Annual Review of Aircraft Accident Data
U.S. General Aviation, Calendar Year 2003

ACCIDENT REPORT

NTSB/ARG-07/01
PB2007-105388

National Transportation Safety Board

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

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Abstract: The National Transportation Safety Board's *2003 Annual Review of Aircraft Accident Data for U.S. General Aviation* is a statistical compilation and review of general aviation accidents that occurred in 2003 involving U.S.-registered aircraft. As a summary of all U.S. general aviation accidents for 2003, the review is designed to inform general aviation pilots and their passengers and to provide detailed information to support future government, industry, and private research efforts and safety improvement initiatives.

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

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2003 General Aviation Accident Summary

A total of 1,739 general aviation accidents occurred during calendar year 2003, involving 1,758 aircraft.[1] The number of general aviation accidents in 2003 was slightly higher than in 2002, with a 1% increase of 24 accidents. Of the total number of accidents, 352 were fatal, resulting in 632 fatalities. The number of fatal general aviation accidents in 2003 increased 2% from calendar year 2002, and the number of fatalities increased by 9%. The circumstances of these accidents and details related to the aircraft, pilots, and locations are presented throughout this review.

2003 General Aviation Accident Statistics

General Aviation Accidents	
Total Accidents	1,739
Fatal Accidents	352
Accident Aircraft	1,758
General Aviation Accident Injuries	
Fatal	632
Serious	324
Minor	523
Persons involved in accidents with no injuries	1,697
General Aviation Accident Rate	
General Aviation Hours Flown[a]	25,998,000
All Accidents[b]	6.67/100,000 hours
Fatal Accidents[b]	1.34/100,000 hours
Accidents per Active Pilots	2.78/1,000 active pilots
Fatal Accidents per Active Pilots	0.56/1,000 active pilots

[a] Federal Aviation Administration, *General Aviation and Air Taxi Survey, 2003.*
[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 11 midair collision accidents that occurred in 2003 involved 22 general aviation aircraft. In addition, 9 ground collision accidents involved 17 general aviation aircraft.

Introduction

Purpose of the Review

The National Transportation Safety Board's *2003 Annual Review of Aircraft Accident Data for U.S. General Aviation* is a statistical compilation and review of general aviation accidents that occurred in 2003 involving U.S.-registered aircraft. As a summary of all U.S. general aviation accidents for 2003, the review is designed to inform general aviation pilots and their passengers and to provide detailed information to support future government, industry, and private research efforts and safety improvement initiatives.

The Safety Board drew on several resources in compiling data for this review. Accident data, for example, were extracted from the Safety Board's Aviation Accident/Incident Database.[2] Activity data were extracted from the *General Aviation and Air Taxi Activity Survey* (*GAATA Survey*)[3] and from *U.S. Civil Airmen Statistics*,[4] both of which are published by the Federal Aviation Administration (FAA), Statistics and Forecast Branch, Planning and Analysis Division, Office of Aviation Policy and Plans. Additional information was extracted from the *General Aviation Statistical Databook*, published by the General Aviation Manufacturers Association (GAMA).

What Is General Aviation?

General aviation can be described as any civil aircraft operation that is *not* covered under 14 *Code of Federal Regulations* (CFR) Parts 121, 129, and 135, commonly referred to as commercial air carrier operations.[5]

Which Operations Are Included in This Review?

This review includes accidents involving U.S.-registered aircraft operating under 14 CFR Part 91, as well as public aircraft[6] flights that do not involve military or intelligence agencies. Aircraft operating under Part 91 include aircraft that are flown for recreation and personal transportation and certain aircraft operations that are flown with the intention of generating revenue,[7] including business flying, flight instruction, corporate/executive flights, positioning or ferry flights, aerial application, pipeline/powerline patrols, and news and traffic reporting.

Which Aircraft Are Included in This Review?

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

[2] See appendix A for more details.

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

[4] FAA, *U.S. Civil Airmen Statistics*, 2003, available online at <http://www.faa.gov/data_statistics/aviation_data_statistics/civil_airmen_statistics/>.

[5] For a review of accident statistics related to air carrier operations, see National Transportation Safety Board, *Annual Review of Aircraft Accident Data, U.S. Air Carrier Operations, Calendar Year 2003* (Washington, DC: 2006), available at <http://www.ntsb.gov>.

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

[7] See 14 CFR 119.1.

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. Also not included are data for military or intelligence agencies, non-U.S.-registered aircraft, unregistered ultralights, and commercial space launches, unless the accident also involved aircraft conducting general aviation operations. Crashes involving illegal operations, stolen aircraft, suicide, or sabotage are included in the accident total, but not in accident rates.[8]

Organization of the Review

The *2003 Annual Review* is organized into four parts.

1. The first part summarizes general aviation accident statistics for 2003, industry markers related to general aviation activity in 2003, and contextual statistics from previous years.
2. The second part investigates trends over the past 10 years and provides context for such accident information as operation types, levels of aircraft damage, and injuries.
3. The third part focuses on specific circumstances of accidents that occurred during 2003. This section describes accident occurrences and summarizes the Safety Board's findings of probable cause and contributing factors.
4. The fourth section presents in-depth coverage of a special topic important to general aviation safety. The *2003 Annual Review* focuses on night flying, which has historically accounted for a disproportionate number of fatal accidents.

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

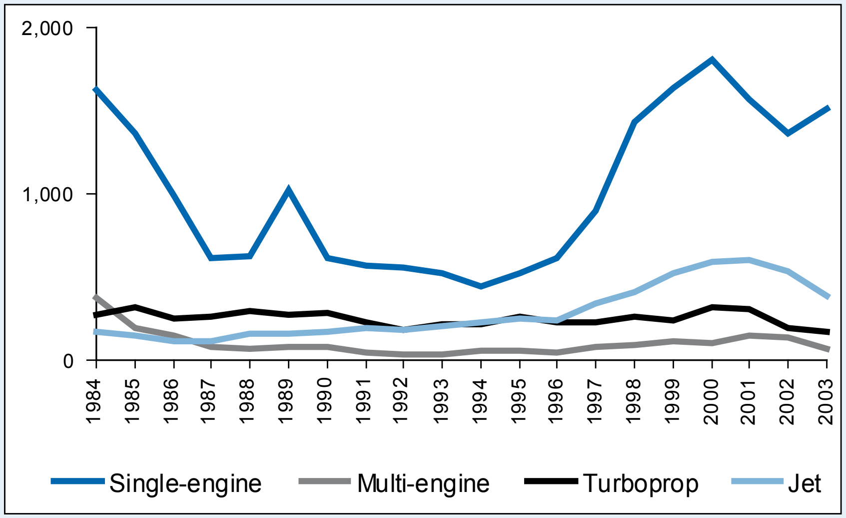
[8] In 2003, three crashes were attributed to pilot suicide and one accident to sabotage.

The General Aviation Environment in 2003

General Aviation Industry Indicators

A theme repeated throughout this review is that general aviation accident numbers should be interpreted in light of related information, such as aircraft type, type of operation, and operating environment. Because personal and business flying account for the largest percentage of general aviation flying, prevailing economic conditions and/or trends may noticeably affect both the general aviation industry and flight operations. In 2003, the general aviation climate was influenced by generally favorable economic conditions and an increase in general aviation aircraft production.

Annual Shipments of U.S.-Manufactured General Aviation Aircraft, 1984-2003

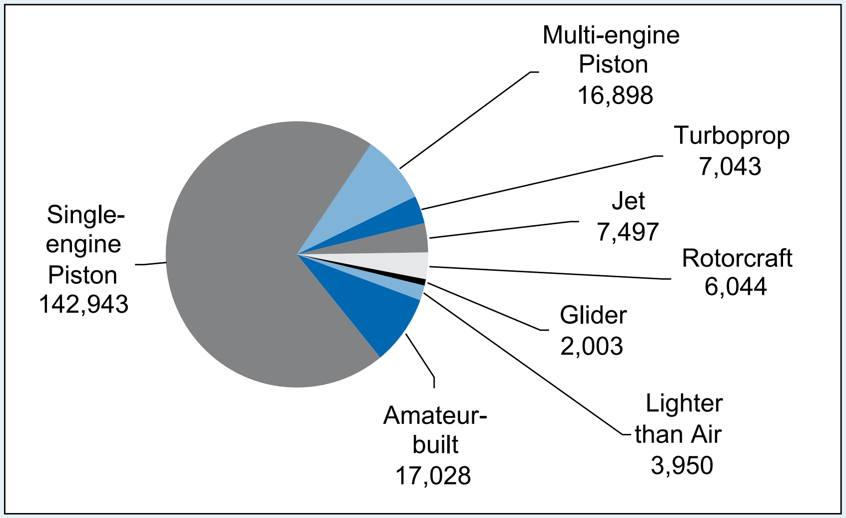


Fleet Makeup

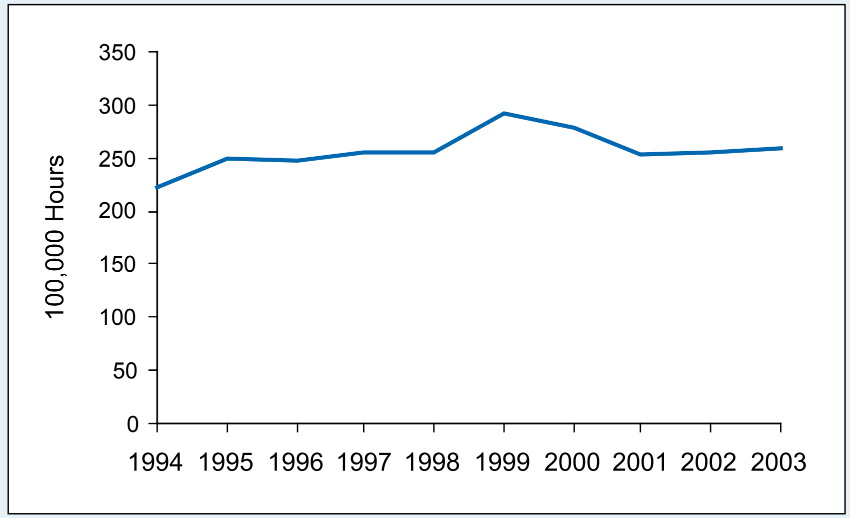
Although sales of new general aviation aircraft increased noticeably after the mid-1990s, most general aviation aircraft in use in 2003 were more than 25 years old.[9] U.S. manufacturers delivered 2,137 new general aviation aircraft in 2003, compared to an estimated total of 206,917 in service. Single-engine 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.

[9] In 2002, the FAA estimated the average age of all single-engine and multi-engine aircraft to be 31 years. No revised estimate is associated with 2003.

Number of Active Aircraft in General Aviation, 2003



Number of General Aviation Hours Flown Annually, 1994-2003



General Aviation Activity

Because general aviation includes such a diverse group of aircraft types and operations, some measure of exposure must be considered to make meaningful comparisons of accident numbers. Flight activity is typically used to normalize accident numbers across different groups, with the level of activity corresponding to the level of exposure to potential accident risk. Total flight hours, departures, and miles flown are common indicators used to measure activity. As the graph shows, annual general aviation flight hour estimates from 1994 through 2003 peaked in 1999, but were lower after that. In 2003, the estimated number of general aviation flight hours was 25.9 million, up slightly from 2002.

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,[10] operators of general aviation aircraft are not required to report actual flight activity data. As a result, activity for this group of aircraft must be estimated using data from the *GAATA Survey*,[11] 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 *GAATA Survey*, and reporting is not required.

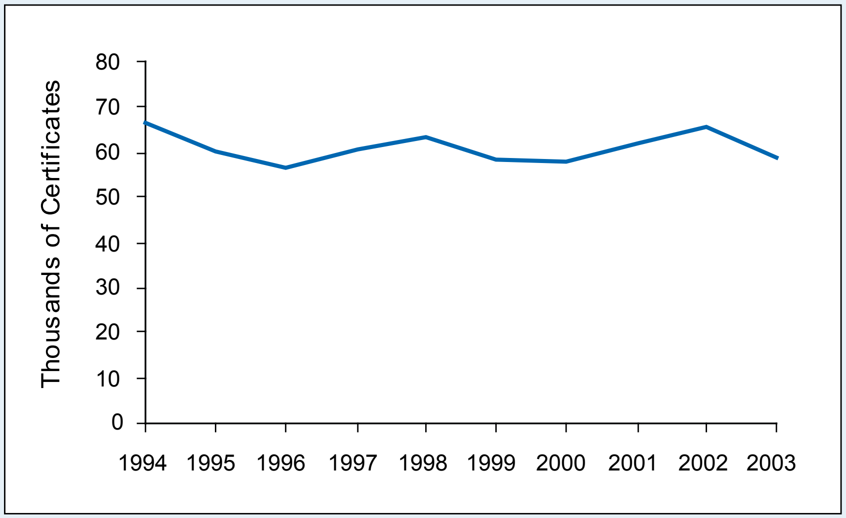
[10] Part 121 operators report activity monthly, and scheduled Part 135 operators report quarterly.

[11] The *GAATA Survey* is available at <http://www.faa.gov/data_statistics/aviation_data_statistics/general_aviation/CY2003/>.

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

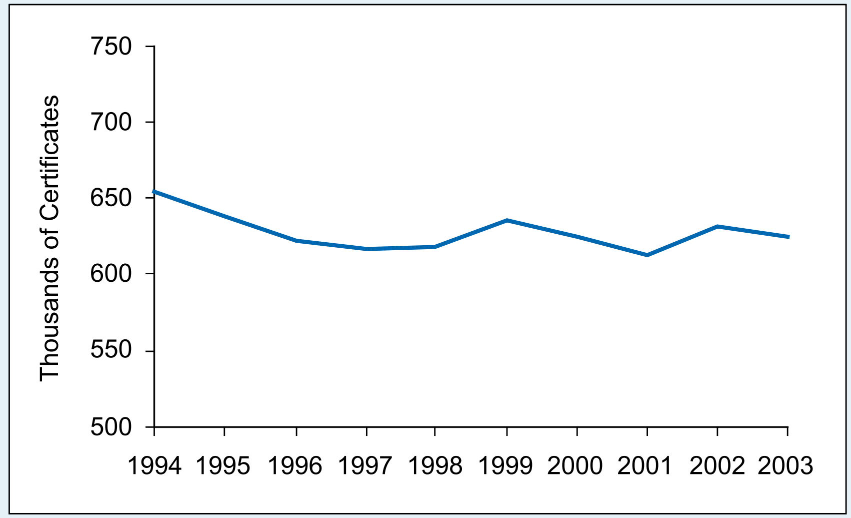
The number of new student pilot certificates annually fluctuated between 1994 and 2003.[12] The total number of new student certificates issued in 2003 came to 58,842, a decrease from the total of 65,421 issued in 2002.

Number of New Student Pilot Certificates Issued, 1994-2003



As shown by the number of medical certificates issued, the total number of active pilots in U.S. general aviation decreased steadily throughout the early and mid-1990s, from 702,659 in 1990 to 622,261 in 1996. Between 1997 and 2003, the number of active pilots fluctuated, with an estimated total of 625,011 active U.S. pilots in 2003.

Estimated Number of Active Pilot Certificates, 1994-2003



In summary, general aviation indicators—flight hours and the total number of active and newly issued pilot certificates—decreased annually between 1990 and 1996. From 1996 through 2003, the number of active and new student pilots fluctuated annually, with little overall change, during a period with a noticeable increase in estimated flight activity. This increase in activity had a noticeable effect on the accident rate and should be considered when attempting to interpret the general aviation accident record for 2003 in the context of previous years.

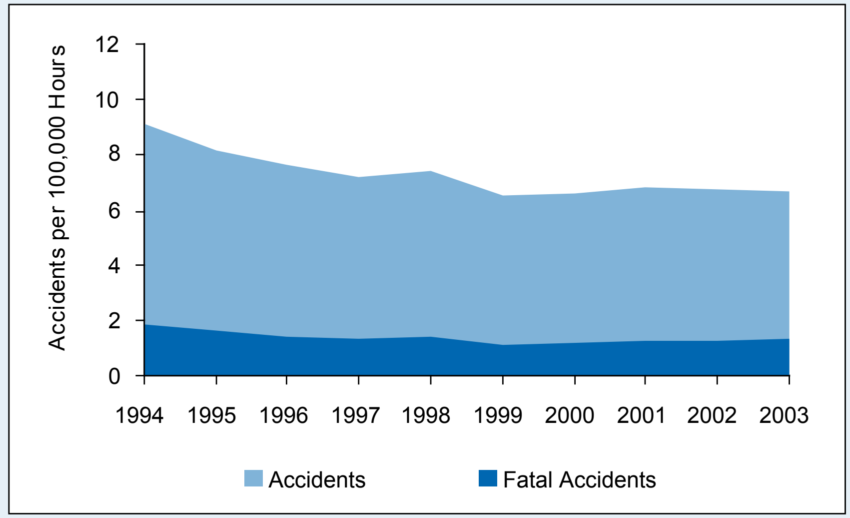
[12] FAA, *U.S. Civil Airmen Statistics*, 2003, is available at <http://www.faa.gov/data_statistics/aviation_data_statistics/civil_airmen_statistics/>.

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 noticeably[13] without a corresponding increase in the number of accidents. The rate of 6.67 accidents per 100,000 hours flown in 2003 was substantially lower than the 9.08 accidents per 100,000 hours recorded in 1994. In fact, the 2003 rate was only slightly higher than that of 1999, which had the lowest rate since the Safety Board began reporting general aviation-only annual accident rates in 1975.[14] The relative percentage of fatal accidents remained fairly constant from 1994 through 2003, at 18 to 21% of the total rate. The 2003 rate of 1.34 fatal accidents per 100,000 flight hours was only slightly higher than the 2002 fatal accident rate of 1.33.

General Aviation Accident Rate
1994-2003

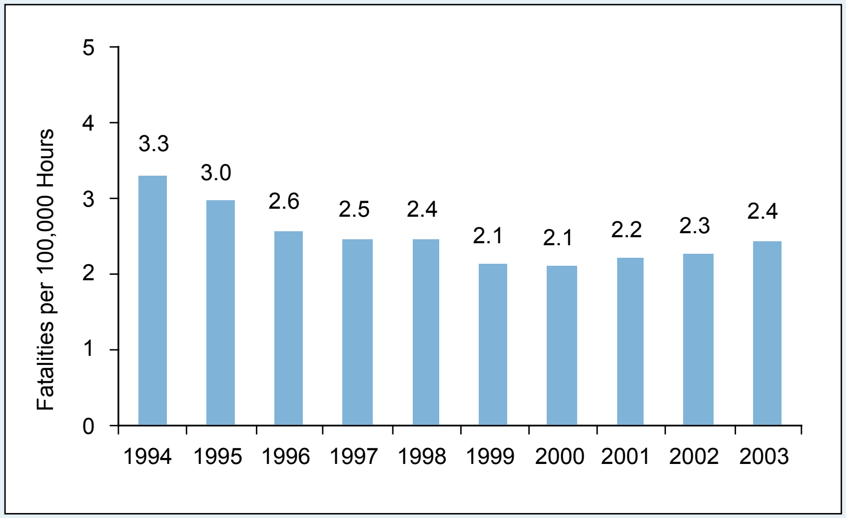


In 2003, accident-related deaths per flight hour were 2.43 fatalities per 100,000 hours flown. The highest annual fatality-per-hour rate occurred in 1994 with 3.28 deaths per 100,000 hours flown.

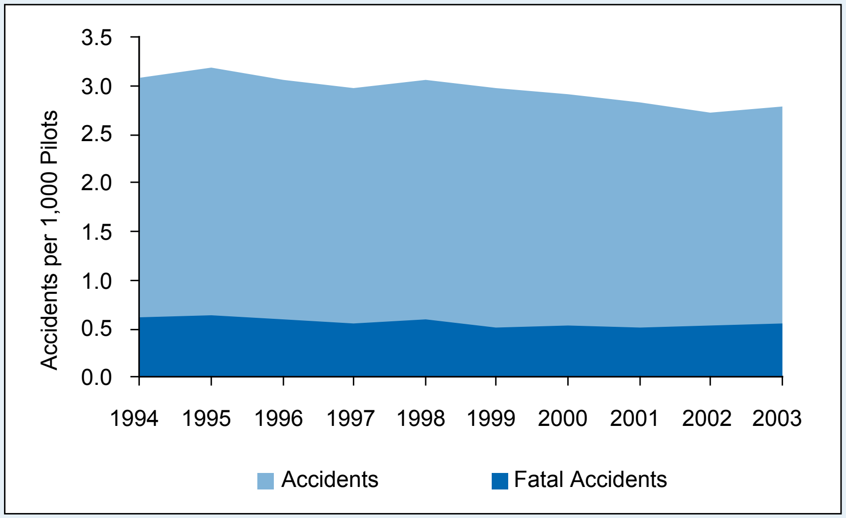
[13] FAA estimates of annual general aviation activity increased noticeably after 1998 due to a change of *GAATA Survey* methodology that increased the estimated general aviation aircraft population by about 10 %. See appendix A of the *GAATA Survey, Calendar Year 2003*, for an explanation of the changes in survey methodology.

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

Number of General Aviation Fatalities per 100,000 Hours Flown, 1994-2003



General Aviation Accident Distribution per Active Pilot, 1994-2003



Another measure of accident distribution is the number of accidents per active pilot. Although this measure was considerably more stable from 1994 through 2003 than the per-hour accident rate, it did decrease slightly overall. The per-pilot rate in 2003 was only slightly higher than the low for the period, which occurred in 2002.

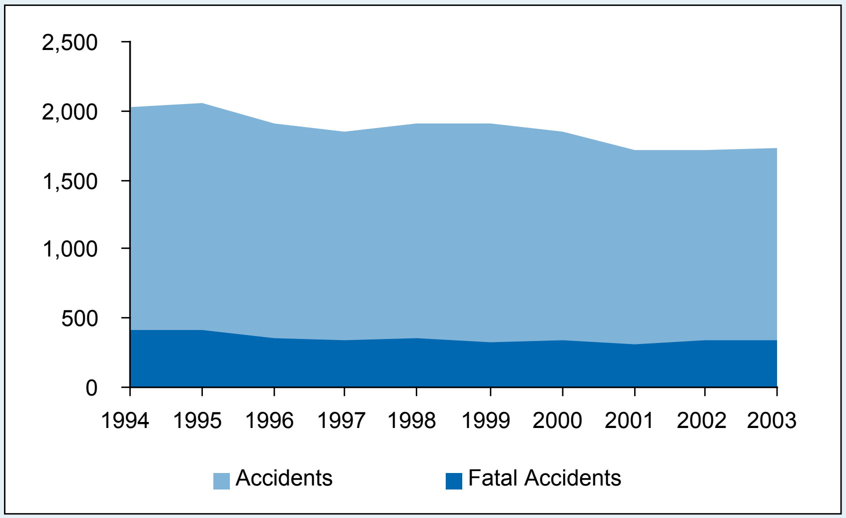
Accident rate calculations based on flight hours require the use of *GAATA Survey* activity data extrapolated from a relatively small sample of aircraft owners. As a result, the calculated values are accurate only to the extent that the sample represents the larger population of general aviation operators.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

Number of Accidents and Fatalities

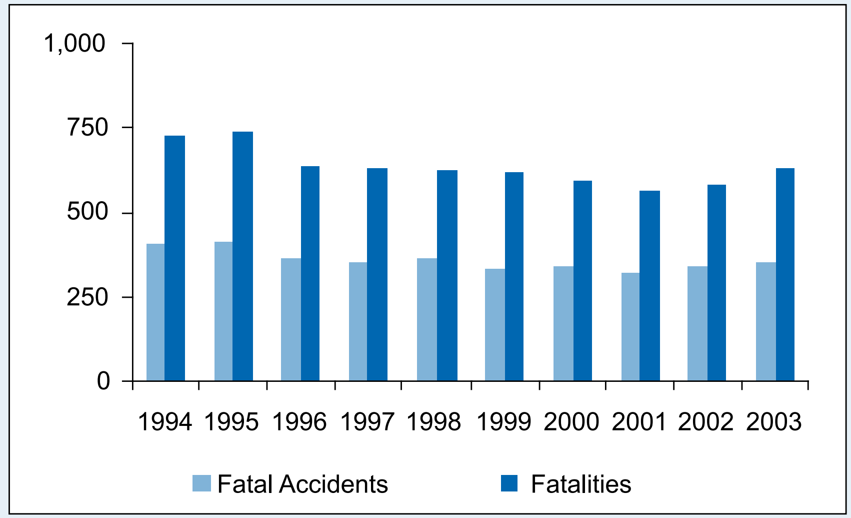
Although the number of general aviation accidents fluctuated slightly from year to year, the number of accidents that occurred annually between 1994 and 2003 declined overall from 2,021 in 1994 to 1,739 in 2003, and the number of fatal accidents decreased overall, from 404 to 352.

The number of fatalities from general aviation accidents also exhibited a generally downward trend from the high of 730 in 1994 to 632 in 2003. It should be noted that 2003 continued a generally downward trend in total fatalities for the overall 10-year period. It should also be noted that the trend reflects a decrease in general aviation flight hours flown annually following the events of September 11, 2001.

Number of General Aviation Accidents 1994-2003



Number of Fatal General Aviation Accidents and Fatalities, 1994-2003



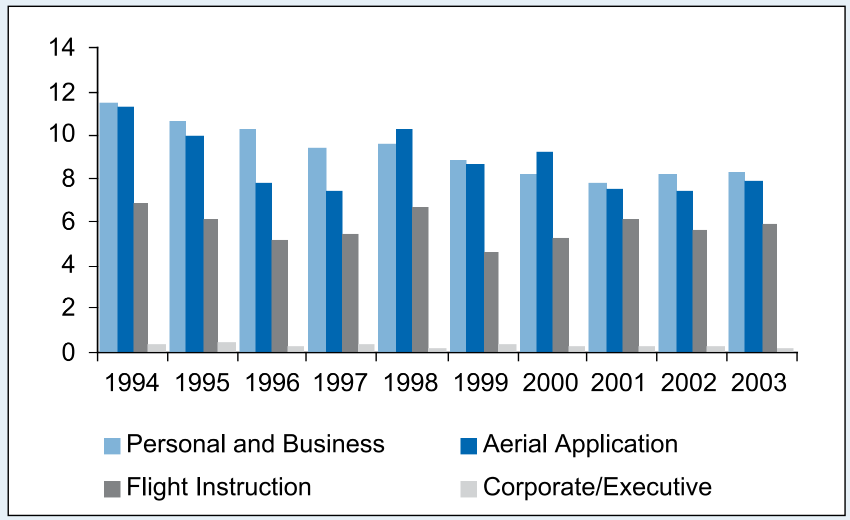
Accident Rate by Type of Operation

General aviation includes a wide range of operations, each with unique aircraft types, flight profiles, and operating procedures. This diversity is evident in the accident record. However, the flight data collected in the *GAATA Survey* allow for only a coarse representation of the many types of general aviation operations. For some types of operations, such as public aircraft flights,[15] 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 flying,[16] corporate flying, aerial application, and instructional flights.

- Personal flying makes up the largest portion of general aviation activity and includes all flying for pleasure and/or personal transportation. Although similar to personal flying, business flying includes the use of an aircraft for business transportation without a paid, professional crew. Personal and business flights are typically conducted in single- and multi-engine piston airplanes, but may include a range of aircraft including gliders, rotorcraft, and balloons.
- Corporate flying includes any business transportation with a professional crew and usually involves larger, multi-engine piston, turboprop, and jet airplanes.
- Aerial application includes the use of specially equipped aircraft for seeding and for spraying pesticides, herbicides, and fertilizer. Aerial application is unique because it requires pilots to fly close to the ground.
- Instructional flying includes any flight under the supervision of a certificated flight instructor.[17] Instructional flying typically includes both dual training flights and student solo flights. Aircraft used for instruction are often similar to those used for personal flying. However, instructional operations are unique because they often involve the repeated practice of takeoffs and landings, flight maneuvers, and emergency procedures.

In 8 out of the 10 years, personal and business flying 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.

Accident Rate by Type of Operation, 1994-2003 (per 100,000 Flight Hours)



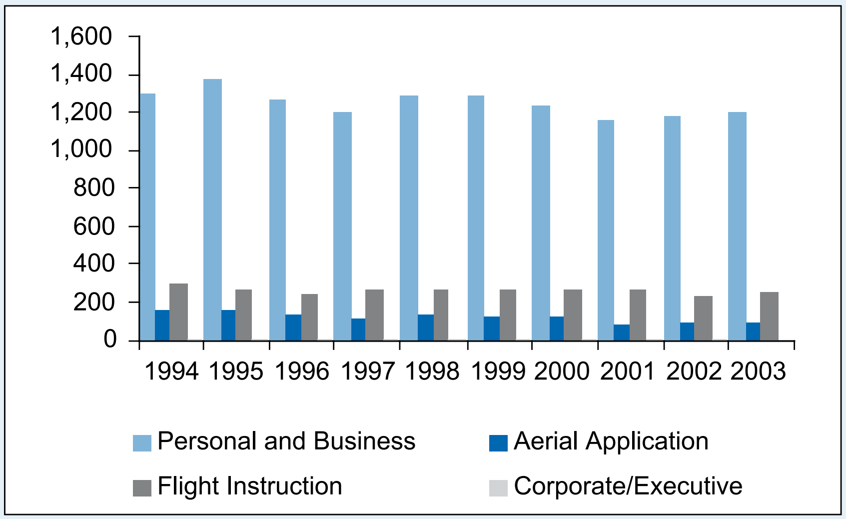
[15] The *2003 Annual Review* data include 20 public aircraft accidents, 3 of which resulted in 1 or more fatalities.

[16] 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).

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

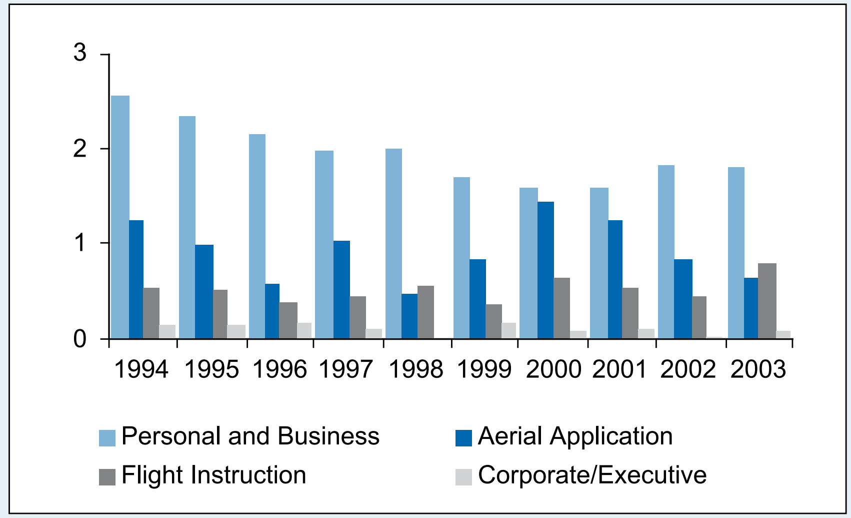
In 2003, the highest proportion of flying time was associated with personal and business operations, which accounted for the largest proportion of accidents, 69% (n = 1197), a percentage consistent with the 10-year average. Less than 1% of the accidents (n = 5) were corporate/executive operations, 5% were aerial application (n = 86), and 14.7%, instructional flying (n = 255). Totals for corporate/executive accidents are barely visible when graphed in comparison to accidents involving other types of operations. For both corporate/executive operations and instructional flights, the proportion of flight hours was higher than the proportion of accidents, reflecting the relative safety of these missions.

Number of Accidents by Type of Operation, 1994-2003



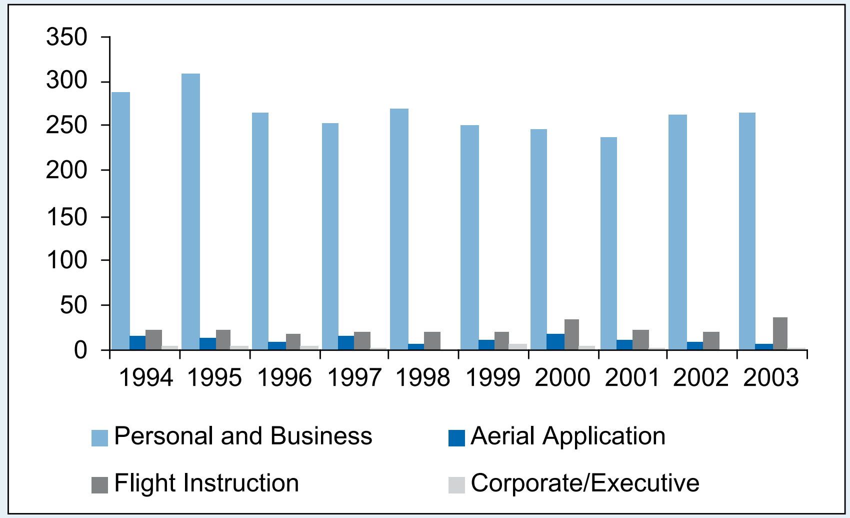
Throughout the 10-year period, the combined category of personal/business flying also had the highest fatal accident rate. Except for 2000 and 2001, the rate was typically more than double the rate for any other type of flying.

Fatal Accident Rate by Type of Operation, 1994-2003 (per 100,000 Flight Hours)



Between 1994 and 2003, an average 265 fatal accidents per year were personal/business flights, compared to an average 24 fatal accidents per year related to instructional flying, 12 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 74% of all fatal injuries for 1994 through 2003.

Number of Fatal Accidents by Type of Operation, 1994-2003



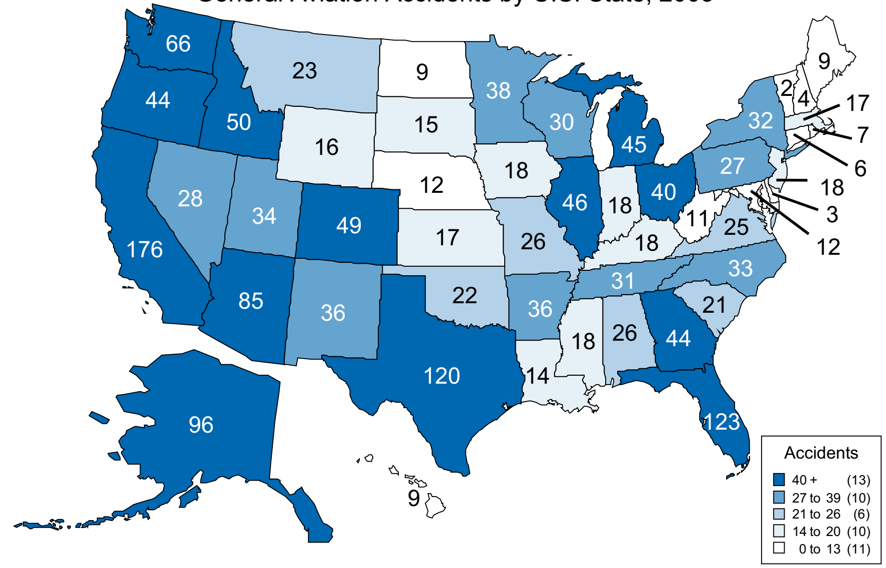
2003 in Depth

Location of General Aviation Accidents in 2003

United States Aircraft Accidents

Geographic location can contribute to general aviation accident totals because of increased activity associated with population density, or increased risk due to hazardous terrain, a propensity for hazardous weather, or a concentration of particularly hazardous flight operations. The following map shows state by state the number of all general aviation accidents that occurred within the United States in 2003. Although the specific hourly activity data needed to calculate general aviation accident rates for each state are not available, some assumptions can be made about general aviation activity levels based on the size and population of each state. For example, California, Florida, and Texas had the greatest number of accidents in 2003. U.S. Census Bureau data[18] indicate that California had the highest state population in 2003, 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 aviation traffic from other states. These states also had the largest numbers of active pilots[19] and active aircraft.[20] These data suggest that the high number of accidents in California, Florida, and Texas are related primarily to a high level of activity.

General Aviation Accidents by U.S. State, 2003



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[21] to aviation that are reflected in the general aviation accident record. After California, Florida, and Texas, Alaska had the most general aviation accidents in 2003.

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

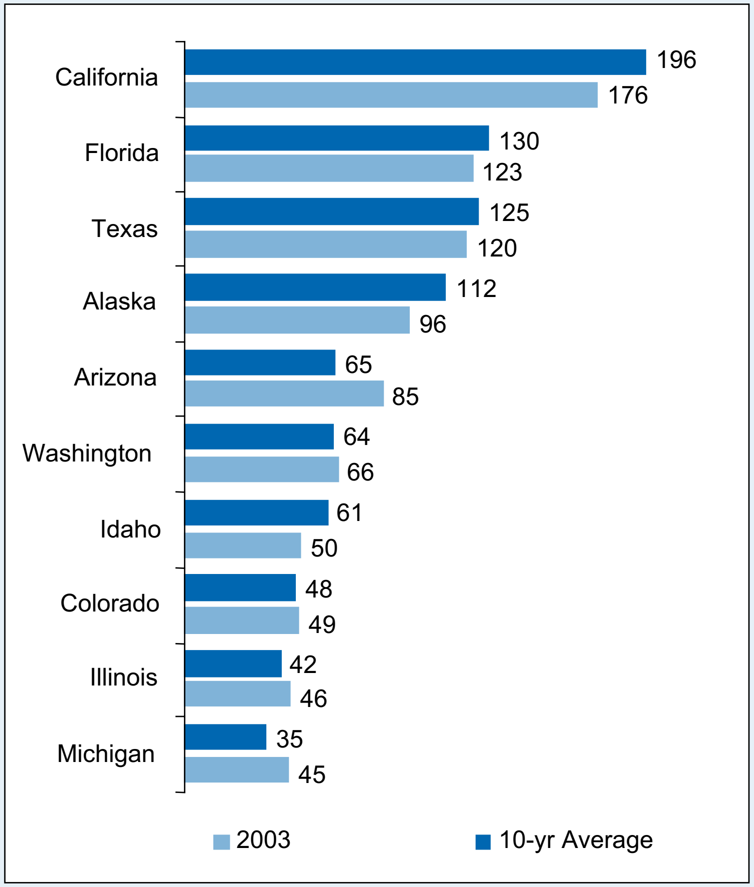
[19] FAA, *U.S. Civil Airmen Statistics, 2003*, available at <http://www.faa.gov/data_statistics/aviation_data_statistics/civil_airmen_statistics/>.

[20] FAA, *GAATA Survey 2003*, available at <http://www.faa.gov/data_statistics/aviation_data_statistics/general_aviation/CY2003/.>.

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

The top 10 states by number of general aviation accidents in 2003 are presented here along with the 10-year average. Note that many of the state accident totals for 2003 were below historical averages, but the distribution of accidents among states remained similar during the period.

Top 10 General Aviation Accident States 2003



Foreign Aircraft Accidents

In 2003, U.S.-registered aircraft were involved in 34 accidents outside the 50 United States. Those accidents occurred in 17 different countries and territories, in the Atlantic and Pacific Oceans, and in the Gulf of Mexico. Of those accidents, 15 were fatal, resulting in 31 deaths. Most of these accidents occurred in Mexico, with 5 accidents, followed by Canada with 4. 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 2003, accidents occurred as far away as Germany, Bolivia, Malaysia, and Antarctica.

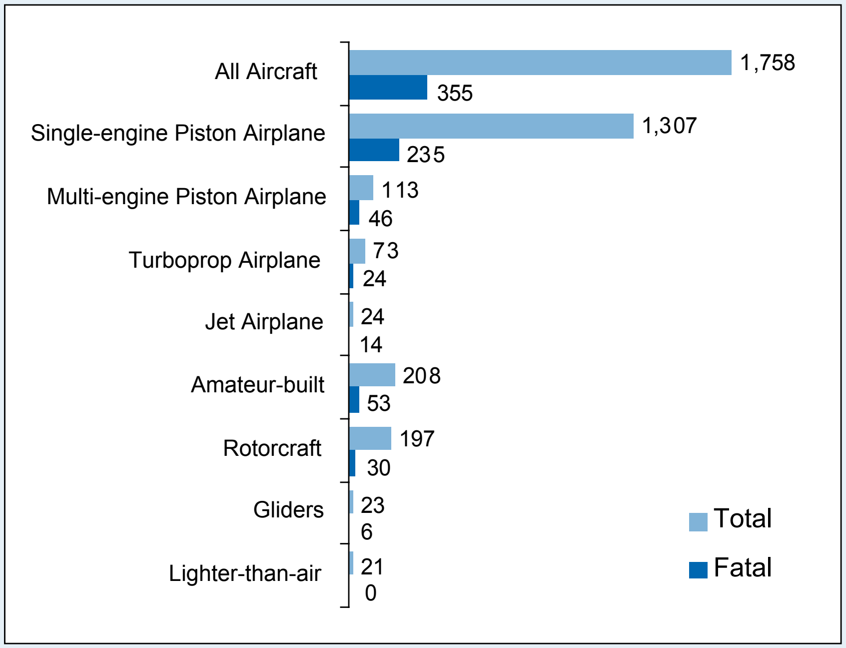
Accidents Involving U.S.-Registered General Aviation Aircraft Outside the 50 United States, 2003

	Number of Accidents	Number of Fatal Accidents	Number of Fatalities
Pacific Ocean			
En route Hawaii	1	0	1
Subtotal	**1**	**0**	**1**
Atlantic Ocean			
Off Florida	1	1	1
Subtotal	**1**	**1**	**1**
Gulf of Mexico			
Off Oil Platform	1	0	0
Subtotal	**1**	**0**	**0**
Other Locations			
Antarctica	1	0	0
Bahamas	3	2	2
Bolivia	1	1	2
Canada	4	2	3
Colombia	1	1	1
Costa Rica	3	1	3
Dominican Republic	1	0	0
France	1	0	0
Germany	1	0	0
Martinique	1	0	0
Mexico	5	4	7
Malaysia	1	0	0
Netherlands	1	0	0
Netherlands Antilles	1	0	0
Puerto Rico	3	0	0
Spain	1	1	3
United Kingdom	2	2	4
Subtotal	**31**	**14**	**29**
Total	**34**	**15**	**31**

Aircraft Type

The following graphs summarize the total number of general aviation accidents and fatal accidents occurring in 2003 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 66% of all fatal accident aircraft.

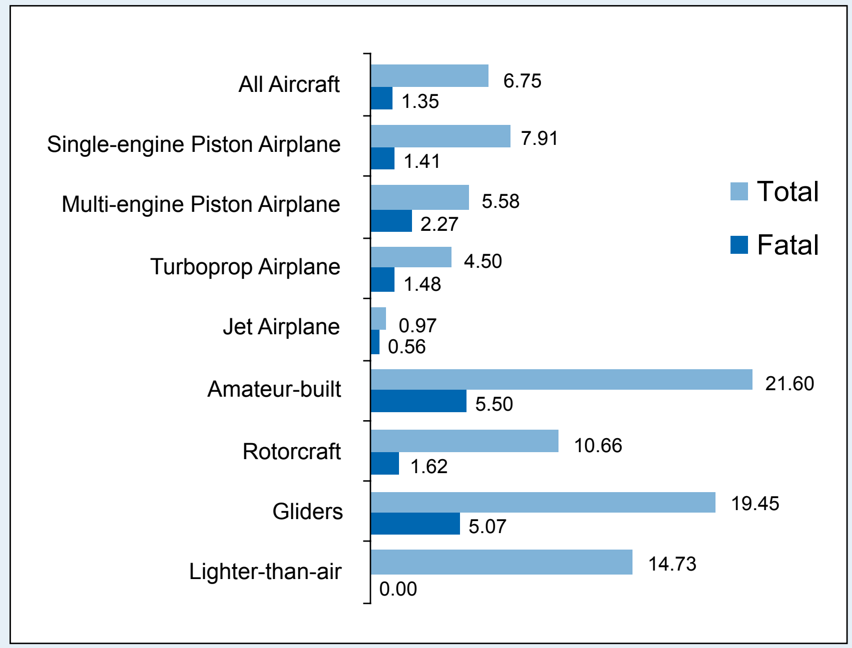
Number of Accidents by Type of Aircraft, 2003



In 2003, the per-aircraft accident rate for all aircraft types was 6.75 accidents and 1.35 fatal accidents per 100,000 hours flown.[22]

Among fixed-wing powered aircraft, the rate for single-engine piston airplanes was 7.91 accidents and 1.41 fatal accidents per 100,000 hours flown. Amateur-built aircraft[23] had the highest accident rate with 21.60 accidents and 5.50 fatal accidents per 100,000 flight hours. Rotorcraft had the second-highest rate among powered aircraft, with 10.60 accidents and 1.62 fatal accidents per 100,000 hours flown. However, glider operations had the second-highest accident rate overall, with 19.45 accidents and 5.07 fatal accidents per 100,000 hours flown.

Accident Rate per Aircraft Type, 2003 (per 100,000 Flight Hours)



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

[23] Title 14 CFR Part 21 (21.191(g)) provides for the issuance of a Special Airworthiness Certificate in the experimental category to permit the operation of amateur-built aircraft. Amateur-built aircraft may be fabricated from plans or assembled from a kit, so long as the *major* portion 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 *GAATA Survey*, which includes 14 purpose/use categories. Two of these categories, air taxis and air tours, are covered under 14 CFR Part 135 and are therefore not included in this review. The remaining 12 include the previously mentioned categories of "personal," "business," "instructional," "corporate," and "aerial application," which together accounted for 90% of all general aviation operations during 2003. The remaining 10% are included in more specific categories, such as "external load" and "medical use." A limitation of the *GAATA* activity data is that those categories provide only a coarse representation of the range of possible flight operations. For example, "personal flying" includes but does not distinguish between travel, recreation, or proficiency flying. At the same time, the differences between similar categories like "personal" and "business flying" are not easily identified. Accordingly, the purpose-of-flight information presented in this review is limited to the combined categories of personal and business flying, as well as corporate, instructional, and aerial application flights.

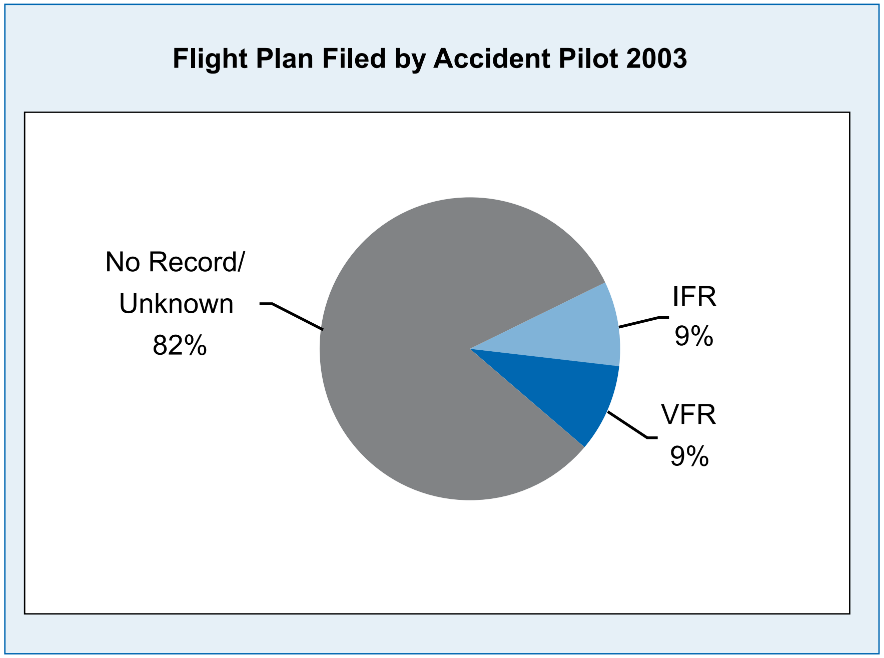
According to the *GAATA Survey*, most general aviation operations are conducted for personal and/or business purposes. Of the estimated 26 million general aviation hours flown in 2003, more than half—14.6 million—were conducted for personal or business reasons.[24] Accordingly, a large percentage of general aviation accidents involve personal/business flying. However, personal/business flying is still over-represented in the accident record: although this segment represented about 56% of the general aviation hours in 2003, it accounted for 68% of all general aviation accidents (n=1,197) and 76% of all fatal accidents in 2003 (n=264).

The accident rate for instructional flights is about half that of personal/business flights. This relatively low rate is surprising because student pilots could be expected to make more mistakes than experienced pilots while they are learning to fly. Flight instruction accidents were also less likely to be fatal. Only 13% of the flight instruction accidents that occurred in 2003 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 0.77 fatal accidents per 100,000 hours flown. The fatal accident rate for personal/business flying remained the highest in general aviation with 1.78 fatal accidents per 100,000 hours flown.

Flight Plan

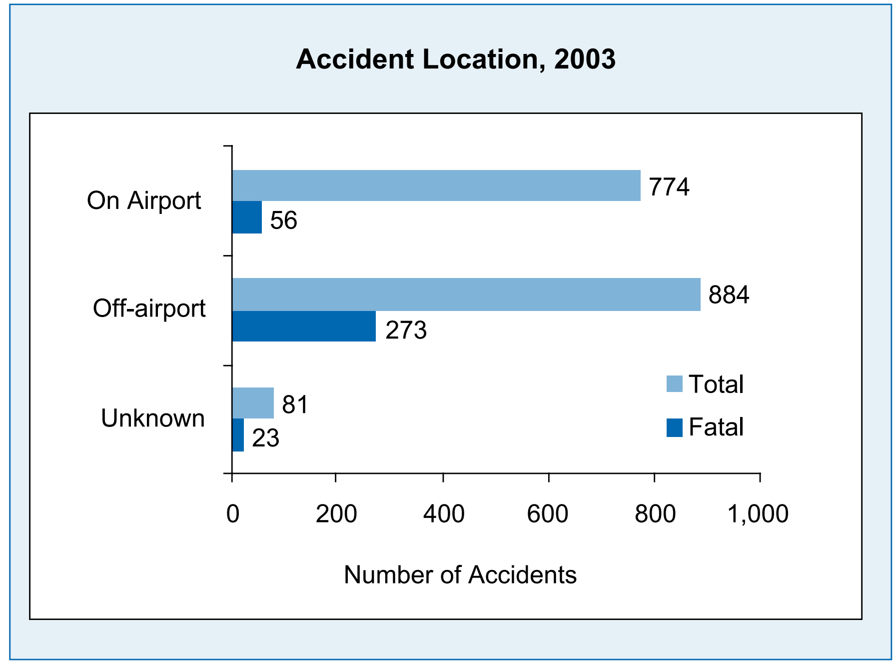
There were 1,758 pilots involved in general aviation accidents in 2003, and for 1,434 (82%) of those pilots, there was no record of filing a flight plan. In most cases, a flight plan is required only for flight under instrument flight rules (IFR). However, pilots operating under visual flight rules (VFR) on point-to-point flights have the option of filing a flight plan, which aids search and rescue efforts for pilots who fail to arrive at their intended destinations.

[24] FAA, *GAATA Survey 2003*, available at http://www.faa.gov/data_statistics/aviation_data_statistics/general_aviation/CY2003/.



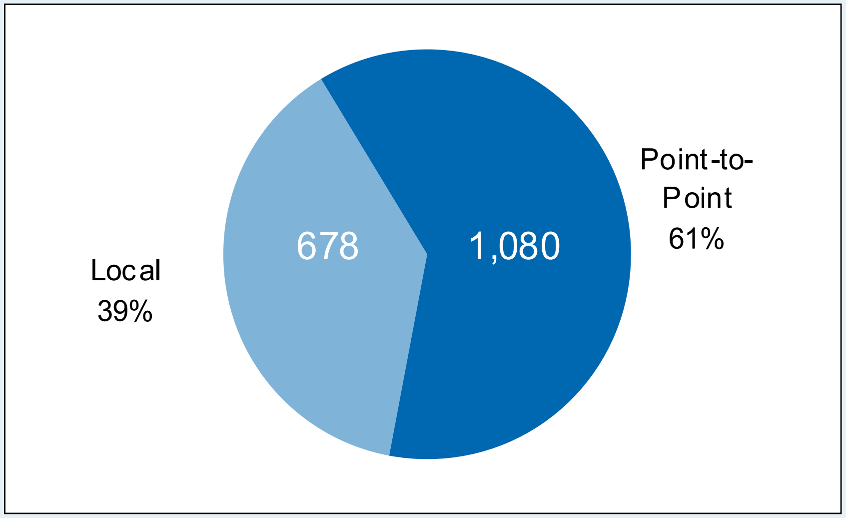
Airport Involvement

Aircraft accident locations were closely split between those occurring on airport property (45%) and those occurring away from an airport (51%). Comparing accident risk based on location is difficult because of the exposure differences among different operations and aircraft types. For example, a single-engine piston aircraft used for instructional flights will spend a large percentage of its operating time near an airport while a jet aircraft used for corporate transportation will not. However, a relationship can be observed between the location and severity of accidents. Accidents on or near an airport or airstrip typically involve aircraft operating at relatively low altitudes and airspeeds while taking off, landing, or maneuvering to land. 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 2003 (78%) were located away from an airport or airstrip.



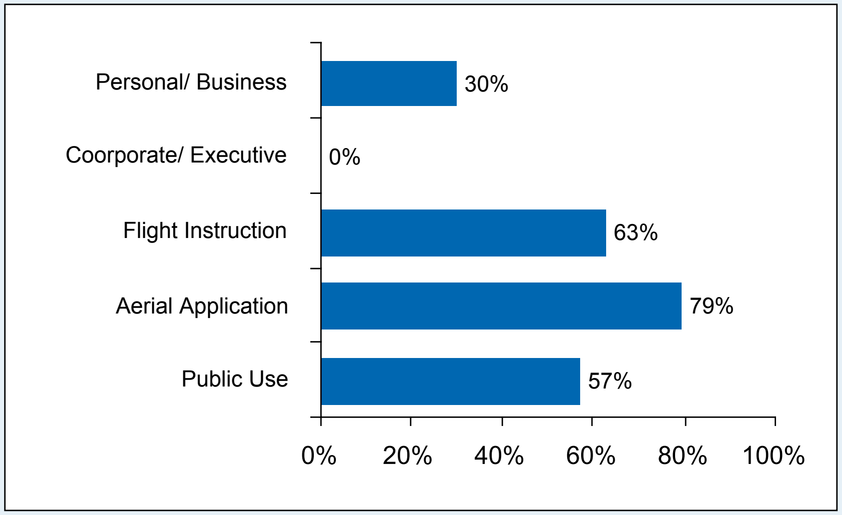
Another distinction that can be drawn between flight profiles is between local and point-to-point operations. A local flight is one that departs and lands at the same airport, and a point-to-point flight is one that lands at an airport other than the one from which it departed. Typical local flight operations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

Local and Point-to-Point Flights, 2003



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 graph shows that most personal/business flights were point-to-point, while most instructional flights were local. Corporate/executive transportation and aerial application operations were also inversely proportionate, with 100% of corporate flights being point-to-point and 79% of aerial application flights being local.

Percentage of Local Flights by Type of Accident Operation, 2003



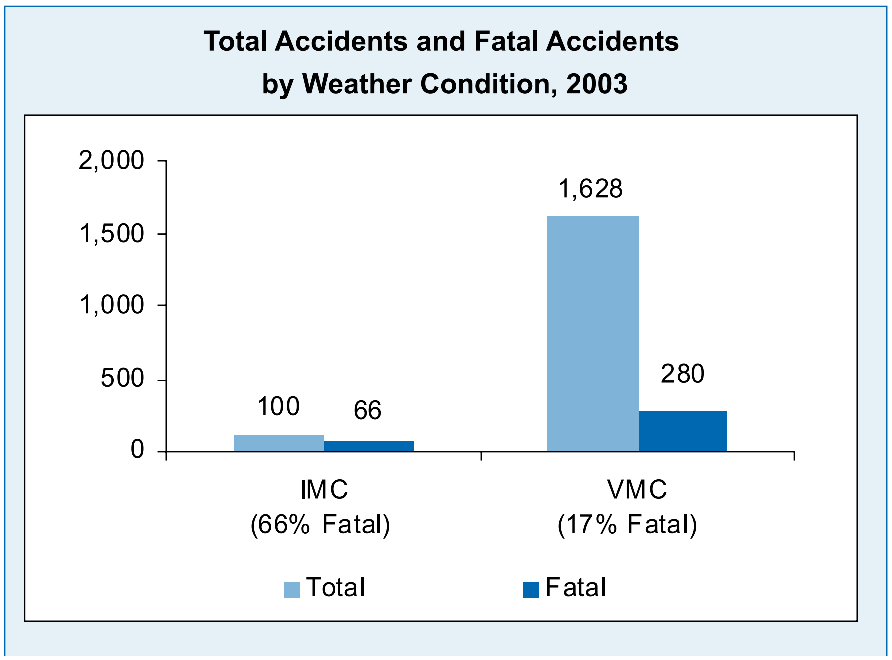
Environmental Conditions

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[25] for flight in instrument meteorological conditions (IMC). According to the FAA *Pilot/Controller Glossary*,[26] "instrument meteorological conditions" are defined as "meteorological

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

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

conditions expressed in terms of visibility, distance from cloud, and ceiling less than the minima[27] specified for Visual Meteorological Conditions (VMC)." Weather minima differ based on altitude, airspace, and lighting conditions, but 3 statute miles visibility and a cloud clearance of 1,000 feet above, 500 feet below, and 2,000 feet horizontal distance is typical. The following chart illustrates the percentage of accidents and fatal accidents that occurred in VMC and IMC. A comparison of the percentages of accidents in each weather condition that resulted in a fatality illustrates the hazards associated with flight in IMC. In 2003, only 17% of the accidents that occurred in visual conditions resulted in a fatality, but 66% of accidents in instrument conditions were fatal.

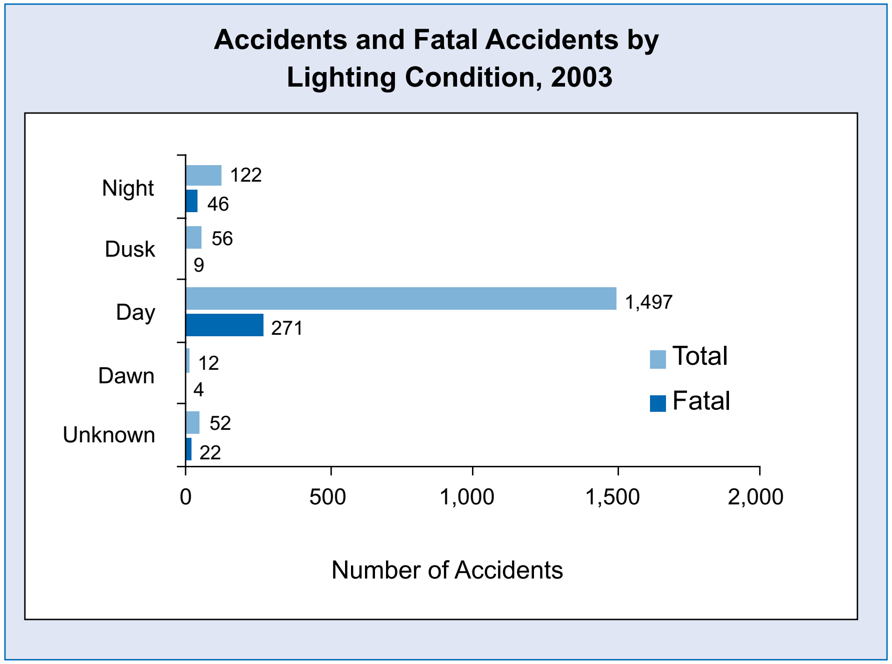


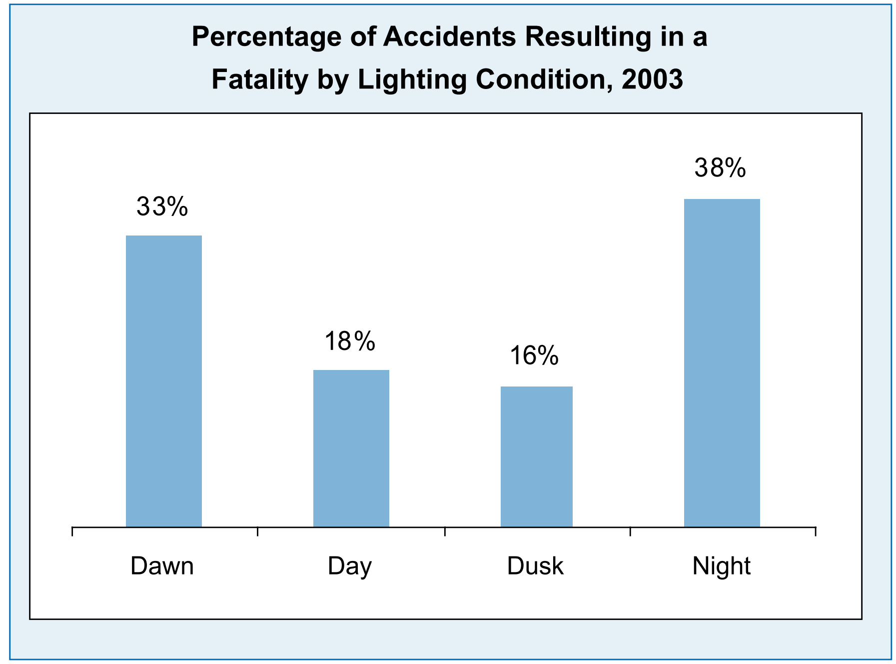
Although instrument conditions were present for only 6% of all accidents, 19% of fatal general aviation accidents in 2003 occurred in IMC. One reason for the disproportionate number of fatal accidents in IMC is that such accidents are more likely to involve pilot disorientation, loss of control, and collision with terrain or objects—accident profiles that typically result in high levels of damage and injury. Instrument conditions may also contribute to accident severity by further complicating situations that might be more easily handled in visual conditions. For example, a forced landing due to an engine malfunction or failure, which might result in minor damage if it were to occur in visual conditions, might pose an even greater threat to a pilot flying in instrument conditions because reduced visibility would make the selection of a suitable landing site more difficult.

Lighting Conditions

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

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





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 that result in higher levels of injury. The reduction in visual cues at night also hinders pilots from identifying deteriorating weather conditions and further complicates their ability to deal with any aircraft equipment malfunctions. For additional information about the safety issues associated with night flying, refer to the special topic section of this report for a more detailed discussion of night accidents.

Injuries and Damage for 2003

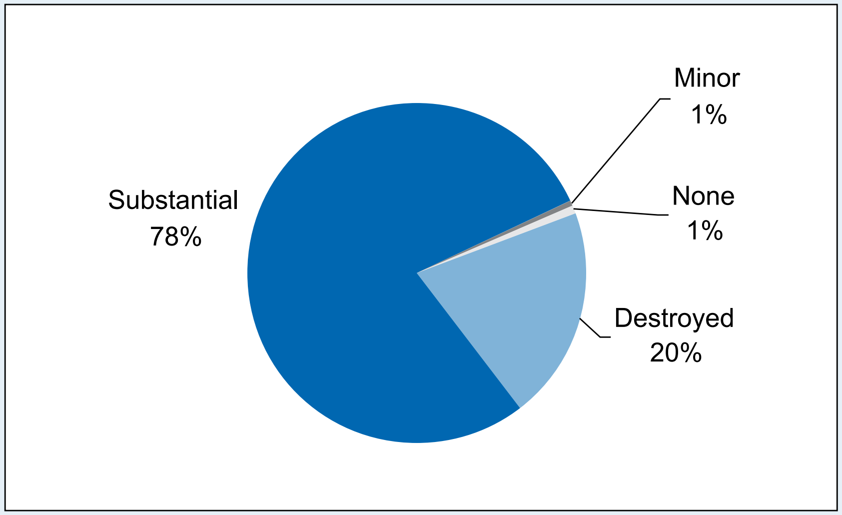
Aircraft Damage

Safety Board 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,[28] and "minor" damage as any damage that is not classified as either "destroyed" or "substantial."

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

Nearly 8 of every 10 aircraft involved in accidents during 2003 sustained substantial damage, and about 1 in 5 accident aircraft was destroyed. "Minor" and "no damage" classifications together comprised about 1% of accident aircraft.

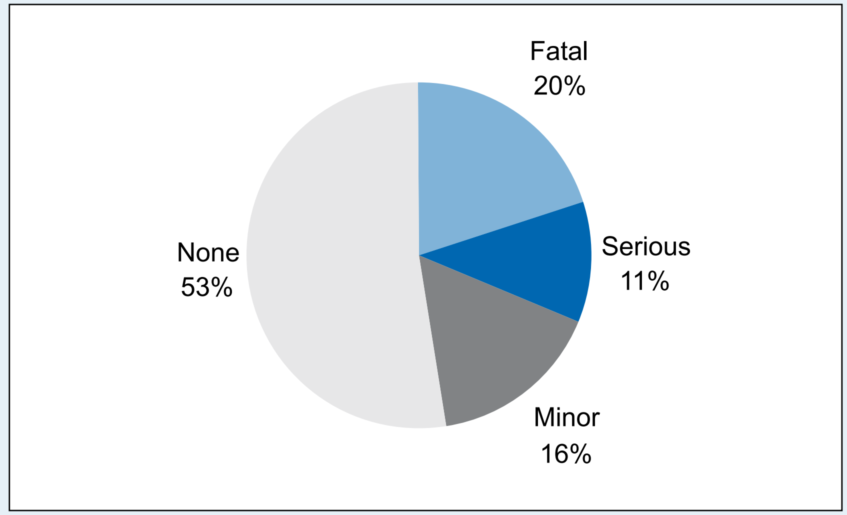
Damage to Accident Aircraft, 2003



Accident Injuries

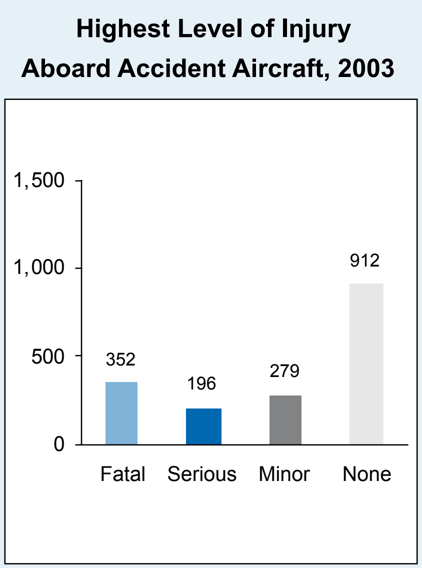
In accordance with 49 CFR 830.2, Safety Board investigators categorize general aviation injuries as "fatal," "serious," or "minor." A fatal injury is defined as "any injury which results in death within 30 days of the accident." Title 49 CFR 830.2 also outlines several qualifications[29] of serious injury that include, but are not limited to, hospitalization for more than 48 hours, bone fracture, internal organ damage, or second- or third-degree burns. The following graph depicts the percentage of general aviation accidents resulting in each level of injury during 2003. Most notable is the fact that more than half the accidents did not result in injury.

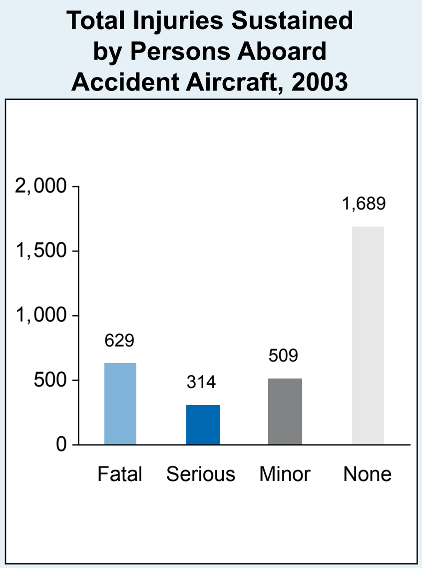
Highest Level of Accident Injury, 2003



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

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





Injuries by Role for 2003

The following table presents detailed information about the types of injuries incurred by all persons involved in general aviation accidents during 2003. The distribution of injuries varies with the type of operation and the size of aircraft, and the number of injuries experienced by any group of persons varies with their level of activity (that is, their exposure to risk). For example, all aircraft have a pilot, but not all have passengers on board.

General Aviation Accident Injuries, 2003

Personal Injuries	Fatal	Serious	Minor	None	Total
Pilot	338	166	284	970	1,758
Copilot	19	14	9	37	79
Flight instructor	14	4	6	24	48
Dual student	11	8	15	62	96
Check pilot	1	2	1	6	10
Other crew	6	4	7	15	32
Passenger	240	116	187	575	1,118
Total aboard	629	314	509	1,689	3,141
On ground	3	10	13	0	26
Other Aircraft	0	0	1	8	9
Total	632	324	523	1,697	3,176

In 2003, 543 passengers suffered some level of injury in general aviation accidents, compared to the 830 pilots and copilots who were injured. Pilots sustained the highest percentage of injuries in general aviation accidents in 2003, suffering 53% of all fatalities, 51% of all serious injuries, and 54% of all minor injuries.

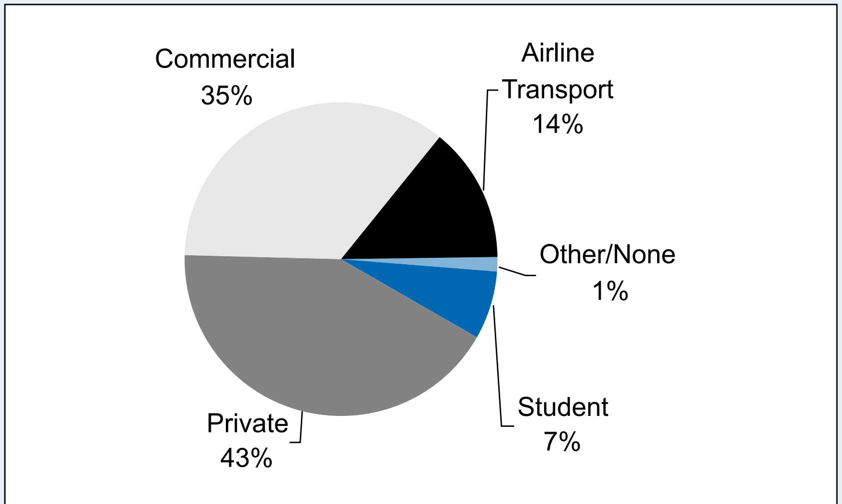
In addition to injuries sustained by persons on board the accident aircraft, 26 persons on the ground sustained injuries as a result of general aviation accidents. For example, one person was killed and eight were seriously injured when an aircraft hit an apartment building after losing control in IMC, a person operating a jet ski was seriously injured after being struck by the float of a landing seaplane, and six people sustained minor injuries when the wreckage of two single-engine aircraft fell on a residential neighborhood after a midair collision.

Accident Pilots

Rating

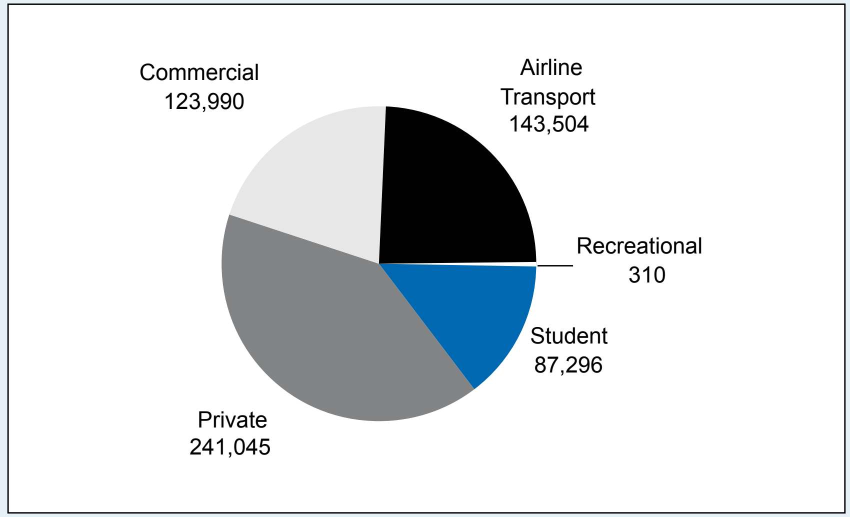
Of the 1,758 pilots involved in general aviation accidents in 2003, the largest percentage held a private pilot certificate.[30] The second-largest percentage held a commercial pilot certificate, which is required for any person to act as pilot-in-command of an aircraft for compensation or hire.[31]

Highest Certificate Held by Accident Pilot, 2003



When compared to the number of active pilots in 2003 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 35% of all general aviation accidents in 2003.

Number of Active Pilots by Highest Certificate, 2003

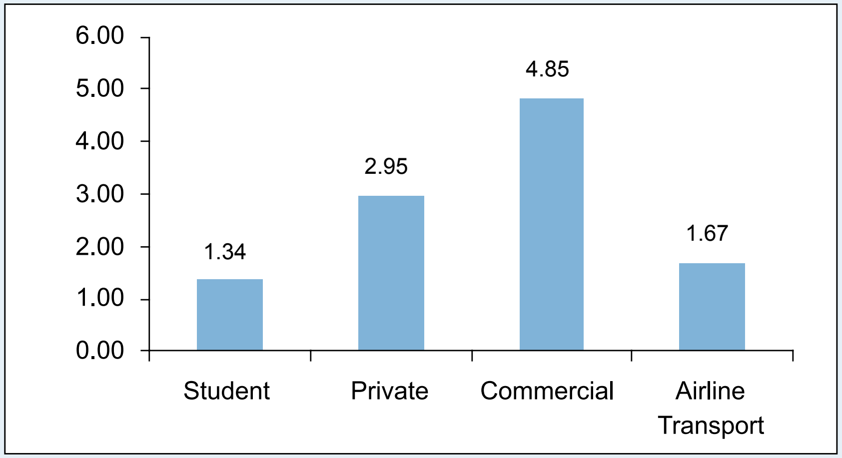


Similarly, the per-pilot accident rate was highest for commercial pilot certificate holders during 2003, with 4.85 accidents per 1,000 active pilots. One possible explanation for the higher numbers of accidents is that commercial certificate holders may be employed as pilots and would therefore be likely to fly more hours annually than student or private pilots. However, more than one-third of commercial pilots involved in accidents during 2003 (35%) were conducting personal flights and were not involved in commercial operations at the time of the accidents.

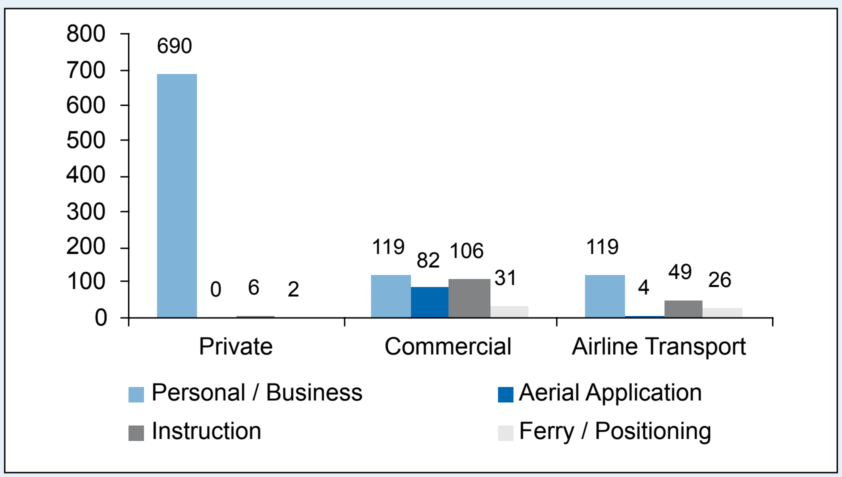
[30] FAA, *U.S. Civil Airmen Statistics*, 2003.

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

Accident Rate per 1,000 Active Pilots by Certificate, 2003



Type of Operation Conducted by Accident Pilot Certificate, 2003



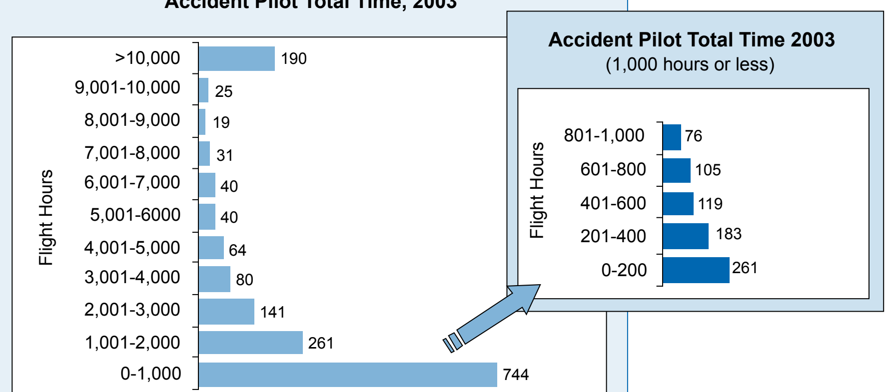
(1,693 of accident pilot records with data available, 2003)

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

Total Time

For the 1,635 accident pilots for which total flight experience data are available, 46% involved pilots with a total flight time of 1,000 hours or less. The following chart depicts the distribution of experience among accident pilots. The inset focuses on those pilots with less than 1,000 total 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 16% of accident pilots had 200 hours of flight experience or less.

Accident Pilot Total Time, 2003

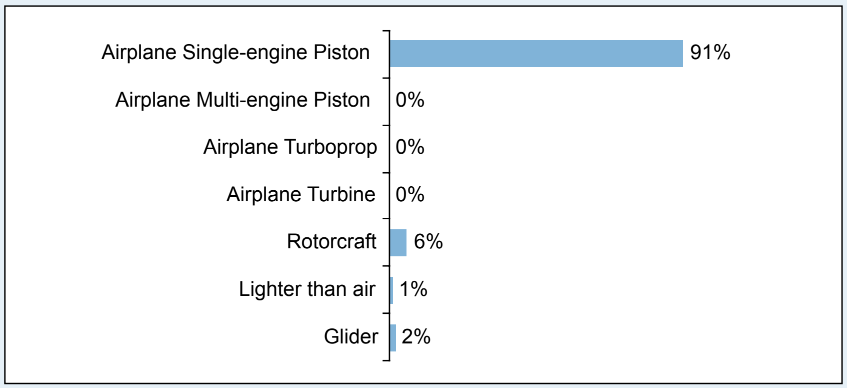


(1,635 accident pilot records with total flight time information)

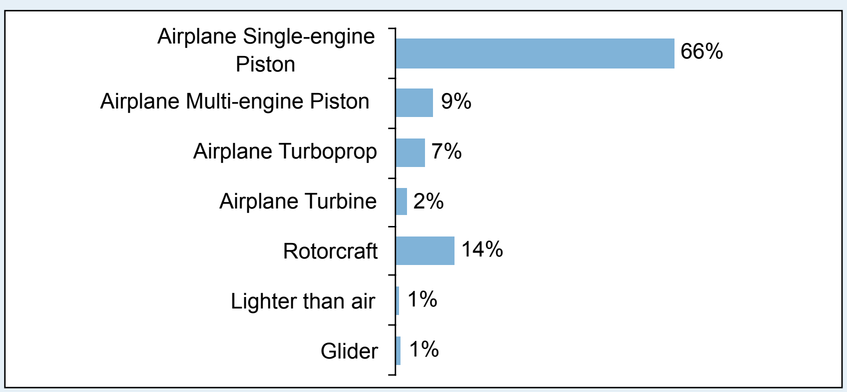
[32] FAA, *U.S. Civil Airmen Statistics*, 2003.

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 the list includes a more diverse selection of aircraft, multi-engine piston, turboprop, and turbine-powered airplanes, and more than twice as many who were flying rotorcraft.

Type Aircraft Flown by Accident Pilots With 200 or Less Hours Total Flight Time, 2003



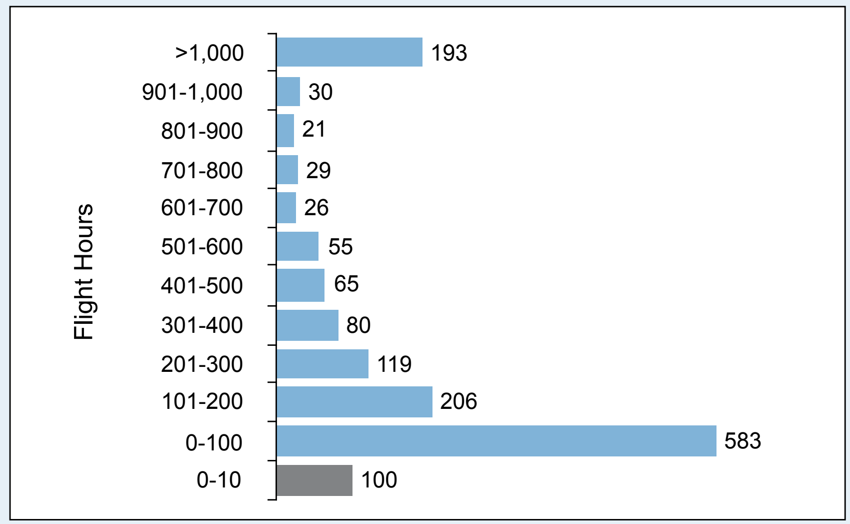
Type Aircraft Flown by Accident Pilots with More than 1,000 Hours Total Flight Time, 2003



Time in Type of Aircraft

Of the 1,407 accidents in 2003 for which pertinent data are available, 41% involved pilots with 100 hours or less of time in the accident aircraft make and model. Of those, 100 pilots (7% of all accident pilots for whom data are available) had less than 10 hours in type. Most accident pilots with less than 10 hours of flight time in make and model were flying single-engine piston aircraft.

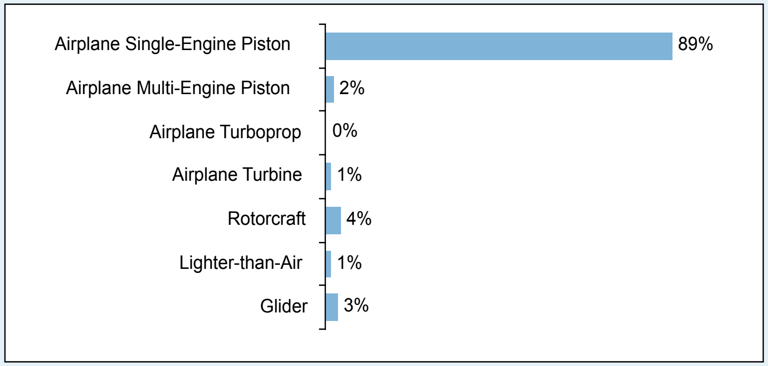
Accident Pilot Total Time in Aircraft Type, 2003



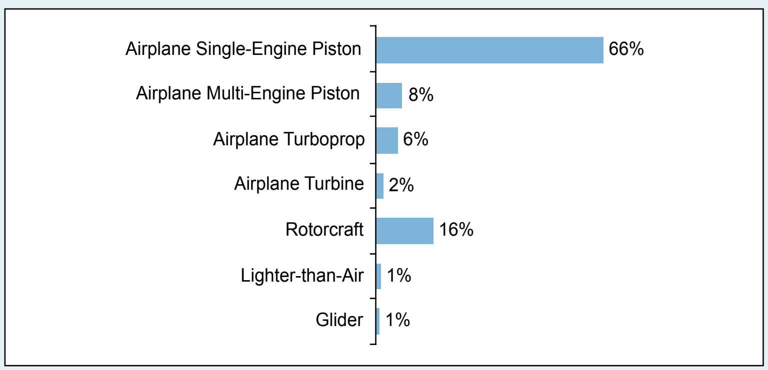
(1,407 accident pilot records with time in aircraft type information)

Pilots may have low time in type because they are new pilots with low total time or they are experienced pilots who are transitioning to a new aircraft. Two groups of pilots who might be expected to have accumulated significant time in make and model are those who own their own airplanes and fly them often and professional pilots who fly the same aircraft often. A large number of general aviation pilots who own aircraft have single-engine piston airplanes. Helicopters and multi-engine piston, jet, and turboprop airplanes are more likely to be operated by professional pilots. Although not specifically detailed in the chart, it is particularly worth noting that 38 of the 100 accident pilots in 2003 who had less than 10 hours in the accident aircraft type were operating amateur-built aircraft.

Type Aircraft Flown by Accident Pilots With 10 or Less Hours in Accident Aircraft Type, 2003



Type Aircraft Flown by Accident Pilots With More than 200 Hours in Accident Aircraft Type, 2003

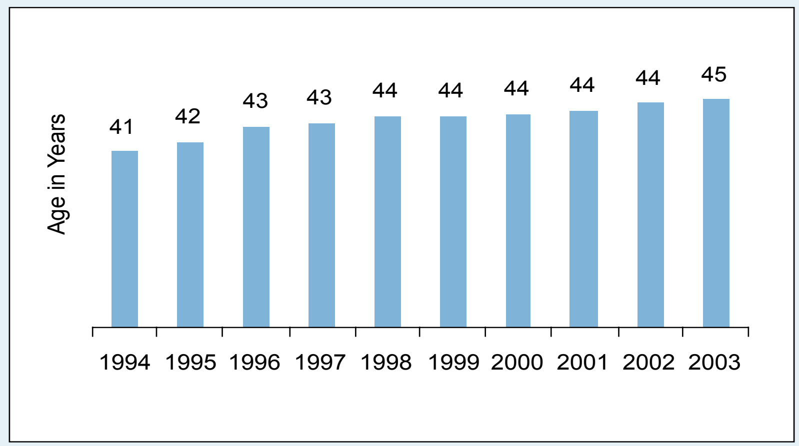


Comparison of these two graphs shows that accident pilots with more than 200 hours in make and model were more likely than pilots with fewer hours in type to be flying rotorcraft or multi-engine piston, jet, or turboprop airplanes.

Age

The average age of all active pilots in the U.S. increased steadily from 1994 through 2003 and by 2003 was 45 years.[33] In contrast, the average age of general aviation accident pilots was 51. 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.

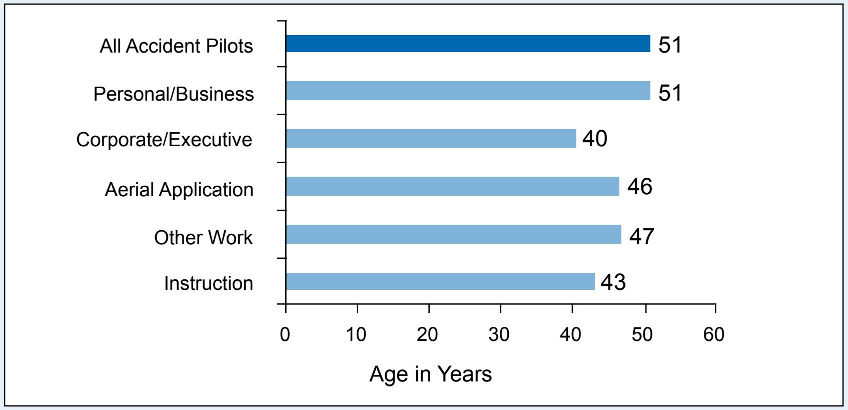
Average Age of Active Pilots 1994-2003



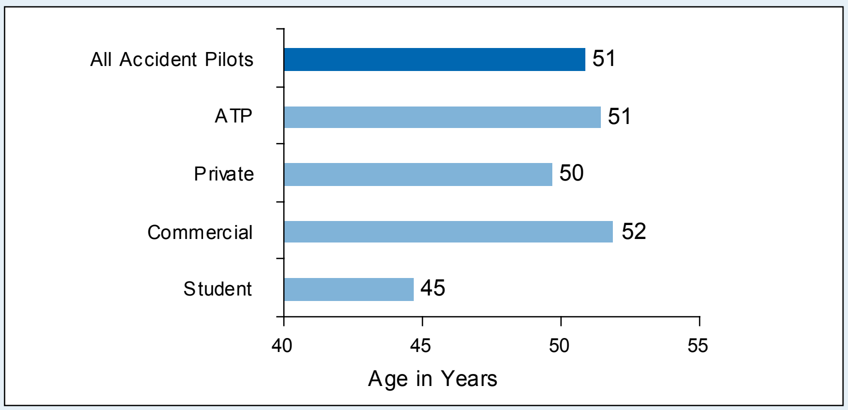
[33] FAA, *U.S. Civil Airmen Statistics*, 2003.

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

Average Age of Accident Pilot By Type of Operation, 2003



Average Age of Accident Pilot By Highest Pilot Certificate, 2003



Accident Occurrences for 2003

Safety Board accident reports document the circumstances of an accident as "accident occurrences" and the "sequence of events." Occurrence data can be defined as *what* happened during the accident. A total of 54 occurrence codes are available to describe the events for any given accident.[34] 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 1,695 accident aircraft in 2003 for which data are available, 1,345 cited 2 or more occurrences, 707 cited 3 or more, 117 cited 4 or more, 11 cited 5 or more, and 1 cited a total of 6.

The excerpt from a brief report shown here, which is for a 2003 accident with three occurrences, illustrates how an accident with multiple occurrences is coded. In this accident, the pilot was flying to a remote mountain airstrip when a witness saw the aircraft make a wrong turn into a dead-end canyon. The aircraft impacted trees while the pilot was attempting to reverse course. The pilot subsequently lost control of the airplane, and it impacted terrain. Each of these occurrences was coded in order, as shown.

Example of Occurrence Findings Cited in an NTSB Accident Brief, 2003

Occurrence #1: IN FLIGHT COLLISION WITH OBJECT
Phase of Operation: MANEUVERING

Occurrence #2: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: DESCENT - UNCONTROLLED

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

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

Occurrence data do not include specific information about why an accident may have happened; the first occurrence can instead be considered the first observable link in the accident chain of events. The following table displays first occurrences for all year-2003 general aviation accident aircraft with sequence of events data available. To simplify the presentation of accident occurrence data, similar occurrences are grouped into eight major categories.

General Aviation Accident First Occurrences, 2003

First Occurrences	Total	Fatal
Collision – In-flight	254	82
In-flight Collision with Object	141	40
In-flight Collision with Terrain/Water	76	30
Midair Collision	20	12
Undershoot	17	0
Near Collision Between Aircraft	0	0
Noncollision – In-flight	443	166
Loss Of Control - In-flight	247	95
Airframe/Component/System Failure/Malfunction	94	16
In-flight Encounter with Weather	87	51
Abrupt Maneuver	11	3
Vortex Turbulence Encountered	3	1
Altitude Deviation, Uncontrolled	1	0
Forced Landing	0	0
Decompression	0	0
Collision – On-ground or Water	89	5
On Ground/Water Collision with Object	35	1
On Ground/Water Encounter with Terrain/Water	31	1
Collision Between Aircraft (Other Than Midair)	16	2
Dragged Wing, Rotor, Pod, Float or Tail/Skid	7	1
Noncollision – On-ground or Water	405	7
Loss of Control - On Ground/Water	229	2
Hard Landing	98	1
Overrun	50	2
Nose Over	11	0
Roll Over	5	0
Propeller/Rotor Contact to Person	5	2
Propeller Blast or Jet Exhaust/Suction	4	0
Nose Down	2	0
Ditching	1	0
On Ground/Water Encounter with Weather	0	0

First Occurrences (Cont.)	Total	Fatal
Power Related	446	52
Loss of Engine Power	182	22
Loss of Engine Power(Total) - Nonmechanical	131	18
Loss of Engine Power(Total) - Mech Failure/Malf	64	5
Loss of Engine Power(Partial) - Nonmechanical	37	6
Loss of Engine Power(Partial) - Mech Failure/Malf	19	1
Propeller Failure/Malfunction	8	0
Rotor Failure/Malfunction	5	0
Engine Tear-away	0	0
Landing Gear	29	0
Gear Collapsed	11	0
Wheels-up Landing	8	0
Main Gear Collapsed	4	0
Gear Retraction on Ground	3	0
Nose Gear Collapsed	2	0
Complete Gear Collapsed	1	0
Wheels-down Landing in Water	0	0
Tail Gear Collapsed	0	0
Other Gear Collapsed	0	0
Gear Not Extended	0	0
Gear Not Retracted	0	0
Miscellaneous	25	5
Miscellaneous/Other	19	5
Fire	3	0
Cargo Shift	2	0
Fire/Explosion	1	0
Hazardous Materials Leak/Spill	0	0
Explosion	0	0
Undetermined	4	4
Missing Aircraft	4	4
Undetermined	0	0

Among the eight major categories of first occurrences, the largest percentage of accidents (26%) included occurrences related to aircraft power. Among the individual occurrences, the most common involved a loss of control in flight (15%), followed closely by loss of control on the ground (14%). Although occurrences involving loss of aircraft control on the ground resulted in only 2 fatal accidents in 2003, loss-of-control occurrences in flight resulted in a total of 95 fatal accidents—more than one-quarter of all fatal accidents and more than twice that of any other single occurrence.

Phase of Flight

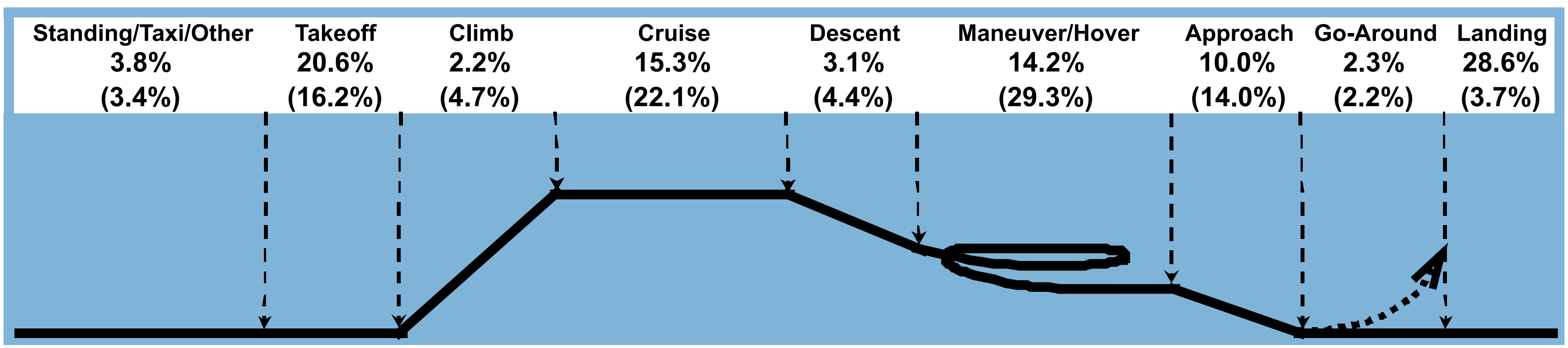
The following illustration displays the percentage of accident aircraft in each phase of flight at the time of the first occurrence. The phase of flight can be defined as when, during the operation of the aircraft, the first occurrence took place. Fifty distinct phases of flight are used to describe the operational chronology of occurrences. To simplify the presentation of this information, the detailed phases are grouped into the nine broad categories shown in this illustration. For example, the category "approach" includes any segment of an instrument approach or position in the airport traffic pattern and continues until the aircraft is landing on the runway. The upper set of numbers 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 in the illustration, almost half of all general aviation accidents (49%) occurred during either takeoff or landing, despite the relatively short duration of these phases compared to the entire profile of a normal flight. The high number of accidents that occurred during takeoff and landing reflects the increased workload placed on both the flight crew and the aircraft during these phases. During both takeoff and landing, the flight crew must control the aircraft, change altitude and speed, communicate with air traffic control (ATC) and/or other aircraft, and maintain separation from obstacles and other aircraft. Aircraft systems are also stressed during takeoff and landing with changes to engine power settings, the possible operation of retractable landing gear, flaps, slats, and spoilers, and changes in cabin pressurization. While the aircraft is at low altitude during takeoff and landing, it is also most susceptible to hazards caused by wind and weather conditions.

Notably, landing accounted for the largest percentage of total accident first occurrences (29%) of any single phase but only 4% of fatal accident first occurrences. The combination of the cruise and maneuvering phases accounted for about half (51%) of fatal accident first occurrences, but less than one-third (29%) of all accidents. These differences reflect the relative severity of accidents that are 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.

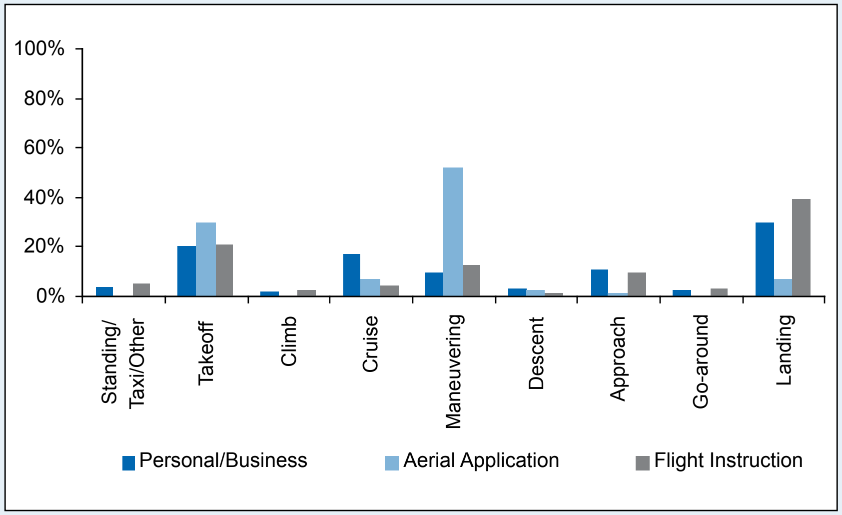
The likelihood of an aircraft accident first occurrence during each phase of flight varies by aircraft type and type of operation due to the unique hazards associated with each. For example, flight instruction typically involves a lot of time spent practicing takeoffs and landings. As a result, about 39% of all first occurrences for 2003 accidents involving instructional flights occurred during landing compared to 29% of personal/business flights and 7% of aerial application flights.

Accident Aircraft Phase of Flight During First Occurrence, 2003

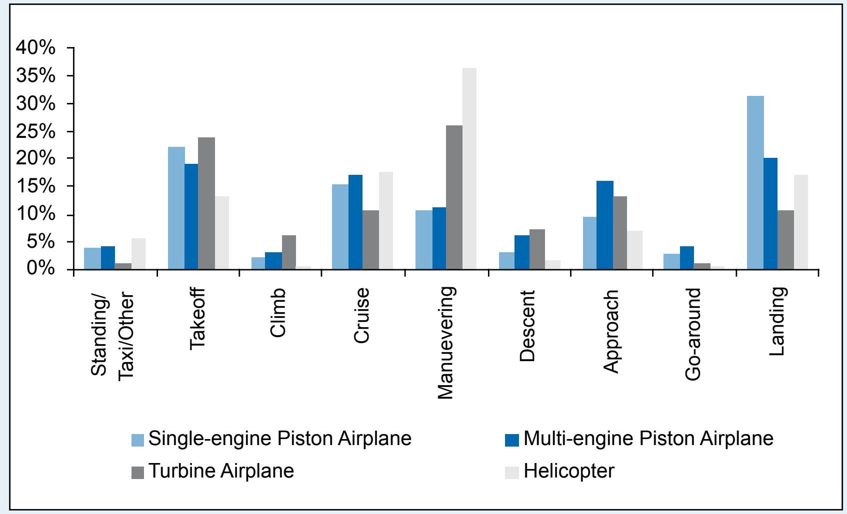


1,695 accident aircraft with phase of flight data

Accident Aircraft Phase of Flight During Accident First Occurrence by Type of Operation, 2003



Accident Aircraft Phase of Flight During Accident First Occurrence by Aircraft Type, 2003



Accident phase-of-flight differences among aircraft types are the result of the amount of time spent in each phase, aircraft-specific hazards associated with that phase, and the type of operations typically conducted with that aircraft. For example, the largest percentage of first occurrences for accidents involving helicopter flights, about 37%, occurred while maneuvering. The percentage of accidents during this phase reflects the hazards unique to helicopters while hovering and during operations that are unique to helicopters, such as carrying external loads. In contrast, the largest percentage of accidents involving single-engine piston aircraft occurred during landing. Takeoff accounted for 20-25% of accidents involving airplanes, but only 13% 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 1,695 accidents that occurred during 2003 for which occurrence data are available, 405 unique combinations of accident occurrences were cited. The following tables, which list the top ten combinations of occurrences for all accidents and fatal accidents, illustrate the most common events.

Chain Of Occurrences - All General Aviation Accidents, 2003

Rank		Number of Accidents
1	1) Loss Of Control - In Flight 2) In Flight Collision With Terrain/water	157
2	1) In Flight Collision With Object	74
3	1) In Flight Collision With Terrain/water	67
4	1) Loss Of Control - On Ground/water 2) On Ground/water Encounter With Terrain/water	65
5	1) In Flight Collision With Object 2) In Flight Collision With Terrain/water	43
6	1) Hard Landing	42
7	1) Loss Of Control - In Flight 2) In Flight Collision With Object	39
8	1) Loss Of Engine Power 2) Forced Landing 3) In Flight Collision With Object	37
9	1) Loss Of Control - On Ground/water 2) On Ground/water Collision With Object	34
10	1) Loss Of Engine Power 2) Forced Landing 3) In Flight Collision With Terrain/water	32

The top ten occurrence chains cited in fatal accidents are similar to those cited for all accidents. Loss of control followed by in-flight collision with terrain or water tops both lists, with almost half those accidents being fatal. It is important to note that, although this was the most frequent chain of occurrences in 2003, it accounted for only 9% of all accidents for the year.

Chain Of Occurrences - Fatal General Aviation Accidents, 2003

Rank		Number of Accidents
1	1) Loss Of Control - In Flight 2) In Flight Collision With Terrain/water	71
2	1) In Flight Collision With Terrain/water	30
3	1) In Flight Collision With Object	17
4	1) In Flight Collision With Object 2) In Flight Collision With Terrain/water	17
5	1) In Flight Encounter With Weather 2) In Flight Collision With Terrain/water	17
6	1) In Flight Encounter With Weather 2) Loss Of Control - In Flight 3) In Flight Collision With Terrain/water	14
7	1) Loss Of Control - In Flight 2) In Flight Collision With Object	14
8	1) Loss Of Engine Power 2) Forced Landing 3) Loss Of Control - In Flight 4) In Flight Collision With Terrain/water	9
9	1) Airframe/component/system Failure/malfunction 2) Loss Of Control - In Flight 3) In Flight Collision With Terrain/water	8
10	1) Loss Of Control - In Flight 2) In Flight Collision With Object 3) In Flight Collision With Terrain/water	7

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 2003 did not involve catastrophic events, and a large number of accidents involved aircraft on the ground that resulted in minor or no injuries.

Most Prevalent Causes/Factors for 2003

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

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

Example of NTSB Accident Brief, 2003

Occurrence #1: MISCELLANEOUS/OTHER
Phase of Operation: MANEUVERING
Findings
1. (C) DOOR - NOT SECURED
2. (C) ALTITUDE/CLEARANCE - NOT MAINTAINED - PILOT IN COMMAND
3. DOOR - OPEN
4. (C) PREFLIGHT PLANNING/PREPARATION - INADEQUATE - PILOT IN COMMAND

Occurrence #2: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: EMERGENCY LANDING AFTER TAKEOFF
Findings
5. AIRCRAFT CONTROL - NOT MAINTAINED - PILOT IN COMMAND
6. DIVERTED ATTENTION - PILOT IN COMMAND

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: MANEUVERING
Findings
7. TERRAIN CONDITION - GROUND

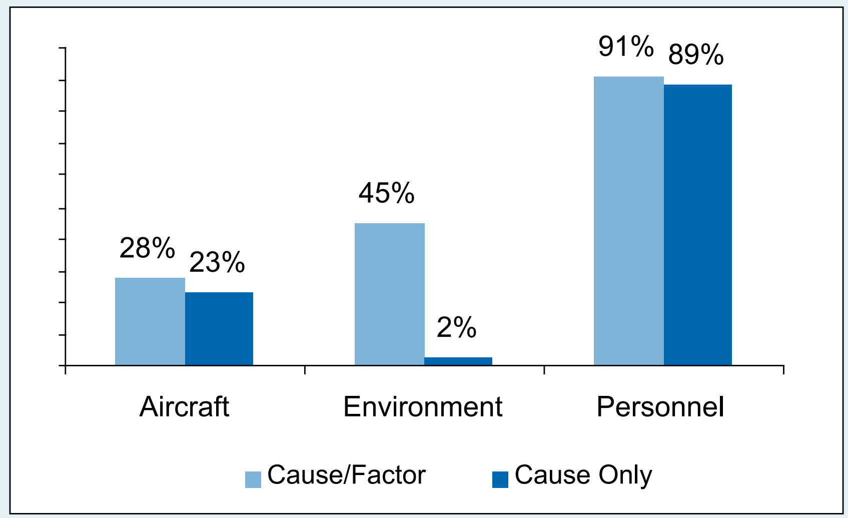
Findings Legend: (C) = Cause, (F) = Factor

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's inadequate preflight preparation in which he failed to secure the cabin door which diverted his attention and resulted in the failure to maintain directional control.

This accident happened just after takeoff, when the aircraft door opened in flight. The pilot attempted to return to the runway and make an emergency landing. While maneuvering to land, the pilot lost control of the airplane and began descending. The aircraft struck trees, power lines, and then impacted the ground. The investigation revealed that the airplane door had not been properly latched and locked prior to departure. In this accident, the unsecured door, the pilot's failure to maintain altitude in flight, and inadequate preflight preparation were cited as causes. The open door, the pilot's diverted attention, and the subsequent loss of aircraft control were all cited as findings but not assigned as a cause or factor.

To simplify the presentation of probable cause information in this review, the hundreds of unique codes used by investigators to code probable cause are grouped into broad cause/factor categories. This broad cause/factor classification provides an overview of fundamental accident origins by dividing all accident causes and factors into three groups: aircraft, environment, and personnel. The following graph shows the percentage of general aviation accidents that fall into each broad cause/factor classification. Personnel-related causes or factors were cited in 91% of the 1,677 general aviation accident reports for 2003 for which cause/factor data were available. Environmental causes/factors were cited in 45% of these accident reports, and aircraft-related causes/factors were cited in 28%.[35]

Accident Broad Cause/Factor and Cause, 2003



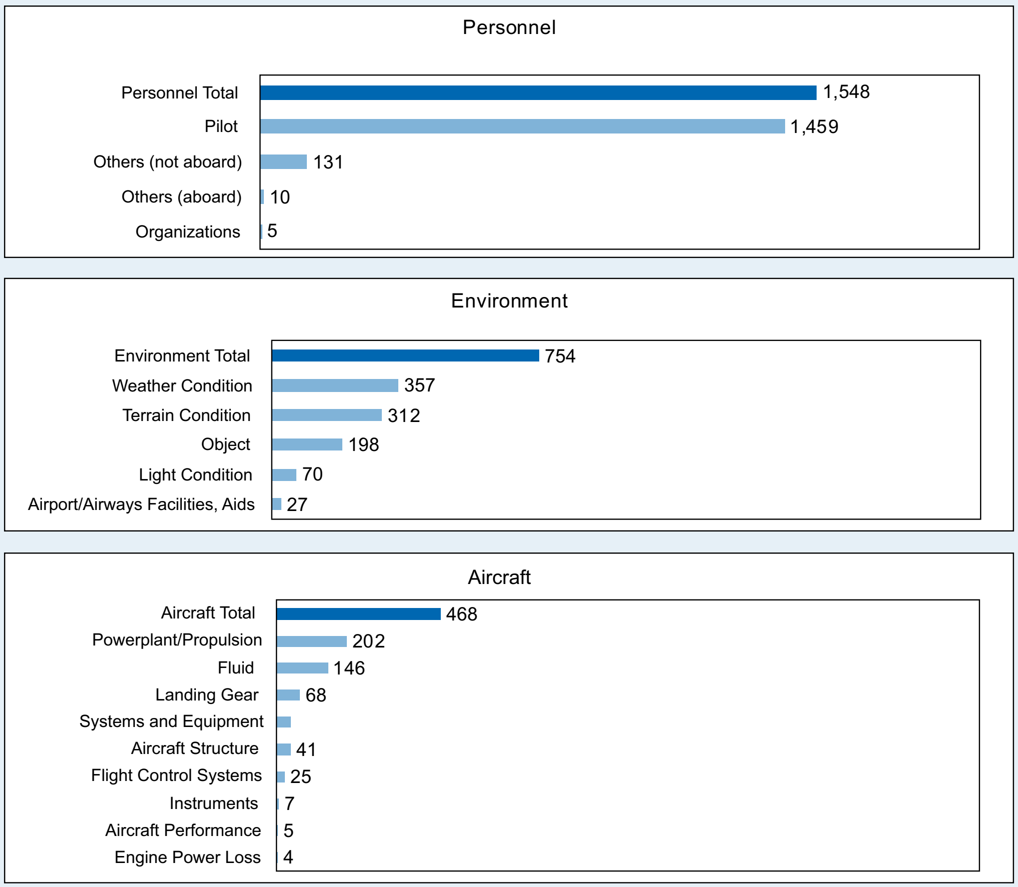
(1,677 accidents with findings)

Environmental conditions are rarely cited as an accident cause but are more likely to be cited as a contributing factor. In 2003, only 39 of 754 environmental citations (2% of all causes/factors cited) were listed as

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

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.

Summary of Findings Cited as Cause or Factor in General Aviation Accidents, 2003



(1,677 accidents with findings in 2003)

As mentioned previously, several hundred unique codes are available to document causes/factors, as summarized in the graph on this page.

As this graph shows, most causes and factors attributed to general aviation accidents in 2003 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.

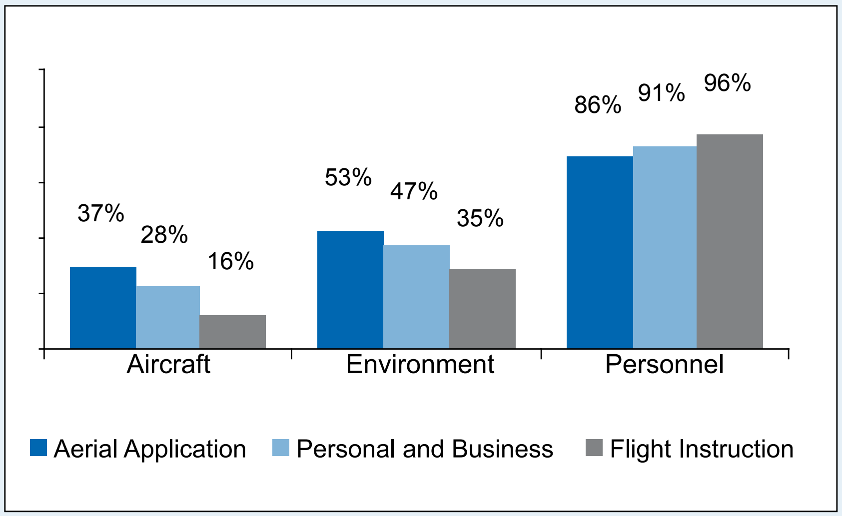
Although the pilot was the most frequently cited individual in the personnel category in 2003, other persons not aboard the aircraft were also cited as a cause or factor in 131 accidents. Such personnel included flight instructors, maintenance technicians, and airport personnel. In the broad category of environmental factors, weather conditions were cited in 357 (21%) of the accidents. Powerplant-related[36] causes/factors, cited in 202 (12%) 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 96% of instructional flight accidents and 91% of personal/business accidents, compared to 86% for aerial application accidents. The high percentage of personnel causes/factors for flight instruction accidents is likely the

[36] "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.

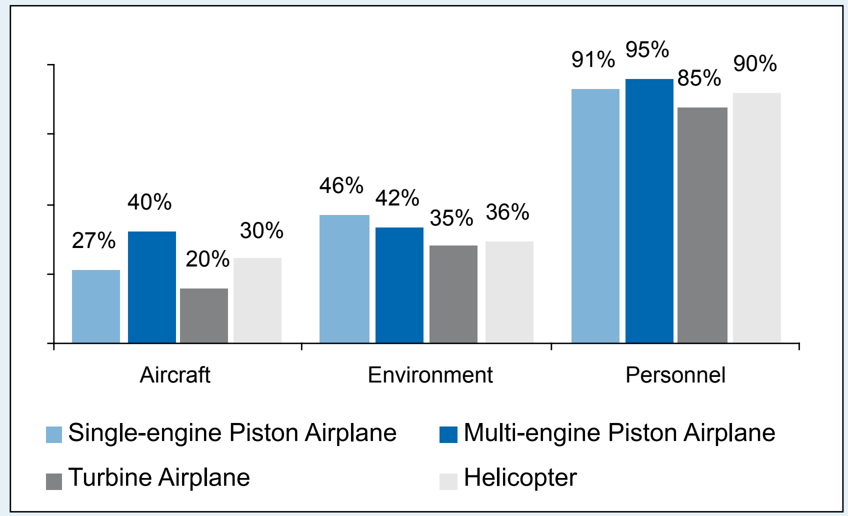
result of aircraft control and decision-making errors due to students' lower level of skill and ability, as well as the large amount of time practicing maneuvers like takeoffs and landings, which are more likely to result in accidents. In contrast, aerial application accidents cited a higher percentage 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.

Broad Causes/Factors by Type of Operation, 2003



A comparison of the causes/factors cited in accidents involving different types of aircraft reveals similar results. The higher percentage of multi-engine piston accidents that cited aircraft causes/factors in 2003 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. There is also a noticeable drop in the percentage of environmental causes/factor citations progressing from single- to multi-engine piston, and turbine airplane accidents, mirroring increases in the typical range, performance, and equipment capabilities of those aircraft.

Broad Causes/Factors by Accident Aircraft Type, 2003



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.

Human Performance and Explanatory Causes/Factors 2003

	All Accidents	Fatal Accidents
Human Performance Issues	1,431	285
Aircraft Handling/Control	1,012	227
Planning/Decision	530	125
Use of Aircraft Equipment	162	22
Maintenance	90	10
Communications/Information/ATC	62	12
Meteorological Service	8	8
Airport	2	1
Dispatch	0	0
Underlying Explanatory Factors	157	75
Qualification	51	19
Physiological Condition	46	42
Psychological Condition	40	15
Aircraft/Equipment Inadequate	11	2
Procedure Inadequate	8	1
Institutional Factors	5	2
Facility Inadequate	4	1
Information	2	2
Material Inadequate	2	1

Of the 1,431 accidents for which the cause or factor was attributed to human performance in 2003, the most frequently cited cause/factor was aircraft handling and control (71%), followed by planning and decision-making (37%) and use of aircraft equipment (11%). Issues related to personnel qualification were cited in about 32% of the 157 accidents with underlying explanatory factors related to human performance. Examples of qualification issues that were cited in the 2003 accident record included lack of total experience, lack of recent experience, and lack of certification.

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. Smaller aircraft are affected to a greater degree by adverse wind conditions; and precipitation, icing, and convective weather have a greater effect on aircraft that lack the speed, altitude, and/or range capabilities to avoid those conditions. Weather conditions cited most often as a cause or factor in general aviation accidents are related to winds, including "gusts," "crosswind," and "tailwind."

The top three environmental causes/factors cited in general aviation accidents in 2003 were all related to wind. Because aircraft are most susceptible to the effects of wind during takeoffs and landings, the effect of adverse wind was reflected in a high percentage of general aviation accidents that occurred during those phases of flight.

Accidents by Weather Cause/Factor

	All Accidents	Fatal Accidents
Weather Condition	357	91
Crosswind	94	4
Gusts	85	7
Tailwind	43	1
Low ceiling	38	33
High density altitude	30	4
Fog	22	17
High wind	22	10
Carburetor icing conditions	19	1
Clouds	19	17
Downdraft	14	3
Icing conditions	13	8
Unfavorable wind	9	0
Sudden windshift	8	0
Rain	8	7
Turbulence	7	3
Snow	4	1
Thunderstorm	4	1
Windshear	4	1
Variable wind	4	0
Turbulence (thunderstorms)	4	2
Temperature, low	3	0
Turbulence in clouds	3	1
Hail	3	1
No thermal lift	3	0
Mountain wave	2	2
Dust devil/whirlwind	2	0
Haze/smoke	2	1
Other	2	0
Turbulence, terrain induced	1	0
Whiteout	1	0
Updraft	1	0
Obscuration	1	1
Below approach/landing minimums	1	1
Drizzle/mist	1	1
Lightning	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 2003 were not fatal. The wind-related weather factors "crosswind," "gusts," and "tailwind" were cited as a cause/factor in 222 accidents, but only 12 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. The high number of fatal general aviation accidents occurring in low visibility weather led the Safety Board to conduct a safety study of these accidents.[37] Several of the weather-related accidents that occurred during 2003 were included in that study.

[37] National Transportation Safety Board, *Risk Factors Associated with Weather-Related General Aviation Accidents*, NTSB/SS-05/01 (Washington, DC: 2005)

Focus on General Aviation Safety: Night Flying

Recent general aviation accident data demonstrate that accidents that occur at night are more likely to be fatal than those that occur during the day. This section attempts to explain the risks associated with flying at night. To that end, this section includes statistical data and discusses safety issues related to general aviation operations at night. This section is not meant to be an exhaustive discussion of all the related safety concerns, but rather a discussion of the details of an issue important to the safety of general aviation pilots.

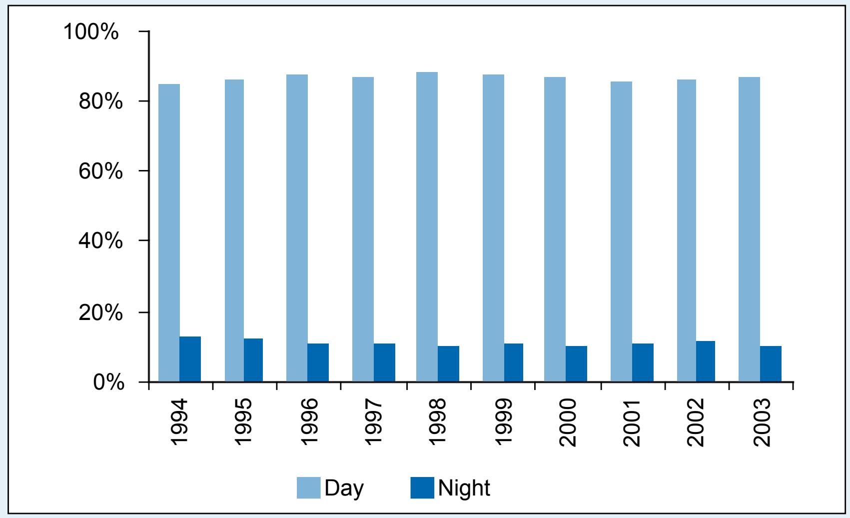
General Aviation Night Accident Statistics, 2003

All General Aviation Accidents	
Total Accidents	1,739
Fatal Accidents	352
Accident Aircraft	1,758
Night Accidents	
Total Accidents	178
Accident Aircraft	179
Night Accidents by Injury Level	
Fatal	55
Serious	24
Minor	29
None	70
Number of Accident Injuries	
Fatal	104
Serious	45
Minor	66
Persons aboard with no injuries	168
Night Accident Aircraft Damage	
Destroyed	52
Substantial	121
Minor	2
None	4

Historical Record of Night Accidents

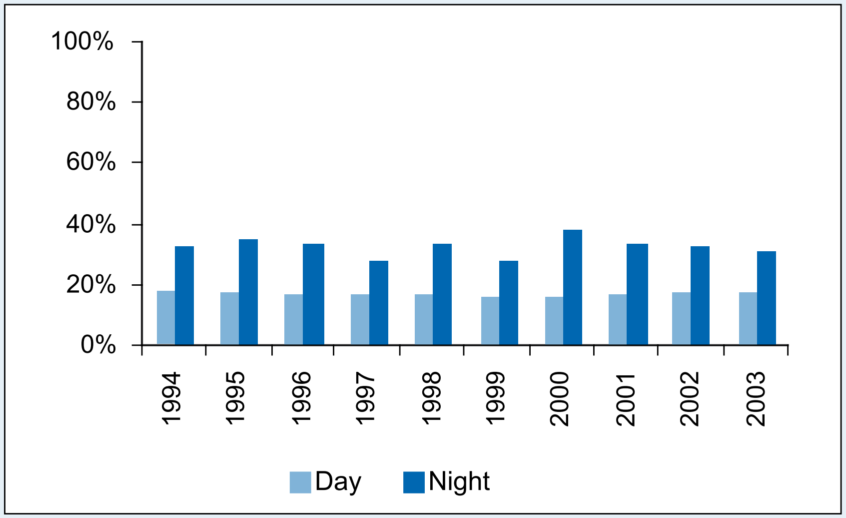
Each year between 1994 and 2003, an average 11% of general aviation accidents occurred at night. Estimates of the distribution of general aviation flight hours based on the FAA general aviation activity survey[38] suggest that accidents are proportionate to activity, with an estimated 12% of general aviation hours flown at night. However, each year, an average 33% of night accidents were fatal, making them almost twice as likely to be fatal as accidents that occurred during the day. Reasons for the increased risk include the effects of darkness on the pilot's ability to see and avoid obstacles and the increased difficulty of safely responding to emergency situations.

Percentage of General Aviation Accidents Occurring Day and Night, 1994-2003



[38] Data were provided by the FAA, Office of Accident Investigation, using results from the newly revised, 2004 *General Aviation and Air Taxi Activity and Avionics Survey*. Estimates of the day/night distribution of activity were calculated from survey responses, excluding those from aircraft owners who reported having flown any time in 14 CFR Part 135 operations.

Percentage of General Aviation Accidents Resulting in a Fatality by Day and Night, 1994-2003



What Is Night?

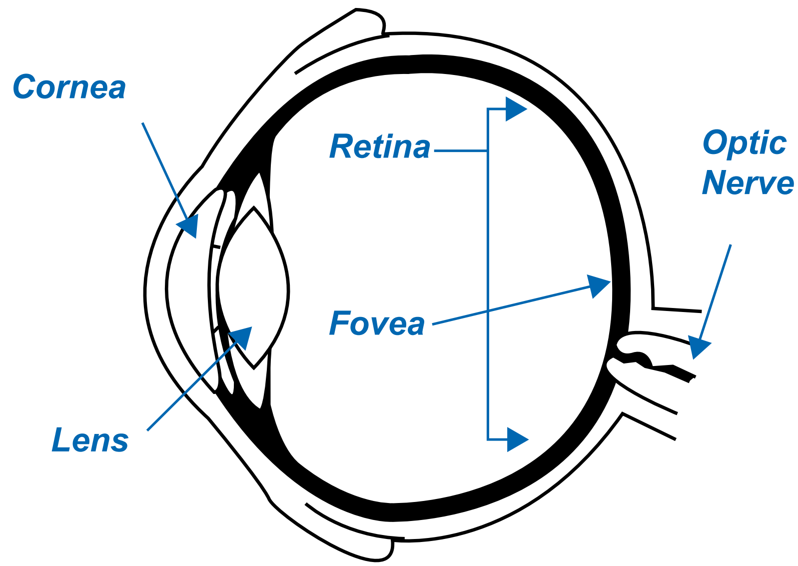
In 14 CFR Part 1, the FAA defines night as "the time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time." Civil twilight is defined as the time at which the sun is 6 degrees below the horizon, roughly 30 minutes before sunrise and 30 minutes after sunset. This definition applies to most night-related regulatory requirements, such as required minimum aircraft equipment, VFR weather minimums, logging of flight time, and required fuel reserves.

Rather than using a simple day/night distinction, Safety Board investigations record lighting conditions at the time of an accident as one of the following: dawn, day, dusk, and night, with the additional classifications of dark night and bright night. For purposes of clarity, the data presented in this section will be limited to the day/night classification.[39]

Light Condition's Influence on Vision

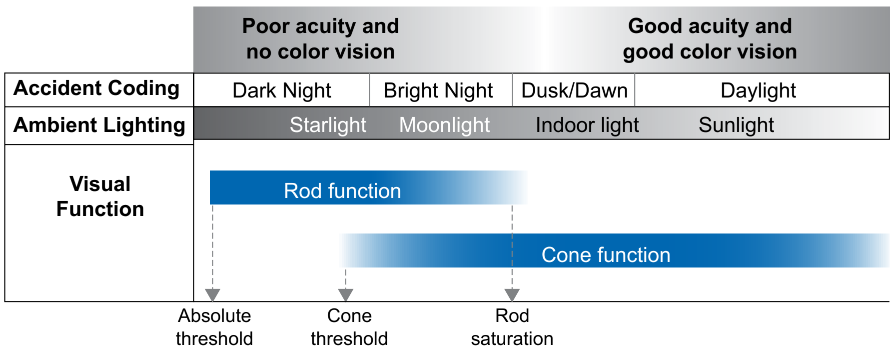
Many of the human performance difficulties associated with night flying begin with the structure and function of the human visual system, and the corresponding effects of low-light conditions on a pilot's visual perception. To better explain those human performance issues, this section includes a brief overview of the visual system.

Light enters the eye through the pupil, passing through the cornea and lens, which together focus light on the inside surface of the back of the eye, called the retina. The retina contains about 125 million light-sensitive photoreceptor cells that convert light from a visual scene into neural impulses.



[39] For the purposes of this section, "day" includes the Safety Board reporting categories of "dawn" and "day," and "night" includes Board reporting categories "dusk," "night," "bright night," and "dark night," unless otherwise specified.

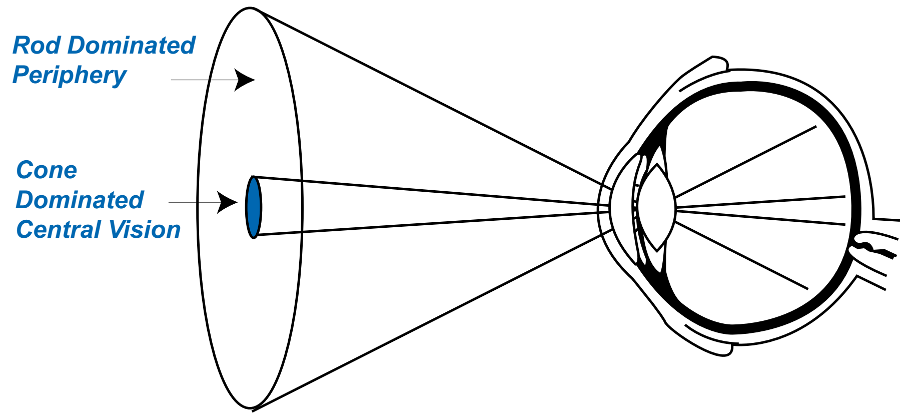
The human visual system is able to function over an extreme range of light conditions from sunlit day to starlit night. This range is possible because the retina includes two distinct types of photoreceptors—cones and rods—that interact dynamically based on ambient light levels. Because cones and rods differ in size, shape, and response, and in the way they interact, cones mediate visual function in bright light conditions, and rods mediate visual function in low light conditions. At intermediate light levels, both systems operate together and the resulting visual function shares qualities of both systems.



Pilots should be aware that their ability to read text, identify objects and terrain features, and perceive color are all impaired in low light conditions.

Cones are mostly concentrated in the part of the retina associated with the central field of vision, called the fovea. Cone cells include three additional subtypes that are sensitive to different wavelengths of light—what we perceive as red, green, and blue—which allow for color vision. Rods are more abundant than cones and are distributed throughout the remaining area of the retina. Unlike cones, rods provide no color information.

Cones are smaller in both diameter and length than rods, allowing room for more cone cells in a smaller area, which results in higher visual acuity. Rods tend to be larger and accumulate light over a longer period of time than cones, making them more sensitive in low-light conditions because they are more likely to absorb enough light to stimulate a response.



Pilots should modify their scanning technique in dark conditions to compensate for changes in visual acuity, and try to look to the side of small targets rather than trying to fixate on them.

In addition to the size and shape of individual photoreceptors, rods and cones differ in how they interact with each other. Although the retina is made of about 125 million photoreceptor cells, the optic nerve that carries the signals from the retina to the brain is made up of only about 1 million cells; as a result, many photoreceptors feed a single optic nerve cell. However, the ratio of receptors to nerve cells is not uniform across the retina. Cone cells in the fovea can have a receptor-to-nerve cell ratio as low as one to one while rod cells in the periphery can have a ratio of several hundred to one. Combining the inputs of multiple cells over a larger area further increases the sensitivity of rod cells at the expense of visual acuity; as a result, large objects remain visible under low light levels but fine detail features are harder to detect and text is harder to read. Further, the cones provide little information in low light conditions to help us perceive the color of unlighted objects at night and a functional blind spot is created in the fovea.

Pilots should allow sufficient time for their eyes to adapt before departing on a night flight, and should thereafter avoid exposure to bright light for more than a second or two to avoid a loss of dark adaptation.

When a rod or cone is stimulated by light, pigments in the cell convert the light into a neural impulse. The cell must regenerate these pigments after each impulse before it is ready to fire again. Pigment regeneration takes about 5 minutes in the cone cells and up to 30 minutes in rod cells. These differences in cell recovery time result in a two-stage increase in sensitivity when transitioning from bright to low light. When a person moves from bright to low light, sensitivity improves for the first 3-4 minutes and levels off briefly as the cones adjust. Sensitivity then continues to increase as the rods adapt, reaching maximum sensitivity after about 30 minutes.

Dim red light is used for cockpit illumination because rods are least sensitive to long wavelength (red) light, and it has little negative effect on dark adaptation. However, the *Aeronautical Information Manual* recommends the brief use of dim white light as necessary in the cockpit at night because red light illumination can make it difficult to read aeronautical charts or focus on objects in the cockpit. If pilots must use white light in the cockpit, they should close one eye to retain some dark adaptation.

Pilots can take steps to improve their night vision.

Smoking, vitamin A deficiency, high cabin altitude, exposure to carbon monoxide from engine exhaust, and fatigue can all negatively affect a pilot's night vision. In addition to not smoking and maintaining a healthy diet, pilots can improve their night vision by maintaining a lower cabin altitude and/or using oxygen at night.

Pilots should use all available flight instruments, navigation aids, and approach guidance to counter potential illusory perceptions resulting from changes in visual function in the dark.

Even healthy pilots with good night vision are susceptible to perceptual problems in low light conditions. In addition to acuity changes and dark adaptation, visual performance is negatively affected by reduced contrast at night. As ambient lighting decreases, contrast—the difference between the brightest and darkest visual features—also decreases. In daylight conditions, we are able to detect obstacles, rising terrain, and ground features because of the high-contrast edges outlining an obstacle, or the line where terrain or water meets sky. As ambient lighting decreases, the contrast of objects and terrain features decreases and it becomes harder to distinguish those features from the surrounding environment.

Perceptions of speed and direction of movement are based on visual details like the apparent flow of the surroundings when moving through the environment, the relative size and height of familiar objects, texture gradients, and linear perspective. When flying, these details also provide information about altitude and climb/descent rate. Reduced lighting limits the amount of visual detail available and increases the likelihood of experiencing illusory perceptions of speed, distance, altitude, or climb/descent rate. As a result, pilots may simply be unable to see rising terrain, trees, or unlit obstacles. In other cases, they may become disoriented and have difficulty maintaining level flight in cruise or flying a proper descent angle while on approach to landing.

Some examples of nighttime perceptual illusions include the following:

- False Horizon Illusion – At night, pilots may become disoriented because they are unable to distinguish ground lights from stars. Cloud formations or patterns of ground lights can also create the illusion of sloping terrain or the perception that the plane is banking. Such illusions can disorient pilots and cause them to lose control of their aircraft if they rely on their perceptions, which can be false, rather than aircraft flight instruments.

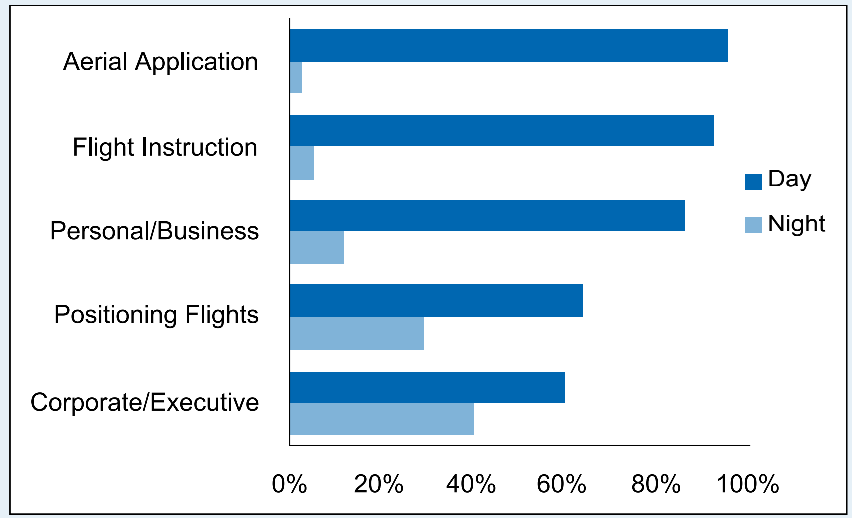
- Distance Illusions – Bright approach or runway lights can be seen from long distances at night. This can create the illusion that the aircraft is much closer to the runway than it is, leading to a lower than appropriate approach path.
- Featureless Terrain or "Black Hole" Illusion – In dark conditions, with few ground lights, pilots may be unable to perceive enough orientation clues to judge altitude or descent rate, causing them to perceive the aircraft to be higher than it actually is. If this occurs while on approach, pilots may have the sensation that the aircraft is stationary while the runway is sloping away. This illusion can cause pilots to unknowingly descend into terrain or water, or cause them to fly a low approach or undershoot the runway while landing.

In general, pilots are susceptible to illusions at night that are similar to those encountered during flight in instrument conditions. The best way to overcome these and similar illusions is to use aircraft flight instruments and other resources. For example, pilots should use glideslope, visual approach path indicator lighting, and/or global positioning system (GPS) vertical navigation information, if available, during approach and landing at night to counter possible false perceptions of altitude or decent rate. Long straight-in approaches should also be avoided in favor of an appropriate traffic pattern whenever possible.

Purpose of Flight

Accident likelihood is based on the level of risk associated with an activity and the frequency of that activity. The Safety Board has found that the distribution of accidents that occur during the day and at night is proportionate to the number of hours flown; however, the unique risks that night conditions pose to specific operations is reflected in the distribution of accidents by purpose of flight. For example, only 2% of aerial application accidents occur at night, most likely because aerial application is almost exclusively a daytime activity.

Day and Night Distribution of Accidents by Purpose of Flight, 2003

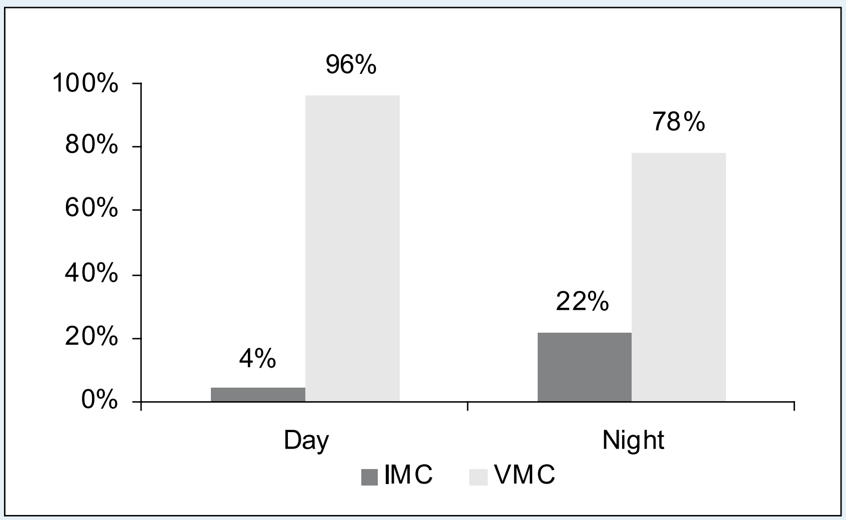


For other types of flight operations, the differences may be more complex. Positioning flights are a unique type of general aviation operation because they usually involve aircraft and pilots that do much of their flying under either 14 CFR Part 121, or more likely, Part 135. If an on-demand Part 135 operator flies an empty airplane to pick up passengers for a subsequent flight, the empty leg is a positioning flight subject to Part 91, and therefore a general aviation operation. As the previous graph illustrates, one-third of general aviation accidents in 2003 that involved positioning flights occurred at night. These flights may pose an additional risk if the pilot is experiencing the effects of fatigue due to the time of day and/or from having already completed a long day of flying.

Weather

Another source of increased risk for fatal accidents at night is the hazard posed by weather. Conditions like fog and low clouds that reduce visibility can either form or worsen as the temperature decreases at night and water vapor in the air condenses. Clouds, fog, and precipitation are an even greater threat to VFR flights at night than during the day because the conditions are harder to see and avoid, particularly because the illumination that is available from ground lights or moonlight is limited. The minimum visibility and cloud clearance requirements for visual flight outlined in 14 CFR 91.155 address this increased risk by requiring greater clearance for night VFR in class G (uncontrolled) airspace. However, 2003 data on accident weather conditions indicate that night accidents occurred more than five times more often in IMC than in VMC. These data demonstrate that preflight planning and obtaining weather information are critical at night—even for local flights—because clouds and precipitation are harder to see.

Percentage of Accidents in VMC/IMC by Day and Night, 2003

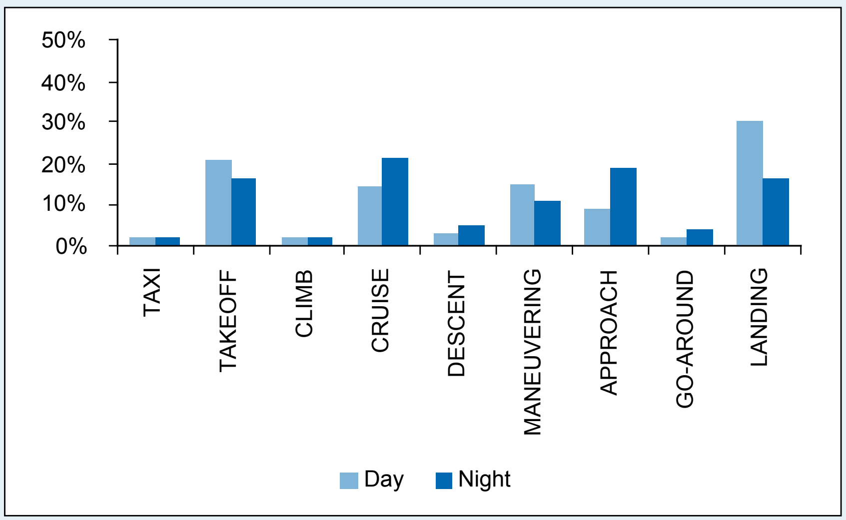


Phase of Flight

As previously noted, the percentage of general aviation accidents that occur at night is roughly equivalent to the percentage of general aviation flying estimated to occur at night. However, accidents that occur at night are about twice as likely to result in a fatal injury, which can be explained partly by differences in typical day and night accident profiles.

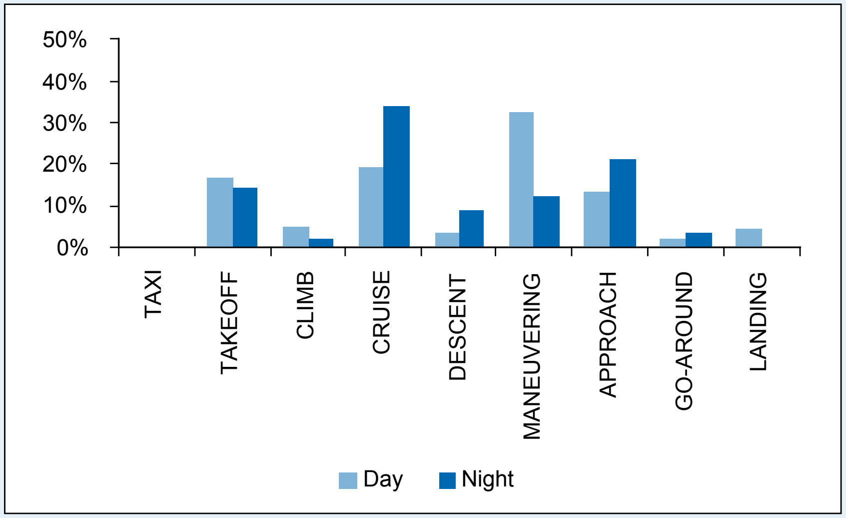
As noted earlier, most general aviation accidents occur during takeoff and landing. In 2003, the combined phases of takeoff and landing accounted for 51% of daytime accidents; night accidents do not, however, exhibit a similar distribution. As the following chart shows, the largest percentage of night-accident initiating events occurred during cruise, followed by approach. Night accidents also involved slightly higher percentages during descent and go-around.

First Occurence Phase of Flight for Day/Night Accident Aircraft, 2003



The distribution of fatal accidents by phase of flight shows that injury severity is closely related to the impact forces generated by the speed and altitude typical of each phase. In 2003, cruise and approach phases together accounted for 54% of all fatal night accidents. In contrast, none of the accidents that occurred during landing, which involve relatively slow speeds and low impact forces, were fatal.

First Occurence Phase of Flight for Fatal Day/Night Accident Aircraft, 2003



Accident First Occurrence

General aviation accidents at night differ from those that occur during the day with regard to how the accident events typically unfold. As the following tables show, loss of control in flight, loss of engine power, and aircraft system and equipment malfunctions are frequently cited as first occurrences in both day and night accidents. However, the percentage of accidents citing collision with objects, collisions with terrain, and in-flight encounters with weather were noticeably higher for accidents that occurred at night.

Ten Most Frequently Cited Occurrences in Day Accidents, 2003

	Accident Aircraft	% of Day Accident Aircraft
Loss of control - on ground/water	220	15%
Loss of control - in flight	219	14%
Loss of engine power	163	11%
In flight collision with object	116	8%
Loss of engine power (total) - nonmechanical	112	7%
Hard landing	91	6%
Airframe/component/system failure/malfunction	83	5%
In flight encounter with weather	66	4%
In flight collision with terrain/water	64	4%
Loss of engine power (total) - mechanical failure/malfunction	59	4%

Ten Most Frequently Cited Occurrences in Night Accidents, 2003

	Accident Aircraft	% of night Accident Aircraft
Loss of control - in flight	29	16%
In flight collision with object	25	14%
In flight encounter with weather	22	12%
Loss of engine power	18	10%
Loss of engine power (total) - nonmechanical	18	10%
In flight collision with terrain/water	13	7%
Airframe/component/system failure/malfunction	10	6%
Loss of control - on ground/water	8	4%
Hard landing	6	3%
On ground/water collision with object	5	3%

The earlier discussion of the human visual system and how it functions in low light helps explain why higher percentages of night flying accidents occur during cruise, approach, and descent, and why accidents at night are more likely to involve collision with objects or terrain.

Regulatory Requirements

The FAA has established specific requirements for pilot training and currency to address the unique risks associated with night flight. For example, 14 CFR 61.109 requires applicants for a private pilot license to have logged at least 3 hours of night-flight training, including at least one night-cross-country flight greater than 100 nautical miles, and at least 10 takeoffs and landings to a full stop at night. Private pilot applicants must also have logged at least 3 hours of instruction flying solely by reference to aircraft instruments, which is relevant to night flying because of the similarities between operating at night and in IMC conditions. Once certificated, pilots must also maintain a minimum level of activity to be eligible to carry passengers at night. The currency requirements of 14 CFR 61.57(b) state that pilots may not carry passengers at night unless they have, within the last 90 days, performed at least three takeoffs and landings to a full stop during the period from 1 hour after sunset until 1 hour before sunrise.

Unlike the United States, many countries require a separate rating to fly at night. For example, Canada, the United Kingdom, Australia, and the European Joint Aviation Authority all require pilots to receive additional training to fly at night. To fly VFR at night, Australian Civil Aviation Orders require[40] pilots to have at least 10 hours of flight time at night including, among other things, 3 hours of dual instruction on a cross-country flight greater than 100 nautical miles in length and landing at a remote airfield without sufficient lighting to create a discernible horizon. Once they have completed this training, pilots must demonstrate their knowledge and proficiency by passing a flight test to receive a night visual flight rules (NVFR) rating. Canadian requirements[41] for a night rating state that applicants must have logged a minimum of 20 hours in the same category of aircraft, including at least 10 hours of night flying and 10 hours of instrument instruction. The 10 hours at night must consist of 5 hours of dual instruction, including a cross-country, and 5 hours of solo flight, including at least 10 takeoffs and landings.

Pilot Experience

Much like flight by reference to instruments, flying at night requires practice and can be more difficult for pilots with little experience. However, the data that are available for 2003[42] suggest that many of the pilots involved in night accidents were not inexperienced, and the median total flight experience of pilots involved in night flying accidents was only slightly less than that of all general aviation accident pilots.

A comparison of night flying experience indicates, however, that the median number of flight hours logged at night was higher for pilots involved in nighttime accidents. This difference may be another example of increased exposure to risk: pilots who spend more time flying at night are naturally more likely to be involved in an accident at night than pilots who do most of their flying during the day.

Median Flight Experience

	Total	Night
All Accident Pilots	1,194 hrs	65 hrs
Night Accident Pilots	1,078 hrs	100 hrs

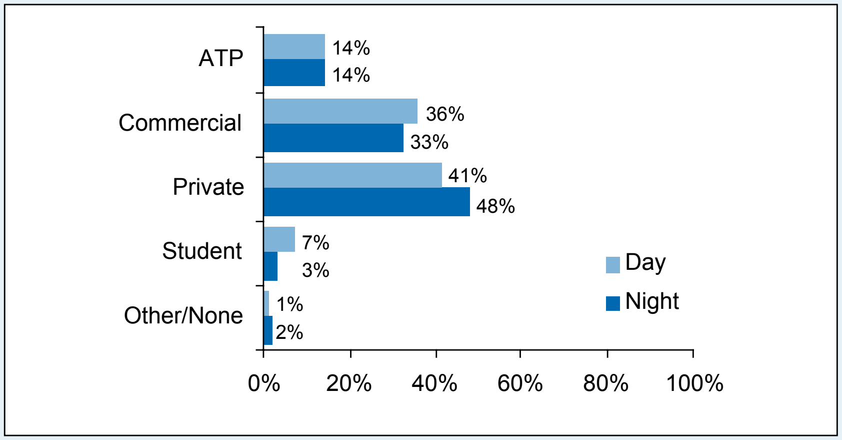
[40] Australian Civil Aviation Orders, 40.2.2.

[41] Canadian Aviation Regulations, 421.42.

[42] Total flight hour data were available for 1,639 accident pilots and night flight hour data were available for 1,049 pilots.

Similarly, differences in the distribution of accident pilots with regard to their highest level of certification do not appear to be large.

Percentage of Accident Pilots by Highest Certificate Day and Night, 2003



Conclusion

The 2003 accident record and recent general aviation accident data indicate that accidents at night are more likely to be fatal than those that occur during daylight. Over the past decade, one-third of all general aviation accidents at night resulted in a fatality. The severity of night accidents is the result of an increased likelihood of accidents involving collision with objects or terrain and in-flight encounters with weather, which are in turn the byproduct of low light conditions and their effect on human performance.

Although the human visual system is capable of functioning over a wide range of light conditions, it is limited in low light, making pilots susceptible to illusory perceptions of speed, altitude, and distance that can lead to severe accidents. Much like flight in IMC, safe night flying requires training and practice. Pilots can minimize their risks at night by maintaining proficiency with aircraft instruments, using all available approach guidance while landing, and taking the necessary steps to maintain or improve their night vision.

Appendix A

The National Transportation Safety Board Aviation Accident/Incident Database

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

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

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

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

Appendix B

Definitions

Definitions of Safety Board Severity Classifications

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

Definitions for Highest Level of Injury

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

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

Minor—Any injury that is neither fatal nor serious.

None—No injury.

Definitions for Level of Aircraft Damage

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

[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 Safety Board Headquarters in Washington, D.C. or from one of the 10 regional offices in the United States (see appendix D).

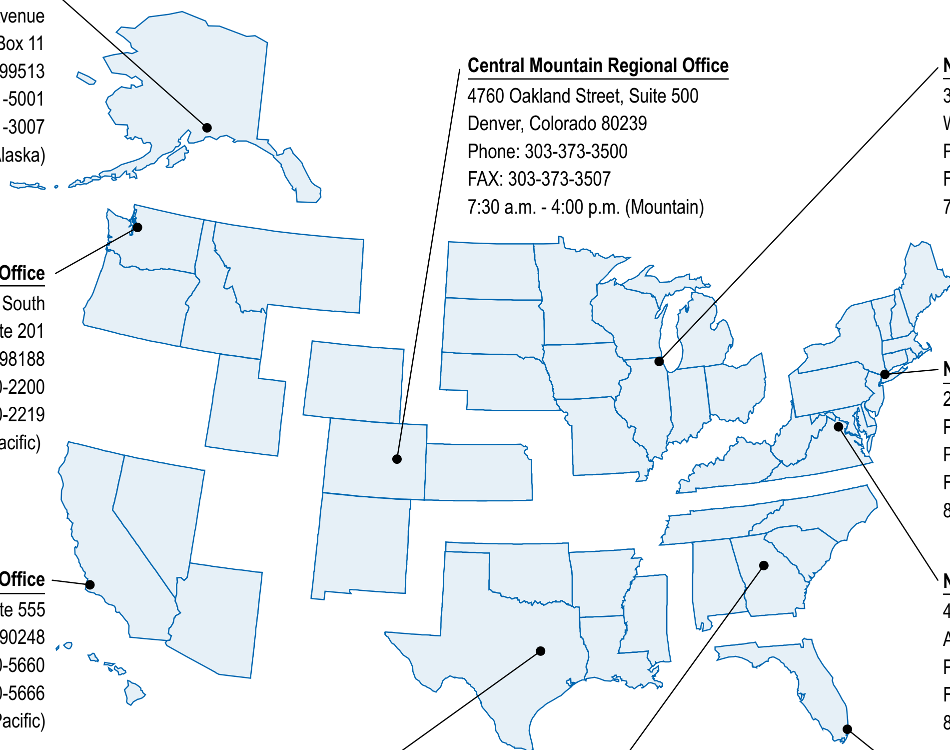
In determining probable cause(s) of a domestic accident, investigators consider the facts, conditions, and circumstances of the event. The objective is to ascertain those cause and effect relationships in the accident sequence about which something can be done to prevent recurrence of the type of accident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

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

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

Appendix D

National Transportation Safety Board Regional Offices[1]



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

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

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

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

North Central Regional Office
31 West 775 North Avenue
West Chicago, Illinois 60185
Phone: 630-377-8177
FAX: 630-377-8172
7:30 a.m. - 4:00 p.m. (Central)

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

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

South Central Regional Office
624 Six Flags Drive
Suite 150
Arlington, Texas 76011
Phone: 817-652-7800
FAX: 817-652-7803
7:30 a.m. - 4:00 p.m. (Central)

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

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

[1] As of FY 2003