

Annual Review of Aircraft Accident Data U.S. General Aviation, Calendar Year 2006



Annual Review of Aircraft Accident Data

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**National
Transportation
Safety Board**

Annual Review of Aircraft Accident Data

Annual Review of U.S. General Aviation Accident Data 2006



**National
Transportation
Safety Board**

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Abstract: In calendar year 2006, 1,523 general aviation accidents occurred, involving 1,535 aircraft, 147 fewer accidents than in 2005 and a drop of about 9%. Slightly more than 20% of these accidents were fatal (308), resulting in 706 total fatalities (table 1). Thus, while the number of fatal general aviation accidents in 2006 decreased 4% from calendar year 2005, the total number of fatalities increased by over 25%. The circumstances of these accidents and details related to the aircraft, pilots, and locations are presented throughout this review.

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2006 General Aviation Accident Summary

In calendar year 2006, 1,523 general aviation accidents occurred, involving 1,535 aircraft,¹ 147 fewer accidents than in 2005 and a drop of about 9%. Slightly more than 20% of these accidents were fatal (308), resulting in 706 total fatalities (table 1). Thus, while the number of fatal general aviation accidents in 2006 decreased 4% from calendar year 2005, the total number of fatalities increased by over 25%. The circumstances of these accidents and details related to the aircraft, pilots, and locations are presented throughout this review.

Table 1. 2006 general aviation accident statistics.

General Aviation Accidents	
Total accidents	1,523
Fatal accidents	308
Accident aircraft	1,535
General Aviation Accident Injuries	
Fatal	706
Serious	265
Minor	363
Persons involved in accidents with no injuries	1,628
General Aviation Accident Rate	
General aviation hours flown ^a	23,963,000
All accidents ^b	6.35/100,000 hours
Fatal accidents ^b	1.28/100,000 hours
Accidents per active pilots	2.55/1,000 active pilots
Fatal accidents per active pilots	0.52/1,000 active pilots

^a Federal Aviation Administration, *General Aviation and Air Taxi Survey, 2006*.

^b Excludes events involving suicide, sabotage, and stolen/unauthorized use

¹ In this review, the collision between two aircraft is counted as one accident. The 706 fatalities in 2006 include the 154 persons killed aboard a foreign-registered Boeing 737 aircraft operated by Gol Airlines when it collided with an Embraer Legacy 600 business jet over the Brazilian Amazon jungle.

Introduction

Purpose of the Review

The National Transportation Safety Board's *2006 Annual Review of Aircraft Accident Data for U.S. General Aviation* is a statistical review of calendar year 2006 data from general aviation accidents involving U.S.-registered aircraft. This summary of U.S. general aviation accidents is designed to inform the public, as well as the general aviation community, about trends in general aviation safety and to provide detailed information to support future government, industry, and private research efforts and safety improvement initiatives.

The NTSB drew on several resources in compiling data for this review. Accident data were taken from the NTSB's Aviation Accident/Incident Database.² Activity data were extracted from the *General Aviation and Air Taxi Activity and Avionics Survey* (GAATAA 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 obtained from the *General Aviation Statistical Databook*, published by the General Aviation Manufacturers Association.

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, which regulate 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 aircraft⁶ flights that do not involve military or intelligence agencies. Aircraft operating under Part 91 include aircraft that are flown for recreation and personal transportation, as well as a number of aircraft operations that are flown with the intention of generating revenue.⁷ These revenue operations include business flights, flight instruction,

² See appendix A for more details.

³ FAA: <[GAATAA Survey 2006](#)>. Although they are included in the GAATAA Survey, data associated with air taxi and air tour operations are not included in this review.

⁴ FAA: <[US 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 2006* (Washington, DC: 2009), available at <<http://www.nts.gov>>.

⁶ Although the precise statutory definition has changed over the years, public aircraft operations for NTSB 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.

corporate/executive flights, positioning or ferry flights, aerial application, pipeline/powerline patrols, and news and traffic reporting.

Which Aircraft Are Included in this Review?

General aviation operations employ a wide range of aircraft, including airplanes, rotorcraft, gliders, balloons and blimps, and registered 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 frequently used for corporate/executive transportation, while smaller single-engine piston aircraft are commonly used for instructional flights. A wide variety of aircraft types, from balloons and gliders to very light jets, are used for personal and business flights.

This review does not include accident data associated with aircraft operating under 14 CFR Parts 121, 129, or 135 inside and outside the United States, aircraft flown by military or intelligence agencies, non-U.S.-registered aircraft, unregistered ultralights, and commercial space launches, unless such aircraft were involved in a collision with aircraft conducting general aviation operations. Accidents involving illegal operations, stolen aircraft, suicide, or sabotage are included in the accident totals, but not in accident rates.⁸

Organization of the Review

The *2006 Annual Review* is organized into three principal parts:

1. A summary of general aviation accident statistics for 2006, industry data on general aviation activity in 2006, and contextual statistics from previous years.
2. An investigation of 10-year accident trends by type of operation, levels of aircraft damage, and injuries.
3. A discussion of specific accident circumstances, a description of accident occurrences, and a summary of the NTSB's findings of probable cause and contributing factors.

Much of the information in this review is presented graphically. 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.nts.gov/aviation/Stats.htm> >.

⁸ In 2006, two crashes involved stolen/unauthorized use of aircraft.

The General Aviation Environment in 2006

The General Aviation Fleet

Figure 1 describes the active general aviation fleet, which totaled 221,943 aircraft in 2006. Single-engine piston aircraft dominated the fleet, accounting for 65% of the active aircraft. It is notable that the next largest category of general aviation aircraft, with 10% of the fleet in 2006, consisted of experimental or amateur-built aircraft. The larger twin-engine piston airplanes, along with turboprop and jet aircraft, collectively accounted for 17% of the fleet. Rotorcraft accounted for only 4% of the fleet, while the new category of light-sport aircraft began to enter the fleet, accounting for 1% in 2006.

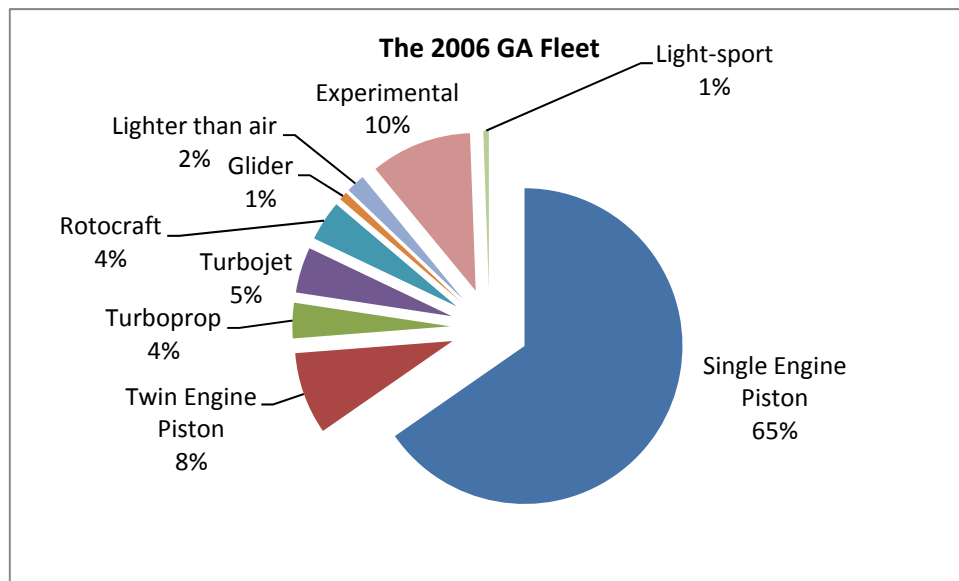


Figure 1. Aircraft in the general aviation fleet in 2006.

Only 8.4% of the single-engine piston and 5.4% of the twin-engine piston aircraft were built in the 10 years prior to 2006, compared to 29.5% of the turboprop aircraft, 47.3% of the jet aircraft, and 38.6% of all rotorcraft. Figure 2 shows the age distribution of the 145,033 active single-engine piston aircraft in the 2006 fleet.

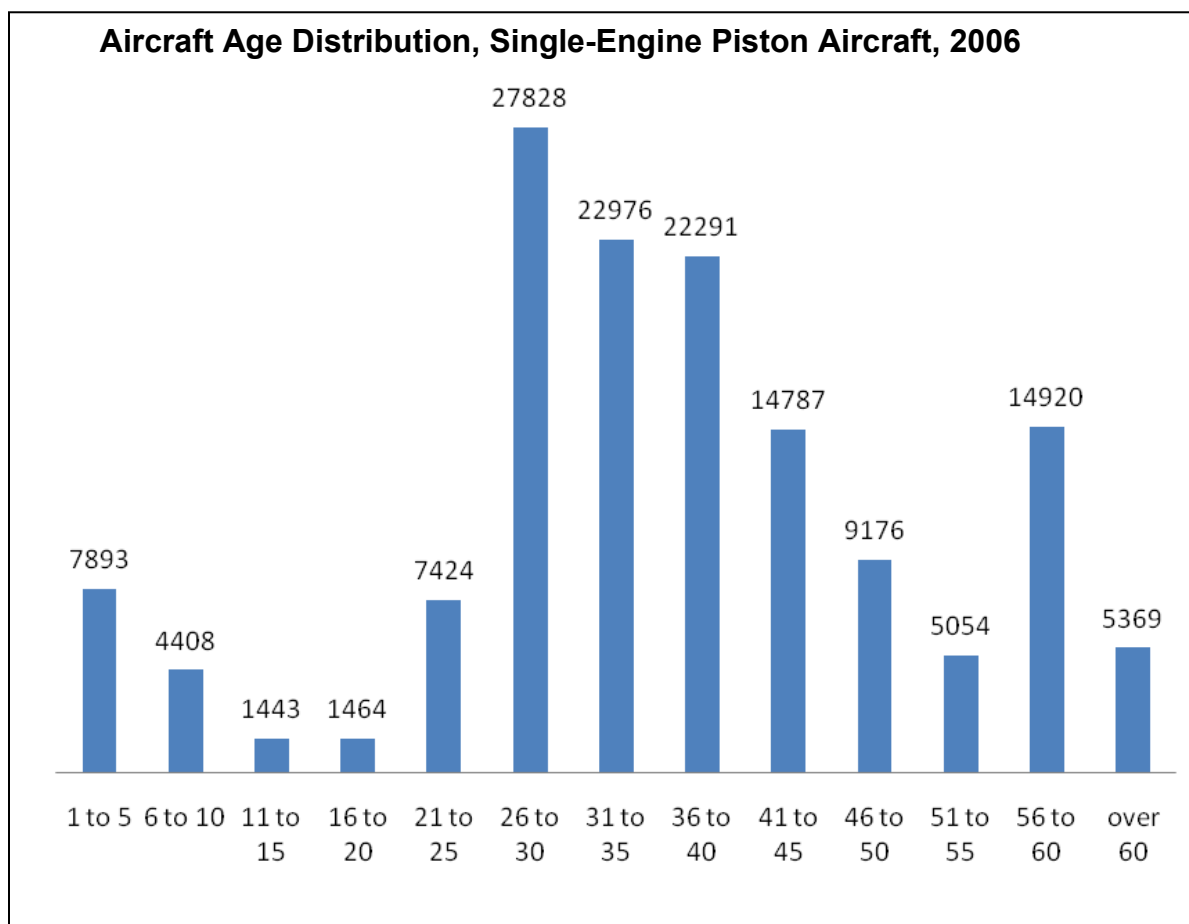


Figure 2. Age distribution of single-engine piston aircraft in the 2006 fleet.

General Aviation Activity

Meaningful year-to-year comparisons of general aviation accident data, or comparisons between different sectors of aviation, require that the raw accident counts be “normalized” or reported as accident “rates” in reference to an appropriate measure of exposure to the risk of accident. Measures of flight activity, such as total flight hours, number of departures (or flights), and miles flown, are often used to calculate accident rates. Commercial air carriers operating under Part 121 and Part 135 are required to report total flight hours, departures, and miles flown, for each of their flights, to the Department of Transportation,⁹ making the computation of such rates straightforward. Operators of general aviation aircraft are not required to report actual flight activity data. Instead, activity for this group of aircraft is estimated using data from the GAATAA Survey,¹⁰ which was established in 1978 to gather information about aircraft use, flight hours, and use of avionics equipment from owners of general aviation and on-demand Part 135 aircraft. General aviation activity data are much less precise and less reliable because (a) the GAATAA Survey is sent to a sample selected from the registry of aircraft owners, (b) reporting is voluntary, (c) the response rate is low, and (d) survey respondents provide only a single annual estimate of activity rather than a detailed accounting of their flying activity.

As figure 3 shows, annual general aviation flight hour estimates from 1997 through 2006 peaked in 1999 and experienced an overall decline after that. In 2006, the estimated number of general aviation flight hours was 23.96 million hours.

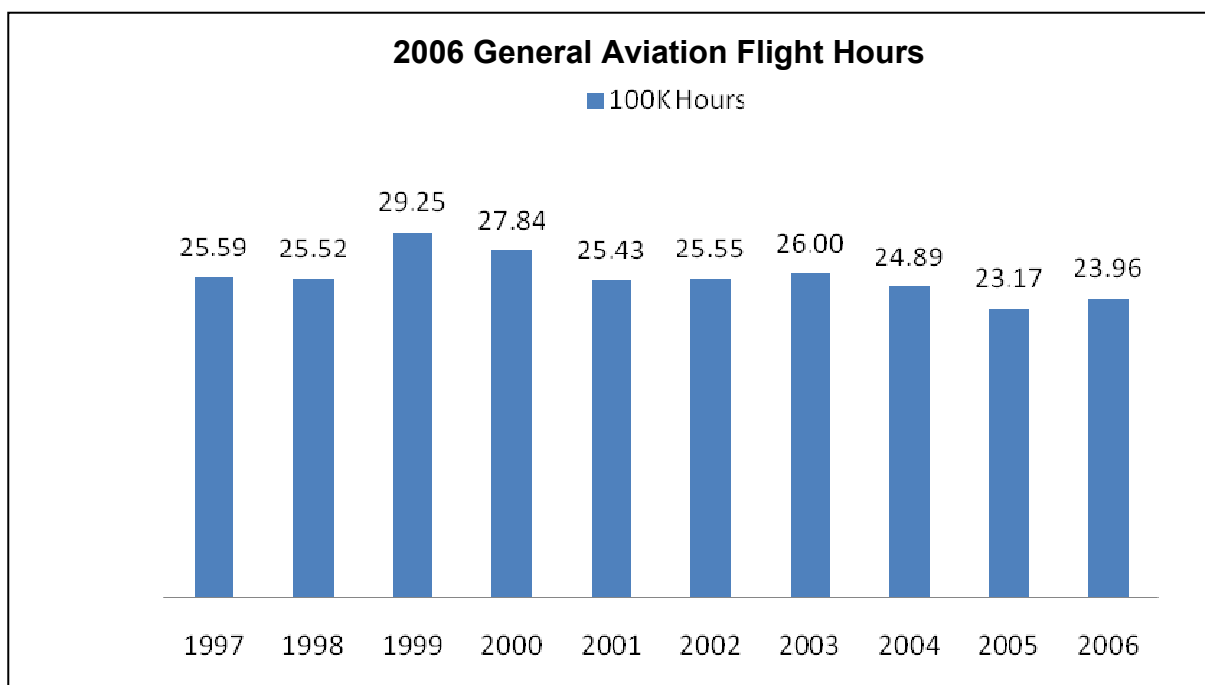


Figure 3. Overall general aviation flight hours estimated from the 2006 GAATAA Survey.

⁹ Part 121 operators report activity monthly, and scheduled Part 135 operators report quarterly.

¹⁰ Available at <[GAATAA Survey 2006](#)>.

Historical Trends in Accident Data

Accident Rates

The overall general aviation accident rate per 100,000 flight hours was relatively flat across the decade, but the 6.35 accidents per 100,000 flight hours recorded in 2006 was down markedly from the 7.20 rate recorded in 2005 (figure 4). In fact, the 2006 rate was the lowest overall accident rate since the NTSB began reporting general aviation-only annual accident rates in 1975.¹¹

The 2006 rate of 1.28 fatal accidents per 100,000 flight hours was down slightly from the 2005 rate of 1.38 fatal accidents per 100,000 flight hours.

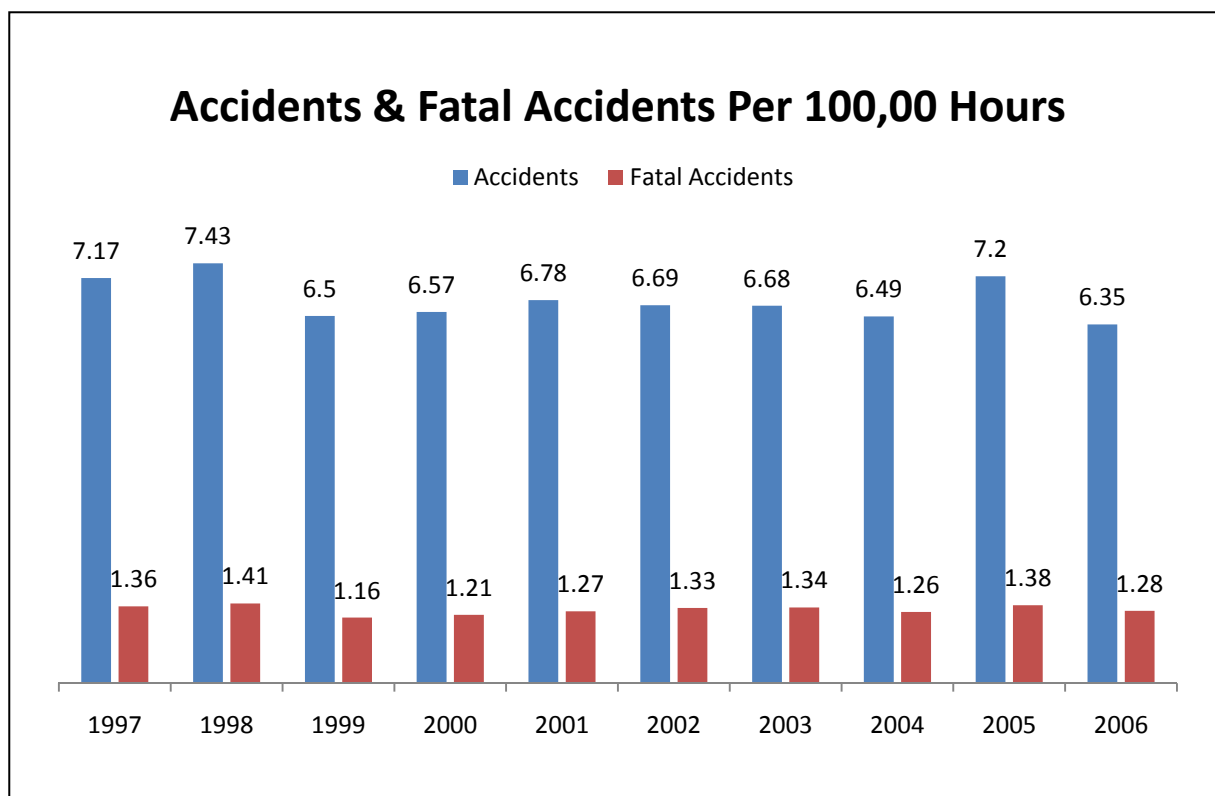


Figure 4. General aviation accident and fatal accident rates per 100,000 flight hours.

¹¹ Prior to 1975, scheduled 14 CFR 135 commuter and nonscheduled 14 CFR 135 air taxi aircraft operations were included in the NTSB's annual general aviation accident total and rate.

Total accident-related deaths (aboard accident aircraft, other aircraft, or on ground) per flight hour jumped to 2.94 fatalities per 100,000 hours flown in 2006 although the onboard death rate per 100,000 flight hours was only 2.28 (figure 5). The spike in the rate of total accident-related deaths was due entirely to a single midair collision between a general aviation Part 91 ferry flight and a commercial air carrier, killing all 154 persons aboard the commercial airliner.

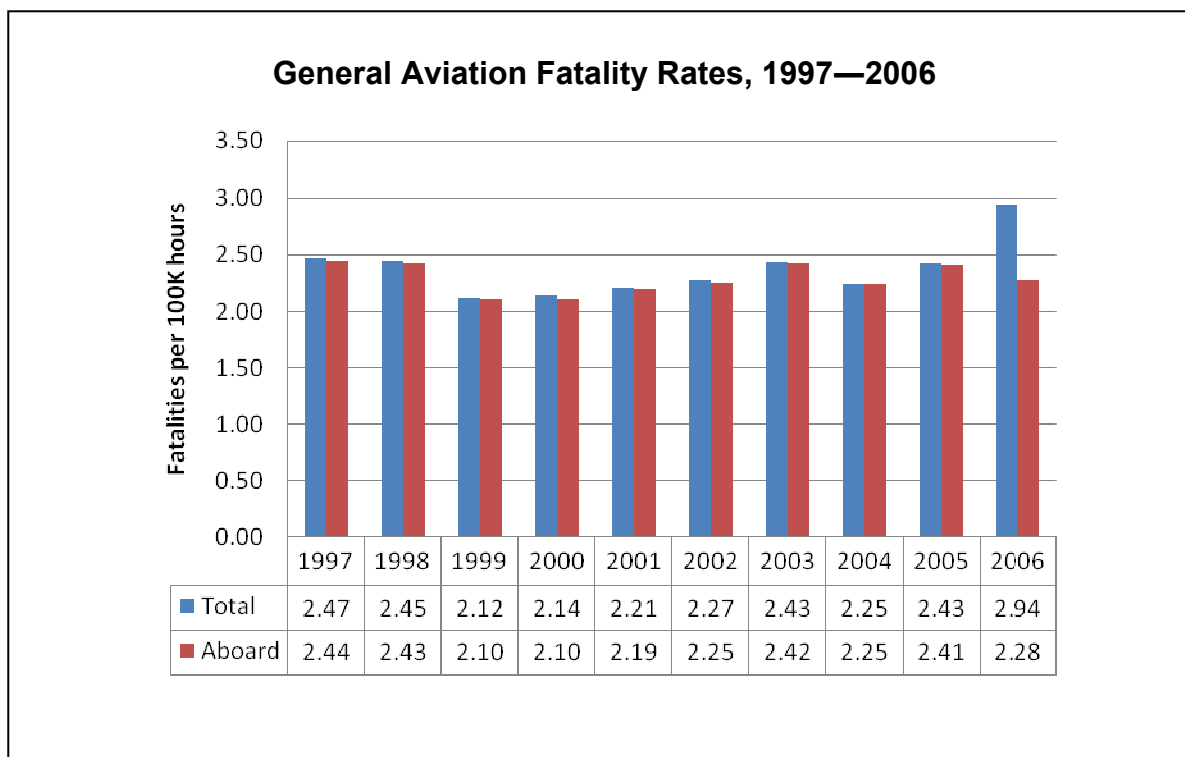


Figure 5. Total and onboard fatality rates per 100,000 general aviation flight hours.

As indicated previously, accident rate calculations are based on flight hours estimated from the GAATAA Survey, which extrapolates 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, it is important to examine the raw accident frequencies, in addition to the rate data.

Number of Accidents and Fatalities

Despite slight year-to-year fluctuations, the annual number of general aviation accidents between 1997 and 2006 declined to a decade low of 1,523 in 2006, and the number of fatal accidents decreased overall, to 308 (figure 6).

The lowest number for the decade was the 546 onboard general aviation fatalities recorded in 2006, but the number of fatalities, 706, was the highest (figure 7). As discussed previously, the difference between the total fatalities and the fatalities aboard for 2006 can be attributed to one midair collision between a general aviation ferry flight and an air carrier.

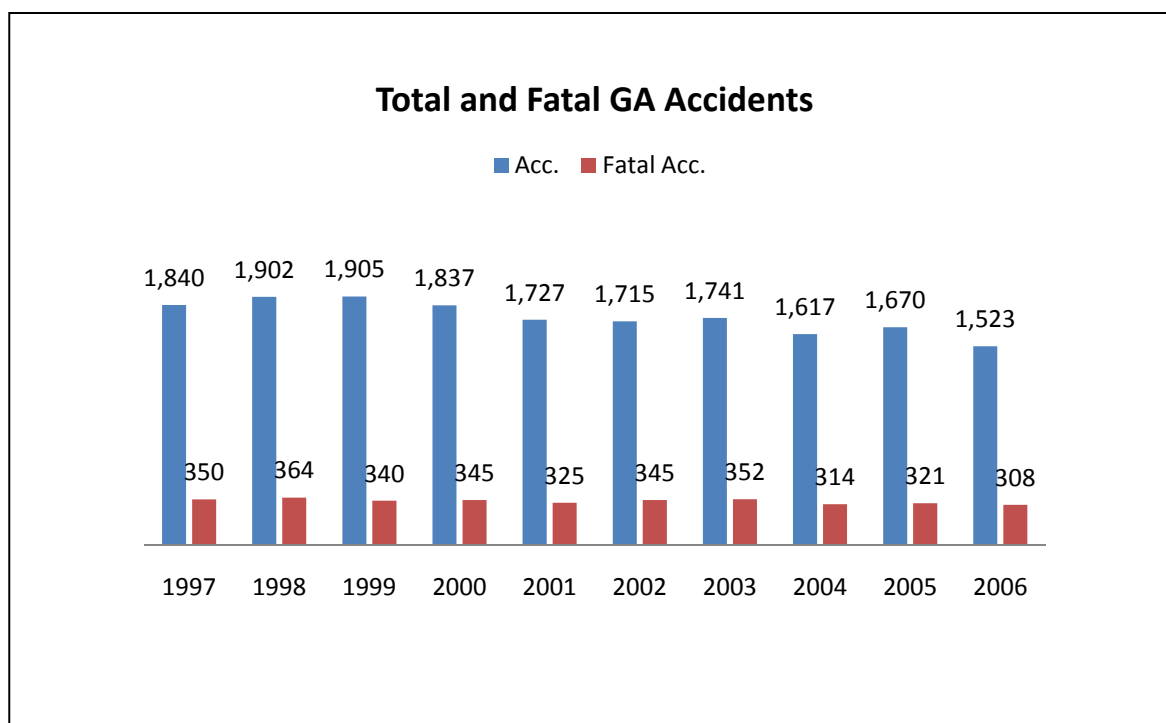


Figure 6. Annual numbers of total and fatal general aviation accidents.

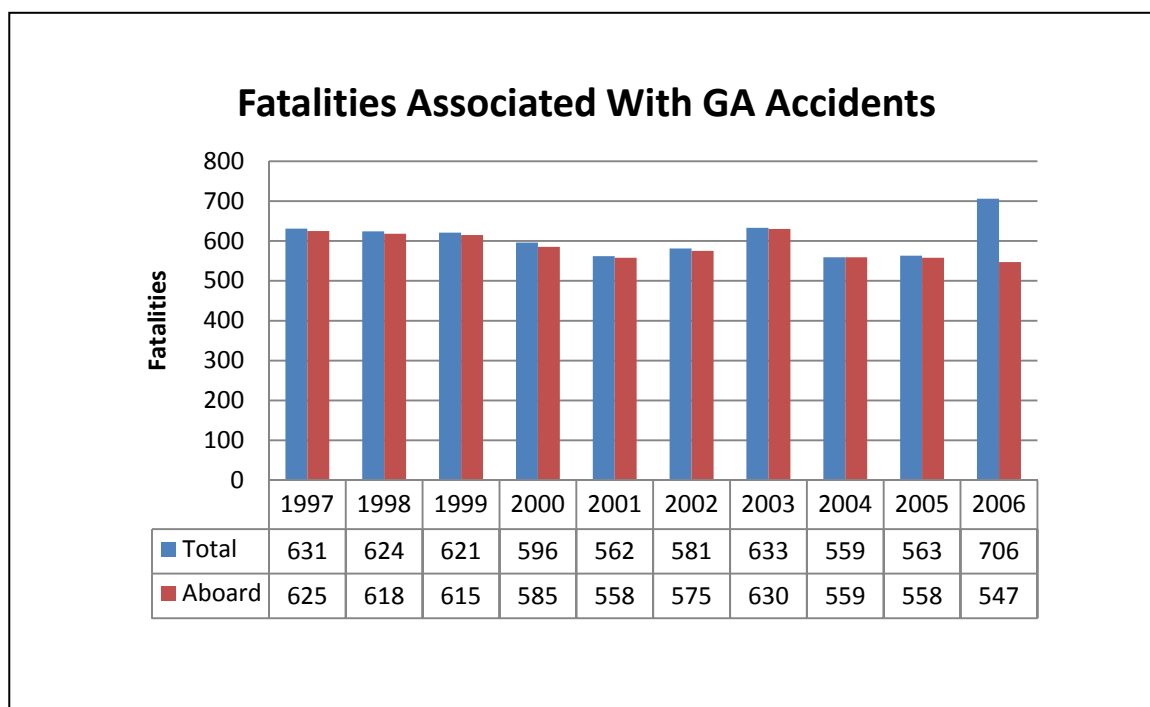


Figure 7. Annual number of persons killed, total and onboard accident aircraft.

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, GAATAA flight data allow for only a coarse representation of the many types of general aviation operations. For some types of operations, such as public aircraft flights,¹² no activity data are available. The data presented here include four operational categories, which were selected because they are representative of the general aviation and activity information that is available for them:

- Personal flights, the largest portion of general aviation activity, include all flying conducted for pleasure and/or personal transportation. Although similar to personal flights, business flights include the use of an aircraft for business transportation without a paid, professional crew. Personal and business flights are typically conducted in single- and multiengine piston airplanes but may include a range of aircraft including gliders, rotorcraft, and balloons.¹³
- Corporate/executive flights include any business transportation with a professional crew and usually involve larger, multiengine 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 flights include any flight under the supervision of a certificated flight instructor.¹⁴ Instructional flights typically include 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.

In 2006, 52% of the flying time reported on the GAATA Survey was associated with personal and business operations, compared with 18% for instructional flying, 13% for corporate flying, and 4% for aerial application.

In addition to accounting for the largest proportion of general aviation flying, in 8 of the last 10 years, personal and business flights have had the highest overall accident rate, followed by aerial application, and then by flight instruction (figure 8). The lowest accident rate was for corporate/executive transportation, which ranked lowest of all of these categories each year.

¹² The 2006 *Annual Review* data include 11 public aircraft accidents, 3 of which resulted in one or more fatalities.

¹³ 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).

¹⁴ See 14 CFR Part 61, subpart H, for flight instructor certificate and rating requirements.

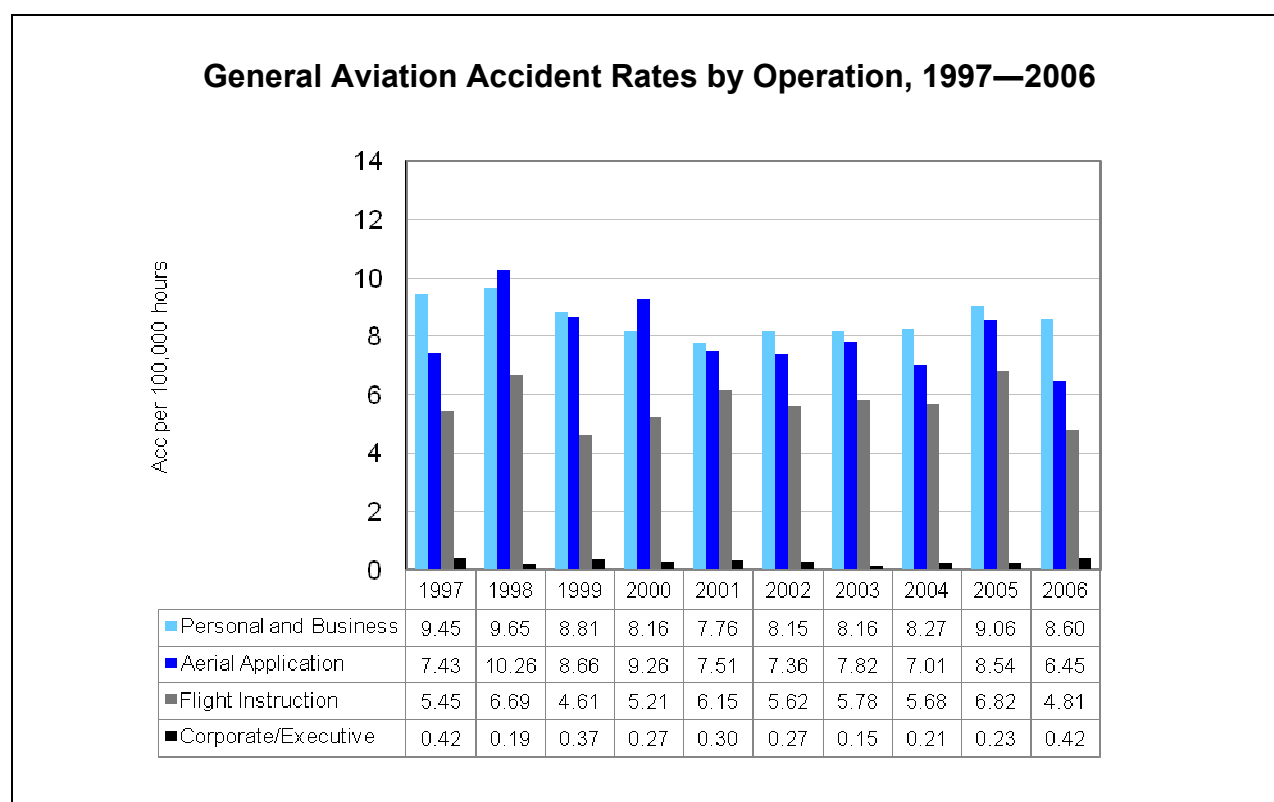


Figure 8. Accident rates per 100,000 flight hours by major category of flying operation.

Throughout the 10-year period, the combined category of personal/business flights also had by far the highest fatal accident rate—typically more than double that for any other type of flying (figure 9). While the overall accident rate for aerial application was close to the overall rate for personal/business flying throughout most of the decade, and exceeded it in 1998 and 2000, the fatal accident rate per 100,000 hours for personal/business flying was much higher than for aerial application in each of the 10 years.

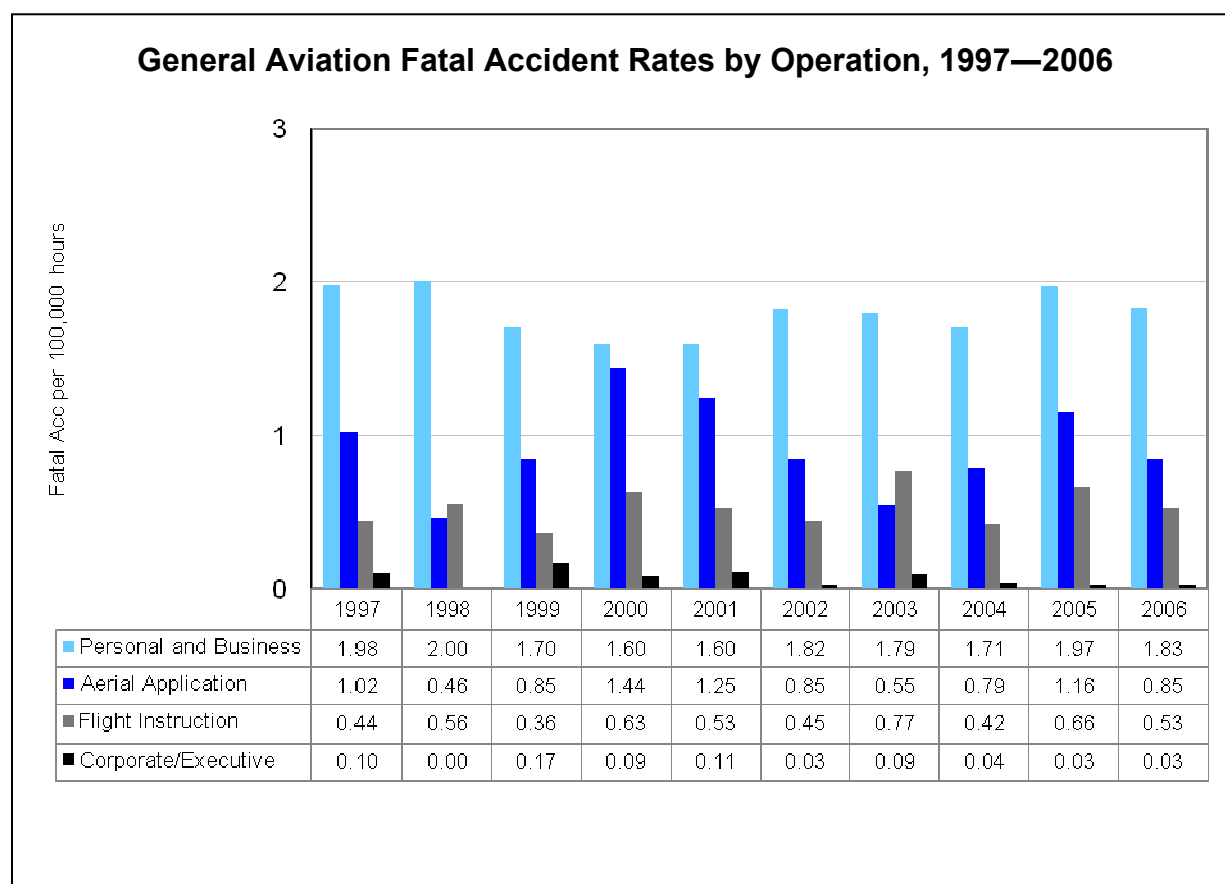


Figure 9. Fatal accident rates per 100,000 flight hours for the major categories of general aviation flight operations.

Figures 10 and 11 show that most (75%) general aviation accidents, and an even larger proportion of fatal accidents (87%), involved personal and business flying from 1997 through 2006. Differences in the number and rate of accidents, and of fatal accidents between these types of operations, 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.

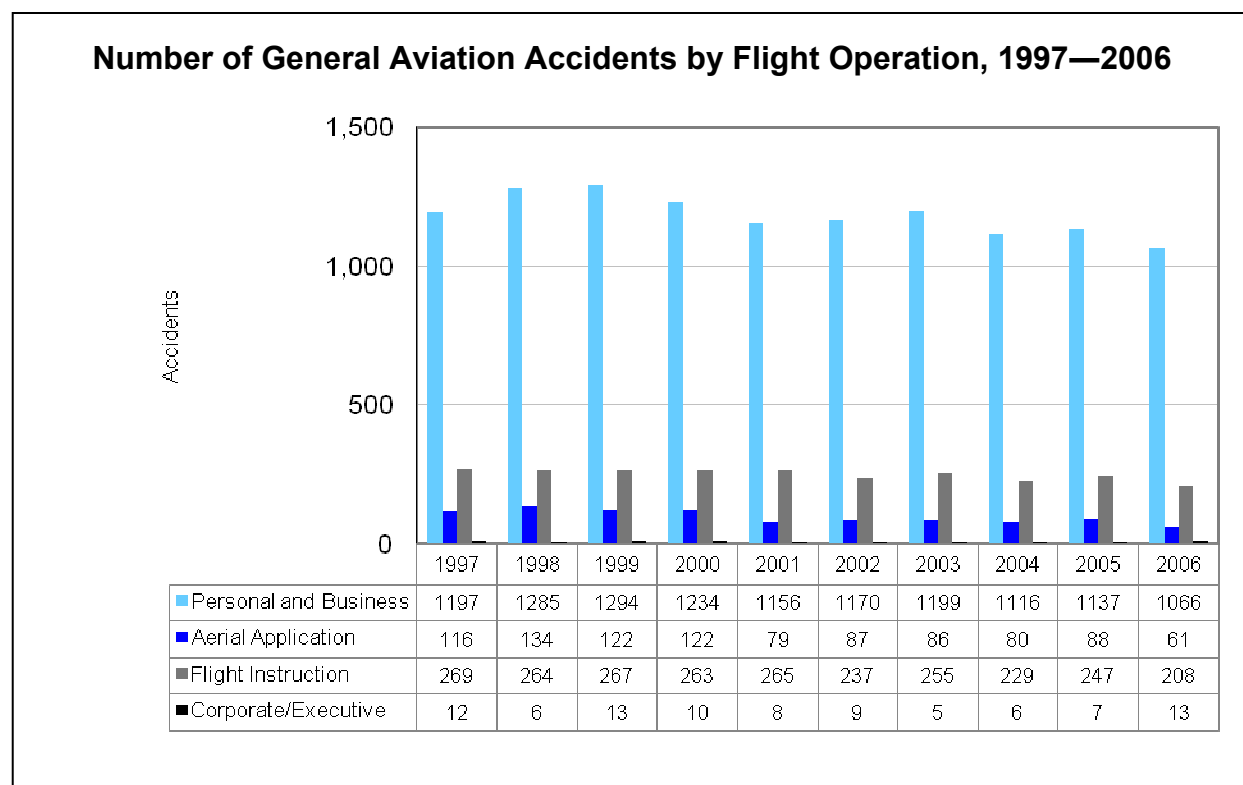


Figure 10. Total number of general aviation accidents for each major category of flight operation.

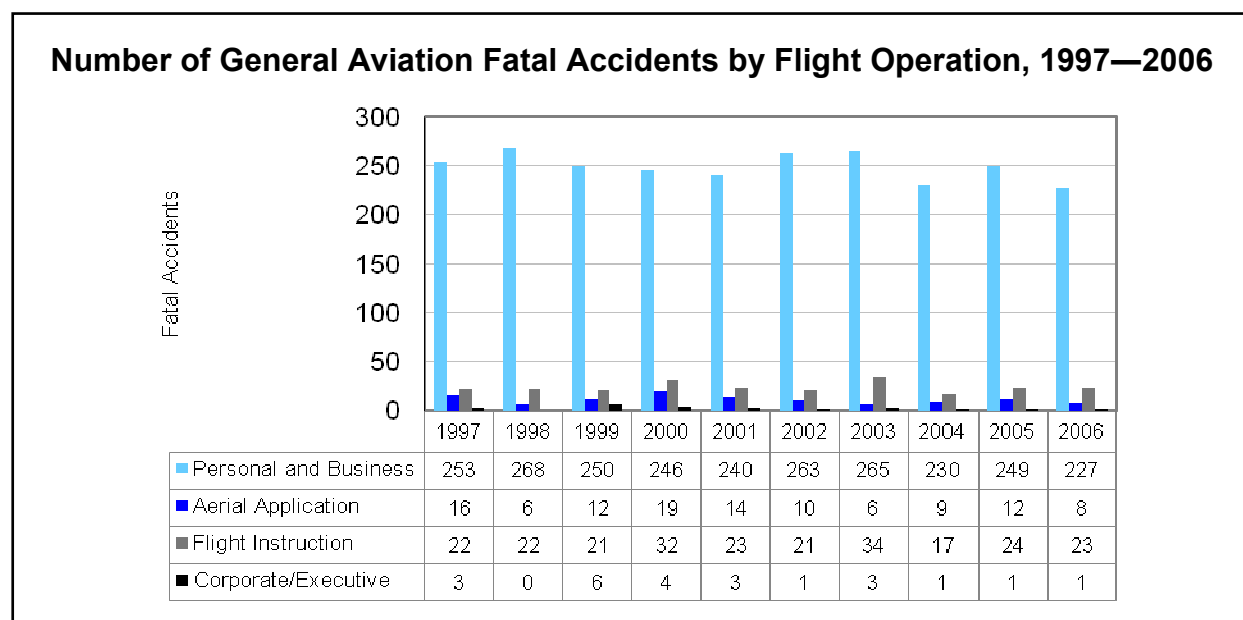


Figure 11. Annual numbers of fatal accidents for each major category of general aviation flight operations.

2006 In Depth

Location of General Aviation Accidents in 2006

United States Aircraft Accidents

Geographic location can influence general aviation accidents because of increased activity associated with population density, increased risk due to hazardous terrain, a propensity for hazardous weather, or a concentration of particularly hazardous flight operations. Figure 12 shows, state by state, the number of general aviation accidents that occurred in the United States in 2006. Although the specific flight hour 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 and other factors.

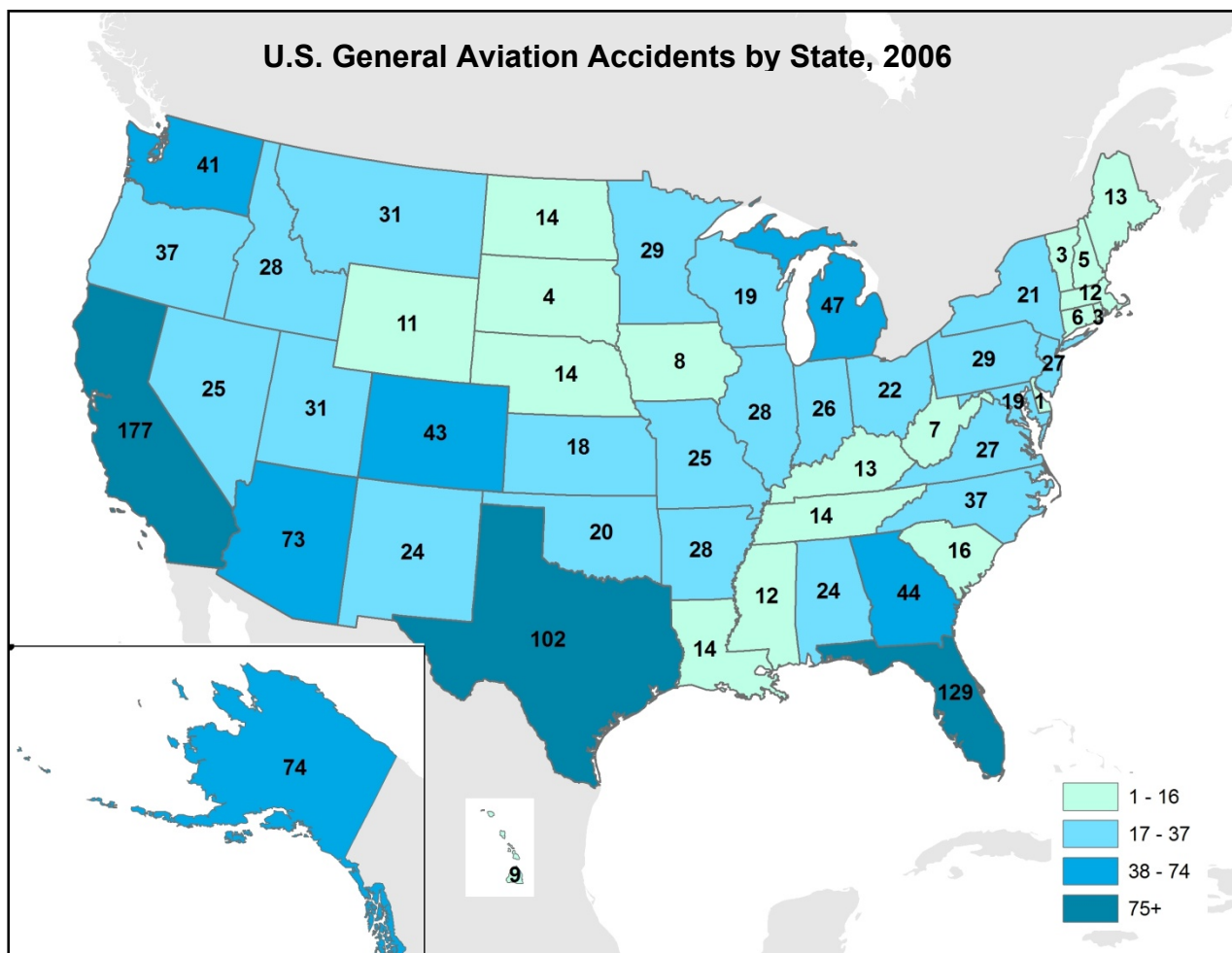


Figure 12. Geographic distribution of 2006 general aviation accidents occurring within the United States.

For example, California, Florida, and Texas had the greatest number of accidents in 2006. U.S. Census Bureau data¹⁵ indicate that California had the highest state population in 2006, followed by Texas (second), and Florida (fourth). In addition, all three states have warm climates that favor year-round flying and are popular travel destinations that attract general aviation traffic from other states. These states also had the largest numbers of active pilots¹⁶ and active aircraft.¹⁷ These data suggest that the high number of accidents in California, Florida, and Texas are related primarily to a high level of activity. 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 challenges¹⁸ to aviation that are reflected in the general aviation accident record. Alaska and Arizona were ranked four and fifth in numbers of general aviation accidents in 2006. The top 10 states by number of general aviation accidents in 2006 are presented in figure 13 along with the 10-year average. Note that many of the state accident totals for 2006 were below historical averages, but the distribution of accidents among states remained similar during the period.

¹⁵ U.S. Census Bureau data are available at <<http://factfinder.census.gov/2006/population>>.

¹⁶ Available at <[US Civil Airmen Statistics](#)>.

¹⁷ Available at <[GAATAA Survey 2006](#)>.

¹⁸ 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 NTSB is also supporting an ongoing effort to identify and mitigate risk factors specific to aviation operations in Alaska; for details, see the following database: <http://www.nts.gov/aviation/AK/alaska_stat.html>.

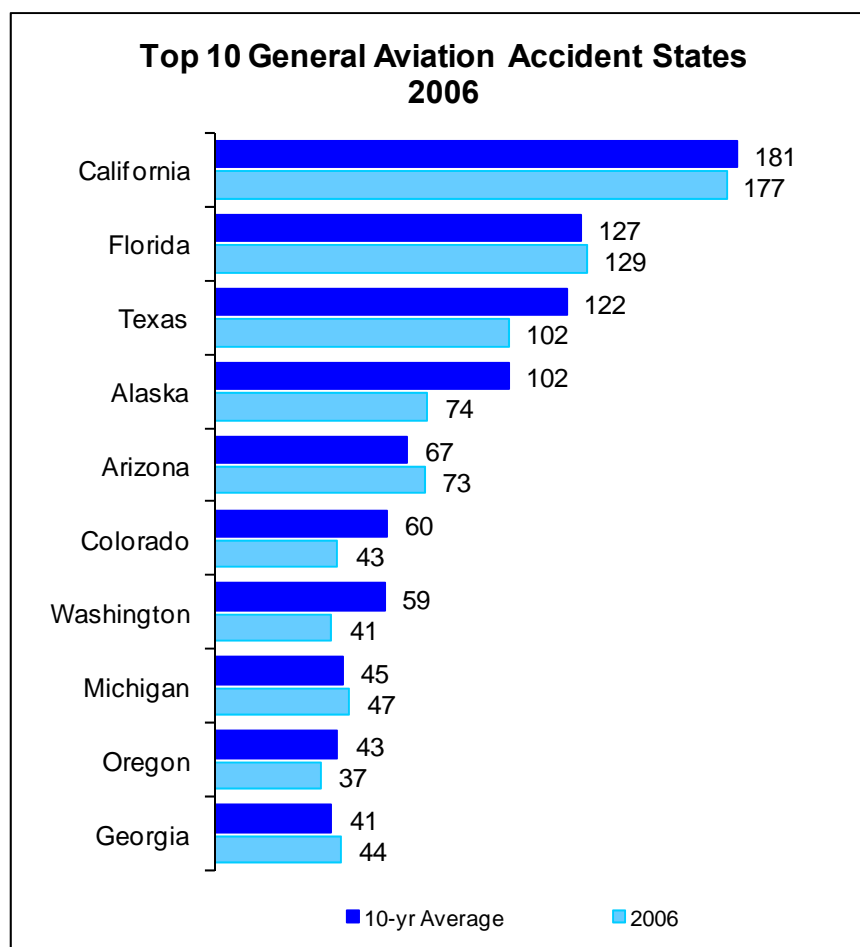


Figure 13. The ten states with the highest number of general aviation accidents in 2006.

Foreign Aircraft Accidents

In 2006, U.S.-registered aircraft were involved in 36 accidents outside the 50 United States. As shown in table 2, those accidents occurred in 20 different countries and territories and in the Gulf of Mexico. Of those accidents, 11 were fatal, resulting in 173 deaths. The 154 fatalities in Brazil were all aboard a foreign-registered Boeing 737 aircraft operated by Gol Airlines that collided with an Embraer Legacy 600 business jet that was operated as a Part 91 ferry flight. In 2006, accidents occurred as far away as Europe, Malaysia, and Australia.

Table 2. Distribution of accidents involving U.S.-registered general aviation aircraft outside the 50 United States, 2006.

	Number of Accidents	Number of Fatal Accidents	Number of Fatalities
Gulf of Mexico			
Off oil platform	2	0	0
Subtotal	2	0	0
Other locations			
Australia	1	0	0
Bahamas	1	0	0
Brazil	1	1	154
Canada	4	2	2
Costa Rica	1	1	2
Dominican Republic	1	1	4
France	3	2	5
Germany	6	2	2
Guam	1	0	0
Hungary	1	0	0
Italy	1	0	0
Mexico	1	1	3
Malaysia	1	0	0
Northern Mariana Islands	1	0	0
Poland	1	0	0
Puerto Rico	3	0	0
Switzerland	1	1	1
United Kingdom	2	0	0
Venezuela	1	0	0
Virgin Islands	2	0	0
Subtotal	34	11	173
Total	36	11	173

Aircraft Type

Figure 14 summarizes the total number of general aviation accidents and fatal accidents occurring in 2006 by aircraft type. The largest number of accidents involved single-engine piston airplanes, which accounted for 75% of all accident aircraft and 66% of all fatal accident aircraft. It is notable that the category of aircraft ranking second in total general aviation accidents (14%) and third in fatal accidents (19%) was amateur-built aircraft.

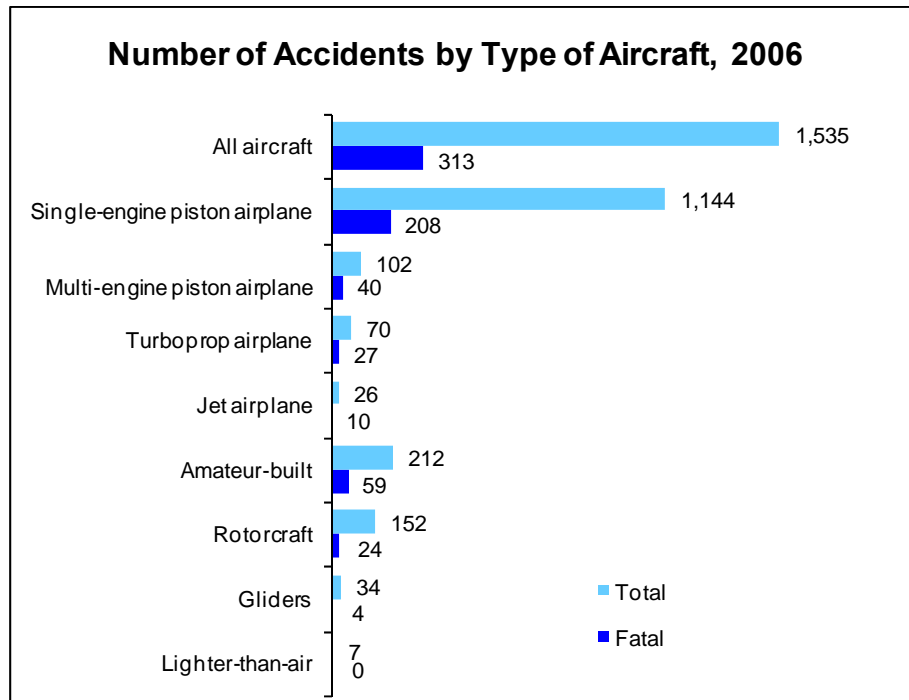


Figure 14. Number of 2006 general aviation accidents by aircraft type.

In 2006, the per-aircraft accident rate for all aircraft types was 6.40 accidents and 1.30 fatal accidents per 100,000 hours flown (figure 15).¹⁹ Among fixed-wing powered aircraft, the rate for single-engine piston airplanes was 8.48 accidents and 1.54 fatal accidents per 100,000 hours flown. Gliders had the highest overall accident rate and the second highest fatal accident rate, with 32.05 accidents and 3.77 fatal accidents per 100,000 hours flown, while amateur-built aircraft showed the second highest overall accident rate and the highest fatal accident rate with 23.58 accidents and 6.56 fatal accidents per 100,000 hours. The overall accident rate (6.65) for rotorcraft was only slightly higher than the rate for all aircraft, but the rotorcraft fatal accident rate (1.01) was lower than all categories except jets and lighter-than-air aircraft.

¹⁹ Note that the reported rates are per aircraft and differ from per-accident rates because each aircraft is counted separately for collisions. Included in the accident totals, but excluded from the associated rates, are two single-engine piston aircraft accidents with a probable cause attributed to stolen/unauthorized use.

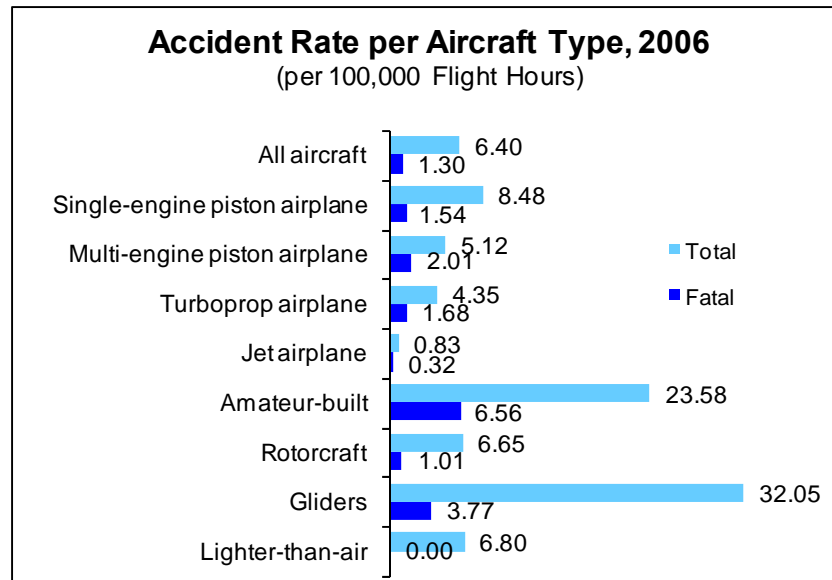


Figure 15. 2006 general aviation accident rates by aircraft type.

Purpose of Flight

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 GAATAA Survey, which includes 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. Another 12 categories include the previously mentioned personal, business, instructional, corporate, and aerial application, which together accounted for 90% of all general aviation operations during 2006. The remaining 10% of operations are included in other, more specific categories, such as external load and medical use. A limitation of the GAATAA 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, recreational, or proficiency flying. At the same time, the differences between similar categories, such as 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 GAATAA Survey, most general aviation operations are conducted for personal and/or business purposes. Of the estimated 24 million general aviation hours flown in 2006, more than half—12.4 million—were associated with personal or business flights.²⁰ Accordingly, a large percentage of general aviation accidents involve personal/business flights. However, personal/business flying is still overrepresented in the accident record: although this segment represented about 52% of the general aviation hours in 2006, it accounted for 70% of all general aviation accidents (n = 1,066) and 74% of all fatal accidents (n = 227).

²⁰ See <[GAATAA Survey 2006](#)>.

The accident rate for instructional flights is about half that of personal/business flights overall. This relatively low rate is surprising because student pilots could be expected to make more mistakes than experienced pilots. Flight instruction accidents were also less likely to be fatal. Only 11% of the flight instruction accidents that occurred in 2006 resulted in fatalities, compared to 21% of personal/business flight 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 flights remained the highest in general aviation with 1.83 fatal accidents per 100,000 hours flown.

Flight Plan

In 2006, 1,535 pilots were involved in general aviation accidents, and for those pilots, 1,222 (80%) showed no record of filing a flight plan (figure 16). 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 if they fail to arrive at their intended destinations.

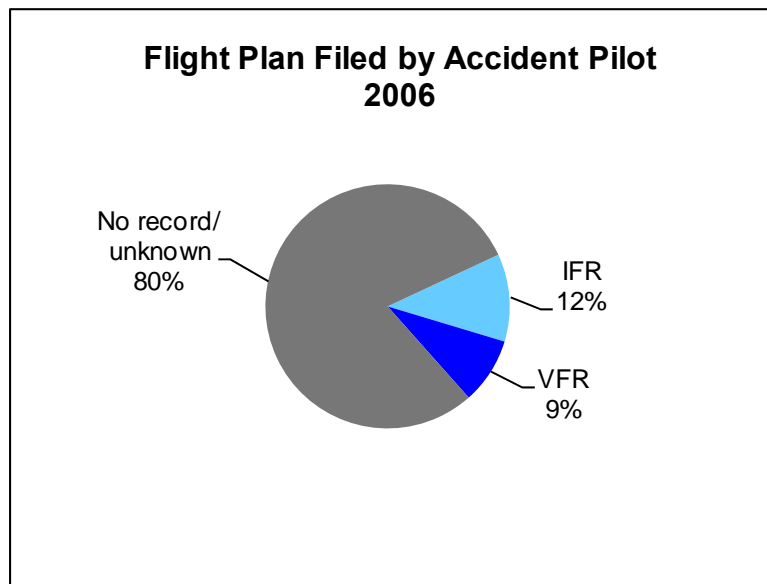


Figure 16. Proportion of general aviation accidents with and without flight plans filed by the pilot-in-command in 2006.

Airport Involvement

As shown in figure 17, aircraft accident locations were closely split between those occurring on airport property (45%) and those occurring away from an airport (44%). (The remaining 11% are unknown.) Comparing accident risk based on location is difficult because of the exposure differences between types of operations and types of aircraft. 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. In contrast, accidents that occur away from an airport typically involve the climb, cruise, maneuvering, and descent phases of flight, which typically occur at higher altitudes and higher airspeeds. As a result, these accidents 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 fatal accidents in 2006 (77%) were located away from an airport or airstrip.

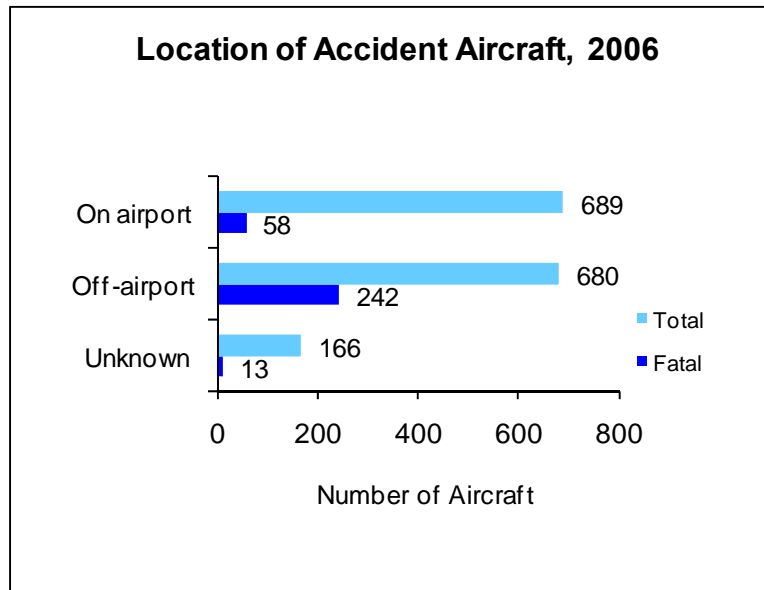


Figure 17. Location of 2006 general aviation accidents in relation to airport.

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 to move 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. 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 point-to-point flights accounted for more accident aircraft (figure 18).

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 provides an indirect measure of the types of flying represented in both flight profiles. Figure 19 shows that most personal/business flights were point to point, while more than half of instructional flights were local.

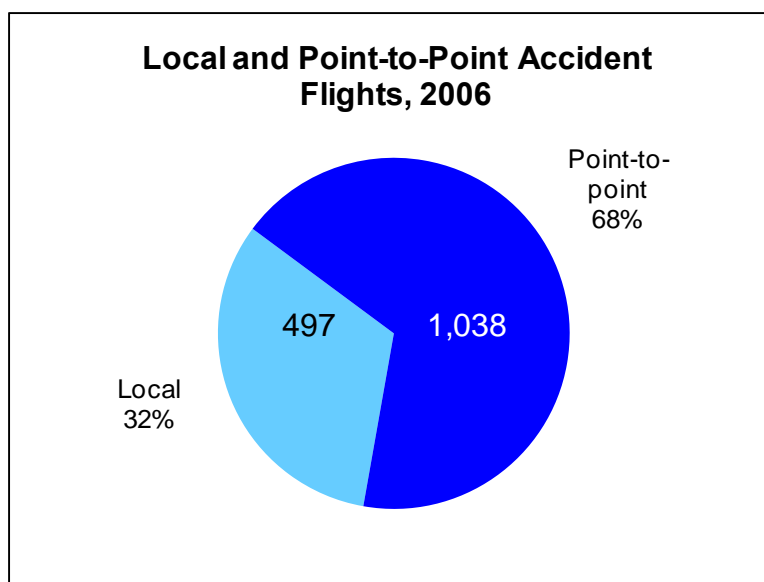


Figure 18. Proportions of point-to-point vs. local accident flights in 2006.

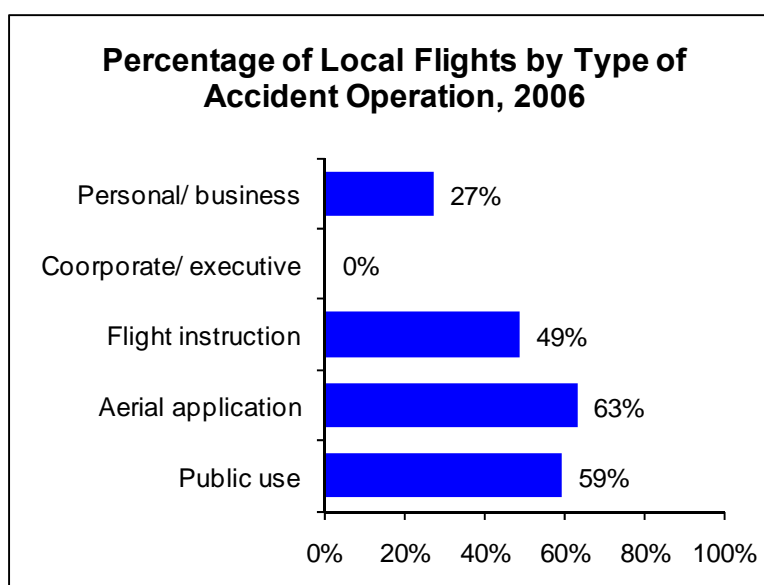


Figure 19. Proportions of 2006 local accident flights by type of flying operation.

Environmental Conditions

Many hazards 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 dependent on visual cues related to speed, distance, orientation, and altitude. When visual information is degraded or obscured 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 requirements²¹ for flight in instrument meteorological conditions (IMC). According to the FAA *Pilot/Controller Glossary*,²² instrument meteorological conditions are defined as “meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling less than the minima²³ 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. Figure 20 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 2006, only 17% of the accidents that occurred in visual conditions resulted in a fatality, but 72% of accidents in instrument conditions were fatal.

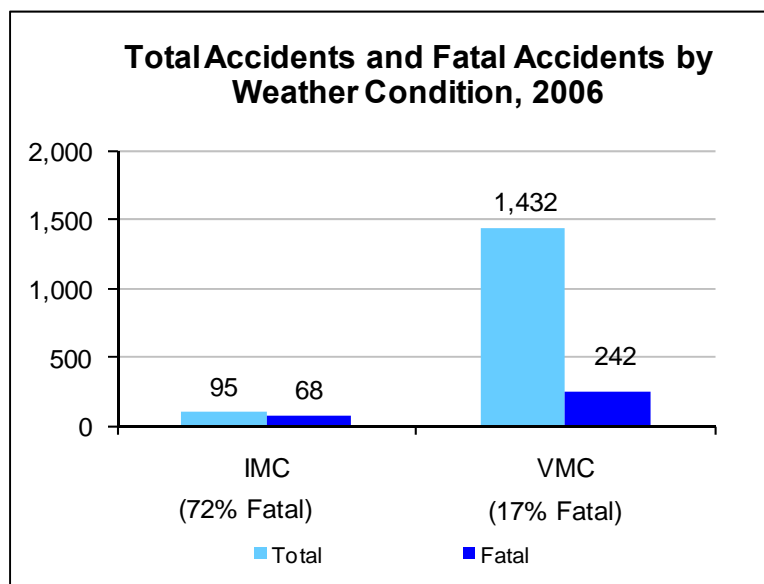


Figure 20. Numbers of total and fatal general aviation accidents in 2006 by weather condition.

Although instrument conditions were present for only 6% of all accidents, 22% of fatal general aviation accidents in 2006 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 occurred in visual conditions, could pose an even greater threat to a pilot flying in instrument conditions because reduced visibility would hinder selection of a suitable landing site.

²¹ Title 14 CFR 61.579(c), 91.167-193, 91.205(d).

²² FAA, *Pilot/Controller Glossary*, Washington, D.C., available at <[FAA Pilot/Controller Glossary](#)>.

²³ Minima for visual meteorological conditions are specified in 14 CFR 91.155.

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. Figure 21 illustrates that most accidents occurred in daylight conditions but a larger percentage of the accidents that occurred at night resulted in fatalities.

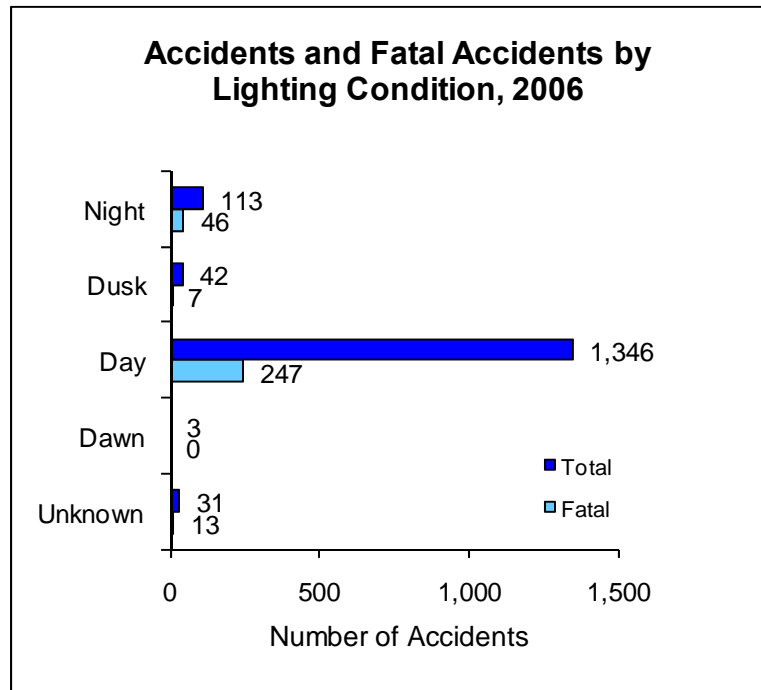


Figure 21. Numbers of total and fatal general aviation accidents in 2006 by lighting condition.

In fact, accidents that occurred at night were more than twice as likely as daylight accidents to be fatal (figure 22). Like weather-related accidents, accidents at night are more likely to involve disorientation, loss of control, and/or collision with objects or terrain, resulting in higher levels of injury. The reduction in visual cues at night also hinders pilots from identifying deteriorating weather conditions and further complicates their ability to deal with any aircraft equipment malfunctions.

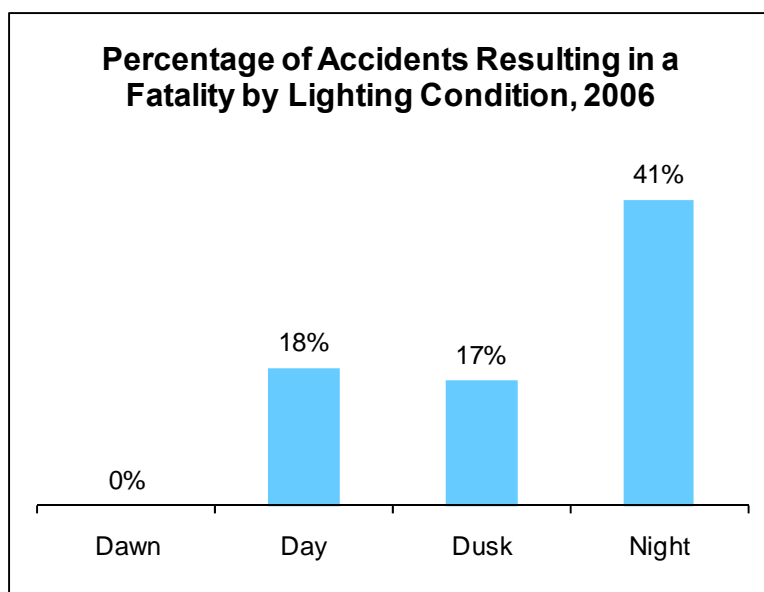


Figure 22. Proportion of all accidents that were fatal by lighting condition in 2006.

Injuries and Damage for 2006

Aircraft Damage

NTSB investigators record aircraft damage as destroyed, substantial, or minor. Title 49 CFR 830.2 defines substantial damage 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.” Although not specifically defined in 49 CFR 830.2, destroyed can be operationally defined as any damage in which repair costs exceed the value of the aircraft,²⁴ and minor damage as any damage that is not classified as either destroyed or substantial.

More than 8 of every 10 aircraft involved in accidents during 2006 sustained substantial damage, and about 1 in 6 accident aircraft were destroyed. Minor and no damage classifications together comprised about 2% of accident aircraft (figure 23).

²⁴ Missing or unrecoverable aircraft are also considered destroyed.



Figure 23. Extent of damage experienced by general aviation aircraft involved in accidents in 2006.

Accident Injuries

In accordance with 49 CFR 830.2, NTSB investigators categorize general aviation injuries as fatal, serious, or minor. A fatal injury is defined as “any injury which results in death within 30 days of the accident.” Title 49 CFR 830.2 also outlines several attributes²⁵ 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. Figure 24 depicts the percentage of general aviation accidents resulting in each level of injury during 2006. Most notable is the fact that more than half the accidents did not result in injury.

²⁵ See appendix B for a complete definition of injury categories.

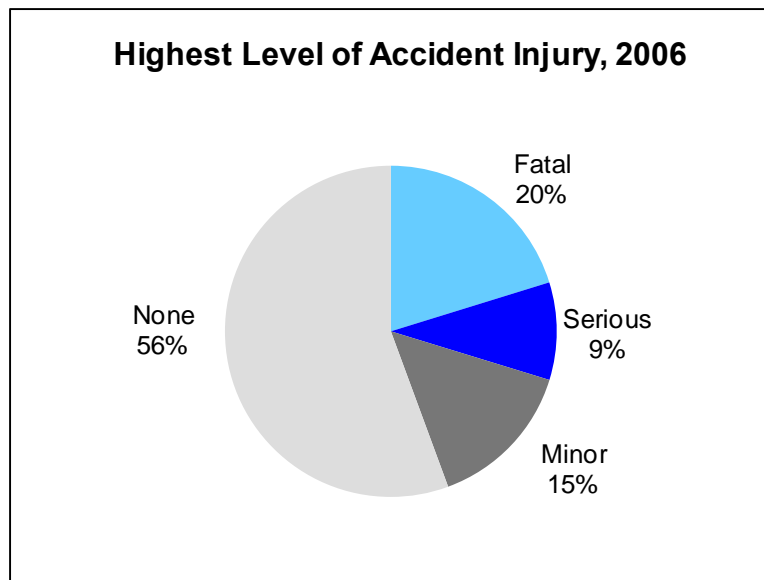


Figure 24. Proportions of fatal, serious injury, minor injury and non-injury general aviation accidents in 2006.

Figure 25 illustrates 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 any occupant of an accident aircraft. Again, most persons who were aboard general aviation aircraft that were involved in accidents sustained no injuries.

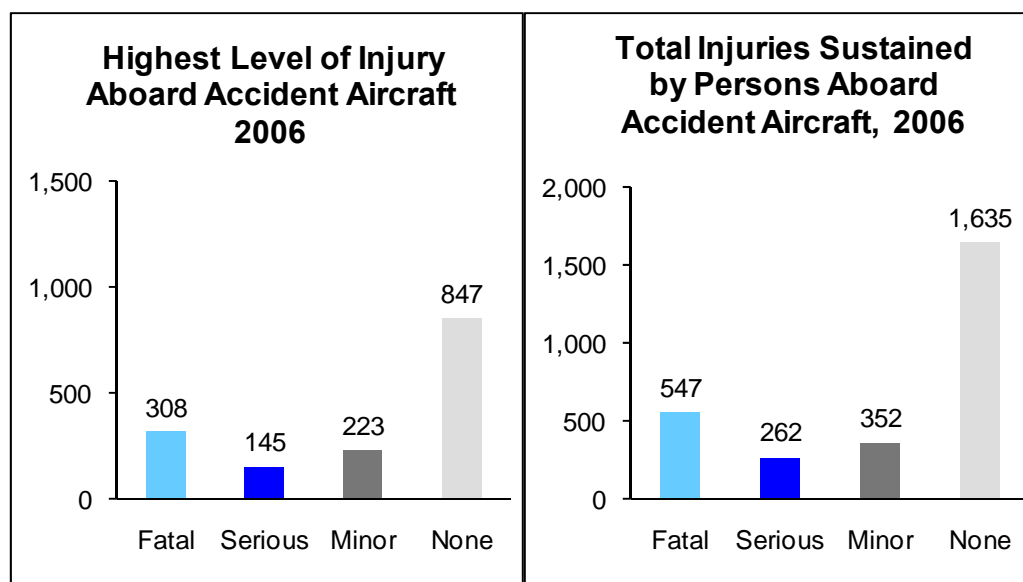


Figure 25. Distributions of general aviation accidents by level of highest injury and number of individuals suffering various levels of injury in 2006.

Injuries by Role for 2006

The distribution of general aviation accident injuries in 2006 varied with the type of operation and the size of aircraft as indicated in table 3. The number of injuries experienced by any group of persons varied with their level of activity (that is, their exposure to risk). For example, all aircraft have a pilot, but not all have passengers on board.

Table 3. Levels of injury experienced by various persons involved in general aviation aircraft accidents in 2006

Personal Injuries	Fatal	Serious	Minor	None	Total
Pilot	282	139	209	905	1,535
Copilot	21	4	10	26	61
Flight instructor	6	4	7	22	39
Dual student	12	7	17	56	92
Check pilot	0	0	2	1	3
Other crew	6	4	0	12	22
Passenger	220	104	107	613	1,044
Total aboard	547	262	352	1,635	2,796
On ground	4	3	10	0	17
Other aircraft	155	0	0	1	156

In 2006, 220 passengers were killed and 211 passengers suffered some level of nonfatal injury in general aviation accidents, compared to the 613 passengers aboard these aircraft who were uninjured. In these same accidents, 327 pilots or other flight crew were killed, 403 suffered nonfatal injuries, and 1,022 were uninjured. Pilots sustained the highest percentage of injuries, suffering 54% of all fatalities, 56% of all serious injuries, and 55% of all minor injuries.

In addition to injuries sustained by persons on board the accident aircraft, 4 persons on the ground were killed and 13 sustained injuries as a result of general aviation accidents. The 155 fatalities shown in table 3 as aboard other aircraft include 154 people aboard the aircraft involved in the midair collision between a Part 91 ferry flight and a Brazilian airliner over Brazil.

Accident Pilots

Rating

Of the 1,509 pilots involved in general aviation accidents in 2006, the largest percentage held a private pilot certificate (figure 26).²⁶ The second-largest percentage held a commercial

²⁶ Available at <[US Civil Airmen Statistics](#)>.

pilot certificate, which is required for any person to act as pilot-in-command of an aircraft for compensation or hire.²⁷ When compared to the number of active pilots in 2006 holding each type of pilot certificate, commercial pilots were overrepresented among general aviation accidents (figure 27). Although commercial pilot certificate holders accounted for only 21% of all active general aviation pilots, they were involved in 36% of all general aviation accidents in 2006.

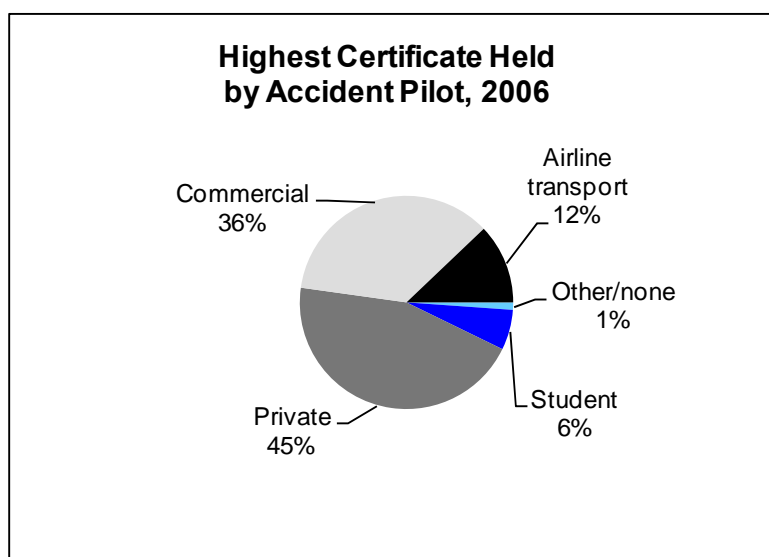


Figure 26. Proportion of general aviation accident pilots holding various types of certificates in 2006.

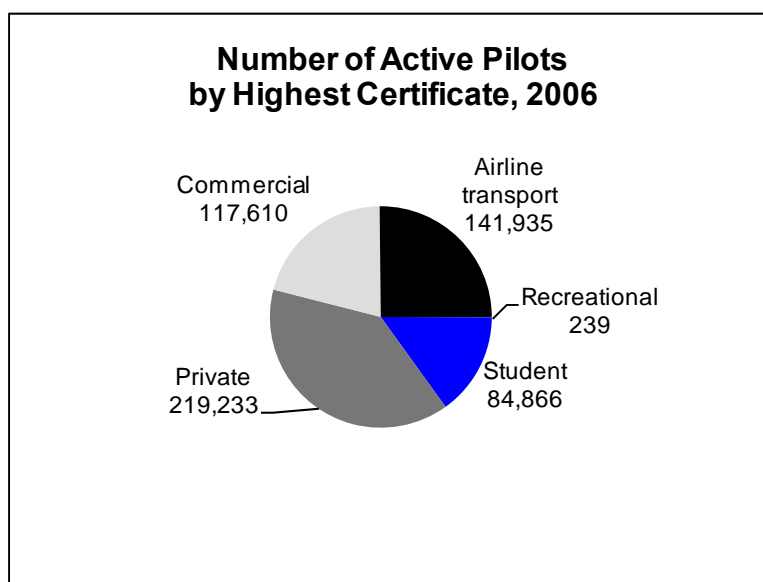


Figure 27. Number of active U.S. pilots in 2006 holding various types of certificates.

²⁷ See 14 CFR 61.133 for the privileges granted by a commercial pilot certificate.

Similarly, the per-pilot accident rate was highest for commercial pilot certificate holders during 2006, with 4.57 accidents per 1,000 active pilots (figure 28). 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, of the 453 commercial pilots involved in accidents during 2006, 59% were conducting personal/business flights and were not involved in commercial operations at the time of the accidents.

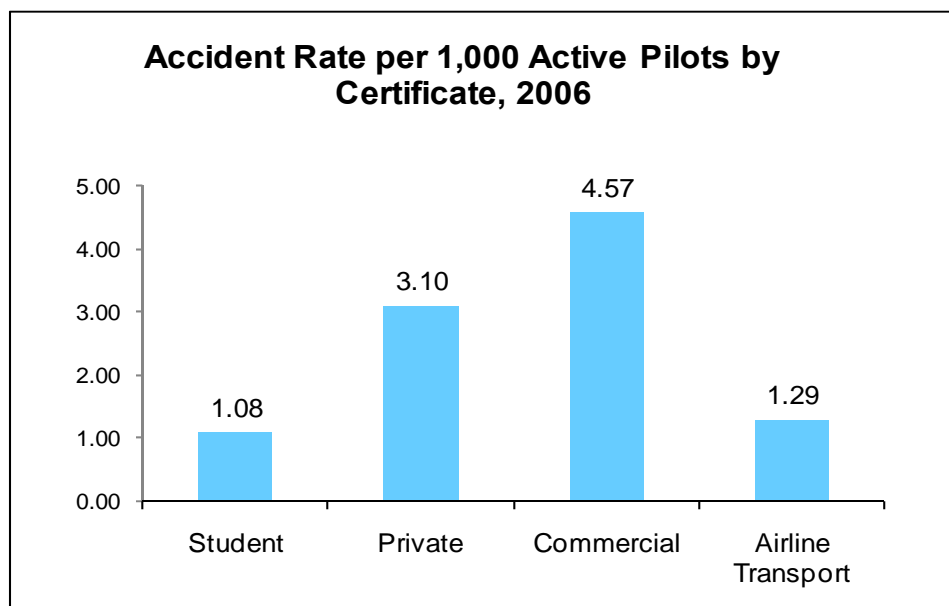


Figure 28. 2006 general aviation accident rates per 1,000 active pilots by type of certificate held by accident pilots.

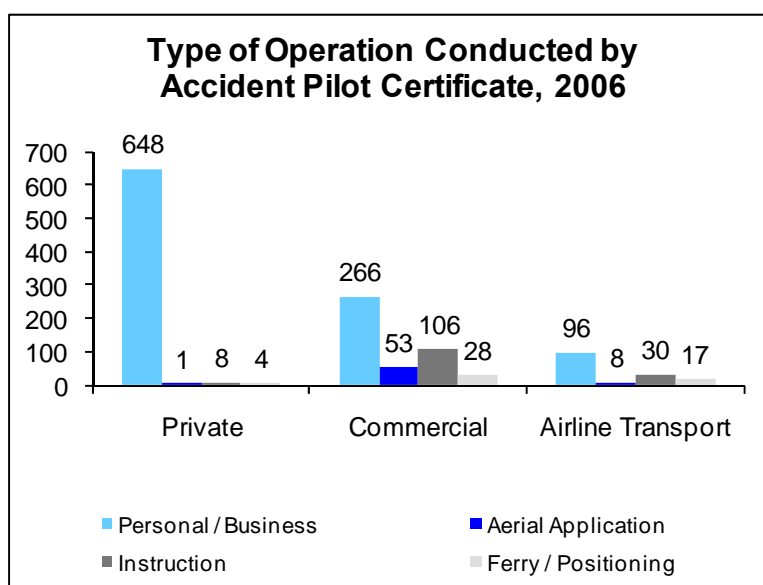


Figure 29. Types of flying operation conducted by accident-involved general aviation pilots, by certificate type (1,265 accident pilot records with data available, 2006).

Because annual flight-hour data are not compiled separately for pilots holding each type of certificate, it is not possible to compare activity-based accident rates. The *U.S. Civil Airmen Statistics*²⁸ also do not include information about the type of operation that certificate holders engage in. Examples of other commercial operations not presented in figure 29 include corporate/executive transportation, sightseeing flights, banner towing, and aerial observation.

Total Time

Of the 1,483 accident pilots for whom total flight experience data are available, 46% had a total flight time of 1,000 or fewer hours. Figure 30 depicts the distribution of experience among accident pilots. The inset focuses on those pilots with fewer than 1,000 hours. The largest percentage of accident pilots in this group, about 15%, had 200 or fewer hours of total flight time.

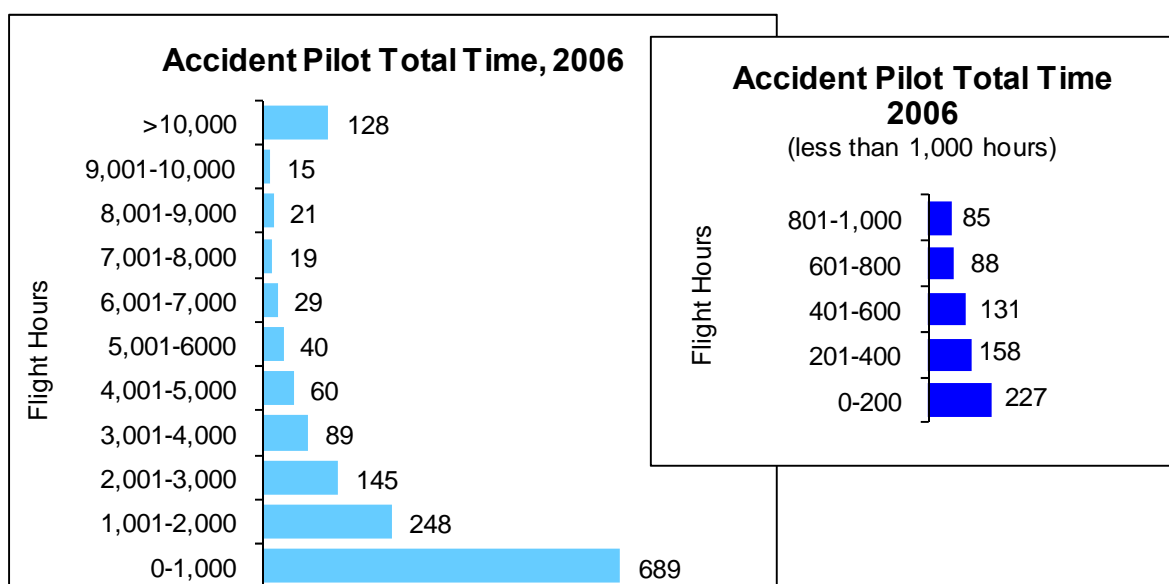


Figure 30. Distributions of total flying time by pilots involved in general aviation accidents in 2006.

It is not surprising that 9 of 10 accident pilots with 200 or fewer hours total flight time were flying single-engine piston airplanes (figure 31). Although most accident pilots with more than 1,000 hours were flying single-engine piston airplanes, this group also operated a more diverse selection of aircraft—multiengine piston, turboprop, and turbine-powered airplanes—and more than twice as many rotorcraft.

²⁸ Available at [US Civil Airmen Statistics](http://www.ntsb.gov/publications/US_Civil_Airmen_Statistics/).

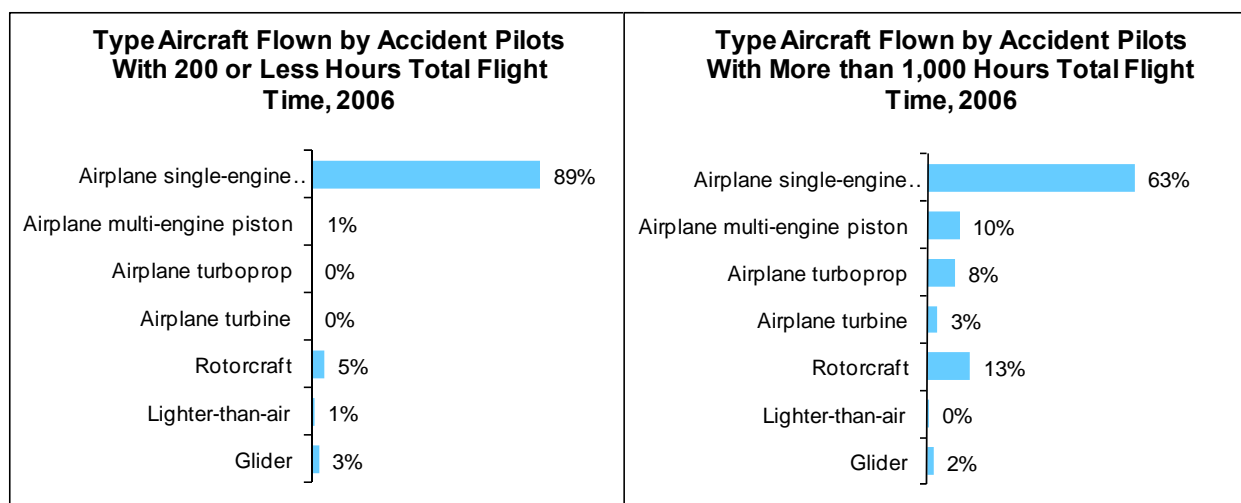


Figure 31. Types of aircraft flown by accident pilots by hours of flight time in 2006.

Time in Type of Aircraft

As figure 32 shows, of the 1,393 accidents in 2006 for which pertinent data are available, 41% involved pilots with 100 or fewer hours in the accident aircraft make and model. Of those, 93 pilots (7% of all accident pilots for whom data are available) had fewer than 10 hours in their accident aircraft type. Most accident pilots with fewer than 10 hours of flight time in make and model were flying single-engine piston aircraft.

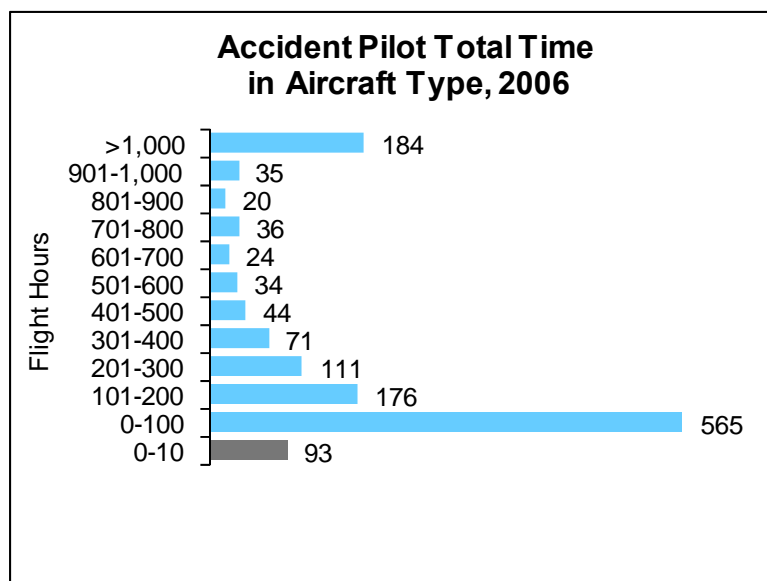


Figure 32. Distribution of total time in accident aircraft type for pilots involved in 2006 general aviation accidents (1,393 accident pilot records with time in aircraft type information).

Pilots may have low time in type because they are new pilots with low total time or they may be 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 multiengine piston, jet, and turboprop airplanes are more likely to be operated by professional pilots. Although not specifically detailed in figure 33, it is particularly noteworthy that 40 of the 93 accident pilots in 2006 who had 10 or fewer hours in the accident aircraft type were operating amateur-built aircraft. Comparison of the two graphs in figure 33 shows that accident 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 multiengine piston, jet, or turboprop airplanes.

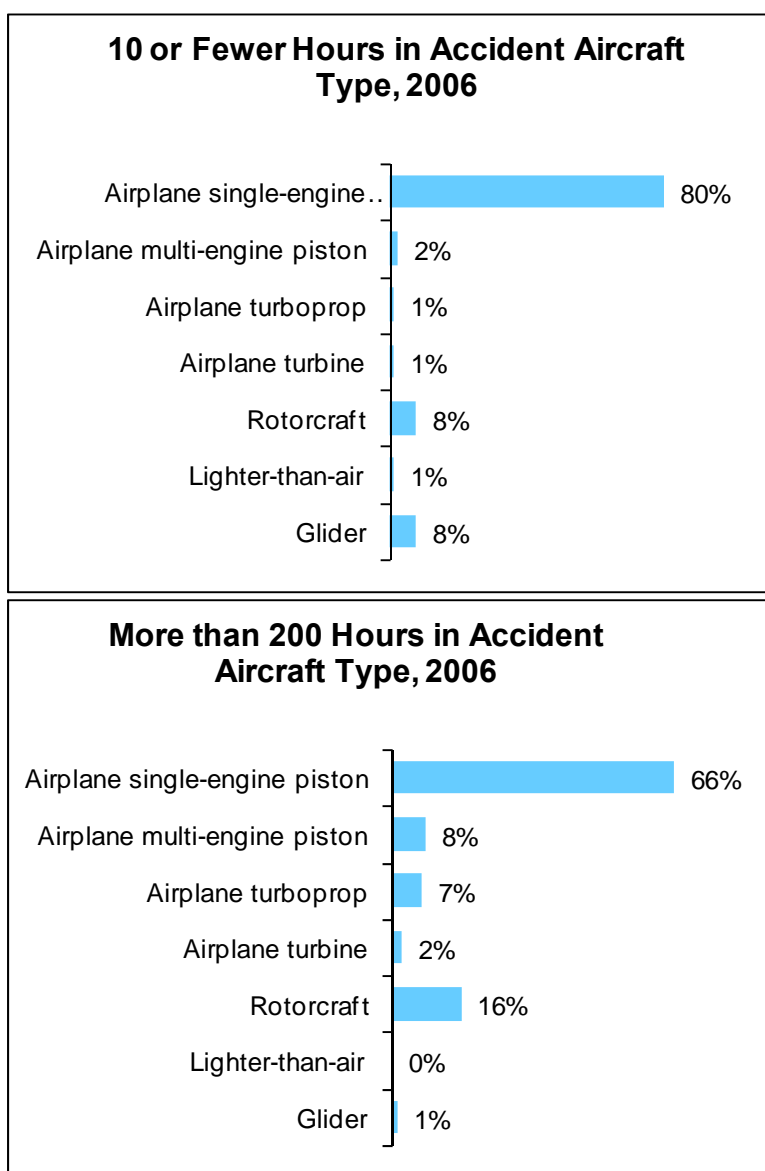


Figure 33. Type of accident aircraft by pilot hours by type in 2006.

Age

Figure 34 compares the broad age distribution of active pilot certificate holders with the age distribution of pilots involved in general aviation accidents in 2006. While the population of pilots is relatively uniform across the four broad age categories, accident pilots are disproportionately represented in the higher age categories, particularly in the 55 and over category. Unfortunately, FAA flight-hour estimates from the GAATAA Survey are not available by age group, so it is not possible to determine whether the groups are uniformly exposed to the risk of accident.

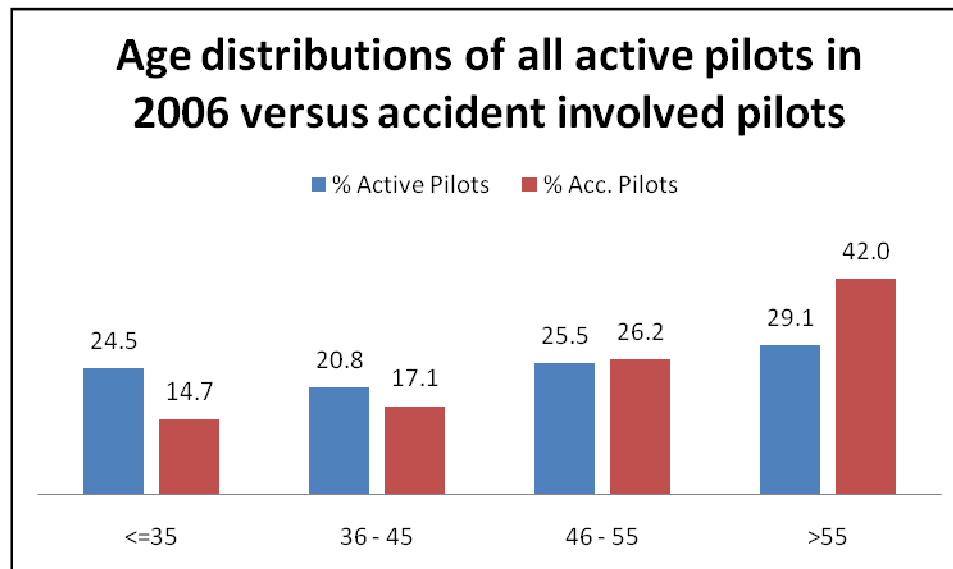


Figure 34. Proportions of active pilots and accident pilots by broad age category.

Figure 35 shows accident pilot age distributions for each of the primary types of flying. Nearly half the accident pilots performing personal or business flying were 55 or older while most of the accident pilots engaged in some aspect of flight instruction were younger than 45. Age distributions for aerial application and corporate/executive accident pilots were more uniform.

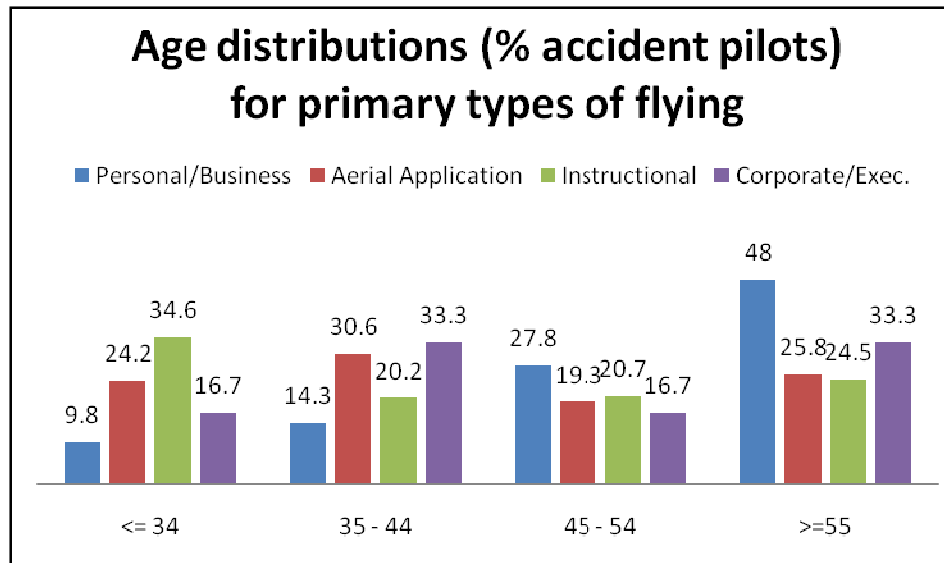


Figure 35. 2006 age distributions of pilots involved in 2006 general aviation accidents by principal types of flying operation.

Figure 36 shows the age distributions of accident pilots by the highest certificate held. While all four certificate groups (student, private, commercial, and air transport pilot) were skewed toward the upper end of the age range, this was more pronounced for the private and airline transport pilot certificate holders. Again, GAATAA Survey data are not available to estimate flight hours as a function of either type of flying or highest pilot certificate.

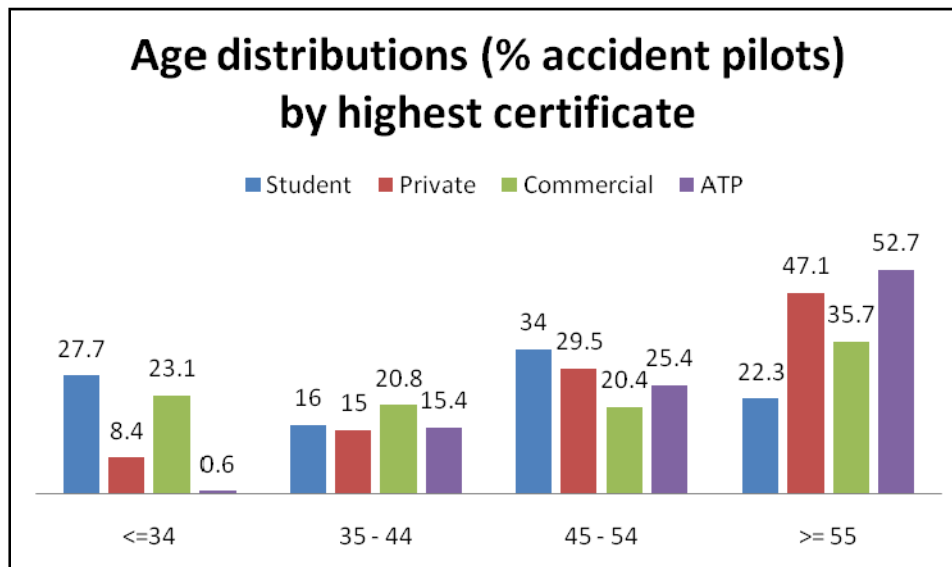


Figure 36. Age distributions of accident pilots by highest pilot certificate held.

Accident Occurrences for 2006

NTSB 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. Accident events are described by means of 54 occurrence codes.²⁹ 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, and so on), with as many as six different occurrence codes in one accident. For accidents that involve more than one aircraft, the list of occurrences may be different for each aircraft. Of the 1,506 accident aircraft in 2006 for which data are available, 1,186 cited two or more occurrences, 611 cited three or more, 127 cited four or more, and 3 cited five or more.

The following brief report excerpt, for a 2006 accident with three occurrences, shows how an accident with multiple occurrences is coded. In this accident, the pilot filed an IFR flight plan and was advised of a weather front and areas of icing along the route. The pilot later changed his en route altitude to avoid an area of predicted higher-altitude icing. Subsequently, the pilot reported “engine issues” and said that he needed a VFR airport. Several minutes later, the pilot stated that he did not have engine power, and the controller tried to vector the pilot to an airport but lost voice and radar contact. A farmer subsequently heard the airplane approach through a snow squall without power. The airplane impacted hilly terrain and burst into flames. No mechanical anomalies were noted with the airframe, but the fuel system could not be examined because it was damaged by impact forces and fire. The engine was successfully run in an engine test cell. The pilot was fatally injured. Each of these occurrences was coded in order, as shown.

Example of occurrence findings cited in an NTSB accident brief, 2006

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

Phase of Operation: CRUISE

Occurrence #2: FORCED LANDING

Phase of Operation: DESCENT – EMERGENCY

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER

Phase of Operation: DESCENT – EMERGENCY

²⁹ Two of the codes, missing aircraft and undetermined, do not represent operational events.

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. Table 4 shows the coding for first occurrences for all 2006 general aviation accident aircraft for which sequence of events data are available.

To simplify the presentation of accident occurrence data, similar occurrences are grouped into eight major categories. Among these categories, the largest percentage of accidents (27%) involved in-flight noncollision events, the most common being loss of control in flight (56% of the in-flight noncollision events). Noncollision on the ground was the next most frequent major category (25%), and 56% of these events were instances of loss of control on the ground. Engine power-related occurrences were the third most common major category in 2006.

By far, the most common major category of fatal first occurrences was noncollision in-flight events (49%), and most of these (66%) involved loss of control in-flight. In-flight collisions (27%), the next most common fatal accident first occurrences, primarily involved in-flight collisions with objects or terrain.

Table 4. General aviation accident first occurrences, 2006.

2006 Accident First Occurrences	Total	Fatal	2006 Accident First Occurrences (Cont.)	Total	Fatal
Collision – In-flight	204	82	Power Related	368	53
In-flight Collision with Object	107	43	Loss of Engine Power	157	20
In-flight Collision with Terrain/Water	69	28	Loss of Engine Power(Total) - Nonmechanical	100	17
Midair Collision	14	10	Loss of Engine Power(Total) - Mech Failure/Malf	54	6
Undershoot	13	0	Loss of Engine Power(Partial) - Nonmechanical	29	4
Near Collision Between Aircraft	1	1	Loss of Engine Power(Partial) - Mech Failure/Malf	25	5
Noncollision – In-flight	411	146	Propeller Failure/Malfunction	2	1
Loss of Control - In-flight	231	97	Rotor Failure/Malfunction	1	0
Airframe/Component/System Failure/Malfunction	97	13	Engine Tear-away	0	0
In-flight Encounter with Weather	70	34	Landing Gear	42	1
Abrupt Maneuver	4	1	Gear Collapsed	12	0
Vortex Turbulence Encountered	2	1	Wheels-up Landing	17	1
Altitude Deviation, Uncontrolled	1	0	Main Gear Collapsed	6	0
Forced Landing	6	0	Gear Retraction on Ground	3	0
Decompression	0	0	Nose Gear Collapsed	3	0
Collision – On-Ground or Water	77	4	Complete Gear Collapsed	0	0
On Ground/Water Collision with Object	39	3	Wheels-down Landing in Water	1	0
On Ground/Water Encounter with Terrain/Water	29	1	Tail Gear Collapsed	0	0
Collision Between Aircraft (Other Than Midair)	6	0	Other Gear Collapsed	0	0
Dragged Wing, Rotor, Pod, Float or Tail/Skid	3	0	Gear Not Extended	0	0
Noncollision – On-Ground or Water	375	11	Gear Not Retracted	0	0
Loss of Control - On Ground/Water	210	7	Miscellaneous	28	2
Hard Landing	99	1	Miscellaneous/Other	21	2
Overrun	40	1	Fire	5	0
Nose Over	12	0	Cargo Shift	2	0
Roll Over	5	0	Fire/Explosion	0	0
Propeller/Rotor Contact to Person	3	2	Hazardous Materials Leak/Spill	0	0
Propeller Blast or Jet Exhaust/Suction	1	0	Explosion	0	0
Nose Down	0	0	Undetermined	1	1
Ditching	0	0	Missing Aircraft	1	1
On Ground/Water Encounter with Weather	5	0	Undetermined	0	0

Phase of Flight

Figure 37 displays the percentage of accident aircraft in each phase of flight at the time of the first occurrence. The phase of flight can be defined as when, during the operation of the aircraft, the first occurrence took place. Fifty distinct phases of flight are used to describe the operational chronology of occurrences. To simplify this information, the detailed phases are grouped into the nine broad categories shown. For example, the approach category includes any segment of an instrument approach or position in the airport traffic pattern and continues until the aircraft lands on the runway. For each broad phase of flight (during the first occurrence), the upper set of numbers shows the percentage of total accidents, and the numbers in parentheses show the percentage of fatal accidents.

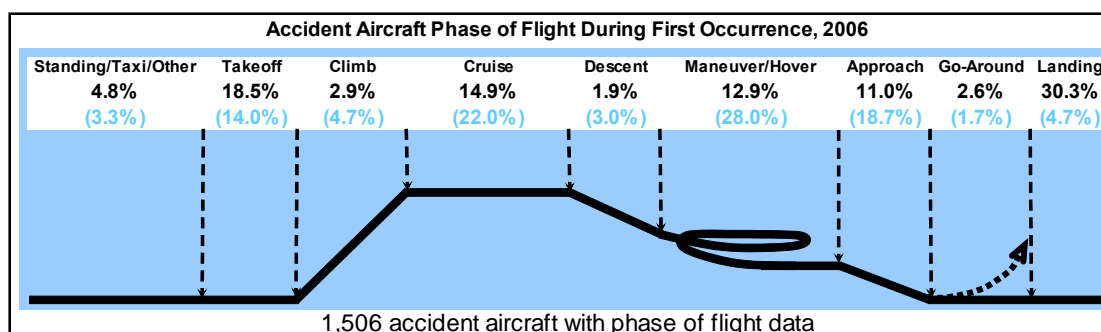


Figure 37. 2006 general aviation accidents by phase of flight.

As shown in figure 37, about half of all general aviation accidents occurred during either takeoff or landing, despite the relatively short duration of these phases compared to the entire profile of a normal flight. This high number of accidents reflects the increased workload during takeoff and landing, when the flight crew must control the aircraft, change altitude and speed, communicate with air traffic control 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. In addition, while the aircraft is at low altitude, it is also most susceptible to hazards caused by wind and weather conditions.

Notably, landing accounted for the largest percentage of total accident first occurrences (30.3%) of any single phase, but only 4.7% of fatal accident first occurrences. The combination of cruise and maneuvering phases accounted for 50% of fatal accident first occurrences, but less than one-third (27.9%) of all accidents. These differences reflect the relative severity of accidents likely to occur during each phase. Accidents during cruise and maneuvering are more likely to result in higher levels of injury and aircraft damage due to higher speeds and altitudes.

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, flight instruction typically involves a lot of time practicing takeoffs and landings. As a result, about 44% of all first occurrences for 2006 involving instructional flights occurred during landing as compared to 31% of personal/business flights and 8% of aerial application flights (figure 38).

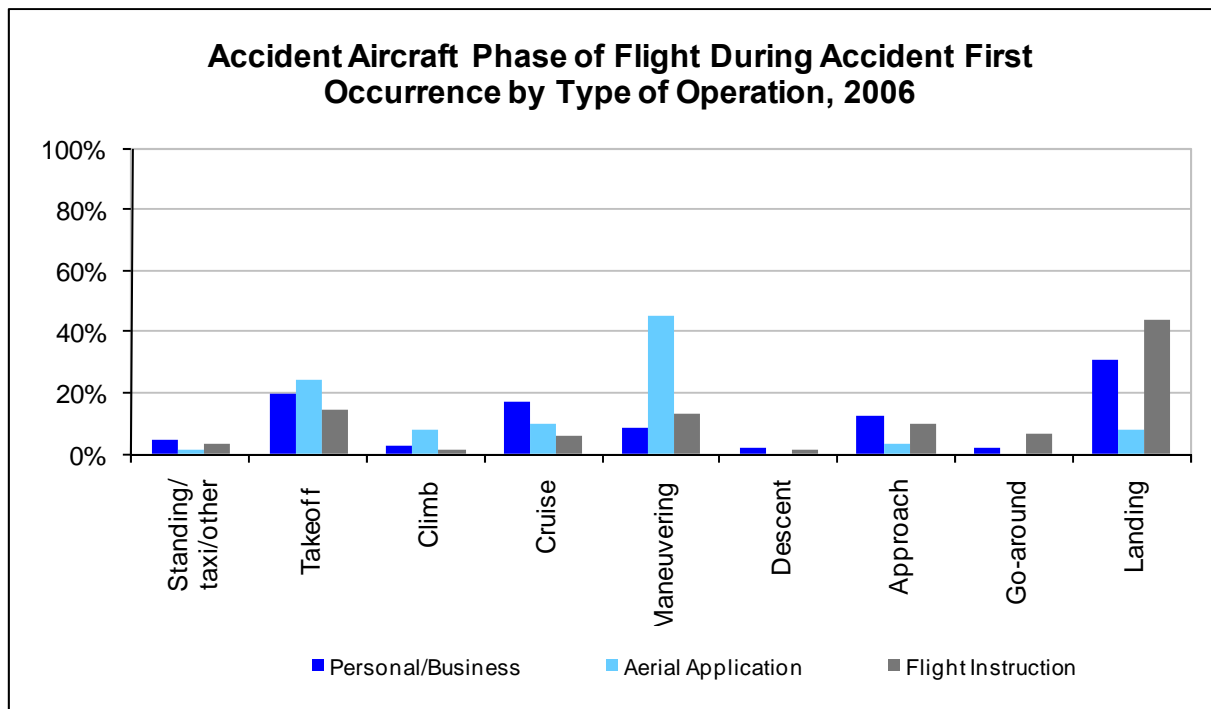


Figure 38. Phase of flight by type of flying operation for 2006 general aviation accidents.

Similarly, 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 type of operation typically conducted with that aircraft. For example, as figure 39 shows, the largest percentage of first occurrences for accidents involving helicopter flights, about 40%, occurred while maneuvering. The percentage of accidents during this phase reflects the hazards unique to helicopters while hovering and during operations that are unique to helicopters, such as carrying external loads. In contrast, the largest percentage of accidents involving single-engine piston aircraft occurred during landing (32%). Further, takeoff accounted for 20% of accidents involving all airplanes, but only 9% of accidents involving helicopters.

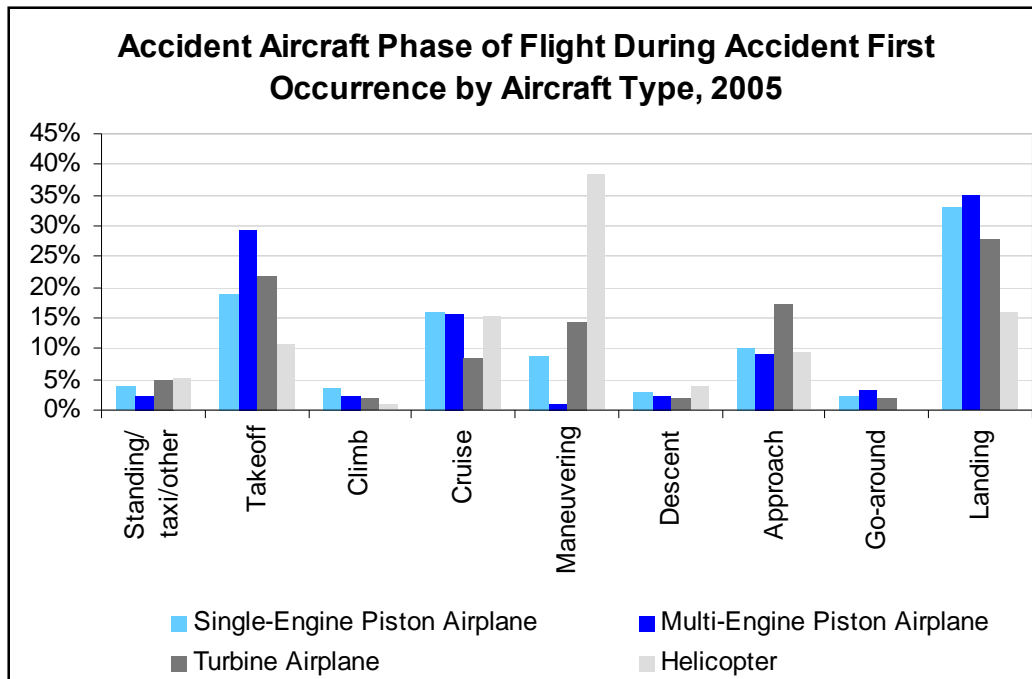


Figure 39. Phase of flight by aircraft type.

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 1,535 aircraft involved in accidents during 2006 for which occurrence data are available, 385 unique combinations of accident occurrences were cited. The top 10 combinations of occurrences for all accidents and fatal accidents are listed in tables 5 and 6. Occurrence chains cited in fatal accidents are similar to those cited for all accidents. The most common occurrence chain for both total and fatal accidents in 2006 was loss of control in flight, followed by in-flight collision with terrain or water. Nearly half of those accidents were fatal.

A diverse range of events can, in combination, result in an accident. Fatal accidents, however, are more likely to result from an in-flight collision, often preceded by loss of control and/or weather encounters or equipment malfunctions. For example, all of the top 10 chains of fatal accident occurrences included an in-flight collision with terrain or object, events that are more likely to result in the high impact forces likely to cause serious injury. In contrast to the severity of these cases, a greater number of nonfatal accidents in 2006 did not involve on-ground contact with objects or terrain (including hard landings), which resulted in lower impact forces, and thus less severe or no injuries.

Table 5. Ten most frequent chains of occurrences for 2006 general aviation accidents overall.	Total
Loss of control - in flight- in flight collision with terrain/water	143
Loss of control - on ground/water- on ground/water encounter with terrain/water	65
Hard landing	60
In flight collision with terrain/water	58
In flight collision with object	44
In flight collision with object- in flight collision with terrain/water	42
Loss of control - on ground/water- on ground/water collision with object	41
Loss of control - in flight- in flight collision with object	35
Loss of engine power- forced landing- in flight collision with terrain/water	32
On ground/water collision with object	32

Table 6: Ten most frequent chains of occurrences for 2006 fatal general aviation accidents.	Total
Loss of control - in flight - in flight collision with terrain/water	69
In flight collision with terrain/water	26
In flight collision with object - in flight collision with terrain/water	24
In flight encounter with weather loss of control - in flight - in flight collision with terrain/water	16
In flight collision with object	15
Loss of control - in flight - in flight collision with object	15
In flight encounter with weather - in flight collision with terrain/water	9
Loss of control - in flight - in flight collision with object - in flight collision with terrain/water	8
Loss of engine power(total) - nonmechanical - forced landing - in flight collision with terrain/water	7
Airframe/component/system failure/malfunction loss of control - in flight - in flight collision with terrain/water	6

Most Prevalent Causes/Factors for 2006

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

In addition to coding accident occurrences, the NTSB makes a determination of probable cause with the objective of defining the cause-and-effect relationships in the accident sequence. The probable cause could be described as *why* the accident happened. In determining probable cause, the NTSB 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 qualified as either a cause or contributing factor. The term contributing factor is used to describe situations or circumstances central 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 those events led to an accident may reflect 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.

Example of NTSB Accident Brief, 2006

Occurrence #1: LOSS OF CONTROL – IN FLIGHT

Phase of Operation: MANEUVERING

Findings

1. WEATHER CONDITION – LOW CEILING
2. (C) **AIRSPPEED (VSO) – NOT MAINTAINED – PILOT IN COMMAND**
3. STALL – INADVERTENT – PILOT IN COMMAND
4. (F) IFR PROCEDURE – NOT FOLLOWED – PILOT IN COMMAND
5. (F) CHECKLIST – NOT FOLLOWED – PILOT IN COMMAND

Occurrence #2: IN FLIGHT COLLISION WITH OBJECT

Phase of Operation: DESCENT

Findings

4. OBJECT - TREES
5. TERRAIN CONDITION - GROUND

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

The National Transportation Safety Board determines the probable cause(s) of this accident as follows: The pilot's failure to maintain airspeed while maneuvering with a low ceiling in instrument flight conditions, resulting in an inadvertent stall, and collision with trees and the ground. Factors in the accident were the pilot's failure to follow the published missed approach procedures, and the airplane's checklist procedures for a balked approach.

In this accident, which occurred during a cross-country flight, the pilot encountered IMC, and the airplane was destroyed after impacting mountainous terrain. According to a pilot flying in the area, there were low clouds with bases between 8,500 to 9,000 feet mean sea level in the area of the accident. Scattered light snow showers were likely in the area, and terrain was mostly obscured above 8,500 feet. In this accident, the pilot's inadvertent flight into IMC and failure to

maintain clearance from terrain were cited as causes. Weather was cited as a factor, and terrain condition was cited as the only finding.

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 three broad cause/factor categories: aircraft, environment, and personnel. Figure 40 shows the percentage of general aviation accidents that fall into each category. Personnel-related causes or factors were cited in 91% of the 1,494 general aviation accident reports for 2006 for which cause/factor data were available. Environmental causes/factors were cited in 38% of these reports, and aircraft-related causes/factors were cited in 24%.³⁰ Environmental conditions are rarely cited as an accident cause but are more likely to be cited as a contributing factor.

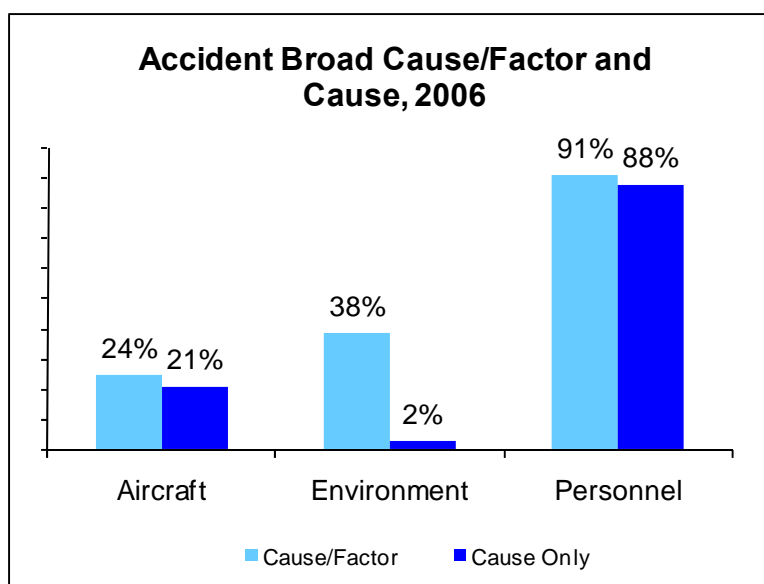


Figure 40. 2006 general aviation accidents by broad cause/factor.

As mentioned previously, several hundred unique codes are available to document causes/factors, as summarized in figure 41 (1,494 accidents with findings).

³⁰ Because the NTSB 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.

Summary of Findings Cited as Cause or Factor in General Aviation Accidents, 2006

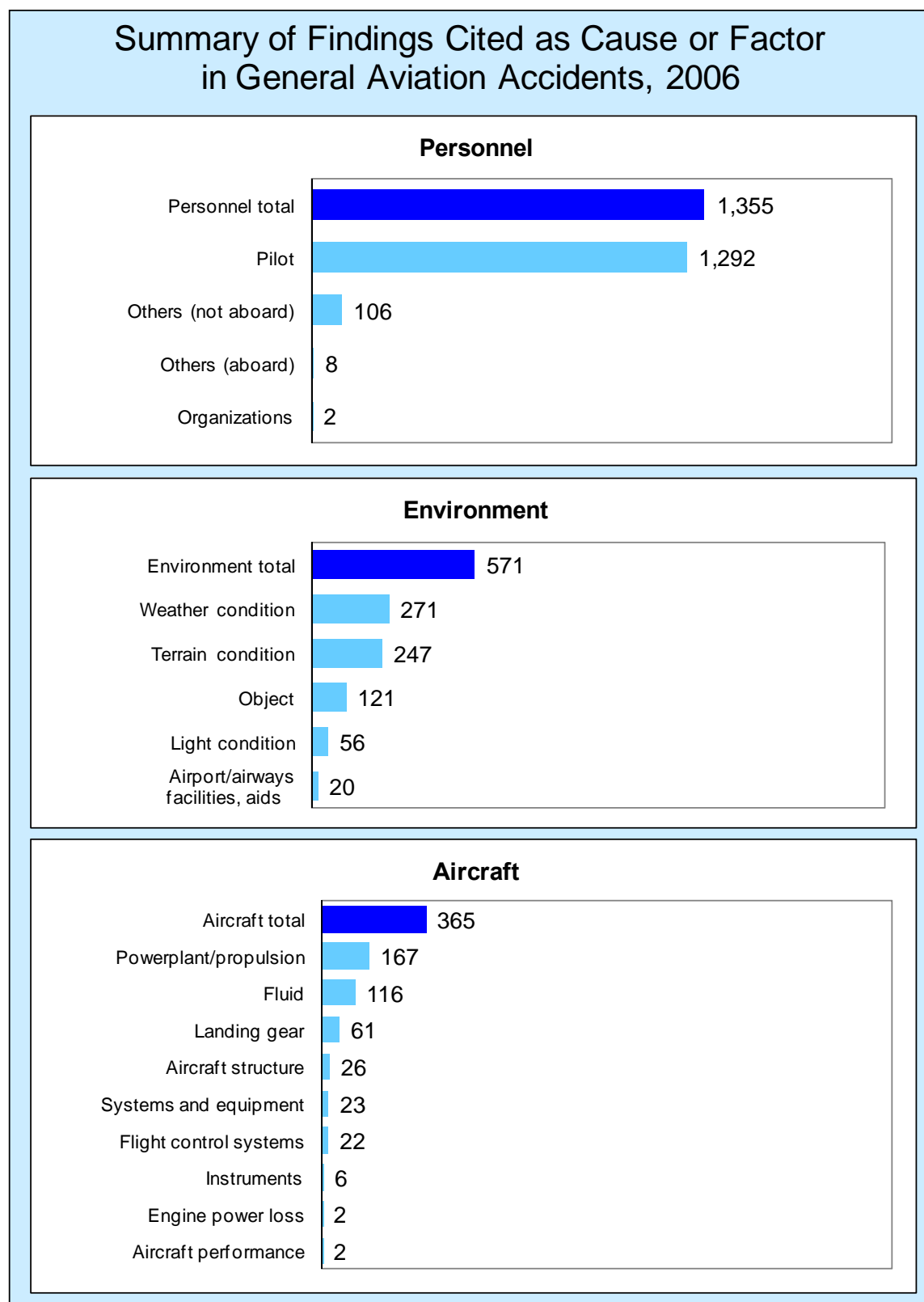
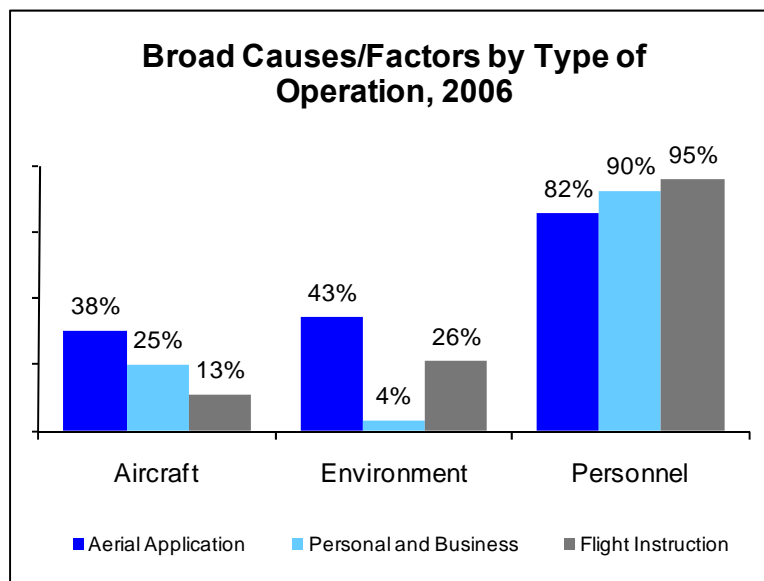


Figure 41. Distributions of personnel, environmental, and aircraft causes and factors in the 2006 general aviation accidents.

As figure 42 shows, most causes and factors attributed to general aviation accidents in 2006 were related to personnel. Much like the pilot and passenger injury differences discussed previously, part of the reason 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 2006, other persons not aboard the aircraft were also cited as a cause or factor in 106 accidents. Such personnel included flight instructors, maintenance technicians, and airport personnel. The most commonly cited environmental factor was weather, cited in 271 (18%) of the accidents. The most commonly cited aircraft factor was powerplant/propulsion,³¹ cited in 167 (11%) of all general aviation accidents.

Figure 42 shows how specific accident causes and factors varied by type of flight operation. For example, personnel were cited in 95% of instructional flight accidents and 90% of personal/business accidents, compared to 82% of 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, as well as the large amount of time practicing maneuvers that are more likely to result in accidents, such as takeoffs and landings. 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.



³¹ 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.

Figure 42. Broad causes and factors of the 2006 general aviation accidents by type of flight operation.

A comparison of the causes/factors cited in accidents involving different types of aircraft, shown in figure 43, reveals results similar to those in figure 42. The percentage of environmental cause/factor citations drops noticeably between single- and multiengine piston airplane accidents, and between multiengine piston and turbine airplane accidents, mirroring progressive increases in the typical range, performance, and equipment capabilities of the aircraft.

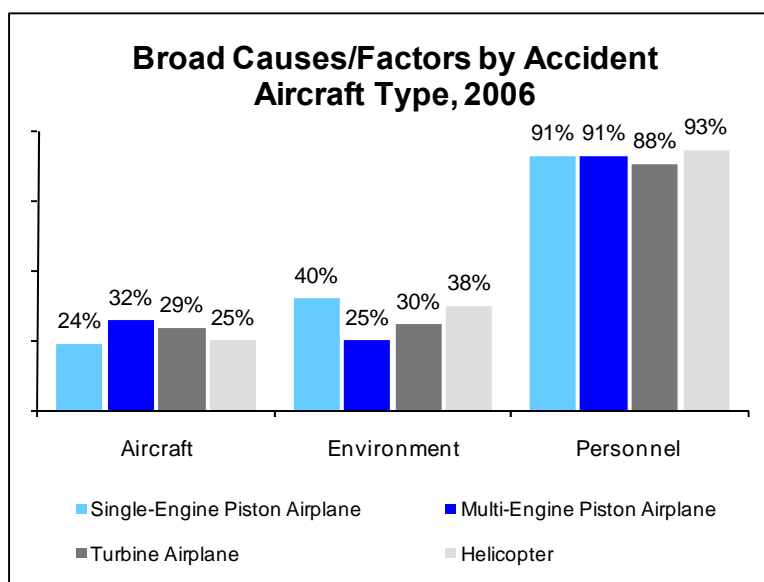


Figure 43. Broad causes and factors of the 2006 general aviation accidents by aircraft type.

Human Performance

The information recorded in the personnel category refers primarily to *whose* actions were a cause or factor in an accident. However, details 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's inability to maintain control 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.

Table 7 shows that of the 1,228 accidents in 2006 with a human performance cause or factor, the most frequently cited cause/factor was aircraft handling and control (71%), followed by planning and decision-making (36%) and use of aircraft equipment (9%). Physiological or psychological conditions were cited in 68% of the 105 accidents as underlying explanatory factors related to human performance. Issues related to personnel qualification were cited as explanatory factors in 23% of these 105 accidents. Examples of qualification issues cited included lack of total experience, lack of recent experience, and lack of certification.

Table 7. Human performance causes and factors and underlying operator conditions cited as causes and factors in 2006 accidents and fatal accidents.

Human Performance and Explanatory Causes/Factors 2006			
	All Accidents		Fatal Accidents
Human Performance Issues	1,228		258
Aircraft handling/control	873		198
Planning/decision	437		118
Use of aircraft equipment	108		14
Maintenance	83		11
Communications/information/ATC	59		13
Meteorological service	3		0
Airport	0		0
Dispatch	0		0
Underlying Explanatory Factors	105		54
Physiological condition	48		39
Qualification	24		9
Psychological condition	23		8
Procedure inadequate	5		3
Aircraft/equipment inadequate	4		0
Material inadequate	3		0
Institutional factors	2		1
Information	0		0
Facility inadequate	0		0

Weather as a Cause/Factor

Because general aviation aircraft are usually smaller, slower, and more limited in maximum altitude and range than transport-category aircraft, they can be more vulnerable to hazards posed by weather (table 8). Adverse wind conditions, precipitation, icing, and convective weather have a greater effect on aircraft that lack the speed, altitude, and/or range capabilities to avoid those conditions. The top three environmental causes/factors cited in general aviation accidents in 2006 were all related to wind: crosswind, gusts, and tailwind. 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.

Table 8. Weather conditions cited as causes and factors in accidents and fatal accidents.

Weather Condition	All Accidents	Fatal Accidents
Weather Condition	271	69
Gusts	64	3
Crosswind	55	0
Tailwind	33	5
Low ceiling	25	20
Clouds	17	15
High density altitude	16	2
Downdraft	15	1
Carburetor icing conditions	14	2
Icing conditions	11	8
High wind	10	2
Fog	9	6
Unfavorable wind	9	0
Thunderstorm	8	7
No thermal lift	7	0
Rain	7	5
Windshear	7	1
Snow	6	3
Sudden windshift	5	0
Below approach/landing minimums	4	4
Obscuration	4	4
Turbulence	3	2
Dust devil/whirlwind	2	0
Mountain wave	2	1
Turbulence in clouds	2	2
Turbulence, terrain induced	2	0
Variable wind	2	1
Drizzle/mist	1	1
Haze/smoke	1	0
Temperature, high	1	0
Thermal lift	1	0
Whiteout	1	0

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

As previously discussed, most landing accidents do not result in fatal injuries. Because of the strong association of wind with landing accidents, it is not surprising that most wind-related accidents in 2006 were not fatal. The wind-related weather factors gusts, crosswind, and tailwind were cited as a cause/factor in 152 accidents, but only 8 of those accidents were fatal. Among fatal general aviation accidents, the two most frequently cited weather factors were related to conditions that resulted in reduced visibility, including low ceiling 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.

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 NTSB'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 *Code of Federal Regulations* (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 NTSB'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, becomes available. A factual report with additional information concerning the occurrence is available within a few months. The final report, which documents the completed investigation, includes a statement of the probable cause and other contributing factors and may not be completed for months.

An accident-based relational database is currently available to the public at <http://www.nts.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 <<http://www.nts.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

NTSB Accident Severity Classifications

According to 49 *Code of Federal Regulations* (CFR) 830.2, 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.¹

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 cowlings, 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.²

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

None: No damage.

¹ Title 49 CFR 830.2 does not define destroyed. This term is difficult to define because aircraft are sometimes rebuilt even when it is not economical to do so.

² See 49 CFR 830.2.

Appendix C: The NTSB 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 NTSB Headquarters in Washington, D.C., or from one of the regional offices.²

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 NTSB and those that are included in the *Annual Review of Aircraft Accident Data, U.S. General Aviation*. Although the NTSB is mandated by Congress to investigate all civil aviation accidents that occur in the United States (including those involving both domestic and foreign operators), the *Annual Review* describes accidents that occurred among U.S.-registered aircraft worldwide.

¹ For more detailed information about the NTSB's investigation of aviation accidents or incidents, see 49 *Code of Federal Regulations* 831.2.

² For locations of NTSB offices, see <http://www.nts.gov/Abt_NTSB/regions/aviation.htm>.