NTSB/ARG-03/01
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Annual Review of Aircraft Accident Data

U.S. General Aviation, Calendar Year 1998

National Transportation Safety Board
Washington, D.C.

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National Transportation Safety Board
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Washington, D.C. 20594

National Transportation Safety Board. 2003. ***U.S. General Aviation, Calendar Year 1998*****. Annual Review of Aircraft Accident Data NTSB/ARG-03/01 Washington, D.C.**

Abstract: A total of 1,928 aircraft were involved in 1,904 accidents during calendar year 1998. The total number of general aviation accidents occurring in 1998 represented a 3.2% increase over calendar year 1997. Of the total number of accidents, 364 were fatal accidents that resulted in a total of 624 fatalities. Although the number of fatal general aviation accidents in 1998 represented a 4% increase over calendar year 1997, the number of resulting fatalities declined 1.1% between 1997 and 1998. The circumstances of these accidents and the details related to the aircraft, pilots, and locations involved are represented throughout this report.

The National Transportation Safety Board is an independent Federal agency dedicated to promoting aviation, railroad, highway, marine, pipeline, and hazardous materials safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The Safety Board makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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Introduction

Purpose of the *Annual Review*

The National Transportation Safety Board's *1998 Annual Review of Aircraft Accident Data for U.S. General Aviation* presents a statistical compilation and review of general aviation accidents that occurred in 1998 involving U.S.-registered aircraft. In addition to providing accident statistics for 1998, the review also includes general economic indicators that may have influenced general aviation activity for 1998 and contextual accident data from several years preceding the reporting period.

The accident data used in this review were extracted from the Safety Board's Aviation Accident/Incident Database.[1] The activity data used in this review were extracted from the *General Aviation and Air Taxi Activity Survey* (*GAATA Survey*)[2] and from *U.S. Civil Airmen Statistics*, both of which are published by the Federal Aviation Administration (FAA), Statistics and Forecast Branch, Planning and Analysis Division, Office of Aviation Policy and Plans. Additional information was extracted from the General Aviation Manufacturers Association (GAMA), *General Aviation Statistical Databook*.

What Is General Aviation?

General Aviation can be described as any civil aircraft operation that is *not* covered under 14 *Code of Federal Regulations* (CFR) Parts 121, 129, and 135, commonly referred to as commercial air carrier operations.[3]

Which Operations Are Included in this Review?

This review includes accidents involving U.S.-registered aircraft operating under 14 CFR Part 91, as well as civilian public use[4] aircraft operations. Aircraft operating under Part 91 include aircraft that are flown for recreation and personal transportation, as well as certain aircraft operations that are flown with the intention of generating revenue,[5] including business flying, flight instruction, corporate/executive flights, positioning or ferry flights, pipeline/powerline patrols, and news and traffic reporting.

Which Aircraft Are Included in this Review?

General aviation operations are conducted in a wide range of aircraft, including airplanes, rotorcraft, gliders, balloons and blimps, and registered ultralight, experimental, or amateur-built aircraft.

[1] A detailed description of the Aviation Accident/Incident Database is included in Appendix C.

[2] Data are available at <http://api.hq.faa.gov/pubsarchive.asp>. Although included in the *GAATA Survey*, data associated with air taxi and air tour operations are not included in this review.

[3] For an analysis of accidents related to air carrier operations, see National Transportation Safety Board, *Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, Calendar Year 1998*, NTSB/ARC-02-02 (Washington, DC: NTSB, 2002), available at <http://www.ntsb.gov>.

[4] Although the precise statutory definition has changed over the years, public aircraft operations are qualified government missions that may include law enforcement, low-level observation, aerial application, firefighting, search and rescue, biological or geological resource management, and aeronautical research.

[5] See 14 CFR 119.1.

The wide range of operations and aircraft types included within the scope of general aviation must be considered when interpreting the data presented in this review. For example, the 1998 general aviation review includes accidents involving aircraft ranging in size from 250-pound ultralights to 40,000-pound business jets.

Not included in this review are any accident data associated with aircraft operating under 14 CFR Parts 121, 129, or 135, such as scheduled 121 air carrier operations, foreign air carrier operations, scheduled 135 air carrier operations (commuters), and nonscheduled 135 air carrier operations (air taxis).

Also not included are data involving military or non-U.S.-registered aircraft, such as military aircraft accidents, unless the accident also involves civil aircraft, foreign-registered aircraft, unregistered ultralights, and commercial space launches. Crashes involving illegal operations or stolen aircraft are included in the accident total, but not in accident rates.

Changes to the *Annual Review*

The *Annual Review* has been modified from past years and is now organized into five parts.

- The first part presents a summary of the general aviation accident statistics for 1998 and an overview of economic and industry markers related to general aviation activity in 1998, as well as contextual statistics from previous years.
- The second part investigates trends over the past 10 years in terms of such factors as types of flight, levels of aircraft damage, and level of injury.
- The third part focuses on accidents that occurred during the 1998 calendar year and their circumstances. Cause and factor findings for accidents occurring in 1998 are also listed.
- The fourth part focuses on several issues particularly relevant to general aviation safety. The *1998 Annual Review* focuses on the issues of survivability, midair collisions, and controlled flight into terrain.
- The fifth part, new this year, is a special topic that provides in-depth coverage of an important general aviation safety topic. For the *1998 Annual Review*, the special topic is flight in instrument meteorological conditions (IMC).

In addition to being reorganized, the *1998 Annual Review* presents statistical data more graphically than in previous years. Readers who wish to view the data in a tabular format or who wish to manipulate the data used in the report may access the data set online at http://www.ntsb.gov. They may also contact the Safety Board's Public Inquiries Branch at 202-314-6551or at 800-877-6799.

1998 General Aviation Accident Summary

A total of 1,928 aircraft were involved in 1,904[6] accidents during calendar year 1998.[7] The total number of general aviation accidents occurring in 1998 represented a 3.2% increase over calendar year 1997. Of the total number of accidents, 364 were fatal accidents that resulted in a total of 624 fatalities. Although the number of fatal general aviation accidents in 1998 represented a 4% increase over calendar year 1997, the number of resulting fatalities declined 1.1% between 1997 and 1998. The circumstances of these accidents and the details related to the aircraft, pilots, and locations involved are presented throughout this report.

[6] There were 4 accidents, 2 of which were fatal, during 1998 involving stolen or unauthorized aircraft operations. For the purposes of this report, those accidents and aircraft are included in accident totals but not in accident rates.

[7] In this report, a collision between 2 aircraft is counted as a single accident. The 15 midair collision accidents that occurred in 1998 involved 27 general aviation aircraft and 3 non-GA aircraft. The 14 ground collision accidents involved 21 general aviation aircraft and 9 non-general aviation aircraft.

Overview of the State of the General Aviation Environment in 1998

General Economic and Aviation Industry Indicators

This overview of economic and industry indicators provides a contextual background for 1998 general aviation (GA) accident data. The following table provides U.S. economic indicators and measures of personal income since 1975. The table also includes U.S. economic indicators pertaining to the general aviation industry.

General Economic and Aviation Industry Indicators 1975-1998

	1975	1980	1985	1990	1995	1998
Population (Millions)[8]	216.0	227.2	237.9	249.5	262.8	270.2
Gross Domestic Product (Billions)[9]	$4,084.4	$4,900.9	$5,717.1	$6,707.9	$7,543.8	$8,508.9
Disposable Personal Income (Billions)[10]	$3,108.5	$3,658.0	$4,347.8	$5,014.2	$5,539.1	$6,168.6
Disposable Personal Income Per Capita[8]	$14,393	$16,063	$18,229	$20,058	$20,795	$22,354
Number of GA Aircraft Sold[11]	14,056	11,877	2,029	1,144	1,077	2,200
Net Factory Billings for GA Aircraft (Millions)[9]	$1,032.9	$2,486.2	$1,430.6	$2,007.5	$2,841.9	$5,761.2
Value of New GA Aircraft Sold: Piston	$570	$794	$194	$92	$123	$330
Value of New GA Aircraft Sold: Turbine (Millions)[9]	$461	$1,691	$1,237	$1,916	$2,719	$5,431

The table shows steady growth in U.S. industrial and personal income since 1975. The table also shows that, between 1995 and 1998, the U.S. resident population increased by 2.8%, the gross domestic product rose by 12.8%, and disposable personal income rose by 11.4%.

Between 1975 and 1995, economic indicators for the general aviation industry were either generally steady or declining. The number of aircraft sold in 1995 reflects a 92.3% decrease from 1975 sales. Net factory billings for new aircraft sold fluctuated over the period, with 1995 billings 175% greater than those in 1975, primarily because an increase in the value of turbine aircraft sales made up for losses in piston aircraft sales. In contrast to the years between 1975 and 1995, which had modest to negative growth, general aviation industry indicators increased by approximately 100% between 1995 and 1998. One reason for this rapid growth, in addition to generally favorable economic conditions, was the increased production of general aviation aircraft following the 1994 passage of the General Aviation Revitalization Act[12] limiting manufacturer liability.

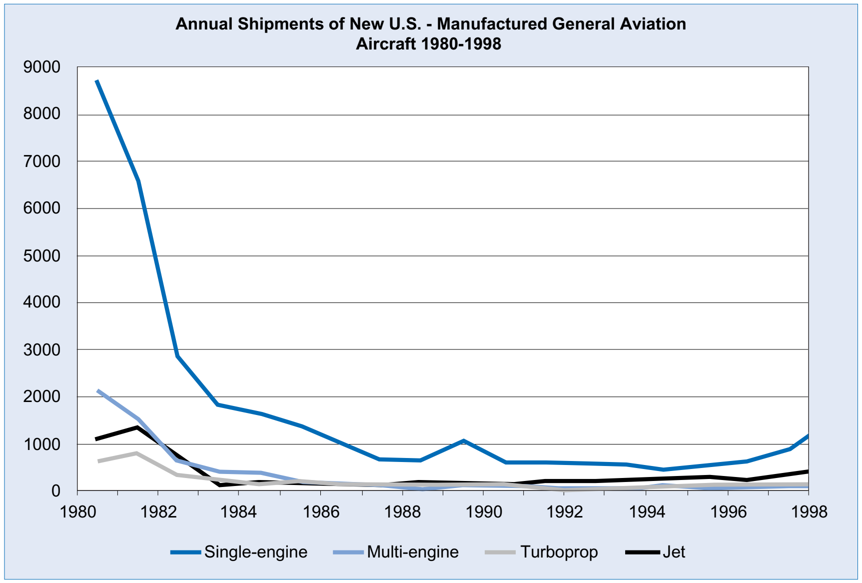
[8] U.S. Census Bureau data, which are available at <http://eire.census.gov/poptest/archives/pre1980/popclockest.txt>.

[9] Bureau of Economic Analysis, real gross domestic product using chained 1996 dollars, available at <http://www.bea.doc.gov/bea/dn/gdplev.xls>.

[10] Bureau of Economic Analysis, chained 1996 dollars, available at <http://www.bea.gov/bea/dn/nipaweb/>.

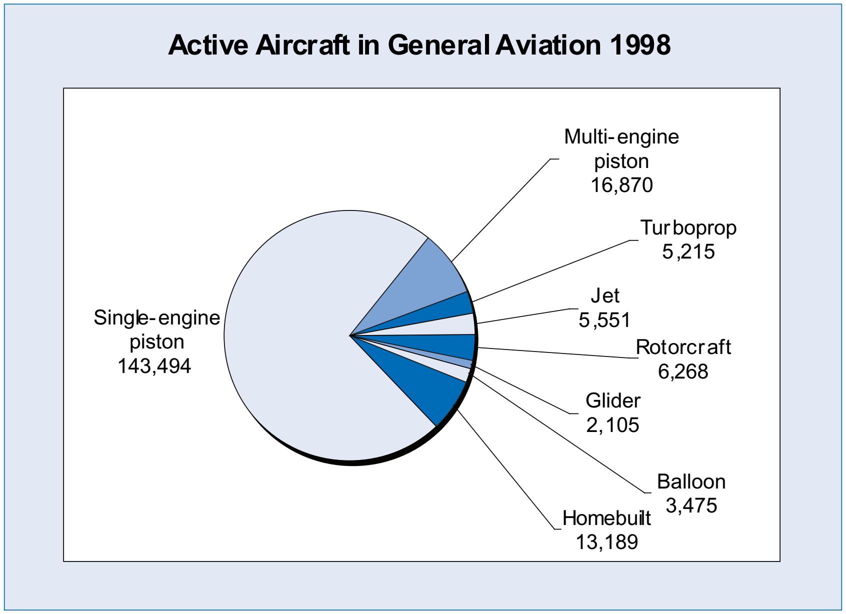
[11] General Aviation Manufacturers Association, *General Aviation Statistical Databook*, 2001.

Sharp declines in general aviation aircraft shipments[13] during the '70s and '80s were followed by gradual declines in the numbers of shipments during the early '90s and an increase in shipments after 1994.



Fleet Makeup

Although sales of new general aviation aircraft have increased over the last 5 years, most general aviation aircraft currently in use are more than 20 years old. U.S. manufacturers delivered 2,200 new general aviation aircraft in 1998, compared to an estimated total of 199,500 general aviation aircraft already in service. Single-engine piston aircraft have the highest average age of all types of general aviation aircraft and represent the majority of the fleet. A consequence of this fleet makeup is that changes incorporated into newly manufactured aircraft may not be reflected in the accident record for several years.



[12] The General Aviation Revitalization Act, signed into law August 17, 1994, limits the liability of general aviation manufacturers to 18 years.

[13] *General Aviation Statistical Databook*, 2001.

	Seats	Average Age
Single-engine Piston	1-3	28
	4	31
	5-7	25
	8+	42
Multi-engine Piston	1-3	30
	4	27
	5-7	30
	8+	31
Turboprop	all	19
Jet	all	16
All Aircraft		27

General Aviation Activity

Because of the diversity of aircraft types and operations included in general aviation, activity level must be considered in order to make meaningful comparisons of accident numbers among aircraft types or types of operations. The level of activity corresponds to the level of exposure to potential accident risk. Total flight hours, departures, and miles flown are common indicators used to measure activity.

Unlike Part 121 and scheduled Part 135 air carriers, which are required to report total flight hours, departures, and miles flown to the Department of Transportation (DOT) Research and Special Programs Administration (RSPA),[14] operators of general aviation aircraft are not required to report actual flight activity data. As a result, activity for this group of aircraft must be estimated using data from the *GAATA Survey*.[15] The *GAATA Survey* was established in 1978 to gather information about aircraft use, flight hours, and avionics equipment installations from owners of general aviation and nonscheduled Part 135 aircraft. Because activity totals are derived from a limited sample of aircraft[16] selected from the registry of aircraft owners and reporting is not required, activity data for general aviation are far less reliable than the data available for air carriers.

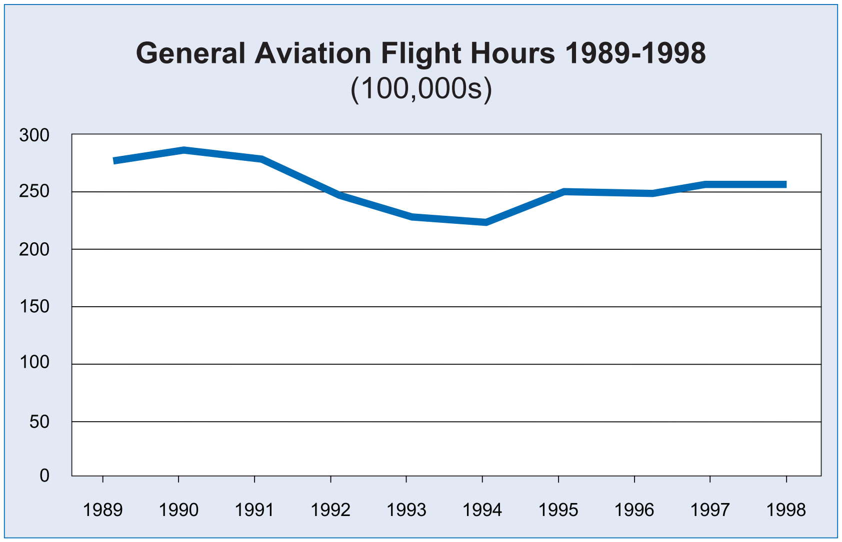
Although included in the *GAATA Survey*, nonscheduled Part 135 operations are excluded from the *1998 Annual Review of General Aviation Accidents*. Accordingly, for this review, general aviation activity was determined by subtracting those data pertaining to nonscheduled Part 135 operations from activity totals whenever possible. However, in many cases, general aviation activity data could not be calculated because the survey data represent the aggregate of all aircraft activity, including both general aviation and nonscheduled Part 135 operations. Examples of such aggregate data include the number of landings, flight hours by state or region, and flight hours by day/night or weather conditions.

[14] Part 121 operators report activity on a monthly basis, and scheduled Part 135 operators report quarterly.

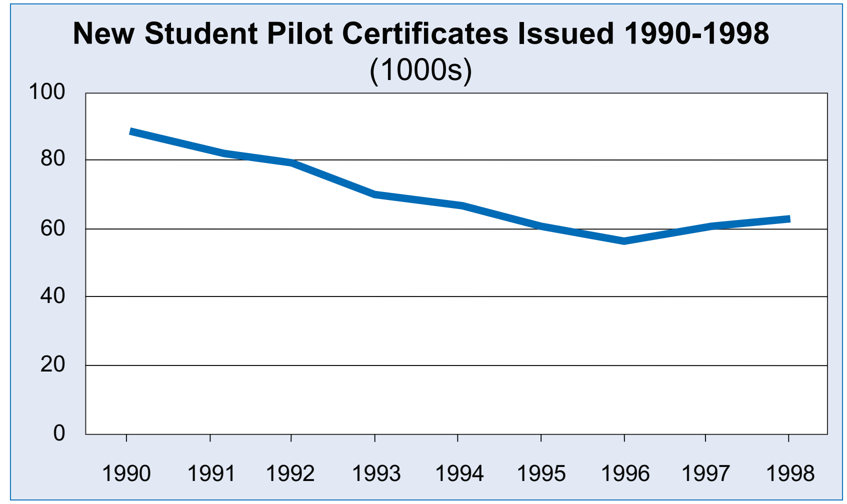
[15] Available at <http://api.hq.faa.gov/pubsarchive.asp>.

[16] The 1998 *GAATA Survey* sample frame consisted of 255,309 registered aircraft, from which 30,114 records (11.8%) were selected in a sample stratified by state/territory and aircraft type. Of that sample, 28,521 were found to include valid owner/address information. From the valid sample, 18,342 (64.3%) completed surveys were collected (*GAATA Survey, Calendar Year 1998*).

The following graph illustrates the estimated total number of general aviation flight hours annually for the years 1989 to 1998.[17] General aviation flight hours began to increase in 1994 after a decline during the preceding years. The number of general aviation flight hours in 1998 was estimated to be 25,518,000, a 14.8% increase over the 10-year low of 22.2 million hours, estimated in 1994.



Two indirect indicators of general aviation activity are the number of active pilots and the number of new pilot certificates issued. The number of new student pilot certificates issued is particularly meaningful because it represents positive growth in the pilot population. The number of new student pilot certificates issued [18] decreased steadily each year from 88,586 in 1990 to 56,653 in 1996.[19] Between 1996 and 1998, the number of new student pilot certificates issued annually increased to a total of 63,037.

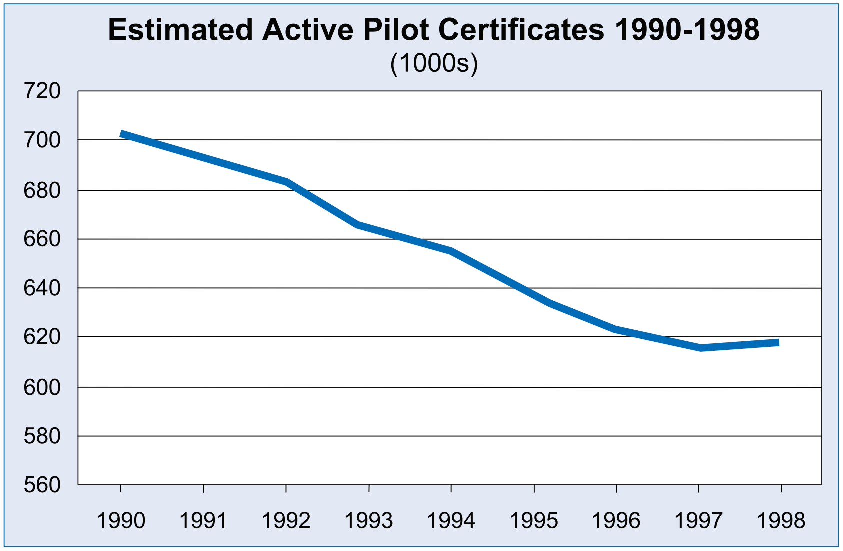


[17] FAA, *GAATA Survey*, 1998, available at <http://api.hq.faa.gov/GAATA/GA98tables/table1-6.pdf>.

[18] FAA, *U.S. Civil Airmen Statistics*, available at <http://api.hq.faa.gov/CivilAir/docs/air22-99.XLS>.

[19] Based on medical certificates issued.

Similarly, the total number of active pilots decreased throughout the early and mid '90s, decreasing steadily from 702,659 in 1990 to 622,261 in 1996. Between 1996 and 1998, the number of active pilots began to level off to an estimated 618,298 U.S. pilots active in 1998.

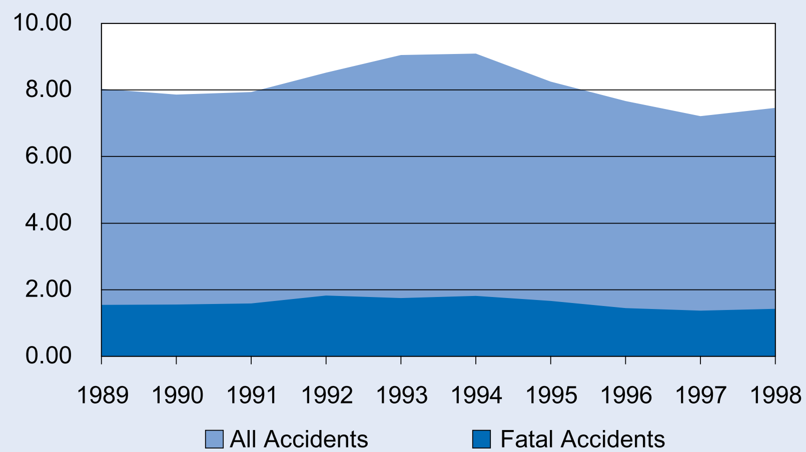


In summary, the indicators of general aviation activity—flight hours and the total number of active new and current pilot certificates issued—decreased annually between 1990 and approximately 1996. Since then, these indicators have generally remained steady or begun to increase. This noticeable change in activity over the period should be considered when attempting to interpret the general aviation accident record for 1998.

Historical and Current Accident Data

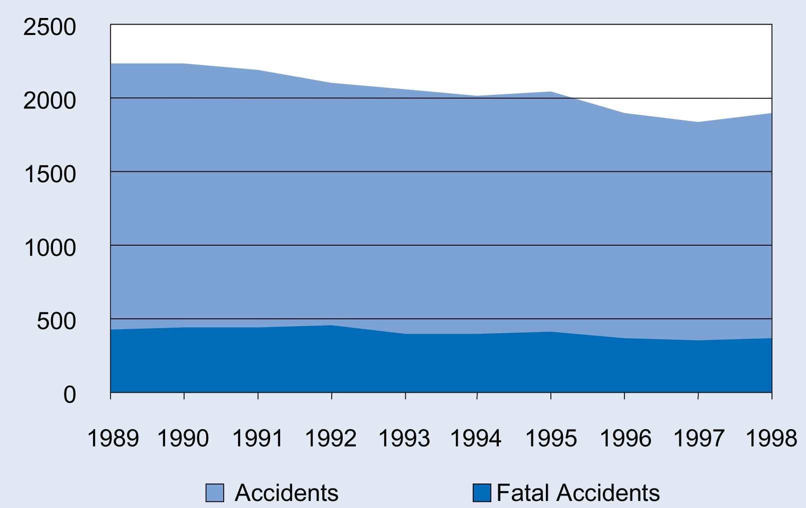
The general aviation accident rate fluctuated between 1989 and 1998 with 7.45 accidents per 100,000 hours flown in 1998, which was noticeably lower than the 1994 high of 9.09 accidents per 100,000 hours. The fatal accident rate remained fairly constant during the entire period, at 18 to 21% of the total accident rate. Because rate calculations require the use of activity data extrapolated from a relatively small sample of aircraft owners, the resulting values are accurate only to the extent that the sample represents the larger population of general aviation operators. For this reason, accident rate data presented in this report will include raw frequency data for comparison.

General Aviation Accident Rate 1989-1998
per 100,000 hours flown



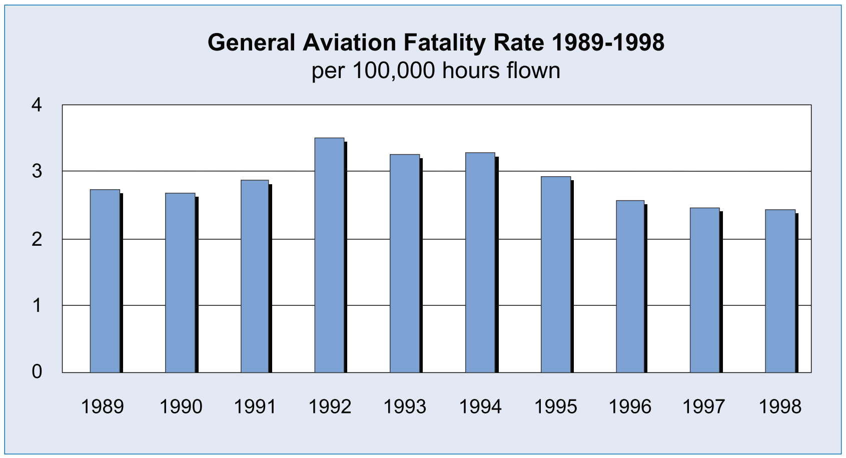
There was a stable, to slightly downward overall, trend in the number of accidents that occurred annually between 1989 and 1997. The total number of general aviation accidents in 1998 (1,904) increased slightly (3.2%) from a 10-year low of 1,845 accidents in 1997. The number of fatal accidents increased to 364 (4%) in 1998 from the 10-year low of 350 in 1997.

Number of General Aviation Accidents 1989-1998

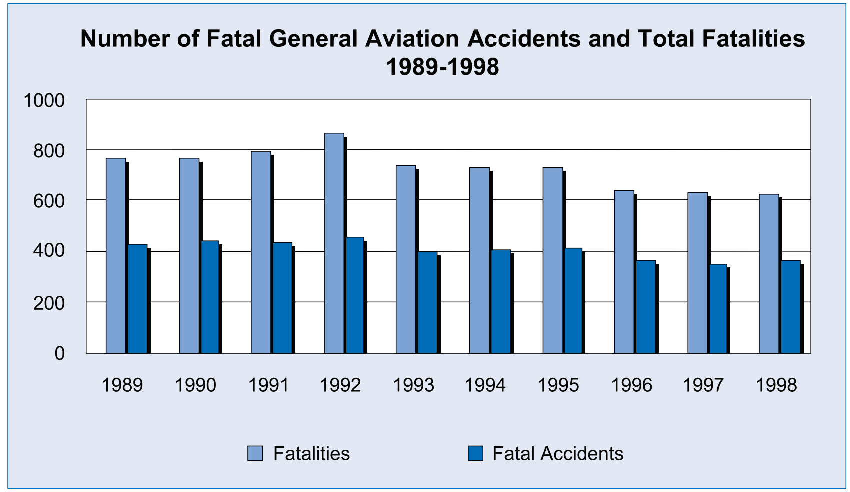


The number of general aviation accidents occurring annually has generally decreased over the last 10 years. However, general aviation activity has also fluctuated over this period, and the accident frequency appears to correspond to changes in new aircraft sales, total general aviation flight hours, and new student pilot starts.

In 1998, the fatality rate, or number of accident-related deaths per flight hour, was 2.4 fatalities per 100,000 hours flown, the lowest rate of the 10-year period between 1989 and 1998. The high annual rate for this period occurred in 1992 with 3.5 deaths per 100,000 hours flown.



The total number of fatalities resulting from general aviation accidents between 1989 and 1998 reached a high of 867 in 1992 and then began a general downward trend to a low of 624 in 1998. The observed decline in fatalities is consistent with trends in both the level of activity and the number of fatal accidents for those years.



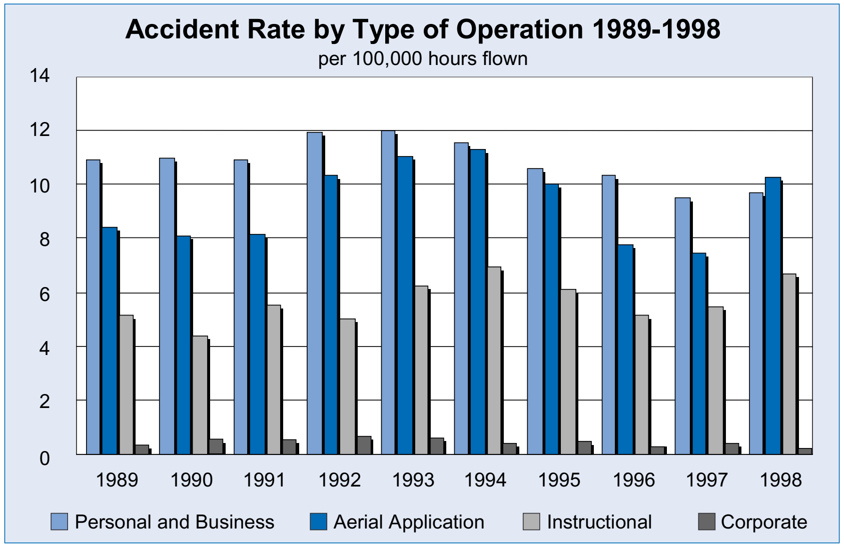
General aviation includes a wide range of operations, each with unique aircraft types, flight profiles, and operating procedures. This diversity is evident in the accident record.

Because the flight data collected in the *GAATA Survey* allows for only a coarse representation of all general aviation operations, the operations data presented here include only four operational categories, which were selected as typical of general aviation activity: personal/business flying,[20] corporate flying, aerial application, and instructional flights.

[20] Because of the difficulty of accurately distinguishing between personal and business flying for both the activity survey and the accident record, the rate presented in this report is calculated using combined exposure data (hours flown).

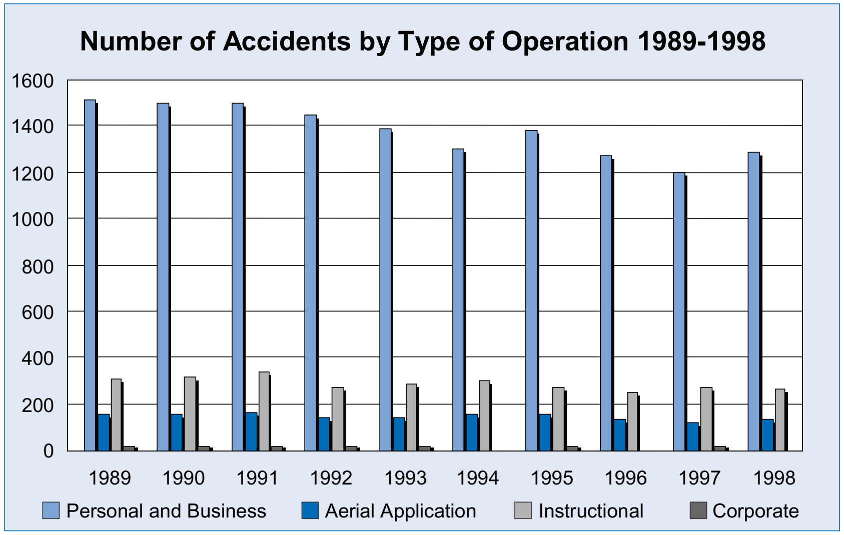
- Personal flying makes up the largest portion of general aviation activity and includes all flying for pleasure and/or personal transportation. Although similar to personal flying, business flying includes the use of an aircraft for business transportation without a paid, professional crew. Personal and business flights are typically in single- and multi-engine piston airplanes, but may include a range of aircraft including gliders, rotorcraft, and balloons.
- Corporate flying includes any business transportation with a professional crew and usually involves larger multi-engine piston, turboprop, and jet airplanes.
- Aerial application includes the use of specially equipped aircraft for seeding and for spraying pesticides, herbicides, and fertilizer. Aerial application is unique because it requires pilots to fly close to the ground.
- Instructional flying includes any flight under the supervision of a certificated flight instructor.[21] Aircraft used for instructional flights are often similar to those used for personal flying, but instructional operations are unique because they often involve the repeated practice of takeoffs and landings, flight maneuvers, and emergency procedures.

Between 1989 and 1998, personal and business flying had the highest accident rate, followed by aerial application and instruction. The accident rate for corporate/executive transportation was consistently the lowest overall, at only 3 to 10% of the next-lowest rate (that is, the rate that was observed for instructional flying).

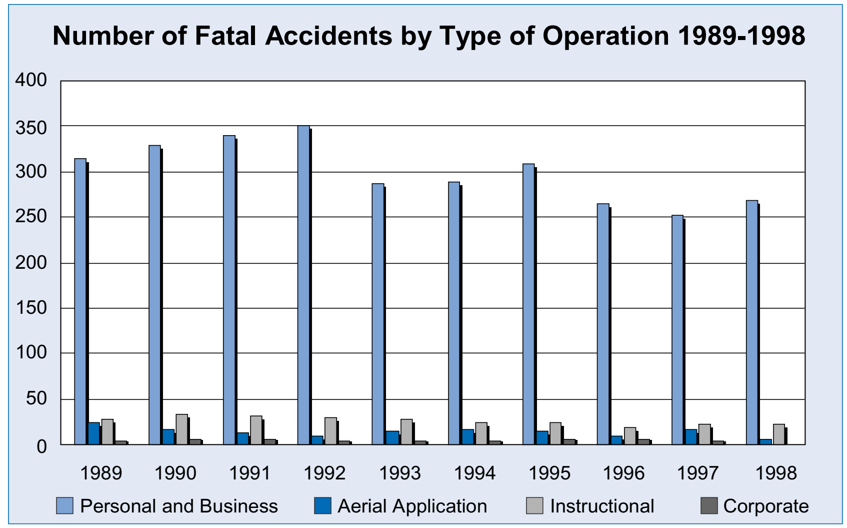


The vast majority of general aviation accidents involve personal and business operations. Between 1989 and 1998, personal/business flying accounted for an average 67% of all general aviation accidents. Instructional flying has historically accounted for the next highest number, with an average 14% of all general aviation accidents.

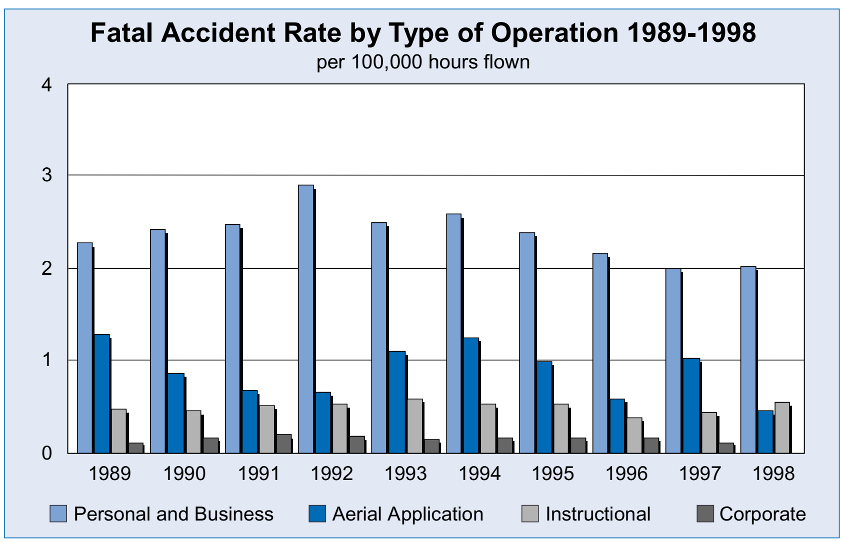
[21] See 14 CFR Subpart H for flight instructor certificate and rating requirements.



Between 1989 and 1998, personal/business flying accounted for an average 74.2% of fatal general aviation accidents and 75.3% of all fatal general aviation injuries. An average 548.5 fatal injuries per year between 1989 and 1998 were associated with personal/business flying, compared to the average 48.1 deaths per year related to instructional flying.



The fatal accident rate is also highest for the combined category of personal/business flying, which is typically more than double the rate for any other type of flying. These differences are probably related to the type of aircraft and equipment, the level of pilot training, and the operating environments unique to each type of operation.



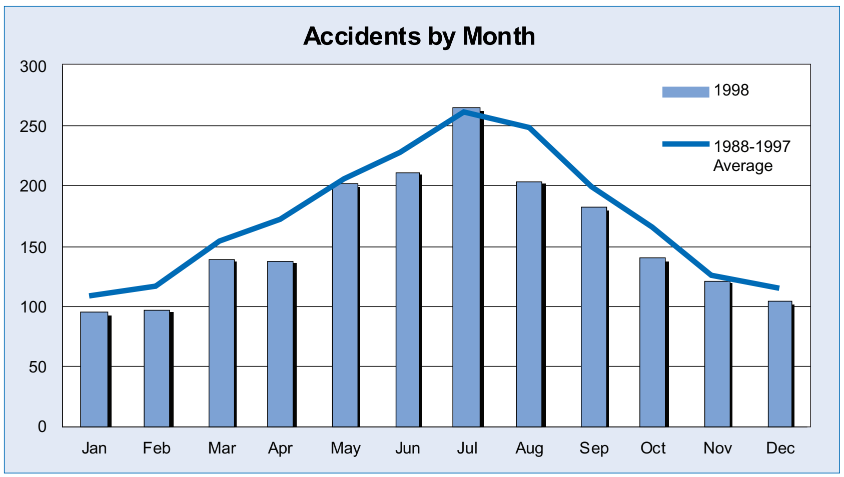
Typical General Aviation Accident Characteristics

The analysis of trends in accident data may be used to identify potential safety-related issues. However, accident data trends must be interpreted carefully to ensure that those results that may indicate safety concerns are separated from those results that simply reflect characteristics of normal operations. This is especially true when interpreting general aviation accident data that include a large percentage of recreational and pleasure flying. In these cases, trends in the accident numbers may simply be the result of exposure due to trends in general aviation activity.

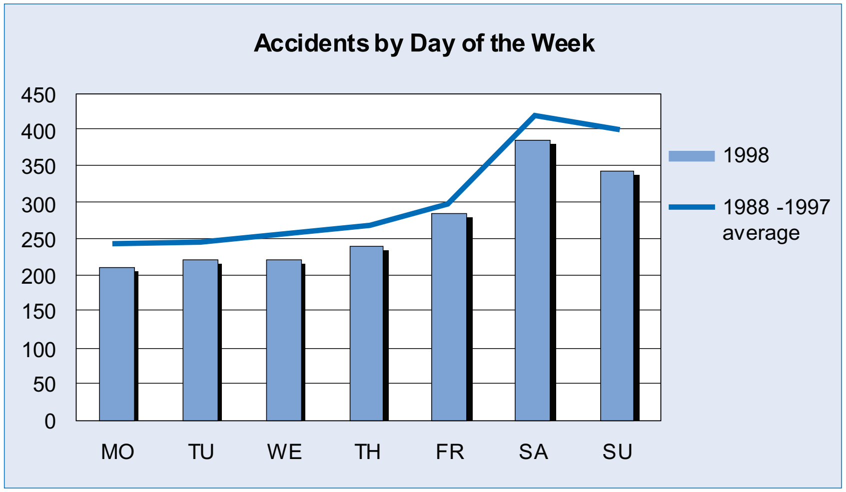
The following section discusses what could be considered "typical" characteristics of general aviation accidents. In most cases, these characteristics reflect the fact that the bulk of pleasure flying takes place on weekends during the summer months.

Time of Accident

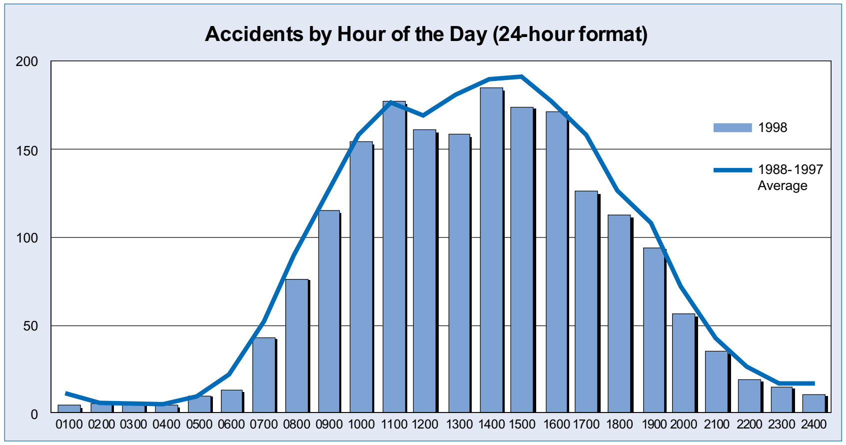
The following graph depicts the number of accidents per month over the last 10 years. The vertical bars depict 1998 accidents, and the curved line represents the historical average. As the graph illustrates, the total number of general aviation accidents in 1998 was lower than the historical average, but the distribution pattern remained similar. Data were not available for the number of general aviation hours flown each month, but the consistent pattern of increased accident numbers during the spring and summer months, with a peak in July, probably results from increased activity during these months rather than season-specific hazards.



A similar pattern emerges for the number of accidents that occur each day of the week. The following graph depicts the number of accidents per weekday for both 1998 and the average for the preceding 10-year period. Again, the total number of accidents in 1998 is lower than the 10-year average, but the daily distribution of accidents for 1998 is similar to the historical average. The number of accidents is relatively steady Monday through Thursday, then begins to increase on Friday, and is highest on Saturday and Sunday. Again, this distribution probably reflects a weekend increase in recreational general aviation activity.

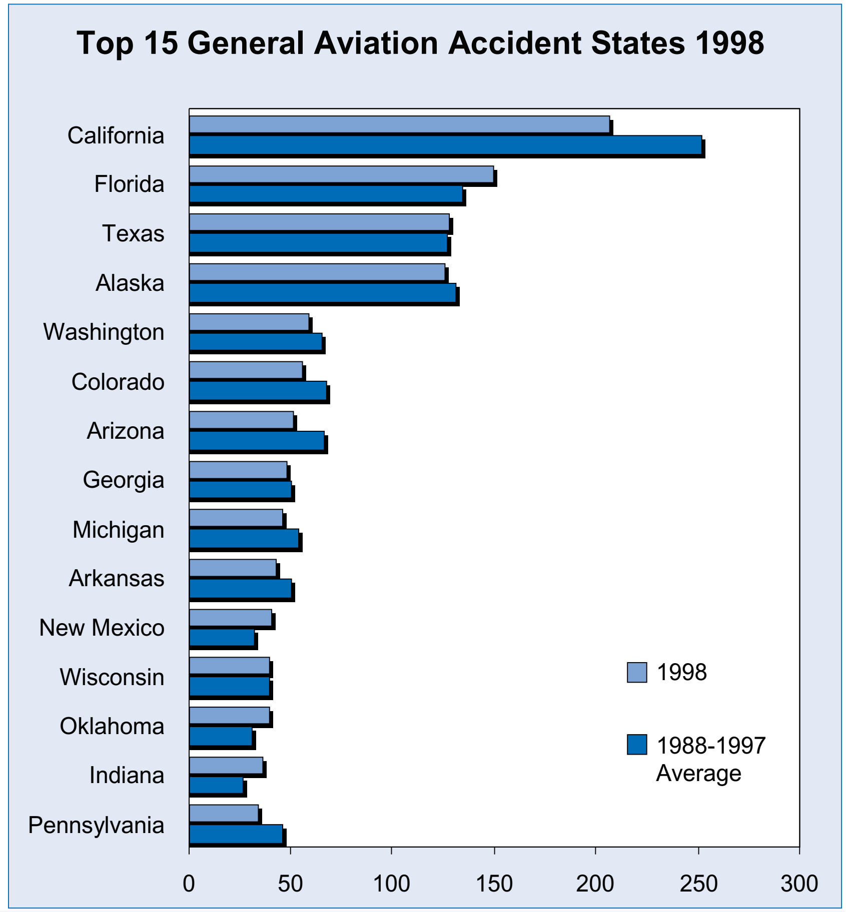


Depicted in the following graph are the numbers of accidents by the time of day they occurred, with a comparison of 1998 accident data with the average for the 10 years preceding 1998. As with the previous data, the observed distribution should be considered a result of exposure to risk due to the level of activity rather than a risk associated with the time of day. For example, note the dip in the number of accidents during the hours of noon and 1 p.m., probably corresponding to a reduction in activity during the lunch hour.



Location

Just as seasonal and daily changes in the level of general aviation activity can be observed in the number of general aviation accidents, regional differences are also reflected in the accident record. Regional differences that affect general aviation accident numbers include aviation activity levels and hazards unique to the local terrain and/or weather. The following graph shows the top 15 states by number of general aviation accidents in 1998. Included for comparison are the average numbers of accidents occurring in each of those states over the 10 years preceding 1998. As the graph illustrates, the distribution of accidents among these 15 states is similar to that of their historical averages. In order to make direct comparisons between the accident risks associated with each state, the number of accidents should be compared with a measure of general aviation activity level, such as the number of hours flown in that state annually. Although the hourly activity data needed to calculate general aviation accident rates for each state were not available for 1998, some assumptions can be made about general aviation activity level based on the size and population of each state. For example, California, Florida, and Texas had the greatest number of accidents in 1998; U.S. Census Bureau data[22] indicate that California had the highest state population in 1998, followed by Texas (second), and Florida (fourth). California, Florida, and Texas are also popular travel destinations that would attract additional general aviation traffic from other states. The next section includes more detailed information about the locations of 1998 accidents, and similar patterns can be observed in highly populated areas and areas that are likely to attract visitors.



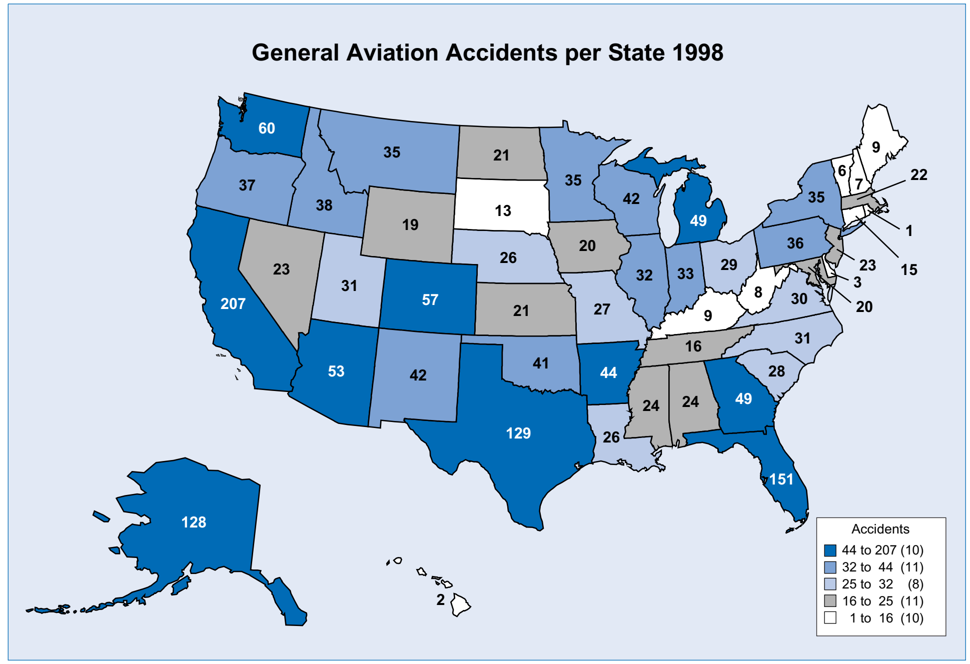
[22] Data are available at <http://eire.census.gov/popest/archives/state/st-99-1.txt>.

1998 In Depth

Location of General Aviation Accidents in 1998

United States Aircraft Accidents

This map depicts the number of general aviation accidents that occurred in each state during 1998. The states are also color-coded from light to dark, qualitatively signifying (from low to high) the number of accidents. As discussed in the previous section, the number of general aviation accidents occurring annually in a state is related to the population, general aviation activity level, and flying conditions unique to that state. Although general aviation flight hours were not available for each state, the largest numbers of general aviation accidents during 1998 were in California, Texas, and Florida,[23] states that also had the largest numbers of active pilots[24] and active aircraft,[25] suggesting that the number of accidents may be related to activity. However, Alaska had the fourth-highest number of general aviation accidents with 128, which was 2.7 times more than Michigan, a state estimated to have a similar number of active aircraft and pilots.[26] The operating environment, infrastructure, and travel requirements in Alaska provide unique challenges [27] to aviation, and these challenges are reflected in the general aviation accident record.



[23] The total of 151 accidents for Florida includes one accident off the coast of Florida in the Atlantic Ocean and one accident off the coast in the Gulf of Mexico.

[24] FAA, *U.S. Civil Airmen Statistics*, 1998, available at <http://api.hq.faa.gov/airmen/98AirmenCnty.pdf>.

[25] FAA, *GAATA Survey*, *1998*, available at <http://api.hq.faa.gov/GAATA/GA98tables/table1-8.pdf>.

[26] Because the *GAATA Survey* cannot accurately separate air taxi operations (unscheduled Part 135) from general aviation operations, the comparison between these estimates is included only as a demonstration of similar activity.

[27] For an analysis of aviation safety in Alaska, see National Transportation Safety Board, *Aviation Safety in Alaska, Safety Study*, NTSB/SS-95/03 (Washington, DC: NTSB, 1995). The Safety Board is also supporting an ongoing effort to identify and mitigate risk factors specific to aviation operations in Alaska; for details, see <http://www.ntsb.gov/aviation/AK/alaska_stat.htm>.

Foreign Aircraft Accidents

U.S.-registered aircraft were also involved in 33 accidents in locations outside the 50 United States.[28] These included15 different countries, the Atlantic and Pacific Oceans, the Caribbean Sea, and the Gulf of Mexico. Of those accidents, 17 were fatal, resulting in 50 deaths and 10 serious injuries. The largest number of accidents outside the 50 states occurred in the Bahamas, with 8 accidents, followed next by Canada with 4. Although most general aviation accidents involving U.S.-registered aircraft outside the United States usually occur in neighboring countries like Canada and the Caribbean island nations, the 1998 accident record also includes accidents that occurred as far away as Ethiopia, Iceland, and the Philippines.

Accidents Involving U.S. Registered General Aviation Aircraft Outside the 50 United States 1998

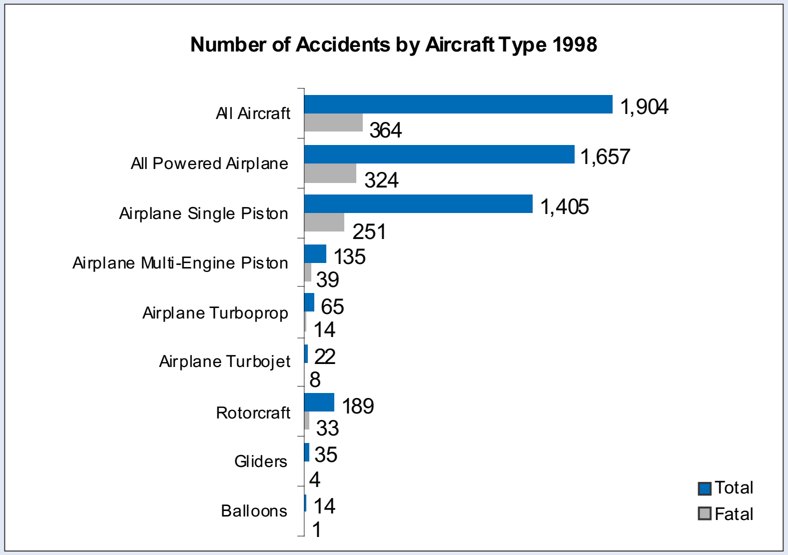
	Accidents	Fatal Accidents	Fatalities	Serious Injuries
Pacific Ocean Off American Samoa (1) Off Guam (1)	2	2	3	0
Atlantic Ocean Missing off Azores (1) Missing off Jamaica (1)	2	2	4	0
Gulf of Mexico Operating from oil platforms (2)	2	1	1	0
Caribbean Sea Off Puerto Rico (1) Missing off Bahamas (1)	2	2	5	0
Other Foreign Azores, Portugal (1) Bahamas (8) Belize (1) Canada (4) Colombia (1) Ethiopia (1) France (1) Greenland (1) Guatemala (1) Haiti (1) Iceland (1) Philippines (1) Turks & Caicos Islands (1) Isle of Man, UK (1) Venezuela (1)	25	10	37	10
Total	33	17	50	10

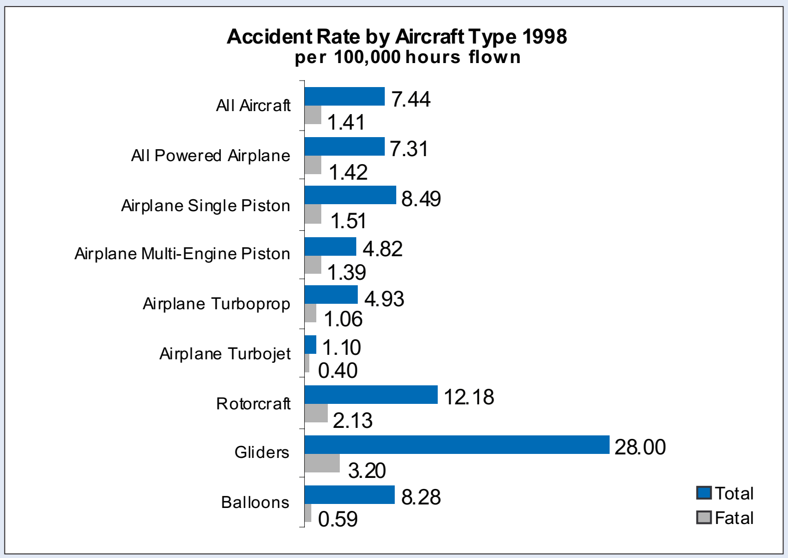
Aircraft Type

The following graphs illustrate the total number of accidents and the number of fatal accidents occurring in 1998 by type of aircraft. Most notable is the large number of accidents involving single-engine piston aircraft, accounting for 73.8% of all general aviation accidents and 69% of fatal accidents.

The general aviation accident rate for all aircraft was 7.44 accidents per 100,000 hours flown, and 1.41 fatal accidents per 100,000 hours flown. Among fixed-wing powered aircraft, the accident rate was highest for single-engine piston aircraft with 8.49 accidents and 1.51 fatal accidents per 100,000 hours flown. Among all powered aircraft, the accident rate was highest for rotorcraft, with 12.18 accidents and 2.13 fatal accidents per 100,000 hours flown. Glider operations had the highest accident rate, with 28.00 accidents and 3.20 fatal accidents per 100,000 hours flown.

[28] An additional four accidents (no injuries) occurred in the U.S. territory of Puerto Rico.





Type of Flying

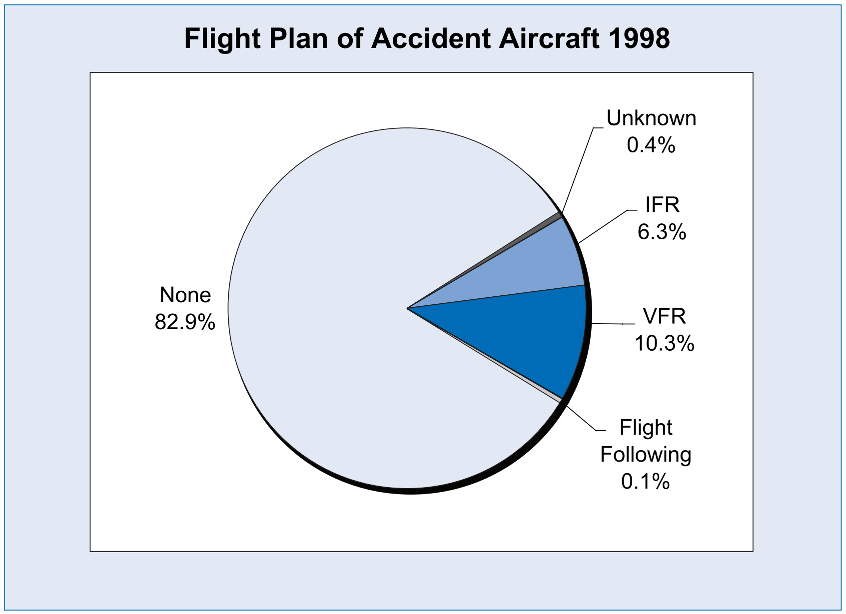
Because, as mentioned previously, general aviation includes a wide range of operations, each with unique aircraft types, flight profiles, and operating procedures, the total number of accidents and the accident rates vary considerably based on the type of flying. The purpose of flight can be defined as the reason that flight was initiated. Most general aviation operations are conducted for personal and/or business purposes. Of the 25.5 million general aviation hours flown in 1998, more than half—13.3 million—were for personal or business reasons.[29] Because of this activity level, personal/business flying accounted for 67.7% (1,286) of all general aviation accidents and 74.0% (268) of all fatal general aviation accidents in 1998.

Although personal/business flying has historically had the highest accident rate, aerial application had the highest accident rate in 1998 with 10.26 accidents per 100,000 hours. Because accidents that occur during aerial application operations typically involve contact with the ground, power lines, or other obstacles at relatively low speeds and from relatively low altitudes, they often do not result in fatal injury. Only 4.5% of the aerial application accidents that occurred in 1998 resulted in fatalities, compared to 20.8% of personal/business flying accidents. When compared with the number of hours flown, the fatal accident rate for aerial application operations is 0.46 fatal accidents per 100,000 hours flown. The fatal accident rate remains highest for personal and business flying, with 2.01 fatal accidents per 100,000 hours flown.

[29] FAA, *GAATA Survey*, 1998, available at <http://api.hq.faa.gov/GAATA/GA98tables/table1-6.pdf>.

Flight Plan

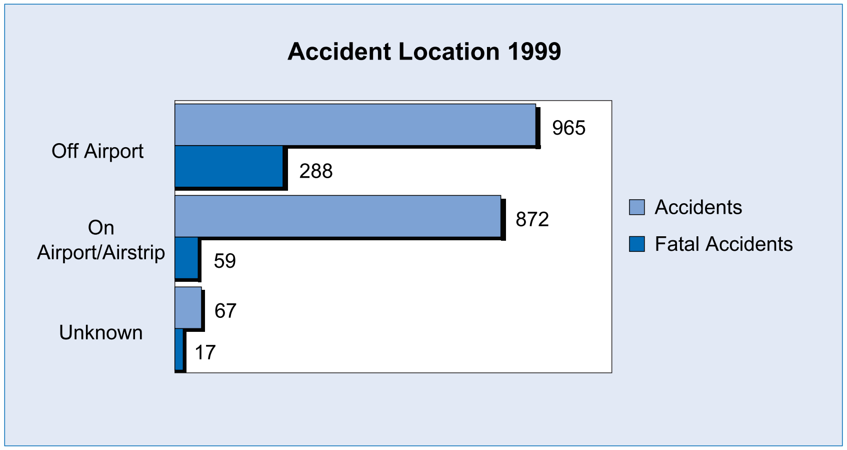
Most pilots (1,594) who were involved in accidents in 1998 did not file a flight plan. In most cases, a flight plan is required only for flight under instrument flight rules (IFR); however, pilots operating under visual flight rules (VFR) on point-to-point flights can also file a flight plan to aid search and rescue efforts if they fail to arrive at their intended destinations. The relationship between the filing of flight plans and weather-related accidents is also discussed in the special topic section of this report.



Airport Involvement

Accident locations were closely split between those occurring away from an airport (50.7%) and those occurring on an airport or airstrip (45.8% combined). Accidents that occur on an airport or airstrip typically involve aircraft at relatively low altitudes and airspeeds that are taking off, landing, or maneuvering to land.

Accidents that occur away from an airport may include aircraft in all phases of flight, at all altitudes, and at all airspeeds. Because of these potential differences, accidents that occur away from an airport are more likely to result in higher levels of injury and aircraft damage. As the graph below shows, most fatal accidents (79.1%) occurred away from an airport or airstrip.



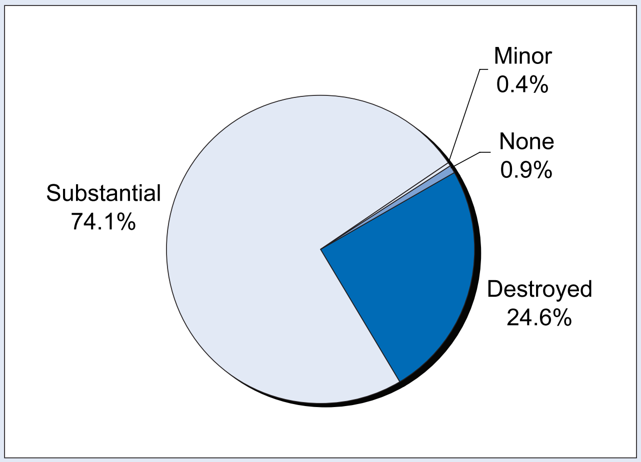
Injuries and Damage for 1998

Aircraft Damage

Safety Board investigators record aircraft damage as either "destroyed," "substantial," or "minor." "Substantial damage" is defined in 49 CFR 830.2 as "damage or failure which adversely affects the structural strength, performance, or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected component." "Destroyed" and "minor" are not specifically defined in 49 CFR 830.2; however, "destroyed" can be defined as any damage in which repair costs would exceed the value of the aircraft,[30] and "minor" damage as any damage that is not classified as either "destroyed" or "substantial."

Most aircraft involved in accidents during 1998 sustained substantial damage (74.1%), and approximately one quarter of aircraft (24.6%) were destroyed. "Minor" and "no damage" classifications each included less than 1% of accident aircraft.

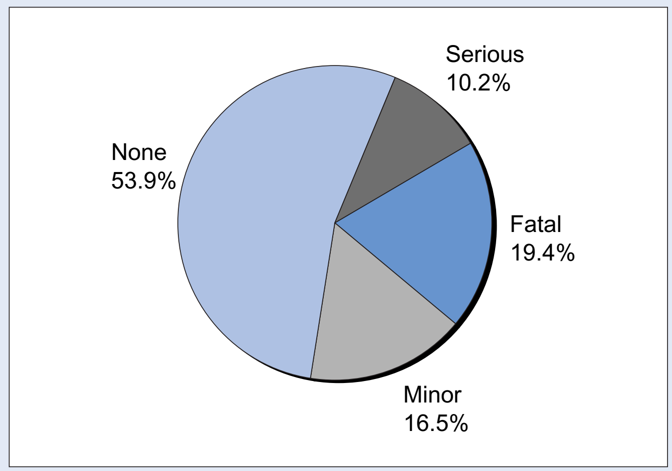
Aircraft Damage 1998



Accident Injuries

Safety Board investigators categorize injuries resulting from general aviation accidents as "fatal," "serious," or "minor." Title 49 CFR 830.2 defines a fatal injury as "any injury which results in death within 30 days of the accident." Title 49 CFR 830.2 also outlines several qualifications[31] of serious injury that include, but are not limited to, hospitalization for more than 48 hours, bone fracture, internal organ damage, or second- or third-degree burns. The following graph depicts the percentage of each injury category for general aviation accidents in 1998.[32] Most notable is the fact that more than half (53.9%) of general aviation accidents do not result in injury.

Highest Level of Injury per Accident Aircraft 1998

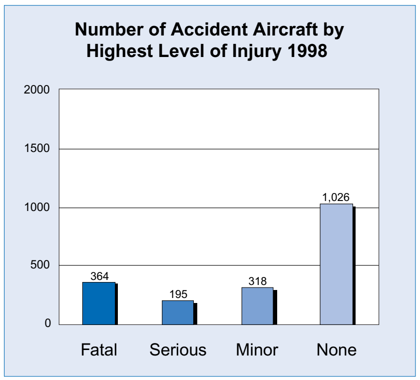


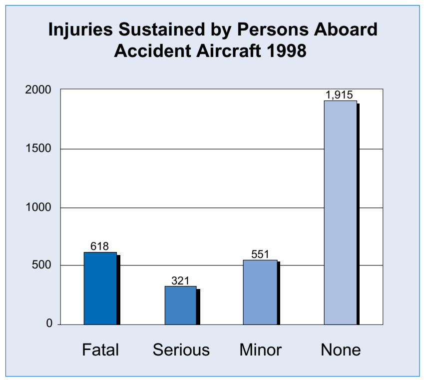
[30] Missing or unrecoverable aircraft are also considered "destroyed."

[31] See Appendix A for the complete definition of injury categories.

[32] Injury level is defined for accident aircraft as the highest level of injury sustained.

The following graphs illustrate both the number of accident aircraft in each injury category and the corresponding number of persons aboard those aircraft who sustained injuries in each category. Aircraft injury level is equal to the highest level of injury sustained by an occupant of that aircraft. Again, most persons who were aboard general aviation aircraft that were involved in accidents sustained no injuries.





Injuries by Role for 1998

The following table presents detailed information about the types of injuries incurred by all persons involved in general aviation accidents in 1998. The distribution of general aviation accident injuries varies with the type of operation and the size of aircraft. All aircraft have a pilot, but the exposure risk for other persons varies with the occupant load. For example, in 1998, 61 copilots suffered some level of injury in general aviation accidents, but the injury rate for copilots was commensurate with that of pilots, considering that only 5.9% of accidents involved aircraft with a copilot. As noted previously, most general aviation accidents involve personal/business flights in single-engine piston aircraft, which are likely to have only one pilot. Because of this exposure difference, pilots sustained the highest percentage of injuries in general aviation accidents in 1998, suffering 55.3% of all fatalities, 52.3% of all serious injuries, and 55.4% of all minor injuries.

Personal Injuries	Fatal	Serious	Minor	None	Total
Pilot	345	171	310	1,102	1,928
Copilot	32	13	16	52	113
Flight engineer	0	0	0	2	2
Dual student	10	7	16	77	110
Check pilot	1	0	2	4	7
Other crew	12	4	4	11	31
Flight attendant	0	0	0	1	1
Passenger	218	126	203	666	1,213
Total aboard	618	321	551	1,915	3,405
On ground	5	5	9	0	19
Other Aircraft	1	1	0	9	11
Total	624	327	560	1,924	

In addition to injuries sustained by persons on board the accident aircraft, 19 persons who were not aboard accident aircraft also sustained injuries. Examples of accidents in 1998 that resulted in fatal injuries to persons not aboard an aircraft include occupants of a van killed when it collided with an aircraft making an emergency landing on a highway and a utility worker killed when a helicopter being used to attach power lines collided with a utility pole.

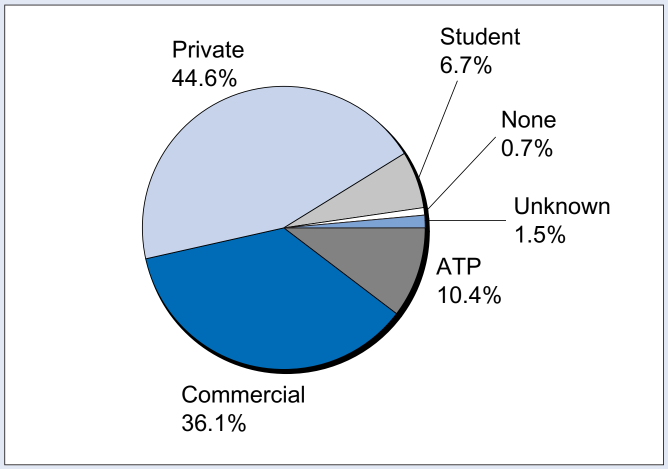
Accident-involved Pilots

Rating

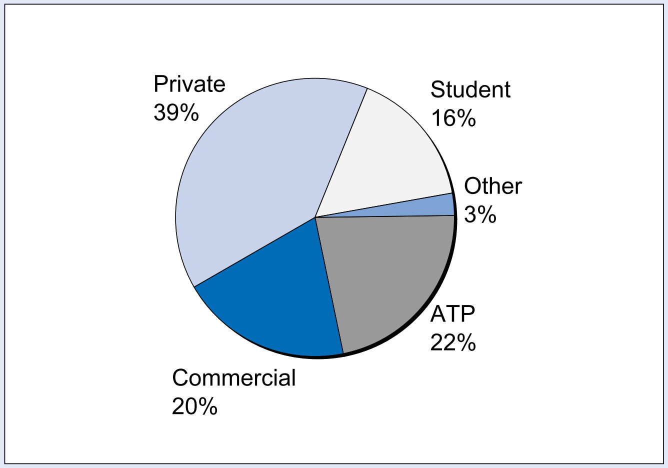
Of the 1,928 pilots involved in general aviation accidents in 1998, the largest percentage (44.6%) held a private pilot certificate.[33] The second-largest percentage (36.1%) held a commercial pilot certificate, which is required for any person to act as pilot-in-command of an aircraft for compensation or hire.[34]

When compared to the number of active pilots in 1998 holding each type of pilot certificate, both private and commercial pilot certificate holders were over-represented in general aviation accidents. The 39% of active pilots with private pilot certificates accounted for 44.6% of accidents, and the 20% of active pilots with commercial pilot certificates accounted for 36.1% of accidents.

Highest Rating Held by Accident-Involved Pilot

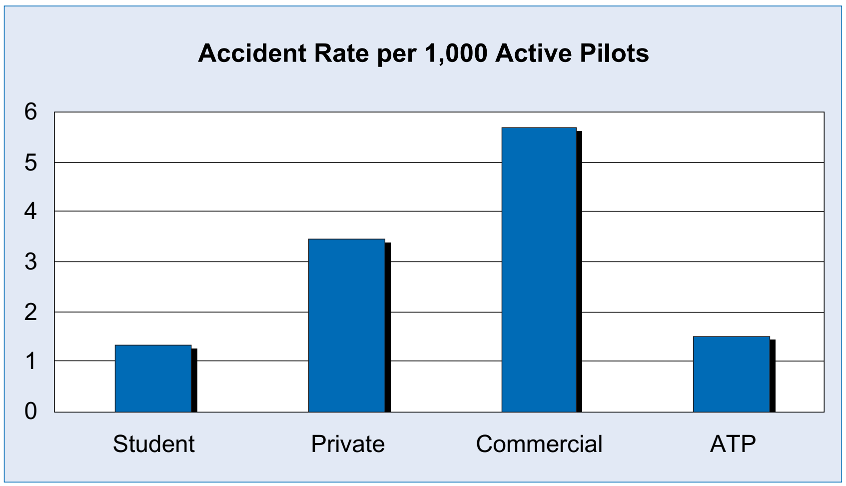


Active Pilots by Certificate



[33] FAA, *U.S. Civil Airmen Statistics*, available at <http://api.hq.faa.gov/CivilAir/index.htm>.
[34] See 14 CFR 61.133 for the privileges granted by a commercial pilot certificate.

As the following graph shows, the accident rate per 1,000 active pilots was highest for commercial pilot certificate holders, who can be employed as pilots and are likely to fly more hours annually than student or private pilots. Annual flight-hour data for pilots holding each type of certificate are not available to confirm this conclusion. The *U.S. Civil Airmen Statistics* compiled by the FAA[35] also do not include information about the type of operation that certificate holders engage in, but examples of commercial operations include corporate executive transportation, flight instruction, sightseeing flights, banner towing, and aerial application.



The largest percentage of commercial pilots involved in accidents during 1998 (41.8%) were conducting personal flights and were not involved in commercial operations at the time of the accident. Airline Transport Pilot (ATP) certificate holders, in addition to being employed as pilots,[36] can engage in air carrier operations,[37] which are not included in this review; therefore, ATP certificate holders may fly fewer general aviation hours and have a lower general aviation accident rate.

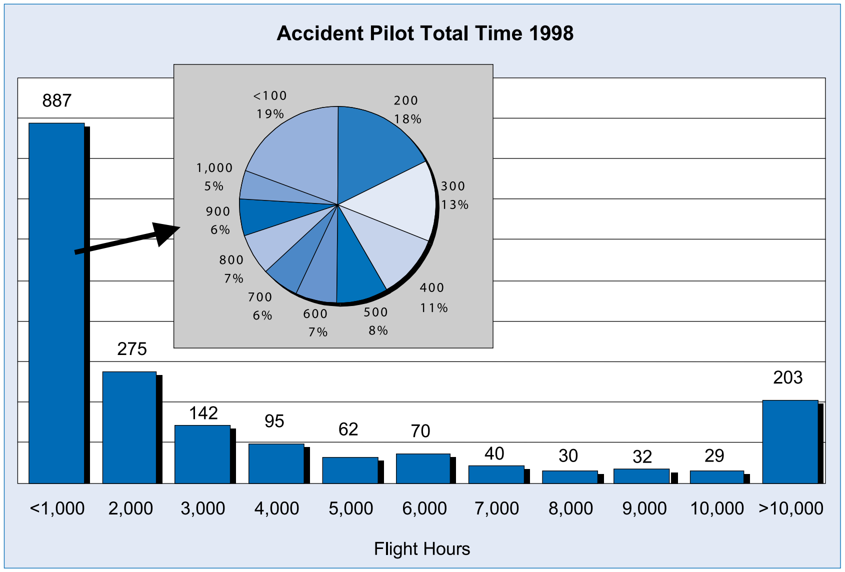
Total Time

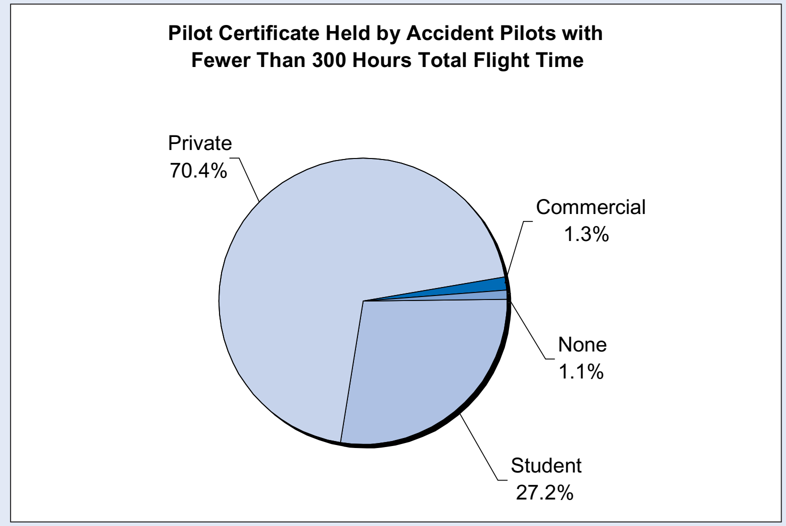
Of the 1,865 accidents in 1998 for which pilot total flight experience data are available, 887 (47.6%) involved pilots with fewer than 1,000 hours of flight time. The inset chart on the next page depicts the distribution of experience among those accident pilots with fewer than 1,000 hours. The largest percentage of accident pilots in this group had fewer than 100 hours of total flight time, and a total of 449 pilots had 300 hours or fewer. When compared to the total number of accident pilots, those with 300 hours or fewer accounted for 24.1% of all accident pilots for whom data are available.

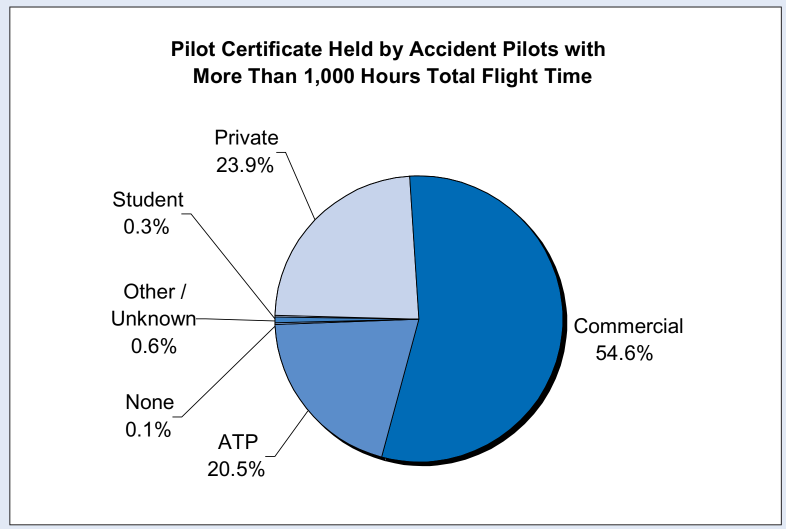
[35] FAA, *U.S. Civil Airmen Statistics*, 1998, available online at <http://api.hq.faa.gov/CivilAir/index.htm>.

[36] Refer to 14 CFR 61, Subpart G, for the privileges and limitations of the ATP certificate.

[37] See 14 CFR 121.437



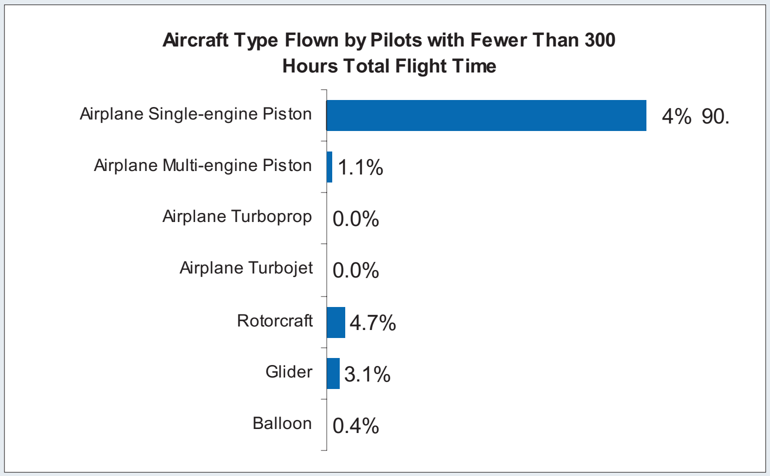


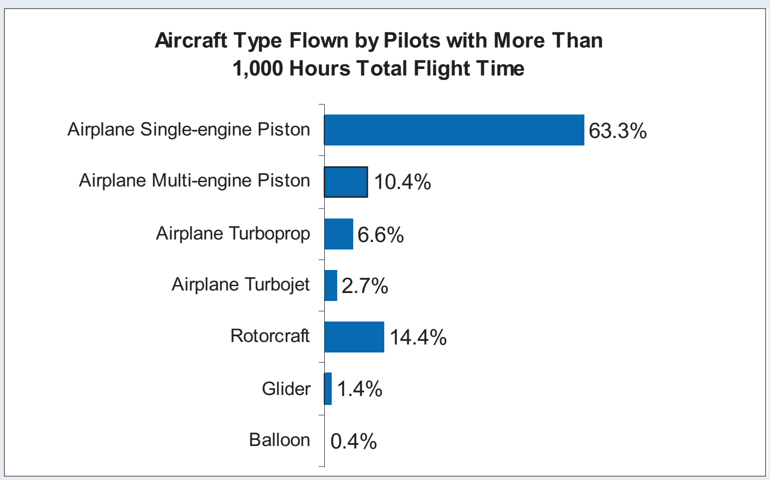


Not surprisingly, most accident pilots with fewer than 300 total hours of flight time held private pilot certificates;[38] the second-highest percentage held student pilot certificates. Most pilots with more than 1,000 total hours of flight time held commercial pilot certificates, followed next by those with private pilot certificates, and last by those with ATP certificates. Three accident pilots with more than 1,000 hours total time held only student pilot certificates.

[38] Refer to 14 CFR Part 61 for the requirements of each type of pilot certificate and to 14 CFR 141 for changes to those requirements for training conducted at approved flight schools.

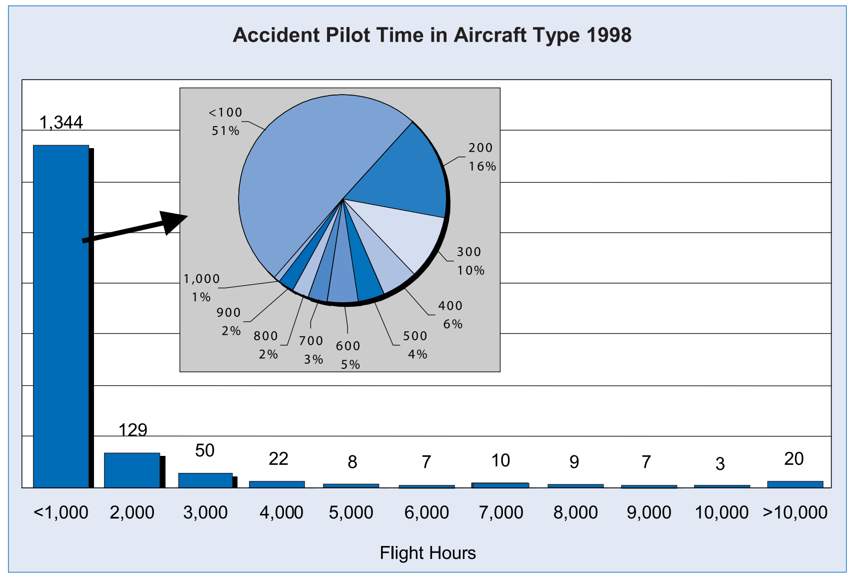
It is also not surprising that most accident pilots with fewer than 300 hours total flight time were flying single-engine piston airplanes when the accidents occurred. Accident pilots with more than 1,000 hours were flying a more diverse selection of aircraft, including 14.4% who were flying helicopters.





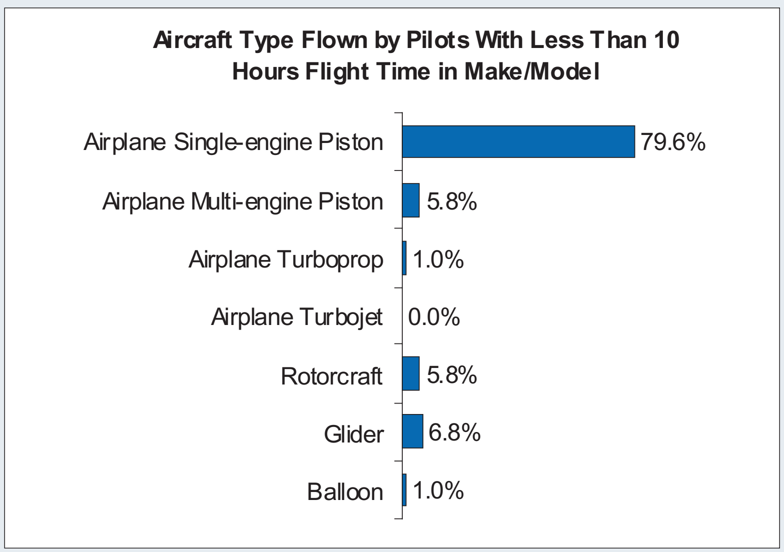
Time in Type of Aircraft

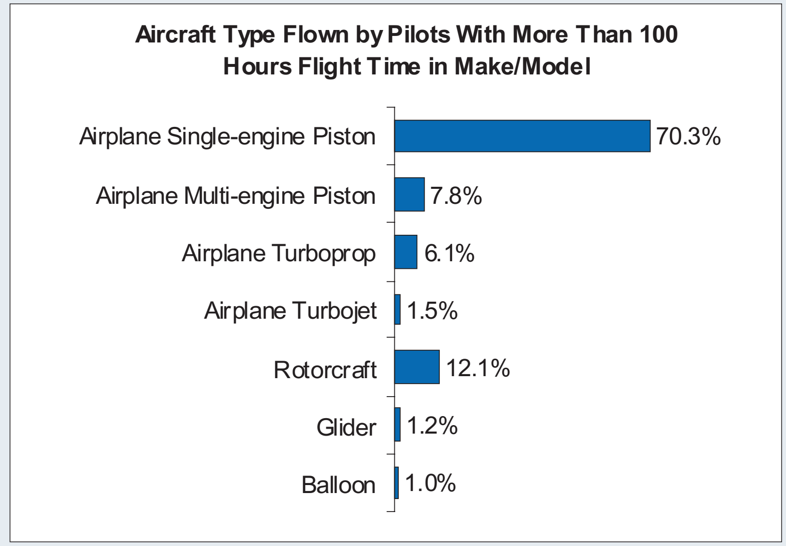
Of the 1,609 accidents in 1998 for which data are available about pilot experience in the accident aircraft make and model, 83.5% involved pilots with fewer than 1,000 hours of time in the accident aircraft make and model. The inset chart depicts the distribution of experience among those accident pilots with fewer than 1,000 hours in type. The largest percentage of accident pilots in this group (51%) had fewer than 100 hours of total flight time in the accident aircraft type, and a total of 103 pilots (6.4% of all accident pilots for whom data are available) had fewer than 10 hours in type.



Two types of pilots may have low time in type: new pilots with low total time and more experienced pilots who are transitioning to a new aircraft. Most accident pilots with fewer than 10 hours of flight time in make and model were flying single-engine piston aircraft. The percentage of accident pilots with low time in make and model who were flying gliders is also worth noting and is probably due to the shorter durations typical of glider flights compared to those of powered aircraft.

Two types of pilots who might be expected to have accumulated significant time in make and model are those who own their own airplanes and fly them often and professional pilots who fly the same aircraft often. A large number of general aviation pilots who own aircraft have single-engine piston airplanes. Helicopters and multi-engine piston, jet, and turboprop airplanes are more likely to be operated by professional pilots. Comparison of the two graphs that follow shows that pilots with more than 100 hours in make and model were more likely than pilots with fewer hours in type to be flying rotorcraft, or multi-engine piston, jet, or turboprop airplanes.

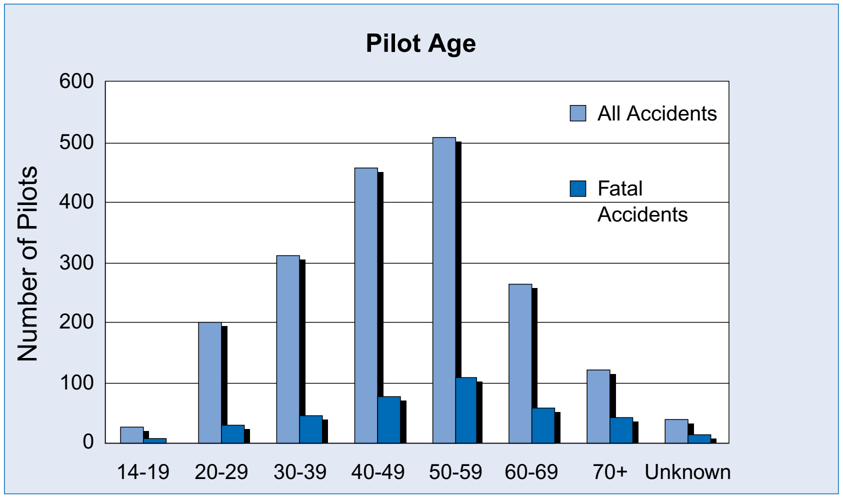


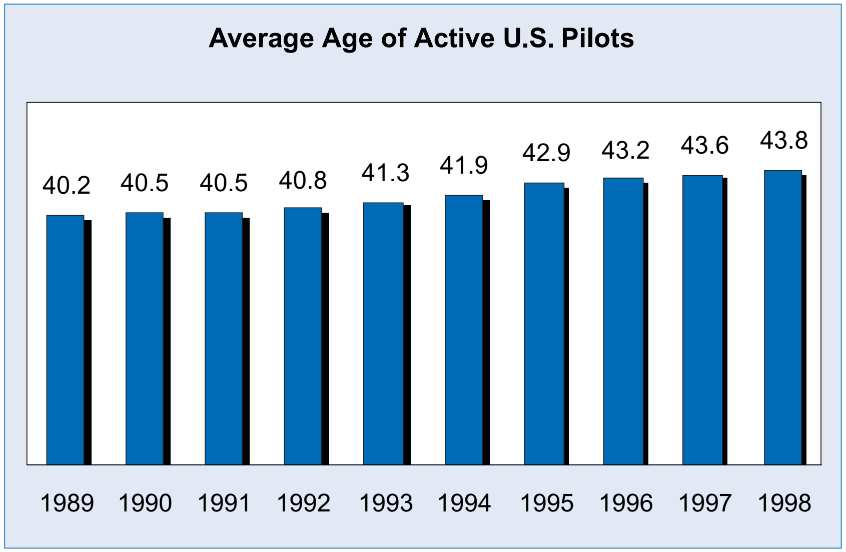


Age

The next two graphs illustrate the age distribution of pilots involved in accidents during 1998. Most accident pilots were between the ages of 50 and 59. The average age of all active pilots in the U.S. increased steadily from 1988 to 1998 and was equal to 43.8[39] years in 1998. Because flight-hour activity numbers are not available for each age group, no meaningful inferences can be made regarding specific age-related accident risk.

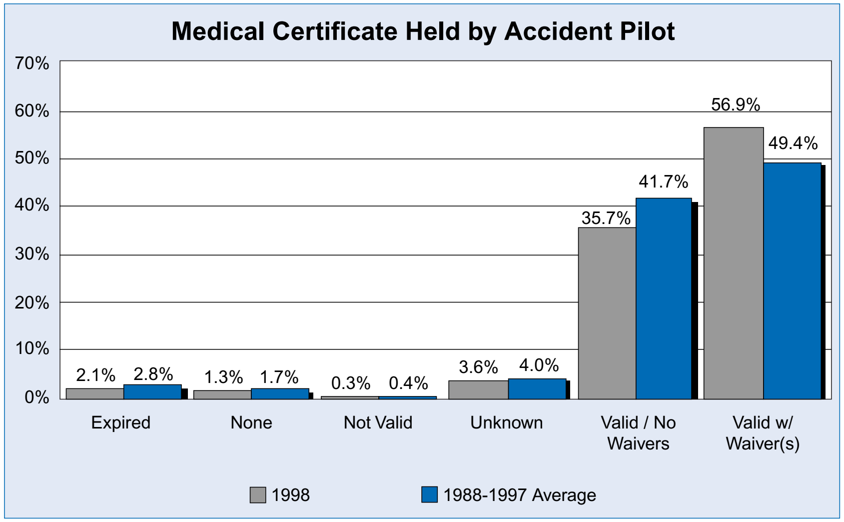
[39] FAA, *U.S. Civil Airmen Statistics*, 1998, available at http://api.hq.faa.gov/Airmen/Air13-97.pdf.





Medical Certification

The following graph depicts the percentage of accident pilots who held medical certificates in 1998[40] and the average percentage of accident pilots who held medical certificates for the preceding 10-year period.[41] Almost all (92.6%) of the pilots involved in accidents during 1998 held valid medical certificates. Of those, 56.9% held medical certificates with waivers, and 35.7% held medical

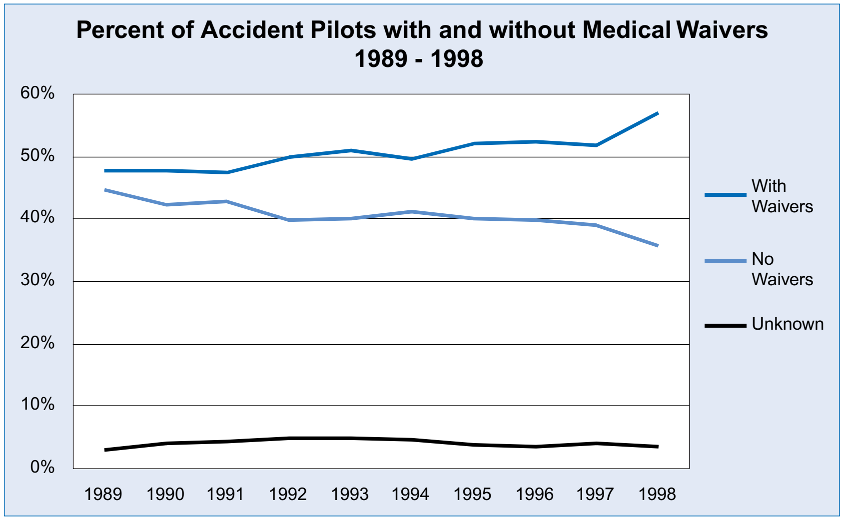


[40] Medical certification as required by 14 CFR 61.23.

[41] Pilots of gliders and lighter-than-air aircraft are not required to have medical certification.

certificates with no waivers.[42] In comparison to the historical averages, the percentage of accident pilots with waivers on their medical certificates increased by 7.5%, and the percentage of accident pilots holding medical certificates with no waivers decreased by 6%. Data about the total number of active pilots holding medical certificates with and without waivers, and the details of any waivers issued, were not available.

As depicted in the following graph,[43] the percentage of accident pilots holding valid medical certificates with no waivers generally decreased, and the number of accident pilots holding certificates with waivers generally increased, between 1989 and 1998. Although data are not available about the total number of active pilots with and without medical waivers, the observed trend suggests that the number of active pilots with medical certificate waivers is increasing. Any increase in the number of pilots with medical certificate waivers between 1989 and 1998 may be related to the increasing average age of pilots observed during those years. Without specific information about details of any waivers issued, the data are insufficient to suggest a link between medical waivers and pilot accident risk.



[42] Title 14 CFR 67 prescribes the medical standards and certification procedures for issuing medical certificates for airmen and for remaining eligible for a medical certificate. Title 14 CFR 67.401 covers the authorization for special issuance of medical certificates. Pilots who fail to meet the required standards for medical certification may in some cases be granted an Authorization for Special Issuance of a Medical Certificate, commonly referred to as a waiver. Conditions requiring a waiver range from vision or hearing deficiencies to insulin-dependent diabetes or heart disease.

[43] Graph does not include data for accident pilots with invalid, expired, or no medical certificates.

Accident Occurrences for 1998

The circumstances of an accident occurrence are documented in the Safety Board's accident report as the "sequence of events." The sequence of events can be defined as *what* happened during the accident. Sequence of events was first used as a method for classifying accidents in 1982. A total of 54[44] occurrence codes are available to describe the events for any given accident. Because aviation accidents are rarely limited to a single event, each accident is coded as a sequence of events (that is, occurrence 1, occurrence 2, etc.), with as many as five different event codes. Of the 1,894 accidents in 1998 with sequence of events data available, 638 had 2 or more occurrences, 446 had 3 or more, 48 had 4 or more, and 2 had a total of 5 occurrences (each) coded in the accident sequence of events. Each accident event includes information about sequential order of its occurrence. For example, one accident in 1998 involved an aircraft that lost engine power due to contaminated fuel. The aircraft began an emergency descent and then collided with trees before landing on unsuitable terrain. Each of these events was coded with "loss of engine power" coded as the first occurrence. An excerpt from the brief report for that accident is included here as an example of how occurrences are coded.

```
Occurrence #1:          LOSS OF ENGINE POWER(PARTIAL) - NONMECHANICAL
Phase of Operation:     CRUISE

Findings
   1. (C) FLUID,FUEL - CONTAMINATION,OTHER THAN WATER
   2. (C) FLUID,FUEL - CONTAMINATION,WATER
----------

Occurrence #2:          IN FLIGHT COLLISION WITH OBJECT
Phase of Operation:     EMERGENCY DESCENT/LANDING

Findings
3. (F) OBJECT - TREE(S)
----------

Occurrence #3:          IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation:     EMERGENCY LANDING

Findings
   4. (F) TERRAIN CONDITION - NONE SUITABLE

Findings Legend: (C) = Cause, (F) = Factor
```

The National Transportation Safety Board determines the probable cause(s) of this accident/incident as follows.
A loss of engine power while in cruise flight caused by a contaminated fuel supply and the subsequent inflight collision with trees and unsuitable terrain during the emergency descent and landing.

[44] Two of the codes, "missing aircraft" and "undetermined," do not represent operational events.

The following table displays the first occurrences for all of the 1998 general aviation accidents with sequence of events data available.

1998 Accident First Occurrences

	Total	Fatal
Collision - Inflight	**300**	**107**
In Flight Collision With Object	154	49
In Flight Collision with Terrain/Water	96	35
Midair Collision	27	21
Undershoot	15	1
Dragged Wing, Rotor, Pod, Float or Tail/Skid	8	1
Near Collision Between Aircraft	0	0
Noncollision - Inflight	**488**	**181**
Loss of Control - In Flight	272	108
Airframe/Component/System Failure/ Malfunction	108	16
In Flight Encounter With Weather	89	48
Abrupt Maneuver	10	6
Forced Landing	5	0
Vortex Turbulence Encountered	2	2
Altitude Deviation, Uncontrolled	1	0
Decompression	1	1
Collision - On-Ground or Water	**122**	**2**
On Ground/Water Collision with Object	56	1
On Ground/Water Encounter with Terrain/Water	41	1
Collision Between Aircraft (Other than Midair)	21	0
Dragged Wing, Rotor, Pod, Float or Tail/Skid	4	0
Noncollision - On-Ground or Water	**410**	**8**
Loss of Control -On Ground	216	2
Hard Landing	106	1
Overrun	42	2
Nose Over	24	0
Roll Over	8	0
Propeller/Rotor Contact to Person	7	3
On Ground Encounter with Weather	5	0
Nose Down	1	0
Propeller Blast or Jet Exhaust/Suction	1	0
Ditching	0	0

	Total	Fatal
Power Related	**507**	**53**
Loss of Engine Power	195	14
Loss of Engine Power (Total) - Nonmechanical	156	14
Loss of Engine Power (Total) - Mech Failure/Malfunction	68	10
Loss of Engine Power (Partial) - Mech Failure/Malfunction	44	6
Loss of Engine Power (Partial) - Nonmechanical	33	6
Rotor Failure/Malfunction	7	3
Propeller Failure/Malfunction	4	0
Engine Tearaway	0	0
Landing Gear	**35**	**0**
Wheels Up Landing	12	0
Gear Collapsed	7	0
Main Gear Collapsed	7	0
Gear Retraction on Ground	4	0
Nose Gear Collapsed	3	0
Complete Gear Collapsed	1	0
Wheels Down Landing in Water	1	0
Tail Gear Collapsed	0	0
Other Gear Collapsed	0	0
Gear Not Extended	0	0
Gear Not Retracted	0	0
Miscellaneous	**28**	**4**
Miscellaneous/Other	18	3
Fire	9	1
Explosion	1	0
Fire/Explosion	0	0
Hazardous Materials Leak/Spill	0	0
Cargo Shift	0	0
Undetermined	**4**	**4**
Missing Aircraft	3	3
Undetermined	1	1

Among the categories of first occurrences, the largest portion of accidents (26.8%) included occurrences related to aircraft power. Among the subcategories, the most common first occurrences involved a loss of control either in flight (14.4%) or on the ground (11.4%). Although loss-of-aircraft-control-on-the-ground occurrences resulted in only 2 fatal accidents, loss-of-control-in-flight occurrences resulted in a total of 108 fatal accidents, which was 29.8% of all fatal accidents with available data and more than twice as many as for any other single occurrence.

Phase of Flight

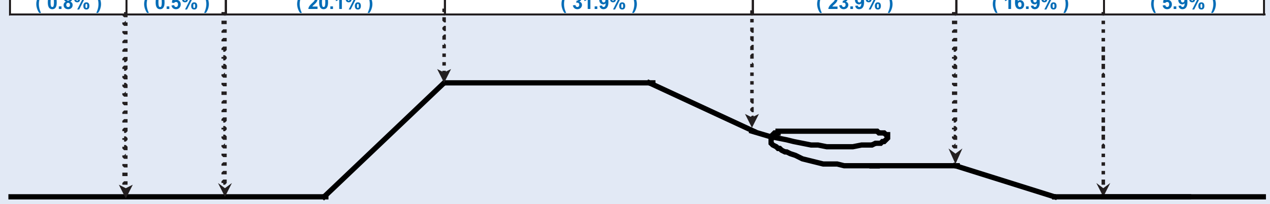
The illustration below displays the percentage of accident aircraft in each phase of flight at the time of first occurrence. The phase of flight can be defined as *when*, during the operation of the aircraft, the first occurrence took place. There are 50 distinct phases-of-flight that investigators may use to describe the operational chronology of occurrences. To simplify the presentation of this information, the detailed phases have been grouped into eight broad phase categories for this illustration. For example, the category "approach/landing" includes any segment of an instrument approach or position in the airport traffic pattern and continues through the landing until the aircraft clears the runway. The upper set of numbers represents the percentage of all accidents that occurred in each phase, and the numbers in parentheses indicate fatal accidents.

As depicted in the illustration, most accidents occurred during landing and takeoff, despite the relatively short duration of these phases in comparison to the entire profile of a normal flight. The high number of accidents that occur during takeoff and landing reflects the increased workload placed on both the flight crew and the aircraft during these phases. During takeoff and landing, the flight crew must control the aircraft while changing altitude and speed, communicating with air traffic control (ATC) and/or other aircraft, and maintaining separation from obstacles and other aircraft. Aircraft systems are also stressed during takeoff and landing with changes in engine power settings, changes in cabin pressurization, and the possible operation of retractable landing gear, flaps, slats, and spoilers. While the aircraft is at low altitude during takeoff and landing, it is also most susceptible to any hazards caused by wind and weather conditions.

Notably, the largest percentage of total accident first occurrences (38.7%) happened during the approach/landing phase of flight, but only 16.9% of fatal accident first occurrences happened during this phase. The largest percentage of fatal accident first occurrences (31.9%) occurred during the cruise/descent phase of flight, but only 18.6% of all accident first occurrences occurred during this phase. These statistics reflect the relative severity of the types of accidents that are likely to occur during each of these phases. Accidents during cruise/descent are more likely to result in higher levels of injury and aircraft damage due to the higher speeds and altitudes associated with these phases of flight.

Accident Aircraft Phase of Flight During First Occurrence 1998

Standing	Taxi	Takeoff / Climb	Cruise / Descent	Manuevering / Hovering	Approach / Landing	Not Reported / Other
1.0%	3.0%	24.0%	18.6%	13.3%	38.7%	1.4%
(0.8%)	(0.5%)	(20.1%)	(31.9%)	(23.9%)	(16.9%)	(5.9%)



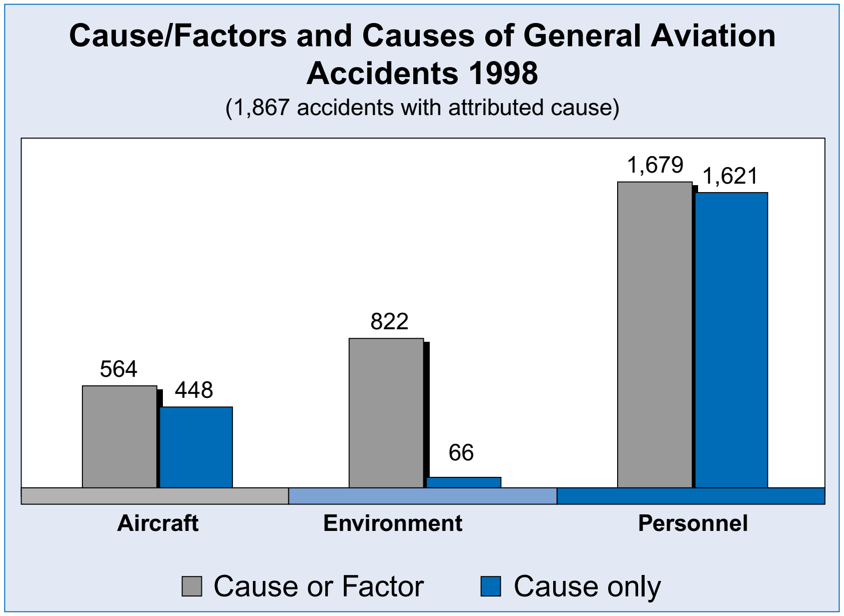
The likelihood of an aircraft accident first occurrence during each phase of flight varies with different aircraft types and types of flying. For example, single-engine piston aircraft used for instructional flights fly more takeoffs and landings as new pilots practice these skills. As a result, 51% of all first occurrences for 1998 accidents involving single-engine aircraft on instructional flights occurred during the approach/landing phase. In contrast, the largest percentage of first occurrences for accidents involving aerial application flights occurred during the maneuvering phase of flight, reflecting the hazards associated with low altitude operations.

Most Prevalent Causes/Factors for 1998

Probable Causes, Factors, Findings, and the Broad Cause/Factor Classification

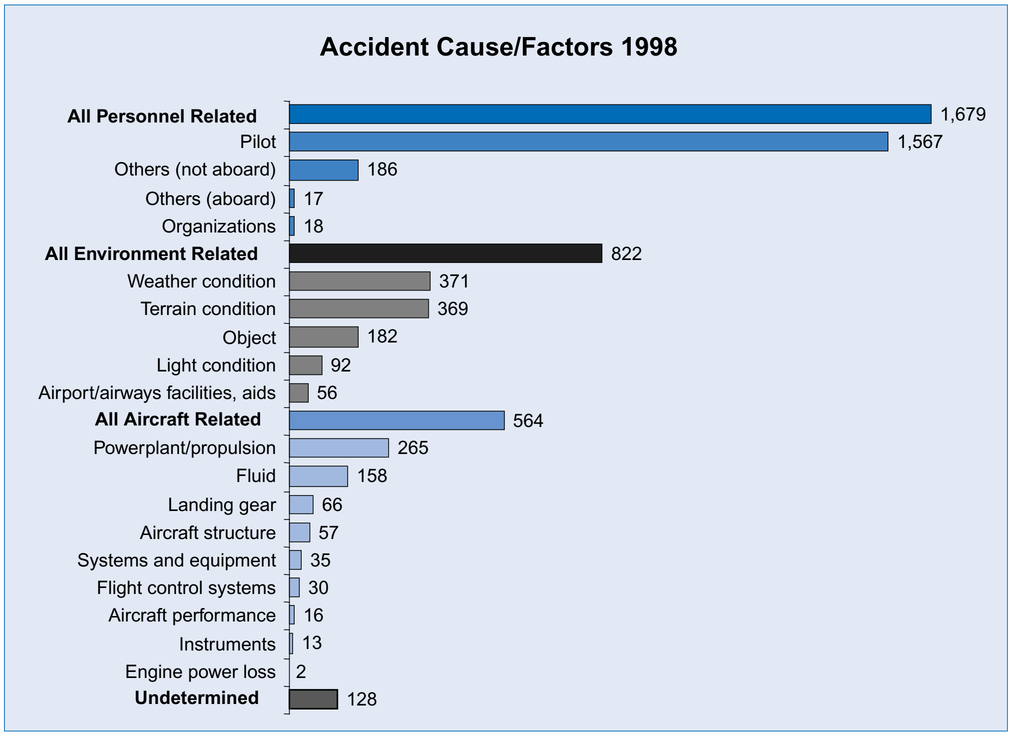
In addition to coding accident occurrences, the Safety Board is required to make a determination of probable cause. The objective of this determination is to discern the cause-and-effect relationships in the accident sequence. This could be described as *why* the accident happened. In determining probable cause(s) of an accident, the Safety Board considers all facts, conditions, and circumstances. The term "factor" is used to describe situations or circumstances that contributed to the accident. For example, if the cause of an accident were the malfunction of the aircraft brakes, which caused the aircraft to slide off the end of the runway, environmental conditions might be cited as a "factor" if the braking problem were made worse by a wet runway. Any additional information that is neither a cause nor a factor but that further supplements the explanation of an accident is indicated as a "finding." The details of probable cause are coded as the combination of all causes, factors, and findings associated with the accident. Just as accidents often include a series of events, many factors often combine to cause an accident. For this reason, a single accident report can include multiple cause and factor codes. In many cases, an accident record will have a single cause and multiple factors.

To simplify the presentation of probable cause information, the hundreds of unique codes have been grouped into broad cause/factor categories. This broad cause/factor classification provides an overview of fundamental accident origins by dividing all accident causes and factors into three groups: aircraft, environment, and personnel. The following graph depicts the number of general aviation accidents that fall into each broad cause/factor and cause classification. Personnel-related causes or factors were cited in 89.9% of all general aviation accident reports for 1998 for which cause/factor data were available (N=1,867). Environmental causes/factors were cited in 44% of these accident reports, and aircraft-related causes/factors were



cited in 30.2% of reports.[45] Environmental conditions are rarely cited as an accident cause but are more likely to be cited as a contributing factor. In 1998, only 66 of 822 environmental citations (8% of all environmental causes/factors) were listed as a cause, with the remainder listed as contributing factors.

The following graph displays the causes/factors of the 1998 accidents with available information. Although several hundred unique codes are available to document causes/factors, this graph summarizes them by the broad cause and factor categories of personnel, environment, and aircraft and by the next-lower-level subcategory.



This graph clearly shows that most causes and factors attributed to general aviation accidents are personnel related. The pilot was the most frequently cited individual in the personnel category; however, other persons not aboard the aircraft were cited as a cause or factor in 186 accidents. Examples of accident-related personnel not aboard the aircraft could include an air traffic controller, a maintenance technician, or airport personnel. In the broad category of environmental factors, weather conditions were cited in a total of 371 (19.5%) accidents. Powerplant-related[46] causes/factors were the most commonly cited factors within the broad category of aircraft and were cited in 265 (13.9%) of the general aviation accidents in 1998.

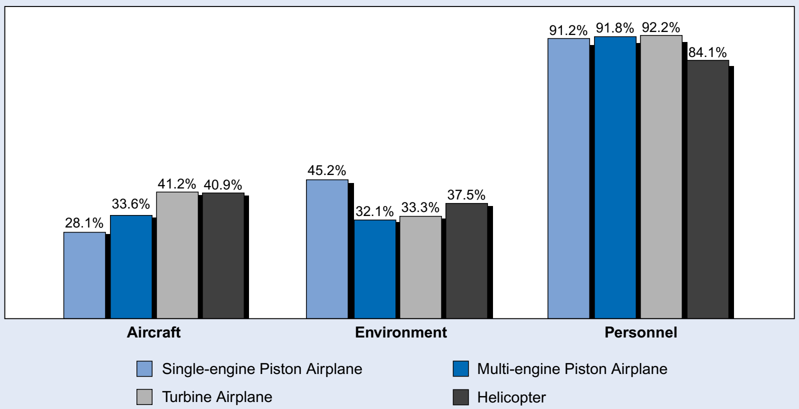
The following graph shows that specific accident causes and factors can vary for different types of aircraft. For example, environmental causes and factors were cited in 45.2% of accidents involving single-engine piston airplanes, compared to 32.1% and 33.3% respectively for multi-engine piston and turbine airplanes. Because single-engine piston airplanes are smaller, fly at lower altitudes, and usually have less-sophisticated avionics, environmental conditions like wind and weather pose a greater hazard than to larger aircraft. However, because of the complexity of the systems and equipment

[45] Because the Safety Board frequently cites multiple causes and factors for an aircraft accident, adding together the number of causes and factors will result in a sum that is greater than the total number of accidents.

[46] "Powerplant/propulsion" causes and factors include any partial loss or disruption of engine power, as well as the malfunction or failure of any part(s), equipment, or system associated with engine propulsion, while "engine power loss" refers only to the total loss of engine power.

in larger aircraft, they may be more sensitive to failures. As the graph illustrates, aircraft causes and factors were cited in only 28.1% of accidents involving single-engine piston airplanes, compared to 33.6% for multi-engine piston airplanes, 41.2% for turbine-powered airplanes, and 40.9% for helicopters. Percentages of accidents citing personnel causes and factors were similar for all airplane types and only slightly lower for accidents involving helicopters.

Cause/Factors of General Aviation Accidents by Aircraft Type 1998



Human Performance

The information recorded in the personnel category refers primarily to *whose* actions were a cause or factor in an accident. To increase the level of detail about the actions or behavior that may have led to an accident, causal data related to human performance issues and any underlying explanatory factors are also recorded. The information in these categories can be thought of as *how* and *why* human performance contributed to the accident. For example, if a pilot became disoriented and lost control of the aircraft after continuing a visual flight into instrument flight conditions, the pilot would be cited as "cause"in the personnel category, and planning/decision-making would likely also be cited in the human performance issues category.

Of the 1,570 accidents for which the cause or factor was attributed to human performance, the most frequently cited cause/factor was aircraft handling and control (64.2%), followed by planning and decision-making (38.2%), and use of aircraft equipment (14.6%). Issues related to personnel qualification were cited in 48.1% of the 283 accidents with underlying explanatory factors related to human performance. Examples of qualification issues that were cited in the 1998 accident record include lack of experience, inadequate training, and the use of unfamiliar equipment.

	Cause / Factor	Cause
Human Performance Issues	1,570	1,506
Aircraft handling/control	1,008	954
Planning/decision	600	507
Use of aircraft equipment	229	196
Maintenance	132	90
Communications/information/ATC	69	46
Meteorological service	14	5
Airport	5	2
Dispatch	0	0
Underlying Explanatory Factors	283	58
Qualification	136	8
Psychological condition	65	12
Physiological condition	58	25
Aircraft/equipment inadequate	16	6
Institutional factors	10	2
Material inadequate	9	3
Information	6	0
Procedure inadequate	6	4
Facility inadequate	1	0

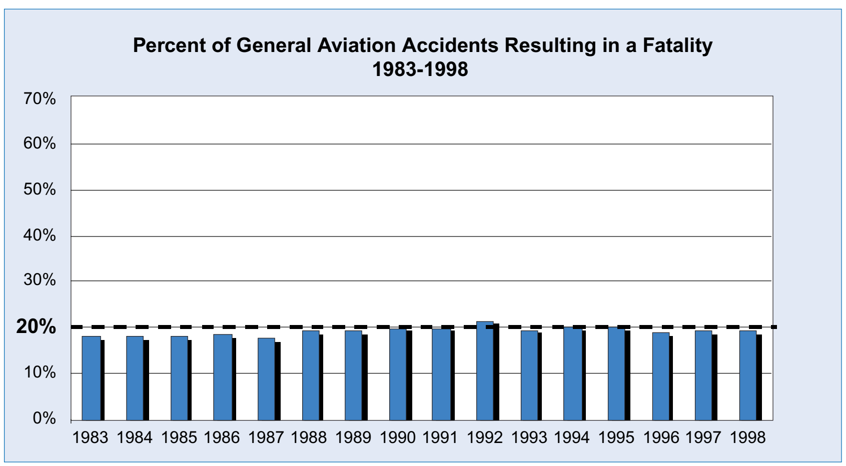
Note: due to the possibility of multiple findings, the sum of cause/factors is greater than the accident total.

General Aviation Safety Issues

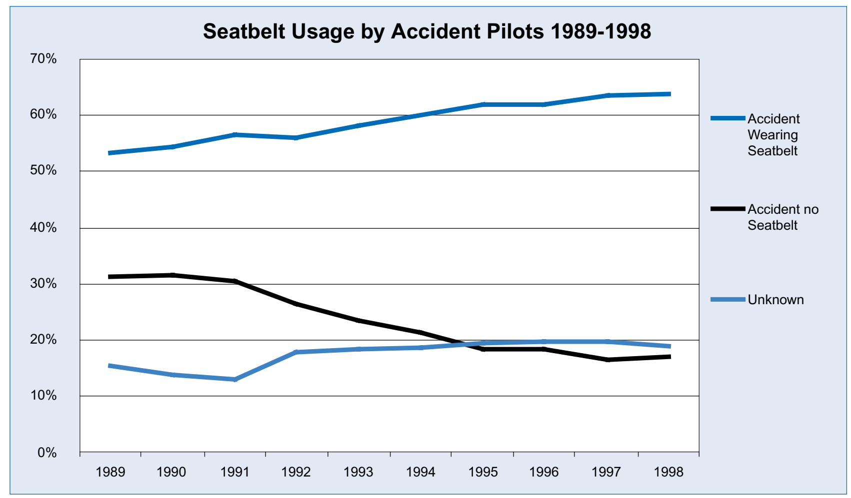
This section discusses several issues particularly relevant to general aviation safety. It is not meant to be an exhaustive discussion of all safety concerns, but rather a sample of the issues important to general aviation.

Survivability

Because of their relatively small size, low gross weight, and lower cost, most general aviation aircraft have not received some of the cabin safety enhancements available to larger commuter and transport-category aircraft. Examples of enhancements include fire suppression systems and improved fire retardant materials, redesigned restraint systems and seats, and improved impact-absorbing materials.[47] In addition, due to the high average age of the general aviation fleet—27 years—enhancements that have been made in recent years to newly manufactured aircraft have affected relatively few aircraft. As a potential consequence, the percentages of general aviation accidents resulting in a fatality have fluctuated only slightly since 1983, remaining at approximately 18-21% throughout the period.

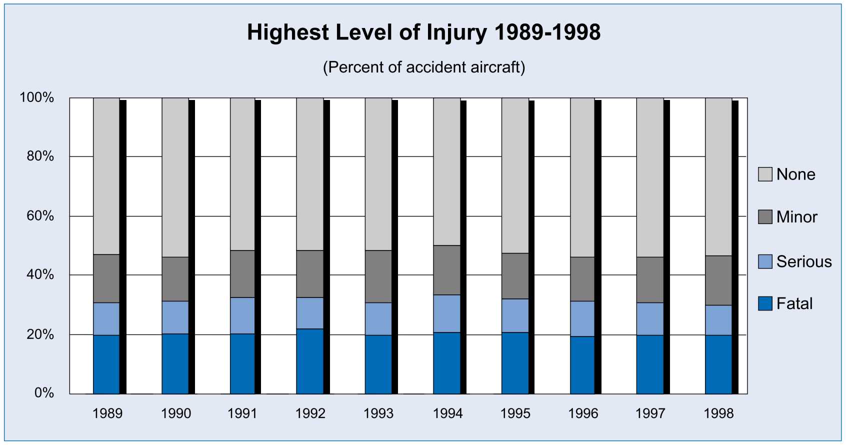


Pilot behaviors related to improving survivability of accidents have increased noticeably over the last 10 years. For example, the number of accident pilots who wear seatbelts has increased steadily since 1989, as the following graph shows.



[47] See 14 CFR 23.853 for passenger and crew interior compartment design requirement differences among normal, utility, acrobatic, and commuter aircraft categories.

However, despite the observable increase in seatbelt use by pilots over the last 10 years, the following graph illustrates that the distribution of accident injuries has not changed meaningfully since 1989.[48] This stability in injury and fatality rates despite changes in pilot behavior suggests 1) that a subset of accidents remains "unsurvivable," regardless of seatbelt and shoulder harness use, due to the speed and/or angle of impact,[49] and 2) that the severity of nonfatal accident injuries may depend upon aircraft cabin safety features that in most cases reflect the 27-year average age[50] of the general aviation fleet.



Aircraft-specific factors, such as size, weight, and speed, can contribute both directly and indirectly to the severity of accident injuries. Higher speed contributes directly to accident injury because it results in higher impact force.

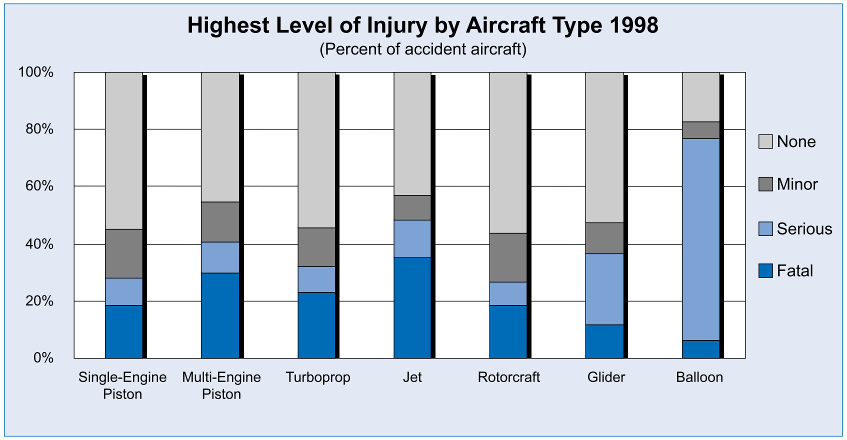
The size and weight of an aircraft can have an indirect effect on accident injury. Larger, heavier aircraft are typically not used for flight instruction, aerial application, and personal pleasure, and are not exposed to the same types of situations as smaller aircraft, nor are they involved in exactly the same types of accidents. At the same time, smaller, lighter aircraft may not have the same cabin safety features and fire suppression equipment as the larger aircraft. Because of these differences in design, construction, and typical operation, accident injury level can vary with the type of aircraft. Evidence for these differences is illustrated in the following graph, which shows the percentage of accidents by injury level for each aircraft type in 1998. For example, 17.9% of accidents in 1998 involving single-engine piston aircraft were fatal, compared to 34.8% of accidents involving jet aircraft. This does not suggest that jet aircraft are more dangerous than single-engine aircraft; rather, it is an indication of the circumstances of the accidents in which each type of aircraft is likely to be involved. Single-engine piston aircraft are more likely to be involved in accidents during takeoff and landing due to crosswinds or weather conditions than are the larger, heavier jet aircraft. These accidents are usually at low

[48] Increased seatbelt use may also reduce the number of injuries resulting from in-flight encounters with turbulence and/or weather, but these data are not currently available.

[49] See National Transportation Safety Board safety reports *General Aviation Crashworthiness Project, Phase One* NTSB/SR-83/01 (Washington, DC: NTSB, 1983), *Phase Two*, NTSB/SR-85/01, (Washington, DC: NTSB, 1985), and *Phase Three,* NTSB/SR-85/02 (Washington, DC: NTSB, 1985).

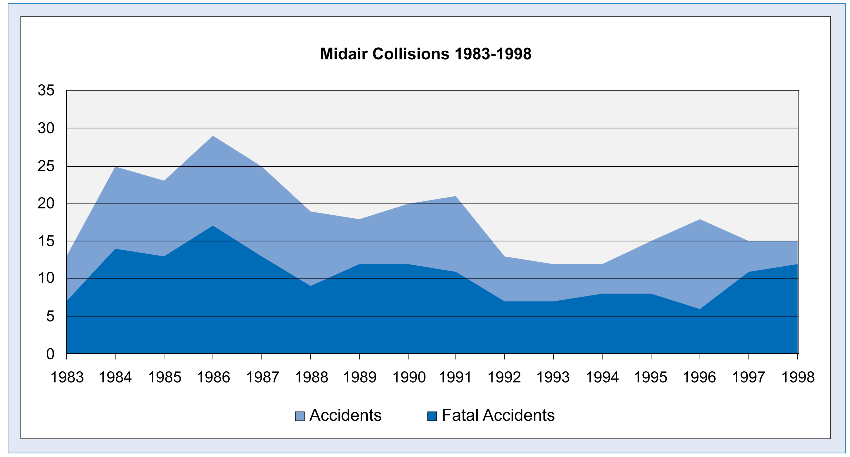
[50] GAMA, *General Aviation Statistical Databook*, 2001.

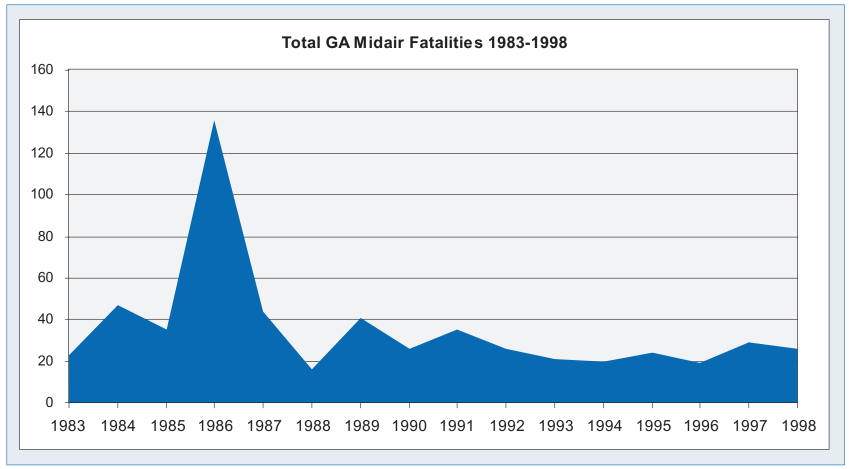
speeds and less likely to cause severe injury. In contrast, jet aircraft are larger and heavier and therefore less likely to be involved in accidents associated with crosswinds and wind gusts. However, any accidents in which jet aircraft are involved are likely to occur at higher speeds and are therefore likely to result in more severe injuries.



Midair Collisions

In 1998, 27 general aviation aircraft were involved in 15 midair collision accidents.[51] Twelve[52] of these accidents were fatal, resulting in a total of 26 deaths. The number of midair collisions in 1998 was unchanged from the previous year when 15 midair collisions occurred; of these accidents, 11 were fatal and resulted in 29 deaths. The number of midair collisions occurring annually has fluctuated between 1983 and 1998, with a general decline in the number of such accidents from a peak observed in 1986.



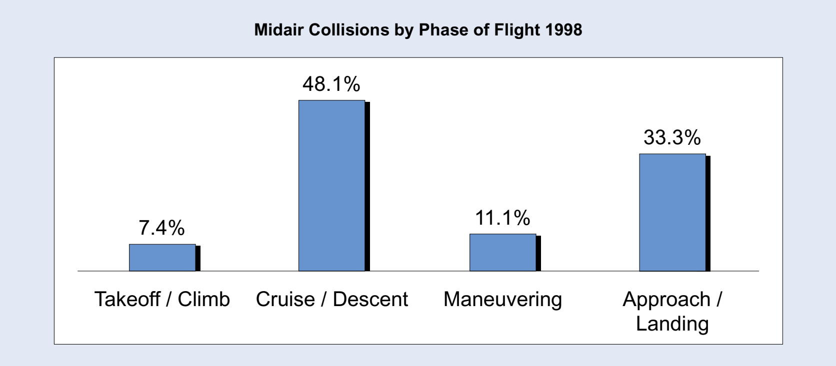


Of the 27 general aviation aircraft involved in midair collisions during 1998, 24 were airplanes, 2 were helicopters, and 1 was a glider. The highest percentage of aircraft involved in midair

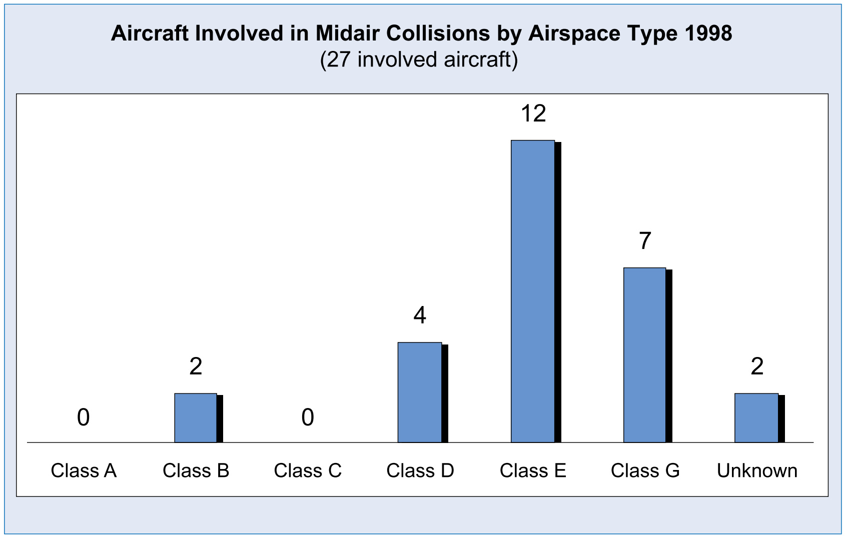
[51] A total of 30 aircraft were involved in 15 midair collisions. However, one of the aircraft involved was a military helicopter, and two were conducting Part 135 operations and are not included in this report.

[52] Of the aircraft involved in midair collisions, 21 had at least one fatality.

collisions was for aircraft in cruise flight, while one-third were in the approach/landing phase of flight. Of the nine aircraft involved in midair collisions during approach/landing, four were on the downwind segment of a VFR pattern and four were on final approach (14.8% each).



As illustrated in the following graph, two of the aircraft involved in midair collisions were in Class B airspace at the time, and four were in Class D[53] airspace. Class B and Class D are both examples of controlled airspace that require pilots to communicate with the ATC facility having jurisdiction for that area.[54] This suggests that these failures were not simply due to a lack of ATC services. Furthermore, all of the midair collisions in 1998 occurred in visual meteorological conditions and daylight conditions, suggesting that these failures to maintain aircraft separation were also not due to limited visibility.



Collisions with Terrain or Objects

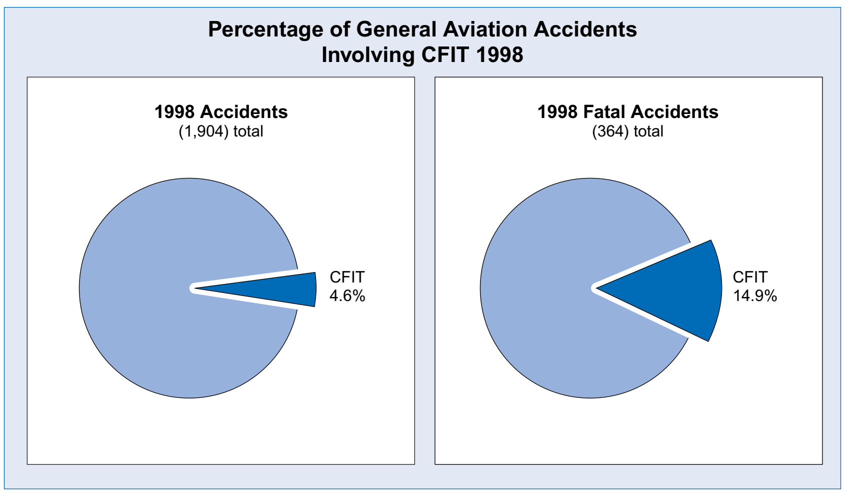
A unique group of accidents occurs when, during otherwise normal operations, an aircraft collides with terrain, water, or an obstacle with no indication of loss of control or engine failure. The phrase "controlled flight into terrain" (CFIT) is commonly used to refer to such accidents. Because of the variety of standards used to designate an accident as CFIT, and the ambiguity surrounding its definition, it is necessary to specify the standard being used when presenting CFIT data. The following accident data were derived using a working definition of CFIT that includes any accident involving an in-flight collision with terrain, water, or

[53] Airspace types are designated in 14 CFR 71. Also see Chapter 3, Sections 1 and 2, of the Aeronautical Information Manual for a detailed description of operating procedures and requirements of each class of airspace.

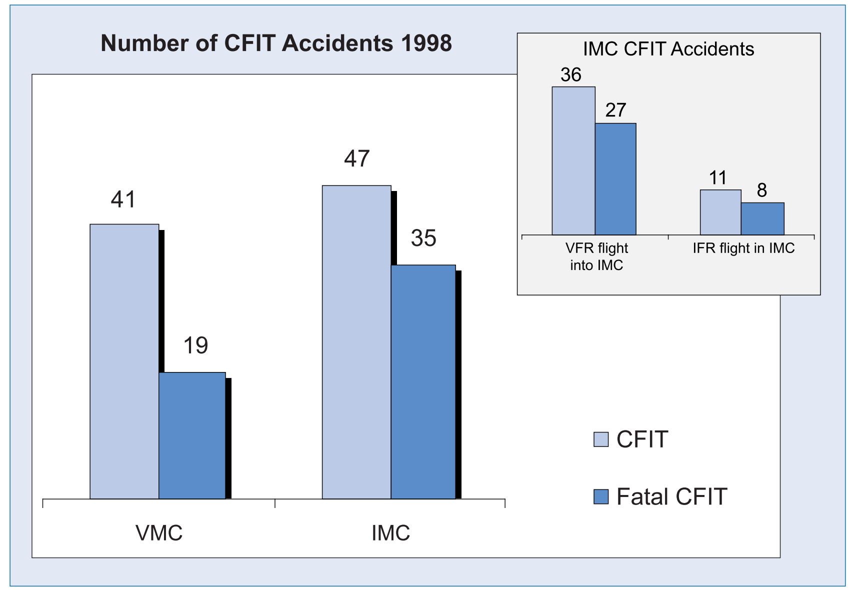
[54] Class B airspace extends from the surface to 10,000 feet mean sea level and is designated around the busiest airports. All aircraft must be granted an ATC clearance to operate in Class B airspace and are subject to minimum pilot qualification and aircraft equipment requirements. Class D airspace is designated around airports with an operating control tower and extends from the surface to 2,500 feet above the airport elevation. See 14 CFR 91.129 for rules governing aircraft operations in Class D airspace and 14 CFR 91.131 for rules governing aircraft operations in Class B airspace.

an object. The data do not include accidents resulting from a loss of aircraft control, including uncontrolled altitude deviations, any total or partial loss of engine power, or engine failure. Also excluded are accidents that result from a bird strike or that occur during intentional aerobatic or low-level maneuvers, during normal or aborted takeoffs, during maneuvers related to landing or takeoff emergencies, or on the runway.

In 1998, 88 general aviation accidents involved collision with terrain, water, or objects during controlled flight. Of those 88 accidents, 54 (61.3%) were fatal, in contrast to the 18 to 21% fatal accident rate observed in general aviation over the last 15 years. CFIT accidents accounted for only 4.6% of the total number of general aviation accidents in 1998, but 14.9% of the fatal accidents. Because of their nature, CFIT accidents typically result in severe injury and aircraft damage.



The following graph presents the number of CFIT accidents and fatal CFIT accidents that occurred in both instrument and visual meteorological weather conditions during 1998. The graph illustrates that most of these accidents, both fatal and non-fatal, occurred in IMC. The inset graph further illustrates that most of the CFIT accidents that occurred in IMC involved continued VFR flight into instrument conditions. In total, continued VFR flight into instrument conditions accounted for half of all fatal controlled flight crashes in 1998.



Weather as a Cause/Factor

Because general aviation aircraft are often smaller, slower, and limited in maximum altitude and range in comparison to transport-category aircraft, they can be more vulnerable than larger aircraft to hazards posed by weather. Smaller aircraft are affected to a greater degree by adverse wind conditions, and precipitation, icing, and convective weather have a greater effect on aircraft that lack the speed, altitude, and/or range capabilities to avoid those conditions. The weather conditions cited most often as a cause or factor in general aviation accidents are related to winds, including "crosswind," "gusts," and "tailwind." Of the top 10 causes/factors cited in general aviation accidents in 1998, 5 were related to wind. Aircraft are most susceptible to the effects of wind during takeoffs and landings, and the effect of adverse wind is reflected in the high percentage of general aviation accidents that occur during those phases of flight.

Weather As Cause / Factor 1998	Accidents
Crosswind	87
Gusts	75
Tailwind	46
Low Ceiling	41
High Density Altitude	37
Fog	29
Carburetor Icing Conditions	26
Clouds	23
High Wind	19
Downdraft	16
Obscuration	12
Sudden Windshift	12
Variable Wind	10
Icing Conditions	9
Rain	9
Turbulence	9
Unfavorable Wind	7
Snow	6
Windshear	6
Turbulence, Terrain Induced	6
Haze/Smoke	4
No Thermal Lift	4
Mountain Wave	3
Thunderstorm	3
Drizzle/Mist	3
Turbulence, Clear Air	2
Turbulence In Clouds	2
Turbulence (Thunderstorms)	2
Freezing Rain	2
Whiteout	1
Updraft	1
Microburst/Dry	1
Dust Devil/Whirlwind	1

Just as most landing accidents do not result in fatal injuries, most wind-related accidents are also not fatal. Among fatal general aviation accidents, the most frequently cited weather factors are related to conditions that result in reduced visibility, including "low ceiling," "fog," and "clouds." Accidents under conditions of low visibility may include pilot disorientation, loss of control, or collision with obscured obstacles or terrain, all of which are likely to result in severe accidents.

Weather As Cause / Factor 1998	Fatal Accidents	Fatalities
Low Ceiling	33	55
Fog	22	32
Clouds	17	37
High Density Altitude	8	19
Obscuration	8	11
Gusts	7	14
Rain	7	11
Tailwind	6	12
Icing Conditions	5	11
Snow	5	8
Turbulence, Terrain Induced	4	6
Turbulence	3	4
High Wind	2	3
Windshear	2	2
Haze/Smoke	2	5
Thunderstorm	2	4
Drizzle/Mist	2	3
Turbulence In Clouds	2	2
Turbulence (Thunderstorms)	2	6
Freezing Rain	2	2
Crosswind	1	2
Carburetor Icing Conditions	1	1
Downdraft	1	2
Sudden Winshift	1	1
Mountain Wave	1	1
Turbulence, Clear Air	1	1
Variable Wind	0	0
Unfavorable Wind	0	0
No Thermal Lift	0	0
Whiteout	0	0
Updraft	0	0
Microburst/Dry	0	0
Dust Devil/Whirlwind	0	0

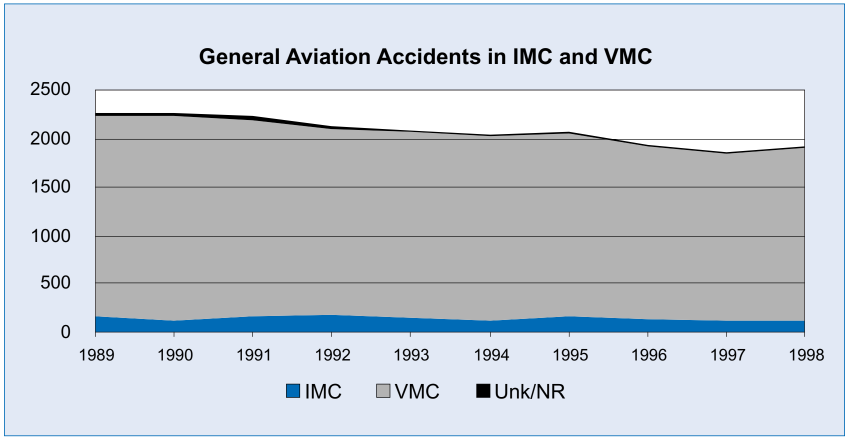
Because of the number of fatal general aviation accidents each year citing visibility-limiting weather phenomena like clouds, haze, fog, and mist as a cause or factor, the special topic chosen for 1998 is instrument meteorological conditions. The following section discusses the issues associated with general aviation accidents that occur in IMC in greater detail.

Special Topic

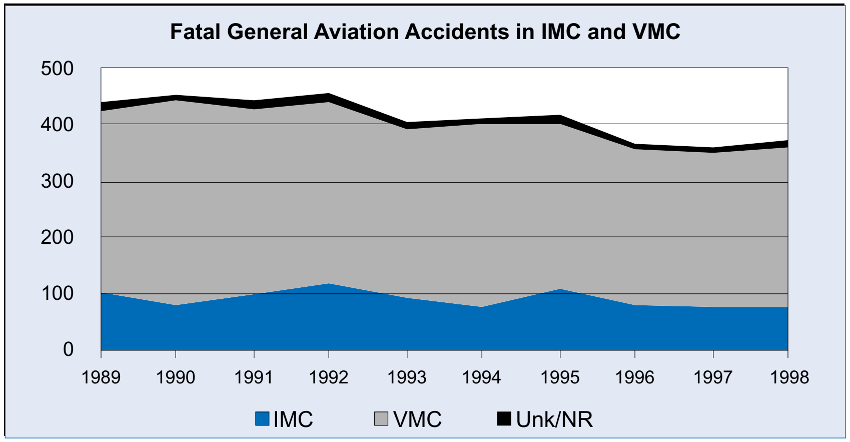
Accidents in Instrument Meteorological Conditions

According to the FAA Pilot/Controller Glossary, "instrument meteorological conditions" are defined as "Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling less than the minima[55] specified for Visual Meteorological Conditions (VMC)." In many cases, general aviation flight minima are 3 statute miles flight visibility and 1,000 feet above, 500 feet below, and 2,000 feet distance from clouds.

As the next graph shows, more general aviation accidents occur during VMC than during IMC. Over the 10-year period from 1989 to 1998, accidents in IMC accounted for 6.8% of all general aviation accidents. In 1998, the 116 general aviation accidents that occurred in IMC comprised 6.0% of the total accidents. Although this proportion may simply reflect general aviation activity in VMC and IMC, information regarding flight hours by meteorological condition is not available to support this conclusion.

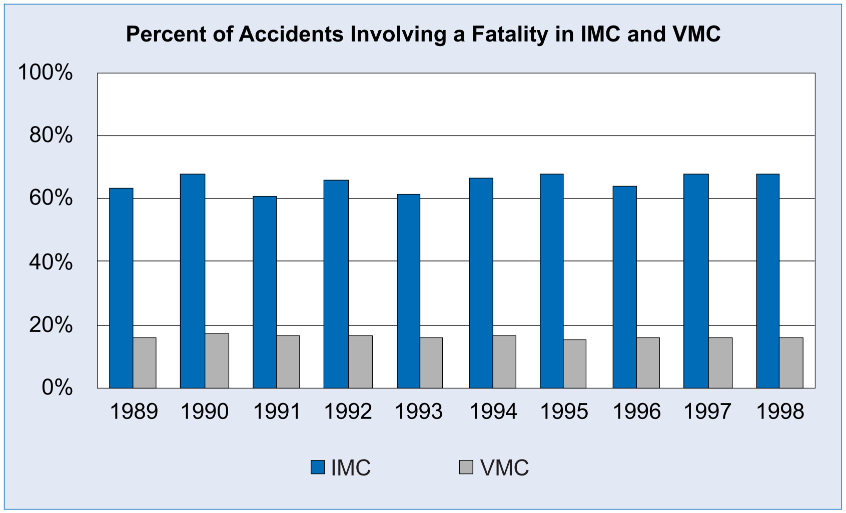


Although accidents in IMC make up a relatively small proportion of all general aviation accidents, they represent a larger percentage of fatal accidents. Over the 10-year period from 1989 to 1998, accidents in IMC accounted for 22.3% of fatal general aviation accidents. In 1998, 79 fatal IMC accidents accounted for 21.2% of all fatal general aviation accidents.

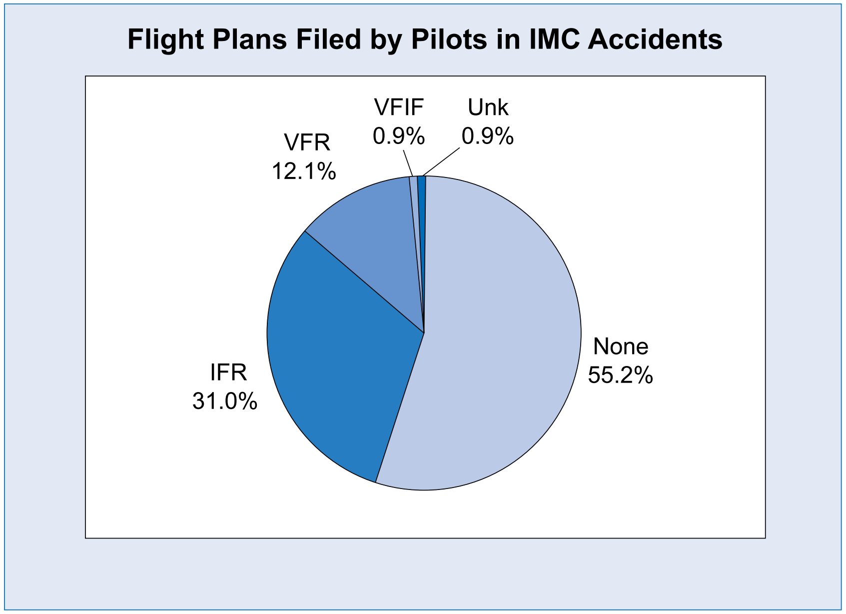


[55] Minima for visual meteorological conditions are specified in 14 CFR 91.155.

Correspondingly, accidents in IMC are much more likely to involve a fatality than accidents in VMC. On average, 65.4% of all IMC accidents between 1989 and 1998 involved a fatality as opposed to 16.0% of VMC accidents. In 1998, 68.1% of IMC accidents involved a fatality as compared to 15.7% of VMC accidents.



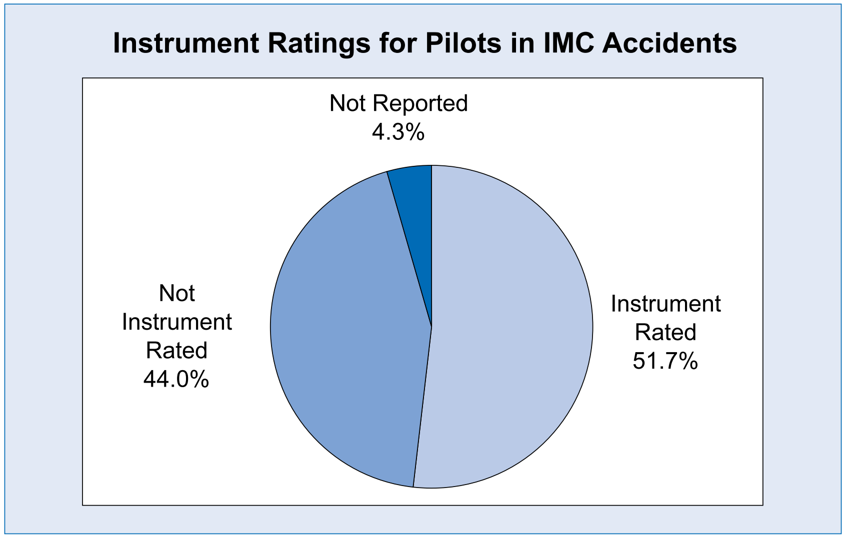
An IFR flight plan is required to fly in IMC;[56] however, in 1998, only 36 of 116 pilots involved in IMC accidents had filed an IFR flight plan.[57] In 64 accidents (55.2%), no flight plan had been filed, and in 14 cases (12.1%), only a VFR flight plan had been filed. This suggests that most pilots in these accidents were unaware of the possibility and/or risk of flight into IMC.



Although few pilots involved in accidents in IMC had filed an IFR flight plan, it is possible that they were flying by reference to their instruments at the time of the accident. However, the following chart indicates that only 60 (51.7%) of the 116 pilots involved in accidents in IMC had current instrument ratings.

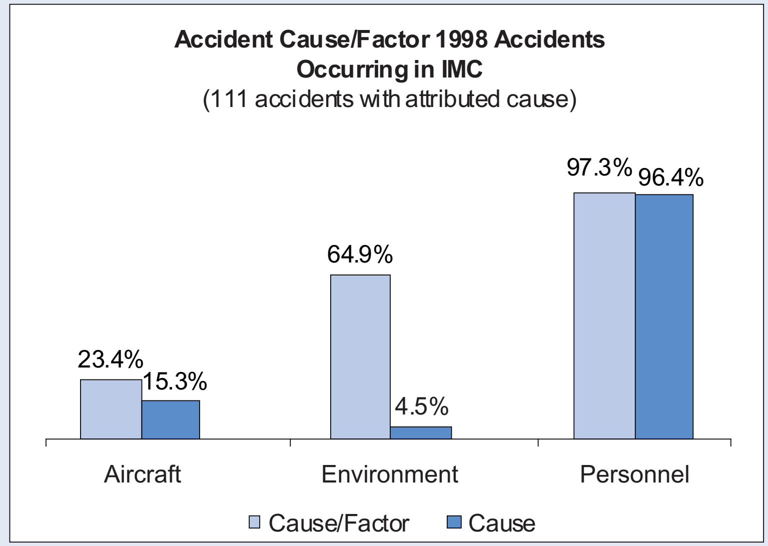
[56] Title 14 CFR 91.173 states, "No person may operate an aircraft in controlled airspace under IFR unless that person has (a) Filed an IFR flight plan; and (b) Received an appropriate ATC clearance."

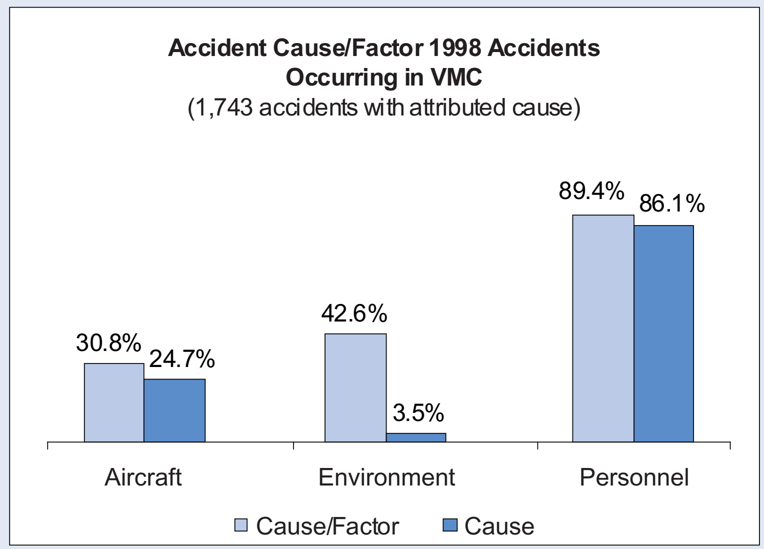
[57] One of these pilots had filed a VFIF flight plan, which is a combination IFR/VFR flight plan.



Furthermore, among the 74 pilots who filed a VFR flight plan or who had filed no flight plan, only 32.4% were instrument rated. This suggests that many pilots involved in accidents in IMC are not qualified for this type of flight.

The following graphs summarize the broad causes and factors of 1998 general aviation accidents occurring in IMC and in VMC.[58] As one might expect, accidents that occurred in IMC were more likely to have environment-related causes/factors. In addition, although IMC accidents were less likely to be attributed to aircraft-related causes/factors, they were more likely to be attributed to personnel-related causes/factors. Finally, for both IMC and VMC, personnel and aircraft-related issues were more likely to be reported as *causes* of accidents, and environmental issues were far more frequently listed as *factors* (that is, *contributing* factors).

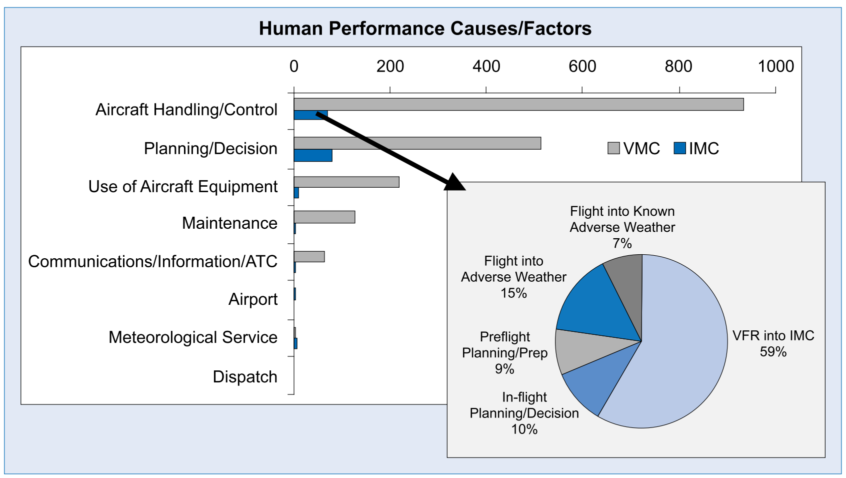




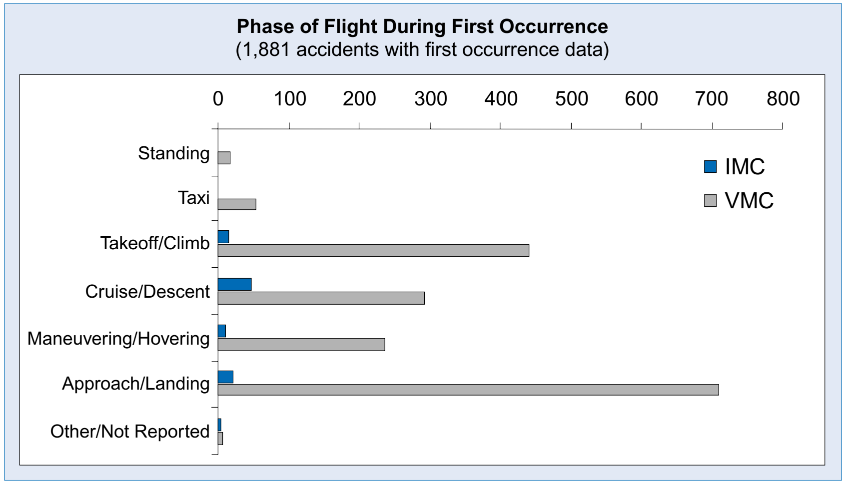
[58] Of the 1,924 general aviation accidents that occurred in IMC, causal attribution and IMC/VMC data are available for 1,854.

A total of 1,560 general aviation accidents that occurred in VMC or IMC had at least one cause or factor attributed to human performance. Because multiple causes/factors may be attributed in a single accident, the total number of human performance attributions within this group was 2,043.

Aircraft handling/control was the most frequently cited cause/factor within the human performance category; however, although it accounted for 49.9% of causes/factors in VMC accidents, handling/control was listed in only 38.6% in IMC accidents. Conversely, planning and decision-making accounted for 27.6% of the causes/factors in VMC and 45.5% in IMC. This finding is not surprising given that many pilots who had accidents in IMC did not file an IFR flight plan. This is further supported by the types of planning and decision-making factors listed within this group, which included "VFR flight into IMC" and other decisions prior to and during the flight that led to flight into adverse weather.

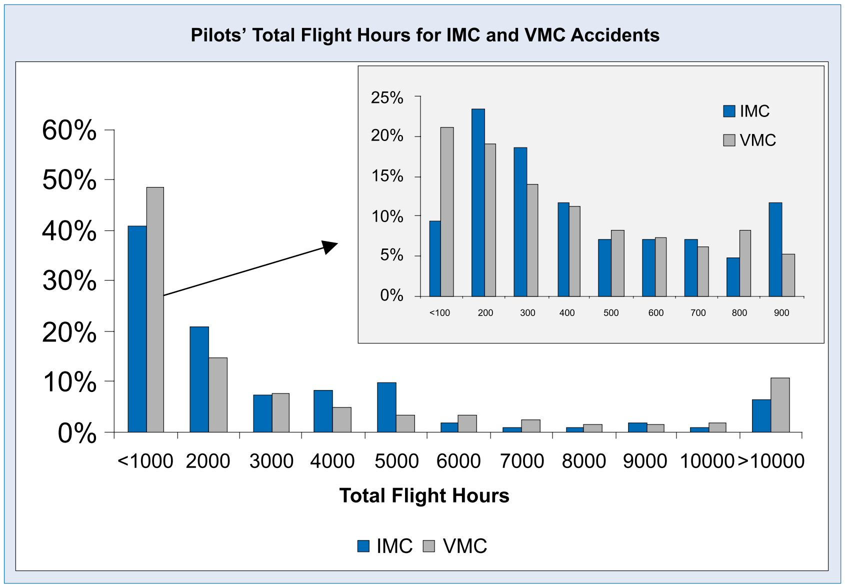


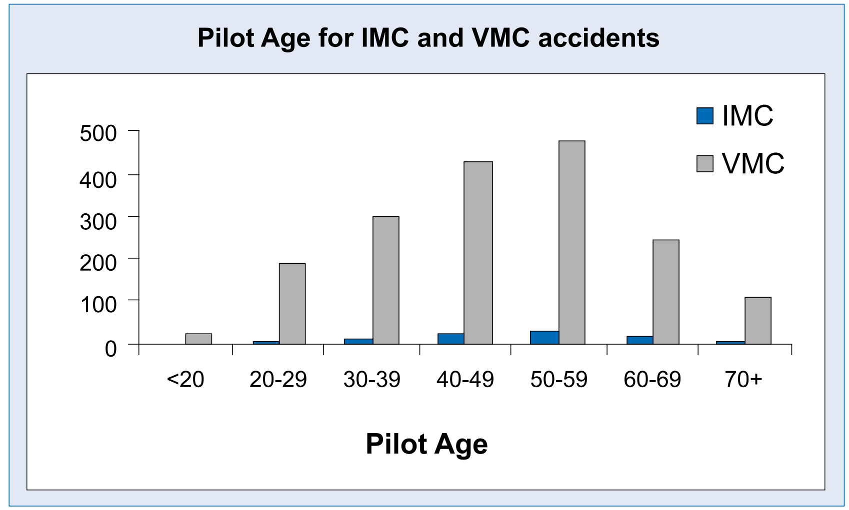
The phase of flight during which the first accident occurrence took place may provide some insight into the planning and decision-making processes of accident pilots. Although most accidents tend to occur during takeoff and landing, IMC accidents do not follow this trend. For this group, the largest proportion of first occurrences (45.0%) took place during the cruise/descent portion of flight, suggesting that pilots may not be aware of upcoming weather/visibility conditions or that those conditions may have changed during the flight.



[59] An attempt was made to investigate pilots' experience with instrument flight; however, these data were not available in enough cases to permit this analysis.

One possible explanation for pilots' lack of awareness regarding the risks of flying in IMC may relate to their lack of flight experience. However, as shown in the following charts, the distinction between IMC and VMC accident pilots is not clear regarding total flight experience[59] or pilot age. However, unsurprisingly, a larger proportion of brand-new pilots (that is, those with fewer than 100 flight hours) are involved in VMC accidents, probably because pilots spend their first flights in VMC. In terms of pilot age, pilots involved in accidents in IMC and VMC had similar age distributions.





In summary, Safety Board aviation accident data confirm that, although most general aviation accidents occur during VMC, IMC accidents are far more likely to include a fatality. A closer look revealed that most pilots involved in IMC accidents had not filed a VFR flight plan and only about half had current instrument ratings.

As expected, accidents that occurred in IMC were more likely than those that occurred in VMC to be linked to environmental factors. However, environmental events were rarely identified as causal to accidents in either group. Rather, for both groups, most causes were personnel-related. Within the subgroup of human performance issues, accidents in VMC were most frequently associated with aircraft handling/control issues, and IMC accidents were most often related to planning and decision-making. This might suggest that pilots involved in accidents in IMC lacked flight experience. However, analyses of age and total flight hours data did not clearly support this theory.

Appendix A

Definitions

Definitions of Safety Board Severity Classifications

The severity of a general aviation accident is classified by the highest level of injury (that is, fatal, serious, minor, or none) and level of aircraft damage (that is, destroyed, substantial, minor, or none).

Definitions for Highest Level of Injury

Fatal - Any injury that results in death within 30 days of the accident.

Serious - Any injury that (1) requires the individual to be hospitalized for more than 48 hours, commencing within 7 days from the date the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burns affecting more than 5% of the body surface.

Minor - Any injury that is neither fatal nor serious.

None - No injury.

Definitions for Level of Aircraft Damage

Destroyed - Damage due to impact, fire, or in-flight failures to the extent that the aircraft cannot be repaired economically.[60]

Substantial Damage - Damage or failure that adversely affects the structural strength, performance, or flight characteristics of the aircraft and that would normally require major repair or replacement of the affected component. Engine failure or damage limited to an engine if only one engine fails or is damaged, bent fairings or cowling, dented skin, small puncture holes in the skin or fabric, ground damage to rotor or propeller blades, and damage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wingtips are not considered "substantial damage."[61]

Minor Damage – Any damage that neither destroys the aircraft nor causes substantial damage (see definition of substantial damage for details).

None – No damage.

[60] Title 49 CFR 830.2 does not define "destroyed." This term is difficult to define because aircraft are sometimes rebuilt even when it is not economical to do so.

[61] See 49 CFR 830.2.

Appendix B

The National Transportation Safety Board Investigative Process

The National Transportation Safety Board investigates every civil aviation accident that occurs in the United States. It also provides investigators to serve as U.S.-Accredited Representatives as specified in international treaties for aviation accidents overseas involving U.S.-registered aircraft or involving aircraft or major components of U.S. manufacture.[62] Investigations are conducted from Safety Board Headquarters in Washington, D.C., or from one of the 10 regional offices in the United States (see Appendix D).

In determining probable cause(s) of an accident, investigators consider facts, conditions, and circumstances. The objective is to ascertain those cause and effect relationships in the accident sequence about which something can be done to prevent recurrence of the type of accident under consideration.

Note the distinction between the population of accidents investigated by the Safety Board and those that are included in the *Annual Review of Aircraft Accident Data, U.S. General Aviation*. Although the Safety Board is mandated by Congress to investigate all civil aviation accidents that occur on U.S. soil (including those involving both domestic and foreign operators), the *Annual Review* describes accidents that occurred among U.S.-registered aircraft in all parts of the world.

[62] For more detailed information about the criteria for Safety Board investigation of an aviation accident or incident, see 49 CFR 831.2.

Appendix C

The National Transportation Safety Board Aviation Accident/Incident Database

The National Transportation Safety Board is responsible for maintaining the government's database on civil aviation accidents. The Safety Board's Accident/Incident Database is the official repository of aviation accident data and causal factors. The database was established in 1962 and approximately 2,000 new event records are added each year.

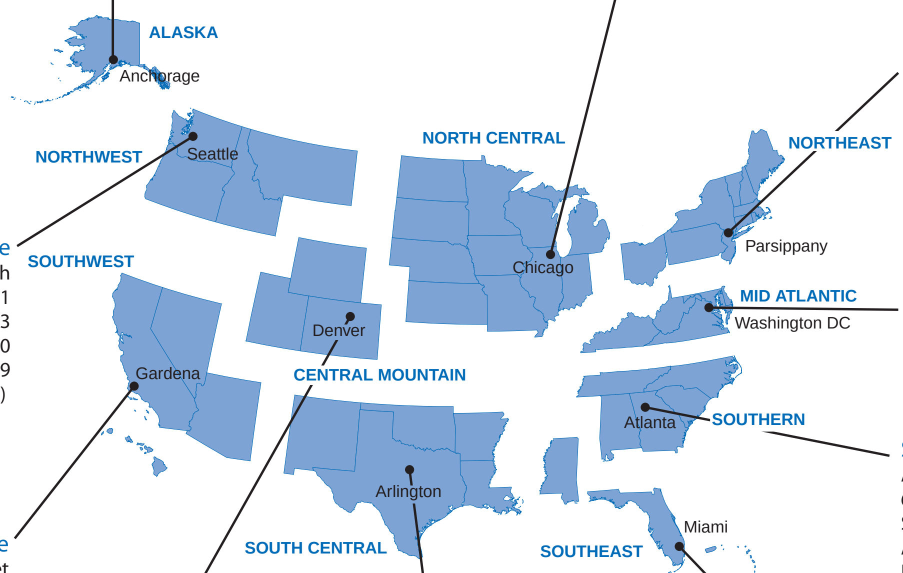
The Accident/Incident Database is primarily composed of aircraft accidents. An "accident" is defined in 49 CFR 830.2 as "an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage." The database also contains a select number of aviation "incidents," defined in 49 CFR 830.2 as "occurrences other than accidents that are associated with the operation of an aircraft and that affect or could affect the safety of operations."

Accident investigators use the Safety Board's Accident Data Management System (ADMS) software to enter data into the Accident/Incident Database. Shortly after the event, a preliminary report containing a few data elements, such as date, location, aircraft operator, type of aircraft, etc., becomes available. A factual report with additional information concerning the occurrence is available within a few months. A final report, which includes a statement of the probable cause and other contributing factors, may not be completed for months after the investigation has been completed.

An accident-based relational database is currently available to the public at http://www.ntsb.gov/ntsb/query.asp#query_start. It contains records of approximately 40,000 accidents and incidents that occurred between 1982 and the present. Each record may contain more than 650 fields of data concerning the aircraft, event, engines, injuries, sequence of accident events, and other topics. Individual data files are also available for download at ftp://www.ntsb.gov/avdata, including one complete data set for each year beginning with 1982. The data files are in Microsoft Access (.mdb) format and are updated monthly. This download site also provides weekly "change" updates and complete documentation.

Appendix D

National Transportation Safety Board Regional Offices[1]



Alaska Regional Office
222 West 7th Avenue
Room 216, Box 11
Anchorage, Alaska 99513
Phone: 907-271-5001
FAX: 907-271-3007
8 a.m.-4:30 p.m (Alaska)

North Central Regional Office
31 West 775 North Avenue
West Chicago, Illinois 60185
Phone: 630-377-8177
FAX: 630-377-8172
7:30 a.m.-4 p.m. (Central)

Northeast Regional Office
2001 Route 46
Suite 504
Parsippany, New Jersey 07054
Phone: 973-334-6420
FAX: 973-334-6759
8:30 a.m.-5 p.m. (Eastern)

Northwest Regional Office
19518 Pacific Highway South
Room 201
Seattle, Washington 98188-5493
Phone: 206-870-2200
FAX: 206-870-2219
8 a.m.-4:30 p.m (Pacific)

Mid-Atlantic Regional Office
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594
Phone: 202-314-6320
FAX: 202-314-6329
8:30 a.m.-5 p.m. (Eastern)

Southwest Regional Office
1515 W. 190th Street
Suite 555
Gardena, California 90248
Phone: 310-380-5660
FAX: 310-380-5666
7 a.m.-3:30 p.m. (Pacific)

Southern Regional Office
Atlanta Federal Center
60 Forsyth Street, SW
Suite 3M25
Atlanta, Georgia 30303-3104
Phone: 404-562-1666
FAX: 404-562-1674
8 a.m.-4:30 p.m. (Eastern)

Central Mountain Regional Office
4760 Oakland Street
Suite 500
Denver, Colorado 80239
Phone: 303-361-0600
FAX: 303-361-0619
7:30 a.m.-4 p.m (Mountain)

South Central Regional Office
624 Six Flags Drive
Suite 150
Arlington, Texas 76011
Phone: 817-652-7800
FAX: 817-652-7803
7:30 a.m.-4 p.m. (Central)

Southeast Regional Office
8405 N.W. 53rd Street
Suite B-103
Miami, Florida 33166
Phone: 305-597-4610
FAX: 305-597-4614
8 a.m.-4:30 p.m. (Eastern)

[1] As of FY 2003