NTSB/ARG-06/01
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Annual Review of Aircraft Accident Data

U.S. General Aviation, Calendar Year 2001

National
Transportation
Safety Board
Washington, D.C.

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National Transportation Safety Board
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

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Abstract: The National Transportation Safety Board's 2001 Annual Review of Aircraft Accident Data for U.S. General Aviation is a statistical compilation and review of general aviation accidents that occurred in 2001 involving U.S.-registered aircraft. As a summary of all U.S. general aviation accidents for 2001, the review is designed to inform general aviation pilots and their passengers and to provide detailed information to support future government, industry, and private research efforts and safety improvement initiatives.

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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2001 General Aviation Accident Summary

A total of 1,727 general aviation accidents occurred during calendar year 2001, involving 1,749 aircraft.[1] The total number of general aviation accidents in 2001 was lower than in 2000, with a 6% decrease of 110 accidents. Of the total number of accidents, 325 were fatal, resulting in a total of 562 fatalities. The number of fatal general aviation accidents in 2001 decreased 6% from calendar year 2000, and the total number of fatalities that resulted also decreased by 6%. The circumstances of these accidents and details related to the aircraft, pilots, and locations are presented throughout this review.

2001 General Aviation Accident Statistics

General Aviation Accidents	
Total	1,727
Fatal	325
General Aviation Accident Injuries	
Minor	493
Serious	321
Fatal	562
Persons involved in GA accidents with no injuries	1,849
General Aviation Accident Rate	
General Aviation Hours Flown [a]	25,431,000
All Accidents	6.78/100,000 hours
Fatal Accidents	1.27/100,000 hours
Accidents per Pilot	2.82/1,000 active pilots
Fatal Accidents per Pilot	0.53/1,000 active pilots

[a] Federal Aviation Administration, *General Aviation and Air Taxi Survey, 2001*.

[1] In this review, a collision between two aircraft is counted as a single accident. The 7 midair collision accidents that occurred in 2001 involved 14 general aviation aircraft. In addition, 14 ground collision accidents involved 28 general aviation aircraft.

Introduction

Purpose of the *Review*

The National Transportation Safety Board's *2001 Annual Review of Aircraft Accident Data for U.S. General Aviation* is a statistical compilation and review of general aviation accidents that occurred in 2001 involving U.S.-registered aircraft. As a summary of all U.S. general aviation accidents for 2001, the review is designed to inform general aviation pilots and their passengers and to provide detailed information to support future government, industry, and private research efforts and safety improvement initiatives.

The Safety Board drew on several resources in compiling data for this review. Accident data, for example, were extracted from the Safety Board's Aviation Accident/Incident Database.[2] Activity data were extracted from the *General Aviation and Air Taxi Activity Survey (GAATA Survey)*[3] and from *U.S. Civil Airmen Statistics,*[4] 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 Statistical Databook*, published by the General Aviation Manufacturers Association (GAMA).

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.[5]

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 public aircraft[6] flights that do not involve military or intelligence agencies. Aircraft operating under Part 91 include aircraft that are flown for recreation and personal transportation and certain aircraft operations that are flown with the intention of generating revenue,[7] including business flying, flight instruction, corporate/executive flights, positioning or ferry flights, aerial application, pipeline/powerline patrols, and news and traffic reporting.

[2] See Appendix A for more details.

[3] Although included in the *GAATA Survey*, data associated with air taxi and air tour operations are not included in this review.

[4] FAA, *U.S. Civil Airmen Statistics*, 2001, available online at <http://www.faa.gov/data_statistics/aviation_data_statistics/civil_airmen_statistics/>.

[5] For a review of accident statistics related to air carrier operations, see National Transportation Safety Board, *Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, Calendar Year 2001* (Washington, DC: 2005), available at <http://www.ntsb.gov>.

[6] Although the precise statutory definition has changed over the years, public aircraft operations for Safety Board purposes 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.

[7] See 14 CFR 119.1.

Which Aircraft Are Included in this Review?

General aviation operations are conducted using a wide range of aircraft, including airplanes, rotorcraft, gliders, balloons and blimps, and registered ultralight, experimental, or amateur-built aircraft. The diverse set of operations and aircraft types included within the scope of general aviation must be considered when interpreting the data in this review. The type of aircraft being flown is usually closely related to the type of flight operation being conducted. Jet and turboprop aircraft are commonly used for corporate/executive transportation, smaller single-engine piston aircraft are commonly used for instructional flights, and a variety of aircraft types are used for personal and business flights.

Not included in this review are any accident data associated with aircraft operating under 14 CFR Parts 121, 129, or 135, such as scheduled Part 121 air carrier operations, Part 129 foreign air carrier operations, scheduled Part 135 air carrier operations (commuters), and on-demand Part 135 air carrier operations (air taxis). Also not included are data for military or intelligence agencies, non-U.S.-registered aircraft, unregistered ultralights, and commercial space launches, unless the accident also involved aircraft conducting general aviation operations. Crashes involving illegal operations, stolen aircraft, suicide, or sabotage are included in the accident total, but not in accident rates.[8]

Organization of the Review

The 2001 Annual Review is organized into four parts.

1. The first part summarizes general aviation accident statistics for 2001, economic and industry markers related to general aviation activity in 2001, and contextual statistics from previous years.
2. The second part investigates trends over the past 10 years and provides context for such accident information as operation types, levels of aircraft damage, and injuries.
3. The third part focuses on specific circumstances of accidents that occurred during 2001. This section describes accident occurrences and summarizes the Safety Board's findings of probable cause and contributing factors.
4. The fourth and final section presents in-depth coverage of a special topic important to general aviation safety. The *2001 Annual Review* focuses on loss of control, which has historically accounted for the largest number of accidents.

Graphics are used to present much of the information in this review. For readers who wish to view tabular data or to manipulate the data used in this review, the data set is available online at < http://www.ntsb.gov/aviation/Stats.htm>.

[8] In 2001, one accident was attributed to pilot suicide and two accidents resulted from stolen or unauthorized use of aircraft.

The General Aviation Environment in 2001

General Economic and Aviation Industry Indicators

A theme that is repeated throughout this review is that general aviation accident numbers should be interpreted in light of related information, such as aircraft type, type of operation, and operating environment. Because personal and business flying account for the largest percentage of general aviation flying, prevailing economic conditions and/or trends may noticeably affect both the general aviation industry and flight operations.

U.S. industrial and personal incomes grew steadily from 1980 through 2001. Between 1990 and 2001, the U.S. resident population increased almost 15%, the gross domestic product rose by 39%, and disposable personal income per capita rose by 21%.

General Economic and Aviation Industry Indicators, 1980-2001

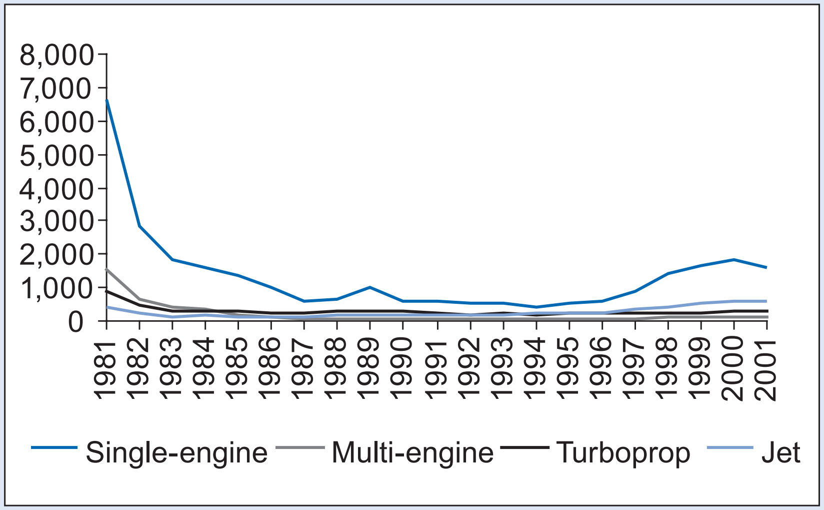
	1980	1990	2001
Resident Population (Millions)[a]	226.5	248.8	285.1
Gross Domestic Product (Billions)[b]	$5,162	$7,112	$9,891
Disposable Personal Income (Billions)[c]	$3,858	$5,324	$7,333
Disposable Personal Income Per Capita[c]	$16,940	$21,281	$25,698
Number of GA Aircraft Sold[d]	11,877	1,144	2,634
Net Factory Billings for GA Aircraft (Millions)[d]	$2,486	$2,008	$8,641
Value of New GA Aircraft Sold: Piston (Millions)[d]	$794	$92	$471
Value of New GA Aircraft Sold: Turbine (Millions)[d]	$1,691	$1,916	$8,170

[a]U.S. Bureau of Transportation Statistics; data are available at http://www.bts.gov/publications/national_transportation_statistics/2005/html/table_a.html
[b]Bureau of Economic Analysis, real gross domestic product, using chained 2000 dollars; data are available at http://www.bea.doc.gov/bea/dn/gdplev.xls.
[c]Bureau of Economic Analysis, chained 2000 dollars; data are available at http://www.bea.gov/bea/dn/nipaweb/.
[d]General Aviation Manufacturers Association, General Aviation Statistical Databook , 2004. Washington, D.C.

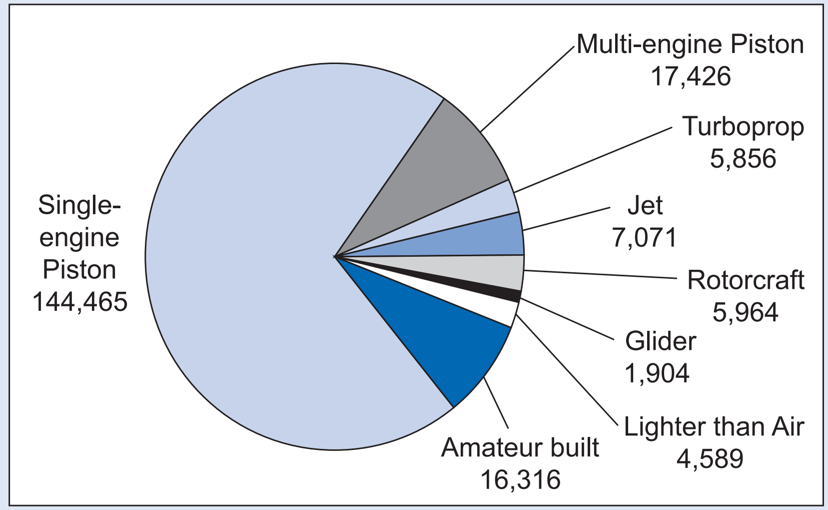
Economic indicators for the general aviation industry either declined or remained generally steady between 1980 and the mid-1990s. Production and sale of light piston aircraft, which account for most of the general aviation fleet, decreased substantially during these years from more than 10,750 in 1980 to about 500 in 1994. The total number of new general aviation aircraft shipped in 1994 was about 7% of the number shipped in 1980. By 2001, general aviation industry indicators had increased noticeably. Aircraft shipments nearly tripled between 1995 and 2001, and the percent increase in net factory billings between 1995 and 2001 was equal to the total increase observed over the previous 20 years. This rapid growth was likely motivated by a combination of generally favorable economic conditions and increased general aviation aircraft production following the 1994 passage of the General Aviation Revitalization Act[9] limiting manufacturer liability.

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

Annual Shipments of U.S.-Manufactured General Aviation Aircraft, 1981-2001



Number of Active Aircraft in General Aviation, 2001



Fleet Makeup

Although sales of new general aviation aircraft increased noticeably after the mid-1990s, most general aviation aircraft in use in 2001 were more than 25 years old. U.S. manufacturers delivered 2,634 new general aviation aircraft in 2001, compared to an estimated total of 207,400 already in service. Single-engine piston aircraft currently have the highest average age of all general aviation aircraft types and account for the largest percentage of the general aviation fleet. As a consequence, any structural or design improvements incorporated into newly manufactured aircraft may not be reflected in the accident record for several years. The safety benefits of improved equipment, such as avionics and aircraft equipment, are also difficult to track because most new equipment is also available for installation in older aircraft.

Category	Engine-type	Seats	Average Age
Single-engine	**Piston**	1-3	28
		4	32
		5-7	25
		8+	43
	Turboprop	all	10
	Jet	all	27
Multi-engine	**Piston**	1-3	21
		4	28
		5-7	31
		8+	30
	Turboprop	all	19
	Jet	all	16
All Aircraft			**27**

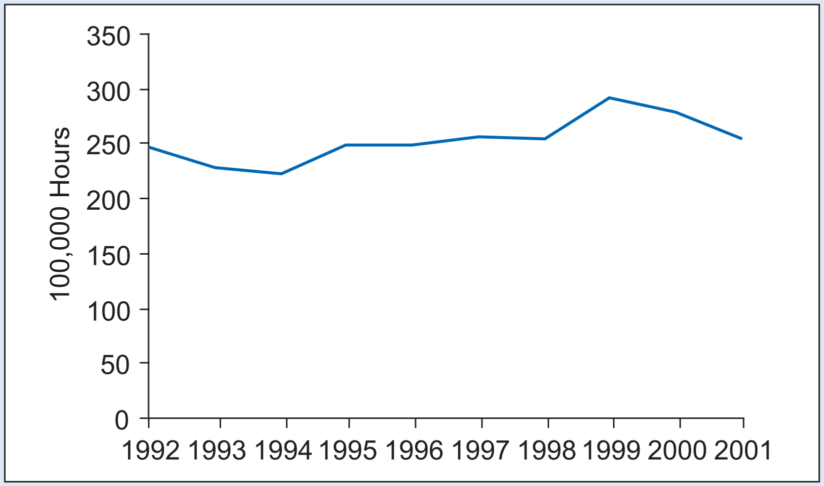
GAMA, General Aviation Statistical Databook, 2001

General Aviation Activity

Because general aviation includes such a diverse group of aircraft types and operations, some measure of exposure must be considered to make meaningful comparisons of accident numbers. Flight activity is typically used to normalize accident numbers across different groups, with the level of activity corresponding to the level of exposure to potential accident risk. Total flight hours, departures, and miles flown are common indicators used to measure activity. As the graph shows, annual general aviation flight hour estimates began to increase in 1994 after a decline during the preceding years. In 2001, the estimated number of general aviation flight hours was 25.4 million, down 9% from 2000.[10]

It should be noted that activity data for general aviation are far less reliable than data available for commercial air carriers. 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),[11] 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*.[12] *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 on-demand Part 135 aircraft. General aviation activity data are considered less reliable because a limited sample[13] of aircraft is selected from the registry of aircraft owners for use in the *GAATA Survey*, and reporting is not required.

Number of General Aviation Hours Flown Annually, 1992-2001



In addition, specific general aviation activity data could not be calculated in many cases because the survey data represented an aggregate of all aircraft activity, including on-demand Part 135 operations (which are not included in this review of general aviation accidents). Such aggregate data included the number of landings, flight hours by state or region, and flight hours by day/night or weather conditions. For this review, therefore, general aviation activity measures were determined by subtracting on-demand Part 135 data from activity totals whenever possible. Such data are not included in this review.

[10] The decrease in flight hours in 2001 was partly due to decreased flight activity following the events of September 11, 2001. For about 20 days after September 11, many flight operations, including air carriers, were suspended and gradually re-introduced.

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

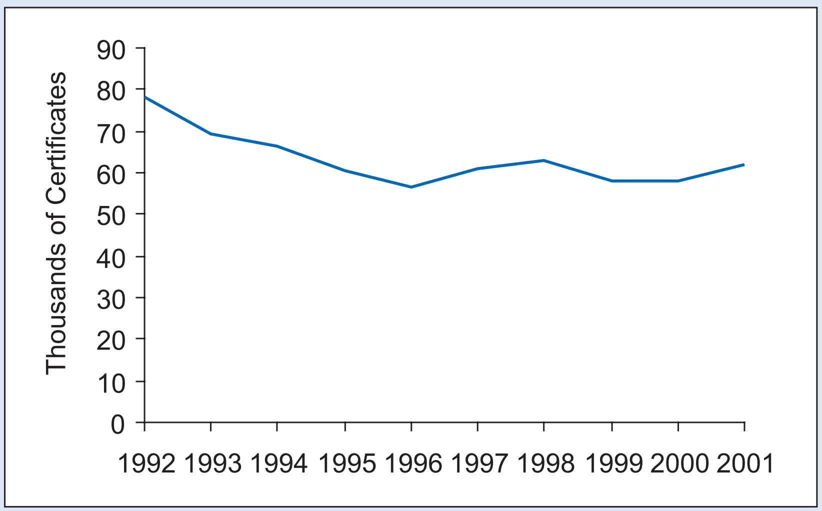
[12] Available at < http://www.faa.gov/data_statistics/aviation_data_statistics/general_aviation/CY2001/>.

[13] The *2001 GAATA Survey* sample frame consisted of 278,094 registered aircraft, from which 30,886 records (11%) were selected in a sample stratified by state/territory and aircraft type. From that sample, 16,432 (54% of the sample and 6% of the total population) completed surveys were collected *(GAATA Survey, Calendar Year 2001)*.

In addition to flight-hour estimates, the number of pilots can be used to establish the level of exposure to risk for the various types of operations included in general aviation. Available measures of the pilot population include both the number of certificates issued to new pilots and medical certificates issued to active pilots. The number of new student pilot certificates represents positive growth in the pilot population, and the number of medical certificates issued represents an informal census of all active pilots.

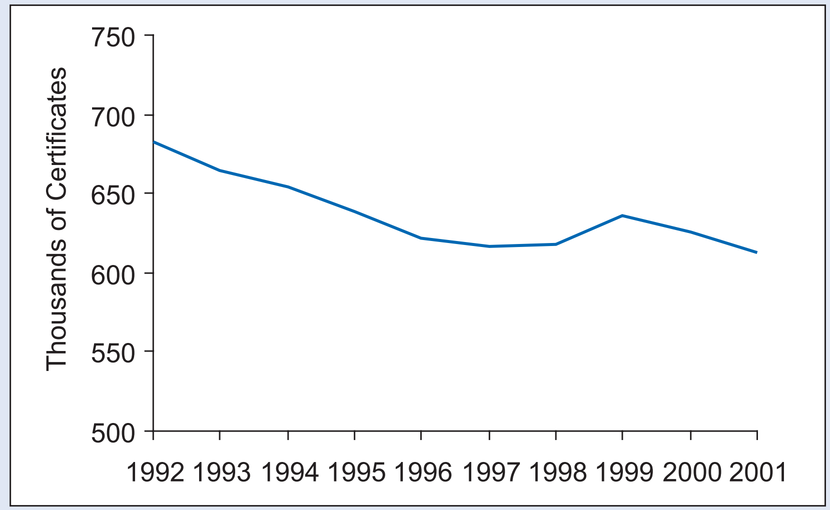
From 1992 through 1996, the number of new student pilot certificates each year decreased steadily from 78,377 to 56,653.[14] The number fluctuated after 1996, but remained generally even, with a total of 61,839 new student certificates issued in 2001.

Number of New Student Pilot Certificates Issued, 1992-2001



The total number of active pilots in U.S. general aviation decreased steadily throughout the early and mid-1990s, from 702,659 in 1990 to 622,261 in 1996. Between 1997 and 2001, the number of active pilots fluctuated, with an estimated total of 612,274 active U.S. pilots in 2001.

Estimated Number of Active Pilot Certificates, 1992-2001



In summary, general aviation indicators—flight hours and the total number of active and newly issued pilot certificates—decreased annually between 1990 and 1996. From 1996 through 2001, the number of active and new student pilots fluctuated annually, with little overall change, during a period with a noticeable increase in estimated flight activity. The increase in estimated activity over the period had a noticeable effect on accident rate and should be considered when attempting to interpret the general aviation accident record for 2001 in the context of previous years.

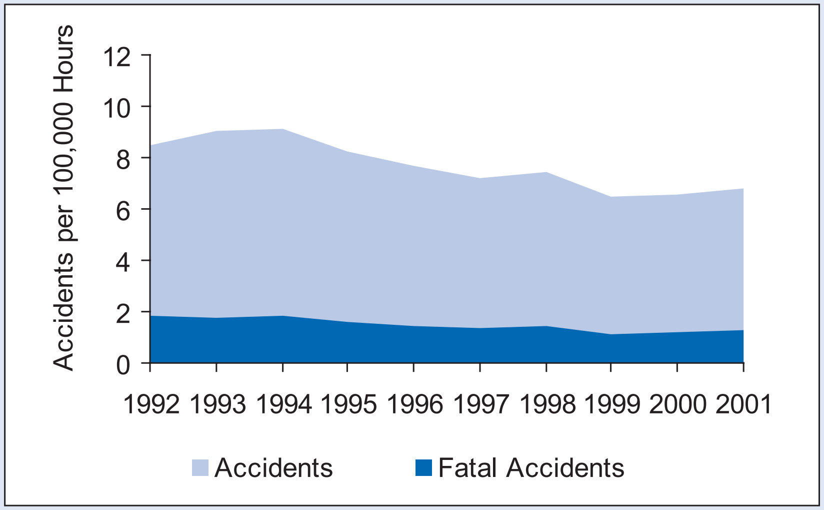
[14] FAA, *U.S. Civil Airmen Statistics*, available at <http://www.faa.gov/data_statistics/aviation_data_statistics/civil_airmen_statistics/>.

Historical Trends in Accident Data

Accident Rates

After 1994, the calculated general aviation accident rate declined overall as annual estimates of general aviation activity increased noticeably[15] without a corresponding increase in the number of accidents. The rate of 6.78 accidents per 100,000 hours flown in 2001 was substantially lower than the 10-year high of 8.51 accidents per 100,000 hours recorded in 1992. In fact, the 2001 rate was only slightly higher than that of 2000, which had the lowest rate since the Safety Board began reporting general aviation-only annual accident rates in 1975.[16] The relative percentage of fatal accidents remained fairly constant from 1992 through 2001, at 18 to 21% of the total rate. The 2001 rate of 1.27 fatal accidents per 100,000 flight hours was only slightly higher than the 2000 fatal accident rate.

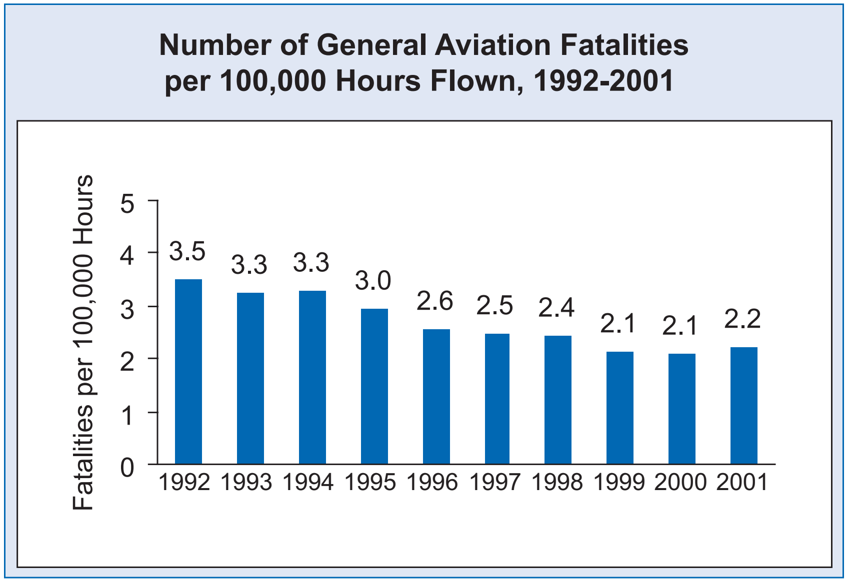
General Aviation Accident Rate 1992-2001

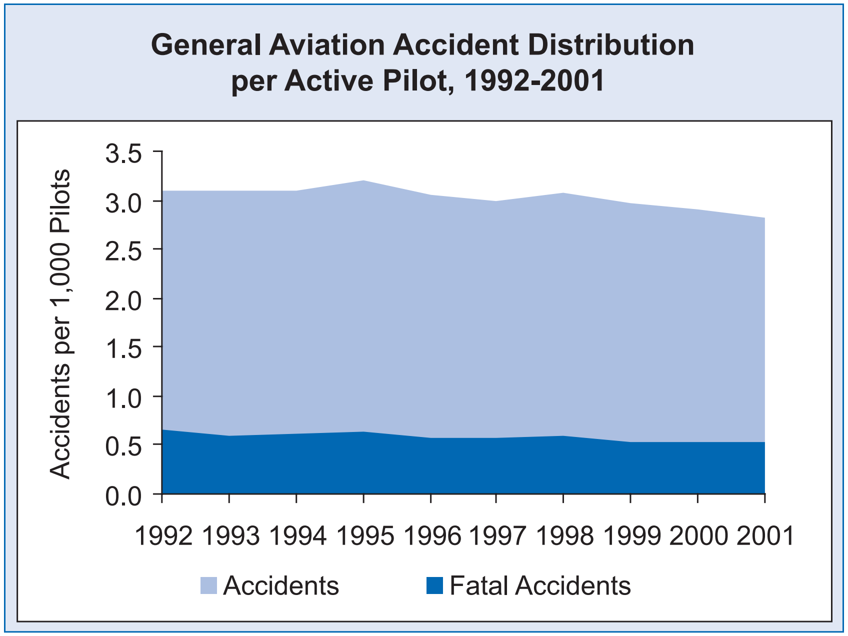


In 2001, accident-related deaths per flight hour were 2.2 fatalities per 100,000 hours flown. The highest annual fatality-per-hour rate for the period occurred in 1992 with 3.5 deaths per 100,000 hours flown.

[15] FAA estimates of annual general aviation activity increased noticeably after 1998 due to a change in *GAATA Survey* methodology that increased the estimated general aviation aircraft population by about 10 percent. See Appendix A of the *GAATA Survey, Calendar Year 2001,* for an explanation of the changes in survey methodology.

[16] Prior to 1975, scheduled 14 CFR 135 "commuter" and non-scheduled 14 CFR 135 air taxi aircraft operations were included in the Safety Board's annual general aviation accident total and rate.





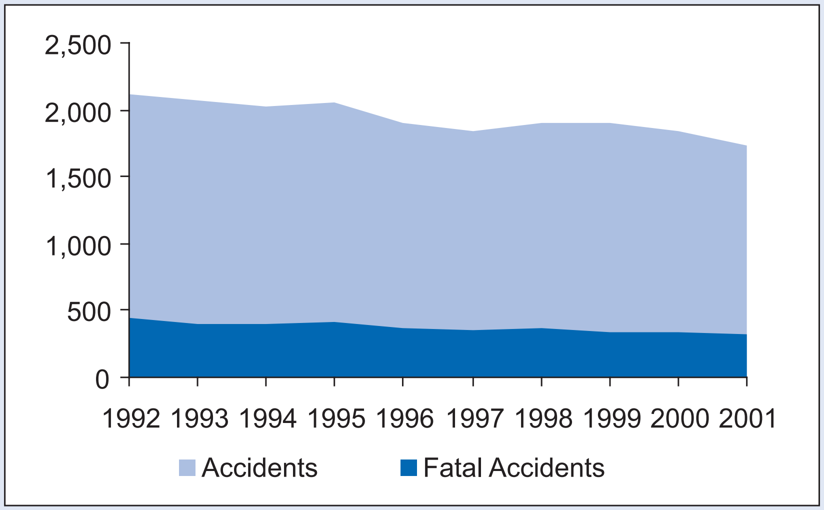
Another measure of accident distribution is the number of accidents per active pilot. Although this measure was considerably more stable from 1992 through 2001 than the per-hour accident rate, it did decrease slightly overall with the lowest number of accidents per pilot for the period occurring in the years 1999–2001.

Accident rate calculations based on flight hours require the use of *GAATA Survey* activity data extrapolated from a relatively small sample of aircraft owners. As a result, the calculated 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 review typically also include raw frequency data for comparison.

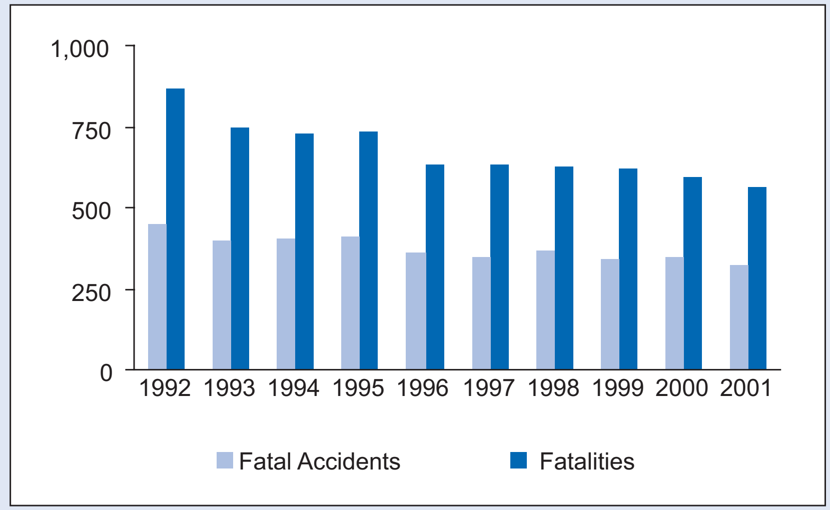
Number of Accidents and Fatalities

Although the number of general aviation accidents fluctuated slightly from year to year, the number of accidents that occurred annually between 1992 and 2001 declined overall from 2,111 in 1992 to a 10-year low of 1,727 in 2001. The number of fatal accidents also decreased overall, from 451 in 1992 to 325 in 2001, recording an additional 4% decline from the 10-year low of 340 reached in 1999.

Number of General Aviation Accidents 1992-2001



Number of Fatal General Aviation Accidents and Fatalities, 1992-2001



The number of fatalities also exhibited a generally downward trend from the high of 867 deaths in 1992 to a record low of 562 deaths from 325 fatal accidents in 2001. This observed decline in fatalities was consistent with other trends for the 10-year period, which showed a decline in the number of active pilots, the number of accidents, and the number of fatal accidents.

Accident Rate by Type of Operation

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. However, the flight data collected in the *GAATA Survey* allow for only a coarse representation of the many types of general aviation operations. For some types of operations, such as public aircraft flights,[17] no activity data are available. The data presented here include four operational categories selected because they are representative of general aviation and have activity information available. The categories selected as being typical of general aviation activity include

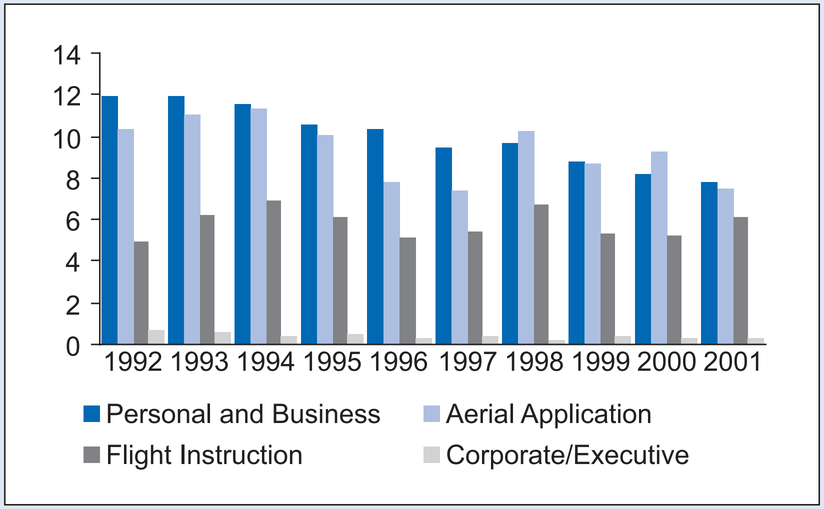
[17] The *Annual Review, 2001*, data include 38 public aircraft accidents, 6 of which resulted in one or more fatalities.

personal/business flying,[18] corporate flying, aerial application, and instructional flights.

- 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 conducted 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.[19] Instructional flying typically includes both dual training flights and student solo flights. Aircraft used for instruction are often similar to those used for personal flying. However, instructional operations are unique because they often involve the repeated practice of takeoffs and landings, flight maneuvers, and emergency procedures.

From 1992 through 1999, personal and business flying had the highest average accident rate, followed by aerial application and instructional flights. The lowest accident rate was for corporate/executive transportation, which for the 10-year period ranked lowest overall each year. In 2001, at 0.30 accidents per 100,000 hours, the accident rate for corporate/executive flying was only 5% of the rate of instructional flying, the next lowest rate.

Accident Rate by Type of Operation, 1992-2001
(per 100,000 Flight Hours)



As previously mentioned, the highest percentage of general aviation accidents typically involves personal and business operations. Between 1992 and 2001, personal/business flying accounted for an average of 67% of all general aviation accidents. In 2001, 67% of all general aviation accidents involved personal/business flying, a percentage consistent with the 10-year average. Instructional flying accounted for the next highest percentage with 15% compared with a 10-year average of 14.0% of all general aviation accidents.

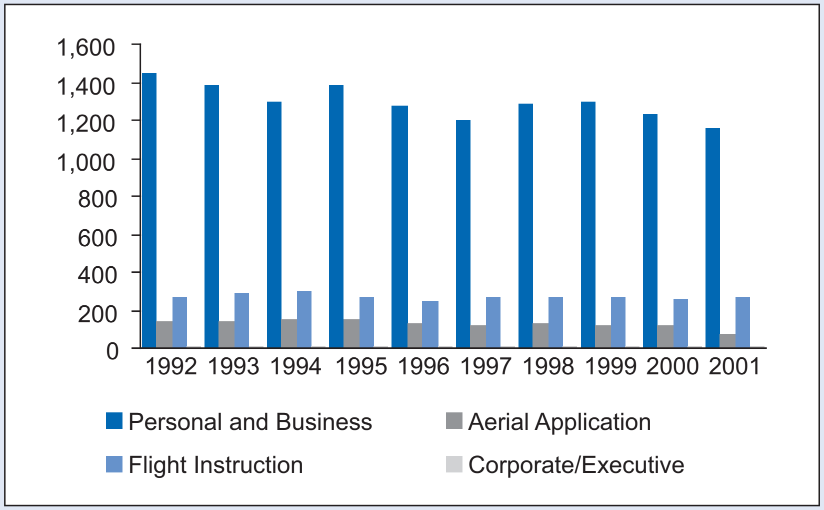
[18] Because of the difficulty of accurately distinguishing between personal and business flying for both the activity survey and the accident record, the rate presented in this review is calculated using combined exposure data (hours flown).

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

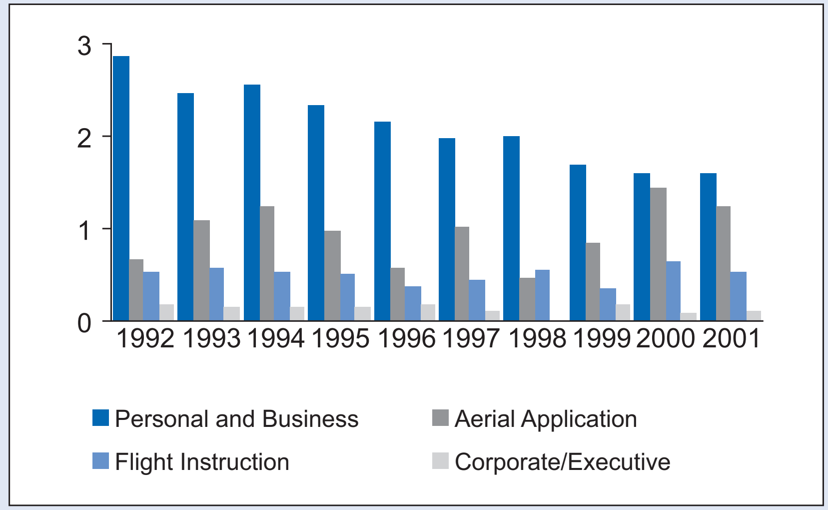
The lowest number of accidents from 1992 through 2001 involved corporate/executive flights. Averaging about 11 accidents per year, annual totals for corporate/executive accidents are barely visible when graphed in comparison to accidents involving other types of operations.

Throughout the 10-year period, the combined category of personal/business flying also had the highest fatal accident rate. Except for 2000 and 2001, the rate was typically more than double the rate for any other type of flying.

Number of Accidents by Type of Operation, 1992-2001

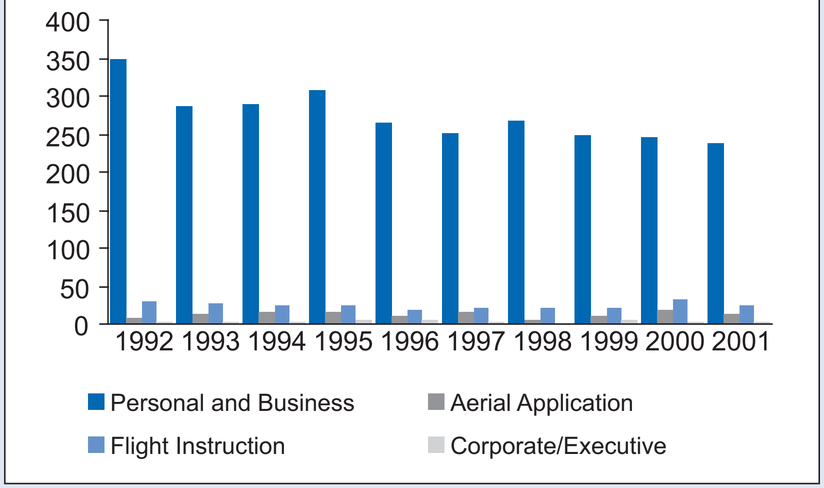


Fatal Accident Rate by Type of Operation, 1992-2001 (per 100,000 Flight Hours)



An average 276 fatal accidents per year were associated with personal/business flying, compared to an average 25 fatal accidents per year related to instructional flying, 13 for aerial application, and 4 for corporate executive flights. Differences in the number and rate of fatalities and injuries among types of operation are likely related to the type of aircraft and equipment, the level of pilot training, and the operating environments unique to each type of operation. The total fatal accidents per year among each type of flight operation exhibit a distribution similar to the total number of accidents per operation, with personal and business flying accounting for an average 73% of all fatal general aviation accidents and 74% of all fatal injuries for 1992 through 2001.

Number of Fatal Accidents by Type of Operation, 1992-2001



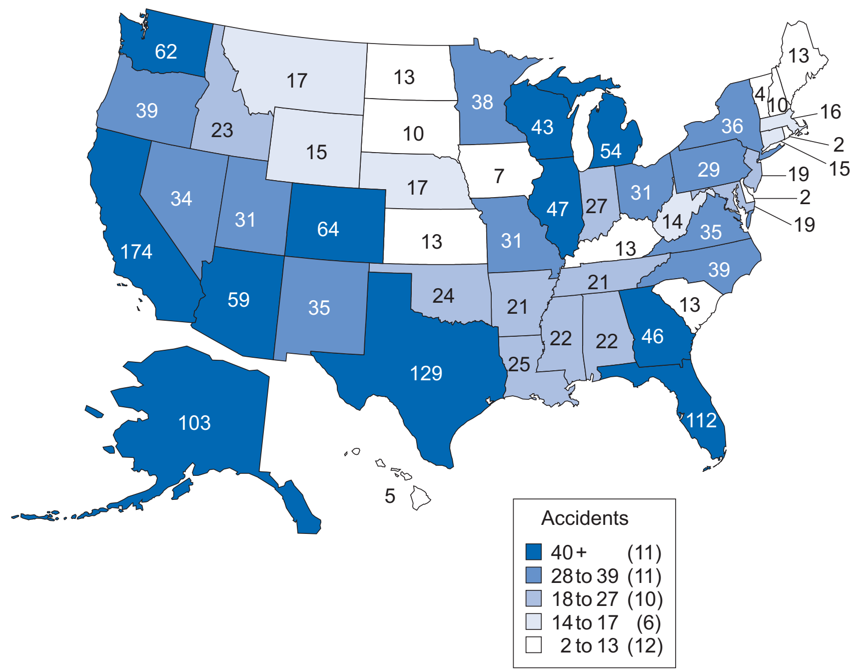
2001 in Depth

Location of General Aviation Accidents in 2001

United States Aircraft Accidents

Geographic location can contribute to general aviation accident totals because of increased activity due to population density or increased risk due to hazardous terrain, a propensity for hazardous weather, or a concentration of particularly hazardous flight operations. This map shows state by state the number of all general aviation accidents that occurred within the United States in 2001. 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 the specific hourly activity data needed to calculate general aviation accident rates for each state are not available, some assumptions can be made about general aviation activity levels based on the size and population of each state. For example, California,[20] Texas, and Florida[21] had the greatest number of accidents in 2001. U.S. Census Bureau data[22] indicate that California had the highest state population in 2001, followed by Texas (second), and Florida (fourth). In addition, all three of these states have warm climates that favor flying year-round, and all three are popular travel destinations that attract general aviation traffic from other states. These states also had the largest numbers of active pilots[23] and active aircraft.[24] These data suggest that the high number of accidents in California, Texas, and Florida are likely related primarily to a high level of activity.

General Aviation Accidents by U.S. State, 2001



[20] The total of 174 accidents for California includes one accident off the coast in the Pacific Ocean.

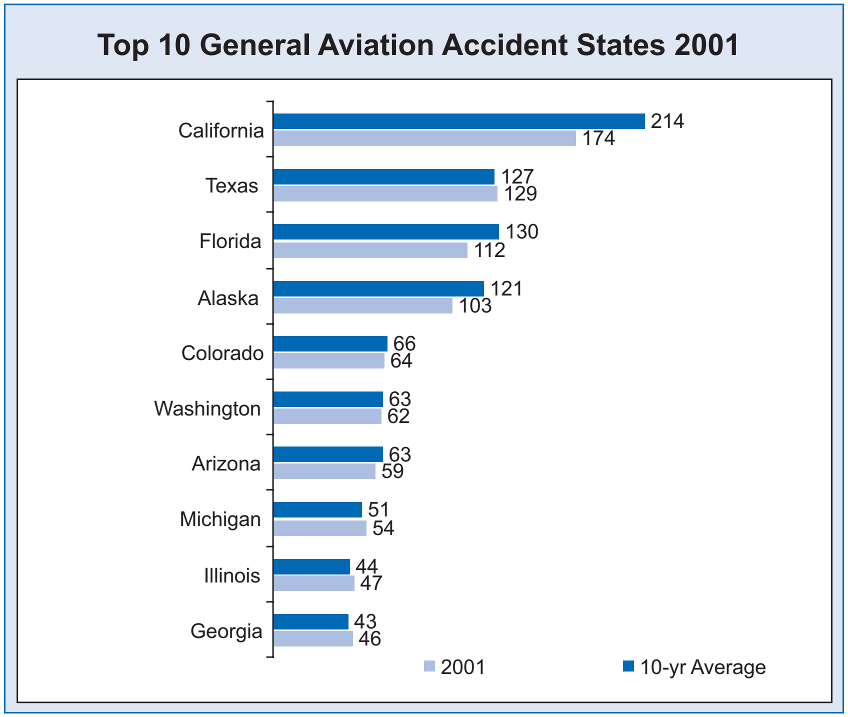
[21] The total of 112 accidents for Florida includes one accident off the coast in the Atlantic Ocean.

[22] U.S. Census Bureau; data are available at <http://factfinder.census.gov/>.

[23] FAA, *U.S. Civil Airmen Statistics, 2001*, available at <http://www.faa.gov/data_statistics/aviation_data_statistics/civil_airmen_statistics/>.

[24] FAA, *GAATA Survey 2001*, available at <http://www.faa.gov/data_statistics/aviation_data_statistics/general_aviation/CY2001/>.

Regional differences that affect general aviation accident numbers may also include hazards unique to the local terrain and weather. For example, the operating environment, infrastructure, and travel requirements in Alaska present unique challenges[25] to aviation that are reflected in the general aviation accident record. After California, Texas, and Florida, Alaska had the most general aviation accidents in 2001.



The top 10 states by number of general aviation accidents in 2001 are presented here along with the 10-year average. Note that many of the state accident totals for 2001 were below historical averages, but the distribution of accidents among states remained similar during the period.

Foreign Aircraft Accidents

In 2001, U.S.-registered aircraft were involved in 34 accidents that occurred outside the 50 United States. Those accidents occurred in 17 different countries and territories, and in the Atlantic and Pacific Oceans. Of those accidents, 12 were fatal, resulting in 22 deaths. The largest number of these accidents occurred in Puerto Rico, with 6 accidents, followed by Canada with 5. Although most general aviation accidents involving U.S.-registered aircraft outside the United States usually occur in neighboring countries like Canada, Mexico, and the Caribbean island nations, the 2001 accident record includes accidents that occurred as far away as Iceland, Saudi Arabia, and Africa.

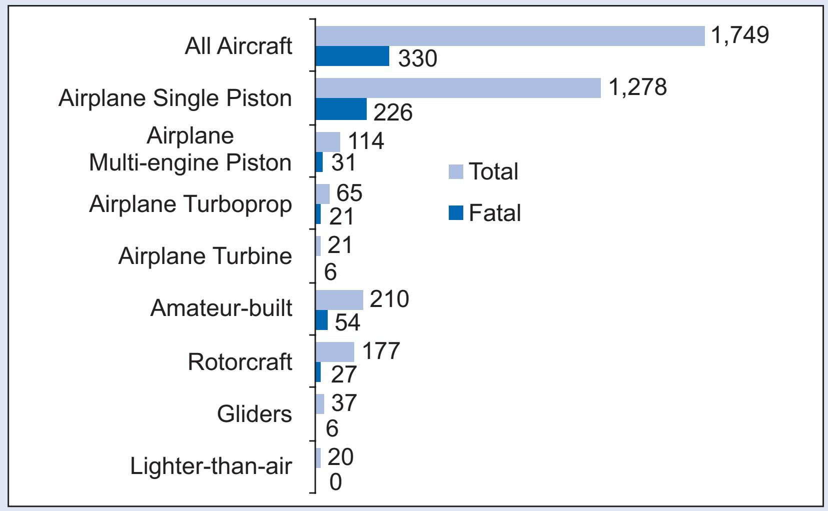
[25] For an analysis of aviation safety in Alaska, see National Transportation Safety Board, Aviation Safety in Alaska, Safety Study, NTSB/SS-95/03 (Washington, DC: 1995). The Safety Board is also supporting an ongoing effort to identify and mitigate risk factors specific to aviation operations in Alaska;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

Accidents Involving U.S.-Registered General Aviation Aircraft Outside the 50 United States, 2001	Number of Accidents	Number of Fatal Accidents	Number of Fatalities
Pacific Ocean			
Ditched in Okhotsk	1	0	0
From Fishing Vessel	1	0	0
Subtotal	**2**	**0**	**0**
Atlantic Ocean			
Off Bahamas	1	0	0
Subtotal	**1**	**0**	**0**
Other Countries / Territories			
Africa	1	0	0
Austria	1	1	2
Bahamas	4	0	0
Belgium	1	1	1
Canada	5	2	2
Cuba	1	0	0
Dominican Republic	1	0	0
France	1	1	3
Germany	2	1	4
Greenland	1	0	0
Iceland	1	1	2
Missing	1	1	1
Romania	1	0	0
Peru	1	1	3
Puerto Rico	6	2	2
United Kingdom	1	0	0
Saudi Arabia	2	1	2
Subtotal	**31**	**12**	**22**
Total	**34**	**12**	**22**

Aircraft Type

The following graphs summarize the total number of general aviation accidents and the number of fatal accidents occurring in 2001 by type of aircraft. Most notable is the large number of accidents involving single-engine piston airplanes, which accounted for 73% of all accident aircraft and 68% of all fatal accident aircraft.

Number of Accidents by Type of Aircraft, 2001

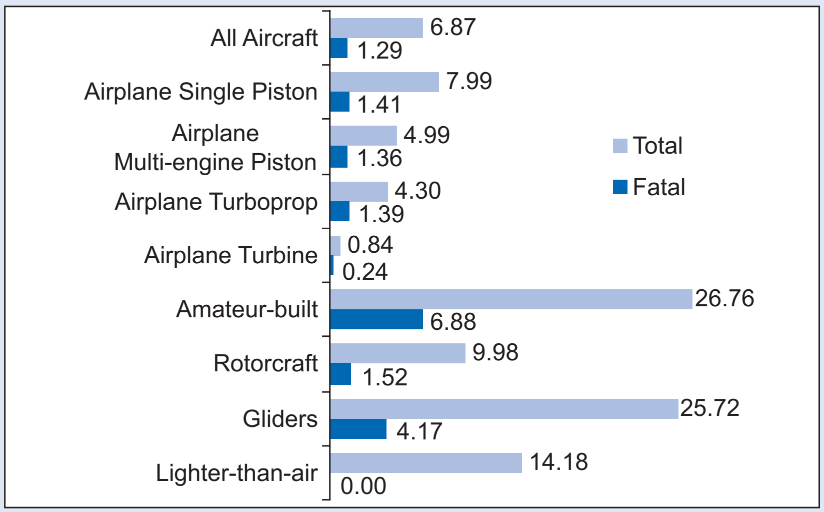


In 2001, the per-aircraft accident rate for all aircraft types was 6.87 accidents and 1.29 fatal accidents per 100,000 hours flown.[26] Among fixed-wing powered aircraft, the rate for single-engine piston airplanes was 7.99 accidents and

[26] Note that the reported rates are per aircraft and differ from per-accident rates because each aircraft is counted separately in the event of a collision. Included in the accident totals, but excluded from the associated rates, are three single-engine piston aircraft accidents with a probable cause attributed to suicide, sabotage, or stolen/unauthorized use.

1.41 fatal accidents per 100,000 hours flown. Amateur-built aircraft[27] had the highest accident rate in 2001 with 26.76 accidents and 6.88 fatal accidents per 100,000 flight hours. Rotorcraft had the second-highest rate among powered aircraft, with 9.98 accidents and 1.52 fatal accidents per 100,000 hours flown. However, glider operations had the second-highest accident rate overall, with 25.72 accidents and 4.17 fatal accidents per 100,000 hours flown.

Accident Rate per Aircraft Type, 2001
(per 100,000 Flight Hours)



Purpose of Flight

As previously mentioned, general aviation includes a wide range of operation types, each with unique aircraft types, flight profiles, and operating procedures. The total number of accidents and the accident rates can vary considerably as a result of these differences. To allow comparisons among different operations, risk exposure is standardized across different operations by using flight hours as a common measure of activity.

The type of operation or purpose of flight can be defined as the reason a flight is initiated. Activity data by purpose of flight are derived from the *GAATA Survey,* which includes 14 purpose/use categories. Two of these categories, air taxis and air tours, are covered under 14 CFR Part 135 and are therefore not included in this review. The remaining 12 categories include the previously mentioned categories of "personal," "business," "instructional," "corporate," and "aerial application," which together accounted for 90% of all general aviation operations during 2001. The remaining 10% of general aviation operations are included in more specific categories, such as "external load" and "medical use." A limitation of the *GAATA* activity data is that those categories provide only a coarse representation of the range of possible flight operations. For example, "personal flying" includes but does not distinguish between travel, recreation, or proficiency flying. At the same time, the differences between similar categories like "personal" and "business flying" are not easily identified. Accordingly, the purpose-of-flight information presented in this review is limited to the combined categories of personal and business flying, as well as corporate, instructional, and aerial application flights.

According to the *GAATA Survey,* most general aviation operations are conducted for personal and/or business purposes. Of the estimated 25.4 million general aviation hours flown in 2001, more than half—14.8 million—were conducted for personal or business reasons.[28] A result of this level of activity is that a large

[27] Title 14 CFR Part 21 (21.191(g)) provides for the issuance of a Special Airworthiness Certificate in the experimental category to permit the operation of amateur-built aircraft. Amateur-built aircraft may be fabricated from plans or assembled from a kit, so long as the *major* portion (51%) of construction is completed by the amateur builder(s).

[28] FAA, *GAATA Survey 2001*, available at <http://www.faa.gov/data_statistics/aviation_data_statistics/general_aviation/CY2001/>

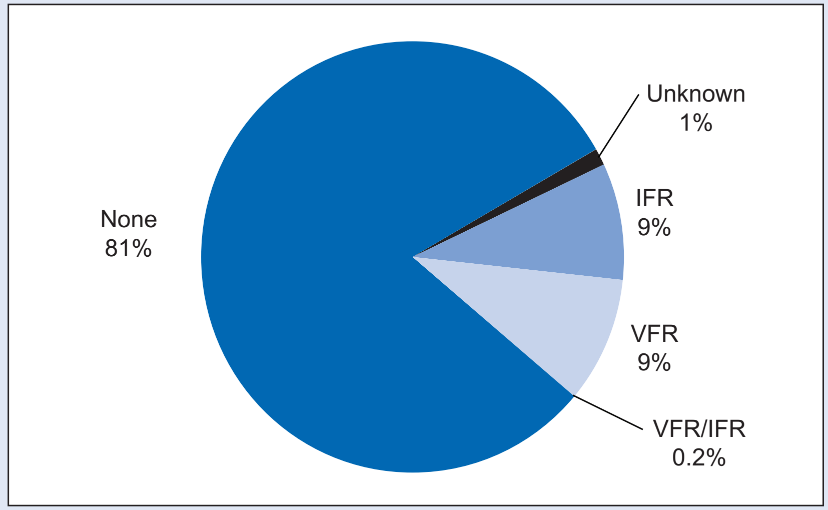
percentage of general aviation accidents involve personal/business flying. However, personal/business flying is still over-represented in the accident record: although this segment represented about 58% of the general aviation hours in 2001, it accounted for 67% (1,155) of all general aviation accidents and 74% (239) of all fatal accidents in 2001.

The accident rate for flight instruction operations was about half that of aerial application and personal/business flights. This relatively low rate is surprising because student pilots could be expected to make more mistakes than experienced pilots while they are learning to fly. Flight instruction accidents were also less likely to be fatal. Only 9% of the flight instruction accidents that occurred in 2001 resulted in fatalities, compared to almost 21% of personal/business accidents. When compared with the number of hours flown, the fatal accident rate for instructional flights was 0.53 fatal accidents per 100,000 hours flown. The fatal accident rate for personal/business flying remained the highest in general aviation with 1.60 fatal accidents per 100,000 hours flown.

Flight Plan

Of the 1,749 pilots involved in general aviation accidents in 2001, 1,408 (81%) 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 have the option of filing a flight plan, which aids search and rescue efforts for pilots who fail to arrive at their intended destinations. VFR flight plans are typically not filed for local flights and, in general, the filing of a flight plan may be more indicative of the type of flight operation than the safety of a particular flight.

Flight Plan Filed by Accident Pilot, 2001

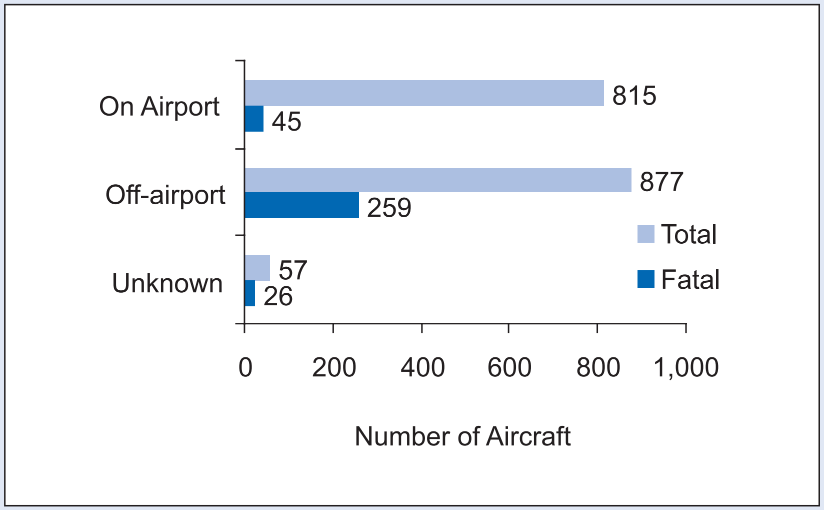


Airport Involvement

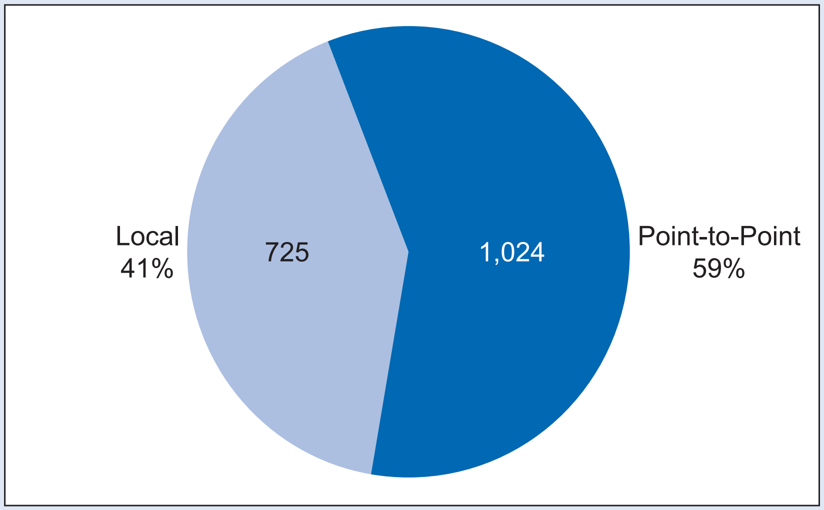
Aircraft accident locations were closely split between those occurring away from an airport (50%) and those occurring on airport property (47%). Comparing accident risk based on location is difficult because of the exposure differences between different operations and aircraft types. For example, a single-engine piston aircraft used for instructional flights will spend a large percentage of its operating time near an airport while a jet aircraft used for corporate transportation will not. However, a relationship can be observed between the location and severity of accidents. Accidents on or near an airport or airstrip typically involve aircraft operating at relatively low altitudes and airspeeds while taking off, landing, or maneuvering to land. Accidents that occur away from an airport typically involve aircraft in the climb, cruise, maneuvering, and descent phases of flight, which typically occur at higher altitudes and higher airspeeds. As a result, accidents that occur away from an airport are more likely to result in higher levels of injury and aircraft damage than accidents that occur on an airstrip or near an airport. Most aircraft involved in fatal accidents in 2001 (78%) were located away from an airport or airstrip.

A comparison of the numbers of accident aircraft on local flights with those on point-to-point flights illustrates that the percentages of aircraft on each type of flight were similar although point-to-point flights accounted for slightly more accident aircraft.

Location of Accident Aircraft, 2001



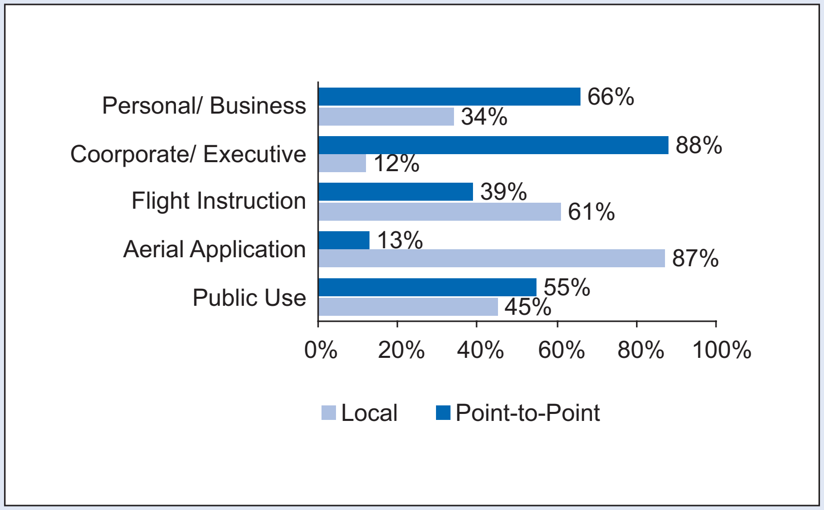
Local and Point-to-Point Flights, 2001



Another distinction that can be drawn between flight profiles is between local and point-to-point operations. A local flight is one that departs and lands at the same airport, and a point-to-point flight is one that lands at an airport other than the one from which it departed. Typical local flight operations include sightseeing, flight instruction, proficiency flights, pleasure flights, and most aerial observation and aerial application flights. Conversely, point-to-point flights include any operation conducted with the goal of moving people, cargo, or equipment from one place to another. Typical point-to-point operations include corporate executive transportation, personal and business travel, and aircraft repositioning flights.

The activity data necessary to compare accident rates for local and point-to-point flights are not available. However, a comparison of the percentage of local and point-to-point accident flights conducted for different purposes of flight provides an indirect measure of the types of flying represented in both flight profiles. The following graph shows that most personal/business flights were point-to-point, while most instructional flights were local. Corporate executive transportation and aerial application operations were also inversely proportionate, with 88% of corporate flights being point to point and 87% of aerial application flights being local.

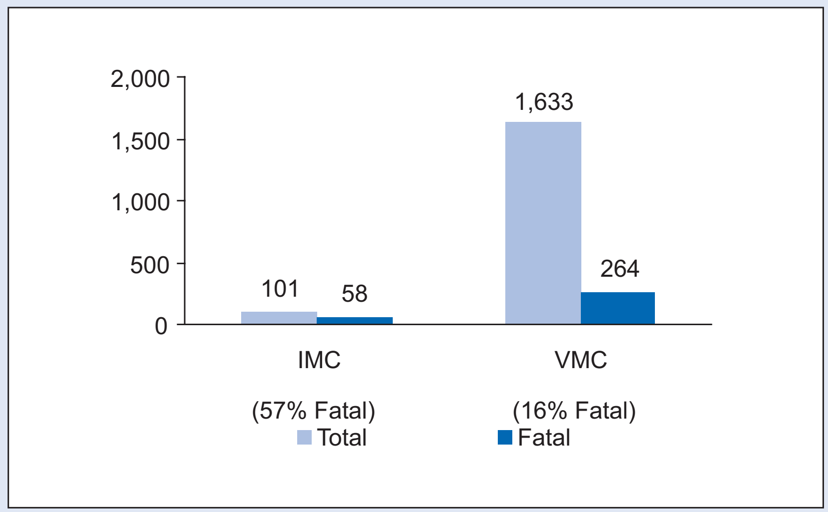
Local and Point-to-Point Comparison by Type of Operation, 2001



Environmental Conditions

Many hazards to safety are unique to the type of flight operation, type of aircraft, and flight profile, but environmental conditions may be hazardous to all flight operations and all types of aircraft to some degree. Aircraft control, for example, is highly dependant on visual cues related to speed, distance, orientation, and altitude. When visual information is degraded or obliterated because of clouds, fog, haze, or precipitation, pilots must rely on aircraft instruments. Because of the difficulties associated with flying an aircraft solely by reference to instruments, the FAA has established specific pilot, aircraft, and procedural requirements[29] for flight in instrument meteorological conditions (IMC). According to the FAA *Pilot/Controller Glossary*,[30] "instrument meteorological conditions" are defined as "meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling less than the minima[31] specified for Visual Meteorological Conditions (VMC)." Weather minima differ based on altitude, airspace, and lighting conditions, but 3 statute miles visibility and a cloud clearance of 1,000 feet above, 500 feet below, and 2,000 feet horizontal distance is typical. The following chart illustrates the percentage of accidents and fatal accidents that occurred in VMC and IMC. A comparison of the percentages of accidents in each weather condition that resulted in a fatality illustrates the hazards associated with flight in IMC. In 2001, only 16% of the accidents that occurred in visual conditions resulted in a fatality, but 57% of accidents in instrument conditions were fatal.

Total Accidents and Fatal Accidents by Weather Condition, 2001



[29] Title 14 CFR 61.579(c), 91.167-193, 91.205(d).

[30] FAA, *Pilot/Controller Glossary*, Washington, D.C., available online at <http://faa.gov/atpubs/PCG/INDEX.HTM>.

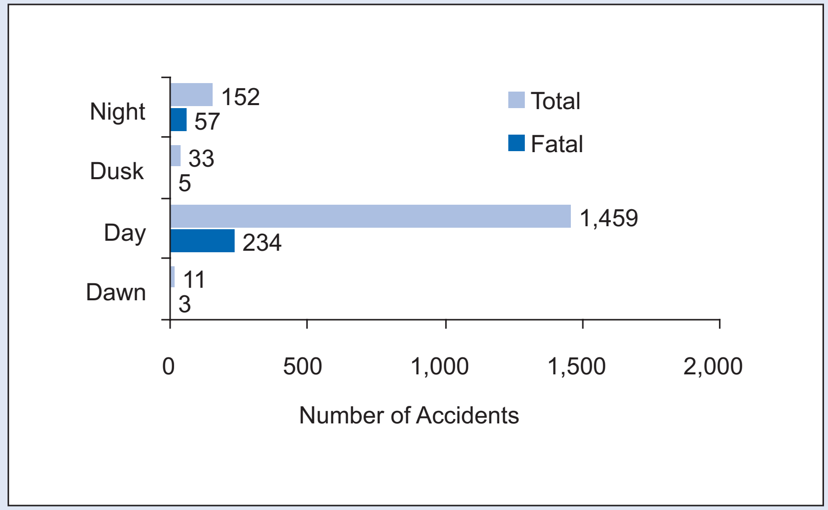
[31] Minima for visual meteorological conditions are specified in 14 CFR 91.155.

Although instrument conditions were present for only 6% of all accidents, 18% of fatal general aviation accidents in 2001 occurred in IMC. One reason for the disproportionate number of fatal accidents in IMC is that such accidents are more likely to involve pilot disorientation, loss of control, and collision with terrain or objects—accident profiles that typically result in high levels of damage and injury. Instrument conditions may also contribute to accident severity by further complicating situations that might be more easily handled in visual conditions. For example, a forced landing due to an engine malfunction or failure, which might result in minor damage if it were to occur in visual conditions, might pose an even greater threat to a pilot flying in instrument conditions because reduced visibility would make the selection of a suitable landing site more difficult.

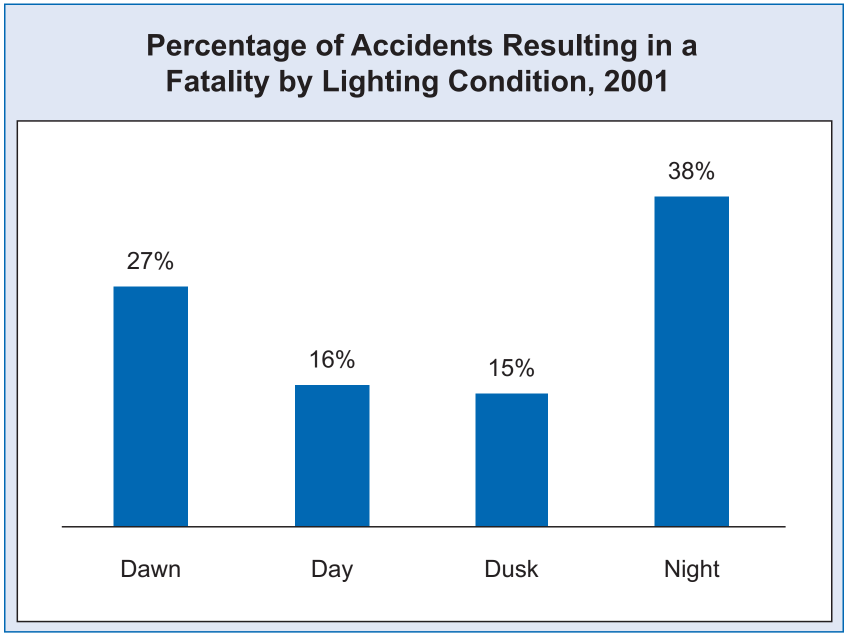
Lighting Conditions

Lighting conditions can present a similar hazard to pilots because of physiological factors related to night vision, difficulties in seeing potential hazards such as mountains, terrain, and unlighted obstructions, and perceptual illusions associated with having fewer visual cues. The following graphs illustrate that, similar to IMC, most accidents occurred in daylight conditions but a larger percentage of the accidents that occurred at night resulted in fatalities.

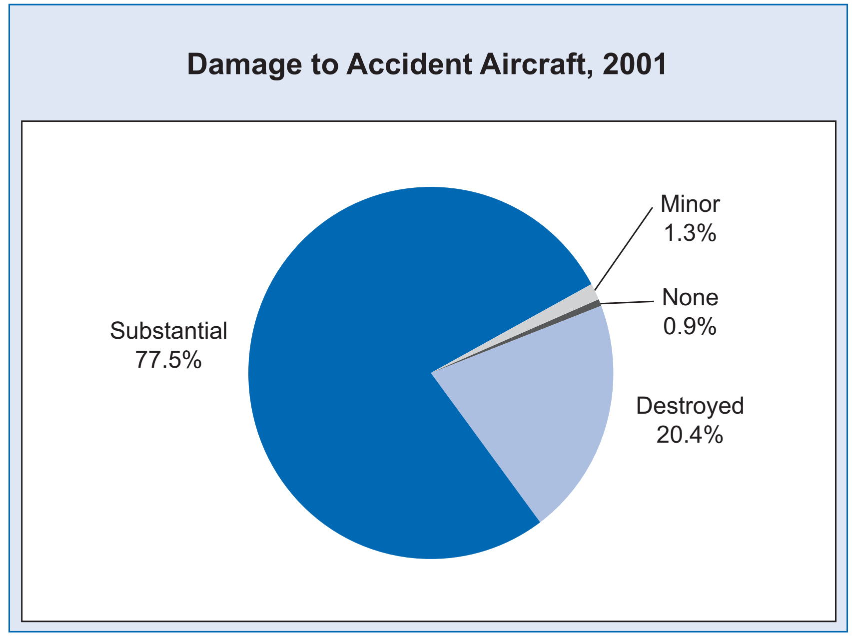
Accidents and Fatal Accidents by Lighting Condition, 2001



In fact, accidents that occurred at night were more than 2.5 times more likely than daylight accidents to be fatal. Like weather-related accidents, accidents at night are more likely to involve disorientation, loss of control, and/or collision with objects or terrain that result in higher levels of injury. The reduction in visual cues at night also hinders pilots from identifying deteriorating weather conditions and further complicates any aircraft equipment malfunctions.



Nearly 8 of every 10 aircraft involved in accidents during 2001 sustained substantial damage, and 1 in 5 accident aircraft were destroyed. "Minor" and "no damage" classifications included less than 1% each of accident aircraft.



Injuries and Damage for 2001

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 operationally defined as any damage in which repair cost would exceed the value of the aircraft,[32] and "minor" damage as any damage that is not classified as either "destroyed" or "substantial."

Accident Injuries

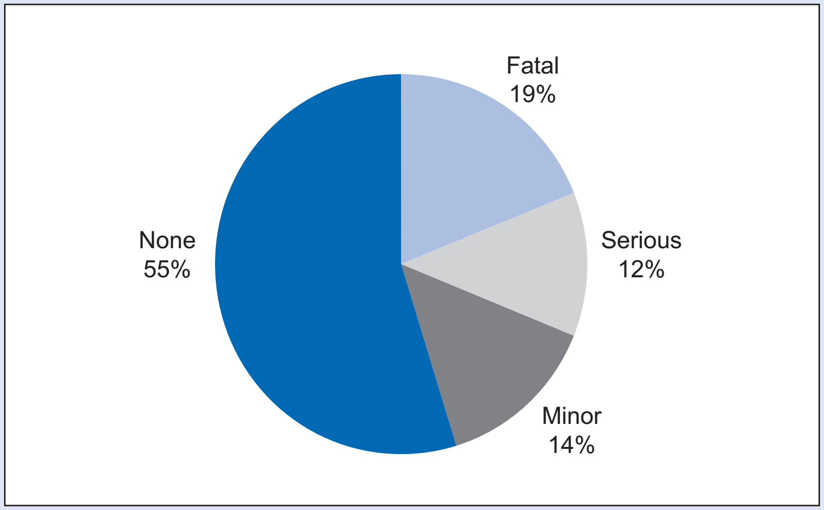
Safety Board investigators categorize injuries resulting from general aviation accidents as "fatal," "serious," or "minor." Title 49 CFR 830.2 defines a fatal injury as "any injury which results in death within 30 days of the accident." Title 49 CFR 830.2 also outlines several qualifications[33] of serious 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

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

[33] See Appendix B for the complete definition of injury categories.

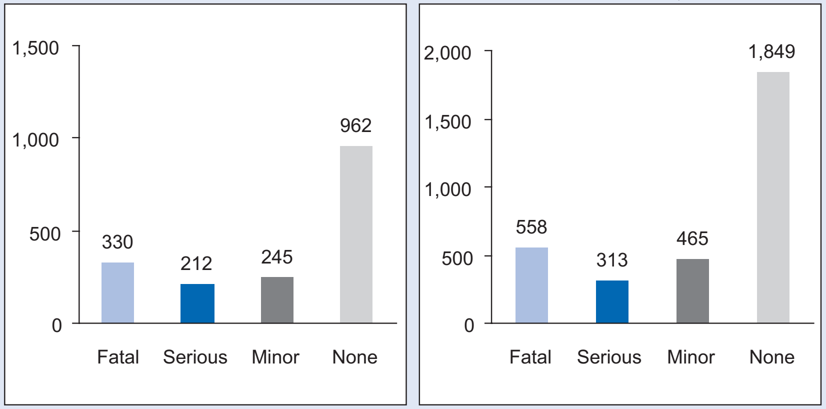
percentage of general aviation accidents resulting in each level of injury during 2001. Most notable is the fact that more than half the accidents did not result in injury.

Highest Level of Accident Injury, 2001



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. Categorization of injury level in an accident is based on the highest level of injury sustained by an occupant of an accident aircraft. Again, most persons who were aboard general aviation aircraft that were involved in accidents sustained no injuries.

Highest Level of Injury Aboard Accident Aircraft, 2001 / **Total Injuries Sustained by Persons Aboard Accident Aircraft, 2001**



Injuries by Role for 2001

The following table presents detailed information about the types of injuries incurred by all persons involved in general aviation accidents during 2001. The distribution of general aviation accident injuries varies with the type of operation and the size of aircraft, and the number of injuries experienced by any group of persons varies with their level of activity (that is, their exposure risk). For example, all aircraft have a pilot, but not all aircraft have passengers on board.

In 2001, 505 passengers suffered some level of injury in general aviation accidents, compared to the 733 pilots who were injured. Despite the apparent difference, the injury rate for passengers was similar to that of pilots, considering that only 1,153 of 1,749 accident aircraft had passengers on board. Although the total number of injured passengers is equal to only 69% of the number of injured pilots, only 66% of accident flights were carrying passengers. 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 2001, suffering 56% of all fatalities, 57% of all serious injuries, and 48% of all minor injuries.

In addition to injuries sustained by persons on board the accident aircraft, 40 persons who were not aboard aircraft also sustained injuries. Examples of such accidents included a security guard who died after walking into a spinning helicopter tailrotor, a ground handler who was seriously injured while attempting to hold down a balloon, and a twin-engined aircraft that collided with vehicles on a highway after an emergency landing due to a loss of engine power during takeoff.

General Aviation Accident Injuries, 2001

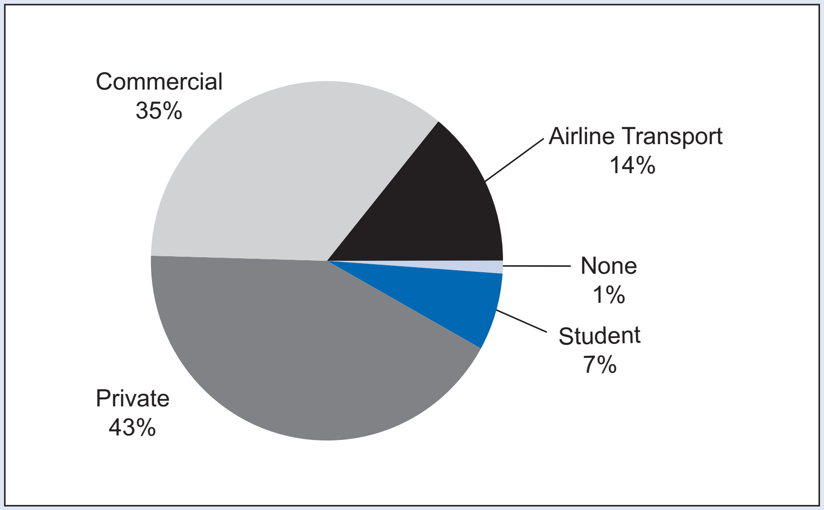
Personal Injuries	Fatal	Serious	Minor	None	Total
Pilot	313	182	238	1,016	1,749
Copilot	20	10	14	45	89
Flight instructor	3	0	3	18	24
Dual student	13	6	12	97	128
Check pilot	0	0	1	5	6
Other crew	7	3	6	20	36
Passenger	202	112	191	648	1,153
Total aboard	558	313	465	1,849	3,185
On ground	4	8	28	0	40
Other Aircraft	0	0	0	0	0
Total	562	321	493	1,849	3,225

Accident Pilots

Rating

Of the 1,749 pilots involved in general aviation accidents in 2001, the largest percentage held a private pilot certificate.[34] The second-largest percentage held a commercial pilot certificate, which is required for any person to act as pilot-in-command of an aircraft for compensation or hire.[35]

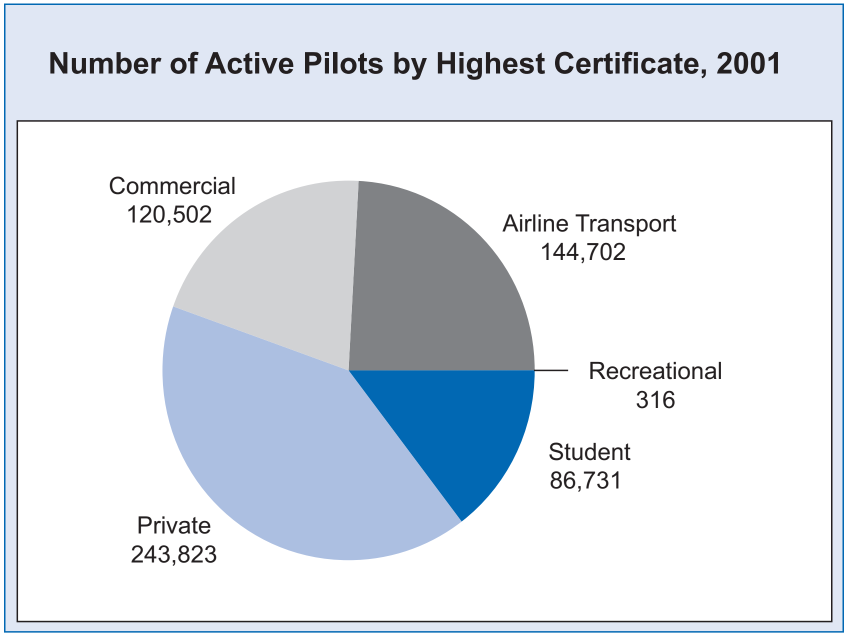
Highest Certificate Held by Accident Pilot, 2001

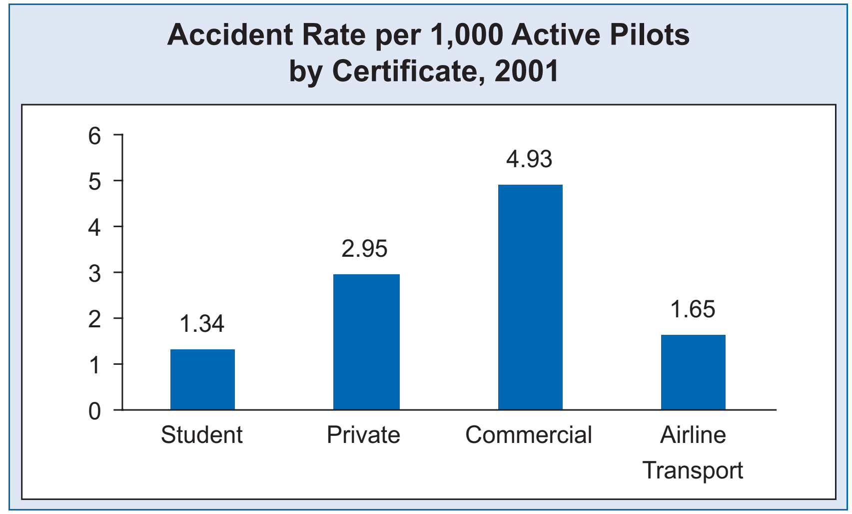


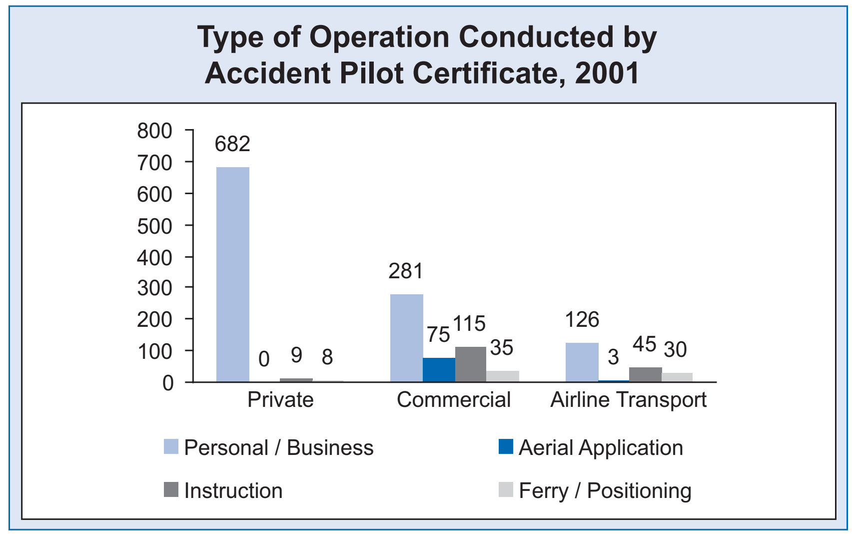
When compared to the number of active pilots in 2001 holding each type of pilot certificate, commercial pilot certificate holders were over-represented among general aviation accidents. Although commercial pilot certificate holders accounted for only 20% of all active pilots, they were involved in 35% of all general aviation accidents in 2001.

[34] FAA, *U.S. Civil Airmen Statistics*, available at <http://www.faa.gov/data_statistics/aviation_data_statistics/civil_airmen_statistics/>.

[35] See 14 CFR 61.133 for the privileges granted by a commercial pilot certificate.







(1,686 of accident pilot records with data available, 2001)

Similarly, the per-pilot accident rate was highest for commercial pilot certificate holders during 2001, with 4.93 accidents per 1,000 active pilots. One possible explanation for the higher numbers of accidents is that commercial certificate holders may be employed as pilots and would therefore be likely to fly more hours annually than student or private pilots.

However, the largest percentage of commercial pilots involved in accidents during 2001 (47%) were conducting personal flights and were not involved in commercial operations at the time of the accidents.

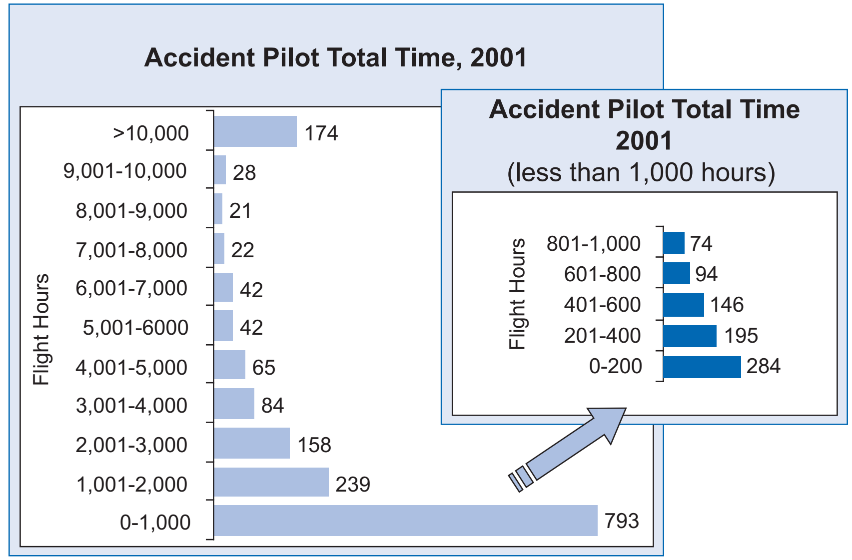
Because annual flight-hour data are not compiled separately for pilots holding each type of certificate, it is not possible to make comparisons between activity-based accident rates. The *U.S. Civil*

Airmen Statistics[36] also do not include information about the type of operation that certificate holders engage in. However, the high number of commercial pilot accidents attributed to aerial application operations might suggest that the historically high accident rate of such flights may have contributed to the increased rate observed for commercial pilots. Examples of other commercial operations not presented in the chart include corporate executive transportation, sightseeing flights, banner towing, and aerial observation.

Airline Transport Pilot (ATP) certificate holders, in addition to being employed as pilots,[37] can engage in air carrier operations,[38] which are not included in this review. As a result, ATP certificate holders may fly fewer general aviation hours and have a lower general aviation accident rate.

Total Time

Of the 1,668 accidents in 2001 for which pilot total flight experience data are available, 47% involved pilots with a total flight time of 1,000 hours or less. The following chart depicts the distribution of experience among accident pilots. The inset focuses on those pilots with less than 1,000 hours. The largest percentage of accident pilots in this group had 200 hours or less of total flight time. When compared to all accident pilots with available data, about 17% of accident pilots had 200 hours of flight experience or less.



(1,668 accident pilot records with total flight time information)

Because of the flight hour requirements[39] for obtaining commercial and ATP certificates, it is not surprising that nearly all accident pilots with 200 total hours or less of flight time held either private pilot certificates (59%) or student pilot certificates (36%).[40] Most pilots with more than 1,000 total hours of flight time held commercial pilot certificates (52%).

[36] FAA, *U.S. Civil Airmen Statistics*, 2001, available online at <http://www.faa.gov/data_statistics/aviation_data_statistics/civil_airmen_statistics/>.

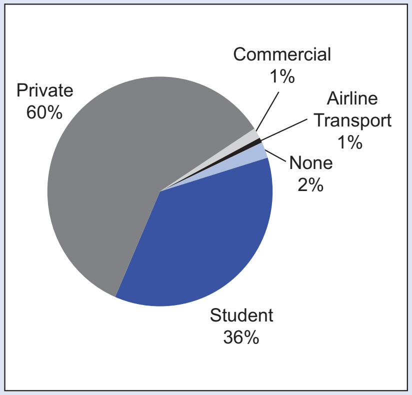
[37] Refer to 14 CFR 61, Subpart G, for the privileges and limitations of the Airline Transport Pilot certificate

[38] See 14 CFR 121.437.

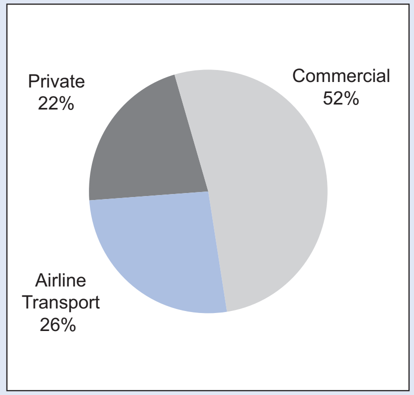
[39] Refer to 14 CFR Part 61 for the requirements of each type of pilot certificate and to 14 CFR 141 for differences in those requirements for training conducted at approved flight schools.

[40] Two accident pilots held commercial certificates but had less than 200 hours total time; one was a balloon pilot and the other was a foreign citizen operating a U.S.-registered aircraft.

Pilot Certificate Held By Accident Pilots With 200 Hours or Less Total Time, 2001

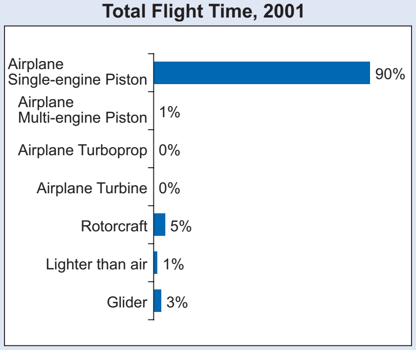


Pilot Certificate Held By Accident Pilots With More Than 1,000 Hours Total Time, 2001

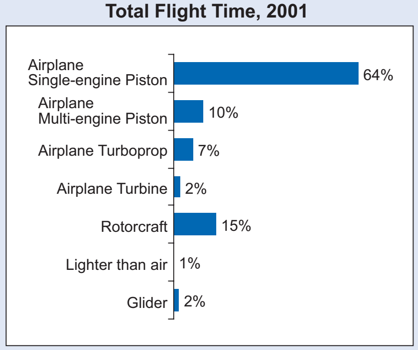


It is also not surprising that most accident pilots with 200 hours total flight time or less were flying single-engine piston airplanes when the accidents occurred. Accident pilots with more than 1,000 hours were flying a more diverse selection of aircraft, including significantly higher percentages who were flying multi-engine piston, turboprop, and turbine-powered airplanes, and about twice as many who were flying helicopters.

Type Aircraft Flown by Accident Pilots With 200 or Less Hours Total Flight Time, 2001



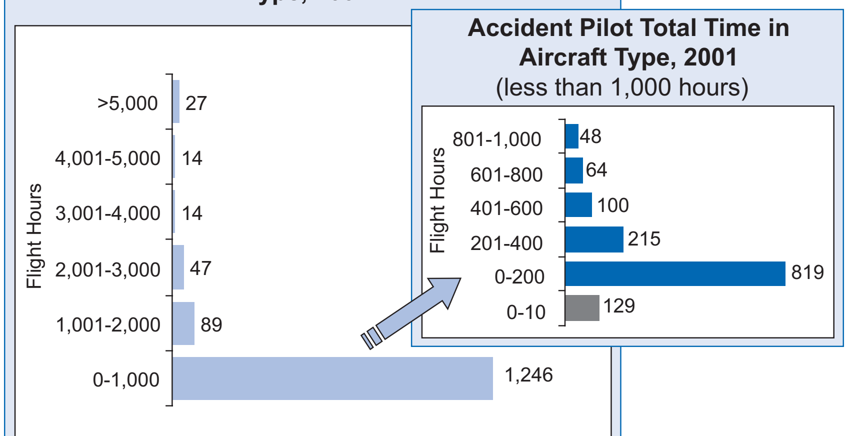
Type Aircraft Flown by Accident Pilots With More than 1,000 Hours Total Flight Time, 2001



Time in Type of Aircraft

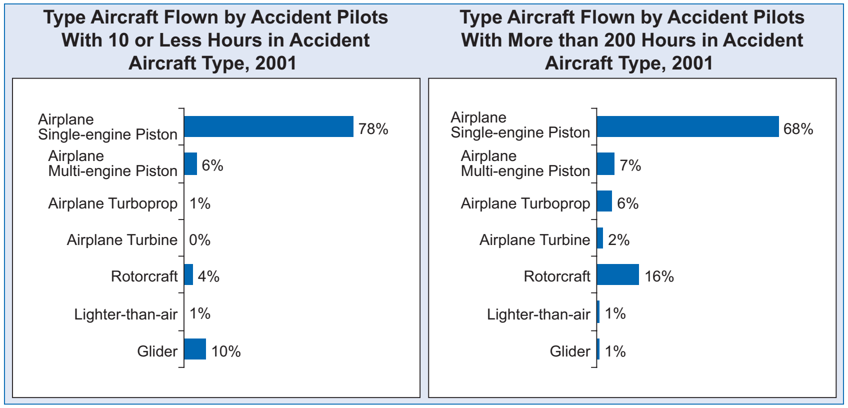
Of the 1,423 accidents in 2001 for which data are available about pilot experience in the accident aircraft make and model, 87% involved pilots with 1,000 hours or less of time in the accident aircraft make and model. Most accident pilots in this group (66%) had less than 200 hours of total flight time in the accident aircraft type, and a total of 100 pilots (9% of all accident pilots for whom data are available) had less than 10 hours in type. Most accident pilots with less than 10 hours of flight time in make and model were flying single-engine piston aircraft.

Accident Pilot Total Time in Aircraft Type, 2001



(1,437 accident pilot records with time in aircraft type information)

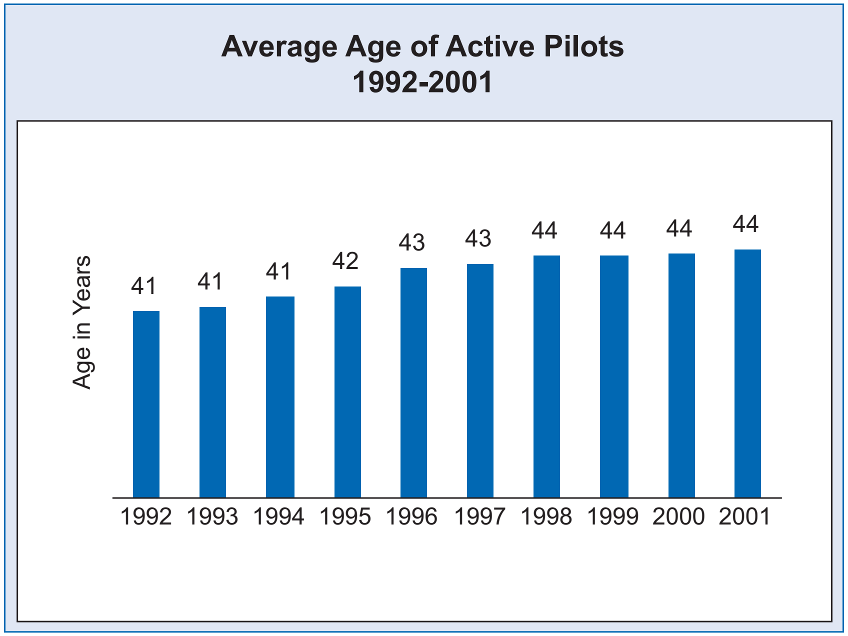
Pilots may have low time in type because they are new pilots with low total time or they are experienced pilots who are transitioning to a new aircraft. Two groups of pilots who might be expected to have accumulated significant time in make and model are those who own their own airplanes and fly them 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. Although not specifically detailed in the chart, it is particularly worth noting that 36 of the 129 accident pilots in 2001 who had less than 10 hours in the accident aircraft type were operating amateur-built aircraft.



Comparison of these two graphs shows that pilots with more than 200 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.

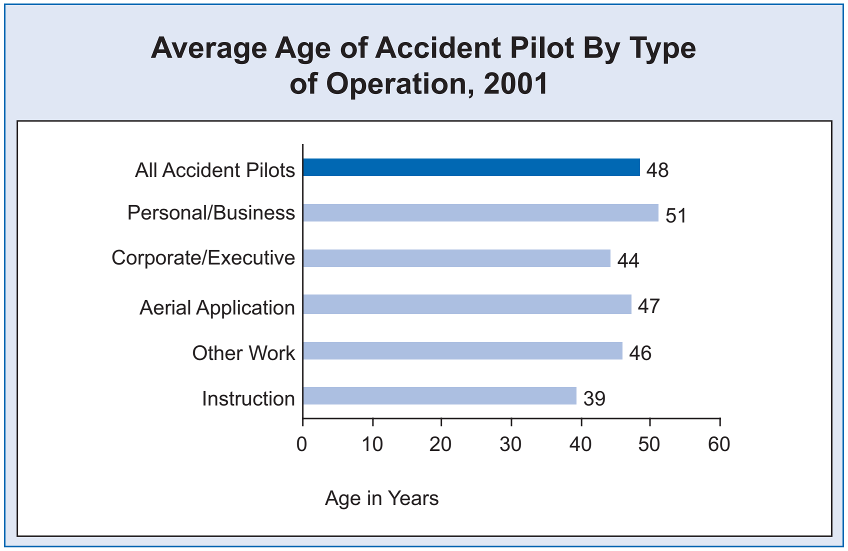
Age

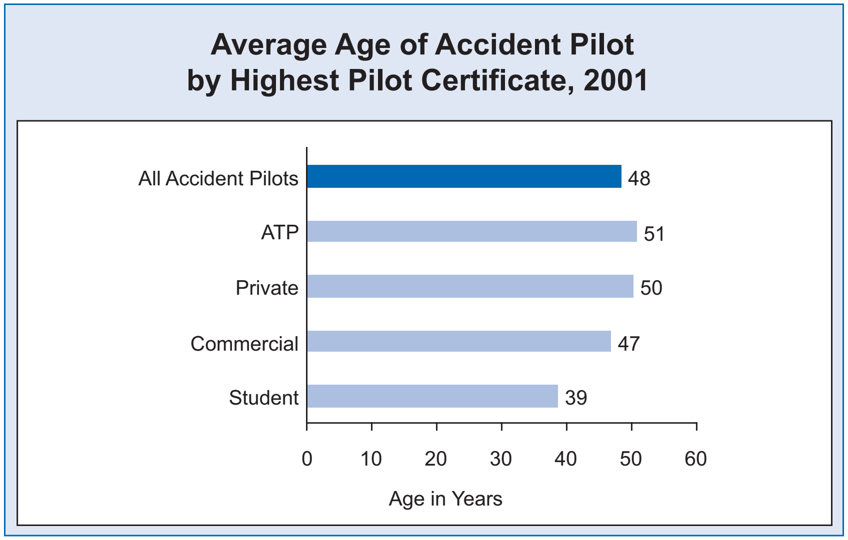
Most accident pilots in 2001 were between the ages of 40 and 59. The average age of all active pilots in the U.S. increased steadily from 1992 through 2001 and by 2001 was 44[41] years. In contrast, the average age of general aviation accident pilots was 48 years. Despite the difference in average age, no meaningful conclusions can be made regarding specific age-related accident risk because FAA flight-hour activity numbers are not available for each age group. Age differences could be the result of activity if opportunities for recreational flying were to increase with age.



Accident pilots conducting flight instruction operations, which include both flight instructors and their students, had the lowest average age of all pilots at 39 years. Accident pilots conducting personal/business flights had the highest average age at 51 years, followed by pilots of aerial application flights at 47 years.

[41] FAA, *U.S. Civil Airmen Statistics,* 2001, available at <http://www.faa.gov/data_statistics/aviation_data_statistics/civil_airmen_statistics/>.





Accident Occurrences for 2001

Safety Board accident reports document the circumstances of an accident as "accident occurrences" and the "sequence of events." Occurrence data can be defined as what happened during the accident. A total of 54[42] occurrence codes are available to describe the events for any given accident. Because aviation accidents are rarely limited to a single occurrence, each occurrence is coded as part of a sequence (that is, occurrence 1, occurrence 2, etc.), with as many as five different occurrence codes in one accident. For accidents that involve more than one aircraft, the list of occurrences may be different for each aircraft.

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

Of the 1,709 accident aircraft in 2001 for which data are available, 1,216 had 2 or more occurrences, 558 had 3 or more, 77 had 4 or more, and 5 had a total of 5 occurrences (each). The excerpt from a brief report shown here is for an accident with five occurrences. The brief illustrates how an accident with multiple occurrences is coded. In this accident, which occurred in 2001, the helicopter pilot was unable to maintain altitude during takeoff because of variable wind conditions and tried to land in a cornfield. As the helicopter slid to a stop, the right front skid caught on a cornrow, and the helicopter rolled over onto its right side. Each of these occurrences was coded in order, as shown.

Occurrence #1: LOSS OF CONTROL - IN FLIGHT

Phase of Operation: TAKEOFF - INITIAL CLIMB

Findings

1. (F) WEATHER CONDITION - VARIABLE WIND
2. (C) AIRCRAFT CONTROL - NOT MAINTAINED - PILOT IN COMMAND
3. (C) SETTLING WITH POWER - ENCOUNTERED - PILOT IN COMMAND

Occurrence #2: FORCED LANDING

Phase of Operation: EMERGENCY LANDING AFTER TAKEOFF

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER

Phase of Operation: EMERGENCY LANDING AFTER TAKEOFF

Occurrence #4: DRAGGED WING,ROTOR,POD,FLOAT OR TAIL/SKID

Phase of Operation: EMERGENCY LANDING AFTER TAKEOFF

Findings

4. (F) TERRAIN CONDITION - CROP

Occurrence #5: ROLL OVER

Phase of Operation: EMERGENCY LANDING AFTER TAKEOFF

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

Example of Occurrence Findings Cited in an NTSB Accident Brief, 2001

Occurrence data do not include specific information about why an accident may have happened; the first occurrence can instead be considered the first observable link in the accident chain of events. The following table displays first occurrences for all year-2001 general aviation accident aircraft with sequence of events data available. To simplify the presentation of accident occurrence data, similar occurrences are grouped into eight major categories.

Among the eight major categories of first occurrences, the largest percentage of accidents (27%) included occurrences related to aircraft power. Among the individual occurrences, the most common involved a loss of control either in flight (14%) or on the ground (12%). Although occurrences involving loss of aircraft control on the ground resulted in only 1 fatal accident in 2001, loss-of-control occurrences in flight resulted in a total of 110 fatal accidents—nearly one-third of all fatal accidents and more than twice that of any other single occurrence.

2001 Accident First Occurrences	Total	Fatal
Collision – In-flight	269	92
In-flight Collision with Object	133	42
In-flight Collision with Terrain/Water	116	44
Midair Collision	12	6
Undershoot	7	0
Near Collision Between Aircraft	1	0
Noncollision – In-flight	392	156
Loss of Control – In-flight	232	110
Airframe/Component/System Failure/ Malfunction	87	14
In-flight Encounter with Weather	58	28
Vortex Turbulence Encountered	7	4
Forced Landing	5	0
Altitude Deviation, Uncontrolled	2	0
Abrupt Maneuver	1	0
Decompression	0	0
Collision – On-ground or Water	117	1
On-ground/Water Collision with Object	55	1
On-ground/Water Encounter with Terrain/Water	33	0
Collision Between Aircraft (Other Than Midair)	22	0
Dragged Wing, Rotor, Pod, Float, or Tail/Skid	7	0
Noncollision – On-ground or Water	379	4
Loss of Control – On-ground/Water	207	1
Hard Landing	93	0
Overrun	33	2
Nose Over	23	0
Roll Over	14	0
On Ground/Water Encounter With Weather	5	0
Propeller/Rotor Contact to Person	2	1
Nose Down	1	0
Propeller Blast or Jet Exhaust/Suction	1	0
Ditching	0	0

2001 Accident First Occurrences (Cont.)	Total	Fatal
Power Related	460	49
Loss of Engine Power	219	24
Loss of Engine Power (Total) – Nonmechanical	110	7
Loss of Engine Power (Total) – Mech Failure/Malfunction	61	9
Loss of Engine Power (Partial) – Nonmechanical	35	8
Loss of Engine Power (Partial) – Mech Failure/Malfunction	24	1
Rotor Failure/Malfunction	7	0
Propeller Failure/Malfunction	4	0
Engine Tear-away	0	0
Landing Gear	40	0
Wheels-up Landing	20	0
Gear Collapsed	12	0
Main Gear Collapsed	4	0
Complete Gear Collapsed	1	0
Gear Retraction on Ground	1	0
Tail Gear Collapsed	1	0
Wheels-down Landing in Water	1	0
Nose Gear Collapsed	0	0
Other Gear Collapsed	0	0
Gear Not Extended	0	0
Gear Not Retracted	0	0
Miscellaneous	48	6
Miscellaneous/Other	31	5
Fire	14	0
Fire/Explosion	3	1
Explosion	0	0
Hazardous Materials Leak/Spill	0	0
Cargo Shift	0	0
Undetermined	4	3
Missing Aircraft	3	2
Undetermined	1	1

Phase of Flight

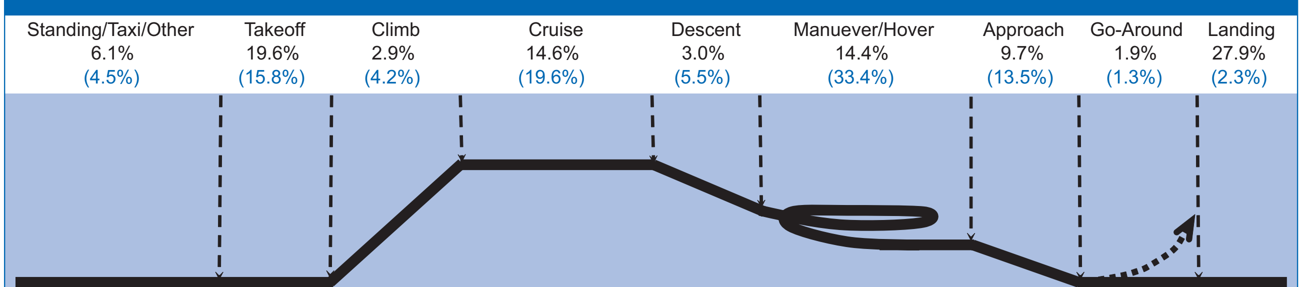
The following illustration displays the percentage of accident aircraft in each phase of flight at the time of first occurrence. The phase of flight can be defined as *when*, during the operation of the aircraft, the first occurrence took place. There are 50 distinct phases of flight that investigators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

As shown in the illustration, most accidents (60%) occurred during takeoff, climb, approach, and landing, despite the relatively short duration of these phases compared to the entire profile of a normal flight. The high number of accidents that occurred during takeoff and landing reflects the increased workload placed on both the flight crew and the aircraft during these phases. During both takeoff and landing, the flight crew must control the aircraft, change altitude and speed, communicate with air traffic control (ATC) and/or other aircraft, and maintain separation from obstacles and other aircraft. Aircraft systems are also stressed during takeoff and landing with changes to engine power settings, the possible operation of retractable landing gear, flaps, slats, and spoilers, and changes in cabin pressurization. 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.

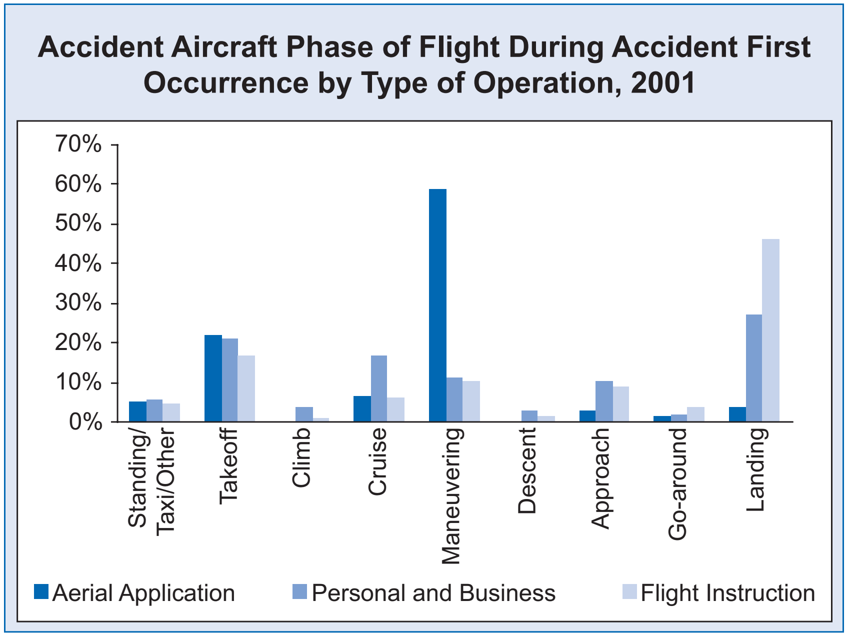
Notably, the landing phase of flight accounted for the largest percentage of total accident first occurrences (28%) but only 2% of fatal accident first occurrences. The largest percentage of fatal accident first occurrences (33%) occurred during the maneuvering phase of flight, but only 14% of all accident first occurrences occurred during this phase. These differences reflect the relative severity of accidents that are likely to occur during each of these phases. Accidents that occur during cruise and maneuvering 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.

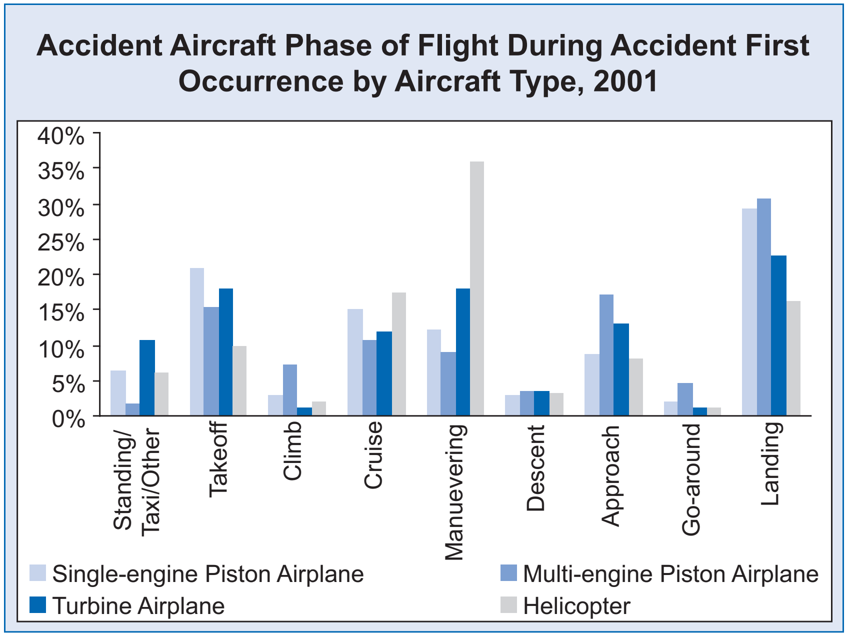
The likelihood of an aircraft accident first occurrence during each phase of flight varies by aircraft type and type of operation due to the unique hazards associated with each. For example, aircraft conducting aerial application flights fly at very low altitudes while spraying and therefore have an increased risk of colliding with terrain or obstructions. As a result, about 59% of all first occurrences for 2001 accidents involving aerial application flights occurred during the maneuvering phase compared to less than 11% of personal/business flights and 10% for instructional flights.

Accident Aircraft Phase of Flight During First Occurrence, 2001



1,709 accident aircraft with phase of flight data





Accident phase-of-flight differences among aircraft types are the result of the amount of time spent in each phase, aircraft-specific hazards associated with that phase, and the type of operations typically conducted with that aircraft. For example, the largest percentage of first occurrences for accidents involving helicopter flights, about 36%, occurred while maneuvering. The percentage of accidents during this phase reflects the hazards unique to helicopters during hover and during operations that are unique to helicopters, such as carrying external loads. In contrast, the largest percentage of accidents involving single- and multi-engine piston aircraft occurred during landing.

Chain of Occurrences

An accident's first occurrence and phase of flight during first occurrence indicate how and when an accident begins. However, the entire accident can also be viewed as a chain of all the accident occurrences cited in the order in which they happen. As previously discussed, accident events often include a combination of multiple occurrences, with many possible combinations. For example, of the 1,709 accidents that occurred during 2001 for which occurrence data are available, 407 unique combinations of accident occurrences were cited. The following tables, which list the top ten combinations of occurrences for all accidents and fatal accidents, illustrate the most common events.

The top ten occurrence chains cited in fatal accidents are similar to those cited for all accidents. Loss of control followed by in-flight collision with terrain tops both lists, with more than half the accidents of this type being fatal. It is important to note that, although this was the most frequent chain of occurrences in 2001, it accounted for less than 10% of all accidents for the year.

A diverse range of events can, in combination, result in an accident. Fatal accidents, however, are usually the result of a more specific set of events. A comparison of the two lists provides insight as to why some accidents are fatal and others are not. Nine of the top ten chains of fatal accident occurrences included an in-flight collision with terrain/water or object, accident profiles that are more likely to result in the high impact forces likely to cause serious injury. In contrast, only five of the chain of occurrences for all GA accidents involved an in-flight collision with terrain/water or object.

Rank	Chain Of Occurrences - All GA Accidents, 2001	Number of Accidents
1	Loss of Control In-flight -> In-flight Collision with Terrain/Water	149
2	In-flight Collision with Terrain/Water	98
3	In-flight Collision with Object	72
4	Hard Landing	58
5	Loss of Control On-ground/water -> On ground/water Encounter with Terrain/Water	51
6	On-ground/water Collision with Object	47
7	Loss of Control On-ground/water	46
8	In-flight Collision with Object -> In-flight Collision with Terrain/Water	40
9	Loss of Control On-ground/water -> On ground/water Collision with Object	39
10	Loss of Engine Power -> Forced Landing -> In-flight Collision with Terrain/Water	31

Rank	Chain Of Occurrences - Fatal GA Accidents, 2001	Number of Accidents
1	Loss of Control In-flight -> In-flight Collision with Terrain/Water	88
2	In-flight Collision with Terrain/Water	44
3	In-flight Collision with Object	22
4	In-flight Collision with Object -> In-flight Collision with Terrain/Water	13
5	In-flight Encounter with Weather -> In-flight Collision with Terrain/Water	11
6	Loss of Control In-flight -> In-flight Collision with Object	10
7	Loss of Control In-flight -> In-flight Collision with Object -> In-flight Collision with Terrain/Water	7
8	In-flight Encounter with Weather -> Loss of Control In-flight -> In-flight Collision with Terrain/Water	6
9	Loss of Engine Power -> Loss of Control In-flight -> In-flight Collision with Terrain/Water	6
10	Airframe/Component/System Failure/Malfunction -> Loss of Control In-flight -> In- flight Collision with Terrain/Water	5

Most Prevalent Causes/Factors for 2001

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

In addition to coding accident occurrences, the Safety Board makes a determination of probable cause. The objective of the probable cause statement is to define the cause and effect relationships in the accident sequence. The probable cause could be described as a determination of *why* the accident happened. In determining probable cause, the Board considers the facts, conditions, and circumstances of the event. Within each accident occurrence, any information that helps explain why that event happened is identified as a "finding" and may be further designated as either a "cause" or "factor." The term "factor" is used to describe situations or circumstances that contributed to the accident cause. 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, the reason why those events led to an accident reflects a combination of multiple causes and factors. For this reason, a single accident report can include multiple cause and factor codes, as shown in the following brief.

Occurrence #1: LOSS OF ENGINE POWER(TOTAL) - NONMECHANICAL

Phase of Operation: CRUISE - NORMAL

Findings
1. (C) AIRCRAFT PREFLIGHT - INADEQUATE - PILOT IN COMMAND
2. FUEL SUPPLY - INADEQUATE
3. (C) FLUID,FUEL - EXHAUSTION
4. ENGINE INSTRUMENTS,FUEL QUANTITY GAGE - INACCURATE

Occurrence #2: FORCED LANDING

Phase of Operation: EMERGENCY DESCENT/LANDING

Occurrence #3: ON GROUND/WATER ENCOUNTER WITH TERRAIN/WATER

Phase of Operation: LANDING - ROLL

Findings
5. (F) AIRPORT FACILITIES,RUNWAY/LANDING AREA CONDITION - ROCK(S)/BOULDER(S)

Occurrence #4: MAIN GEAR COLLAPSED

Phase of Operation: LANDING - ROLL

Findings
6. (F) LANDING GEAR,MAIN GEAR - OVERLOAD

Occurrence #5: ON GROUND/WATER ENCOUNTER WITH TERRAIN/WATER

Phase of Operation: LANDING - ROLL

Findings
7. (F) AIRPORT FACILITIES,RUNWAY/LANDING AREA CONDITION - DROP-OFF/DESCENDING EMBANKMENT

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

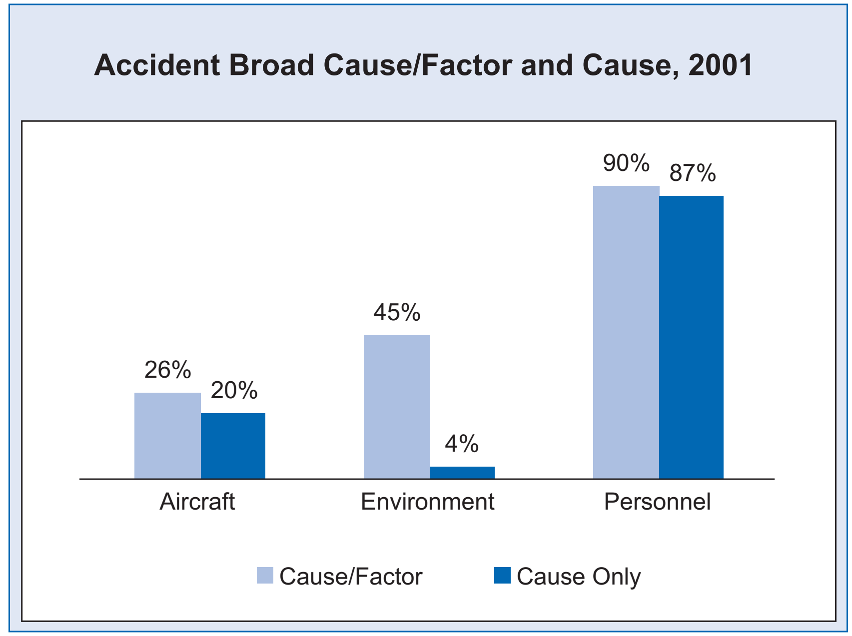
The National Transportation Safety Board determines the probable cause(s) of this accident as follows.
The inadequate preflight performed by the pilot which resulted in an insufficient fuel supply and the subsequent fuel exhaustion. Factors associated with the accident were the inaccurate fuel quantity indicator, the rock which resulted in the overload failure of the right main landing gear, and the embankment which the airplane traveled down.

Example of NTSB Accident Brief, 2001

This accident sequence began with a loss of power during cruise, and the pilot was forced to land. During the forced landing, the right main landing gear separated from the airplane after striking a large rock. The airplane came to rest down an embankment. In this accident, the lack of fuel and inadequate preflight performed by the pilot were cited as causes, with the terrain and the overload on the landing gear cited as contributing factors. The inaccuracy of the fuel gauges was cited in the findings but was not assigned as a cause or factor.

To simplify the presentation of probable cause information in this review, the hundreds of unique codes used by investigators to code probable cause are 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 shows the percentage of general aviation accidents that fall into each broad cause/factor classification. Personnel-related causes or factors were cited in 90% of the 1,686 general aviation accident reports for 2001 for which cause/factor data were available. Environmental causes/factors were cited in 45% of these accident reports, and aircraft-related causes/factors were cited in 26%.[43]

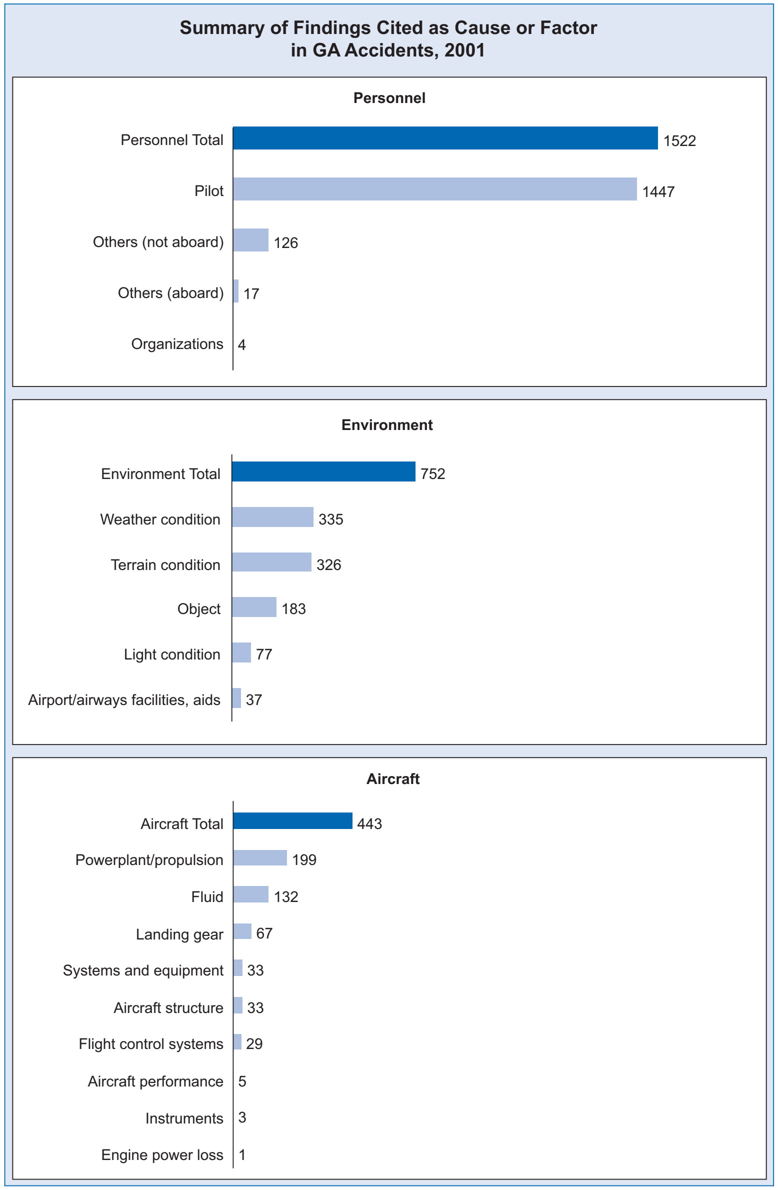
Environmental conditions are rarely cited as an accident cause but are more likely to be cited as a contributing factor. In 2001, only 67 of 752 environmental citations (9% of all environmental causes/factors) were listed as a cause, with the remainder listed as contributing factors. For example, rough terrain might be cited as a contributing factor, but not a cause, to explain why an aircraft was damaged during a forced landing due to engine failure. In that case, the origin(s) of the engine failure would be cited as "cause," but the terrain would be cited as a factor because it contributed to the accident outcome.



(1,686 accidents with findings)

As mentioned previously, several hundred unique codes are available to document causes/factors. A more detailed summary of the cause/factor codes is illustrated in the following graph, grouped into the categories of personnel, environment, and aircraft.

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



1,686 accidents with findings in 2001)

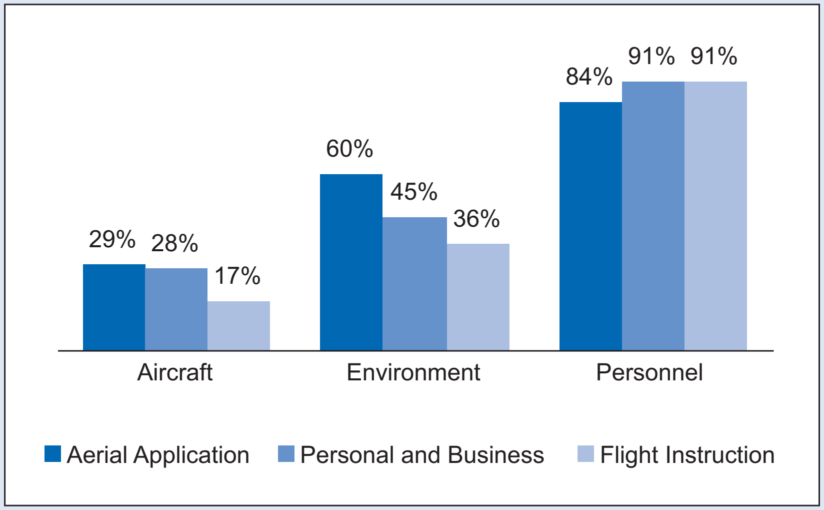
As this figure shows, most causes and factors attributed to general aviation accidents in 2001 were related to personnel. Much like the pilot and passenger injury differences discussed previously, part of the reason why personnel are cited so often may have to do with exposure to risk. Personnel, and pilots in particular, are associated with every flight. However, potential aircraft and environmental accident causes and factors depend on a range of variables, including the type of flight, type of aircraft, time of day, time of year, and location.

Although the pilot was the most frequently cited individual in the personnel category in 2001, other persons not aboard the aircraft were also cited as a cause or factor in 126 accidents. Such personnel included flight instructors, maintenance technicians, and airport personnel. In the broad category of environmental factors, weather conditions were cited in 335 or 20% of the accidents. Powerplant-related[44] causes/factors, cited in 199 or 12% of all general aviation accidents in 2001, were the most commonly cited aircraft factors.

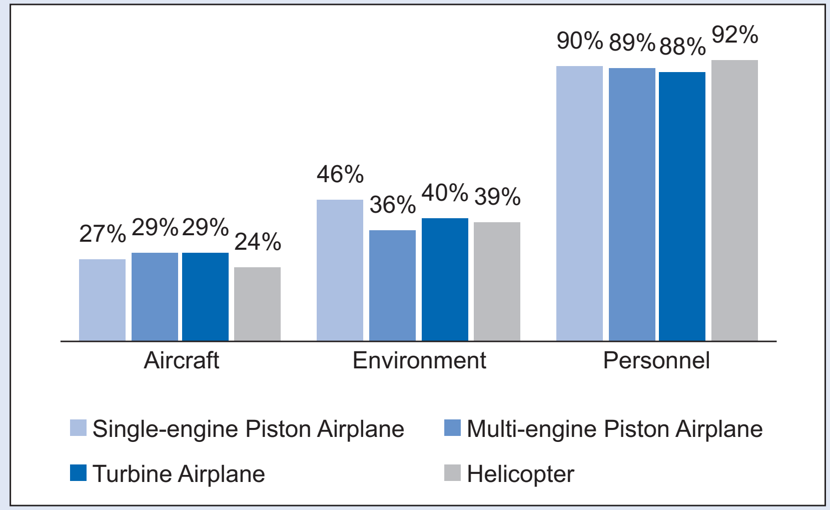
The following graph shows how specific accident causes and factors vary by type of flight operation. For example, personnel were cited in 91% of instructional flight accidents and personal/business accidents, compared to 84% for aerial application accidents. The high percentage of personnel causes/factors for flight instruction accidents is likely the result of aircraft control and decision-making errors due to students' lower level of skill and ability. In contrast, aerial application accidents cited a higher percentage of aircraft causes/factors, most likely because the low altitude flown during spray operations allows few options for recovery in the event of a mechanical failure.

[44] "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. "Engine power loss" refers only to the total loss of engine power.

Broad Causes/Factors by Type of Operation, 2001



Broad Causes/Factors by Accident Aircraft Type, 2001



A comparison of the causes/factors cited in accidents involving different types of aircraft reveals surprisingly similar results. The slightly higher percentage of helicopter and multi-engine piston accidents that cited aircraft causes/factors is likely a result of the mechanical complexity and reliability of the aircraft and powerplants. The higher percentage of environmental causes/factors cited in single-engine aircraft accidents may be due to the range, performance, and equipment limitations of smaller aircraft.

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 becomes disoriented and loses control of an aircraft after continuing visual flight into instrument flight conditions, the pilot would be cited as a "cause" in the personnel category, and planning/decision-making would likely also be cited in the human performance issues category.

Human Performance and Explanatory Causes/Factors, 2001	All Accidents	Fatal Accidents
Human Performance Issues	1,417	273
Aircraft Handling/Control	959	220
Planning/Decision	537	106
Use of Aircraft Equipment	160	21
Maintenance	91	10
Communications/Information/ATC	67	7
Meteorological Service	6	4
Airport	2	0
Dispatch	1	0
Underlying Explanatory Factors	206	87
Qualification	97	32
Physiological Condition	56	46
Psychological Condition	41	11
Aircraft/Equipment Inadequate	8	2
Material Inadequate	4	2
Procedure Inadequate	4	2
Institutional Factors	4	3
Facility Inadequate	3	2
Information	2	1

Of the 1,417 accidents for which the cause or factor was attributed to human performance in 2001, the most frequently cited cause/factor was aircraft handling and control (68%), followed by planning and decision-making (38%) and use of aircraft equipment (11%). Issues related to personnel qualification were cited in almost half of the 206 accidents with underlying explanatory factors related to human performance. Examples of qualification issues that were cited in the 2001 accident record included lack of total experience, lack of recent experience, and inadequate training.

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. 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 five environmental causes/factors cited in general aviation accidents in 2001, three were related to wind. Because aircraft are most susceptible to the effects of wind during takeoffs and landings, the effect of adverse wind was reflected in a high percentage of general aviation accidents that occurred during those phases of flight.

	All Accidents	Fatal Accidents
Weather Condition	335	63
Crosswind	86	0
Gusts	71	5
Tailwind	49	8
Fog	24	19
Low ceiling	24	18
High wind	23	2
Carburetor icing conditions	21	1
High density altitude	21	5
Downdraft	16	4
Variable wind	13	0
Snow	8	4
Clouds	7	5
Sudden windshift	6	0
Obscuration	6	5
Rain	6	3
Dust devil/whirlwind	6	0
Windshear	5	0
Icing conditions	5	2
Turbulence	4	1
Drizzle/mist	4	3
Thermal lift	3	0
Thunderstorm	3	3
Whiteout	3	0
Haze/smoke	3	2
Below approach/landing minimums	2	0
No thermal lift	2	0
Temperature inversion	1	0
Temperature, high	1	0
Turbulence, terrain induced	1	0
Unfavorable wind	1	0
Turbulence in clouds	1	1
Thunderstorm, outflow	1	0
Updraft	1	0
Freezing rain	1	0
Microburst/dry	1	0
Ice fog	1	1

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

As previously discussed, most landing accidents do not result in fatal injuries. Because of the strong association of wind with landing accidents in 2001, it is not surprising that most wind-related accidents are also not fatal. The wind-related weather factors “crosswind,” “gusts,” and “tailwind” were cited as a cause/factor in a total of 206 accidents, but only 13 of those accidents were fatal. Among fatal general aviation accidents, three of the five most frequently cited weather factors were related to conditions that resulted in reduced visibility, including “low ceiling,” “fog,” and “clouds.” Accidents under conditions of low visibility typically involve either loss of aircraft control and/or collision with obstacles or terrain, both of which are likely to result in severe injuries and aircraft damage.

Focus on General Aviation Safety: Loss of Control

A review of accident data reveals that accidents involving a loss of aircraft control represent a significant risk to general aviation safety. The following section includes statistical data and a discussion of general aviation accidents that resulted from a loss of aircraft control. This section is not meant to be an exhaustive discussion of all safety concerns, but rather a discussion of the details of an issue important to general aviation.

2001 GA Loss-of-Control Accident Statistics	
Loss-of-Control Accidents	
Total Accidents	559
Accident Aircraft	564
Loss-of-Control Accident Highest Injury	
Fatal	163
Serious	56
Minor	64
None	276
Loss-of-Control Accident Injuries	
Fatal	278
Serious	94
Minor	132
Persons aboard with no injuries	474
Loss-of-Control Accident Aircraft Damage	
Destroyed	160
Substantial	395
Minor*	3
None*	

What Is Loss of Control?

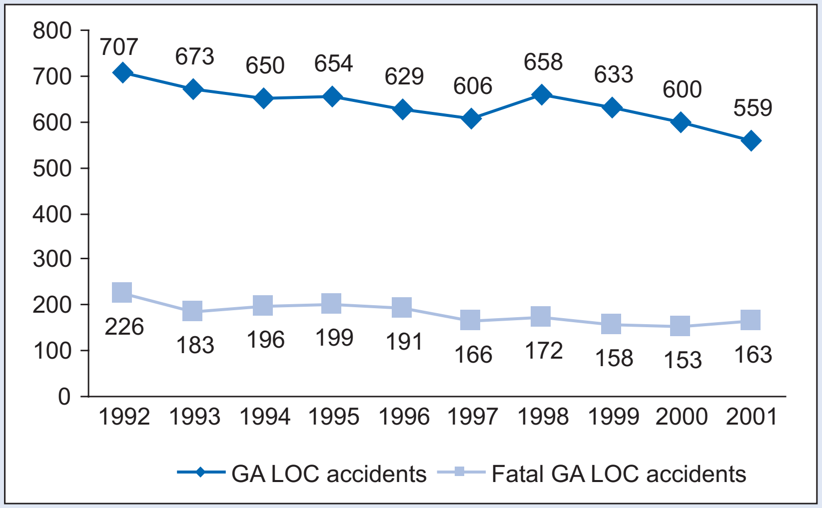
Unlike such accident occurrences as an aircraft equipment failure or a collision with an obstruction, which are defined by an immediately observable event, a loss of control is often only obvious after the fact based on an unsuccessful outcome. The measure of whether or not an aircraft is under control is simply how closely aircraft behavior matches the expectations and intentions of the flight crew. The point at which control is lost can be subjective, but the inability to avoid an accident certainly qualifies. For example, a fluctuation in altitude of 50 feet while a pilot is trying to maintain level flight would not be considered a loss of control, but if that aircraft impacts the runway during landing because the pilot is unable to change the pitch attitude of the aircraft, it would be considered a loss of control.

A loss of control may result from environmental factors such as turbulence, aircraft factors such as a design limitation or equipment failure, or pilot issues such as disorientation or skill deficiency. For this discussion, a loss-of-control accident is defined as any accident citing a loss of control occurrence in the official Safety Board investigation analysis. Unlike the discussion of first occurrence earlier in this review, the accident set referenced in this section includes all general aviation accidents that cite a loss of control occurrence, regardless of the order of that occurrence.

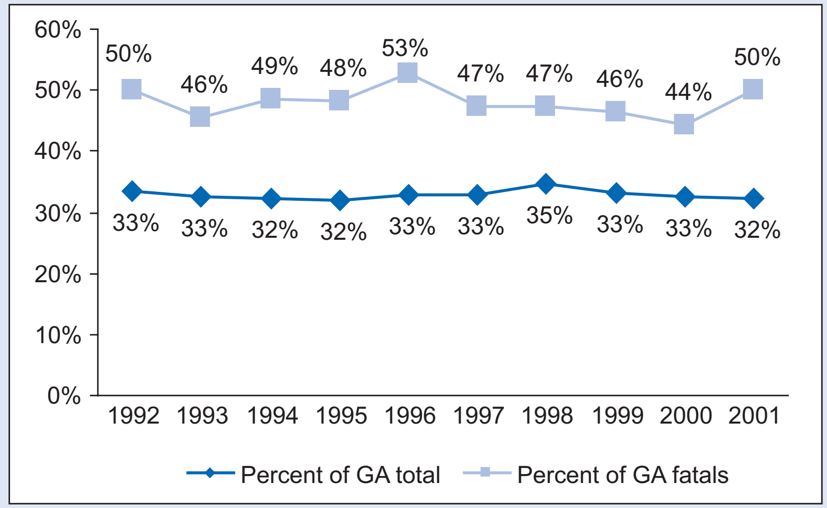
Loss-of-Control Accidents

As discussed in a previous chapter of this review, the combined occurrence categories of *loss of control on ground* and *loss of control in flight* account for the largest number of general aviation accident first occurrences, both fatal and non-fatal. In 2001, loss-of-control accidents accounted for almost a third of all general aviation accidents and half of the fatal accidents. Charting the total and fatal number of accidents that occurred annually from 1992 through 2001 involving any loss-of-control occurrence reveals a consistent pattern; in general, loss-of-control accidents steadily declined during the 10-year period, and averaged 33% of all general aviation accidents and 48% of all fatal accidents.

Total and Fatal General Aviation Accidents Involving Loss-of-Control, 1992-2001



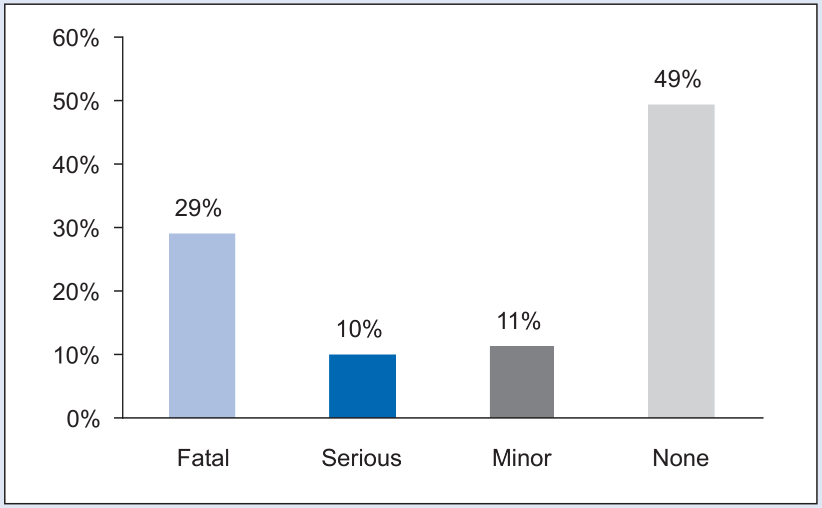
Percent of Total and Fatal General Aviation Accidents Involving Loss-of-Control, 1992-2001



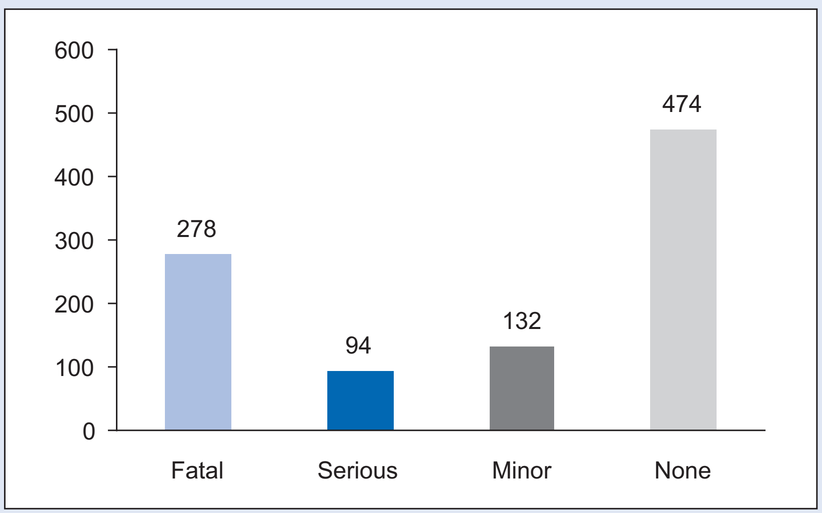
Accident Severity

The high proportion of fatal accidents citing a loss of aircraft control is indicative of the severity of these kinds of accidents. During 2001, approximately 29% of the loss-of-control accidents resulted in fatal injuries compared to about 19% of all types of general aviation accidents. Another 10% of the loss-of-control accidents resulted in serious injuries. A total of 278 persons were killed as a result of loss-of-control accidents during 2001. An additional 226 persons received less than fatal injuries, and 474 persons were uninjured.

Highest Level of Injury Sustained in Loss-of-Control Accidents, 2001

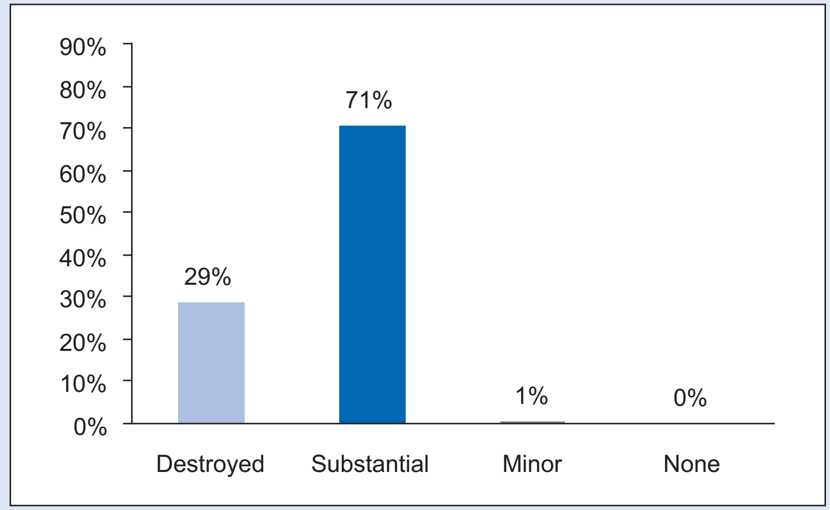


Number of Injuries Resulting From Loss-of-Control Accidents, 2001



Another indication of the severity of accidents involving a loss of aircraft control is that nearly all accident aircraft were substantially damaged or destroyed.

Level of Aircraft Damage Sustained in Loss-of-Control Accidents, 2001



Accident Occurrences

In such cases as a control system malfunction, an aircraft may be rendered uncontrollable. In other cases, a pilot may fail to maintain control of the aircraft or place it in a condition that is difficult or impossible to recover. Aside from the obvious difference of aircraft or pilot-related causes, accidents involving a loss of aircraft control can differ on whether the loss of control led to the accident or resulted from other occurrences.

The following chart ranks, in order by frequency, the first occurrences of all general aviation accidents in 2001 that cited a loss-of-control occurrence. The most frequently cited first occurrence was "loss of control–in flight," followed closely by "loss of control–on ground/water." For 443 accidents, or more than 78% of all loss-of-control accidents, the first cited accident occurrence was the loss of control. The next most common occurrences, "airframe/component/system failure/malfunction" and "loss of engine power," are indicative of situations in which maintaining aircraft control may become difficult but may occur for reasons other than pilot actions. The next most common first occurrences of "in flight encounter with weather," "hard landing," and "in flight collision with object" are again situations in which pilot actions may have resulted in the conditions that made aircraft control difficult.

First Occurrences for Aircraft Involved in Loss-of-Control Accidents, 2001		
	Total	Fatal
Loss of control - in flight	236	110
Loss of control - on ground/water	207	1
Airframe/component/system failure/malfunction	26	9
Loss of engine power	24	13
In flight encounter with weather	13	9
Hard landing	12	0
In flight collision with object	8	4
Miscellaneous/other	8	3
Loss of engine power (partial) - nonmechanical	6	5
Loss of engine power (total) - mechanical failure/malfunction	4	3
On ground/water encounter with weather	4	0
Loss of engine power (partial) - mechanical failure/malfunction	3	1
Loss of engine power (total) - nonmechanical	3	2
On ground/water collision with terrain/water	2	0
Abrupt maneuver	1	1
Gear collapsed	1	0
Main gear collapsed	1	0
Midair collision	1	1
On ground/water collision with object	1	0
Propeller failure/malfunction	1	0
Undershoot	1	0
Undetermined	1	1
Grand Total	**564**	**163**

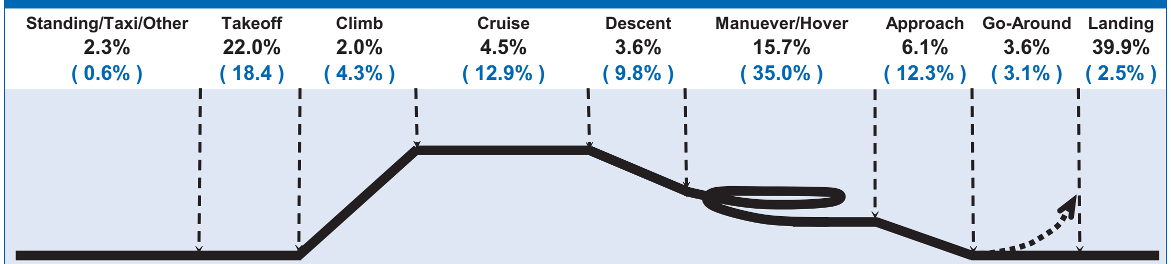
A comparison of the numbers of total and fatal accidents citing each first occurrence illustrate that nearly 50% of accidents citing "loss-of-control–in flight" during 2001 resulted in fatal injuries. In contrast, the occurrences associated with loss of control once the aircraft came in contact with the earth's surface (for example, "loss of control–on ground/water," "hard landing," and on-ground encounters with water, terrain, or objects) account for approximately the same number of accidents (226). However, only one of those accidents was fatal.

Most Frequent Occurrence Chains Reported For GA Accidents Involving a Loss Of Aircraft Control, 2001

1.	**1)** Loss Of Control - In Flight, **2)** In Flight Collision With Terrain/Water	140
2.	**1)** Loss Of Control - On Ground/Water, **2)** On Ground/Water Encounter With Terrain/Water	51
3.	**1)** Loss Of Control - On Ground/Water	46
4.	**1)** Loss Of Control - On Ground/Water, **2)** On Ground/Water Collision With Object	38
5.	**1)** Loss Of Control - In Flight, **2)** In Flight Collision With Object	22
6.	**1)** Loss Of Control - On Ground/Water **2)** Nose Over	16
7.	**1)** Loss Of Control - In Flight | In Flight Collision With Object **2)** In Flight Collision With Terrain/Water	15
8.	**1)** Loss Of Control - On Ground/Water **2)** On Ground/Water Encounter With Terrain/Water **3)** Nose Over	13
9.	**1)** Loss Of Control - In Flight	12
10.	**1)** Airframe/Component/System Failure/Malfunction **2)** Loss Of Control - In Flight **3)** In Flight Collision With Terrain/Water	10

The following graphic illustrates the percentage of loss-of-control accidents that occurred in each of nine distinct phases of flight during the first accident occurrence.

Loss-of-Control Accident Phase of Flight During First Occurrence, 2001



557 of 559 accidents with phase of flight data

Similar to the phase of flight details of all general aviation accidents discussed earlier in this review, the largest percentage of loss-of-control accident occurrences happened during the landing phase, followed by the takeoff phase. The combined phases of takeoff and landing accounted for approximately 62% of all loss-of-control accidents during 2001. Phases of flight that typically involve higher speeds and higher altitudes, including “cruise,” “maneuvering,”and “approach,” accounted for a total of approximately 60% of the fatal loss-of-control accidents.

The reasons why losing control of an aircraft in flight might result in a more severe outcome than losing control on or near the ground may seem obvious. What may be less obvious is how much more deviation in control can be tolerated in flight compared to on the ground.

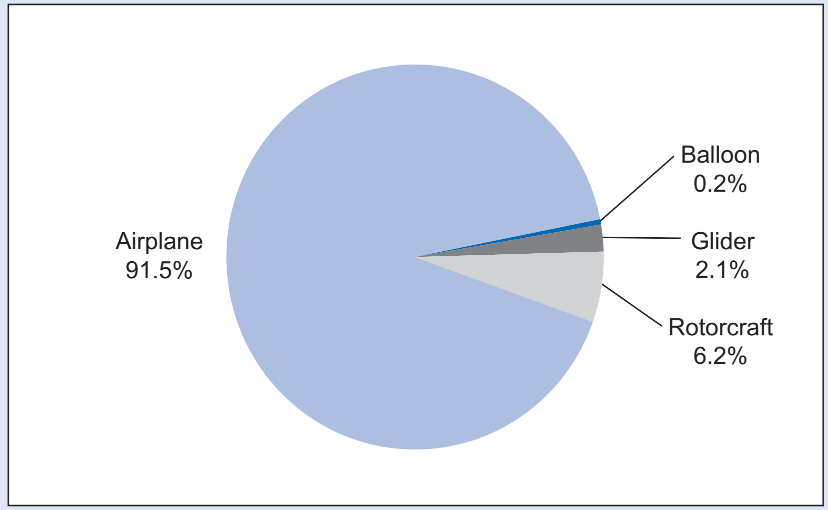
Controlling an aircraft during takeoff or landing typically requires precise, coordinated inputs to aircraft flight controls and/or engine power settings while in close proximity to terrain and obstacles. Failure to quickly and accurately make those inputs can all result in mishaps that would be considered a loss of aircraft control. In contrast, an aircraft operating in cruise flight is typically well above the surface and clear of obstacles. The performance standard for aircraft control is much more generous under such circumstances. A deviation in aircraft pitch, bank, or yaw that could be disastrous during landing or takeoff if not corrected immediately is unlikely to be of any consequence for an aircraft in cruise. A loss of control at higher altitudes therefore typically involves more drastic circumstances like pilot disorientation, hazardous weather encounter, or equipment failure.

In some cases, a loss of aircraft control may occur in flight when a pilot exceeds, or attempts to exceed, the limitations of the aircraft. Aerobatic flight maneuvers or continued flight in icing conditions in an aircraft not equipped or certified[45],[46] for those operations, or failing to adhere to speed limitations, may result in aerodynamic conditions or structural damage that render an aircraft uncontrollable.

Accident Aircraft

A comparison of accident aircraft types illustrates that airplanes are responsible for the greatest proportion of loss-of-control accidents. The percentages of each type of aircraft involved in loss-of-control accidents during 2001 are similar to the percentage of total general aviation flight hours estimated for each aircraft type. For example, slightly more than 87% of general aviation estimated flight hours were flown in fixed-wing aircraft during 2001 compared to approximately 92% of the loss-of-control accidents involving airplanes. Rotorcraft accounted for approximately 7% of GA flight hours compared to slightly more than 6% of all loss-of-control accidents.

Aircraft Type Involved in Loss-of-Control Accidents, 2001



The fact that airplanes are similar to, or even slightly more likely than, rotorcraft to be involved in a loss-of-control accident after controlling for activity is somewhat surprising considering the greater complexity of the flight control systems and control inputs required by pilots of rotorcraft in comparison to airplanes.

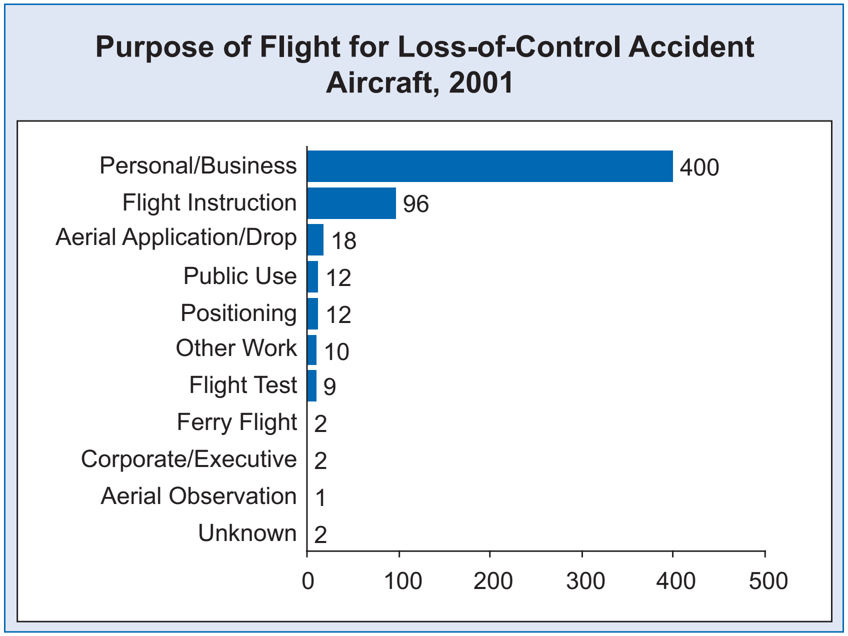
Type of Operation

A comparison of the percentage of accidents involving different flight operations shows that approximately 71% of loss-of-control accidents during 2001 involved personal/business flights.

[45] Refer to 14 CFR, Part 23 for specific airworthiness certification requirements of acrobatic category airplanes.

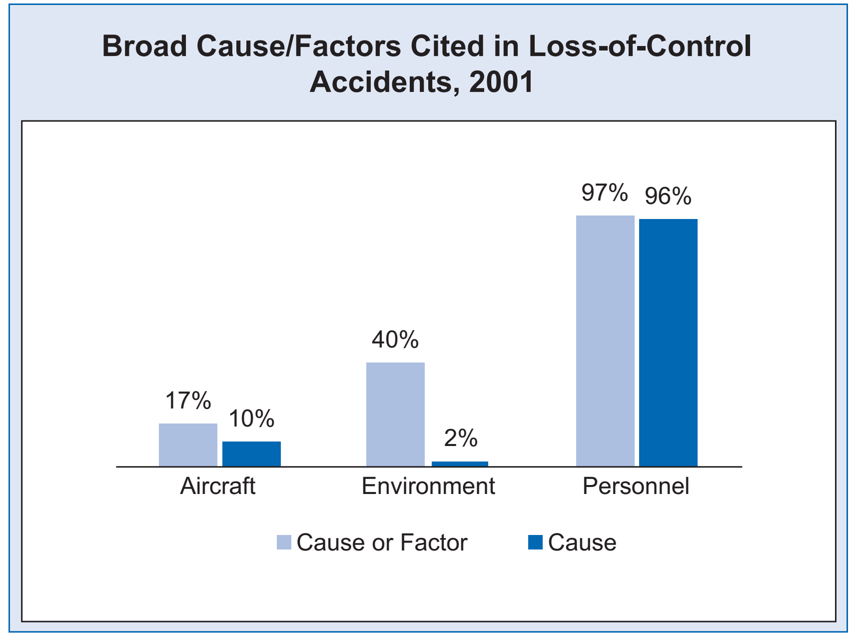
[46] Refer to 14 CFR 91.527 for the requirements of operating in icing conditions.

Instructional flights were the next most common type of flight operation to be involved in a loss-of-control accident, with a total of 17%.



Loss-of-Control Accident Causes/Factors

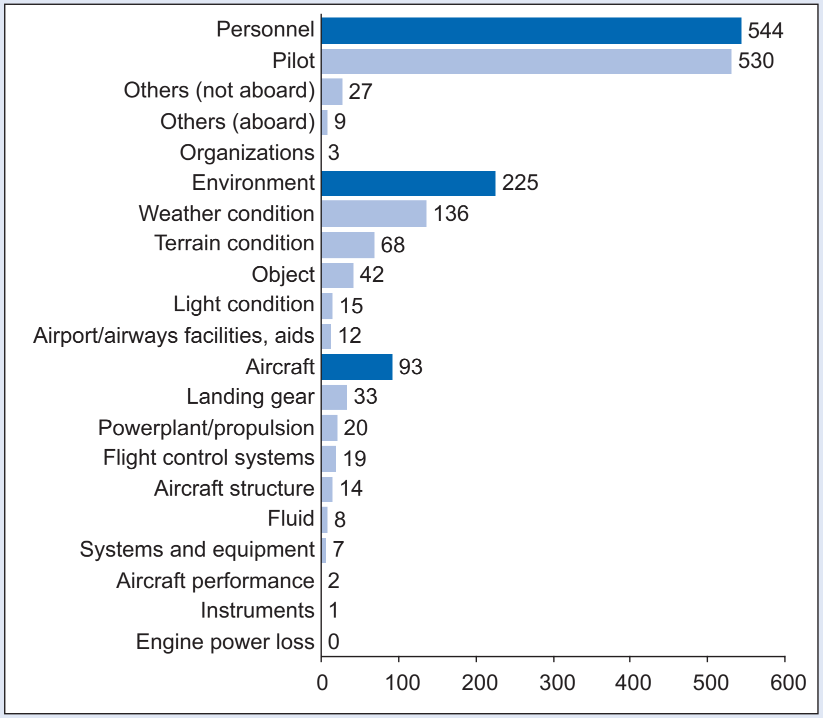
A comparison of the broad categories of accident probable cause and contributing factors cited in the Safety Board accident investigation findings for loss-of-control accidents during 2001 shows that personnel are the most likely to be cited. In fact, probable cause/factors in the broad category of personnel were more likely to be cited for loss-of-control accidents than for GA accidents as a whole in 2001, and the aircraft and environment categories causes/factors were less likely to be cited.



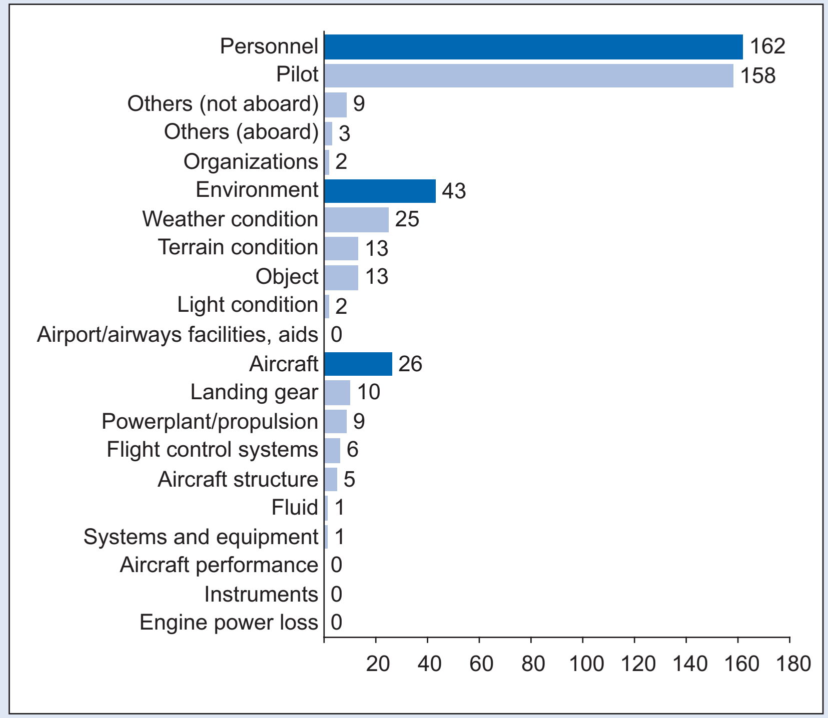
(559 loss-of-control accidents with findings available)

Within the broad category of personnel, pilots were the most frequently cited individuals, and accounted for more than 97% of the personnel cause/factors cited. Examples of the other categories of personnel cited in loss-of-control accident findings during 2001 include a flight instructor cited for failing to provide adequate supervision of a student and a maintenance technician who used incorrect materials in a repair that contributed to a landing gear collapse.

All General Aviation Loss-of-Control Accident Cause/Factors, 2001



Fatal General Aviation Loss-of-Control Accident Cause/Factors, 2001

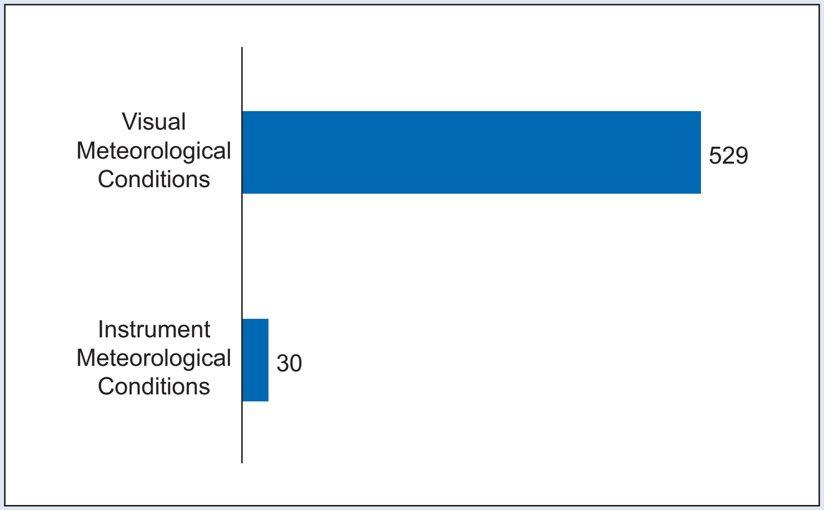


In the aircraft cause/factor category, landing gear was the most commonly cited aircraft component. The most common examples of landing gear issues cited as causes or factors in loss-of-control accidents during 2001 included brake failure and gear collapse. A landing gear malfunction or failure can lead to a loss of control, or it can be the result of damage caused by impact or imposed loads following a loss of control.

Accident Weather

In 2001, the proportion of loss-of-control accidents citing environmental causes and factors was slightly less than the proportion for all accidents. Weather conditions represented the largest percentage of environment-related cause/factor findings cited for loss-of-control accidents. The most commonly cited weather causes and factors associated with non-fatal loss-of-control accidents were related to the wind, such as crosswinds, gusts, and tailwinds. Fatal loss-of-control accidents were more likely to have cited weather conditions related to reduced visibility such as fog or low cloud ceilings. This contrast further illustrates the differences in the severity of accident outcome when the demands of aircraft control are not met under different conditions and phases of flight.

Basic Weather Conditions Associated with Loss-of-Control Accidents, 2001



All Weather-Related GA LOC Accident Cause/Factors, 2001

	Total	Fatal
Weather condition	136	25
Crosswind	67	0
Gusts	42	4
Tailwind	19	4
Fog	7	6
Low ceiling	7	7
High wind	7	1
Variable wind	4	0
Downdraft	4	3
Dust devil/whirlwind	4	0
High density altitude	4	2
Thunderstorm	2	2
Turbulence	2	0
Drizzle/mist	2	2
Icing conditions	2	1
Sudden windshift	1	0
Snow	1	1
Turbulence in clouds	1	1
Obscuration	1	1
Rain	1	1
Haze/smoke	1	1
Clouds	1	1
Ice fog	1	1
Turbulence (thunderstorms)	0	0
Carburetor icing conditions	0	0

Accident Pilots

The percentage of loss-of-control accidents citing personnel-related causes and factors was greater than the percentage for all GA accidents in 2001. This difference suggests pilot-related factors such as skill and decision-making were more likely to be cited in loss-of-control accidents than were equipment or situational factors.

As indicated in the following table, aircraft handling was the most commonly cited human performance issue in loss-of-control accidents. Specifically, failure to maintain airspeed was the most commonly cited performance parameter.

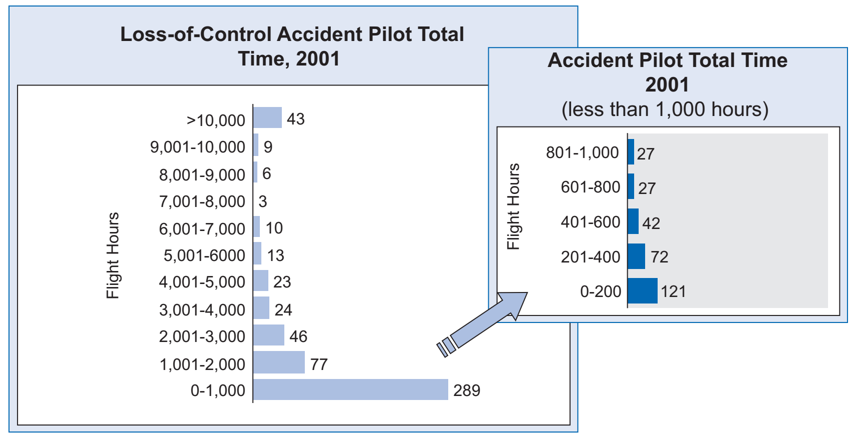
Human Performance and Explanatory Causes/Factors Cited in GA Loss-of-Control Accidents, 2001

Human Performance Issues	**149**
Aircraft Handling/Control	137
Planning/Decision	41
Use of Aircraft Equipment	12
Maintenance	6
Communications/Information/ATC	2
Meteorological Service	1
Airport	0
Dispatch	0
Underlying Explanatory Factors	**52**
Physiological Condition	29
Qualification	23
Psychological Condition	5
Institutional Factors	3
Procedure Inadequate	2
Aircraft/Equipment Inadequate	1
Facility Inadequate	1
Material Inadequate	0
Information	0

The most commonly cited causes and factors underlying human performance were physiological condition and pilot qualification. Of the findings included in these categories, pilots' total and recent flight experience are the most commonly cited.

Pilot Experience

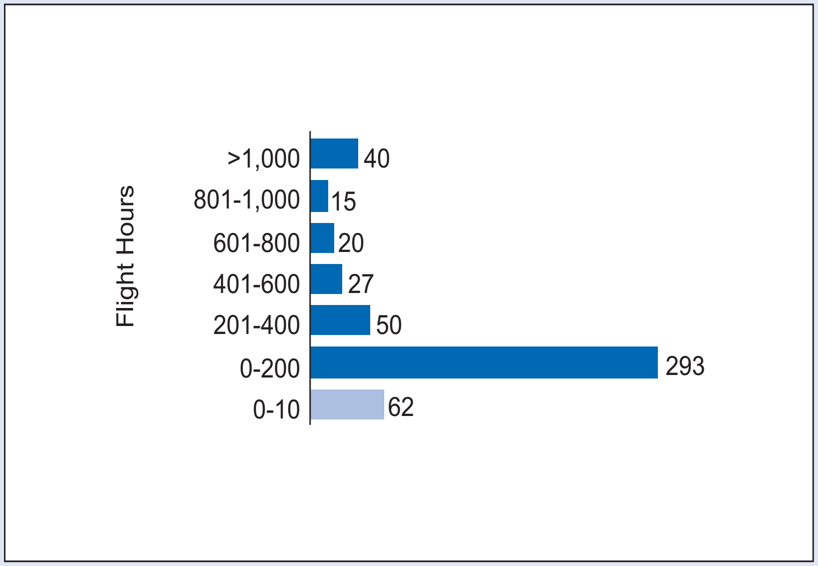
Of the 543 loss-of-control accident pilots with flight time data available, 53% had 1,000 hours of flight experience or less compared to approximately 48% of all accident pilots in 2001. In addition, 22% of loss-of-control accident pilots had 200 hours or less total flight time, compared to approximately 17% of all GA accident pilots.



(543 LOC accident pilots with data available)

A connection between flight experience and loss-of-control accidents can also be observed in the total flight time in accident aircraft type. Of the pilots involved in loss-of-control accidents in 2001 with data available, 14% had 10 hours or fewer in the accident aircraft type. As mentioned previously, 9% of pilots involved in accidents in 2001 had 10 hours or less in type.

Loss-of-Control Accident Pilot Total Time in Aircraft Type, 2001



Summary

A review of the historical data, and those from 2001, indicates that loss of aircraft control is the most commonly cited event in GA accidents. Comparisons between loss-of-control accidents and general aviation accidents in general indicate that accidents involving a loss of aircraft control are more likely to result in higher levels of injury and aircraft damage than accidents that do not include a loss of control. Loss of control in flight is especially deadly; nearly half of loss-of-control accidents that occurred in flight were fatal. In almost all of the accidents (95%), the pilot was cited as the cause or factor, and the human performance issue most frequently cited was aircraft handling and control.

Appendix A

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 about 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 until the investigation is closed.

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 about 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 B

Definitions

Definitions of Safety Board Severity Classifications

The severity of a general aviation accident or incident is classified as the combination of the highest level of injury sustained by the personnel involved (that is, fatal, serious, minor, or none) and level of damage to the aircraft involved (that is, destroyed, substantial, minor, or none). Accidents include those events in which any person suffers fatal or serious injury, or in which the aircraft receives substantial damage or is destroyed. An event that results in minor or no injuries and minor or no damage is not classified as an accident.

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.

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."

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

None—No damage.

Appendix C

The National Transportation Safety Board Investigative Process

The National Transportation Safety Board investigates every accident that occurs in the United States involving civil aviation and public aircraft flights that do not involve military or intelligence agencies. 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.[1] 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).

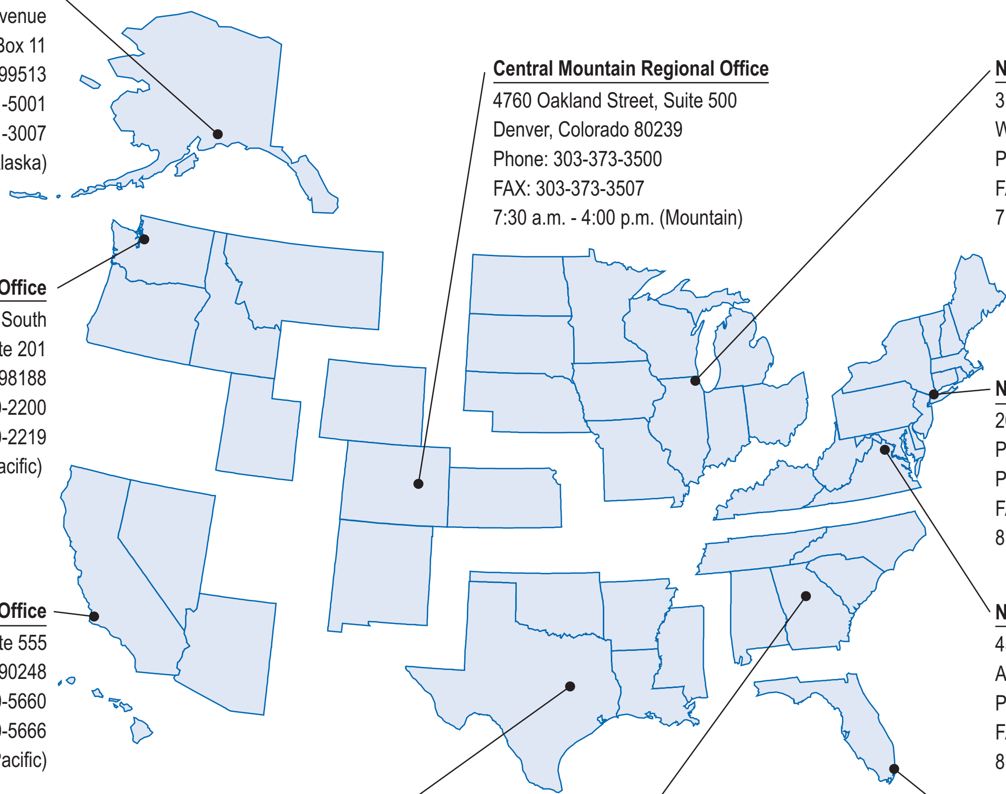
In determining probable cause(s) of a domestic accident, investigators consider the facts, conditions, and circumstances of the event. The objective is to ascertain those cause and effect relationships in the accident sequence about which something can be done to prevent recurrence of the type of accident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

[1] For more detailed information about the Safety Board's investigation of aviation accidents or incidents, see 49 CFR 831.2.

Appendix D

National Transportation Safety Board Regional Offices



Alaska Regional Office
222 West 7th Avenue
Room 216, Box 11
Anchorage, Alaska 99513
Phone: 907-271-5001
FAX: 907-271-3007
7:00 a.m. - 5:00 p.m. (Alaska)

Northwest Regional Office
19518 Pacific Highway South
Suite 201
Seattle, Washington 98188
Phone: 206-870-2200
FAX: 206-870-2219
8:00 a.m. - 4:30 p.m. (Pacific)

Southwest Regional Office
1515 W. 190th Street, Suite 555
Gardena, California 90248
Phone: 310-380-5660
FAX: 310-380-5666
7:00 a.m. - 3:30 p.m. (Pacific)

Central Mountain Regional Office
4760 Oakland Street, Suite 500
Denver, Colorado 80239
Phone: 303-373-3500
FAX: 303-373-3507
7:30 a.m. - 4:00 p.m. (Mountain)

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. - 4:00 p.m. (Central)

Northeast Regional Office - Parsippany
2001 Route 46, Suite 310
Parsippany, New Jersey 07054
Phone: 973-334-6420
FAX: 973-334-6759
8:00 a.m. - 4:30 p.m. (Eastern)

Northeast Regional Office - Ashburn
45065 Riverside Parkway
Ashburn, Virginia 20147
Phone: 571-223-3930
FAX: 571-223-3926
8:00 a.m. - 4:30 p.m. (Eastern)

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. - 4:00 p.m. (Central)

Southeast Regional Office - Atlanta
Atlanta Federal Center
60 Forsyth Street, SW
Suite 3M25
Atlanta, Georgia 30303
Phone: 404-562-1666
FAX: 404-562-1674
7:30 a.m. - 4:00 p.m. (Eastern)

Southeast Regional Office - Miami
8405 N.W. 53rd Street
Suite B-103
Miami, Florida 33166
Phone: 305-597-4610
FAX: 305-597-4614
7:30 a.m. - 4:00 p.m. (Eastern)