Annual Review of Aircraft Accident Data
U.S. General Aviation, Calendar Year 2005

Annual Review of Aircraft Accident Data

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National
Transportation
Safety Board

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Annual Review of Aircraft Accident Data

Annual Review of U.S. General Aviation Accident Data 2005

National
Transportation
Safety Board

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Abstract:

A total of 1,670 general aviation accidents occurred during calendar year 2005, involving 1,688 aircraft. The total number of general aviation accidents in 2005 was slightly higher than in 2004, with a 3% increase of 53 accidents. Of the total number of accidents, 321 were fatal, resulting in a total of 563 fatalities. The number of fatal general aviation accidents in 2005 increased 2% from calendar year 2004, and the total number of fatalities increased by 1%. The circumstances of these accidents and details related to the aircraft, pilots, and locations are presented throughout this review.

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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2005 General Aviation Accident Summary

A total of 1,670 general aviation accidents occurred during calendar year 2005, involving 1,688 aircraft.[1] The total number of general aviation accidents in 2005 was slightly higher than in 2004, with a 3% increase of 53 accidents. Of the total number of accidents, 321 were fatal, resulting in a total of 563 fatalities. The number of fatal general aviation accidents in 2005 increased 2% from calendar year 2004, and the total number of fatalities increased by 1%. The circumstances of these accidents and details related to the aircraft, pilots, and locations are presented throughout this review.

2005 General Aviation Accident Statistics	
General Aviation Accidents	
Total accidents	1,670
Fatal accidents	321
Accident aircraft	1,688
General Aviation Accident Injuries	
Fatal	563
Serious	271
Minor	462
Persons involved in accidents with no injuries	1,746
General Aviation Accident Rate	
General aviation hours flown[a]	23,168,000
All accidents[b]	7.20/100,000 hours
Fatal accidents[b]	1.38/100,000 hours
Accidents per active pilots	2.74/1,000 active pilots
Fatal accidents per active pilots	0.53/1,000 active pilots

[a] Federal Aviation Administration, *General Aviation and Air Taxi Survey, 2005.*

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

[1] In this review, a collision between two aircraft is counted as a single accident. The 10 midair collisions that occurred in 2005 involved 20 general aviation aircraft. In addition, 8 ground collisions involved 16 general aviation aircraft.

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Introduction

Purpose of the Review

The National Transportation Safety Board's *2005 Annual Review of Aircraft Accident Data for U.S. General Aviation* is a statistical compilation and review of general aviation accidents that occurred in 2005 involving U.S.-registered aircraft. As a summary of all U.S. general aviation accidents for 2005, the review is designed to inform general aviation pilots and their passengers 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, for example, were extracted from the NTSB's Aviation Accident/Incident Database.[1] Activity data were extracted from the *General Aviation and Air Taxi Activity and Avionics Survey* (*GAATAA Survey*)[2] and from *U.S. Civil Airmen Statistics*,[3] 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.[4]

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[5] 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

[1] See appendix A for more details.

[2] FAA: <GAATAA Survey 2005>. Although they are included in the *GAATAA Survey*, data associated with air taxi and air tour operations are not included in this review.

[3] FAA: <US Civil Airmen Statistics>.

[4] 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 2005* (Washington, DC: 2009), available at <http://www.ntsb.gov>.

[5] 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.

revenue,[6] including business flights, flight instruction, 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 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 inside and outside the United States. 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.[7]

Organization of the Review

The *2005 Annual Review* is organized into four parts:

1. A summary of general aviation accident statistics for 2005, industry markers related to general aviation activity in 2005, and contextual statistics from previous years.

2. An investigation of trends over the past 10 years, providing the context for such accident information as operation types, 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.

4. In-depth coverage of a special topic important to general aviation safety. The *2005 Annual Review* focuses on flight instruction and associated safety issues.

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>.

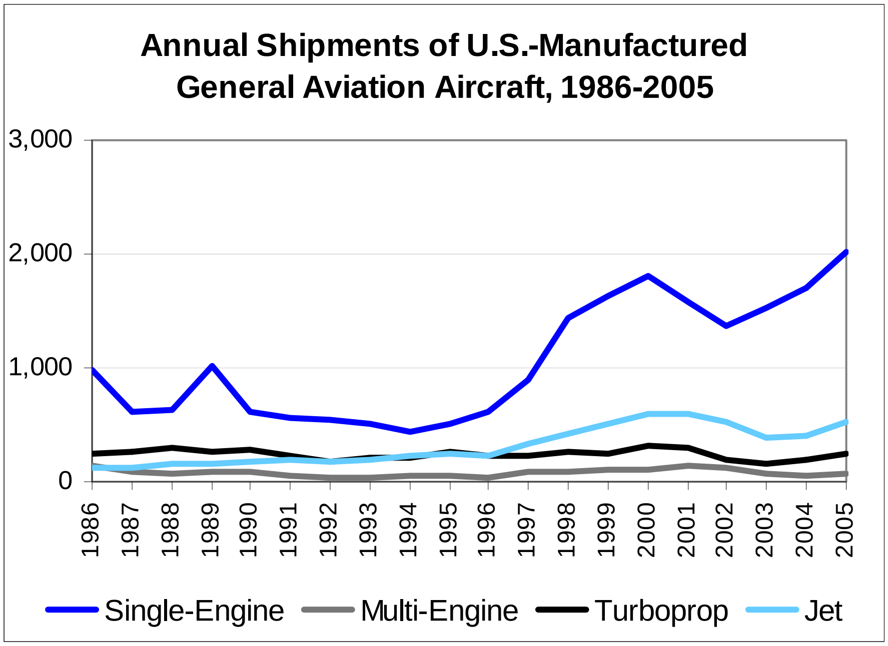
[6] See 14 CFR 119.1.

[7] In 2005, two crashes involved stolen/unauthorized use of aircraft.

The General Aviation Environment in 2005

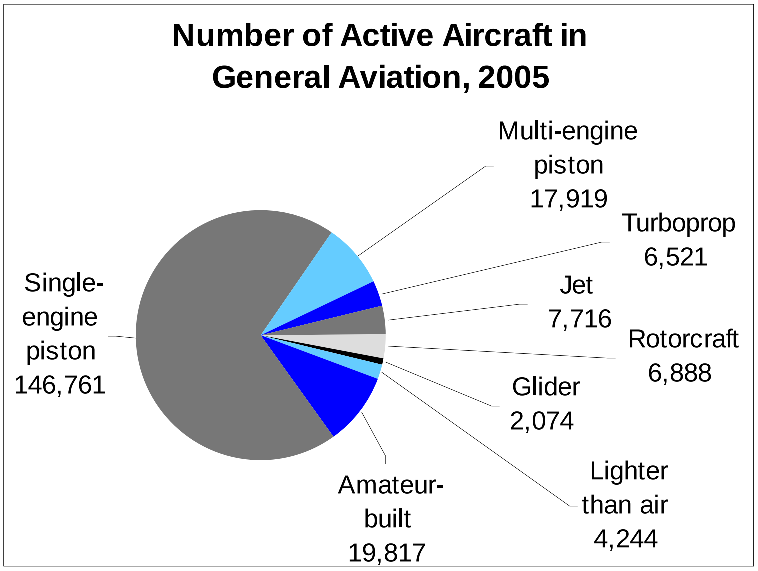
General Aviation Industry Indicators

A theme repeated throughout the annual reviews 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 operations 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. In 2005, the general aviation climate was influenced by generally favorable economic conditions and an increase in general aviation aircraft production.



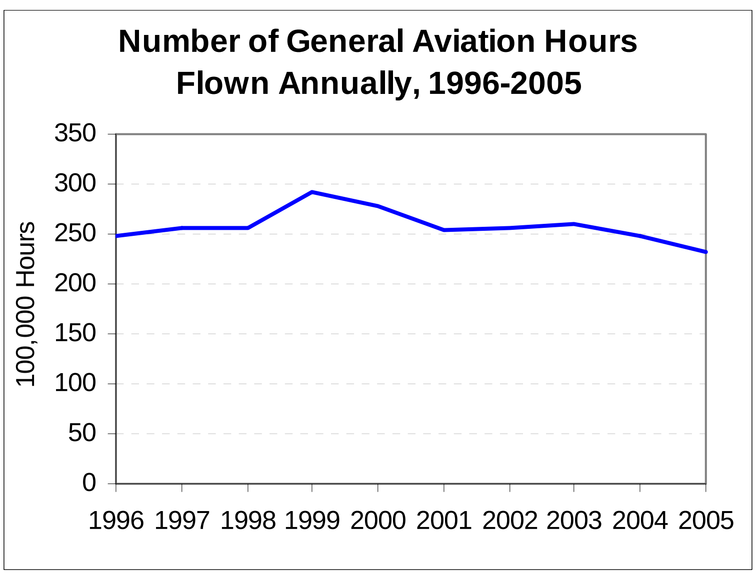
Fleet Makeup

U.S. manufacturers delivered 2,857 new general aviation aircraft in 2005, compared to an estimated 215,837 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, are also difficult to track because most new equipment is also available for installation in older aircraft.



General Aviation Activity

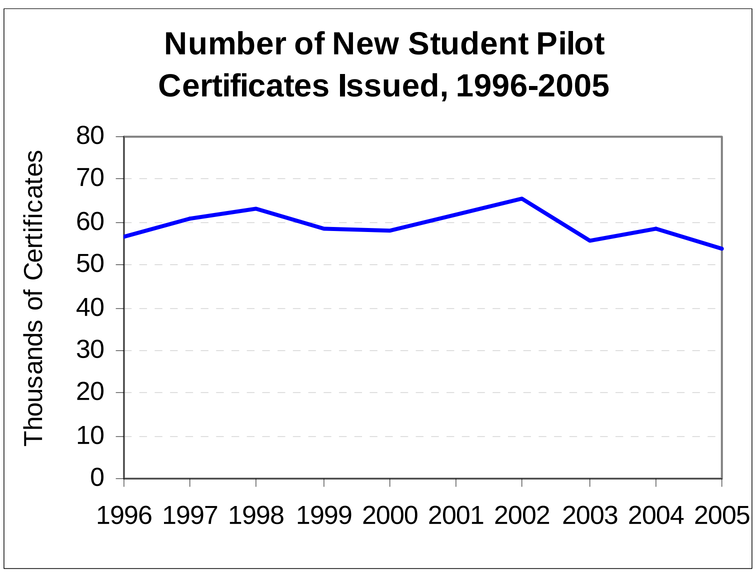
Because general aviation includes such a diverse group of aircraft types and operations, some measure of exposure must be considered to make meaningful comparisons of accident numbers. Flight activity is typically used to normalize accident numbers across different groups, with the level of activity 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 following figure shows, annual general aviation flight hour estimates from 1996 through 2005 peaked in 1999, but were lower after that. In 2005, the estimated number of general aviation flight hours was 23.1 million, slightly lower than in 2004.



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),[8] 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 *GAATAA Survey*,[9] which 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 sample of aircraft is selected from the registry of aircraft owners for use in the *GAATAA Survey*, and reporting is not required.

In addition to flight-hour estimates, the number of pilots can be used to establish the level of exposure to risk for various types of general aviation. One available measure of the pilot population is the number of medical certificates issued, which represents an informal census of all active pilots. The number of medical certificates issued indicates that the total number of active U.S. general aviation pilots decreased steadily throughout the early and mid-1990s, from 692,095 in 1990 to 622,261 in 1996.

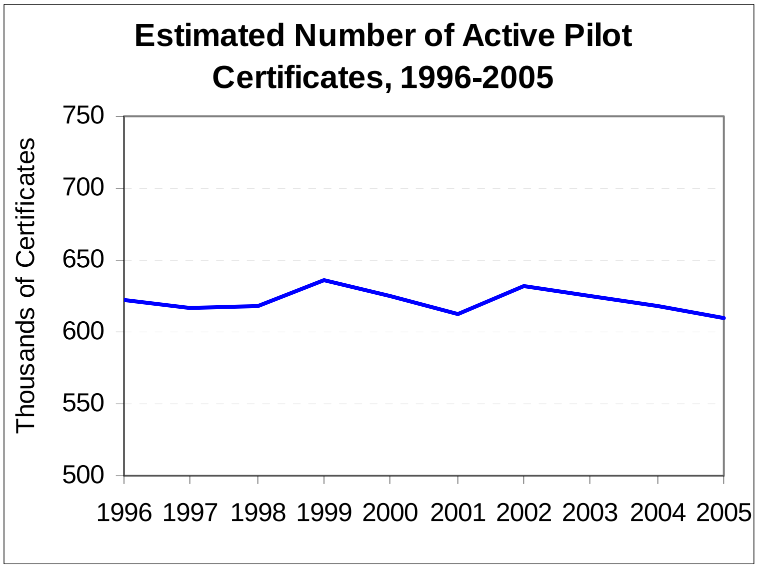
A second measure of the pilot population is the number of certificates issued to new pilots, which represents positive growth in the pilot population. As shown in the figure below, the number of new student pilot certificates fluctuated annually between 1996 and 2005.[10] The total number issued in 2005 came to 53,576, a decrease from the 58,362 issued in 2004. The figure on the next page shows that, between 1996 and 2005, the number of active pilots fluctuated, with an estimated total of 609,737 active U.S. pilots in 2005.



[8] Part 121 operators report activity monthly, and scheduled Part 135 operators report quarterly.

[9] Available at <GAATAA Survey 2005>.

[10] Available at <US Civil Airmen Statistics>.

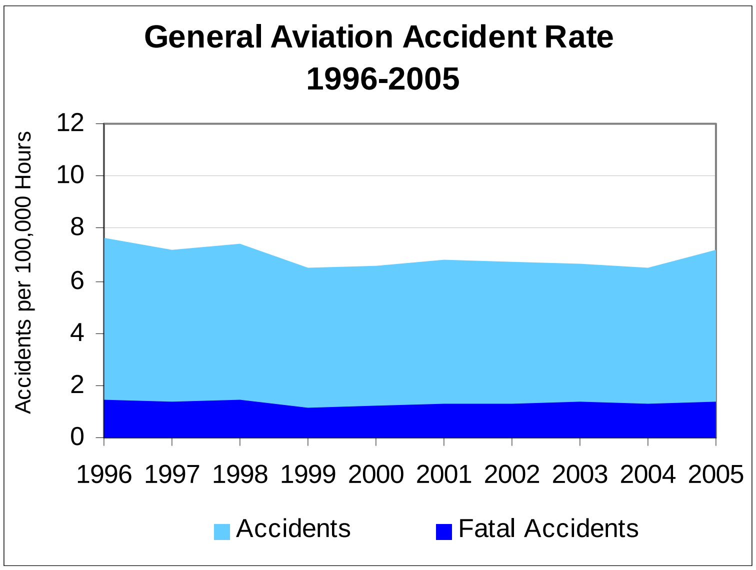


In summary, general aviation indicators—flight hours and the total number of active and newly issued pilot certificates—have fluctuated annually, with little overall change, between 1996 and 2005. Historic estimates of activity should be considered when interpreting the general aviation accident record for 2005 in the context of previous years.

Historical Trends in Accident Data

Accident Rates

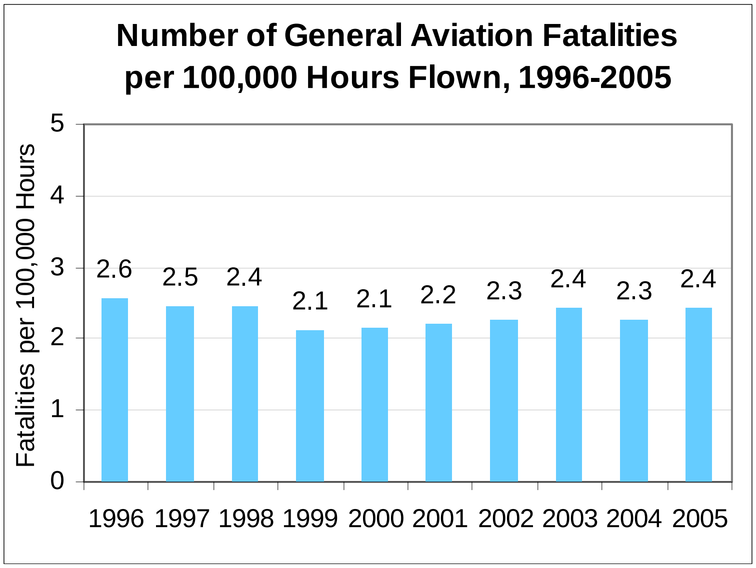
In the last decade, the calculated general aviation accident rate declined overall as annual estimates of general aviation activity increased slightly [11] without a corresponding increase in the number of accidents. The rate of 7.20 accidents per 100,000 hours flown in 2005 was lower than the 7.65 accidents per 100,000 hours recorded in 1996. In fact, the 2005 rate was only slightly higher than that of 2004, which had the lowest rate since the NTSB began reporting general aviation-only annual accident rates in 1975.[12] The 2005 rate of 1.38 fatal accidents per 100,000 flight hours was only slightly higher than the 2004 fatal accident rate of 1.26.



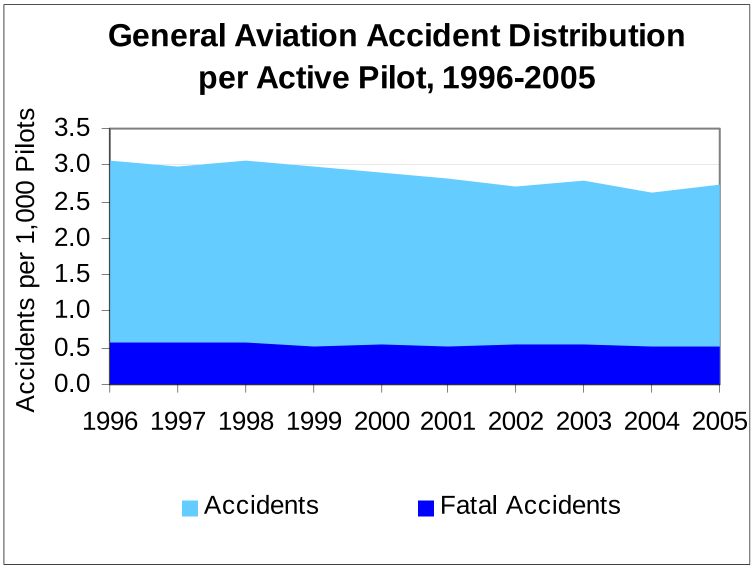
In 2005, accident-related deaths per flight hour were 2.4 fatalities per 100,000 hours flown. The highest annual fatality-per-hour rate occurred in the 10-year period was in 1996 with 2.6 deaths per 100,000 hours flown.

[11] FAA estimates of annual general aviation activity increased noticeably after 1998 due to a change in *GAATAA Survey* methodology that increased the estimated general aviation aircraft population by about 10%. See appendix A of the *GAATAA Survey, Calendar Year 2005,* for an explanation of the changes in survey methodology.

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



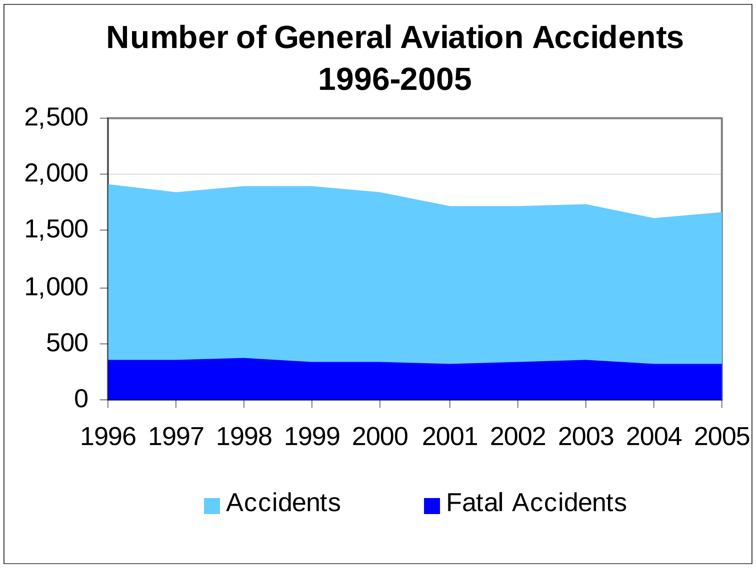
Another measure of accident distribution is the number of accidents per active pilot. Although this measure was considerably more stable from 1996 through 2005 than the per-hour accident rate, it did increase slightly overall. The per-pilot rate in 2005 was only slightly higher than the 2004 rate.



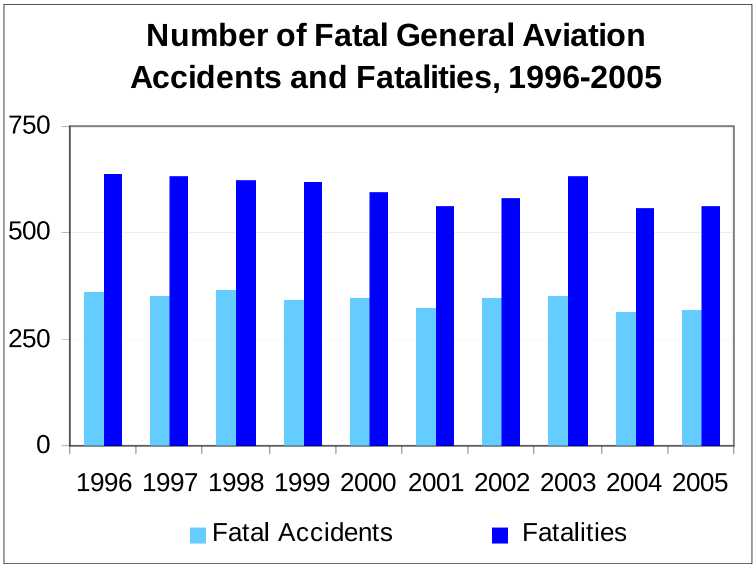
Accident rate calculations based on flight hours require the use of *GAATAA* activity data extrapolated from a relatively small sample of aircraft owners. As a result, the calculated values are accurate only to the extent that the sample represents the larger population of general aviation operators. For this reason, accident rate data presented in this review typically also include raw frequency data for comparison.

Number of Accidents and Fatalities

Despite slight fluctuations year to year, the number of general aviation accidents that occurred annually between 1996 and 2005 declined overall from 1,908 in 1996 to 1,670 in 2005, and the number of fatal accidents decreased overall, from 361 to 321.



The number of general aviation fatalities also exhibited a generally downward trend from a high of 636 in 1996 to 563 in 2005. It should be noted that 2005 continues a generally downward trend in total fatalities for the 10-year period. It should also be noted that the trend reflects a decrease in general aviation flight hours annually following the events of September 11, 2001.



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 *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,[13] 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 typical of general aviation activity include personal/business flights,[14] corporate flights, aerial application, and instructional flights.

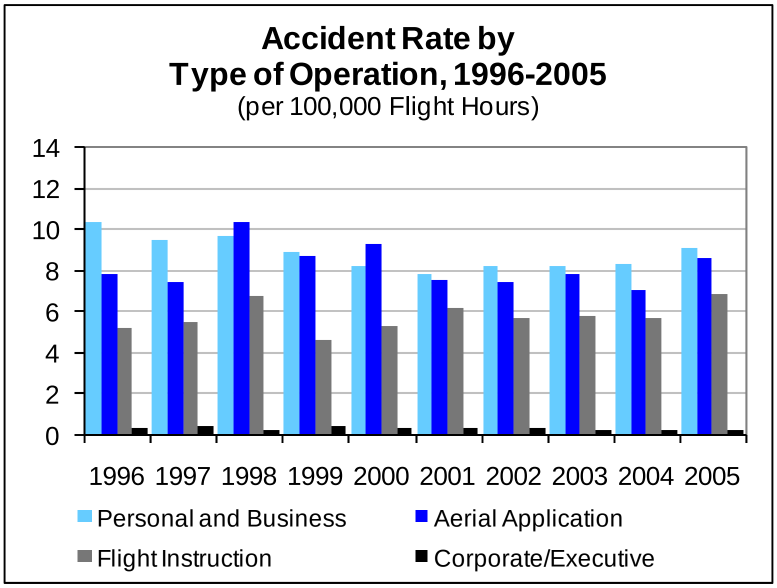
- Personal flights make up the largest portion of general aviation activity and include all flying for pleasure and/or personal transportation. Although similar to personal flights, business flights include the use of an aircraft for business transportation without a paid, professional crew. Personal and business flights are typically conducted in single- and multi-engine piston airplanes, but may include a range of aircraft including gliders, rotorcraft, and balloons.
- Corporate flights include any business transportation with a professional crew and usually involve 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 flights include any flight under the supervision of a certificated flight instructor.[15] 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 8 of the last 10 years, personal and business flights have had the highest average accident rate, followed by aerial application. The lowest accident rate was for corporate/executive transportation, which for the 10-year period ranked lowest overall each year.

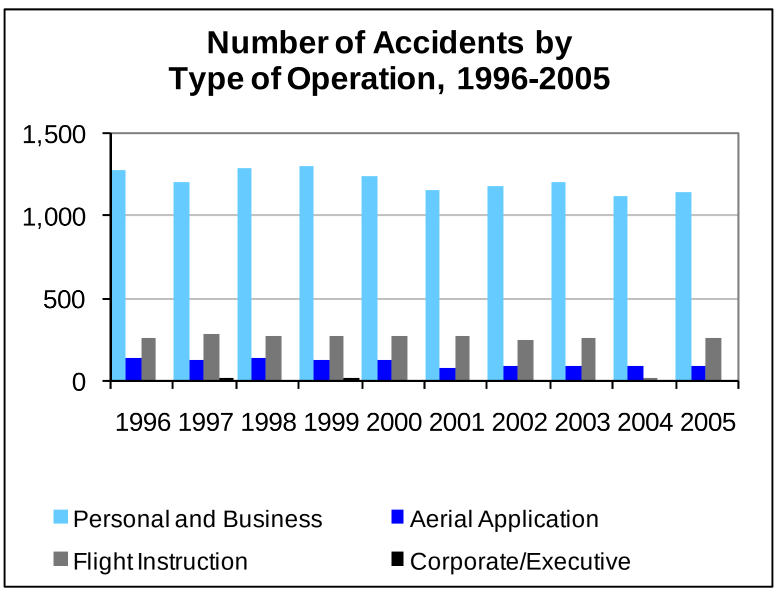
[13] The *2005 Annual Review* data include 11 public aircraft accidents, 3 of which resulted in 1 or more fatalities.

[14] 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).

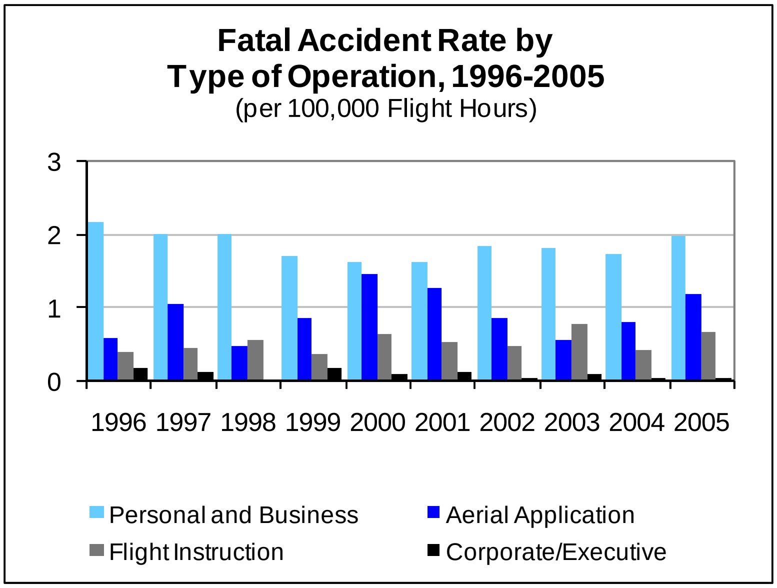
[15] See 14 CFR Part 61, subpart H, for flight instructor certificate and rating requirements.



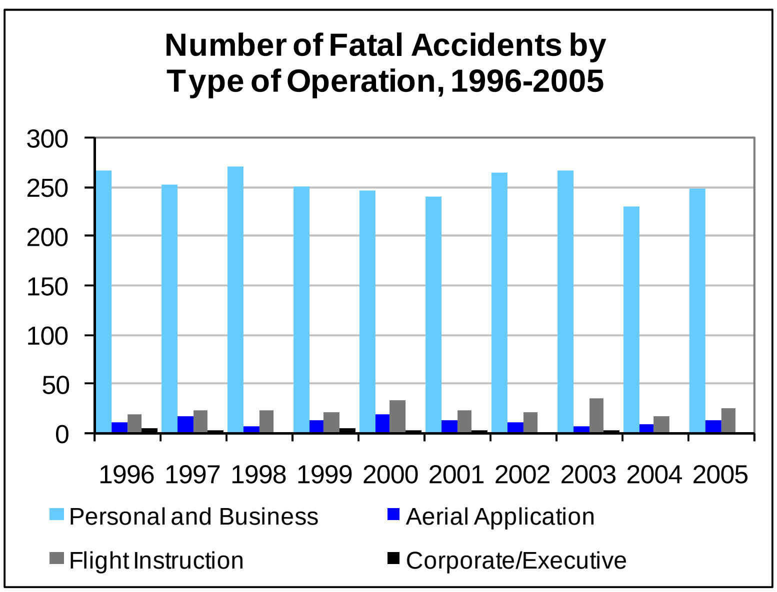
In 2005, the highest proportion of flying time was associated with personal and business operations, which accounted for the largest proportion of accidents, 68% (n = 1,134), a percentage consistent with the 10-year average. Less than 1% of the accidents (n = 7) were corporate/executive operations, 5% were aerial application (n = 88), and 15%, instructional flying (n = 248). 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 flights 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.



As shown in the figure above, between 1996 and 2005, an average 253 fatal accidents per year were personal/business flights, compared to an average 23 fatal accidents for instructional flights, 11 for aerial application, and 3 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 number of fatal accidents per year among each type of flight operation exhibits a distribution similar to the number of accidents; personal and business flying accounted for an average 74% of all fatal general aviation accidents and 75% of all fatal injuries for 1996 through 2005.

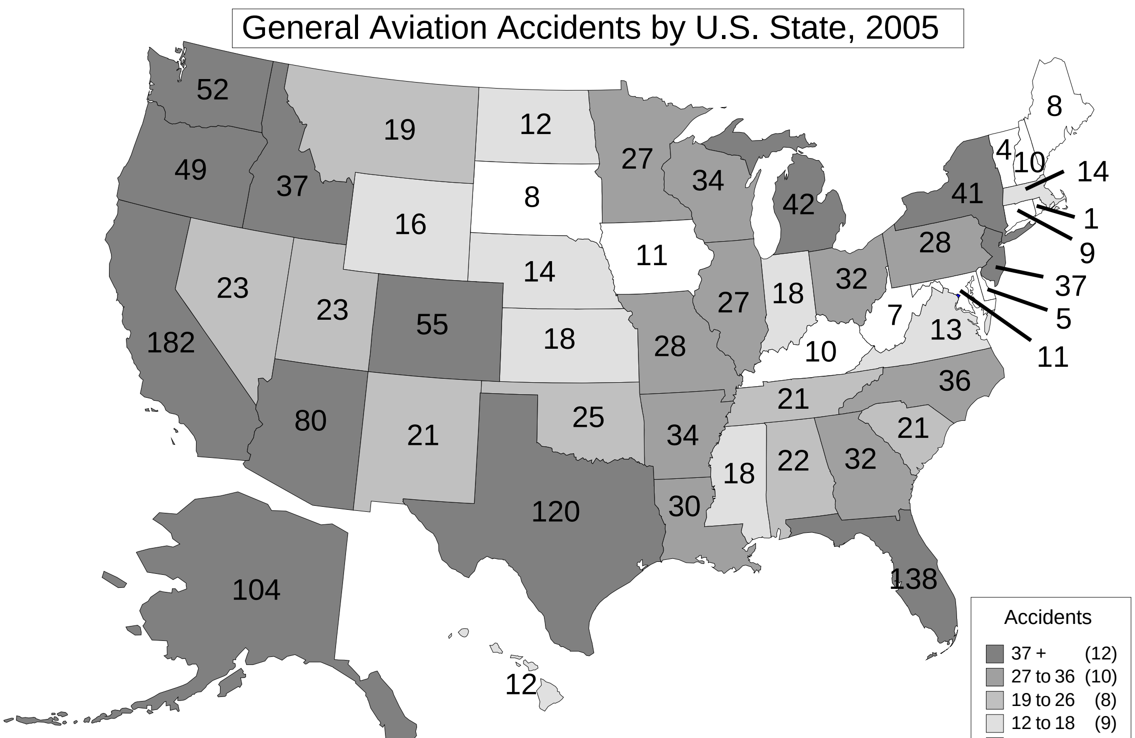


2005 In Depth

Location of General Aviation Accidents in 2005

United States Aircraft Accidents

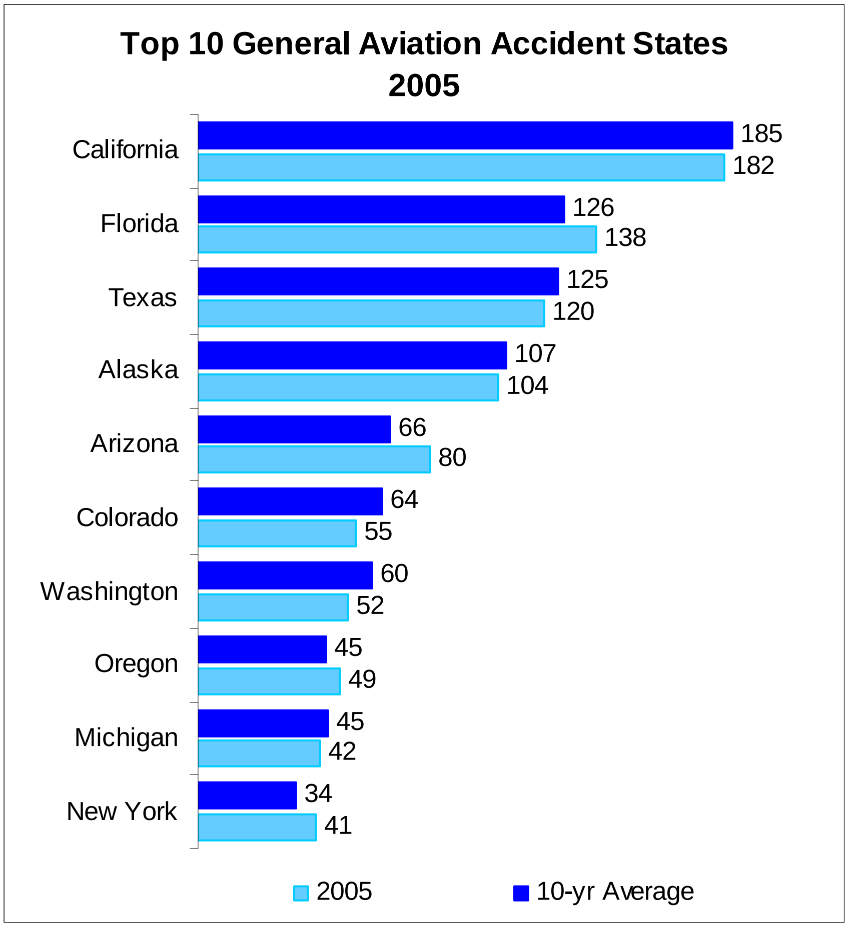
Geographic location can contribute to general aviation accident totals because of increased activity associated with population density, increased risk due to hazardous terrain, a propensity for hazardous weather, or a concentration of particularly hazardous flight operations. The map below shows state by state the number of all general aviation accidents that occurred within the United States in 2005. 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 and other factors.



For example, California, Florida, and Texas had the greatest number of accidents in 2005. U.S. Census Bureau data[16] indicate that California had the highest state population in 2005, followed by Texas (second), and Florida (fourth). In addition, all three states have warm climates that favor year-round flying, and all three are popular travel destinations that attract general

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

aviation traffic from other states. These states also had the largest numbers of active pilots[17] and active aircraft.[18] 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 challenges[19] to aviation that are reflected in the general aviation accident record. After California, Florida, and Texas, Alaska had the most general aviation accidents in 2005. The top 10 states by number of general aviation accidents in 2005 are presented in the next figure along with the 10-year average. Note that many of the state accident totals for 2005 were below historical averages, but the distribution of accidents among states remained similar during the period.



17 Available at <US Civil Airmen Statistics>.

18 Available at <GAATAA Survey 2005>.

19 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 <http://www.ntsb.gov/aviation/AK/alaska_stat.html>

Foreign Aircraft Accidents

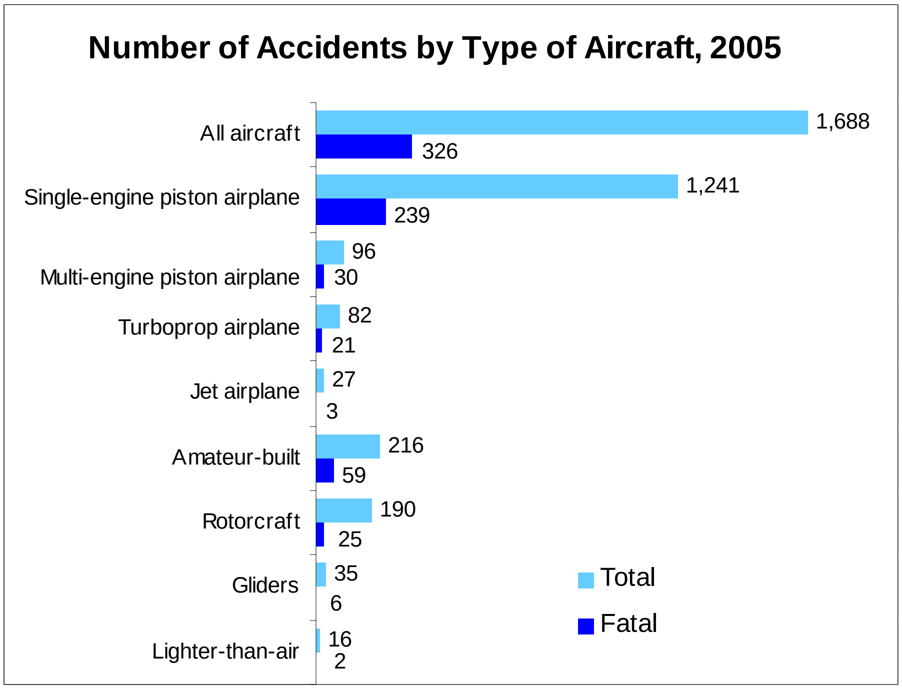
In 2005, U.S.-registered aircraft were involved in 26 accidents outside the 50 United States. Those accidents occurred in 15 different countries and territories, and in the Atlantic and Pacific Oceans. Of those accidents, 18 were fatal, resulting in 44 deaths. As expected, general aviation accidents involving U.S.-registered aircraft outside the United States usually occur in neighboring countries like Canada, Mexico, and the Caribbean island nations, but in 2005, accidents occurred as far away as Italy, South Africa, Mozambique, and Indonesia.

Accidents Involving U.S.-Registered General Aviation Aircraft Outside the 50 United States, 2005

	Number of Accidents	Number of Fatal Accidents	Number of Fatalities
Atlantic Ocean			
Left LaRoma, Dominican Republic enroute to Puerto Rico	1	1	1
Subtotal	**1**	**1**	**1**
Other Locations			
Argentina	1	1	2
Bahamas	2	1	1
Canada	7	6	11
Colombia	1	1	2
Costa Rica	2	2	11
Germany	1	1	3
Guadeloupe	1	0	0
Indonesia	1	0	0
India	1	0	0
Italy	2	1	1
Mexico	2	2	3
Mozambique	1	0	0
South Africa	1	1	5
Turks & Caicos Island	1	1	4
Venezuela	1	0	0
Subtotal	**25**	**17**	**43**
Total	**26**	**18**	**44**

Aircraft Type

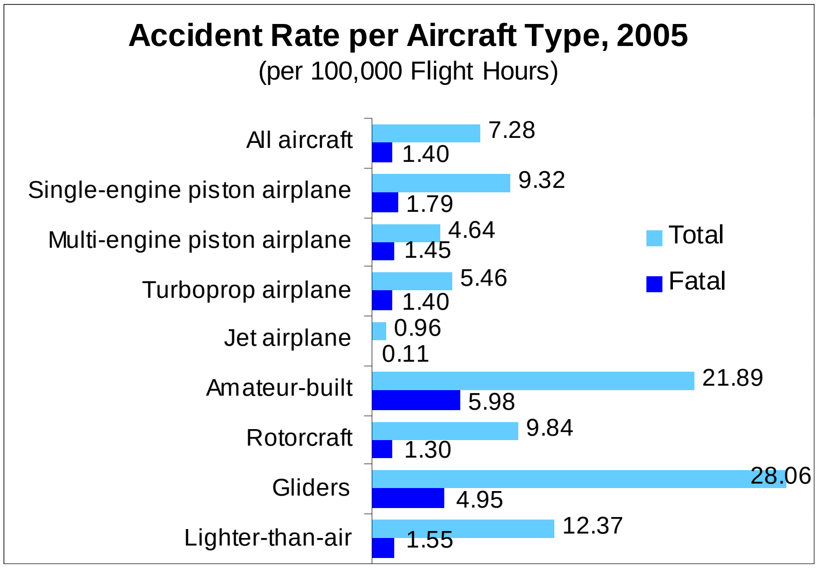
The following figure summarizes the total number of general aviation accidents and fatal accidents occurring in 2005 by aircraft type. Most notable is the large number of accidents involving single-engine piston airplanes, which accounted for 74% of all accident aircraft and 73% of all fatal accident aircraft.



In 2005, the per-aircraft accident rate for all aircraft types was 7.28 accidents and 1.40 fatal accidents per 100,000 hours flown.[20] Among fixed-wing powered aircraft, the rate for single-engine piston airplanes was 9.32 accidents and 1.79 fatal accidents per 100,000 hours flown. Amateur-built aircraft[21] had the highest accident rate among all general aviation aircraft, with 21.89 accidents and 5.98 fatal accidents per 100,000 flight hours. Rotorcraft had the second-highest rate among powered aircraft, with 9.84 accidents and 1.30 fatal accidents per 100,000 hours flown. However, glider operations had the second-highest accident rate overall, with 28.06 accidents and 4.95 fatal accidents per 100,000 hours flown.

[20] 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 crashes with a probable cause attributed to stolen/unauthorized use.

[21] Title 14 CFR 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 of construction is completed by the amateur builder(s).



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 include the previously mentioned categories of “personal,” “business,” “instructional,” “corporate,” and “aerial application,” which together accounted for 90% of all general aviation operations during 2005. The remaining 10% 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, 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 *GAATAA Survey*, most general aviation operations are conducted for personal and/or business purposes. Of the estimated 23 million general aviation hours flown in 2005, more than half—12.5 million—were personal or business flights.[22] Accordingly, a large percentage of general aviation accidents involve personal/business flights. However, personal/business flying is still over-represented in the accident record: although this segment represented about 54% of the general aviation hours in 2005, it accounted for 68% of all general aviation accidents (n = 1,134) and 77% of all fatal accidents (n = 247).

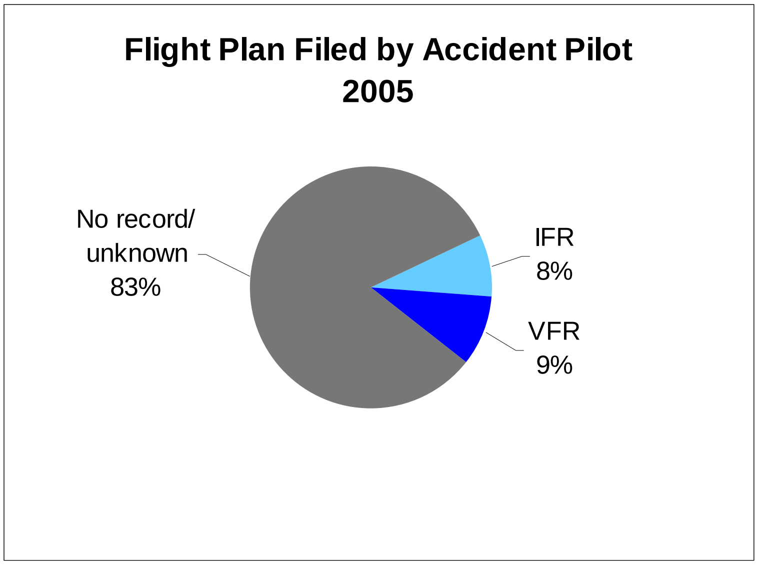
The accident rate for instructional flights is about half that of personal/business flights overall. This relatively low rate is surprising because student pilots could be expected to make

[22] See <GAATAA Survey 2005>.

more mistakes than experienced pilots. Flight instruction accidents were also less likely to be fatal. Only 10% of the flight instruction accidents that occurred in 2005 resulted in fatalities, compared to 22% of personal/business accidents. When compared with the number of hours flown, the fatal accident rate for instructional flights was 0.66 fatal accidents per 100,000 hours flown. The fatal accident rate for personal/business flights remained the highest in general aviation with 1.97 fatal accidents per 100,000 hours flown.

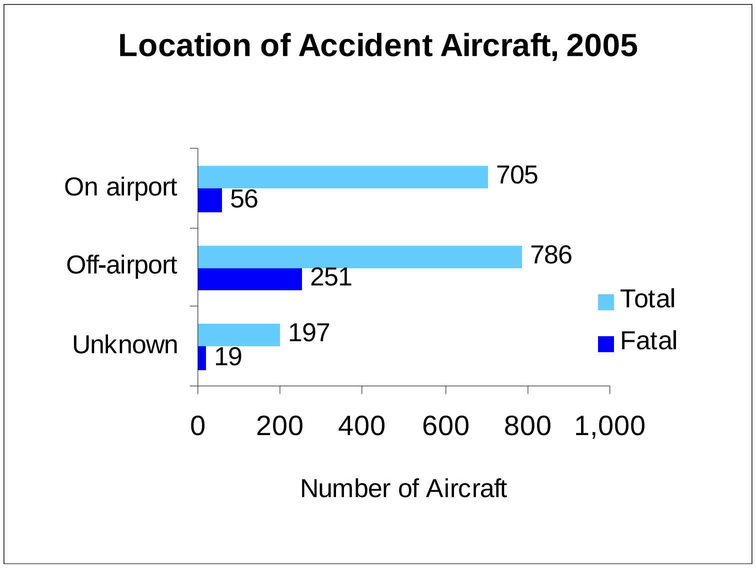
Flight Plan

In 2005, 1,688 pilots were involved in general aviation accidents, and for those pilots, 1,392 (82%) showed no record of filing 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 if they fail to arrive at their intended destinations.

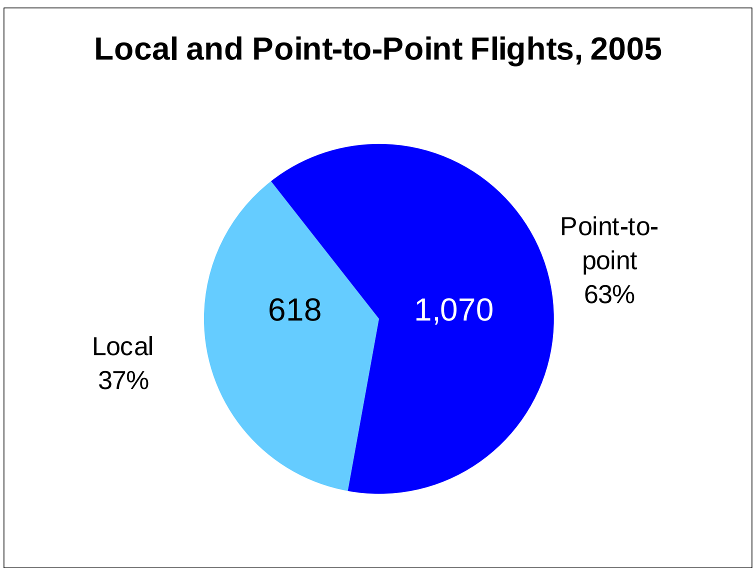


Airport Involvement

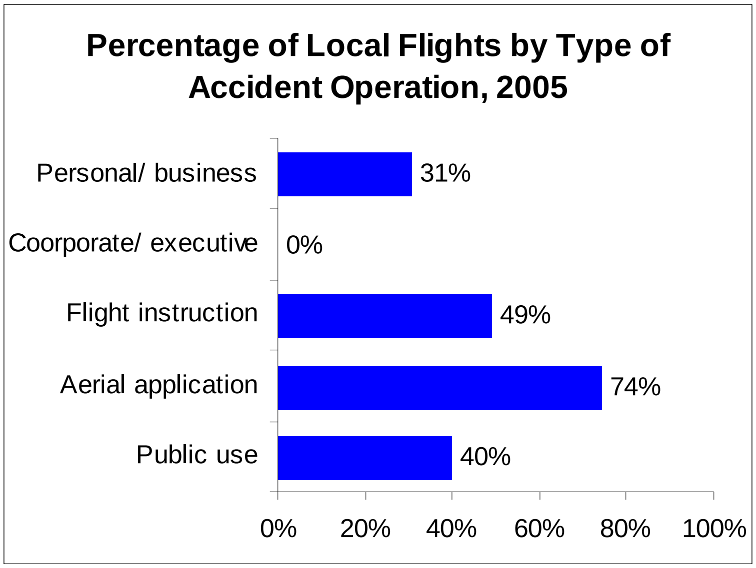
Aircraft accident locations were closely split between those occurring on airport property (42%) and those occurring away from an airport (47%). (The remaining 11% are unknown.) Comparing accident risk based on location is difficult because of the exposure differences between types of operations and 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 2005 (78%) were located away from an airport or airstrip.



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.



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. The following figure shows that most personal/business flights were point to point, while more than half of instructional flights were local.



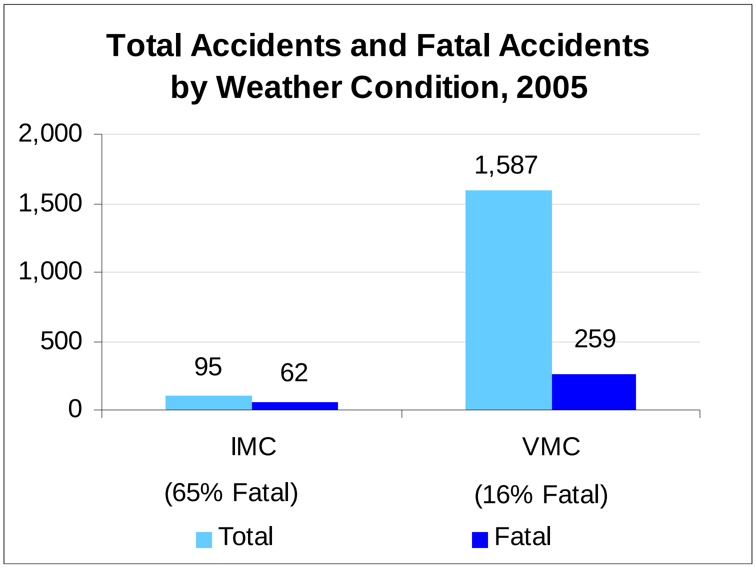
Environmental Conditions

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 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[23] for flight in instrument meteorological conditions (IMC). According to the FAA *Pilot/Controller Glossary*,[24] "instrument meteorological conditions" are defined as "meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling less than the minima[25] 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 figure 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 2005, only 16% of the accidents that occurred in visual conditions resulted in a fatality, but 65% of accidents in instrument conditions were fatal.

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

[24] FAA, *Pilot/Controller Glossary*, Washington, D.C., available at <FAA Pilot/Controller Glossary >.

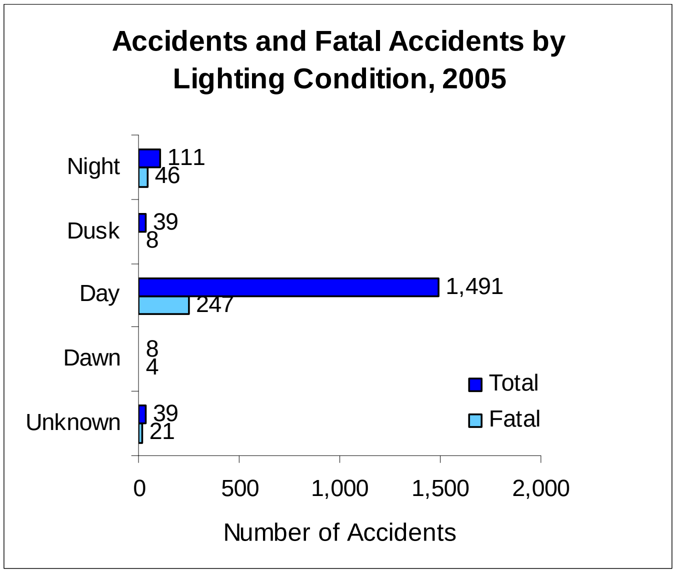
[25] Minima for visual meteorological conditions are specified in 14 CFR 91.155.



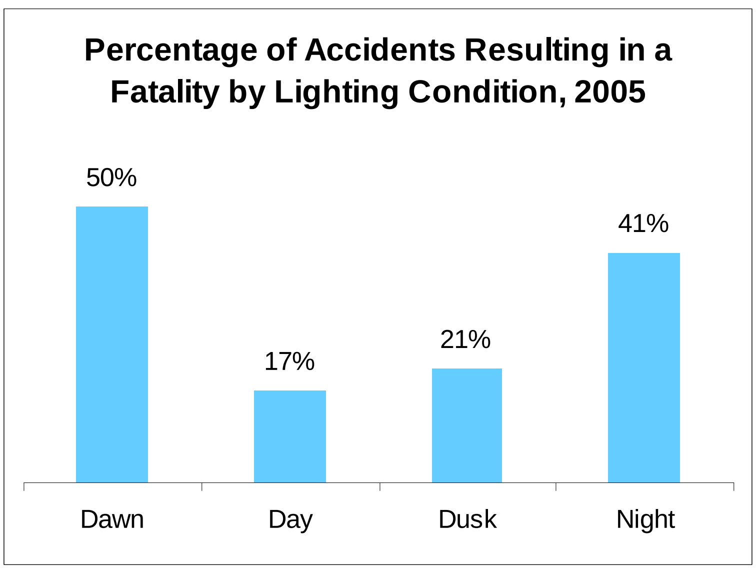
Although instrument conditions were present for only 6% of all accidents, 19% of fatal general aviation accidents in 2005 occurred in IMC. One reason for the disproportionate number of fatal accidents in IMC is that such accidents are more likely to involve pilot disorientation, loss of control, and 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, might pose an even greater threat to a pilot flying in instrument conditions because reduced visibility would hinder selection of a suitable landing site.

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 figure illustrates that, similar to IMC, most accidents occurred in daylight conditions but a larger percentage of the accidents that occurred at night resulted in fatalities.



In fact, accidents that occurred at night were more than twice as likely as 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, 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.

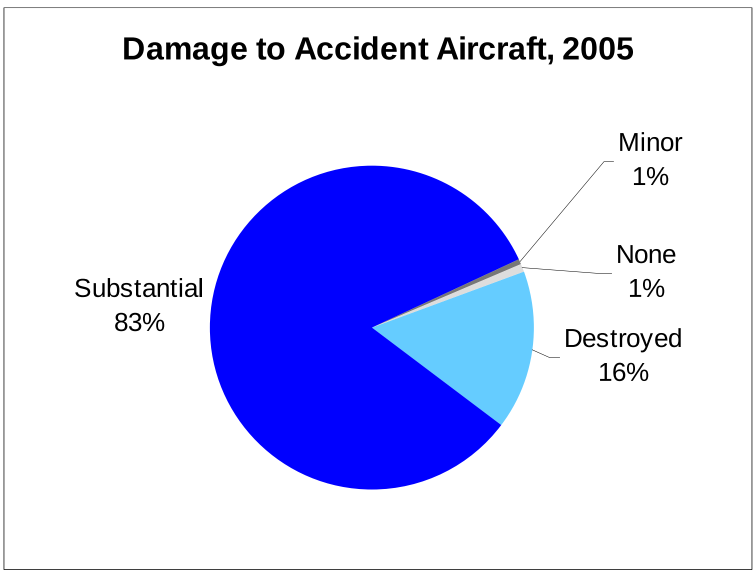


Injuries and Damage for 2005

Aircraft Damage

NTSB investigators record aircraft damage as either “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,[26] and “minor” damage as any damage that is not classified as either “destroyed” or “substantial.”

Nearly 8 of every 10 aircraft involved in accidents during 2005 sustained substantial damage, and about 1 in 5 accident aircraft were destroyed. “Minor” and “no damage” classifications together comprised about 1% of accident aircraft.

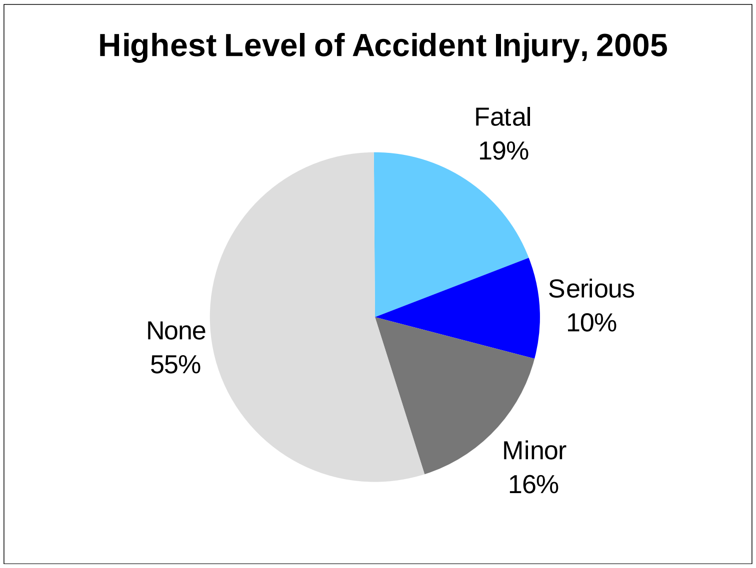


Accident Injuries

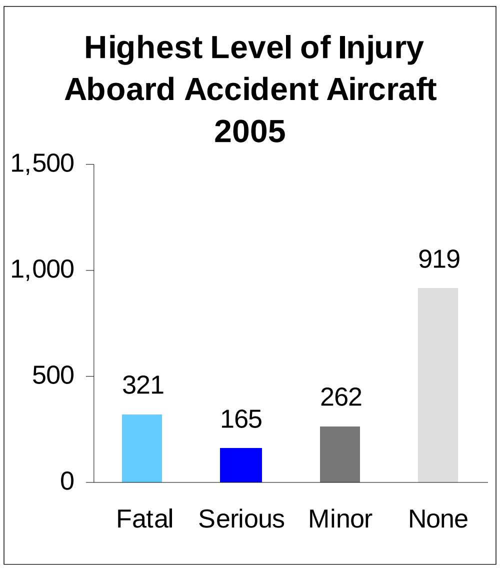
In accordance with 49 CFR 830.2, NTSB investigators categorize general aviation injuries as “fatal,” “serious,” or “minor.” A fatal injury is defined as “any injury which results in death within 30 days of the accident.” Title 49 CFR 830.2 also outlines several attributes[27] of serious injury that include, but are not limited to, hospitalization for more than 48 hours, bone fracture, internal organ damage, or second- or third-degree burns. The following figure depicts the percentage of general aviation accidents resulting in each level of injury during 2005. Most notable is the fact that more than half the accidents did not result in injury.

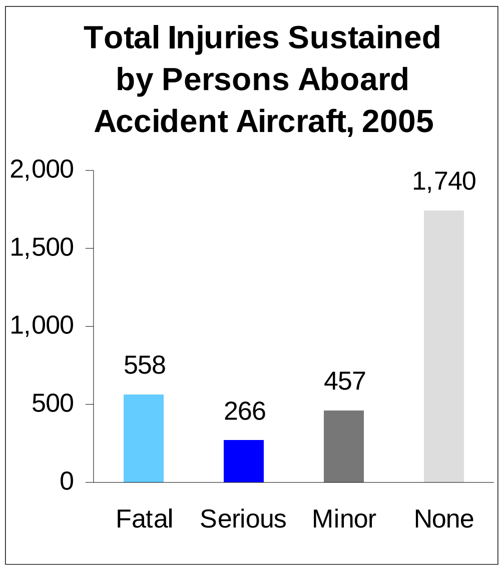
[26] Missing or unrecoverable aircraft are also considered “destroyed.”

[27] See appendix B for the complete definition of injury categories.



The following figures 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.





Injuries by Role for 2005

The distribution of general aviation accident injuries in 2005 varied with the type of operation and the size of aircraft as indicated below. 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.

General Aviation Accident Injuries, 2005					
Personal injuries	Fatal	Serious	Minor	None	Total
Pilot	304	151	254	979	1,688
Copilot	15	6	9	49	79
Flight instructor	5	3	6	26	40
Dual student	12	9	11	70	102
Check pilot	2	0	2	3	7
Other crew	9	1	3	16	29
Flight attendant	0	1	0	3	4
Passenger	211	95	172	594	1,072
Total aboard	558	266	457	1,740	3,021
On ground	3	5	4	0	12
Other aircraft	2	0	1	6	9
Total	563	271	462	1,746	3,042

In 2005, 478 passengers suffered some level of injury in general aviation accidents, compared to the 739 pilots and copilots who were injured. 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, 12 persons on the ground sustained injuries as a result of general aviation accidents. For example, the driver and passenger of a sport utility vehicle were fatally injured when an aircraft that was on final approach collided with their vehicle on a public roadway; a ground crewmember assisting in inflating a balloon became entangled in lines and was seriously injured; and a parachutist sustained minor injuries when a pilot approaching to land struck the parachutist.

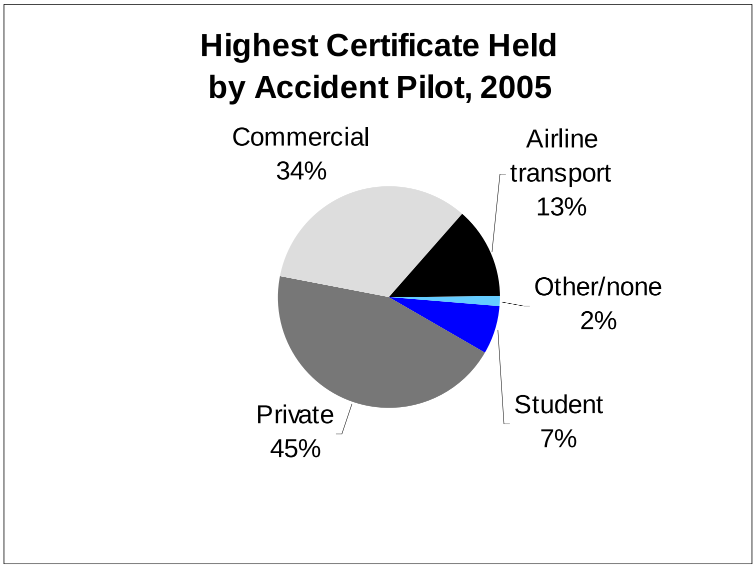
Accident Pilots

Rating

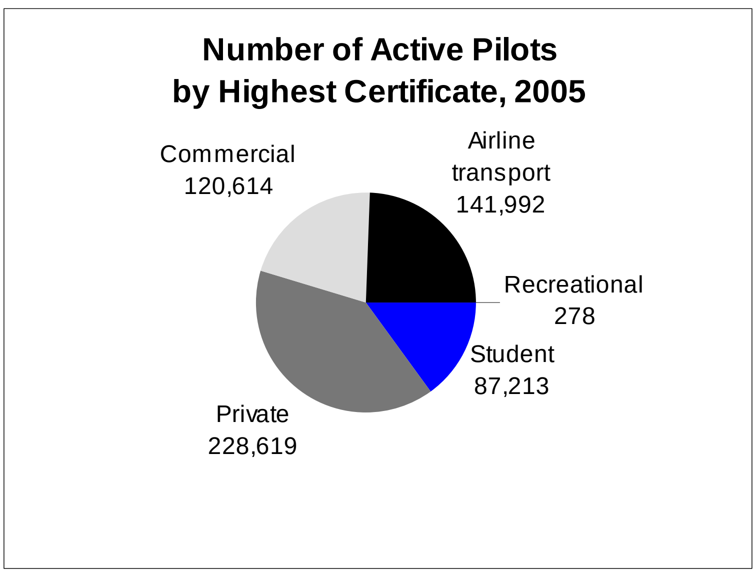
Of the 1,688 pilots involved in general aviation accidents in 2005, the largest percentage held a private pilot certificate.[28] The second-largest percentage held a commercial pilot certificate, which is required for any person to act as pilot-in-command of an aircraft for compensation or hire.[29]

[28] Available at <US Civil Airmen Statistics>.

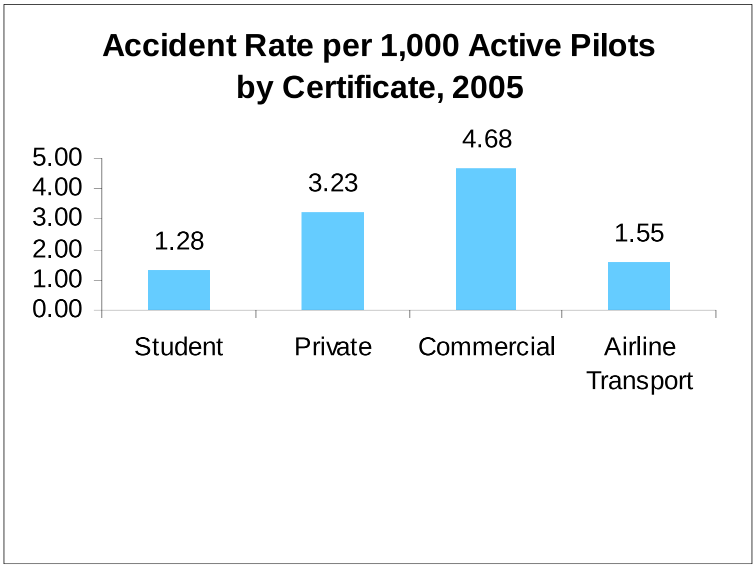
[29] See 14 CFR 61.133 for the privileges granted by a commercial pilot certificate.

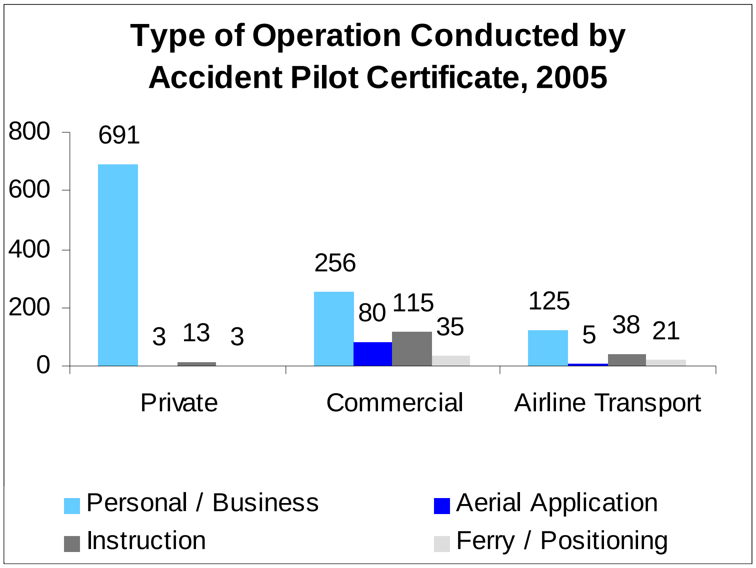


When compared to the number of active pilots in 2005 holding each type of pilot certificate, commercial pilot certificate holders were over-represented among general aviation accidents. Although commercial pilot certificate holders accounted for only 20% of all active general aviation pilots, they were involved in 34% of all general aviation accidents in 2005.



Similarly, the per-pilot accident rate was highest for commercial pilot certificate holders during 2005, with 4.68 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, 565 commercial pilots involved in accidents during 2005 (45%) were conducting personal flights and were not involved in commercial operations at the time of the accidents.





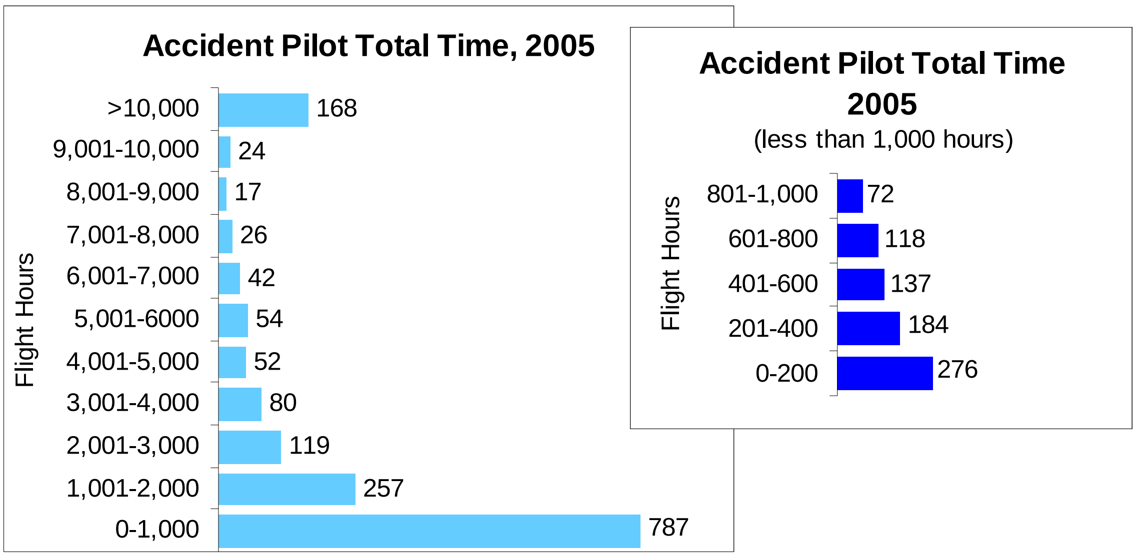
(1,660 of accident pilot records with data available, 2005)

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*[30] also do not include information about the type of operation that certificate holders engage in. Examples of other commercial operations not presented in the figure above include corporate/executive transportation, sightseeing flights, banner towing, and aerial observation.

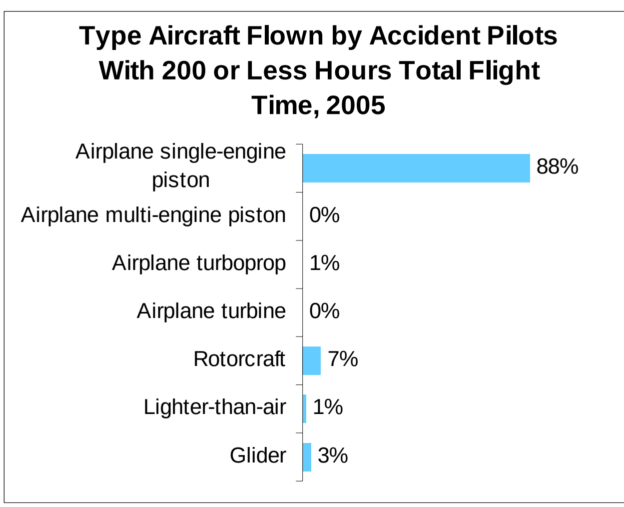
30 Available at <US Civil Airmen Statistics>.

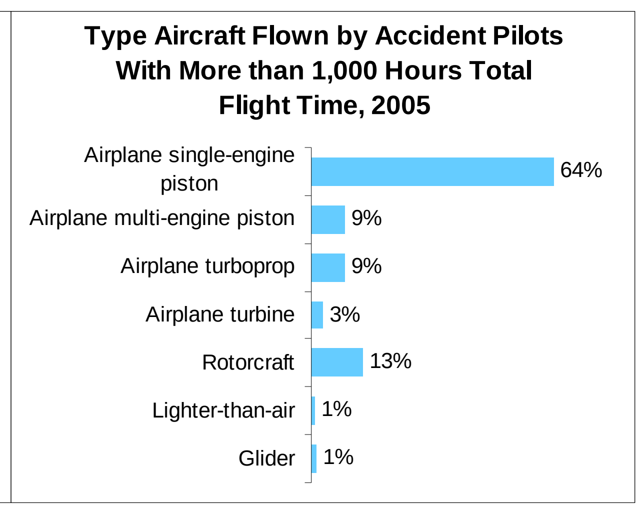
Total Time

For the 1,626 accident pilots for whom total flight experience data are available, 48% were pilots with a total flight time of 1,000 hours or less. The following figure 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.



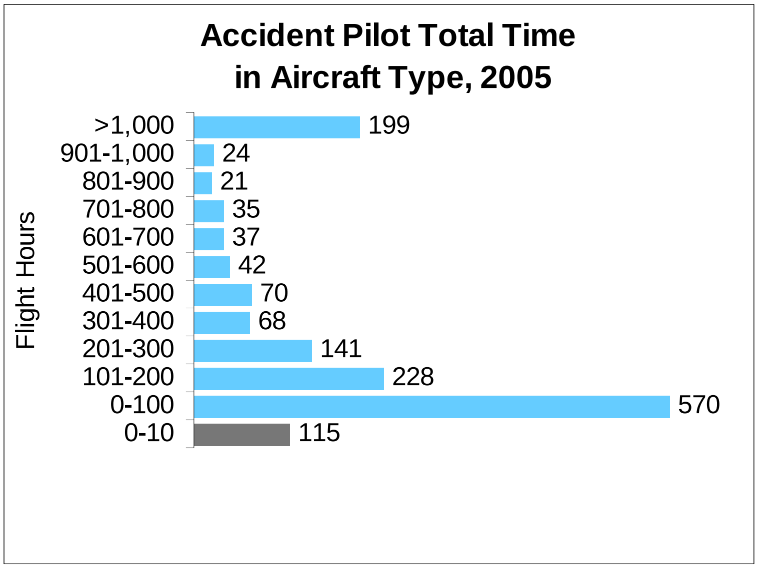
It is not surprising that 9 of 10 accident pilots with 200 hours total flight time or less were flying single-engine piston airplanes. Most accident pilots with more than 1,000 hours were also flying single-engine piston airplanes, but this group also operated a more diverse selection of aircraft—multi-engine piston, turboprop, and turbine-powered airplanes—and more than twice as many rotorcraft.





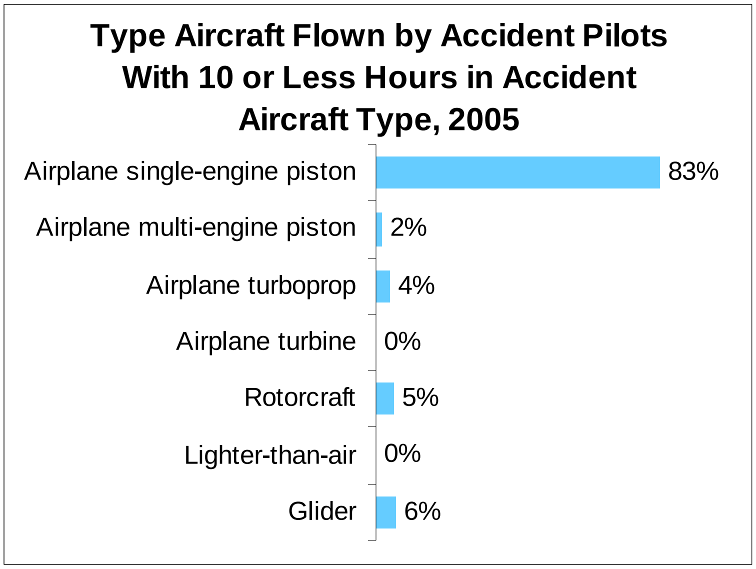
Time in Type of Aircraft

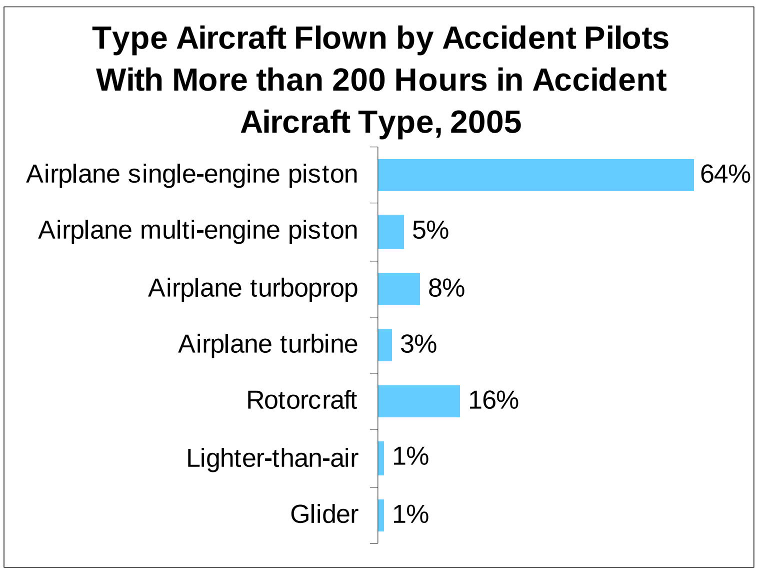
Of the 1,435 accidents in 2005 for which pertinent data are available, 40% involved pilots with 100 hours or less in the accident aircraft make and model. Of those, 115 pilots (8% of all accident pilots for whom data are available) had less than 10 hours in type. Most accident pilots with less than 10 hours of flight time in make and model were flying single-engine piston aircraft.



(1,435 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 figure above, it is particularly worth noting that 47 of the 115 accident pilots in 2005 who had less than 10 hours in the accident aircraft type were operating amateur-built aircraft.



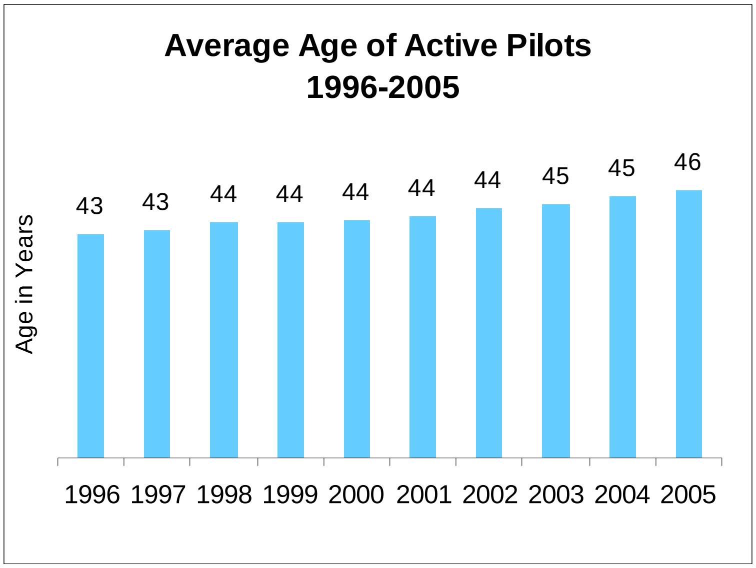


Comparison of these two graphs shows that accident pilots with more than 200 hours in make and model were more likely than pilots with fewer hours in type to be flying rotorcraft or multi-engine piston, jet, or turboprop airplanes.

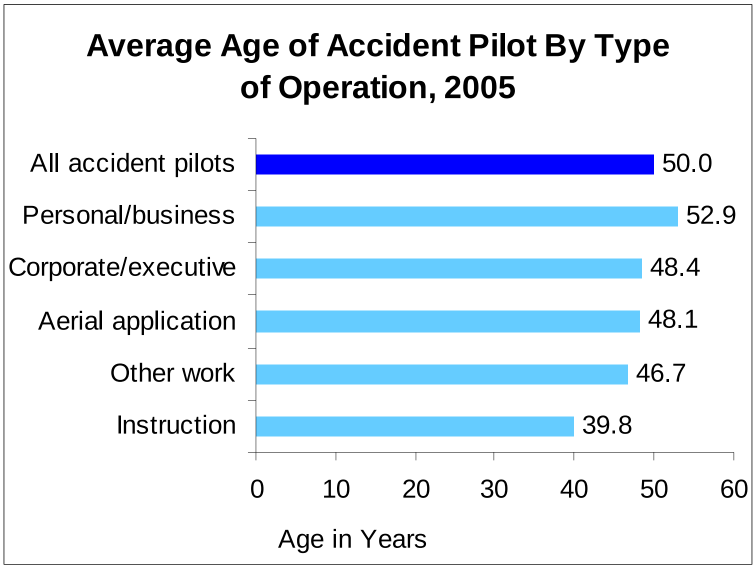
Age

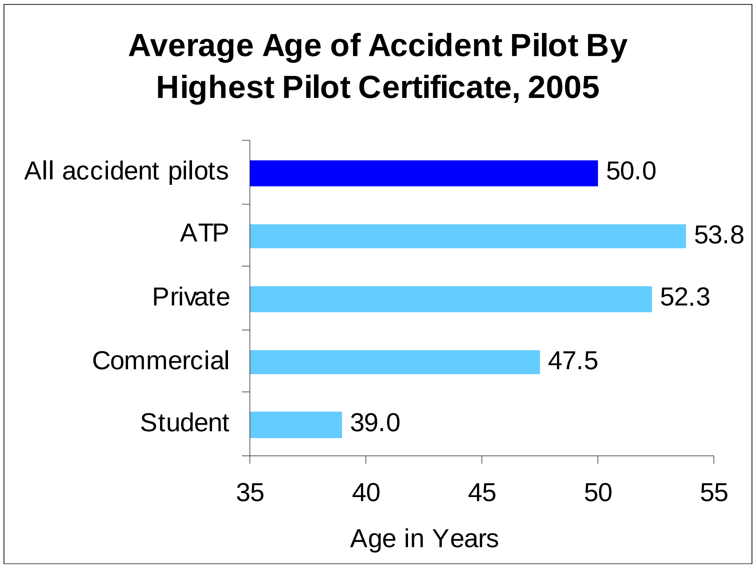
The average age of all active pilots in the U.S. increased steadily from 1996 through 2005 and by 2005 was 46[31] years. In contrast, the average age of general aviation accident pilots was 50. Despite the difference in average age, no meaningful conclusions can be made regarding specific age-related 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.

[31] Available at <US Civil Airmen Statistics>.



The two figures that follow show the relationship of the accident pilot's age by type of operation and by highest pilot certificate.





Accident Occurrences for 2005

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. A total of 54 occurrence codes are available to describe the events for any given accident.[32] 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 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 1,663 accident aircraft in 2005 for which data are available, 1,329 cited 2 or more occurrences, 733 cited 3 or more, 162 cited 4 or more, and 9 cited 5 or more.

The excerpt from the following brief report, which is for a 2005 accident with three occurrences, illustrates how an accident with multiple occurrences is coded. In this accident, an airplane in cruise flight at 4,000 feet lost oil pressure. The pilot reported the difficulty to air traffic control, was vectored to an airport 10 miles away, and was cleared for the descent. About 2 minutes later, the pilot reported the engine had seized and attempted a forced landing. After gliding over a field and striking trees, the aircraft impacted the ground, and a post crash fire ensued. The pilot was fatally injured. Each of these occurrences was coded in order, as shown.

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

Example of Occurrence Findings Cited in an NTSB Accident Brief, 2005

> Occurrence #1: LOSS OF ENGINE POWER (TOTAL) MECH FAILURE/MALFUNCTION
> Phase of Operation: CRUISE
> ----------
> Occurrence #2: FORCED LANDING
> Phase of Operation: DESCENT – EMERGENCY
> ----------
> Occurrence #3: IN FLIGHT COLLISION WITH OBJECT
> Phase of Operation: DESCENT – EMERGENCY

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. First occurrences for all 2005 general aviation accident aircraft with sequence of events data available are shown on the next page. To simplify the presentation of accident occurrence data, similar occurrences can be grouped into eight major categories.

Among the eight major categories of first occurrences, the largest percentage of accidents (26%) related to aircraft power. Among the individual occurrences, the most common involved a loss of control in flight (16%), followed closely by loss of control on the ground (13%). Although occurrences involving loss of aircraft control on the ground resulted in only 3 fatal accidents in 2005, loss-of-control occurrences in flight resulted in a total of 98 fatal accidents—more than one-quarter of all fatal accidents and more than twice that of any other single occurrence.

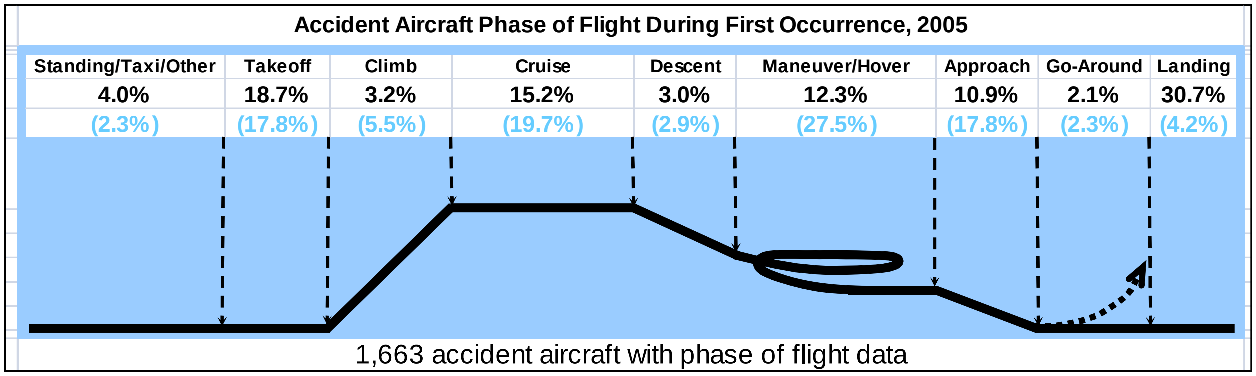
General Aviation Accident First Occurrences, 2005

2005 Accident First Occurrences	Total	Fatal
Collision – In-flight	**222**	**89**
In-flight Collision with Object	104	38
In-flight Collision with Terrain/Water	76	38
Midair Collision	20	10
Undershoot	22	3
Near Collision Between Aircraft	0	0
Noncollision – In-flight	**453**	**147**
Loss of Control - In-flight	270	98
Airframe/Component/System Failure/Malfunction	83	6
In-flight Encounter with Weather	88	38
Abrupt Maneuver	10	5
Vortex Turbulence Encountered	1	0
Altitude Deviation, Uncontrolled	0	0
Forced Landing	1	0
Decompression	0	0
Collision – On-Ground or Water	**95**	**0**
On Ground/Water Collision with Object	33	0
On Ground/Water Encounter with Terrain/Water	44	0
Collision Between Aircraft (Other Than Midair)	10	0
Dragged Wing, Rotor, Pod, Float or Tail/Skid	8	0
Noncollision – On-Ground or Water	**396**	**7**
Loss of Control - On Ground/Water	216	3
Hard Landing	117	1
Overrun	41	2
Nose Over	11	0
Roll Over	6	0
Propeller/Rotor Contact to Person	2	1
Propeller Blast or Jet Exhaust/Suction	0	0
Nose Down	0	0
Ditching	0	0
On Ground/Water Encounter with Weather	3	0

2005 Accident First Occurrences (Cont.)	Total	Fatal
Power Related	**425**	**60**
Loss of Engine Power	187	32
Loss of Engine Power(Total) - Nonmechanical	113	14
Loss of Engine Power(Total) - Mech Failure/Malf	56	8
Loss of Engine Power(Partial) - Nonmechanical	32	4
Loss of Engine Power(Partial) - Mech Failure/Malf	32	2
Propeller Failure/Malfunction	3	0
Rotor Failure/Malfunction	2	0
Engine Tear-away	0	0
Landing Gear	**35**	**2**
Gear Collapsed	11	0
Wheels-up Landing	14	2
Main Gear Collapsed	4	0
Gear Retraction on Ground	3	0
Nose Gear Collapsed	3	0
Complete Gear Collapsed	0	0
Wheels-down Landing in Water	0	0
Tail Gear Collapsed	0	0
Other Gear Collapsed	0	0
	0	0
	0	0
Miscellaneous	**33**	**2**
	23	2
	10	0
	0	0
	0	0
	0	0
	0	0
Undetermined	**4**	**2**
Missing Aircraft	0	0
Undetermined	4	2

Phase of Flight

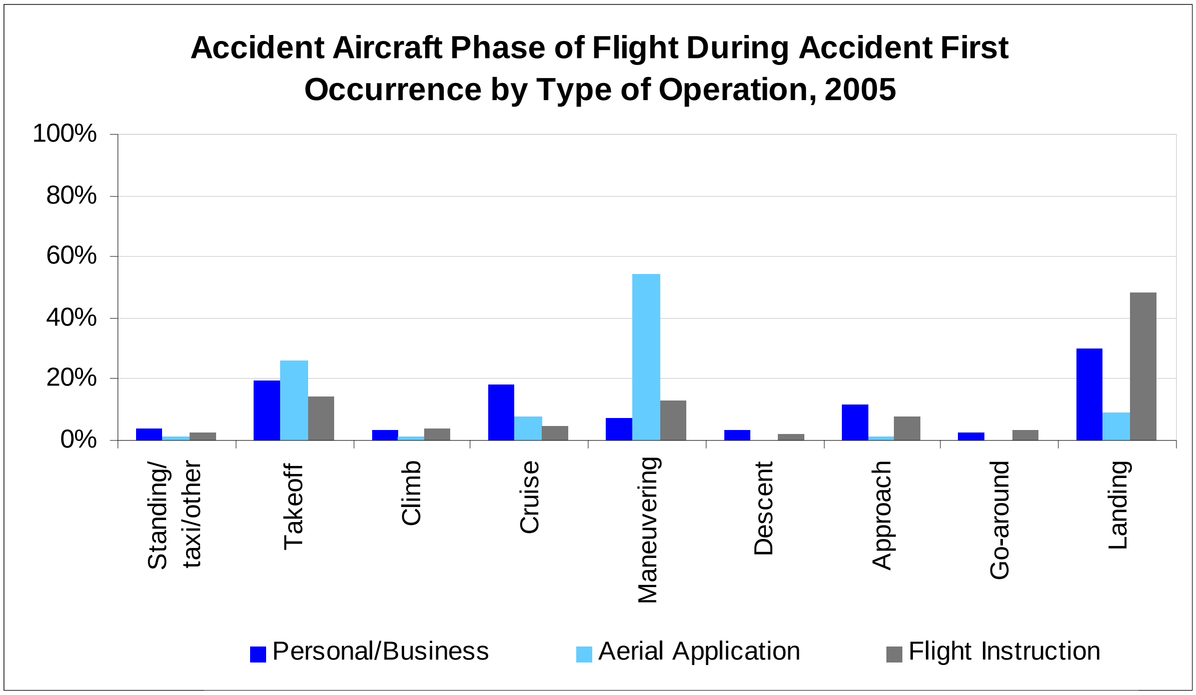
The following illustration displays the percentage of accident aircraft in each phase of flight at the time of the first occurrence. The phase of flight can be defined as when, during the operation of the aircraft, the first occurrence took place. Fifty distinct phases of flight are used to describe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



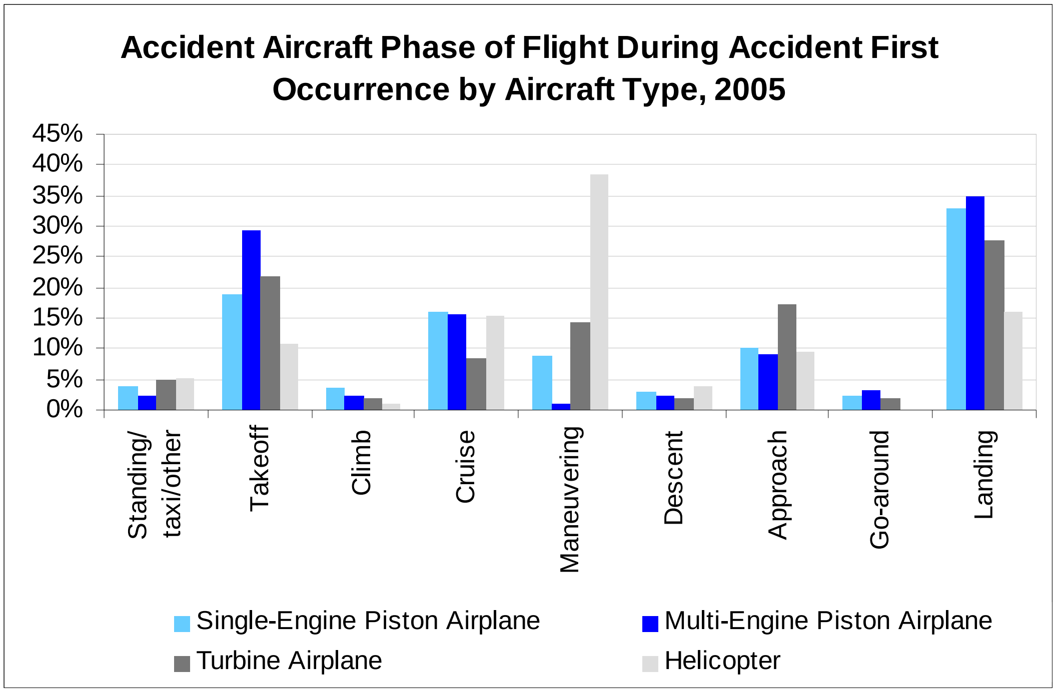
As shown here, about half of all general aviation accidents (49.4%) occurred during either takeoff or landing, despite the relatively short duration of these phases compared to the entire profile of a normal flight. This high number of accidents reflects the increased workload during takeoff and landing when the flight crew must control the aircraft, change altitude and speed, communicate with air traffic control (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. 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 (30.7%) of any single phase but only 4.2% of fatal accident first occurrences. The combination of cruise and maneuvering phases accounted for 47.2% of fatal accident first occurrences, but less than one-third (27.5%) 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 48% of all first occurrences for 2005 involving instructional flights occurred during landing compared to 30% of personal/business flights and 9% of aerial application flights.



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 the type of operations typically conducted with that aircraft. For example, as the next figure shows, the largest percentage of first occurrences for accidents involving helicopter flights, about 38%, 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 33% occurred during landing. Further, takeoff accounted for 20% of accidents involving airplanes, but only 11% of accidents involving helicopters.



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 1,663 accidents that occurred during 2005 for which occurrence data are available, 405 unique combinations of accident occurrences were cited. The top ten combinations of occurrences for all accidents and fatal accidents are listed in the tables on the next page.

Occurrence chains cited in fatal accidents are similar to those cited for all accidents. Most common is loss of control followed by in-flight collision with terrain or water; almost half of those accidents are fatal. It is important to note that, although hard landing was the most frequent first occurrence in a chain of occurrences in 2005, it accounted for only 4% of all accidents for the year.

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 ten 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, most accidents in 2005 did not involve catastrophic events, and a large number of accidents involved aircraft on the ground that resulted in minor or no injuries.

Chain of Occurrences - All GA Accidents, 2005	
HARD LANDING during LANDING	63
LOSS OF CONTROL - IN FLIGHT during MANEUVERING followed by IN FLIGHT COLLISION WITH TERRAIN/WATER during DESCENT	47
LOSS OF CONTROL - IN FLIGHT during TAKEOFF followed by IN FLIGHT COLLISION WITH TERRAIN/WATER during DESCENT	40
LOSS OF CONTROL - ON GROUND/WATER during LANDING followed by ON GROUND/WATER ENCOUNTER WITH TERRAIN/WATER during LANDING	38
LOSS OF CONTROL - ON GROUND/WATER during LANDING followed by ON GROUND/WATER COLLISION WITH OBJECT during LANDING	29
LOSS OF CONTROL - IN FLIGHT during APPROACH followed by IN FLIGHT COLLISION WITH TERRAIN/WATER during DESCENT	28
IN FLIGHT COLLISION WITH TERRAIN/WATER during MANEUVERING	21
LOSS OF CONTROL - ON GROUND/WATER during LANDING followed by ON GROUND/WATER ENCOUNTER WITH TERRAIN/WATER during LANDING followed by NOSE OVER during LANDING	20
LOSS OF CONTROL - IN FLIGHT during GO-AROUND followed by IN FLIGHT COLLISION WITH TERRAIN/WATER during DESCENT	18
IN FLIGHT COLLISION WITH OBJECT during MANEUVERING followed by IN FLIGHT COLLISION WITH TERRAIN/WATER during DESCENT	15

Chain of Occurrences - Fatal GA Accidents, 2005	
LOSS OF CONTROL - IN FLIGHT during MANEUVERING followed by IN FLIGHT COLLISION WITH TERRAIN/WATER during DESCENT	32
LOSS OF CONTROL - IN FLIGHT during TAKEOFF followed by IN FLIGHT COLLISION WITH TERRAIN/WATER during DESCENT	15
LOSS OF CONTROL - IN FLIGHT during APPROACH followed by IN FLIGHT COLLISION WITH TERRAIN/WATER during DESCENT	14
IN FLIGHT COLLISION WITH TERRAIN/WATER during MANEUVERING	13
IN FLIGHT ENCOUNTER WITH WEATHER during CRUISE followed by IN FLIGHT COLLISION WITH TERRAIN/WATER during CRUISE	8
IN FLIGHT COLLISION WITH TERRAIN/WATER during APPROACH	7
LOSS OF CONTROL - IN FLIGHT during GO-AROUND followed by IN FLIGHT COLLISION WITH TERRAIN/WATER during DESCENT	7
IN FLIGHT COLLISION WITH OBJECT during MANEUVERING followed by IN FLIGHT COLLISION WITH TERRAIN/WATER during DESCENT	6
IN FLIGHT COLLISION WITH TERRAIN/WATER during CRUISE	6
IN FLIGHT COLLISION WITH OBJECT during APPROACH	5

Most Prevalent Causes/Factors for 2005

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 why 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, 2005

Occurrence #1: IN FLIGHT ENCOUNTER WITH WEATHER
Phase of Operation: CRUISE

Findings
1. (F) WEATHER CONDITION - CLOUDS
2. (F) WEATHER CONDITION - OBSCURATION
3. (C) VFR FLIGHT INTO IMC - INADVERTENT - PILOT IN COMMAND

Occurrence #2: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: CRUISE

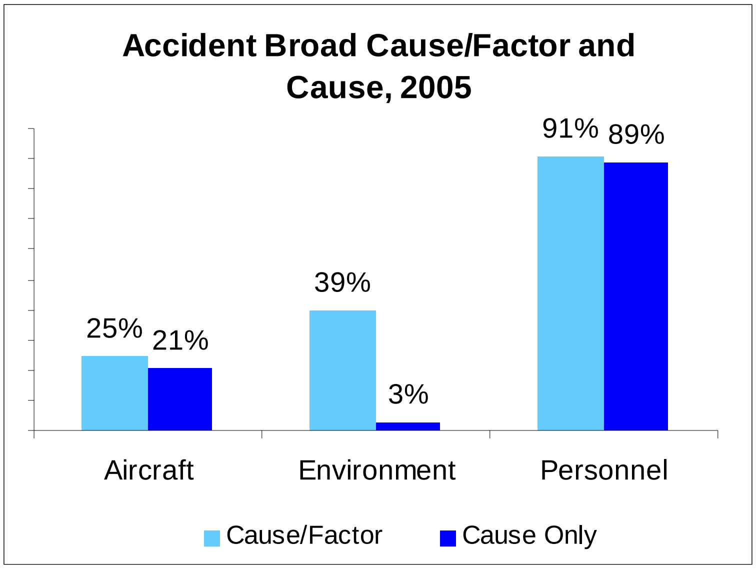
Findings
4. TERRAIN CONDITION - GROUND
5. (C) ALTITUDE/CLEARANCE - NOT MAINTAINED - PILOT IN COMMAND

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

The National Transportation Safety Board determines the probable cause(s) of this accident as follows: the pilot's continued VFR cruise flight into instrument meteorological conditions in mountainous terrain, and his failure to maintain clearance from terrain. A contributing factor was mountain obscuration and clouds.

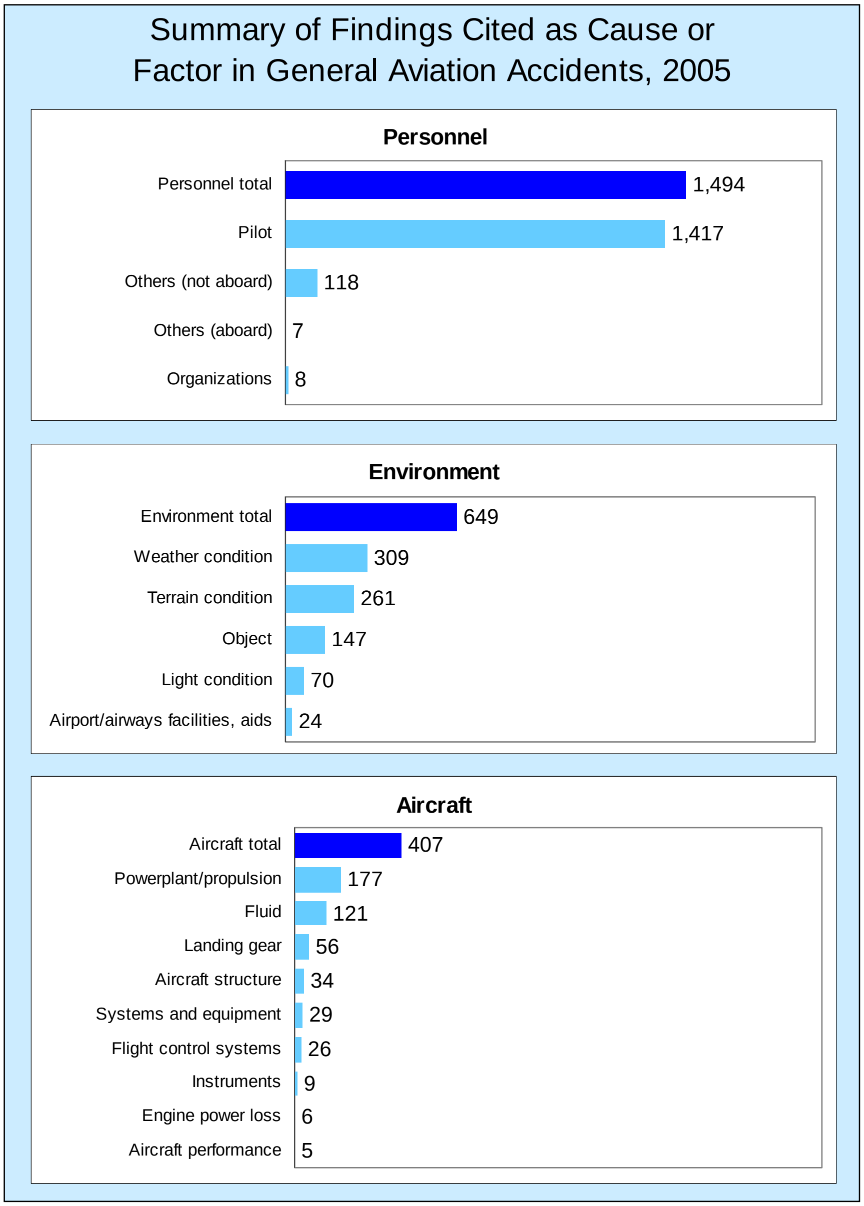
In this accident, which occurred during a cross-country flight, the pilot encountered instrument meteorological conditions (IMC), and the airplane was destroyed after impacting mountainous terrain. According to a pilot flying in the area, there were low clouds with bases between 8,500 to 9,000 feet mean 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 can be grouped into three broad cause/factor categories: aircraft, environment, and personnel. The following graph shows the percentage of general aviation accidents that fall into each category. Personnel-related causes or factors were cited in 91% of the 1,646 general aviation accident reports for 2005 for which cause/factor data were available. Environmental causes/factors were cited in 39% of these accident reports, and aircraft-related causes/factors were cited in 25%.[33]



Environmental conditions are rarely cited as an accident cause but are more likely to be cited as a contributing factor. In 2005, only 44 of 649 environmental citations (3% of all causes/factors cited) 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. As mentioned previously, several hundred unique codes are available to document causes/factors, as summarized in the following figure (1,646 accidents with findings).

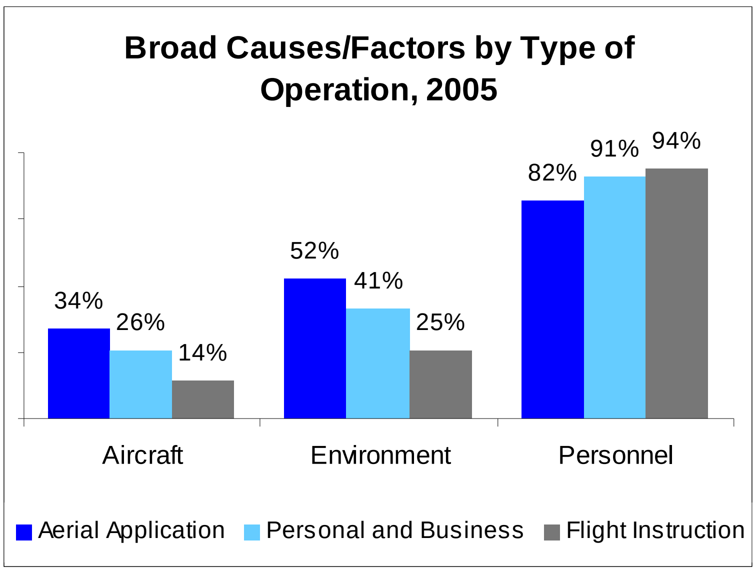
[33] Because the NTSB frequently cites multiple causes and factors for an aircraft accident, the number of causes and factors will result in a sum greater than the total number of accidents.



As this figure shows, most causes and factors attributed to general aviation accidents in 2005 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.

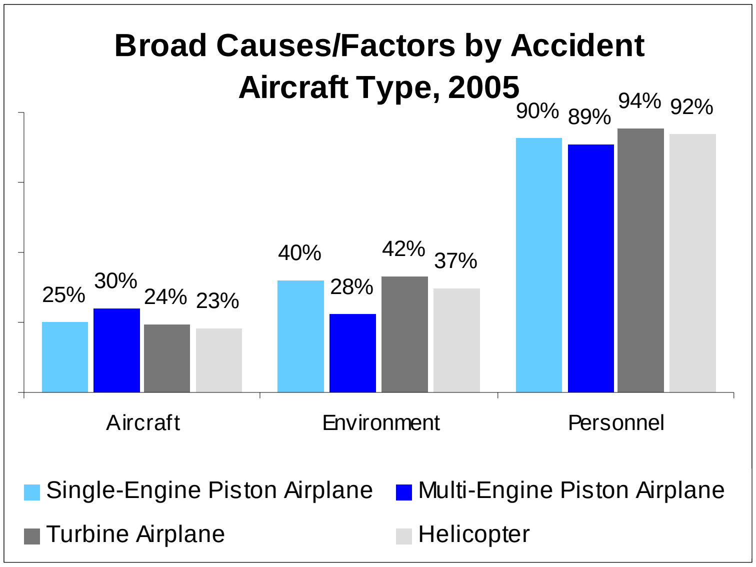
Although the pilot was the most frequently cited individual in the personnel category in 2005, other persons not aboard the aircraft were also cited as a cause or factor in 118 accidents. Such personnel included flight instructors, maintenance technicians, and airport personnel. In the broad category of environmental factors, weather conditions were cited in 309 (19%) of the accidents. Powerplant-related[34] causes/factors, cited in 177 (11%) of all general aviation accidents, were the most commonly cited aircraft factors.

The following graph shows how specific accident causes and factors varied by type of flight operation. For example, personnel were cited in 94% of instructional flight accidents and 91% 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 like takeoffs and landings that are more likely to result in accidents. 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.



A comparison of the causes/factors cited in accidents involving different types of aircraft reveals similar results as shown in the next figure. The higher percentage of multi-engine piston accidents that cited aircraft causes/factors in 2005 is likely a result of more complex systems as compared to single-engine piston airplanes. Conversely, the high reliability of turbine engines likely contributes to the low percentage of aircraft-related findings for those aircraft. The percentage of environmental cause/factor citations drops noticeably between single- and multi-engine piston airplane accidents, and between multi-engine piston and turbine airplane accidents, mirroring progressive increases in the typical range, performance, and equipment capabilities of the aircraft.

[34] "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.



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.

Of the 1,372 accidents in 2005 with a human performance cause or factor, the most frequently cited cause/factor was aircraft handling and control (72%), followed by planning and decision-making (36%) and use of aircraft equipment (11%). Issues related to personnel qualification were cited in about 35% of the 116 accidents with underlying explanatory factors related to human performance. Examples of qualification issues that were cited in the 2005 accident record included lack of total experience, lack of recent experience, and lack of certification.

Human Performance and Explanatory Causes/Factors 2005	All Accidents	Fatal Accidents
Human Performance Issues	1,372	275
Aircraft handling/control	990	229
Planning/decision	489	106
Use of aircraft equipment	148	22
Maintenance	87	14
Communications/information/ATC	69	8
Meteorological service	4	4
Airport	1	0
Dispatch	0	0
Underlying Explanatory Factors	116	57
Qualification	41	18
Physiological condition	31	25
Psychological condition	25	8
Aircraft/equipment inadequate	8	1
Institutional factors	8	6
Procedure inadequate	5	4
Material inadequate	2	0
Information	1	0
Facility inadequate	1	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. 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 2005 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.

	All Accidents	Fatal Accidents
Weather Condition	309	67
Crosswind	68	1
Gusts	57	6
Tailwind	48	3
High density altitude	33	5
Low ceiling	33	30
Carburetor icing conditions	18	0
Fog	18	10
Downdraft	15	0
Icing conditions	12	5
Clouds	10	7
High wind	10	2
Obscuration	7	7
Windshear	6	0
Rain	6	4
Thunderstorm	5	4
Turbulence	5	2
No thermal lift	5	0
Snow	4	4
Variable wind	3	0
Haze/smoke	3	3
Temperature, high	2	0
Whiteout	2	1
Unfavorable wind	2	1
Dust devil/whirlwind	2	0
Turbulence, clear air (CAT)	1	0
Mountain wave	1	1
Turbulence in clouds	1	0
Thunderstorm, outflow	1	0
Below approach/landing minimums	1	1
Drizzle/mist	1	1
Microburst/dry	1	1
Other	1	0
Lightning strike	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 2005 were not fatal. The wind-related weather factors "gusts," "crosswind," and "tailwind" were cited as a cause/factor in 173 accidents, but only 10 of those accidents were fatal. Among fatal general aviation accidents, the three 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: Instructional Flight

This section includes statistical data and a discussion of general aviation operations involving flight instruction and associated safety issues. This section is not meant to be an exhaustive discussion of all safety concerns related to flight instruction, but rather a discussion of an issue important to general aviation. The figure below provides a summary.

General Aviation Instructional Accident Statistics, 2005	
All General Aviation Accidents	
Total Accidents	1,670
Fatal Accidents	321
Accident Aircraft	1,688
Instructional Flight Accidents	
Total Accidents	247
Accident Aircraft	247
Instructional Flight Accidents by Injury Level	
Fatal	24
Serious	15
Minor	30
None	178
Number of Accident Injuries	
Fatal	46
Serious	25
Minor	51
Persons aboard with no injuries	315
Instructional Flight Accident Aircraft Damage	
Destroyed	18
Substantial	229
Minor	0
None	0

Historical Record of Instructional Accidents

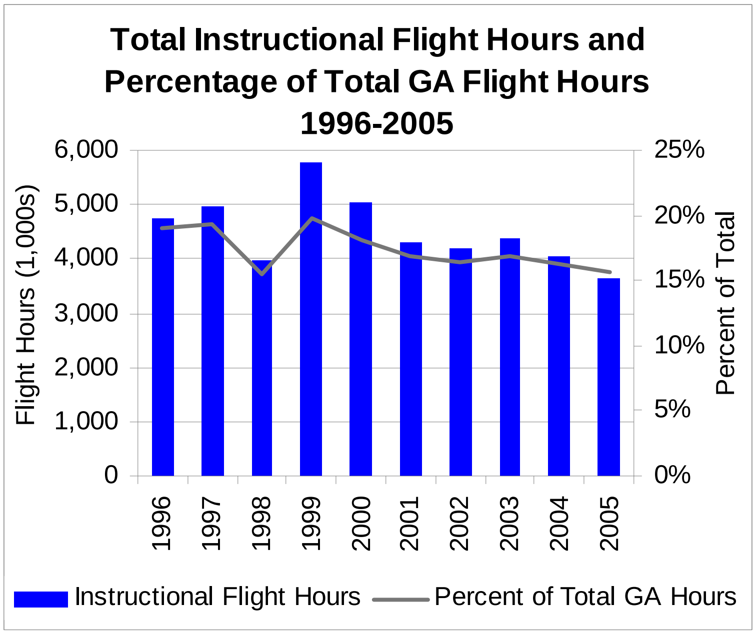
During the 10 years between 1996 and 2005, an average 14% of general aviation accidents involved instructional flight operations. Estimates of general aviation flight activity from the *GAATAA Survey* indicate that during the same period, an average of 4,500,000 of the hours flown in general aviation each year—or 17% of the general aviation total—involved flight instruction. Also during the same time period, an average of 13,700 aircraft, or 7% of the active general aviation fleet, was reported to have been used primarily for flight instruction.

What Is the Definition of Instructional Flight?

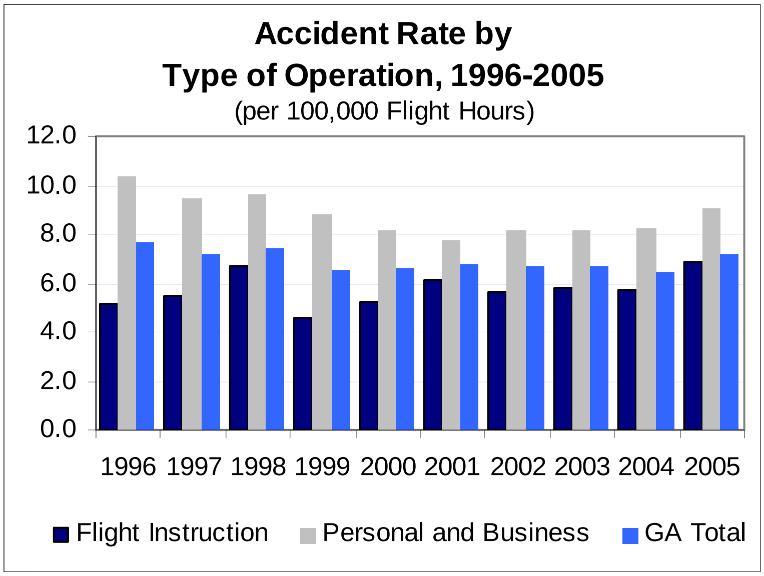
The accident data reported by the NTSB and the flight activity data reported by the FAA presented throughout this review define instructional flying to include all flight operations conducted under the supervision of an authorized instructor, regardless of the certification of the student, and any supervised solo flying by student pilots. Flight operations for personal recreation, aircraft positioning or ferry, or demonstration are not considered instructional flights for the purposes of this review, even if an authorized instructor is on board the aircraft.

Flight Activity

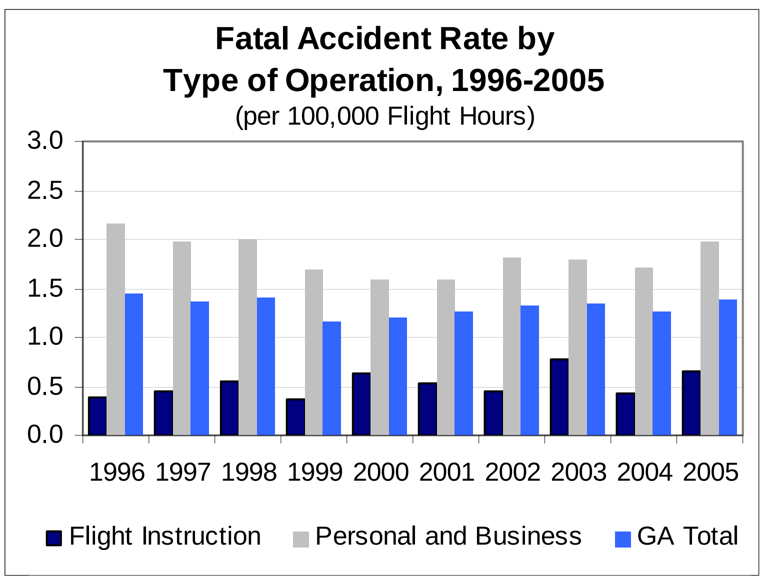
Activity data from the *GAATAA Survey* show that between 1996 and 2005, instructional flight hours, like the rest of general aviation, peaked in 1999 and decreased gradually after that. During 2005, approximately 3.6 million hours or 16% of all general aviation flight hours comprised flight instruction operations. Like most general aviation activity, instructional flights are typically conducted in single-engine piston airplanes. In 2005, approximately 2.9 million instructional flight hours (80% of the total) were flown in single-engine piston airplanes, approximately 340,000 hours (9%) in piston helicopters, and approximately 250,000 hours (7%) in multi-engine piston airplanes.



Based on the distribution of all general aviation flight hours and accidents, instructional flights have historically been safer than some other types of general aviation activities. For example, the most common type of general aviation flying—personal and business—accounted for approximately 53% of general aviation flight hours between 1996 and 2005 and 68% of the accidents while instructional flight accounted for 17% of flight hours and 14% of accidents.



In addition to having a lower total accident rate than personal/business flying and general aviation overall, instructional flights have historically been associated with a noticeably lower rate of fatal accidents. Between 1996 and 2005, instructional flights were associated with an average of 0.52 fatal accidents per 100,000 flight hours, compared to 1.83 fatal accidents per 100,000 hours for personal/business flights and 1.32 for all general aviation operations.

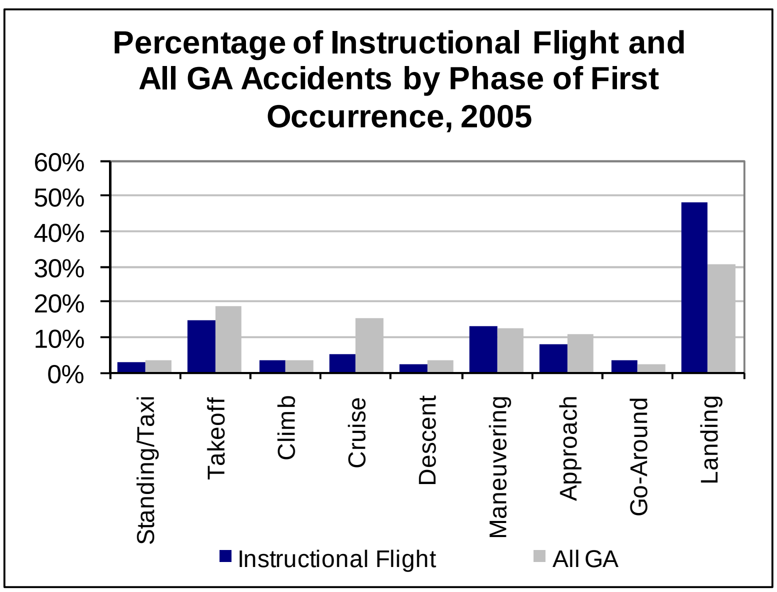


Although it may be safer than many other general aviation operations, instructional flying has unique risks associated with both the personnel and activities typically involved. For example, student pilots are in many cases acquiring new skills and may lack overall experience as pilots and/or experience with a particular type of aircraft or operation. The number and rate of instructional accidents, as well as the circumstances of those events, also reflect the operational differences associated with teaching and practicing piloting skills. Aviation is fundamentally a means of transportation, and the largest percentage of most flights is spent in the cruise phase of flight traveling from one place to another. In contrast, instructional flying typically involves a lot of time spent practicing takeoffs, landings, and maneuvers, and the differences can be observed in the distribution of accidents by phase of flight associated with the occurrence.

Finally, accident risk for instructional flights differs by aircraft category. Of the 248 instructional flight accidents during 2005, 194 (78%) involved fixed-wing airplanes and 48 (19%) involved rotorcraft. In comparison, *GAATAA Survey* data indicate that 88% of instructional hours flown during 2005 were in fixed-wing airplanes and 10% were in rotorcraft. Further, the accident rate for instructional rotorcraft flights was more than double that of airplanes: 6.08 accidents per 100,000 flight hours for airplanes and 12.69 accidents per 100,000 hours for rotorcraft.

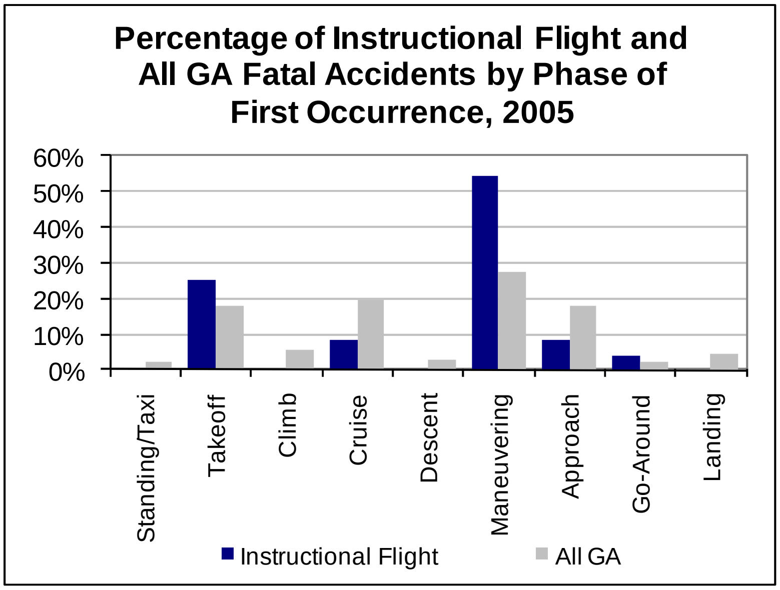
Phase of Flight

This section compares the distribution of accidents by flight phase for instructional flights and all general aviation operations. The largest percentage of instructional accidents (48%) occurred during landing, illustrating both the difficulties associated with becoming proficient at landing an aircraft and the amount of time spent practicing landings. Although prevalent, landing accidents are typically less severe than accidents that occur during other phases of flight because of the relatively slow speeds and low impact forces associated with these events. This is particularly true of instructional flying because of the slow approach speeds characteristic of the aircraft typically used for training.



The distribution of fatal accidents by phase of flight further illustrates the relationship between flight activity and resulting accidents. In 2005, the maneuvering phase accounted for more than 54% of all fatal instructional flight accidents. The maneuvering phase involves common instructional flight activities such as the practice of stalls, steep turns, and ground reference maneuvers to build pilots' proficiency with aircraft control and the management of multiple tasks. Accidents may occur during the maneuvering phase of an instructional flight if a maneuver is not executed properly or if a simulated training event results in an actual emergency.

Therefore, the types of accidents that are likely to occur during the maneuvering phase (for example, loss of aircraft control or a stall/spin) are also more likely to have severe outcomes. In contrast, typical landing accident scenarios associated with instructional flights include hard or bounced landings and maintaining directional control or correcting for wind conditions. Such events may result in dragged wingtips or damaged landing gear, but are typically not severe enough to cause fatal injury. In 2005, none of the instructional flight accidents that occurred during landing was fatal.



Accident First Occurrence

The distribution of the most common accident first occurrences further illustrates the difference between instructional flight accidents and general aviation accidents overall. As indicated by the following tables, loss of control on the ground, loss of control in flight, and hard landings accounted for 58% of instructional flight accidents during 2005, compared to only 36% of all general aviation accidents. Again, the higher percentages of loss of control on the ground and hard landings reflect the combined characteristics of the pilots and activities typically associated with instructional flights.

Five Most Frequently Cited Accident First Occurrences, 2005	Percentage of Flight Instruction Accidents	Percentage of All GA Accidents
LOSS OF CONTROL - ON GROUND/WATER	21%	13%
LOSS OF CONTROL - IN FLIGHT	19%	16%
HARD LANDING	18%	7%
AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION	5%	5%
IN FLIGHT COLLISION WITH TERRAIN/WATER	5%	5%

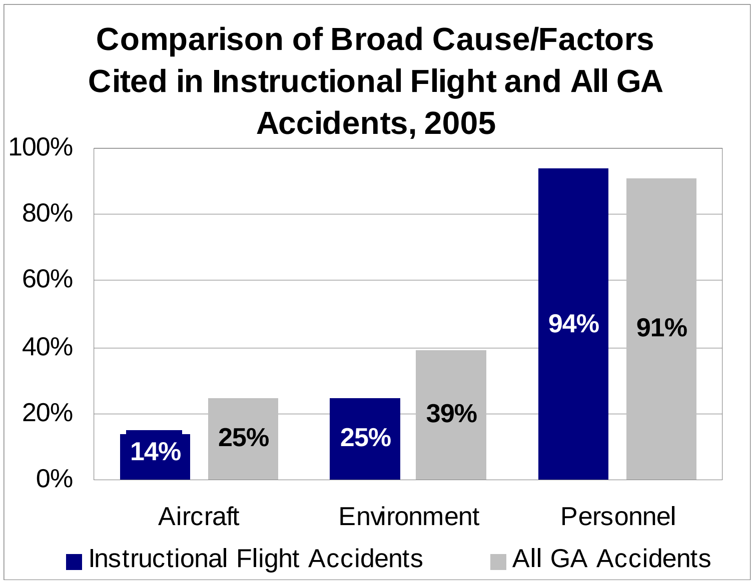
Similarly, loss of control in flight was the most commonly cited first occurrence in fatal accidents during 2005, for both instructional flying and general aviation operations overall. Instructional flying also appears to be similar to the rest of general aviation with regard to the percentage of fatal accidents associated with in-flight collisions with terrain or objects.

Five Most Frequently Cited Fatal Accident First Occurrences, 2005	Percentage of Fatal Flight Instruction Accidents	Percentage of Fatal GA Accidents
LOSS OF CONTROL - IN FLIGHT	46%	32%
IN FLIGHT COLLISION WITH TERRAIN/WATER	17%	12%
MIDAIR COLLISION	13%	3%
AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION	8%	2%
IN FLIGHT COLLISION WITH OBJECT	8%	12%

A notable difference is the high percentage of fatal instructional accidents involving midair collisions. Of the midair collisions that occurred in U.S. civil aviation between 1996 and 2005, 29% involved general aviation instructional flights, even though instructional flights accounted for less than 10% of the total civil aviation (general aviation and commercial aviation combined) flight hours during that period. Instructional flights are more likely to be involved in midair collisions in part because so many of these flights occur near airports, and because pilots and flight instructors must divide their attention between training and avoiding collisions. Pilots who are focusing on a maneuver, or instructors who are observing students, can be easily distracted from monitoring other aircraft traffic.

Accident Causes

Although some occurrences are common to all fatal general aviation accidents, the causes and factors contributing to those accidents are often different for instructional flying than for general aviation as a whole. For example, weather is often a contributing factor in fatal general aviation accidents. Loss of control and/or collision with terrain are typical outcomes when a pilot becomes disoriented during flight in IMC or inadvertently encounters clouds or reduced visibility. However, with the exception of training for an instrument rating, instructional flights are less likely than other general aviation operations to encounter weather-related hazards. Since most instructional flying is done near an airport, the risk of unexpectedly encountering hazardous weather is low. Further, several flight maneuvers commonly practiced during instructional flights, such as stalls and steep turns, are subject to minimum altitude and visibility requirements that often make it impractical to conduct some instructional flights in marginal weather conditions. This difference is illustrated in a comparison of the broad causes and factors cited in accidents during 2005. Environmental conditions were cited in only 25% percent of instructional accidents, compared to 39% of all general aviation accidents.



Dual Instruction and Supervised Solo

Instructional flying includes training both by pilots seeking additional certification or rating and certificated pilots receiving instruction to maintain currency and proficiency requirements. Flight hour requirements for initial flight instruction vary by the type of certificate or rating being pursued and whether the training is conducted by a certificated pilot school. For example, 14 CFR part 61, subpart E, prescribes the minimum aeronautical experience requirements for a private pilot certificate with single-engine airplane privileges, which include 40 hours of flight time of which a minimum of 20 hours of flight training are with an authorized flight instructor and 10 hours are supervised solo flight. The aeronautical experience requirements for certificate eligibility are similar for the recreational pilot and sport pilot certificates, with solo flight comprising approximately 10 to 25% of the required minimum.

Pilots are also required to receive additional dual flight instruction to maintain currency and to qualify for additional certificates and/or ratings. For example, to act as pilot-in-command of an aircraft, 14 CFR 61.56 requires a pilot to complete a flight review by an authorized instructor, or equivalent proficiency training or review, during the preceding 24 months. The FAA general aviation activity data do not distinguish between dual flight instruction and supervised solo, but the distribution of regulatory requirements for supervised solo by unrated pilots in comparison to the dual flight instruction requirements for all pilots suggests that supervised solo comprises a relatively small percentage of all instructional flight activity.

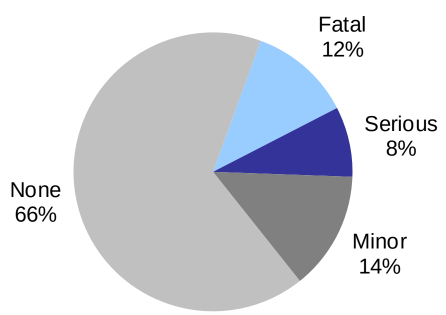
Of the 247 instructional accidents that occurred during 2005, 157 involved dual flight instruction and 90 involved supervised solo flights.

- Of those accidents involving dual flight instruction, 35 involved pilots who held a student pilot certificate and were pursuing a new or additional certificate in the category of aircraft involved in the accident.

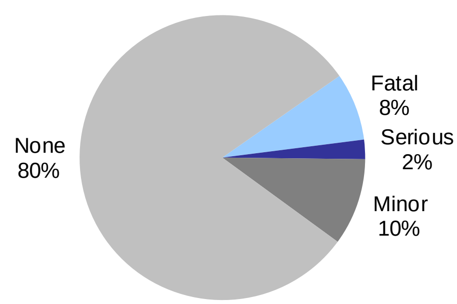
- In the accidents involving supervised solo flight, 79 of the accident pilots held only a student pilot certificate with no other certification. The remaining 11 pilots held a student pilot certificate for the category of aircraft involved in the accident, but held a private certificate or higher in at least one other aircraft category.

A comparison of the flight time requirements for certification and the high proportion of accidents involving supervised solo flights by student pilots—36% of instructional accidents—suggest that solo flights exhibit a greater risk of accident than dual instruction flights. This finding is not particularly surprising since student pilots are still acquiring the skills necessary for certification and lack total flight experience and/or experience with the aircraft they are operating. However, accidents resulting from supervised solo flights had less severe outcomes than those involving dual flights. In 2005, the percentages of accidents resulting in all levels of injury—fatal, serious, and minor—were lower for solo flights than for dual flights, which suggest differences in the circumstances of the two groups of accidents.

Distribution of Accidents by Highest Injury, Dual Instructional Flights, 2005



Distribution of Accidents by Highest Injury, Solo Instructional Flights, 2005



A further analysis of accident first occurrences, comparing dual and solo flights, illustrates that solo flights were more than twice as likely to experience the problems with loss of control on the ground and hard landings as previously discussed, while dual flights were more likely to experience in-flight loss of control or collision with terrain.

Five Most Commonly Cited Accident First Occurrences, 2005	Dual Instruction Flights		Supervised Solo Flights	
	Accidents	%	Accidents	%
LOSS OF CONTROL - IN FLIGHT	33	21%	14	15%
LOSS OF CONTROL - ON GROUND/WATER	23	14%	28	31%
HARD LANDING	19	12%	26	29%
LOSS OF ENGINE POWER	12	8%	1	1%
IN FLIGHT COLLISION WITH TERRAIN/WATER	11	7%	2	2%

Simulated Emergencies

Another difference between dual and solo instructional flights is that flight instructors must often simulate hazardous conditions to train pilots to handle in-flight emergencies. What is not readily apparent from the summary statistics is the number of instructional flight accidents that result not from external hazards but from simulated flight training scenarios going awry. For example, a simulated emergency descent due to engine failure may continue below a safe altitude, or an instructor may fail to intervene in a timely manner when a student is having difficulty maintaining aircraft control. The following narratives from 2005 illustrate training situations that resulted in accidents.

> The flight instructor was demonstrating a simulated emergency landing in a local training area with known transmission power lines. The flight instructor initiated a climb to recover from the simulated emergency landing and the airplane collided with the transmission wire. The flight instructor stated, "I simply failed to maintain a visual look out resulting in the collision with the wires."

> The certificated airline transport pilot was receiving instruction for a seaplane rating. He made three water landings in a float-equipped seaplane, and after the third landing, the flight instructor told him to climb to and maintain 100 feet. The pilot climbed the airplane to the assigned altitude, and made a left turn to a downwind leg at 80-85 knots. Once on the downwind leg, the instructor simulated an engine failure by pulling the power lever back to idle, and the pilot receiving instruction began a left turn to land into the wind. The instructor then told him to turn to the right, and subsequently joined him on the controls for the right turn. Neither pilot added power, nor the airplane "landed hard," in a descending right turn, at an estimated 45-90 degrees from the wind line. Upon landing, the left float separated from the airplane, and the airplane subsequently sank. No mechanical anomalies were noted.

A similar example of the need to balance training realism with accident risk can be observed in the history of spin training. Prior to 1949, pilot applicants were required to demonstrate spin entry and recovery for certification. However, the requirement was changed to focus on spin recognition and avoidance after a large number of fatal accidents were associated with the required spin training. A special study published by the NTSB in 1972 examined the effect of this change and found a noticeable decrease in spin accidents after the 1949 change.

Increasingly, simulators are being used for light aircraft instruction, giving general aviation pilots the training opportunities that have long been available for larger aircraft. Simulators allow pilots to safely practice scenarios that would be impractical or unsafe in a real aircraft. However, since simulator training will not replace training in the aircraft any time soon, the responsibility will continue to be on flight instructors to ensure that their training techniques do not subject their students and themselves to additional accident risk.

Conclusion

The 2005 accident record is similar to the recent history of general aviation accidents, which indicates that instructional flying is less likely than many other types of general aviation flying to result in accidents. The relative safety of instructional flight is notable considering that it involves pilots who, in many cases, are learning new skills and may lack experience in the aircraft they are flying, or in aviation in general. However, the opportunity for improvement still exists, considering that instructional flights typically have less exposure to risks like hazardous weather that often result in serious accidents for other general aviation operations. In many cases, the biggest hazards associated with instructional flying result from training techniques and procedures used by instructors. Most fatal instructional flight accidents in 2005 resulted from a loss of control or a collision with terrain while students practiced flight maneuvers or emergency procedures. Flight instructors can minimize the risks associated with training by ensuring that they do not simulate conditions that actually increase the risk of an accident and do not allow training scenarios to progress to the point that options for safe recovery are limited.

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 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, 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 http://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 NTSB 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.[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 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."[2]

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

None—No damage.

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[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 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 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 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.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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Adopted: May 26, 2009

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

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