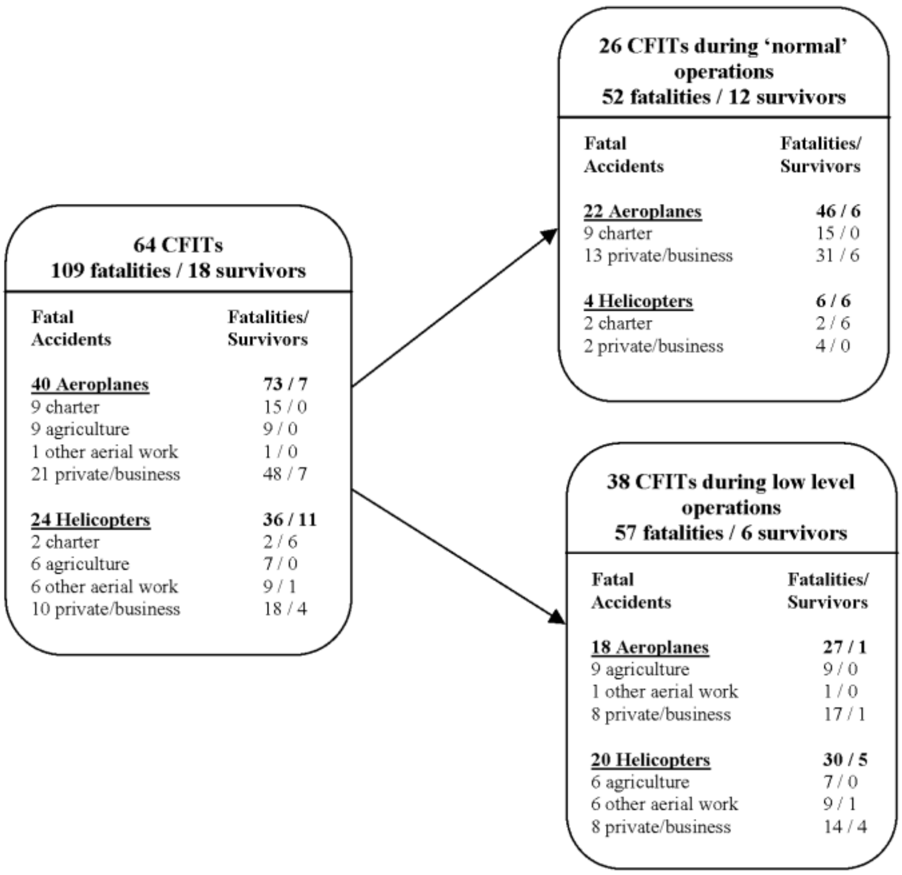
A CFIT accident was defined as an event where an aircraft collided with obstacles, objects or terrain during powered, controlled flight with little or no awareness on the part of the pilot of the impending impact.

There were 64 CFIT fatal accidents (30 per cent of fatal accidents) and 109 associated fatalities (26 per cent of fatalities). Eighteen people survived these fatal accidents (23 per cent of survivors).

The CFIT fatal accidents were sorted to separate those accidents that occurred during 'low-level' operations from accidents that occurred during 'normal' operations. This division allows the analysis of low-level CFIT accidents where the necessity to see-and-avoid obstacles, objects and terrain is to be expected and hence planned for by the pilot, separate from those CFIT accidents during 'normal' operations where the pilot's planned flight path should have meant that objects, obstacles and terrain would be avoided.

Figure 18 shows the breakdown of CFIT fatal accidents into those that occurred during low-level operations and those resulting from 'normal' operations.

Figure 18: CFIT fatal accidents grouped by planned operating height



4.2.1. CFIT fatal accidents during low-level operations

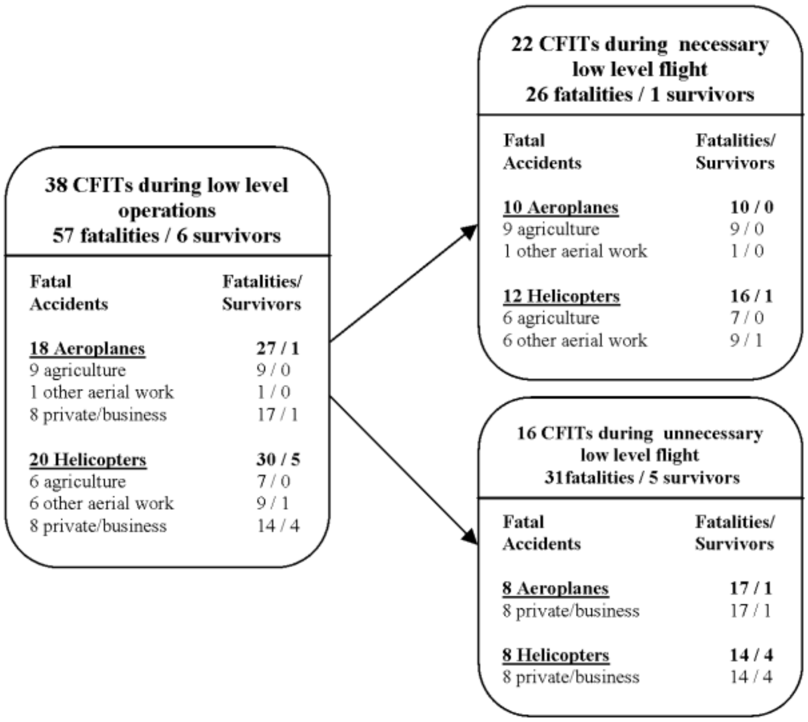
The nature of low-level flying is such that aircraft are being flown close to objects, obstacles and terrain in visual meteorological conditions (VMC). Safe flight during these operations requires pilots to see-and-avoid objects, obstacles and terrain. As some obstacles such as wires are extremely difficult to see in-flight, the risk of a CFIT accident increases unless the pilot is already aware of a wire's existence.

There were 38 CFIT fatal accidents during low-level operations (18 per cent of fatal accidents) and 57 associated fatalities (14 per cent of fatalities). Six people survived these fatal accidents (eight per cent of survivors).

CFIT fatal accidents during low-level operations were sorted into those that occurred during low-level flight that was necessary to the purpose of the flight (i.e. low-level flying during agricultural operations, mustering operations, survey operations etc) and those where low-level flying was unnecessary to the purpose of the flight (i.e. illegal low-level flying during private and business operations).

Figure 19 shows the breakdown of CFIT fatal accidents during low-level flight into the above mentioned groups of necessary and unnecessary low-level flight.

Figure 19: CFIT fatal accidents during low-level flight sorted into necessary and unnecessary low-level flight



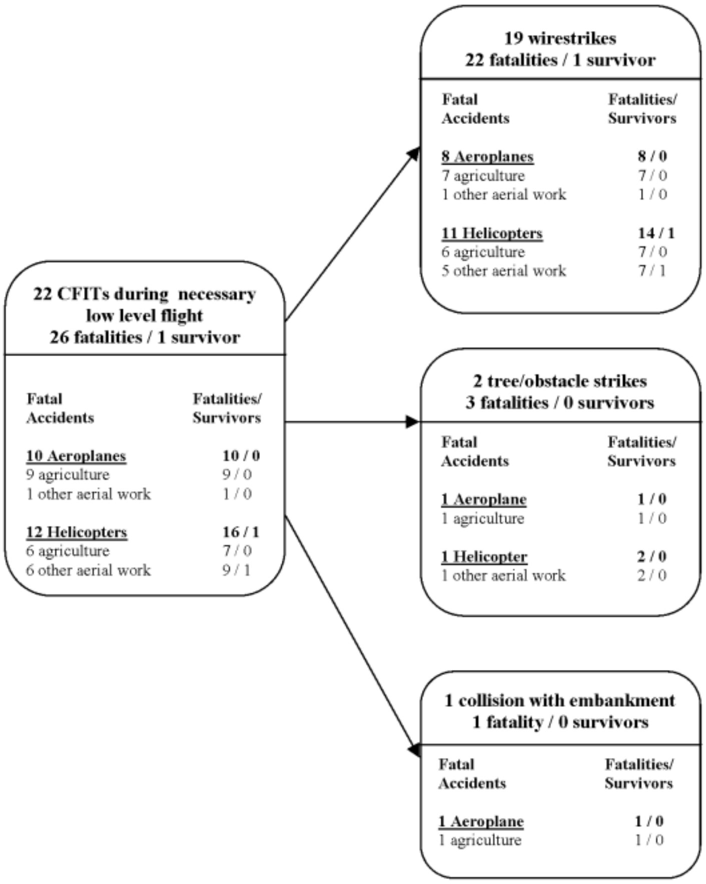
There were 22 CFIT fatal accidents during necessary low-level flight, which resulted in 26 fatalities compared to 16 CFIT fatal accidents during unnecessary low-level flight with 31 associated fatalities. The lack of survivors in fixed wing operations as a result of CFIT fatal accidents during necessary low-level flight reflects the type of operation (agriculture and other aerial work) where generally the pilot is the only occupant on board the aircraft. There were almost two fatalities per aircraft involved in CFIT fatal accidents during unnecessary low-level flight where all the aircraft involved were private/business operations in which passengers are likely to be carried.

Pilots involved in low-level CFITs during agriculture and other aerial work operations (i.e undertaking necessary low-level flying) were on average a little bit older, had greater aeronautical experience and experience on aircraft type and had held their pilots licence almost three times as long as the private/business pilots doing unnecessary low-level flying.

4.2.1.1. CFIT fatal accidents during necessary low-level flight

Figure 20 below shows the breakdown of CFIT fatal accidents during necessary low-level flight into groups indicating the object with which the aircraft collided.

Figure 20: CFIT fatal accidents during necessary low-level flight sorted by object hit



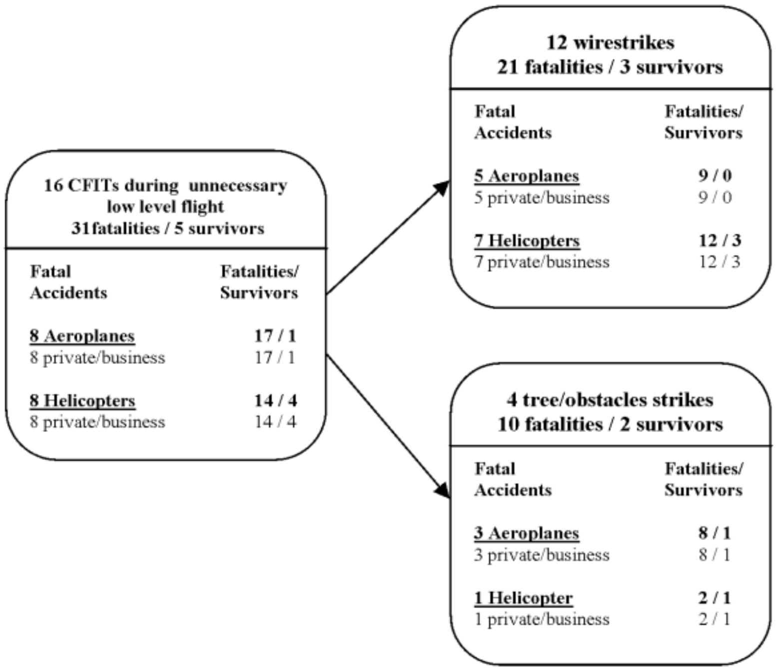
As can be seen in Figure 20, 19 of the 22 accidents during necessary low-level flight were wirestrikes, which resulted in 22 fatalities. Two aircraft collided with trees and one struck an embankment at dusk.

This breakdown of accidents highlights the hazard that wires pose to aircraft undertaking agriculture and other aerial work operations in close proximity to the ground. The pilots involved in CFIT fatal accidents during necessary low-level flight were generally very experienced, with the median aeronautical experience being 6600 hours. This shows that high aeronautical experience will not prevent pilots being involved in wirestrike or other CFIT accidents at low-level. The importance of surveying areas where operations will take place to identify wires and obstacles is paramount; even then, pilots still rely on their perception and memory regarding the location of obstacles in order to avoid them.

4.2.1.2. CFIT fatal accidents during unnecessary low-level flight

Figure 21 below shows the breakdown of CFIT fatal accidents during unnecessary low-level flight into groups indicating the object with which the aircraft collided.

Figure 21: CFIT fatal accidents during unnecessary low-level flight sorted by object hit



Again, wirestrikes were the largest category with 12 accidents and 21 fatalities. There were four collisions with trees/obstacles with 10 associated fatalities. The decision to fly at low-levels when it is not necessary to the purpose of the flight increases risk, as the location of obstacles, especially wires, will generally not be known and they are unlikely to be identified and avoided during flight.

The pilots involved in CFIT fatal accidents during unnecessary low-level flight had greater aeronautical experience, which was gained over a shorter period of time, than pilots involved in other types of fatal accidents. Hence, it is possible they were confident in their ability to handle an aircraft in close proximity to terrain and may have felt the safety of the aircraft would not be compromised even though they were breaking height regulations.

The discipline of surveying a low-level work area for wires prior to low-level operations is less inherent in unnecessary low-level operations, and pilots are less likely to give enough consideration to the hazards that wires and other objects pose to aircraft. There was an average of 1.6 CFIT fatal accidents and 3.1 fatalities per year during unnecessary low-level flight. This type of accident is easily avoided by complying with operating height requirements. If pilots did so, the number of general aviation fatalities could be reduced by approximately 7.5 per cent.

4.2.2. CFIT fatal accidents during 'normal' operations

CFIT fatal accidents during 'normal' operations involved aircraft where the pilot intended to fly the aircraft following normal flight procedures without doing any planned low flying, but for various reasons the aircraft was flown close to the ground or obstacles and a CFIT accident occurred.

There were 26 CFIT fatal accidents during 'normal' operations (12 per cent of fatal accidents) and 52 associated fatalities (13 per cent of fatalities). Twelve people survived these fatal accidents which accounted for approximately 15 per cent of survivors. (Six of these people survived a helicopter CFIT collision with water).

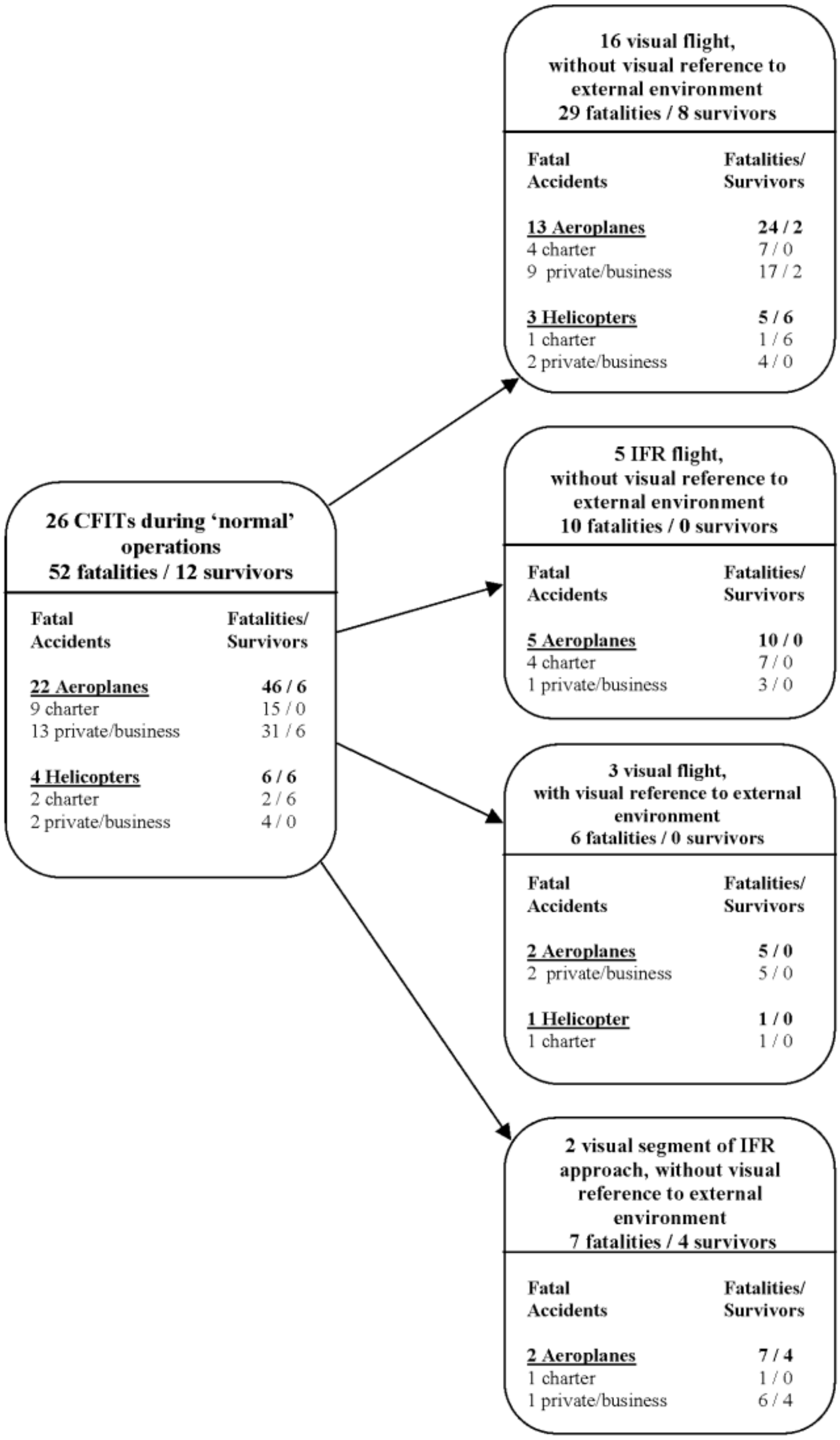
As CFIT accidents occurred when aircraft collided with objects, obstacles and terrain and the pilot had little or no awareness of the impending collision, the first division of these accidents was done taking into account whether the pilot was flying the aircraft visually or via instruments and whether or not the pilot could see the external environment in which the aircraft was being operated. The actual name of the conditions that aircraft were being flown in will be considered later in the analysis (i.e. visual meteorological conditions (VMC), instrument meteorological conditions (IMC), darkness). The conditions that the aircraft were being flown in are described in Appendix B: Aircraft flight rules.

The four main groups of CFIT fatal accidents that occurred during 'normal' operations were where, aircraft were being flown:

- visually, without visual reference to the external environment
- by reference to instruments, without visual reference to the external environment
- visually, with visual reference to the external environment
- in the visual segment of an instrument flight rules (IFR) flight, without visual reference to the external environment.

Figure 22 shows the breakdown of CFIT accidents during 'normal' operations into the groups mentioned previously.

Figure 22: CFIT fatal accidents during 'normal' operations



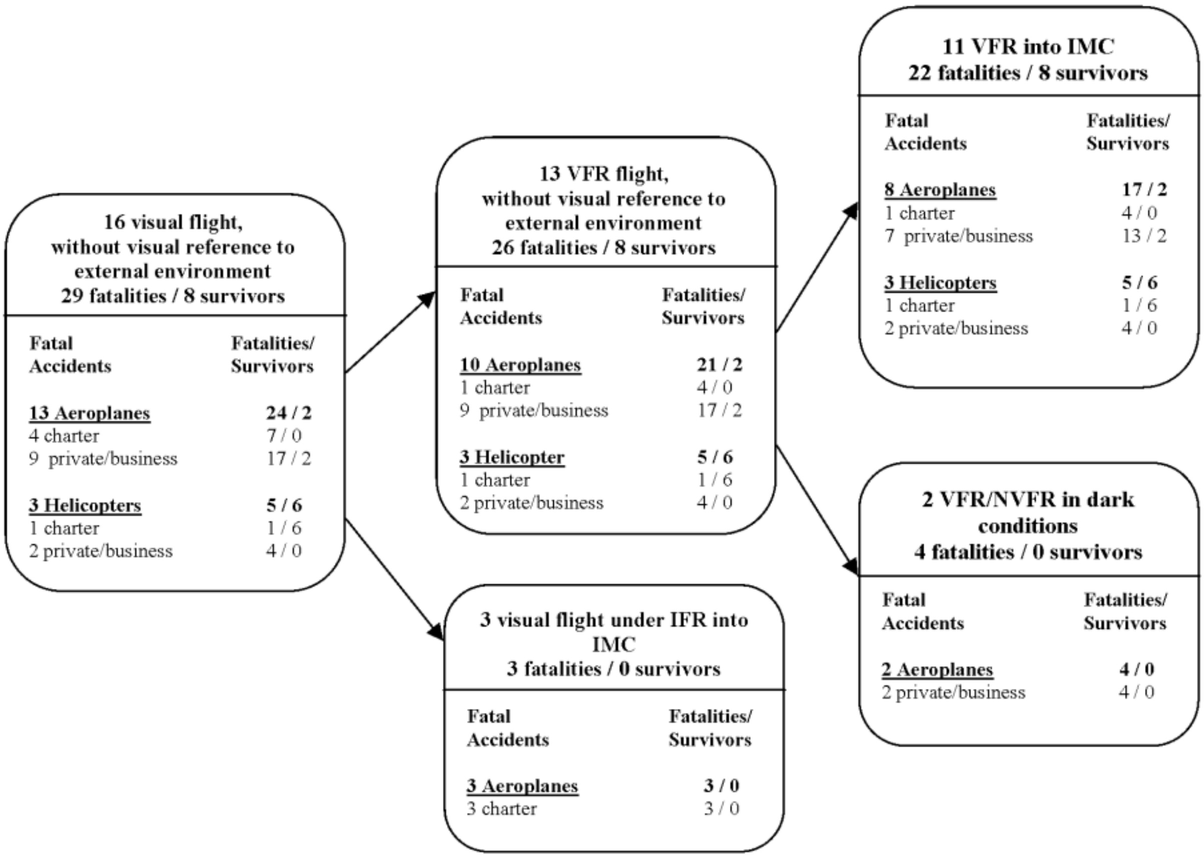
4.2.2.1. CFIT fatal accidents during visual flight, without visual reference to the external environment

There were 16 CFIT fatal accidents, and 29 associated fatalities, during 'normal' operations where the aircraft was being flown visually by the pilot and reference to the external environment was lost.

Figure 23 shows the breakdown of these accidents into groups consisting of:

- pilots flying under visual flight rules (VFR) who could not see the environment in which they were operating. These accidents were further sub-divided into VFR into IMC CFIT fatal accidents, and VFR or Night VFR (NVFR) in dark conditions CFIT fatal accidents; and
- pilots conducting flights under IFR who were proceeding visually when the aircraft entered IMC.

Figure 23: CFIT fatal accidents where aircraft were being flown visually without reference to the external environment



There were 13 fatal accidents, with 26 associated fatalities, where pilots were flying under VFR at the time of the accident. Eleven of the accidents were VFR flights into IMC with the others being a NVFR flight in dark conditions and a VFR flight after dark. In many of the CFIT cases where VFR pilots entered IMC, the pilot initiated a descent to achieve visual flight below cloud creating the circumstances for a CFIT accident.

The pilots involved in CFIT fatal accidents as a result of VFR into IMC were on average a little bit older, obtained their licences later in life and had less aeronautical experience than pilots involved in other types of fatal accidents.

Not all pilots who were involved in VFR into IMC events had CFIT accidents; some lost control of the aircraft when visual reference to the external environment was lost and were involved in UFIT accidents or in-flight break-ups. (Analysis of the whole group of VFR into IMC events can be found at section 4.6.2.).

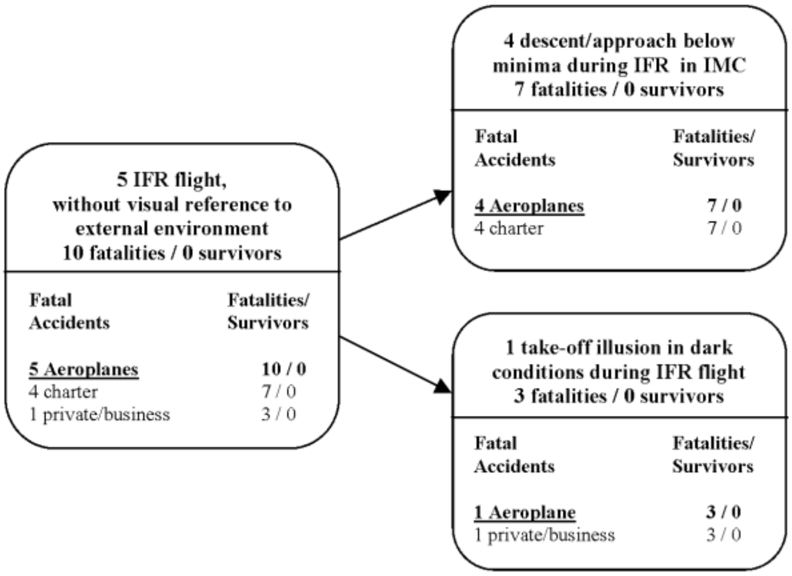
There were also three fatal accidents, with three associated fatalities, where pilots were operating under IFR but were flying the aircraft visually on a visual segment of the flight, when it entered IMC and the CFIT accident occurred.

4.2.2.2. CFIT fatal accidents during an instrument segment of an IFR flight, without visual reference to the external environment

There were five CFIT fatal accidents and 10 associated fatalities, during 'normal' operations where aircraft were being flown by reference to the instruments in IMC or dark conditions.

Figure 24 shows the breakdown of these accidents.

Figure 24: CFIT fatal accidents during IFR flight with no visible external environment



Four of these accidents occurred when aircraft were flown below the minima during an instrument arrival, or on approach, and resulted in seven fatalities.

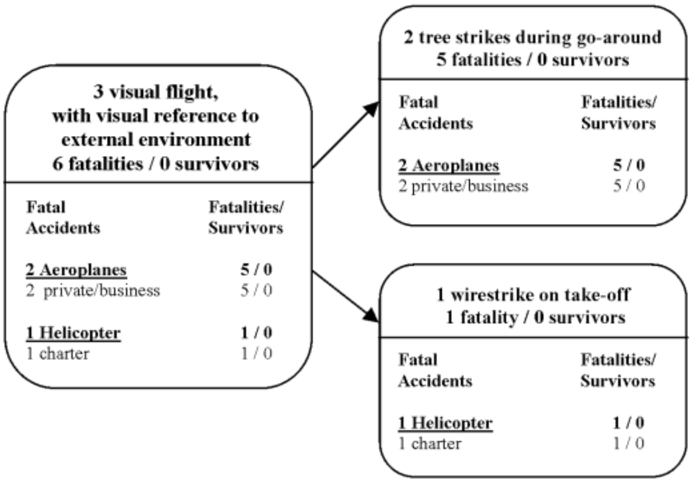
The other accident was probably the result of somatogravic illusion being encountered by the pilot during take-off. Three people were fatally injured in this accident.

4.2.2.3. CFIT fatal accidents during visual flight, with visual reference to the external environment

There were three CFIT fatal accidents that occurred in VMC to aircraft being flown under VFR and they resulted in six fatalities.

Figure 25 shows the breakdown of these accidents into groups based on the object with which the aircraft collided. These fatal accidents differ from those that resulted from necessary low-level flight, as they occurred during 'normal' operation phases (go-around and take-off) and hence have different preventative measures.

Figure 25: CFIT fatal accidents during 'normal' operation phases during visual flight in visual conditions

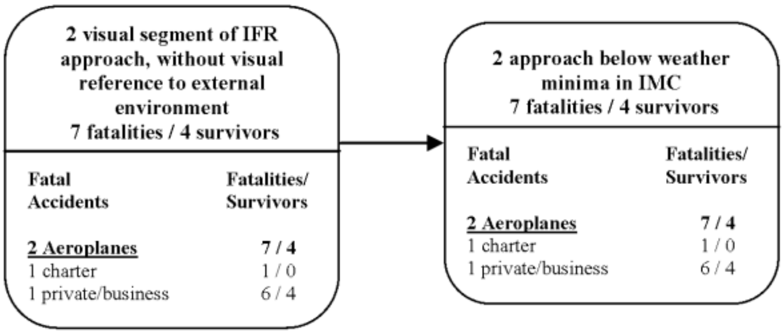


Two of these accidents were tree strikes during go-arounds by aeroplanes and the other was a helicopter wirestrike during take-off. In both of the tree strike accidents, the go-arounds were initiated during the latter part of the approach, but it could not be determined why the trees were not avoided. In one accident, it is possible that the extended forward fuselage of the aircraft could have restricted forward and downward visibility during the climb leading to the CFIT with the tree. In the helicopter wirestrike accident, it appears the aircraft was parked on the ground in the vicinity of the powerline and during take-off, the helicopter's take-off profile took the helicopter into the wire resulting in a wirestrike.

4.2.2.4. CFIT fatal accidents during the visual segment of an instrument flight rules (IFR) approach, without visual reference to the external environment

Figure 26 shows that both accidents arising from pilots flying the visual segment of an IFR flight, where the environment was obscured, to be cases where the pilots descended the aircraft below the weather minimum descent altitude during the visual segment of an IFR approach. These two accidents resulted in seven fatalities.

Figure 26: CFIT fatal accidents during the visual segment of IFR approach and pilot could not see objects/terrain in the environment



Both of these accidents also occurred during dark nights when the pilots descended early during the visual circling segment of the approach.

4.3. Managed flight into terrain (MFIT) fatal accidents

A ‘managed flight into terrain’ (MFIT) accident was defined as an event where an aircraft collided with obstacles, objects or terrain while being flown under limited control or reduced performance, with insufficient height/performance to reach a designated landing area.

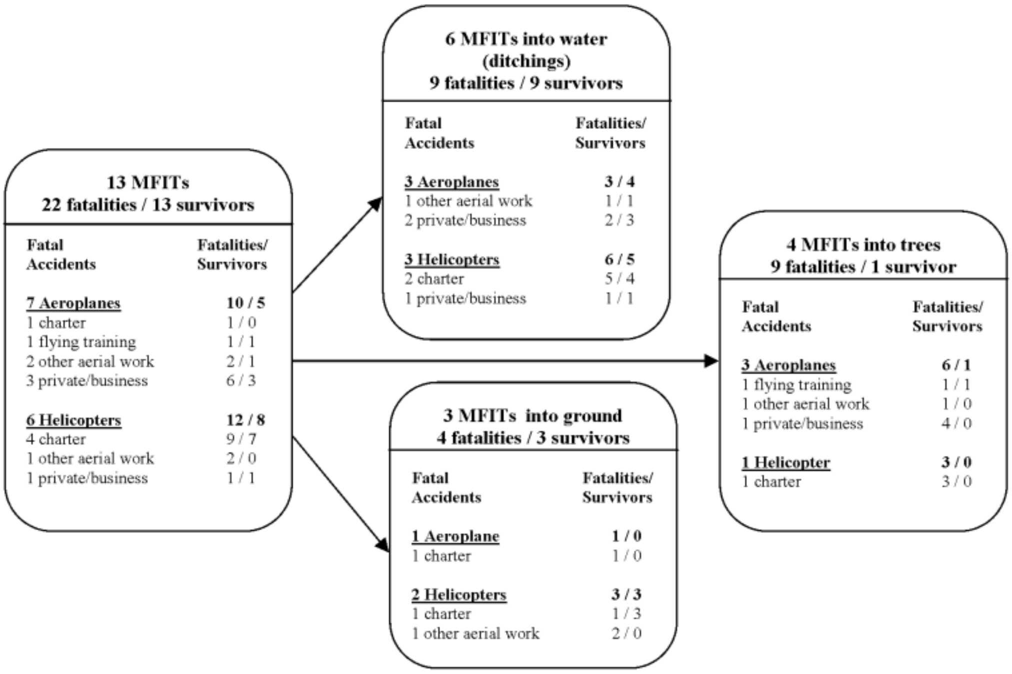
There were 13 MFIT fatal accidents (six per cent of fatal accidents) with 22 associated fatalities (five per cent of fatalities). Thirteen people survived MFIT fatal accidents (17 per cent of survivors).

Only one of the ‘managed flight into terrain’ accidents occurred during low-level operations, but all of the MFITs were considered together as the definition acknowledges that the pilot may not have had the necessary height to land the aircraft on a designated landing area.

All of the MFIT fatal accidents occurred after aircraft had encountered a loss of engine power. Ten aircraft had a complete loss of power and three had a partial loss of power.

Figure 27 shows the breakdown of MFIT fatal accidents by the type of terrain encountered, because in many cases the type of terrain was instrumental in the resulting fatalities.

Figure 27: Managed flight into terrain fatal accidents



4.3.1. Ditchings

There were six fatal ditchings as a result of MFIT accidents, which resulted in nine fatalities. Three accidents involved helicopters and three involved aeroplanes.

Three of the aircraft lost power due to mechanical failure of the engine, two lost power due to fuel starvation (one of which was a problem with the fuel system and the other was pilot-related) and the reason for the power loss could not be determined in the other case.

Fatal injuries in ditching accidents occurred for various reasons. Some persons escaped from the aircraft after the ditching, but because life vests were not available they drowned before they were rescued. Other persons were unable to egress from the aircraft before it sank, and some of those that did make it out of the aircraft with life vests were unable to stay afloat until rescuers arrived due to injuries sustained in the ditching process.

4.3.2. Tree strikes

Three out of four of the managed flight into trees fatal accidents occurred when aircraft lost engine power over terrain that was unsuitable for forced landings. The other fatal accident occurred when power was lost in the circuit area, and the aircraft hit a tree while it was being manoeuvred to land.

Two of the three aeroplane power losses were the result of fuel starvation (one was due to a problem with the fuel system and the other was pilot-related), and the other one was the result of a mechanical failure of the engine. The helicopter lost power due to an engine flame out.

4.3.3. Ground strikes

The three remaining managed flight into terrain fatal accidents occurred after fuel exhaustion events. The pilot of the aeroplane misjudged the forced landing on approach and landed very heavily. One of the helicopters landed heavily in rugged terrain and when the other helicopter landed heavily, a fire started from fuel that was being carried in separate containers on board the aircraft.

The managed flight into terrain fatal accidents show that even in the event of a power loss, the flight can be managed to its point of impact, but the terrain where forced or heavy landings take place plays a major role in the survivability of the accident.

4.4. Uncontrolled flight into terrain (UFIT) fatal accidents

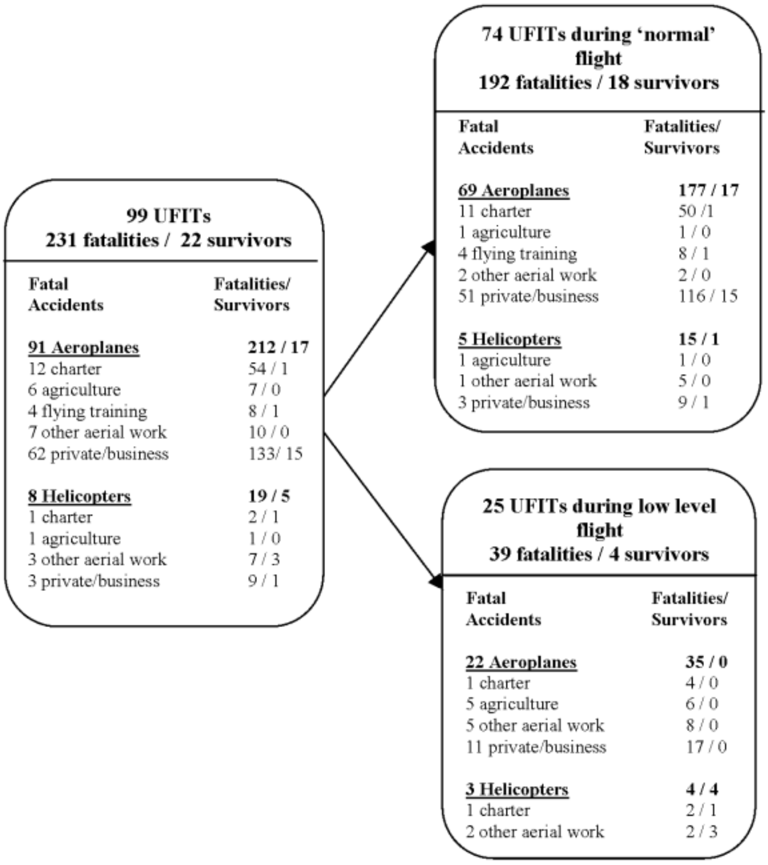
A UFIT accident was defined as an event where an aircraft collided with obstacles, objects or terrain after control of the aircraft was lost in-flight (includes cases where the pilot became incapacitated) but the aircraft structure did not change prior to the impact.

There were 99 UFIT fatal accidents (46 per cent of fatal accidents) and 231 associated fatalities (56 per cent of fatalities). Twenty two people survived these fatal accidents (28 per cent of survivors).

Accidents where aircraft broke up in-flight as a result of a loss of control are not included in this section and are part of the in-flight break up category. These accidents were considered separately, because loss of control accidents where the aircraft remained intact meant that there was some scope to recover the situation; but if a piece of aircraft necessary for controlled flight separates from an aircraft in-flight, recovery to controlled flight is not possible.

Figure 28 shows the breakdown of UFIT fatal accidents into those that occurred during low-level operations and those resulting from 'normal' operations.

Figure 28: UFIT fatal accidents grouped by planned flight level



This division allows the analysis of low-level UFIT accidents where pilots are manoeuvring aircraft during low-level operations where a higher level of skill is required to recover from loss of control situations separate from those UFIT accidents that occurred during the 'normal' envelope of flight for which no extra training is required. Also, UFIT accidents due to loss of control at low-level gives less opportunity to recover control; therefore, some UFITs at low-level will involve types of control losses that could have been recovered from a greater height. Low-level UFIT accidents also include those accidents where pilots were flying unnecessarily low.

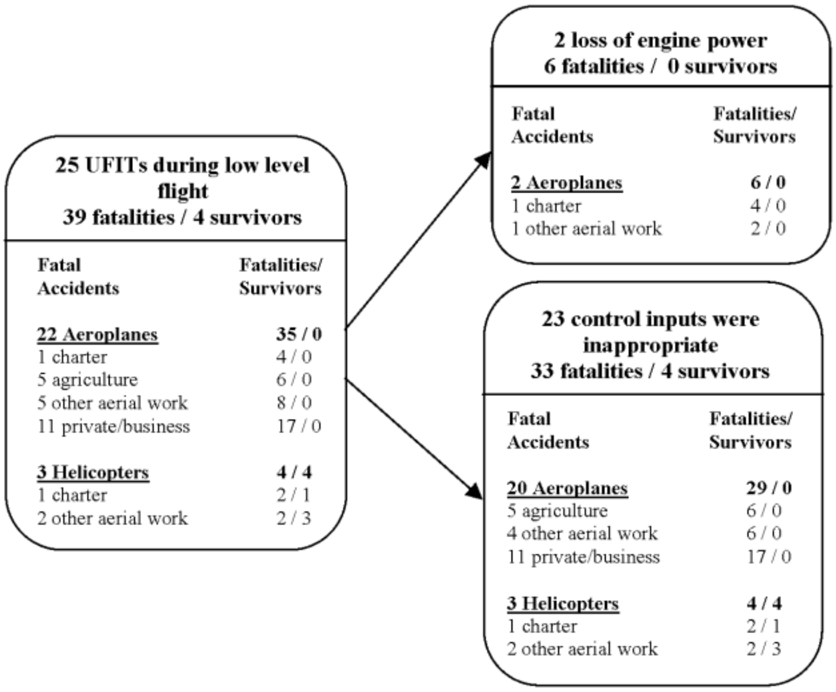
4.4.1. UFIT fatal accidents during low-level operations

Undertaking low-level operations where aircraft are manoeuvring close to the ground means there is little scope for recovery if aircraft control is lost. Low-level flying training is designed to increase pilots' skills to safely operate at low-levels and to recover from incipient loss of control situations during operations such as spraying and other aerial agriculture operations, mustering, surveying, spotting and powerline patrol etc.

There were 25 UFIT fatal accidents during low-level operations (12 per cent of fatal accidents) with 39 associated fatalities (nine percent of fatalities). Four people survived these fatal accidents (five per cent of survivors).

These accidents were then sorted into groups based on the circumstances surrounding the loss of control event, as shown in Figure 29.

Figure 29: UFIT fatal accidents during low-level flight sorted by loss of control initiating event



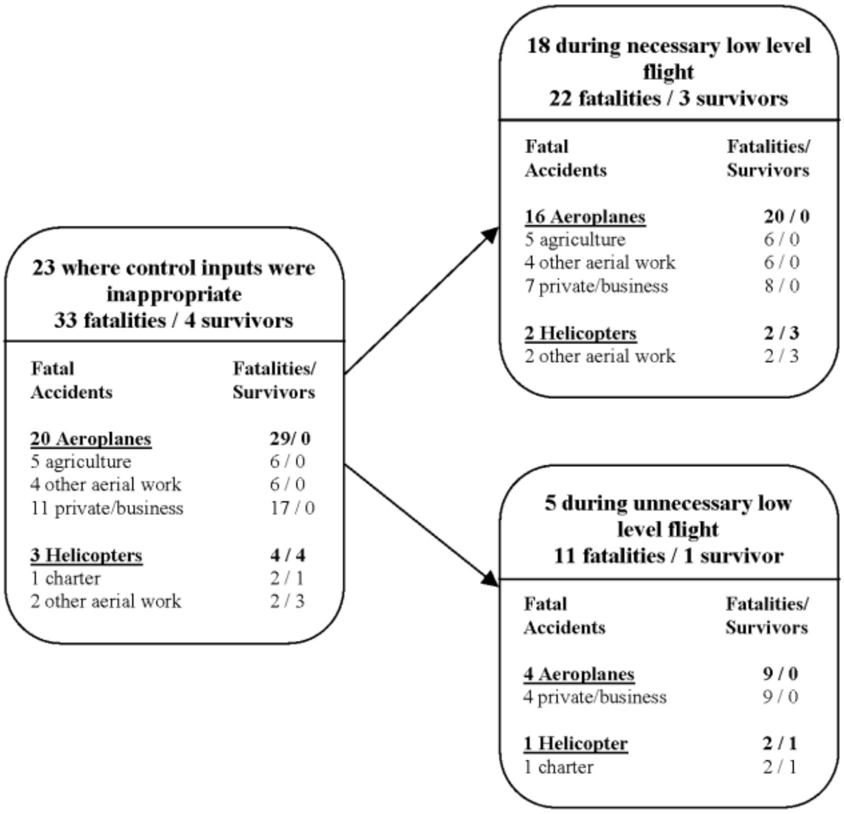
Only two of the UFIT fatal accidents at low-level occurred when an aircraft functionality problem preceded the loss of control by the pilot. In the first case, a twin engine aircraft lost total power in one engine after the pilot turned the fuel off to that engine for unknown reasons. The pilot was unable to maintain control of the aircraft which impacted the ground resulting in fatal injuries to both persons on board.

The other accident also involved a twin engine aircraft. The rear engine was starved of fuel, probably due to unporting of fuel to the right sump during unbalanced flight, and it is possible the pilot inadvertently selected the front engine off instead of selecting the rear engine to auxiliary. The loss of power and ensuing loss of control occurred during a maximum performance turn, resulting in fatal injuries to all four persons on board the aircraft.

The other 23 UFIT fatal accidents during low flying, in which 33 persons received fatal injuries, involved aircraft without functionality problems but the pilot's control inputs were not appropriate to keep the aircraft in controlled flight. These accidents were first sorted into those that occurred during operations where low flying was necessary to the purpose of the flight, and those during low flying that was unnecessary to the purpose of the flight.

Figure 30 shows the breakdown of these accidents into the above mentioned groups.

Figure 30: UFIT fatal accident during low-level operations with inappropriate control inputs sorted into necessary and unnecessary low-level flight

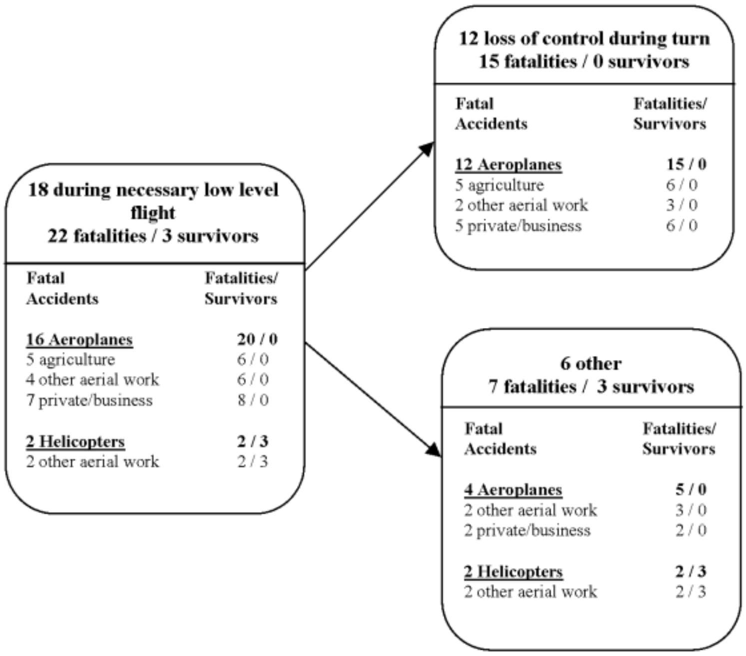


There were 18 fatal accidents with 22 associated fatalities where pilot control inputs initiated a loss of control of the aircraft during necessary low-level flight (i.e. during aerial agriculture, aerial application, surveying, mustering, powerline patrol, spotting and air show display operations). The other 11 people received fatal injuries in five fatal accidents during unnecessary low-level flight when higher-risk manoeuvres were performed during private flying for pleasure/travel and a charter passenger flight.

4.4.1.1. Low-level UFIT fatal accidents during necessary low-level flight

The 18 fatal accidents where pilot control inputs led to a loss of control during necessary low-level flight were then divided into accidents that occurred during turning manoeuvres and those that did not. These groups are depicted in Figure 31.

Figure 31: UFIT fatal accidents during necessary low-level flight sorted into accidents that occurred during turning manoeuvres and the other accident types



Twelve of the fatal accidents where pilot control inputs led to a loss of control occurred during aerial spraying, mustering, surveying, and airshow operations while the aircraft was being flown in a turn. Fifteen people received fatal injuries as a result of these accidents. In three cases, the loss of control happened in adverse wind conditions. The operations being conducted, by their nature, required aircraft to be manoeuvred while very close to the ground, leaving little altitude and time to recover from a stall. Conducting more conservative turn procedures, where possible, would help avoid loss of control during low-level manoeuvring. Also, three pilots involved in these accidents did not have the appropriate training/endorsements to undertake the operation being conducted, and two others were inexperienced, so their aircraft handling skills may have been inadequate to avoid or recover from stalls at such low-levels.

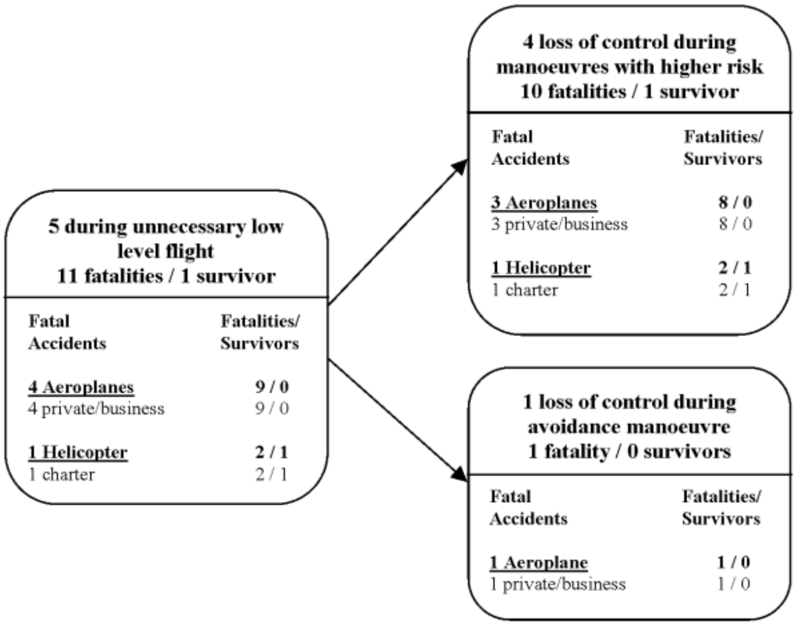
The six ‘other’ fatal accidents where pilot control inputs lead to a loss of control during necessary low-level operations were:

- a helicopter loss of control accident due to loss of tail rotor effectiveness;
- a helicopter loss of control accident due to decay of the main rotor RPM;
- an aeroplane accident which occurred when the pilot was distracted from flying the aircraft;
- an aeroplane accident that occurred when control of the aircraft was lost in a turn during an attempt to out-climb a rising valley floor when windshear and mechanical turbulence were present;
- an aeroplane accident that occurred when control of the aircraft was lost during a climb after a low pass at an airshow; and
- an aeroplane accident where the circumstances surrounding the in-flight loss of control could not be determined but willy-willies had been reported in the general area of the accident and the pilot was not known to have undertaken formal low-level flying training.

4.4.1.2. UFIT at low-level fatal accidents during unnecessary low-level flight

Figure 32 below shows the breakdown of UFIT fatal accidents during unnecessary low-level flight into groups of ‘planned manoeuvres’ and ‘avoidance manoeuvres’.

Figure 32: UFIT fatal accidents during unnecessary low-level flight sorted into planned manoeuvres and avoidance manoeuvres



Four of the fatal accidents during unnecessary low-level flight resulted from attempted manoeuvres that were unnecessary to the purpose of the flight and the pilot lost control of the aircraft at a height from which a recovery could not be executed. The other fatal accident resulted from a pilot doing an unnecessary high-speed low-level pass and losing control during a manoeuvre conducted in order to avoid a tree.

Skylarking at low-levels, ‘buzzing’ and doing high-speed low-level passes can lead to loss of control at heights that do not allow a recovery to be effected, especially for pilots who are not trained in low-level operations. Over the ten-year period examined in this report, these accidents resulted in 11 fatalities, but they are avoidable simply by not flying in this manner.

4.4.2. UFIT fatal accidents during ‘normal’ operations

There were 74 UFIT fatal accidents during ‘normal’ operations (34 per cent of fatal accidents) and 192 associated fatalities (46 per cent of fatalities). Eighteen people survived these fatal accidents (23 per cent of survivors).

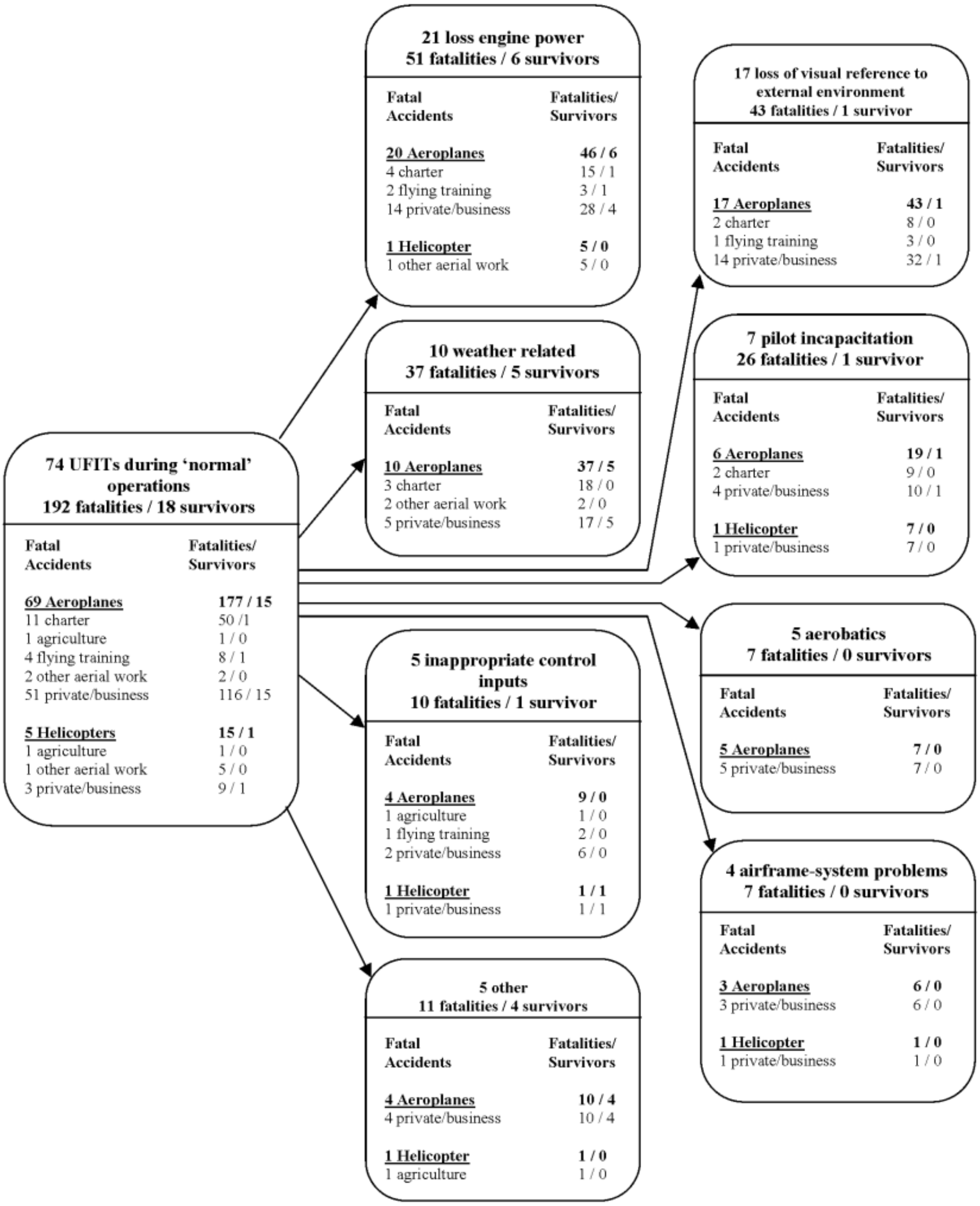
UFIT fatal accidents during ‘normal’ operations (i.e. excluding UFITs during planned low-level flying) mostly fell into well-defined categories, with a number of other categories with smaller numbers of accidents.

The groups used to classify these accidents are listed below.

- Loss of engine power: where loss of control followed a total or partial loss of engine power
- Loss of natural horizon: where the pilots of VFR aircraft lost reference to the natural horizon
- Weather: accidents that occurred during turbulence or icing conditions
- Pilot incapacitation: the pilot became incapacitated leading to loss of control
- Aerobatics: the loss of control (or orientation) occurred during aerobatics
- Pilot control inputs: where the pilot’s control inputs initiated a loss of control
- Airframe/system: the loss of control was a result of an airframe or system problem
- Other: accidents that did not fall into the above groups or where the loss of control circumstances could not be determined.

Figure 33 shows the breakdown of UFIT fatal during ‘normal’ operations into the previously mentioned groups.

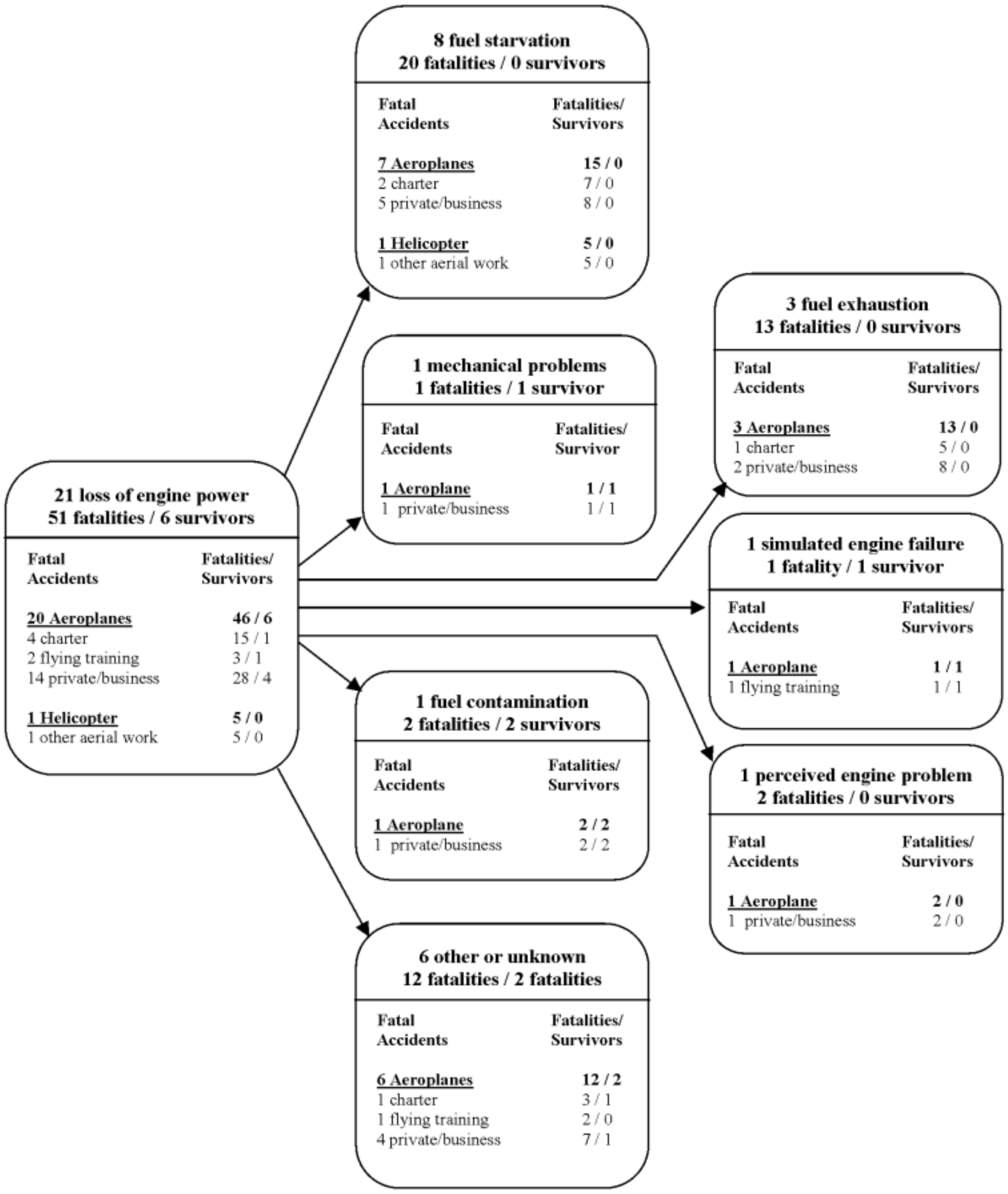
Figure 33: UFIT fatal accidents during ‘normal’ operations sorted by circumstances surrounding loss of control event



4.4.2.1. UFIT fatal accidents initiated from a loss of engine power

There were 21 UFIT fatal accidents during 'normal' operations where pilots lost control of the aircraft after a total or partial loss of engine power, with 51 associated fatalities. Figure 34 shows the initiating event for the loss of power.

Figure 34: UFIT fatal accidents during 'normal' operations where there was a loss of engine power



Just over half of the UFIT fatal accidents during 'normal' operations after a loss of engine power resulted from fuel starvation, contamination or exhaustion. Nine of the 12 fuel starvation/exhaustion/contamination power losses were a result of not testing fuel prior to flight, poor fuel planning, poor in-flight fuel monitoring or misunderstanding the fuel system. The loss of engine power in these cases could have been avoided entirely with rigorous fuel quantity planning and in-flight fuel management. The other three were a result of fuel system/engine accessory malfunctions.

Whether the pilot could have avoided the loss of power or not, once an engine power loss occurred, the opportunity to manage the flight to its landing/impact point arises, as was seen in the discussion of managed flight into terrain fatal accidents. In the UFIT fatal accidents, after total or partial power loss, the pilot's decision regarding flight path, or simply the control inputs after the engine failure initiated a loss of control.

There were four accidents where the pilots appeared to be attempting to turn back to the airfield, after engine problems occurred during climb after take-off. Two of the aircraft were over unsuitable terrain for a forced landing when the power loss occurred, and the other two pilots had reasonable forced landing options available.

Two other pilots also did not utilise available forced landing options when aircraft engine problems occurred. One aircraft was en-route while the other was on approach to land.

In twelve cases it appeared that the first control inputs by the pilots in response to the power loss were inappropriate and the loss of control ensued very soon after the engine problem. Nine of these accidents happened during climb after take-off or the climb phase of a go-around, while three occurred during an approach to land.

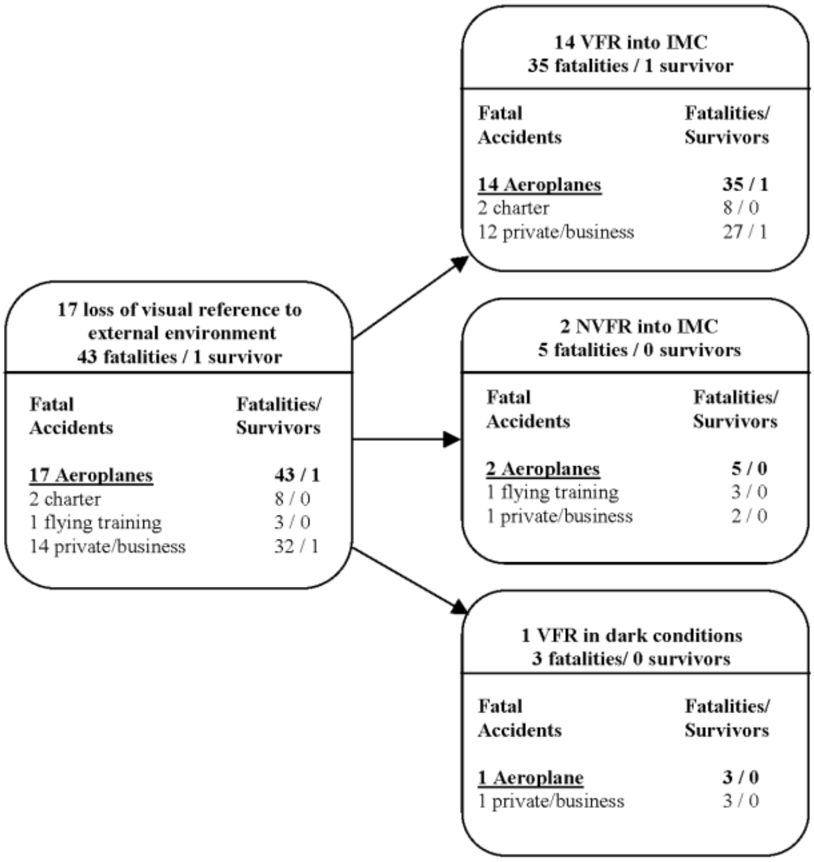
The accidents grouped under the title of 'other' occurred after aircraft experienced a rough running engine or intermittent loss of power that was not determined to be one of the other engine problems listed. The perceived loss of engine power was the result of a power reduction following a low oil pressure indication and the simulated engine failure was carried out after a touch and go at a height of approximately 300 feet.

4.4.2.2. UFIT fatal accidents initiated from loss of visual reference to the external environment during VFR flight

The second largest group of UFIT fatal accidents during 'normal' operations occurred when VFR aircraft were flown in situations where the pilot did not have a visual reference to the external environment and control of the aircraft was lost. There were 17 accidents in this category with 43 associated fatalities.

Figure 35 below shows the conditions that the VFR pilots were operating in when a visual reference to the external environment was lost.

Figure 35: UFIT fatal accidents where VFR pilots lost a visual reference to the external environment.



There were 14 accidents where a VFR flight was continued into IMC, two where NVFR flights were operating in IMC and the other was a VFR flight that was continued after dark.

The survivability from this group of accidents was very low.

4.4.2.3. UFIT fatal accidents initiated from a loss of control in turbulence or icing conditions

Figure 36: UFIT fatal accidents where pilots lost control in turbulence or icing conditions

10 weather related 37 fatalities / 5 survivors	
Fatal Accidents	**Fatalities/ Survivors**
10 Aeroplanes	**37 / 5**
3 charter	18 / 0
2 other aerial work	2 / 0
5 private/business	17 / 5

There were ten fatal accidents where weather conditions (other than operating in IMC) were a factor in the accident.

There were two fatal accidents that occurred while aircraft were flying in icing conditions.

The other eight accidents occurred in conditions of turbulence or windshear. Two aircraft, which were close to the maximum permissible take-off weights, encountered windshear on take-off and the pilot's control inputs did not keep the aircraft under controlled flight.

Two aircraft, one of which was overweight, were being operated in turbulent conditions and at the limit of the aircraft's operating envelope when control of the aircraft was lost. In the four remaining accidents, the pilot's control inputs were not appropriate to keep the aircraft under controlled flight in the wind conditions.

4.4.2.4. UFIT fatal accidents initiated from loss of control after pilot incapacitation

Figure 37: UFIT fatal accidents where control was lost after pilot incapacitation

7 pilot incapacitation 26 fatalities / 1 survivor	
Fatal Accidents	**Fatalities/ Survivors**
6 Aeroplanes	**19 / 1**
2 charter	9 / 0
4 private/business	10 /1
1 Helicopter	**7 / 0**
1 private/business	7 / 0

Accidents where the pilot became incapacitated in-flight formed the next largest group.

There were seven fatal accidents where pilot incapacitation appeared to be the most likely initiating event, with 26 associated fatalities.

4.4.2.5. UFIT fatal accidents initiated from loss of control during aerobatics

Figure 38: UFIT fatal accidents where control was lost during intentional aerobatic manoeuvres

5 aerobatics
7 fatalities / 0 survivors

Fatal Accidents	Fatalities/ Survivors
5 Aeroplanes	**7 / 0**
5 private/business	7 / 0

Five accidents occurred while the pilot was conducting aerobatics with seven fatalities as a result. Control inputs were not appropriate to avoid a fatal accident.

All the fatal accidents in this group occurred while the pilot was conducting an aerobatic manoeuvre, or when a series of aerobatic manoeuvres continued downwards to the accident site. Some aerobatic manoeuvres, particularly spins and flick rolls, can be the consequence of controlled inputs, or of a loss of control during another aerobatic sequence or manoeuvre. In most aerobatic accidents, witnesses observed the aircraft's manoeuvres as it approached the ground, but not at the time of impact. In the majority of fatal aerobatic accidents, the aircraft was last seen rotating and descending rapidly, or the descent from the aerobatic manoeuvres was not witnessed. In one case, a pilot changed from a high negative 'G' manoeuvre to another manoeuvre close to the ground, and it was considered likely that the pilot had experienced a loss of spatial awareness (necessary for maintaining control). In one case, a pilot commenced an aerobatic manoeuvre shortly after take-off, and collided with the ground during the manoeuvre. Subsequent analysis indicated that it would have been possible, but extremely difficult, to conduct that manoeuvre from that position without colliding with the ground.

The nature of the loss of control in aerobatic accidents is not normally the same as in other UFIT accidents. The loss of control appeared to be primarily related either to a loss of situational awareness (a human factors issue), or attempting an aerobatic manoeuvre at a low altitude where it was possible to conduct the manoeuvre but there was not enough room to allow for any imperfection in the aerobatic manoeuvre.

It was considered desirable to classify the fatal aerobatic accidents in one grouping, and the best fit was considered to be in the UFIT group.

4.4.2.6. UFIT fatal accidents initiated by inappropriate control inputs

Figure 39: UFIT fatal accidents where control was lost after an inappropriate control inputs

5 inappropriate control inputs
10 fatalities / 1 survivor

Fatal Accidents	**Fatalities/ Survivors**
4 Aeroplanes	**9 / 0**
1 agriculture	1 / 0
1 flying training	2 / 0
2 private/business	6 / 0
1 Helicopter	**1 / 1**
1 private/business	1 / 1

In five fatal accidents, there did not appear to be a precipitating factor in the accident; however, the pilot's control inputs were not appropriate to sustain controlled flight.

4.4.2.7. UFIT fatal accidents initiated from loss of control after airframe or system problems

Figure 40: UFIT fatal accidents where control was lost after an airframe or a system problem

4 airframe / system problems
7 fatalities / 0 survivors

Fatal Accidents	**Fatalities/ Survivors**
3 Aeroplanes	**6 / 0**
3 private/business	6 / 0
1 Helicopter	**1 / 0**
1 private/business	1 / 0

There were four fatal accidents where the aircraft had a system or airframe problem and seven people received fatal injuries as a result of these accidents. In three cases the aircraft became uncontrollable because of system/airframe problems and in the other accident the vacuum pump failed during an IFR flight in dark conditions, leading to a loss of control.

4.4.2.8. UFIT fatal accidents initiated from other or unknown events

Figure 41: UFIT fatal accidents where the sequence was unknown or different from all the other classifications

5 other
11 fatalities / 4 survivors

Fatal Accidents	Fatalities/ Survivors
4 Aeroplanes	**10 / 4**
4 private/business	10 / 4
1 Helicopter	**1 / 0**
1 agriculture	1 / 0

There were another five UFIT fatal accidents grouped under the heading of 'other' that did not fall into the categories discussed above or where the circumstances surrounding the accident could not be determined.

In two accidents the pilot did not have command over the fight controls due to interference with the controls.

One accident was the result of the aircraft being overweight with a possible movement in the centre of gravity in-flight leading to loss of control and uncontrolled flight into terrain.

The two remaining accidents were:

- a loss of control accident after take-off climb, during an IFR flight in dark conditions; and
- a loss of control accident after take-off, when the aircraft failed to adopt a climb attitude for reasons which could not be determined.

4.5. Remaining fatal accident types

The accident types that were not CFITs, MFITs or UFITs accounted for the remaining 39 fatal accidents (18 per cent) and 51 fatalities (12 per cent).

4.5.1. Fatal in-flight break-ups

Figure 42: In-flight break-up

9 in-flight break-ups
14 fatalities / 1 survivor

Fatal Accidents	Fatalities/ Survivors
5 Aeroplanes	**10 / 0**
2 charter	5 / 0
3 private/business	5 / 0
4 Helicopters	**4 / 1**
2 other aerial work	2 / 1
2 private/business	2 / 0

An in-flight break-up was defined as an event where pieces of an aircraft necessary for controlled flight separated from the aircraft in-flight.

As mentioned at the beginning of the section on UFIT fatal accidents, some accidents in which there was a loss of control in-flight led to in-flight break-ups rather than a UFIT fatal accident by an intact aircraft. Once a piece of aircraft essential for controlled flight has separated from the aircraft there is no chance of recovery, unlike a loss of control where an in-flight break-up did not occur. There were six in-flight break-ups as a result of loss of control in-flight. The other three in-flight break-ups were initiated by airframe failures. A total of 14 people received fatal injuries as a result of in-flight break-ups.

The six loss of control events that preceded in-flight break-ups were when:

- the control inputs by a pilot led to a helicopter mast bump and main rotor failure in-flight
- an IFR aircraft in IMC had a vacuum pump failure leading to an in-flight loss of control and an in-flight break-up
- a VFR flight in IMC resulted in a loss of control and an in-flight break-up
- an aeroplane with a propeller problem broke up in-flight due to overload as the aircraft most likely descended through a small hole in the cloud cover
- a pilot lost control of an aeroplane during an IFR flight at night in dark conditions leading to excess loading on a wing and an in-flight break-up
- a helicopter was flown after dark with no natural horizon and a power loss occurred due to fuel exhaustion, leading to loss of control in-flight and an in-flight break-up.

The three airframe events that preceded in-flight break-ups were when:

- the left tail boom support structure of a helicopter detached in-flight, resulting in the tail boom lifting and being severed by the main rotor blades
- a weakened wing failed on an aeroplane in-flight during an aerobatic flight
- a helicopter main rotor blade separated in-flight.

4.5.2. Fatal mid-air collisions

Figure 43: Mid-air collisions

6 mid-air collisions 8 fatalities / 5 survivors	
Aircraft	**Fatalities/ Survivors**
8 Aeroplanes	**6 / 3**
2 flying training	1 / 1
1 other aerial work	0 / 1
5 private/business	5 / 1
4 Gliders	**2 / 2**
4 gliding	2 / 2

A mid-air collision accident was defined as an event where there was contact between two aircraft while both were airborne.

There were six mid-air collisions in which eight people sustained fatal injuries. All of the mid-air collisions occurred outside controlled airspace and aircraft-to-aircraft communications and see-and-avoid procedures did not prevent these collisions happening.

4.5.3. Fatal collisions between aircraft on the ground

Figure 44: Collision between aircraft on the ground

1 collision on the ground between aircraft 1 fatalities / 1 survivor	
Aircraft	**Fatalities/ Survivors**
2 Aeroplanes	**1 / 1**
1 flying training	1 / 0
1 private/business	0 / 1

A ground collision accident was defined as an event where there was contact between an aircraft with other aircraft, vehicles, objects, animals on runway or taxiway.

One collision occurred on a runway when an aeroplane landed on top of another aeroplane. The pilot of the aeroplane on the runway received fatal injuries.

4.5.4. Fatal accidents from an impact to an external party

Figure 45: Fatal accidents involving an impact to an external party

3 impact to external parties
3 fatalities / 6 survivors

Fatal Accidents	Fatalities/ Survivors
1 Aeroplane	**1 / 1**
1 agriculture	1 / 1
2 Helicopters	**2 / 5**
1 agriculture	1 / 1
1 charter	1 / 4

An impact to external party accident was defined as an event where there was an impact to persons external to the aircraft as a result of aircraft's normal activities (excludes accidents where control of the aircraft had been lost prior to the external party being impacted).

There were three fatal accidents where a person outside the aircraft received fatal injuries as a result of the aircraft's operations. One of these persons was a passenger and the other two were third parties. One third party received fatal injuries during helicopter refueling operations when he was struck by a main rotor blade. The other third party was assisting in aerial agriculture operations by acting as a marker when she was struck by the airborne aircraft and received fatal injuries. In the other accident, a passenger who was to board the aircraft passed to the rear of the helicopter and was struck by the tail rotor.

4.5.5. Fatal accidents from a take-off impact

Figure 46: Fatal accident involving a take-off impact

2 take-off impacts 3 fatalities / 2 survivor	
Fatal Accidents	**Fatalities/ Survivors**
1 Aeroplane	**2 / 2**
1 private/business	2 / 2
1 Helicopter	**1 / 0**
1 flying training	1 / 0

A take-off impact accident was defined as an event where an aircraft impacted with the runway or terrain/obstacles adjacent to the runway during take-off prior to getting airborne (excludes 'ground collision').

In one accident an aircraft ran partially off the side of the runway with a high nose attitude and the rear of the fuselage being dragged along the ground. The aircraft continued over the threshold and gained a little height before contacting water and inverting and submerging. Two of the four persons on board received fatal injuries.

The other take-off impact fatal accident involved the dynamic roll over of a helicopter in which the student pilot received a fatal head injury while not wearing his shoulder harness.

4.5.6. Fatal accidents from a landing impact

Figure 47: Landing impact fatal accidents

3 landing impacts 3 fatalities / 6 survivors	
Fatal Accidents	**Fatalities/ Survivors**
2 Aeroplanes	**2 / 4**
2 private/business	2 / 4
1 Helicopter	**1 / 2**
1 charter	1 / 2

A landing impact accident was defined as an event where an aircraft impacted with the runway or terrain/obstacles adjacent to the runway during landing or landing roll (excludes 'ground collision').

There were three accidents that occurred during the landing sequence. In one accident, an aircraft bounced after a heavy landing and after contact with the ground again left the strip and struck trees. A passenger, one of the four people on board, received fatal injuries. In another accident, a pilot attempted a landing with a significant tailwind component and a go-around was attempted with insufficient airstrip remaining resulting in the aircraft striking a fence and house. The other accident involved a helicopter which rolled over after landing and a passenger who was outside the aircraft, unloading equipment, was struck by a rotor blade during the accident sequence.

4.5.7. Other/unknown fatal accidents

There were 15 fatal accidents where:

- the accident was unusual and did not fall into any of the accident classifications;
- the circumstances surrounding the accident were not considered to be aviation safety matters; or
- details of the circumstances did not reveal enough information to determine to which of the accident groups the accident belonged to.

Eight fatal accidents were classified as 'other' in which eight people were fatally injured. One accident classified as 'other' involved a helicopter where the sling hit a drilling rig and then the helicopter. As a result, part of one main rotor blade was severed. A main rotor blade then struck the cockpit, fatally injuring the pilot. The tail boom was severed by the damaged main rotor blade, the helicopter fell to the ground, and one of the two passengers received fatal injuries.

The seven remaining fatal accidents classified as 'other' were where the circumstances were considered to be matters not involving aviation safety. There were seven fatalities associated with these accidents.

There were seven accidents classified as 'unknown', as a determination of accident type could not be made. There were 10 fatalities associated with these accidents. Fatal accidents classified as 'unknown' are grouped in Figure 48.

Figure 48: Fatal accidents categorised as 'unknown'

7 unknown accident types
10 fatalities / 1 survivor

Fatal Accidents	Fatalities/ Survivors
4 Aeroplanes	**7 / 0**
1 agriculture	1 / 0
3 private/business	6 / 0
3 Helicopters	**3 / 1**
2 charter	2 / 1
1 private/business	1 /0

4.6. Separate event analyses

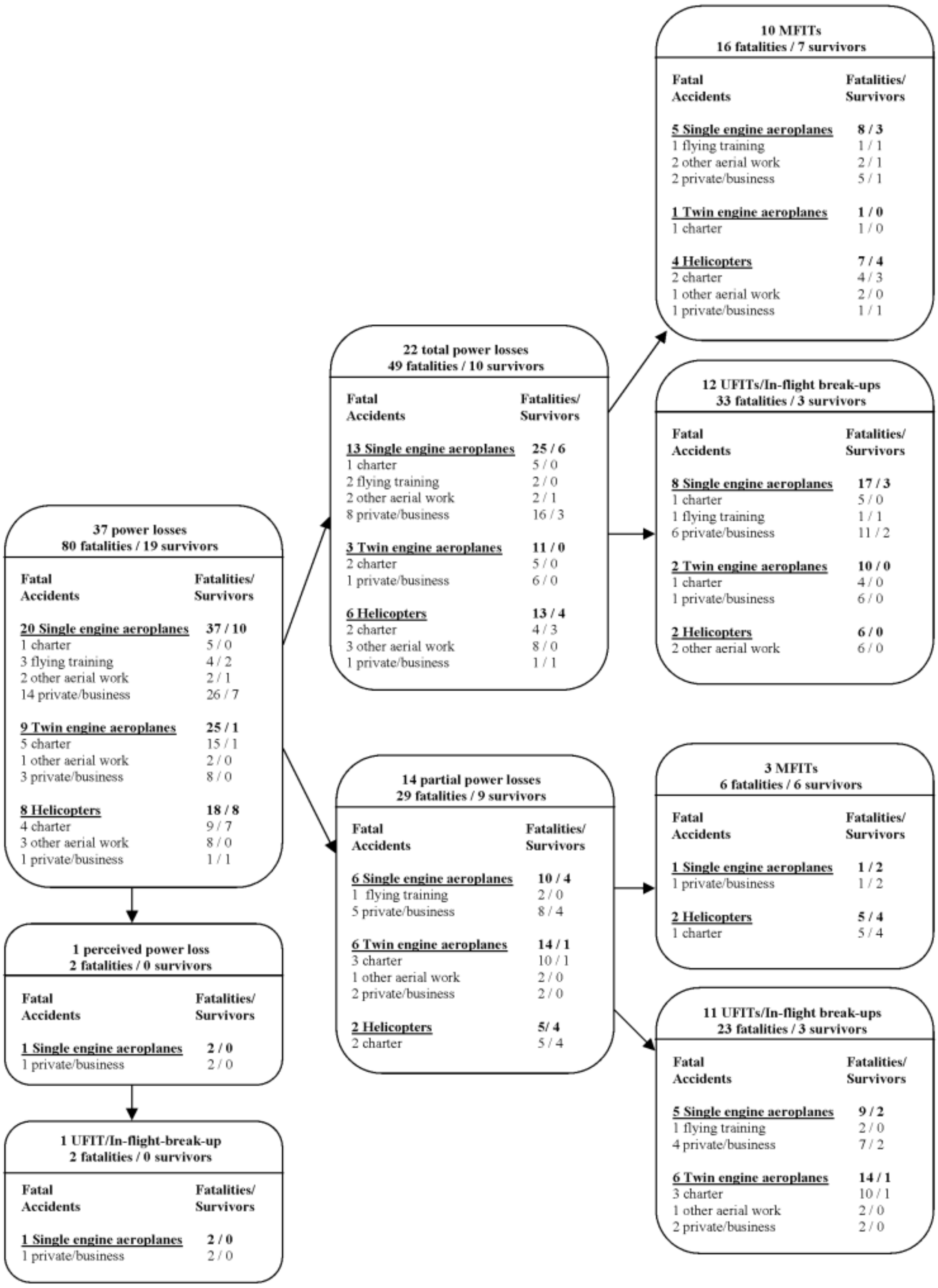
There are two significant groups of events in fatal accidents sequences that are spread across more than one of the fatal accident types described previously. They form the largest sub-groupings in the UFIT group; however, there are events of a similar type in other groups apart from UFIT. The first group comprises accidents that are initiated by a loss of engine power, and the second group relates to accidents in which the pilot was in a situation where they had less visual reference to the outside environment than would normally have been expected for the nature of their operation at that time.

Each of these groups of events has been treated as a population in its own right, and sub-categorised.

4.6.1. Fatal accidents associated with a loss of engine power

Power losses have been sorted by whether the power loss was partial or total, and by the nature of the power loss. Figure 49 shows fatal accidents by consequence after a partial or total power loss.

Figure 49: Fatal accidents initiated by a loss of power, sorted by partial or total power loss



A partial power loss is defined as a situation in which some power remains available. It therefore includes multi-engine aircraft with at least some power from at least one engine. There are significant differences in the figures for single-engine and multi-engine aircraft. A higher proportion of single-engine aircraft do not lose control after a total power loss, compared with a partial power loss. This could be because a pilot is less likely to be distracted by trying to maintain power in a total power-loss situation.

One single-engine aircraft that lost control after a total loss of power broke up in flight before colliding with the ground, but for this analysis only, was categorised with the UFIT accidents, as the initiating conditions were the same.

There were no cases of a partial power loss on a multi-engine aircraft in which the pilot maintained control; i.e. it could be categorised as a MFIT. A multi-engine aircraft is designed to remain airborne after a single engine failure in most cases: as the performance would be adequate to enable the pilot to land at a safe landing site with one engine failed, the most likely scenario for a fatal accident in such a circumstance is for the pilot to lose control in an asymmetric aircraft.

The type of power loss was also categorised by failure type into:

- fuel starvation (when usable fuel was still on the aircraft)
- fuel exhaustion (when there was no usable fuel on the aircraft)
- power loss due to contaminated fuel
- power loss due to mechanical malfunction in the power plant
- perceived power loss (when the pilot responded as if there was a loss of power, even though power was still available)
- simulated power loss (when the power was deliberately reduced)
- power loss for other, or unknown reasons.

Figure 50 shows fatal accidents after power loss by the nature of the power loss.

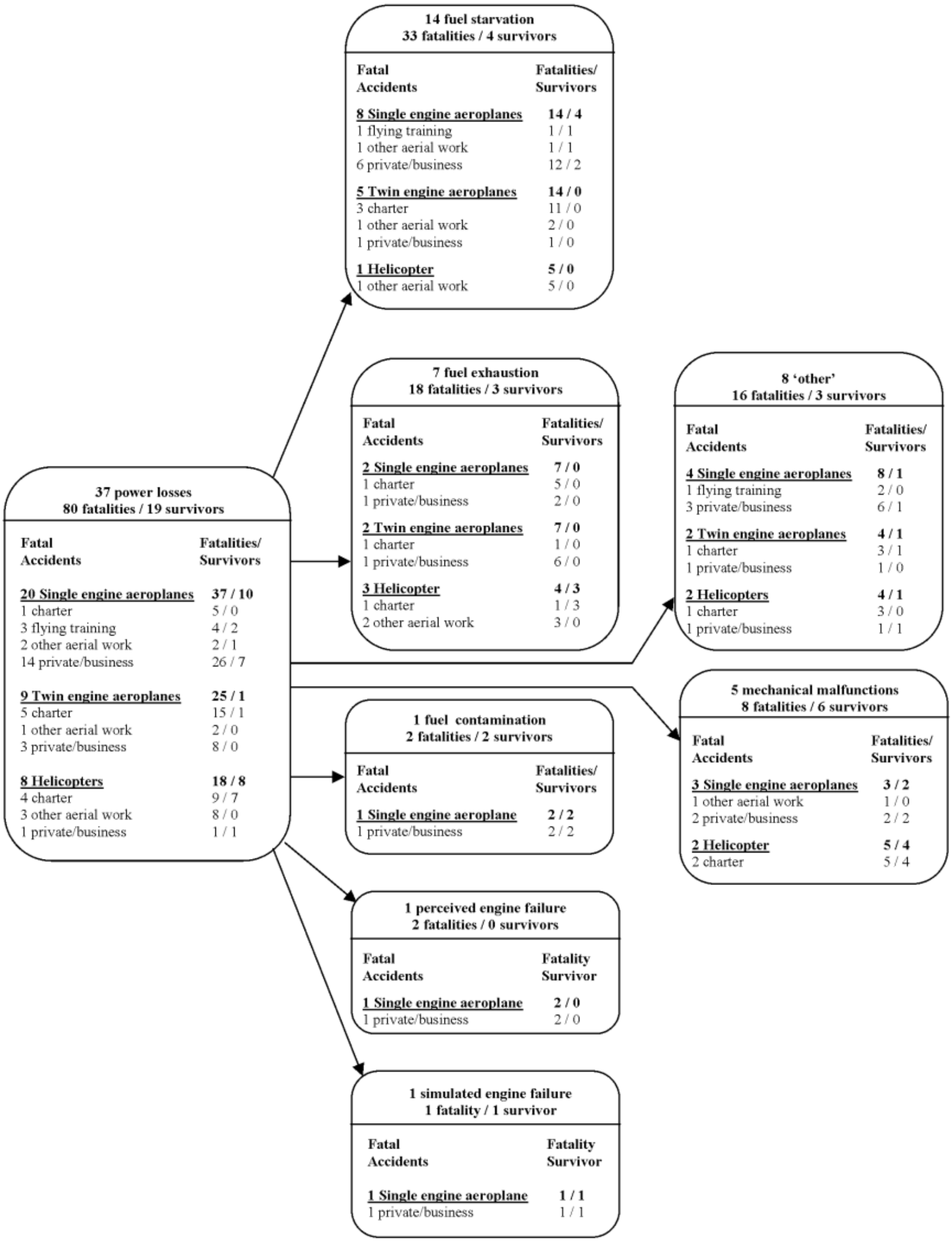
Of the 14 fatal accidents attributed to fuel starvation, nine accidents could be attributed to fuel starvation from pilot intervention or inaction during flight, and five accidents could be attributed to mechanical problems associated with the fuel system. All seven of the fatal accidents attributed to fuel exhaustion could be attributed to fuel quantity management by the pilot. The contaminated fuel should have been identifiable; however, the pilot did not check for water in the fuel prior to flight.

The perceived power loss happened when there was a low oil pressure indication, and the pilot reduced the power.

The simulated power loss involved a training evolution in which the power was not regained in time or control maintained to prevent an accident.

All apart from one of the unknown/other group had power losses for reasons that could not be ascertained. One aircraft had a sudden power loss when the turbine engine flamed out shortly after take off and when the intake had not been de-iced. It was likely that the flameout was induced by ingestion of snow or slush in the air intake.

Figure 50: Fatal accidents initiated by a loss of power, sorted by the power loss circumstances



4.6.2. Fatal accidents associated with a lack of visual reference to the outside environment

4.6.2.1. Fatal accidents associated with VFR operations into IMC

A pilot operating under Visual Flight Rules (VFR) is expected to control the aircraft primarily by visual reference to the environment outside the cockpit. Therefore, a VFR pilot who loses that visual reference will not have all the information available that would normally be expected to be used to control the aircraft. This situation is normally considered to be a higher risk operation.

The common definition for such an event is to consider situations when VFR pilots enter instrument meteorological conditions (IMC). Fatal accidents that precipitate from this condition normally occur either because the aircraft collides with terrain that is not visible to the pilot in sufficient time to evade it (CFIT), or because the pilot loses control of the aircraft (UFIT). In a few cases, the aircraft breaks up after loss of control before colliding with the ground.

Figure 51: Fatal accidents initiated from a 'VFR in IMC' situation, sorted by consequence

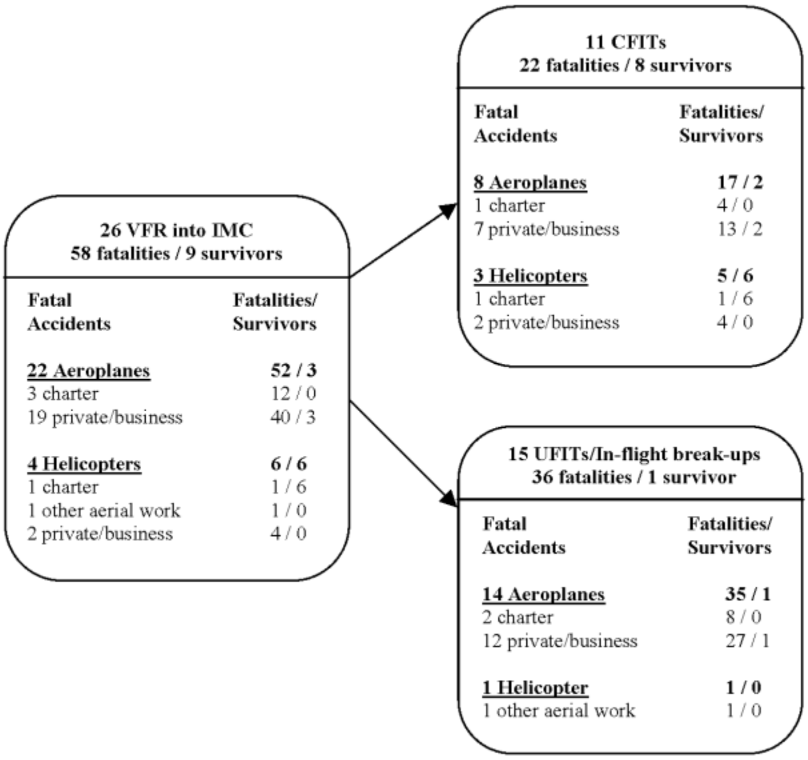
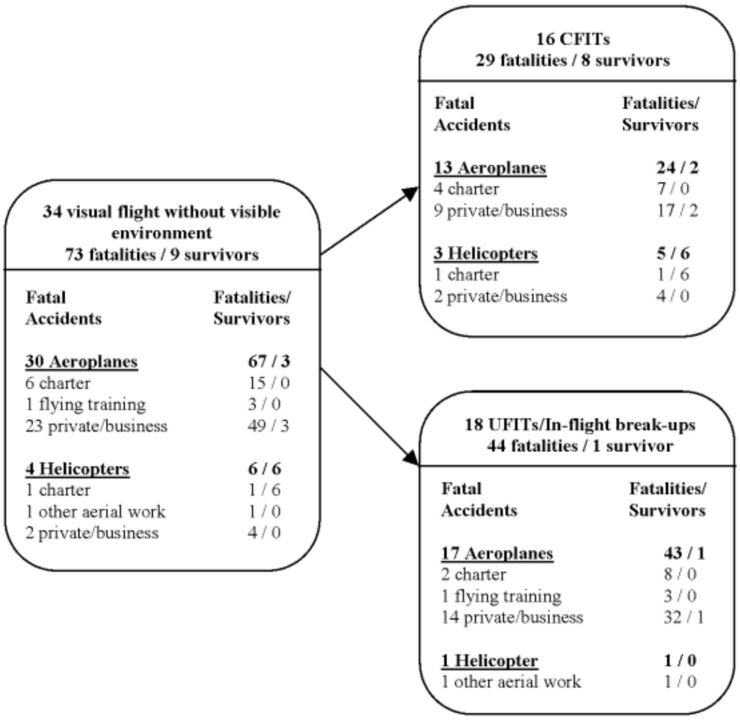


Figure 51 shows that approximately half the fatal accidents that initiate from an aircraft operating under VFR in IMC are CFIT accidents, and half are UFIT accidents.

4.6.2.2. Loss of expected visual reference

The definition of 'VFR into IMC' is based on regulatory requirements. The definition can be expanded, however, to cover all situations in which pilots were at a stage of flight when they should have been able to control the aircraft by visual reference to the outside environment, but were not able to. An ambiguity exists in the classification of night operations. A night VFR (NVFR) flight must be conducted in good weather conditions, but can be flown on a dark night when the environment outside the cockpit cannot be seen. Certain phases of an Instrument Flight Rules (IFR) flight, such as the phase between the end of an instrument approach and a landing must be flown using visual reference to the environment outside the cockpit. That visual reference may also be degraded either by dark night conditions, or by visibility lower than the prescribed minimum. If all situations where a pilot could be expected to control an aircraft using visual reference to the outside environment, but was not able to, are included, the numbers expand from those for only 'VFR into IMC'.

Figure 52: Fatal accidents initiated from a 'loss of expected visual reference' situation, sorted by consequence



The total number of accidents that fall into the category of 'loss of expected visual reference' is greater than for VFR into IMC; however, the ratio between CFIT and UFIT accidents remains similar.

4.6.3. The effect of aircraft certification on rates of Loss of Control (LOC) accidents

Loss of control accidents include both UFIT accidents, and accidents where the aircraft broke up in flight after a loss of control.

Most aircraft on the Australian civil register have been ‘certificated’. This means that they have been assessed by a competent authority against a detailed specification that defines minimum design, airworthiness, performance and handling requirements.

Aircraft that have not been certificated are normally amateur built, or ex-military aircraft. Although they do not have to meet the same rigorous standards required of certificated aircraft, they are normally designed to be usable and effective aircraft.

Aircraft activity data collected for 2002 was used to provide an estimate of aircraft activity for certificated and uncertificated aircraft on the Australian Civil Register. Aircraft that were designed before 1945 were all not certificated because certification did not exist before then. Such aircraft have been included in the certificated group, however, as they were designed and developed according to similar principles. The figures were used to give an indication of an annual rate of LOC accidents by taking a tenth of the total population of fatal LOC fatal accidents over the ten year period from 1991 to 2000.

Table 12: Accident rate figures for Loss of Control of certificated and non-certificated aircraft

	aircraft	hours flown	average hours flown per aircraft	fatal LOC accidents per year	LOCs per 1000 aircraft	LOCs per 100,000 hour flown
Certificated	9101	1644963	180.7	9.1	1.00	0.55
Non-certificated	1018	31022	30.5	1.4	1.38	4.51
Total	10119	1675985	165.6	10.5	1.04	0.63

Table 12 indicates that the likelihood of being involved in a LOC fatal accident in a non-certificated aircraft is higher per hour flown in a non-certificated aircraft than a certificated aircraft.

5. CONCLUSIONS

This study was designed to determine the types of general aviation fatal accidents that have occurred and to identify the events and factors (where possible) that precipitated these fatal accidents.

The re-classification and re-coding of the accidents enabled a more accurate description of the larger groupings of fatal accidents, which could provide a greater opportunity to accurately target specific risk areas in general aviation operations.

Some of the findings are easier to explain (such as a higher proportion of UFIT (uncontrolled flight into terrain) accidents from private/business operations than commercial) than others (such as a greater risk of an occurrence being fatal at certain times of the day or week).

The rate of general aviation fatal accidents was found to be significantly higher during the evening between 1700 and 2059 than the rest of the day and the private/business fatal accident rate was found to be significantly higher over the weekend than during the week. Reasons for these findings could not be clearly identified.

The most prevalent type of accident was a UFIT accident. For fixed wing operations, a higher proportion of UFIT accidents were private/business operations (2/3), compared with MFIT or CFIT accidents (1/2).

The vast majority of low-level UFIT fatal accidents (approximately 90 per cent) could be described as accidents where the pilot's control inputs (or lack of inputs) initiated a loss of control. In almost a quarter of these cases, turbulence or windshear may also have contributed to the loss of control. In contrast, UFIT fatal accidents during 'normal' operations were more likely to have had an initiating factor such as a loss of engine power, loss of reference to the external environment, aircraft system or airframe problem, pilot incapacitation etc., with around 20 per cent being primarily the result of pilot action or inaction. This disparity suggests that many of the loss of control events during low-level operations could have been recovered had the aircraft been at a greater height.

The next largest fatal accident grouping was controlled flight into terrain accidents (CFITs). The majority of CFIT fatal accidents occurred during low-level operations, when the pilot could see the environment. Most of these accidents were wirestrikes. Pilots involved in CFIT fatal accidents who were flying aircraft unnecessarily low, accounted for a quarter of all the fatal CFITs and 42 per cent of fatal CFITs during low-level flying. The large majority of CFIT fatal accidents from 'normal' operations occurred when the pilot was not able to see the outside environment, whether operating under VFR or IFR.

APPENDIX A: CODING FRAMEWORK FOR DESCRIBING ACCIDENTS AND GLOSSARY

Coding framework terms

The following definitions were developed within the ATSB, to provide the most complete description available of the largest groups of accidents.

Examples of fatal aircraft accidents for each of the accidents types are included.

Controlled flight into terrain (CFIT)

An event where an aircraft collided with obstacles, objects or terrain during powered, controlled flight with little or no awareness on the part of the pilot of the impending impact.

> Occurrence 199503986 (CFIT – low-level operations)
> The pilot had been spraying canefields near the accident site. The aircraft was observed flying towards an airstrip about 1 km away where a spray hopper was positioned on a trailer. At about 0650 hours, the aircraft was seen flying straight and level towards the airstrip. The aircraft was then seen to strike powerlines, roll inverted and impact the ground.

> Occurrence 199801517 (CFIT – 'normal' operations)
> The area where the wreckage was located was known to be a popular poor weather route for VFR traffic through the area and weather analysis indicated that low cloud and probably precipitation would have prevailed at the time of the accident. The aircraft attitude at impact and the damage sustained by the airframe and propeller suggest that the aircraft was in near level flight when it first struck trees.

Ground collision

An event where there was contact between an aircraft with other aircraft, vehicles, objects, animals on runway or taxiway.

> Occurrence 199900970
> As the Sundowner was accelerating along the runway, the Pitts landed on top of it about 80 m from the threshold. Both aircraft became entangled and travelled approximately 100 m along the runway before slewing to the right then turning sharply left and coming to rest on the runway. The propeller of the Pitts deeply penetrated the Sundowner cabin and killed the pilot.

Impact to external party

An event where there was an impact to persons external to the aircraft as a result of an aircraft's normal activities (excludes occurrences where control of the aircraft had been lost prior external party being impacted).

> Occurrence 199502549
> The ground hostess watched the ladies follow her towards the helicopter, but when she turned her head to check its proximity, the lady, who had requested the front seat, left the group to pass behind the helicopter, and walked into the tail rotor, receiving fatal injuries.

In-flight break-up

An event where pieces of an aircraft necessary for controlled flight separated from the aircraft in-flight.

> Occurrence 199500373
> While the helicopter was cruising at an estimated indicated airspeed of 70 kts at 700 ft, both lugs of a clevis failed on the left centre frame aft cluster fitting. The failure freed the lower end of the left tail boom support strut. This allowed the tail boom to lift into the main rotor, which cut off the tail boom. The helicopter broke up in-flight falling into shallow water 50 m from a beach.

Landing impact

An event where an aircraft impacted with runway or terrain/obstacles adjacent to the runway during landing or landing roll (excludes 'ground collision').

> Occurrence 199400266
> The aircraft landed heavily in conditions of windshear or downdrafts and probably stalled during the bounce which ensued the heavy landing. The left wing contacted the runway and the aircraft yawed to the left and developed a marked right skid. It continued in this manner across a dirt mound at the left edge of the strip and struck trees. The principal impact occurred when the aircraft fuselage just forward of the right wing root struck a large tree, causing severe deformation to the right side cockpit area.

Low-level operations

'Low-level' operations were planned and conducted below the envelope of normal operations (see the definition of normal operations), and predominantly comprised agricultural operations, mustering operations, survey operations and illegal low-level flying.

Managed flight into terrain (MFIT)

An event where an aircraft collided with obstacles, objects or terrain while being flown under limited control or reduced performance, with insufficient height/performance to reach a designated landing area.

> Occurrence 199300241
> The pilot transmitted a mayday call and stated that the aircraft had experienced an engine failure and he would be conducting a forced landing into trees. The right wingtip struck and was torn off by a branch of a large tree as the aircraft descended into a densely treed, inhospitable area.

> Occurrence 200000778
> The passenger reported that the aircraft engine was operating normally until it suddenly made a loud grinding sound and the propeller stopped rotating. The cockpit then filled with smoke. The pilot tried unsuccessfully to restart the engine. The passenger fitted life jackets to himself and the pilot. On contact with the water the aircraft overturned and rapidly filled with water. The passenger was unable to sight the pilot so he made his way to the surface and inflated his life jacket.

Mid-air collision

An event where there was contact between two aircraft while both were airborne.

> Occurrence 199802022
> A Piper Archer and a Piper Tomahawk collided at an altitude of about 1,200 ft as the Archer was tracking to enter the crosswind leg for a landing on runway 34 at Hoxton Park aerodrome. The collision occurred in fine and clear conditions, about 0.5 NM east of the upwind end of the runway. Both aircraft were being flown under the visual flight rules (VFR). The pilot of the Archer was able to maintain control of his aircraft and make a successful approach and landing on runway 34, although the nose landing gear had been substantially damaged in the collision.

'Normal' operations

Operations that were conducted within the normal rules of flight without any special dispensations for low-level operations. Normal operations included take-off and landing, climb and descent normally associated with take-off and landing, and en-route flying and manoeuvering as well as unplanned descent below the normal minimum flying height because of stress of weather. Activities associated with instrument approach procedures were also considered normal operations.

Other

Events where the circumstances were unusual and did not fit into the defined categories. Also includes those accidents where the circumstances were not considered to be matters of aviation safety.

> Occurrence 199303718
> The helicopter then lifted off and, just after commencing forward flight, the end of the sling momentarily contacted the engine of the drilling rig. The sling was flung upward and struck the helicopter. As a result, a metre long section of the tip end of one main rotor blade was severed. A main rotor blade then struck the forward right side of the cockpit area, fatally injuring the pilot. The tailboom of the helicopter was severed by the damaged main rotor blade and the helicopter fell to the ground, landing on its left side.

Take-off impact

An event where an aircraft impacted with the runway or terrain/obstacles adjacent to runway during the take-off run prior to getting airborne (excludes 'ground collision').

> Occurrence 199800442
> As the helicopter started to lift off the ground into a hover, it rolled to the right until the main rotor struck the ground. The main rotor and transmission then separated from the fuselage, which landed on its right side, facing in the same direction as it was parked. Several rescuers reached the accident site within seconds and shut down the engine. They released the pilot's lap seat belt and moved him from the wreckage. A short time later, the pilot died of his injuries.

Uncontrolled flight into terrain (UFIT)

An event where an aircraft collided with obstacles, objects or terrain after control of the aircraft was lost in-flight (includes cases where the pilot became incapacitated) but the aircraft structure did not change prior to impact.

Occurrence 199703038 (UFIT – low-level operations)
About 30 minutes after spraying had commenced, one of the witnesses observed the aircraft rolling right during a turn reversal in a procedure turn. The aircraft continued rolling until it was in an inverted attitude, and then descended into the ground where it immediately caught fire.

Occurrence 199905121 (UFIT – 'normal operations')
Weather conditions deteriorated more rapidly and more severely than was initially forecast in the weather reports obtained by the pilot. When the aircraft entered cloud the pilot was no longer able to rely on external visual references and probably became spatially disorientated. The aircraft subsequently entered a left turn, descended rapidly and collided with the ground. The accident was consistent with loss of control following flight in instrument meteorological conditions by a non-instrument rated pilot.

Unknown

Events where the state of the aircraft prior to accident damage could not be determined from the information available.

Occurrence 199601265
The pilot submitted an Instrument Flight Rules (IFR) flight plan for a flight from Bankstown to Killiecrankie. The plan showed the aircraft would proceed to Flinders Island aerodrome and from there to Killiecrankie under night Visual Flight Rules (VFR) at an altitude of 1,000 ft, along a coastal route. The pilot of WMD reported at Flinders Island at 2005 and said he was commencing a letdown. Melbourne Centre called the aircraft at 2021. In response, the pilot gave an operations-normal call and said they were now proceeding to Killiecrankie. He also said he would make another operations-normal call at 2045. No other calls were received from the pilot and the main aircraft wreckage was not found.

Glossary of terms

Accident

An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all persons have disembarked, in which:

a) a person is fatally or seriously injured as a result of:
   a. being in the aircraft
   b. direct contact with any part of the aircraft including parts which have become detached from the aircraft, or
   c. direct exposure to jet blast

   except when the injuries are from natural causes, self inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or
b) the aircraft incurs substantial damage or is destroyed; or
c) the aircraft is missing or is completely inaccessible.

NOTE: An aircraft is considered to be missing when the official search has been terminated and the wreckage has not been located.

Agriculture operations

Operations involving the carriage and/or spreading of chemicals, seed, fertiliser or other substances for agricultural purposes, including operation for the purpose of pest and disease control.

Charter operations

Carriage of cargo or passengers on non-scheduled operations by the aircraft operator, or the operator's employees, in trade or commerce, but excluding regular public transport operations.

Fatal accident

An aircraft accident in which at least one person is fatally injured.

Fatal injury

For statistical uniformity only, an injury resulting in death within thirty days of the date of the accident is classified as a fatal injury by ICAO.

Flying training

Flying under instruction for the issue or renewal of a licence or rating, aircraft type endorsement or conversion training. Includes solo navigation exercises conducted as part of a course of applied flying training.

General aviation (GA)

For the purposes of this document, general aviation has been defined as all non-scheduled flying activity in aircraft, with Australian registered aircraft allocated a VH-registration by CASA, excluding VH-registered sailplanes (powered and non-powered). Ultralight aircraft, hang gliders, balloons and autogyros are also excluded.

High capacity regular public transport

A high capacity RPT aircraft is define as an aircraft that is certified as having a maximum seating capacity exceeding 38 seats or a maximum payload exceeding 4,200 kg.

Hours flown

Hours flown are calculated on a ‘chock to chock’ (wheel start to wheel stop) basis, and therefore includes taxiing time.

Incident

An occurrence, other than an accident, associated with the operation of an aircraft that affects or could affect the safety of operation.

Low capacity regular public transport

A low capacity RPT aircraft is defined as being certified as having a maximum seating capacity less than or equal to 38 seats or maximum pay load less that or equal to 4,200 kg.

Minor injury

An injury sustained by a person in an accident that was not a fatal or serious injury.

Other aerial work

Includes aerial survey and photography, spotting, aerial stock mustering, search and rescue, ambulance, towing (including glider, target and banner towing) and other aerial work including advertising, cloud seeding, fire fighting, parachute dropping, and coastal surveillance.

Private/business flying

Encompasses flying by the aircraft owner, the operator’s employees or the hirer or the aircraft for business or professional reasons but not directly in trade or commerce and; flying for private pleasure, sport or recreation, or personal transport not associated with a business or profession.

Regular public transport (RPT)

All air service operations in which aircraft are available for the transport of members of the public, or for use by members of the public for the transport of cargo (freight and/or mail), for trade or commerce and which are conducted in accordance with fixed schedules to and from fixed terminals over specific routes with or without intermediate stopping places between terminals. Charter or other non-scheduled operations are excluded.

Serious injury

An injury which is sustained by a person in an accident and which:

a) requires hospitalisation for more than 48 hours, commencing within seven days from the date the injury was received; or
b) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); or
c) involved lacerations which cause severe haemorrhage, nerve, muscle or tendon damage; or
d) involves injury to any internal organ; or
e) involves second or third degree burns, or any burns affecting more than 5 per cent of the body surface; or
f) involves verified exposure to infectious substances or injurious radiation.

VH-registered aircraft

Any aircraft certified by CASA to appear on the civil aviation register.

Appendix B: Aircraft flight rules

Civil aircraft in Australia may operate under one of two sets of flight rules. They are:

- visual flight rules, and
- instrument flight rules.

Visual flight rules (VFR) are designed for operations that are predominantly controlled by visual reference to the outside environment. They apply more to private operations, and operations in smaller and slower aircraft. An aircraft may only operate under the VFR if the aircraft is subsonic, complies with certain speed restrictions, and when it is near the ground, it must be able to be navigated by visual reference to the ground or water. The aircraft is also required to be operated in certain minimum weather conditions known as visual meteorological conditions (VMC). In general, the aircraft may not be flown nearer than 1,500 metres horizontally, or 1,000 ft vertically to cloud, except at lower altitudes in certain conditions, when it only has to remain 'clear of cloud'. There are also minimum visibility requirements. In general, these are a minimum visibility of 8,000 metres when flying at an altitude above 10,000 ft, and a visibility of 5,000 metres when flying at an altitude below 10,000 ft. Under certain conditions, the minimum visibility may be reduced to 3,000 metres for aeroplanes, and 800 metres for helicopters. A light twin engine aircraft flying at 180 Kt travels 5,000 metres in 54 seconds.

A pilot is permitted to fly in these (visual) conditions at night if the aircraft is equipped with a defined set of instruments that enable the aircraft to be flown without reference to an external visible horizon, so long as the pilot has passed a Night VFR flight test and met certain other requirements. A Night VFR flight may be flown in conditions without a visible horizon when en-route, but only because of a lack of illumination, not because of a lack of visibility. However, at least runway lights and an illuminated wind direction indicator (windsock) must be visible at the destination.

Instrument flight rules (IFR) are designed for operations that can be controlled solely by reference to aircraft instruments, except for short periods surrounding the take off and landing. IFR flights are not constrained to operating under VMC, but may operate in zero visibility for most of the flight. Other meteorological limitations will exist, limited by the specific aircraft's ability to identify or withstand conditions such as turbulence, icing or thunderstorm activity. An aircraft may operate under the IFR if a set of more stringent requirements are met, including minimum aircraft equipment, extra aircraft maintenance, minimum pilot qualifications and pilot recency in instrument flight. Depending on the nature of the operation, other requirements such as the minimum number of aircraft engines, and minimum aircraft performance under normal and abnormal conditions may also apply. Flight under the IFR is more rule-based and procedural than VFR flight, and third party support for the flight from ground services is much greater, including a variety of services for alerting pilots to other aircraft traffic that they may not know about, or arranging guaranteed separation from other aircraft in the vicinity.

Australian Government
Australian Transport Safety Bureau

Media Release

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ATSB Research Paper on General Aviation Fatal Accidents

A study by the ATSB has shown that almost half of the general aviation fatal accidents in the ten year period between 1991 and 2000 were Uncontrolled Flight Into Terrain (UFIT) accidents, where an intact aircraft collided with a stationary obstacle or terrain after an in-flight loss of control had occurred.

In more than half of the UFIT fatal accidents an event that was either not averted, or not managed appropriately by the pilot, or was not within the pilot's control, preceded the loss of control. However, in the vast majority of UFIT fatal accidents that occurred during low-level flying operations, there was no precipitating event and the loss of control situation could not be corrected before the impact, given the aircraft's height above the ground when the loss of control occurred.

Controlled Flight Into Terrain (CFIT) fatal accidents (where an aircraft collided with a stationary obstacle or terrain during powered, controlled flight, taking the pilot unawares) was the second most common accident type (30 per cent of fatal accidents).

The majority of CFIT fatal accidents occurred during low-level flying operations, when the visibility was adequate: most of these accidents were wirestrikes. Pilots involved in fatal CFIT accidents who were flying unnecessarily low accounted for a quarter of all CFITs. They also accounted for 42 percent of all CFITs during low-level flying operations. The large majority of CFIT fatal accidents that happened when the pilot did not plan to conduct low flying operations, occurred when the pilot was not able to see the outside environment. This happened under visual flight rules or instrument flight rules, and was due to either poor visibility or darkness.

Research also showed that general aviation occurrences between 1700 and 2059 were 1.6 times more likely to be fatal than during other times of the day. Furthermore, occurrences involving private/business operations were 1.9 times more likely to be fatal over the weekend than during the working week.

Depending on the scale of feedback about this report, the ATSB will consider releasing a supplementary section of this report that addresses issues and questions that have been raised.

The full Aviation Research Paper, General Aviation Fatal Accidents: How do they happen? is available on the ATSB website: www.atsb.gov.au.

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