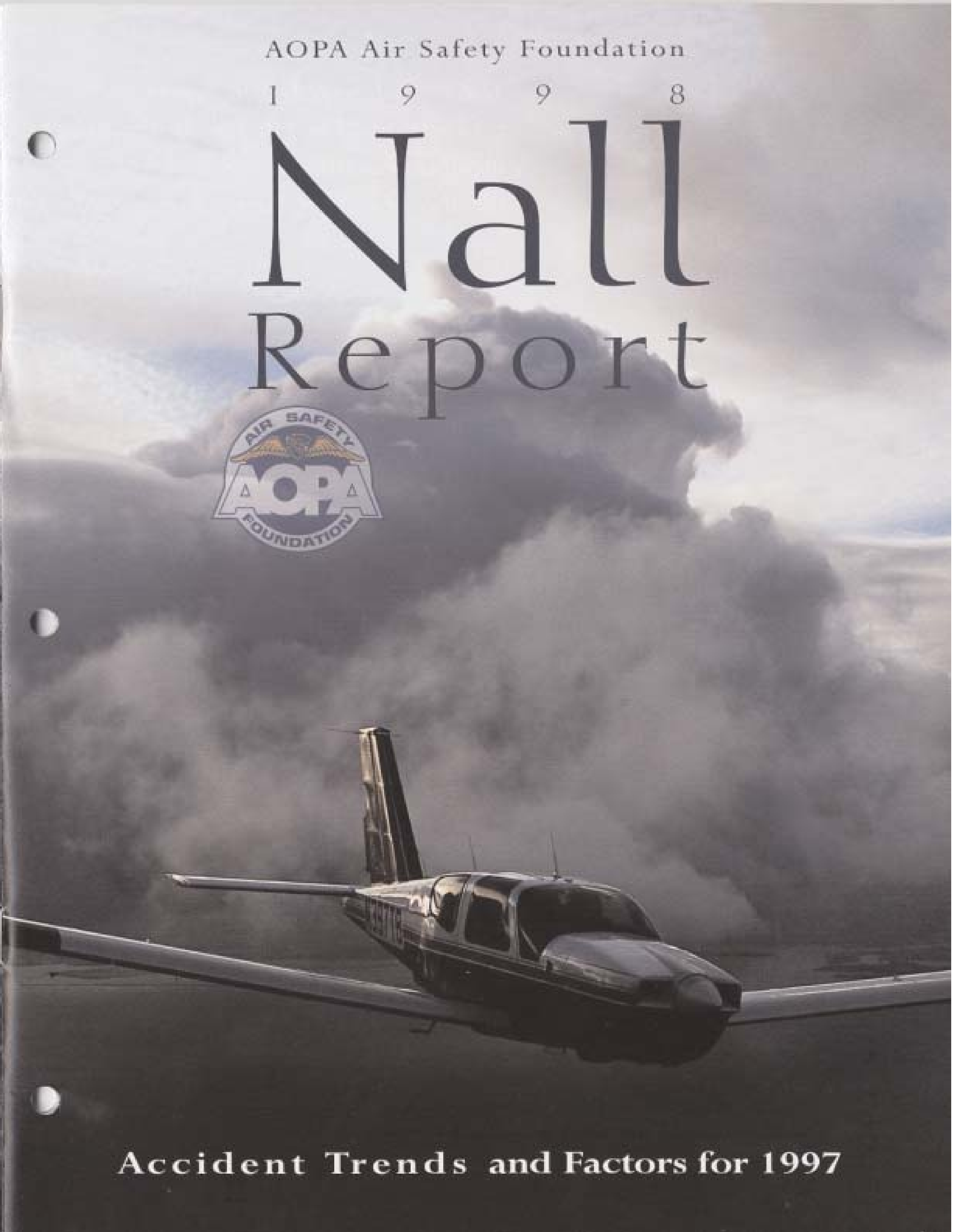
AOPA Air Safety Foundation

1998

Nall Report



Accident Trends and Factors for 1997

The 1998 Joseph T. Nall Report is co-sponsored by Life Hat-in-the-Ring member #2, Mike Lazar, and member #4, Mort Bass.

The AOPA Air Safety Foundation honors the memory of Joseph T. Nall through the publication of its annual general aviation safety report. This memorial tribute demonstrates the need for general aviation safety awareness. The information in this safety report drives the development of dynamic safety education programs for which the AOPA Air Safety Foundation has become nationally known.

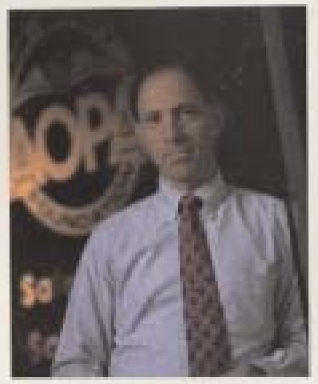
Joseph T. Nall

Joseph Nall was a true believer in general aviation and participated fully as a pilot, flight instructor, ground-school operator, and, ultimately, a distinguished member of the National Transportation Safety Board. Appointed to the NTSB in April 1986 by President Ronald Reagan, Joe Nall died as a passenger in an aircraft accident near Caracas, Venezuela, in 1989.

As detailed by his close friend Pat Hartness, who received his first airplane ride in 1960 in Joe's Cessna 150, Joe Nall excelled in academics and related extracurriculars. Joe was valedictorian in high school and student body president at Furman University, where he was a divinity major. His first career found him preaching to his congregation. Possessed of a keen mind and memory, Joe then decided on a law career. Truly a "man for all seasons," he told his friends about his love for aviation and that he "thought he could make a difference." If his many aviation friends are Joe's legacy, then his "difference" has been significant.

Safe Pilots. Safe Skies.

Executive Director's Introduction



Bruce Landsberg
Executive Director
AOPA Air Safety Foundation

In 1996 general aviation celebrated the *safest year ever*. The record improved in 1997. The overall accident number went down by more than 100, and fatal accidents dropped by more than 20. That is something that we can all be proud of.

However, the fatal accident rate remains stubbornly close to level, and the leading causal factors are the same this year as they were the year before and the year before that. Fatal accidents occurred frequently in maneuvering flight and in poor weather. We should make a clarification: Weather didn't cause the accident - poor judgment on the part of the pilot did. Continued VFR flight into IMC still does more damage than thunderstorms, icing, and most other weather hazards combined.

Much effort is being made to improve forecasts and to communicate weather to the cockpit graphically. It will remain to be seen if this will have a significant impact on weather accidents. Pilots can take some comfort in knowing that if the weather looks bad, it probably is. VFR pilots must stay out of the clouds, and if you can't maintain VFR at a safe altitude above the ground (ASF recommends a minimum of 1,500 feet AGL in flat terrain for extended cross-country), divert to an alternate. It is a simple, life-saving decision.

ASF has made several improvements to the Nall Report this year. Because the report is getting such widespread distribution and is being used by many for research and decision making, we elected to change the mix of accident data. ***The 1997 report used 100 percent preliminary data that, although valid, was subject to some change once final reports came in. For 1998, the report uses 85 percent final accident information and 15 percent preliminary data.*** Some numbers will change slightly, but for the broad look at GA safety, this will be very close.

The AOPA Air Safety Foundation is pleased to bring you this effort and directs researchers and pilots to both our Web site (www.aopa.org/asf) and to the supporting publications listed in the appendix for more information on a variety of topics. Fly safely in 1999, and help us achieve another record year.

Safe flights to all,

Bruce Landsberg

As in all previous years, the leading causes of fatalities were continued VFR flight into instrument conditions and low-level maneuvering flight. These rather sanitary descriptions of unfortunate situations should more properly be called "judgment failures."

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Nall Report

The AOPA Air Safety Foundation acknowledges the technical support and assistance of:

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How Safe Is General Aviation?

Safe is not the equivalent of risk free.
– U.S. Supreme Court, 1972

In a 1972 decision, the U.S. Supreme Court said that "safe is not the equivalent of risk free." If "safe" meant freedom from the possibility of harm, few human activities would meet the standard. In fact, the only way to eliminate risk from any activity is to avoid participating in it. While risk does not guarantee injury or make an activity unsafe, it should not be ignored. By analyzing mishaps, we can learn about potential risks and take proactive steps to control them.

Background

What Is General Aviation?

Although general aviation (GA) is typically characterized by recreational flying, there is also a lot more to this important segment of aviation. In addition to the personal flying that many find so enjoyable, general aviation is a valuable part of the nation's transportation system, making it possible to perform tasks not easily accomplished by other means. Besides providing personal, business, and freight transportation, general aviation supports diverse activities such as law enforcement, forest fire fighting, air ambulance, and other vital services. For a breakdown of general aviation activities and their accident statistics, see "Analysis of Specific Operations" on page 11.

What Does General Aviation Fly?

Aircraft used in general aviation are as varied as the pilots and types of operations involved. The total number of scheduled airline, air taxi, and other general aviation aircraft registered in 1994 (the most recent year available from the FAA) are shown below:

	Airline	Air Taxi	General Aviation
Piston Single-Engine	465	3,017	209,698
Piston Multiengine	359	3,280	29,184
Turboprop Single-Engine	0	435	186
Turboprop Multiengine	1,782	1,347	5,831
Turbojet	4,636	1,182	5,012
Helicopter	128	2,086	10,364
Total	7,370	11,347	260,275

This safety report will address accidents involving most of the types of aircraft listed above. Accidents involving turbojets, aircraft used in Part 121 or Part 135 operations, aircraft weighing more than 12,500 pounds, helicopters, gliders, and balloons will not be covered.

Analysis

Interpreting Aviation Accident Statistics

Everyone has heard about "the accident rate," but what does that really mean? How do we compare statistics and arrive at conclusions?

All too often, comparisons are based on the number of events occurring—raw data counts—but that type of comparison doesn't tell the real story. To be meaningful, comparisons must be based upon equal exposure to risk. The longer we are exposed to a particular risk, or the more times we undertake an activity involving risk, the greater the overall risk. But this alone does not determine total risk. Reduction factors such as experience, proficiency, equipment, and flight conditions can have significant positive safety impact.

To compare different airplanes, pilots, types of operations, etc., in terms of their accident involvement, we must first level the playing field in terms of exposure to risk. Statisticians call this normalizing. The most common way to normalize factors for aviation safety is to compare accidents per 100,000 flight hours or to compare accidents against total flights. General aviation data are usually compared using 100,000 hours of flight time. The FAA estimates the total flight hours for general aviation based on a survey of a sample of aircraft owners and operators. Scheduled air carriers, on the other hand, must report flight hours, departures, and passengers carried, so their accident statistics may be compared using either departures or flight hours.

To make these comparisons as meaningful as possible, all groups must have approximately equal risk per unit, in this case equal risk per flight hour or per flight. To accurately interpret comparisons, it is important to know which normalizing factor—flight hours or flights—is being used and to understand the likely differences between groups. Comparisons based on equivalent data are more likely to be accurate than other types of comparisons. For example, a comparison between one year's general aviation accidents per 100,000 hours and another year's general aviation accidents per 100,000 hours is more likely to be accurate than a comparison of general aviation accidents per 100,000 hours and air carrier accidents per 100,000 hours.

Percentages and ratios are common ways to show relationships within a set of data. This report uses percentages to show what portion of accidents were attributed to particular causes, as well as what portion of accident sequences began in a particular phase of flight. These figures may be used to estimate what statisticians call conditional probabilities. In other words, given an accident that has occurred, what is the probability that it was the result of weather, stall/spin, etc. This type of analysis makes it easier to identify and concentrate on the accident factors that carry the greatest risk.

Sequence of Events and Accident Causality

In its studies of accidents involving large transport-category aircraft, the Boeing Commercial Airplane Co. has found that most accidents are the result of a sequence of events rather than a single catastrophic event. Boeing's research into air carrier accidents has identified as many as 20 events in the course of a single flight that had a direct impact upon the outcome. The National Transportation Safety Board (NTSB) uses a similar method to break down each accident into "occurrences."

In this report, the emphasis is on identifying the phase of flight in which the sequence of events began, often referred to as the "first occurrence," and on the types of problems encountered by the pilots. The objective is to find lessons that can be used to prevent future accidents.

When talking about the causes of accidents, the NTSB is the official source of "probable cause" data in the United States. The definition of "cause" is often elusive. In fact, the regulations charging the NTSB with the responsibility for determining the causes of accidents do not define the term "cause."

Several other countries, notably Australia, have officially abandoned the concept of assigning causes. The Australian Bureau of Air Safety Investigation (BASI) writes a series of "significant findings" and progresses on to its safety recommendations, without an intermediate step of determining accident causes.

This report concentrates on the first occurrence and uses a simple, single-cause/factor classification scheme. The analyses in this report have been based upon a combination of fully investigated final reports from the NTSB and, where final reports were not available, preliminary reports, describing the accident and providing basic factual data.

Approximately 85 percent of the 1997 accident analyses conducted for this report were based upon the NTSB's final reports that included an assessment of probable cause. Of these, 77 percent also included sequence-of-events information. AOPA Air Safety Foundation analysts have classified all of the accidents into groups based on the problem that initiated the accident sequence and that has the most potential for accident prevention.

Resource constraints and the number of accidents occurring annually mean that general aviation accidents are not investigated in nearly as much depth as air carrier accidents, so much will never be known about many mishaps. Despite these limitations, the AOPA Air Safety Foundation believes that pilots can learn valuable lessons from analysis of the most recent year's accidents.

Most scud-running crashes probably don't happen the first time out. The pilot may be emboldened by early successes and might get away with it for months or even years. But, in 1997, over 80 percent of these accidents involved fatalities – the highest fatality rate of any type of mishap.

Overview

1997 Statistics

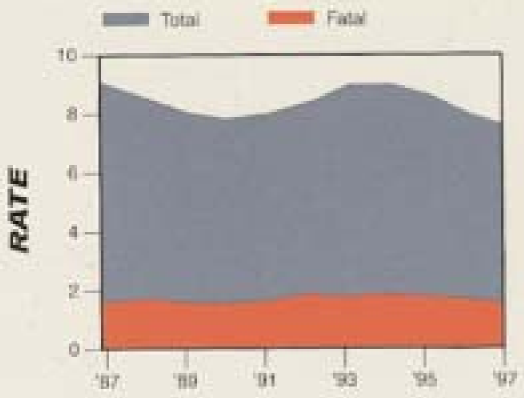
The general aviation accident rate per 100,000 flying hours fell in 1997 compared to previous years. However, the changes in the accident rate shown in the chart to the right may not be statistically significant because their magnitude is within the variability, or "roughness," of the estimates of flying hours on which the accident rate is based.

The general aviation accident statistics below are derived from NTSB accident reports. Where possible, final reports that include probable causes and accident sequence of events were used. Because preliminary reports without this valuable data had to be used for a small part (15 percent) of the accidents analyzed, they could cause minor fluctuations in the data once final reports are completed. They are included in this report to make it more complete and timely.

Flying hours are estimated by the FAA using statistical forecasting techniques and data from its *General Aviation and Air Taxi Activity and Avionics Survey*, which is distributed to a sample population of aircraft owners every year. The FAA estimates that general aviation flying hit a low point in 1994 but then rose slightly over the next three years.

U.S. General Aviation Accidents

per 100,000 hours 1987-97



Accident Statistics Past Seven Years

	1991	1992	1993	1994	1995	1996	1997
Total fixed-wing general aviation accidents	1,897	1,837	1,808	1,741	1,853	1,781	1,642
Fatal fixed-wing general aviation accidents	394	407	360	354	383	355	331
Total fixed-wing general aviation fatalities	724	798	652	641	679	653	667
Estimated general aviation flight hours	27.2M	24.8M	22.8M	22.2M	23.9M	24.1M	24.7M

Lowest Accident Rate in History

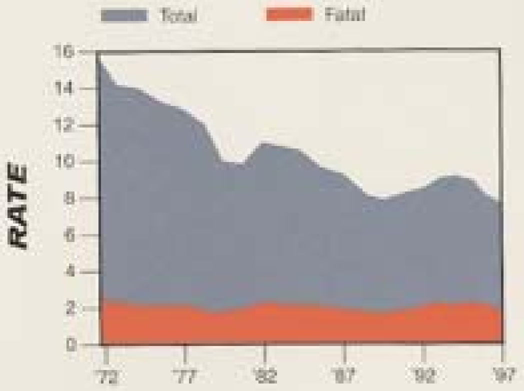
The adjacent chart shows that the overall general aviation accident rate per 100,000 flying hours has declined significantly over the past 25 years. However, the decline has slowed in the past 10 to 12 years, and the accident rate has remained relatively steady over the past six years. The fatal accident rate also has declined over those 25 years, remaining relatively constant over the past 16 to 17 years. Nevertheless, 1997 had the lowest total accident rate and the lowest fatal accident rate since 1938, the first year for which such accident statistics were reported. Although there was a slight increase in the number of fatal injuries in general aviation accidents from 1996 to 1997, the fatality rate (fatalities per hours flown) remained the same, also the lowest since 1938.

General aviation accident rates have always been higher than airline rates because general aviation involves risks that other operations do not share. Listed below are some of the important differences between GA and the airlines.

- Less regulation – GA pilots conduct a wider range of operations.
- Fewer cockpit resources – Air carrier operations require at least two pilots; GA operations are predominantly single pilot.
- More facilities – GA flies to more than 15,000 landing facilities; the airlines serve only about 700.
- GA facilities may lack the precision approaches and advanced services of airline-served airports.
- More operations.
- Aerial application, banner towing, etc.
- More takeoffs and landings – the highest risk phases of any flight.
- Less structure and control.
- Commercial and military operations have many inherent controls and extensive support structures.
- More individual responsibility—individual GA aircraft owners and pilots are responsible for the safety of flight.

U.S. General Aviation Accidents

per 100,000 hours 1972-97



Although the freedom and flexibility of general aviation involve some additional risk, that risk does not guarantee an accident. General aviation is safe. Pilots who actively manage risk can make it even safer.

Comparison with Other Years

Were last year's statistics unique? In a word, no. The most common accident causes continue to be pilot-related. With a few minor exceptions, the majority of accidents in 1997 were due to the same causes, occurring at roughly the same rates, as over the past several years.

Care must be taken, too, when comparing this year's data with previous years. Over the past two years, the AOPA Air Safety Foundation has converted its Aviation Safety Database to incorporate the latest and most complete data available from the NTSB. This has made more final accident reports available for this year's analysis, but it has also changed some of the ways in which we categorize accidents. Weather-related accidents, for example, used to be lumped under the broad category of cruise-weather when there was less data available to characterize them. Now that more data is available for our analysis, more weather-related accidents can be found in the phase of flight where they occurred, such as takeoff or approach. This explains the apparent decrease in the 1997 weather accidents as compared to 1996.

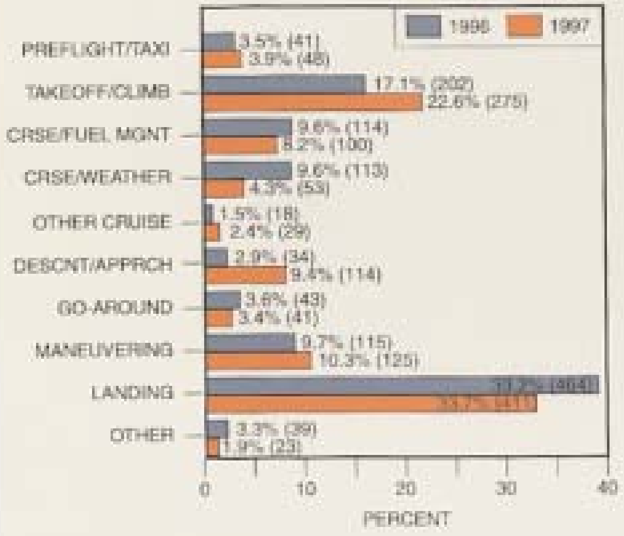
Seasonal Trends

Total accident counts for 1997 were lower than those for 1996, except for the months of June, October, and November, in which the counts were slightly higher for 1997. In both 1996 and 1997, fatal accidents occurred at a relatively uniform rate throughout the year, while total accident rates nearly doubled from May through September. The higher overall accident rates during the spring and summer months were probably the result of the high concentration of flight hours during those months when the weather is better, daylight lasts longer, and more people take time for leisure.

The graph to the right compares trends in monthly accident rates and fatal accident rates for 1996 and 1997.

1996-1997 Comparison

Pilot-Related Accidents



Monthly Accident Trend

1996-1997 Comparison

Breakdown by Aircraft Class

In 1997, as in the past, the number of accidents in each class of aircraft tended to reflect the number of hours and types of operations flown in those aircraft. Individual differences in overall accident rates were more likely to be caused by differences in exposure to risk than by characteristics of the airplanes in which the accidents occurred.

For example, more accidents occurred in single-engine fixed-gear aircraft than in more complex aircraft, not because these aircraft are more dangerous, but because they are more common. Likewise, IFR weather-related and IFR approach accidents were more common in single-engine retractable-gear and multiengine airplanes than in single-engine fixed-gear aircraft because these types of operations are more common in the complex aircraft.

These figures do not mean that differences in the complexity of aircraft can be ignored. Air Safety Foundation studies have shown that low time in type is often a contributing factor in accidents. Transitioning to a new aircraft, even one that is simpler but different from the one the pilot usually flies, can cause problems, even for experienced pilots. Likewise, problems such as stalls during VFR approaches and attempts to continue VFR flight into instrument meteorological conditions (IMC) have affected pilots in all types of airplanes. Pilots never outgrow the need for basic airmanship.

Major Accident Causes and Factors

The proper use of mishap experience is reducing mishap potential.
– U.S. Air Force Guide to Mishap Investigation

Summary of Significant Causes

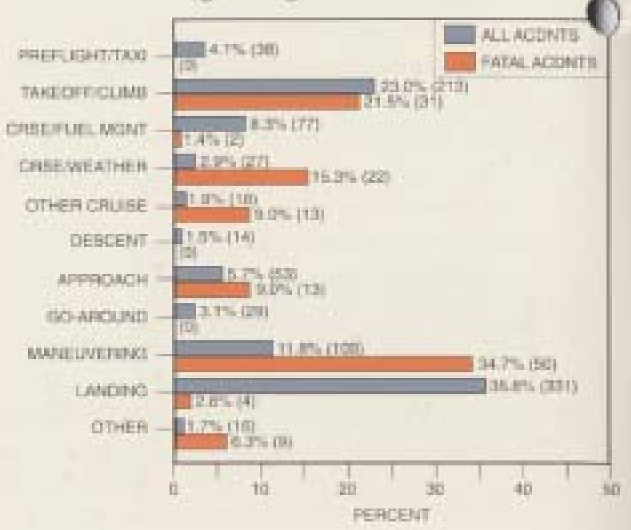
Both total and fatal accident counts dropped slightly during 1997, while the estimated number of hours flown and the number of deaths increased slightly. At the same time, trends in the causes of accidents showed little change from previous years. The majority of accidents – 74 percent of all accidents and 71 percent of fatal accidents – were the result of pilot-related causes.

The following facts about the causes of accidents are worth remembering:

- [1] Takeoff and landing account for less than 5 percent of a typical cross-country flight, but 50.2 percent of the accidents for which the emergency phase of flight is known. The majority of these accidents were nonfatal. Only 18.5 percent of fatal accidents occurred during takeoff or landing.
- Weather-related accidents accounted for 19.5 percent of all fatal pilot-related accidents. In multiengine airplanes, almost 18 percent of fatal accidents were weather related. For single-

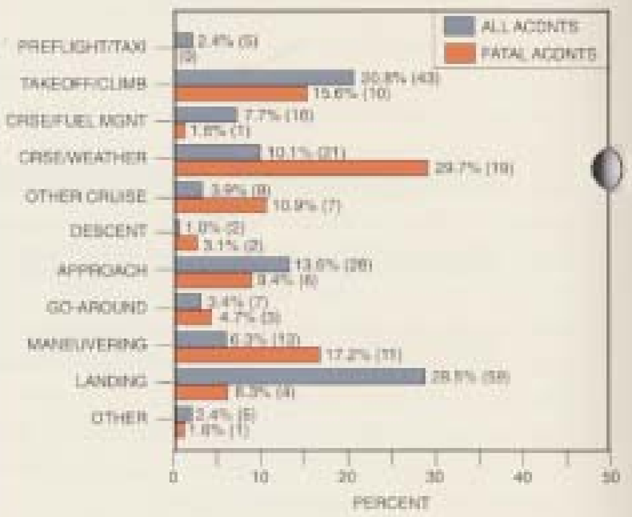
Accident Causes

Single-Engine Fixed-Gear



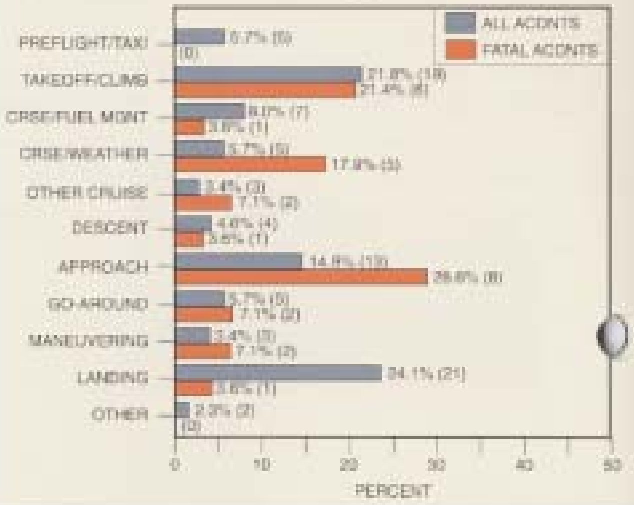
Accident Causes

Single-Engine Retractable Gear



Accident Causes

Multiengine



Most wire strikes occur below 100 feet AGL. The only time an aircraft needs to be that low is just after takeoff and just before touchdown. This is a transition altitude, not a cruising one.

engine retractable-gear airplanes, the figure was 29.7 percent. Fatal accidents during instrument approaches added to this total. These figures are comparable to those for the past decade as reported in the AOPA Air Safety Foundation's *Safety Review: General Aviation Weather Accidents*.

- [2] Darkness increased the likelihood of having a weather-related accident. Fully 19.4 percent of the cruise-weather accidents and 22.9 percent of the approach accidents happened at night. In addition, 46.7 percent of the instrument approach accidents happened at night. This is significantly higher than the average of 11.5 percent of all accidents that happened at night.
- Maneuvering flight accidents accounted for 26.7 percent of all fatal pilot-related accidents. Many of these accidents involved buzzing or low-level flight.
- Although only 41.8 percent of general aviation flight hours were logged on personal flights, these flights accounted for 63.9 percent of all accidents and 66.8 percent of all fatal accidents.

The Accident Setting - Phase of Flight

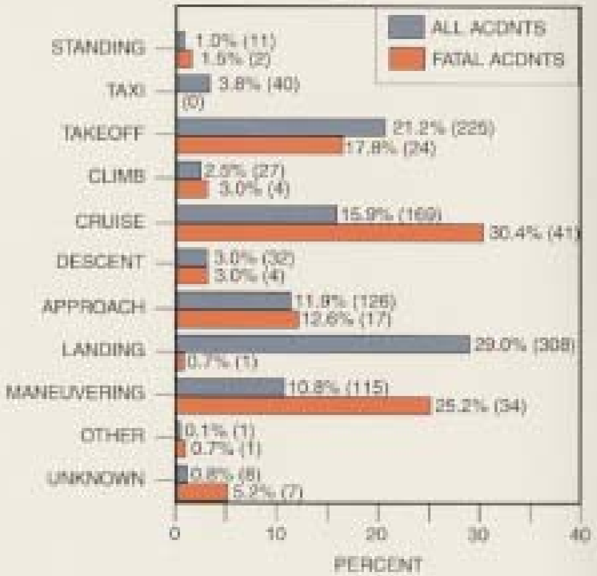
Studies conducted by the Boeing Commercial Aircraft Co. on commercial jet aircraft accidents have estimated that takeoff and landing each constitute only 1 percent of a typical flight. Initial climb adds another 1 percent, and final approach accounts for 3 percent. Cruising flight was estimated to account for 60 percent of a typical flight, with the remainder being distributed fairly evenly between climb to altitude, descent from altitude, and initial approach.

Detailed estimates like this are not available for general aviation flights, and because general aviation operates in different environments than airlines do, the exact percentages of time spent in each phase of flight are probably different. For example, general aviation operations usually involve many more takeoffs and landings per flight hour than airlines. Instructors and their students sometimes spend entire flight lessons in the traffic pattern. Nevertheless, the critical relationships between phases of flight remain basically the same. For both general aviation and commercial flights, takeoff and landing, although the most complex phases of flight, are a relatively small portion of the total flight time.

The majority of accident sequences begin during phases of flight that take up relatively little flight time but contain the highest number of critical tasks and the highest task complexity. Compare the proportions of accidents occurring in the takeoff, cruise, approach, and landing phases, and it is easy to see that there are significant hazards in the phases of flight that account for only a small portion of flight time.

The chart to the right classifies pilot-related accidents according to the phase of flight in which the situation that resulted in the accident began. For example, fuel exhaustion or an encounter with low weather may have caused the pilot to make a precautionary landing. Although the accident actually occurred during this landing, the "emergency phase" of flight would be cruise.

Emergency Phase of Flight



Although an examination of all causes may explain any one accident more completely, use of a single classification for each accident based upon the problems that initiated the accident chain helps to identify predominant factors when summarizing a large number of accidents. This is a technique frequently used in analyses of both general aviation and commercial aviation accidents. The emphasis here is on discussing strategies to help pilots avoid the problems that often begin accident sequences.

Pilot Involvement

Specific Pilot-Related Causes

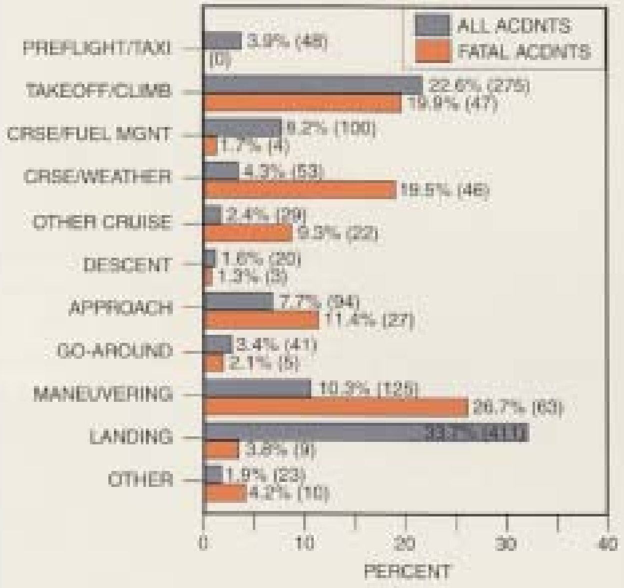
The chart at the right compares accidents where the major cause was attributed to the pilot. Although there is some overlap in the terms used to describe the phase in which the emergency occurred and the cause, the two are not always equivalent. For example, fuel exhaustion may have occurred during cruising flight or during a landing approach, resulting in an accident. The cause of the accidents will then be attributed to fuel management, and the phase of flight will be listed as approach or cruise. Conversely, problems peculiar to approach operations, such as descending below the minimum descent altitude, will show approach as both the phase of flight and the cause.

Analysis of Specific Operations

The accident potential of an individual flight can be highly dependent on the length of the flight, time of day, weather conditions, and how important the pilot perceives the flight to be. The purpose of the flight is referred to in the data as "type of operation." Because the factors cited above often vary according to the type of operation, the following sections focus on three of the most common general aviation operations: personal flying, flight instruction, and business flying. The table below shows how those categories compare to other types of operations.

Accident Causes

Pilot-Related Accidents



OPERATION	Percent of Flying (1996)	Percent of Total Accidents (1997)	Percent of Fatal Accidents (1997)
Personal	41.8	63.9	66.8
Instruction	20.4	14.1	5.7
Aerial Application	7.8	6.3	4.5
Business	14.5	3.8	6.6
Positioning	*	1.6	2.1
Ferry	*	1.0	0.0
Other Work Use	1.1	1.0	0.6
Public Use	2.7	0.6	0.6
Executive/Corporate	5.7	0.4	0.3
Aerial Observation	3.3	0.2	0.6
Other/Unknown	2.7	7.0	12.1

* Included in "Other/Unknown"

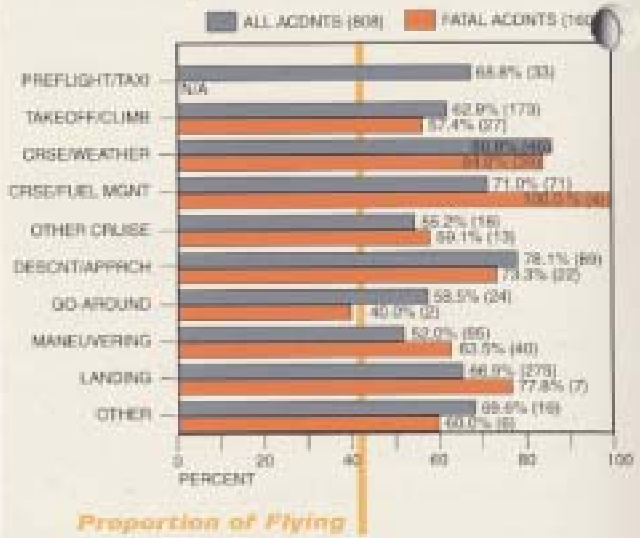
[1] Phase information was only available in 65 percent of the reports.

[2] Only 84 percent of the accidents included data on light conditions.

Personal Flying

Personal flying comprises 41.8 percent of all general aviation flight - by far the largest single type of operation. For 1997, however, accidents during these operations represented an even larger proportion of the total accident picture, accounting for 63.9 percent of all accidents and 66.8 percent of fatal accidents.

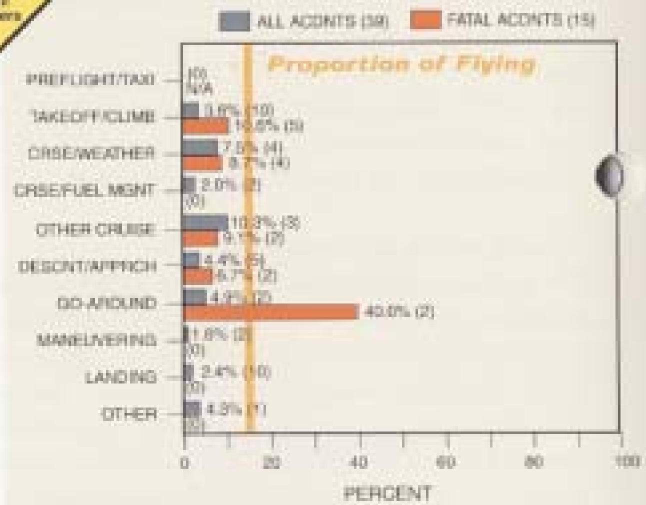
The chart to the right shows the proportion of accidents due to a particular cause that occurred during personal flights. The solid reference line shows the 41.8 percent mark – the point at which the percentage of accidents in each category would be equivalent to the percentage of total flight time spent in personal flights. Bars representing individual causes that extend beyond this line indicate that the accidents in that cause category accounted for more than the personal flying "share" of total accidents. Personal flights resulted in more than their "share" of accidents from all causes.


Personal Flying
Proportion of Accidents

Business Flying

The ability to use an airplane gives many business travelers a flexible, economical way to travel on their own schedules. It also allows them to reach destinations that are difficult or impossible to reach via airlines or other modes of travel. Business flights accounted for only 3.8 percent of the total and 6.6 percent of the fatal accidents in 1997.

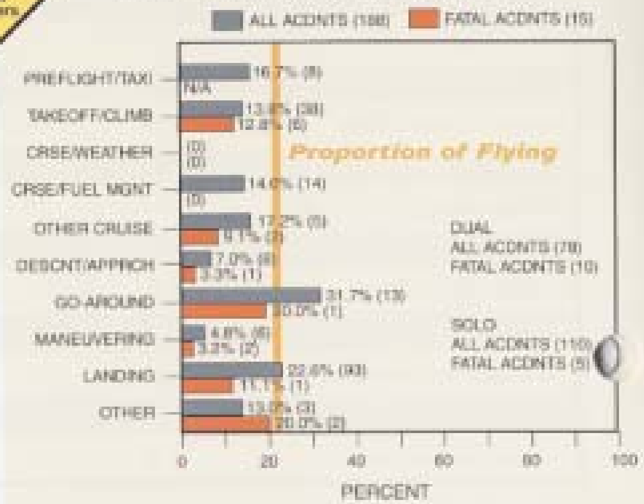
The adjacent chart shows the causes of business travel accidents. The reference line at 14.5 percent may be used in the same manner as described above under "Personal Flying." For 1997, all causal areas of business flight accidents were lower than the proportion of business flying hours to total flying hours, except for accidents during go-around. This particular statistic should be used with caution, however, because of the extremely small number of fatal accidents that took place during go-around. General aviation saw a total of only five fatal go-around accidents in 1997, and only two of those occurred during business flights. Business flying has a very good safety record.


Business Flying
Proportion of Accidents

Instructional Flying

Instructional flying showed an increase in accidents. Flight training accounted for 14.1 percent of the accidents in 1997 as compared to 13 percent in 1997. The percentage of fatal instructional accidents decreased from 5.9 percent in 1996 to 5.7 percent this year. These figures are still well below the 20.4 percent of the flying done for instructional purposes (see table on page 11). It's difficult to make meaningful generalizations with a small number of accidents, but some interesting facts are worth mentioning.

The largest increase in instructional accidents occurred during takeoff/climb – 38 in 1997 as compared to 22 in 1996. Almost two-thirds of these accidents happened on dual flights. Takeoff/climb accidents also accounted for the largest number and the largest increase in fatal training accidents in 1997. There were six fatal takeoff/climb accidents during instructional flights in 1997 as compared to three in 1996. Five of these were on dual training flights.


Instructional Flying
Proportion of Accidents

Personal flight accounted for about 42 percent of the activity and almost 67 percent of the fatal accidents. Compare that to flight instruction, which has grown to over 20 percent of all flight hours, with less than six percent of the fatal accidents.

- Dual flights accounted for 25 of the 38 takeoff/climb accidents.
- In most of these cases the CFI was flying the airplane when the accident occurred.
- Stalls or stall/spins accounted for 9 accidents.
- Loss of control on the runway accounted for 6 accidents.
- Engine failure accounted for 6 accidents.
    - Fuel starvation was a causal factor in 3 accidents – engines failed for unknown reasons in 3 accidents.

A Word to the Flight Instructor

CFI's must be especially careful in demonstrating maximum performance takeoffs. Many of the dual takeoff crashes occurred during soft or short field takeoff demonstrations.

Solo students didn't have a high incidence of stall/spin takeoff accidents. Most of their problems involved loss of control while still on the runway. Their engine failures were often caused by failing to select the proper fuel tank for takeoff. Instructors must be certain their students are proficient in tank switching. Transitions from trainers with on/off only fuel systems need special attention.

Go-around accidents accounted for the other large increase in training accidents in 1997. The 13 that happened during the year were more than three times the four that occurred in 1996. Eleven of these occurred on solo training flights.

- Solo students had most of the go-around accidents – 11 of the 13.
- The single fatal accident in the group occurred in a multi-engine airplane when the CFI attempted a single-engine go-around with the critical engine feathered. This is something no multi-engine pilot should try and it's especially perplexing when the runway was clear and available for landing.
- Clearly more dual instruction must be devoted to go-around practice.
- CFI's should allow their students to make the go-around decision as well as fly the actual procedure. Emphasize the wisdom of making the go-around decision early when there is more margin for error.

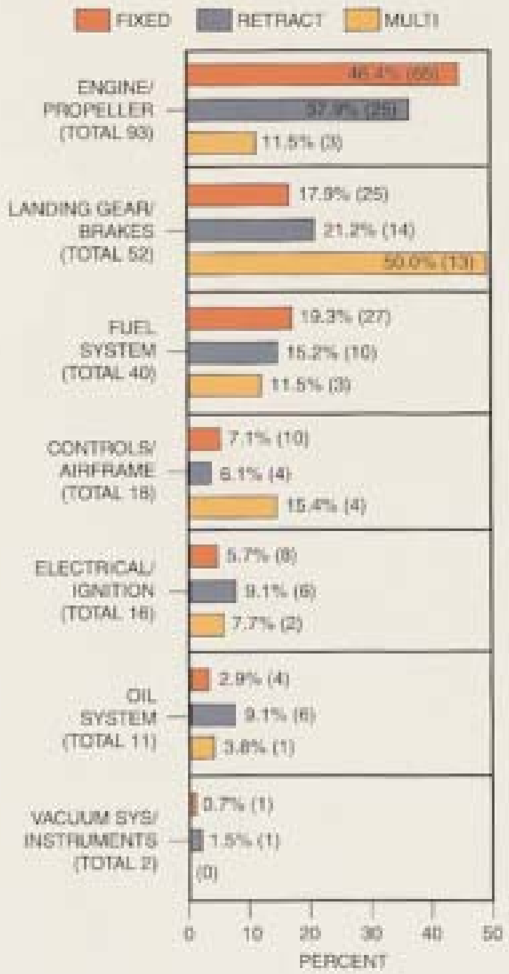
Mechanical/Maintenance

Mechanical/maintenance accidents account for 14.1 percent of all accidents. By far, the largest percentage of these accidents was the result of powerplant or propeller problems. In addition, four other accidents were classified as "power malfunction/loss for unknown reasons" because only preliminary reports were available for them. Although it is probable that some of these accidents will be classified to pilot-related causes, such as fuel mismanagement, once their investigations are complete, some may be confirmed as being mechanical once the mechanical components are analyzed. Thus, the final count of mechanical/maintenance problems may change slightly when the final reports are in.

Pilots should note that several of the mechanical failure accidents could have been prevented by a thorough preflight. Other accidents resulted when pilots incorrectly performed procedures after system failures occurred.

Mechanical/Maintenance

All Accidents



Fatal Accident Factors

Based upon the probability of fatalities, the primary causes of fatal accidents across all classes of airplanes for 1997 were:

- Weather
- Maneuvering Flight
- Approaches

As in the past, the causes of fatal accidents were closely linked to the flight profile, including the length of the trip, the time of day, the purpose of the trip, and whether the flight was IFR or VFR.

Although some classes of aircraft were more likely to be involved in specific types of serious accidents, the accidents were not generally caused by characteristics of aircraft involved. For instance, multiengine and single-engine retractable-gear airplanes were involved in a high proportion of IFR accidents, corresponding to the fact that these complex airplanes were more likely to be flown under instrument rules than fixed-gear aircraft. At the same time, single-engine fixed-gear airplanes were involved in a high proportion of accidents in VFR conditions. Significantly, almost all types of accidents occurred in all classes of airplanes. Good airmanship principles are not class specific.

Severity - Probability of Fatalities

The likelihood that a given accident will be fatal can be estimated by comparing the number of total accidents to the number of fatal accidents with the same cause. Regardless of the cause, however, accidents in single-engine retractable-gear aircraft were more likely to be fatal than those in fixed-gear aircraft. The fatality rate for multiengine airplanes was even higher. This was most likely the result of higher speeds at impact.

- Weather: Weather-related accidents were more likely to be fatal than accidents with any other cause. Fully 86.8 percent, or 46 out of 53 weather-related accidents, involved fatalities. Most weather-related accidents involved aircraft striking objects or terrain at high airspeed or crashing out of control, sometimes after pilot-induced structural failure.

- Maneuvering flight: Slightly more than half of all accidents involving maneuvering flight, 50.4 percent or 63 of 125 accidents, involved fatalities. Like weather accidents, maneuvering accidents frequently involved aircraft crashing out of control or colliding with terrain, wires, or towers.

- Approach: Twenty-seven of 94, or 28.7 percent, of all approach accidents produced fatalities. Aside from steep-turn/stall mishaps, "improper IFR approach" was one of the largest single problems in this area, adding another dimension to the weather-related accident count.

It should also be noted that while only 17.1 percent of accidents attributed to takeoff or initial climb-out were fatal, takeoff errors caused 47 fatal accidents, more than approach problems, which caused 27 fatal accidents. The low fatality rate was due to the large number of nonfatal takeoff accidents – 228 of 275 total takeoff accidents did not involve fatalities. Takeoff accidents involving loss of control at relatively low speeds kept the fatality rate down while producing a large number of total accidents.

Weather

This cause area had the highest overall fatality rate of any accident cause, at 86.8 percent. Most accidents involving weather were the result of controlled flight into terrain or other objects, spatial disorientation leading to uncontrolled flight, or pilot-induced structural failure of the aircraft. The high impact forces made weather accidents some of the deadliest of all.

Some accidents attributed to other causes involved weather as a contributing factor, as in the case of improper IFR approach, which was responsible for 11 fatal approach accidents. Wind shear and crosswinds also caused weather-related accidents in VFR conditions.

Thirty-eight of the 46 fatal weather-related accidents, or 82.6 percent, were caused by "attempted VFR flight into instrument meteorological conditions (IMC)." Twenty of these were in single-engine fixed-gear aircraft, accounting for 90.9 percent of the fatal weather-related accidents in those aircraft. VFR flight into IMC continued to be one of the most frequent causes of fatal accidents, leading one to the question, "What is it about the fact that they can no longer see the ground that pilots don't understand?" Because 38 of 46 of these accidents were fatal, there are few surviving pilots to answer the question. Continued VFR into IMC is an area that needs more study and pilots need to better understand the extreme risk. The AOPA Air Safety Foundation has published the Safety Review: *General Aviation Weather Accidents*, which offers detail and analysis of weather accidents. (See the appendix for more information).

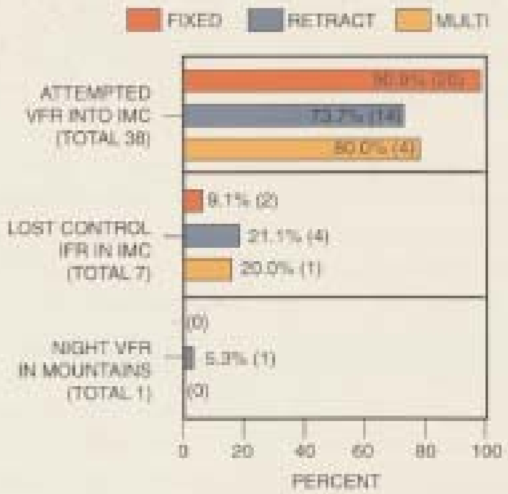
Interaction of Night and Weather

The chart at the right shows the interaction between night and IMC. The dashed lines show the total and fatal accidents per 100,000 hours for those accidents where weather and light conditions were reported. Bars extending above these reference lines indicate a higher than average accident rate under the indicated conditions. The data show that IMC flight produces approximately 42 percent fewer total accidents per 100,000 hours but almost three times the rate of fatal accidents as visual meteorological conditions (VMC). Unfortunately, information on light and weather conditions was not included in 16.6 percent of the NTSB's accident reports for 1997, and in 35.6 percent of the reports on fatal accidents.

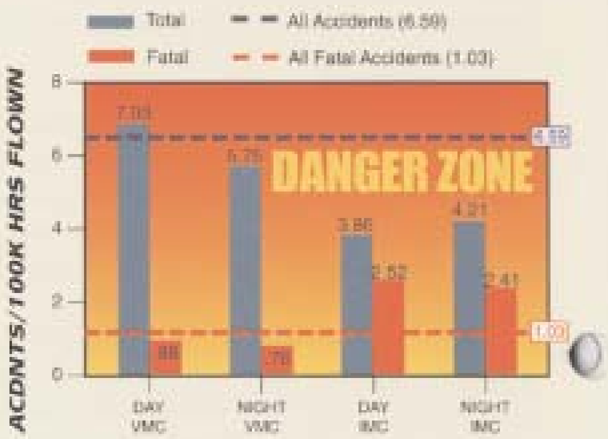
Maneuvering Flight

Maneuvering flight in single-engine airplanes continues to be one of the largest producers of fatal accidents. It is also one of the most pre-

Fatal Weather Accidents



Weather/Light Conditions



Beware the crosswind! Takeoff and landing are the most likely phases of flight to have a mishap, although they are seldom fatal.

ventable. Thirty-one of 63, or 49.2 percent, of fatal maneuvering accidents were the result of "maneuvering during low, slow flight."

Some of these accidents occurred during legitimate activities such as aerial applications, banner towing, and law enforcement. These operations require low, slow flight and considerable mission-related division of attention. In operations where there is a mission beyond just operating the aircraft, the task demands of the mission and the task demands of flying can reach extremes simultaneously, severely taxing the pilot's capability. These operations carry some inherent risk and demand skill and vigilance from the pilot.

More often than not, maneuvering accidents occurred during personal, not mission-related, flights. In fact, 52 percent of all maneuvering accidents and 63.5 percent of fatal maneuvering accidents occurred during flights described as personal.

A few of these accidents were the result of inadvertent loss of control by pilots performing common operations. Some, however, occurred during buzzing or low-level aerobatics. Many involved a degree of recklessness that makes it difficult to term them "accidents" in a true sense. No increase in proficiency can prevent such accidents. Only a change in attitude on the part of the pilots involved can bring about change. Pilots must refrain from this type of reckless activity and encourage their peers to do the same. Such antics are not the mark of a skilled pilot – only a potentially dead one.

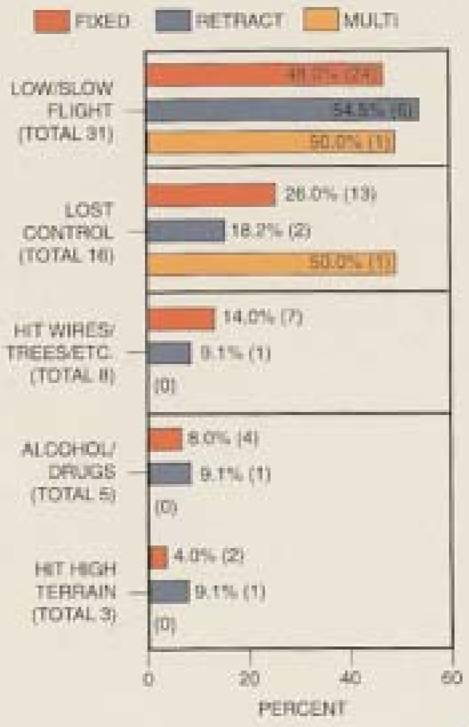
Approach

Accidents resulting from mishandled approaches, although low in number, were fatal 28.7 percent of the time. Most problems were the result of stall/mush or failure to follow instrument approach procedures. All classes of aircraft were represented in both of these problem areas. To prevent these accidents, pilots must build and maintain their instrument skills. Train and stay current!

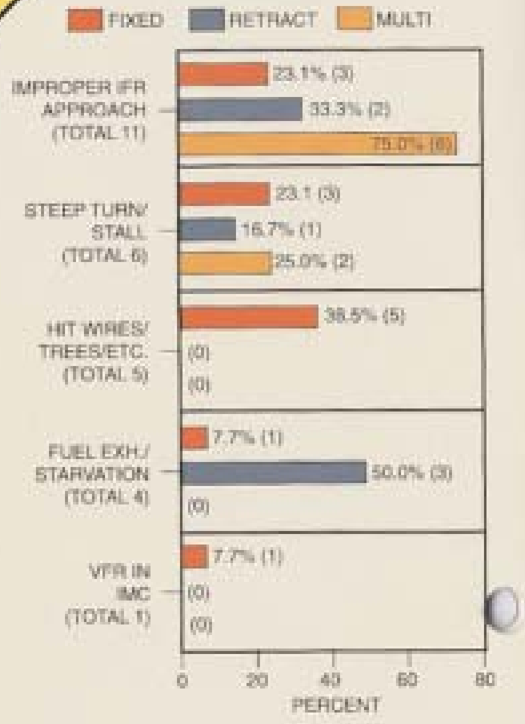
Fatal instrument approach accidents involved six multiengine, two retractable single-engine, and three fixed-gear single-engine airplanes. Instrument pilots must perform complex tasks after flying for long periods in bad weather. This was a significant factor in causing these accidents, especially in single-pilot operations. Private, not-for-hire operations (FAR Part 91) are among the few types of IFR operations that do not require a second pilot or an autopilot.

Studies conducted by NASA and the FAA for the airlines have shown that takeoff/initial climb and approach/landing phases of flight are the most demanding. These studies have also shown that pilot capabilities erode throughout the flight from the combined effects of fatigue and complacency after an uneventful flight. The most demanding tasks must be performed at a time when the pilot's ability to accomplish complex tasks may be significantly diminished.

Fatal Maneuvering Accidents



Fatal Approach Accidents



Other Accident Factors

Midair Collisions

During 1997 there were 13 midair collisions involving a total of 25 general aviation aircraft and one scheduled commuter aircraft. Eleven of these accidents were fatal, resulting in 29 deaths. The number of midair collisions involving GA airplanes was down from 18 in 1996, but the number of fatal accidents rose from six to 11, and the number of deaths rose from 19 to 29. Midair collisions continued to occur mainly on good VFR days, at low altitude, close to airports. The graph shows the trend in these accidents over the past six years.

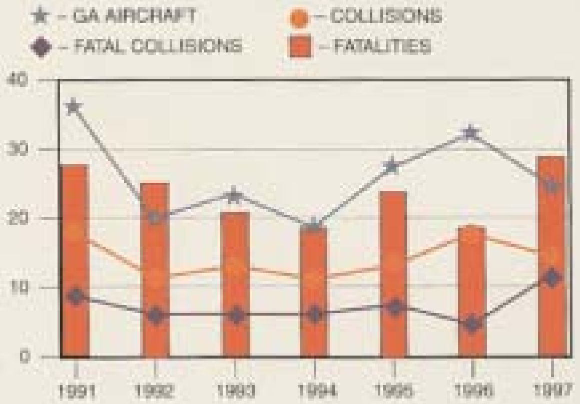
The one other aircraft involved in a midair collision with a general aviation aircraft in 1997 was a BN-2 Islander on a scheduled commuter flight. It collided with another BN-2 Islander that was on a personal flight. They came together over the runway threshold while on visual approach to the same runway at a nontowered airport in Puerto Rico. The commuter flight had flown a standard left traffic pattern while the personal flight flew a nonstandard right traffic pattern. There were no fatalities in this accident.

A recent AOPA Air Safety Foundation study of midair collisions revealed that 49 percent of them occurred in the traffic pattern or on approach to or departure from an airport. Of the other 51 percent, about half occurred during enroute climb, cruise, or descent, and the rest resulted from formation flights or other hazardous activities. Eighty percent of the midair collisions that occurred during "normal" flight activities happened within 10 miles of an airport, and 78 percent of the midair collisions that occurred around the traffic pattern happened at nontowered airports. Important strategies for avoiding these mishaps can be found in the Foundation's *Safety Advisor: Operations at Nontowered Airports.*

Alcohol and Drugs

In 1997, 17 general aviation aircraft accidents involved drug or alcohol abuse. Twelve of these were fatal, killing 22 people. Alcohol was involved in seven accidents, including four fatal accidents, accounting for seven deaths. Illegal drugs figured in four accidents, three of them fatal, resulting in six deaths. The other six accidents, including five fatal accidents claiming nine lives, involved improper use of legal medications. These numbers may change slightly as more accident investigations are completed.

Midair Collisions
1991-1997



	'91	'92	'93	'94	'95	'96	'97
GA Aircraft	36	20	23	19	27	33	25
Collisions	18	11*	13*	11*	14*	18*	13*
Fatal Collisions	9	7	7	7	8	6	11
Fatalities	28	26	21	19	24	19	29

* Involved other aircraft not counted in GA totals.

Fuel Mismanagement

Fuel exhaustion is engine stoppage due to the depletion of all available fuel on board the airplane. Fuel starvation is engine stoppage due to an interruption of the fuel supply to the engine, even though fuel remains available in one or more of the aircraft's fuel tanks. In 1997, there were 110 accidents caused by fuel exhaustion, of which only five were fatal (2 in cruise, 1 in descent, 2 on approach), resulting in six deaths. Another 59 accidents occurred because of fuel starvation. Six of these accidents were fatal (1 on takeoff, 1 in climb, 1 in cruise, 1 while maneuvering, 2 on approach), leading to nine deaths. ASF recommends a minimum fuel reserve of at least one hour for both VFR and IFR operations.

Knowledge of aircraft performance, realistic preflight fuel planning, and diligent monitoring of fuel consumption and flight time would prevent nearly all fuel exhaustion accidents. Likewise, a thorough knowledge of aircraft systems and a disciplined approach to fuel management are antidotes to most fuel starvation problems.

Off-Airport Injuries

One of the myths surrounding general aviation is the perceived danger of light aircraft falling from the sky. In 1997, there were no fatalities or serious injuries to off-airport bystanders. There was only one minor injury to one bystander throughout the year. This accident involved an aircraft trying to make an emergency landing on a highway. The aircraft struck a pickup truck, and its driver received minor injuries. This is a significant decrease from 1996, when two people on the ground were killed, two were seriously injured, and nine more received minor injuries during seven off-airport general aviation aircraft accidents.

Pilot Incapacitation

Seven general aviation aircraft accidents during 1997 involved pilot incapacitation. Six of these were fatal, with nine people killed. Three accidents resulted from heart attacks or strokes, two from carbon monoxide poisoning, one from hypoxia, and one from undetermined illness.

Propeller Strikes

Three pilots/passengers were struck by turning propellers during 1997. Two people were killed, and the third was seriously injured.

Homebuilt Aircraft

Building an airplane can be a satisfying, rewarding experience. It can also give the builder access to technological advances not yet available in factory-built aircraft. In order to take advantage of these advances, however, the builder assumes many of the same responsibilities met by the engineering, flight test, and production departments of a major manufacturer. The builder, with relatively minimal oversight, is responsible for construction, quality control, initial flight testing, and, in some cases, even basic design. The conscientious builder can avoid most of the risks this generates with careful planning.

Fuel management, or rather mismanagement, continues to be a leading identifiable cause of accidents. Last year more than two airplanes a week were crashing with no danger of catching fire – no gas in the tanks. Almost everybody almost made it – usually within just a few miles of the destination.

Remember the following key points when making decisions regarding homebuilt airplanes:

Design

- Adhere to the manufacturer's plans or kit instructions.
- Know whether the aircraft qualifies as an ultralight vehicle or a homebuilt airplane.

Construction

- Get the help and oversight of an experienced builder.
- Be aware of required FAA inspections.

Test Flying

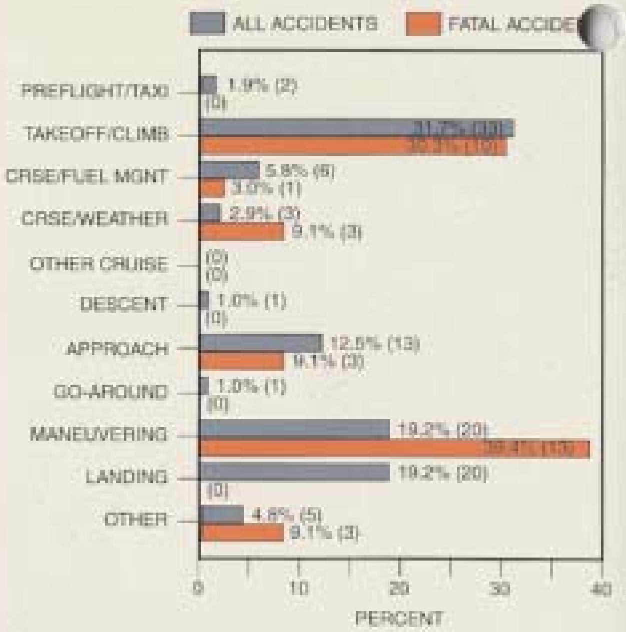
- Plan and take precautions for test flights.
- Have the necessary flight experience and currency to make the test flights.
- Understand the stability and other flight characteristics of high-performance homebuilt aircraft.

The Experimental Aircraft Association (EAA) is an excellent source of more detailed information about building and flying homebuilt aircraft. This organization sponsors many educational activities and maintains a network of volunteer technical counselors in every area of the country. Many kit manufacturers also offer training packages and technical support services for builders and pilots of their products. Local FAA Flight Standards District Offices can answer questions regarding homebuilt aircraft and pilot certification requirements.

The charts at the right show accident causes for homebuilt airplanes and how they compare to those for factory-built airplanes. Some of these accidents were the result of pilots being unprepared for the peculiarities of their aircraft. This is particularly important for initial flight testing and shows up in approach accidents. Unfortunately, however, many of these accidents were the result of poor judgment on the part of the pilots involved and not due to unique features of their aircraft.

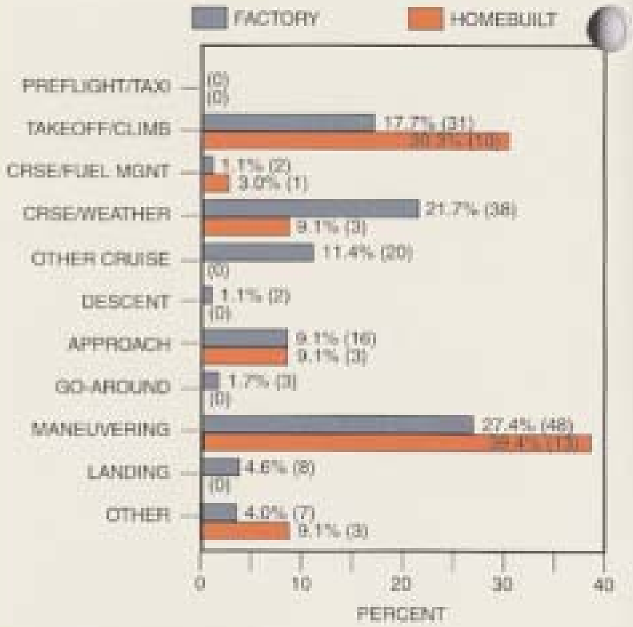
Accident Causes

Homebuilt Aircraft



Homebuilt vs. Factory Aircraft

Fatal Accidents



Homebuilt Accidents

MAJOR CAUSE	ALL ACCIDENTS	FATAL ACCIDENTS
Pilot	63.8%	57.9%
Mechanical/Maintenance	18.4%	10.5%
Other	16.0%	26.3%
Unknown	1.8%	5.3%
Total	100.0%	100.0%

Conclusions

> *Carelessness and overconfidence are usually more dangerous than deliberately accepted risks.*
>
> *– Wilbur Wright 1901*

Risk Management and Accident Prevention Strategies

The sections below outline some steps that can be taken by pilots and non-pilots to reduce the risks of an accident.

In 1901, Wilbur Wright said, "Carelessness and overconfidence are usually more dangerous than deliberately accepted risks." It is worth noting that he made this statement two years before the Wrights' historic flight at Kitty Hawk. Modern pilots would be wise to adopt the Wrights' attitude toward risk – an attitude that helped them succeed where others were injured or killed in similar attempts.

General aviation flying is not without risk, but pilots can minimize their chances of being involved in an accident. The points below can reduce the risks that have been identified in this report:

- **Maneuvering flight:** Many maneuvering flight accidents happen when pilots conduct unauthorized aerobatics, buzzing, or other low level flight. This is easily prevented. Don't be tempted to show off for your peers or others. Instead, enroll in an aerobatics course with a qualified instructor and the proper equipment. You can increase your piloting skills and enjoy these maneuvers safely and legally.

- **Weather:** Consider all aspects of the flight, including weather, time of day, aircraft capabilities, and your own experience, currency, and condition. Be conservative with weather if you're flying VFR, especially at night. Give yourself ample allowance for any deteriorating conditions, and make alternate plans in advance. Forecasts are not guarantees. Get weather updates in flight, and adjust alternate plans accordingly. Learn about weather from more experienced pilots by flying with them when the opportunities exist.

- **Takeoff and landing:** These phases of flight produce relatively few serious accidents but a large number of minor accidents. Many of these accidents involve skill errors rather than the decision-making errors that characterize more serious accidents. Lack of proficiency in basic operations, including failure to properly handle windy conditions, leads to many takeoff and landing accidents. Training and currency are antidotes to these problems.

Non-pilots can also contribute greatly to flying safety. Passengers and flying companions are encouraged to learn as much as possible about flight operations and to assist pilots in their duties. Pilots should involve their passengers in the flight. The following checklist for pilots and passengers will increase safety.

Pilots

- Explain flight operations.
- Enlist passengers' aid in spotting traffic.
- Require a "sterile cockpit" – no conversation that is unrelated to the safety of flight – during takeoff, approach, landing, or high stress phases of flight.
- Make go/no-go/continue decisions solely on the safety of flight, not on convenience or business factors.

Passengers and Flying Companions

- Show an interest in and offer assistance with flight operations.
- Call attention to hazardous situations. If you're not sure whether a hazard exists, it's better to say something than to remain silent.
- Don't pressure the pilot to complete the flight.
- Support the pilot's safety-motivated decisions.

Frequently Asked Questions

How many accidents are caused by "pilot error"?	See page 7
Which flight operations are the riskiest?	See page 7
What are the leading causes of accidents that result in fatalities?	See page 15
How common are midair collisions?	See page 19
Are homebuilt airplanes as safe as factory-built airplanes?	See page 22
Are alcohol and drugs involved in a large number of accidents?	See page 19
Where do single-engine airplanes encounter the most problems?	See page 8
Where do multiengine airplanes encounter the most problems?	See page 8
What is the role of weather in fatal accidents?	See page 16
What kinds of mechanical failures are most likely to lead to an accident?	See page 14
Is night flight really more dangerous that daytime flight?	See page 16
How many people are killed on the ground due to airplane accidents?	See page 20
Do student pilots have more accidents than fully certificated pilots?	See page 12
Which phase of flight has the most accidents?	See page 7
What does the term "accident rate" really mean?	See page 3
How safe is personal flying?	See page12
How safe is business flying?	See page 12
How safe is instructional flying?	See page 12
What can I do as a nonpilot passenger to reduce risk in flying?	See page 24
What types of operations are included in "general aviation?"	See page 2
Where do we get our flight hour estimates?	See page 3

NTSB Definitions

Accident/Incident (NTSB Part 830)

The following definitions of terms used in this report have been extracted from NTSB Part 830 of the Federal Aviation Regulations. It is included in most commercially available FAR/AIM digests and should be referenced for detailed information.

Aircraft Accident – An occurrence incidental to flight in which, "as a result of the operation of an aircraft, any person (occupant or non-occupant) receives fatal or serious injury or any aircraft receives substantial damage."

- A **fatal injury** is one that results in death within 30 days of the accident.
- A **serious injury** is one that:
  - **(1)**Requires hospitalization for more than 48 hours, commencing within seven 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)**Involves lacerations that cause severe hemorrhages, nerve, muscle, or tendon damage;
  - **(4)**Involves injury to any internal organ; or
  - **(5)**Involves second- or third-degree burns, or any burns affecting more than 5 percent of body surface.
- A **minor injury** is one that does not qualify as fatal or serious.
- **Destroyed** means that an aircraft was demolished beyond economical repair, that is, substantially damaged to the extent that it would be impracticable to rebuild it and return it to an airworthy condition. (This may not coincide with the definition of "total loss" for insurance purposes. Because of the variability of insurance limits carried and such additional factors as time on engines and propellers, and aircraft condition before an accident, an aircraft may be "totaled" even though it is not considered "destroyed" for NTSB accident-reporting purposes.)
- **Substantial damage:**
  (As with "destroyed" above, the definition of "substantial" for accident-reporting purposes does not necessarily correlate with "substantial" in terms of financial loss. Contrary to popular misconception, there is no "dollar value" that defines "substantial damage." Because of the high cost of many repairs, large sums may be spent to repair damage resulting from incidents that do not meet the NTSB definition of "substantial damage.")
  - **(1)**Except as provided below, substantial damage means damage or structural failure that adversely affects the structural strength, performance, or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected part.
  - **(2)**Engine failure, damage limited to an engine, bent fairings or cowling, dented skin, small puncture holes in the skin or fabric, ground damage to rotor or propeller blades, damage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wing tips are not considered "substantial damage."
- **Minor damage** is any damage that does not qualify as substantial, such as that in item (2) under substantial damage.

Kind of Flying

The purpose for which an aircraft is being operated at the time of an accident:

On-Demand Air Taxi – Revenue flights, conducted by commercial air carriers operating under 14 CFR 135, that are not operated in regular scheduled service, such as charter flights, and all non-revenue flights incident to such flights.

Personal – Flying by individuals in their own or rented aircraft for pleasure or personal transportation not in furtherance of their occupation or company business. This category includes practice flying (for the purpose of increasing or maintaining proficiency) not performed under supervision of an accredited instructor and not part of an approved flight training program.

Business – The use of aircraft by pilots (not receiving direct salary or compensation for piloting) in connection with their occupation or in the furtherance of a private business.

Instruction – Flying accomplished in supervised training under the direction of an accredited instructor.

Executive/Corporate – The use of aircraft owned or leased, and operated by a corporate or business firm for the transportation of personnel or cargo in furtherance of the corporation's or firm's business, and which are flown by professional pilots receiving a direct salary or compensation for piloting.

Aerial Application – The operation of aircraft for the purpose of dispensing any substance for plant nourishment, soil treatment, propagation of plant life, pest control, or fire control, including flying to and from the application site.

Aerial Observation – The operation of an aircraft for the purpose of pipeline/powerline patrol, land and animal surveys, etc. This does not include traffic observation (electronic news gathering) or sightseeing.

Other Work Use – The operation of an aircraft for the purpose of aerial photography, banner/glider towing, parachuting, demonstration or test flying, racing, aerobatics, etc.

Public Use – Any operation of an aircraft by any federal, state, or local entity.

Ferry – A non-revenue flight for the purpose of (1) returning an aircraft to base, (2) delivering an aircraft from one location to another, or (3) moving an aircraft to and from a maintenance base. Ferry flights, under certain terms, may be conducted under terms of a special flight permit.

Positioning – Positioning of the aircraft without the purpose of revenue.

Other – Any flight that does not meet the criteria of any of the above.

Unknown – A flight whose purpose is not known.

Phase of Operation

The phase of the flight or operation is the particular phase of flight in which the first occurrence or circumstance occurred:

Standing – From the time the first person boards the aircraft for the purpose of flight until the aircraft taxies under its own power. Also, from the time the aircraft comes to its final deplaning location until all persons deplane. Includes preflight, starting engine, parked-engine operating, parked-engine not operating, and idling rotors.

Taxi – From the time the aircraft first taxies under its own power until power is applied for takeoff. Also, when the aircraft completes its landing ground run until it parks at the spot of engine shutoff. Includes rotorcraft aerial taxi. Includes taxi to takeoff and taxi from landing.

Takeoff – From the time the power is applied for takeoff up to and including the first airborne power reduction, or until reaching VFR traffic pattern altitude, whichever occurs first. Includes ground run, initial climb, and rejected takeoff.

Climb – From the time of initial power reduction (or reaching VFR traffic pattern altitude) until the aircraft levels off at its cruise altitude. Also includes enroute climbs.

Cruise – From the time of level-off at cruise altitude to the beginning of the descent.

Descent – From the beginning of the descent from cruise altitude to the IAF, FAF, outer marker, or VFR pattern entry, whichever occurs first. Also includes enroute descents, emergency descent, autorotation descent, and uncontrolled descent.

Approach – From the time the descent ends (either IAF, FAF, outer marker, or VFR pattern entry) until the aircraft reaches the MAP (IMC) or the runway threshold (VMC). Includes missed approach (IMC) and go-around (VMC).

Landing – From either the MAP (IMC) or the runway threshold (VMC) through touchdown or after touchdown off an airport, until the aircraft completes its ground run. Includes rotorcraft run-on, power-on, and autorotation landings. Also includes aborted landing where touchdown has occurred and landing is rejected.

Maneuvering – Includes the following: Aerobatics, low pass, buzzing, pull-up, aerial application maneuver, turn to reverse direction (box-canyon-type maneuver), or engine failure after takeoff and pilot tries to return to runway.

Other – Any phase that does not meet the criteria of any of the above. Examples are practice single-engine airwork, basic airwork, external load operations, etc.

Unknown – The phase of flight could not be determined.

Appendix

For information about AOPA Air Safety Foundation safety materials or seminars, call us at **1-800-638-3101**, e-mail us at **asf@aopa.org**, or visit our Web site at **www.aopa.org/asf**.

AOPA Air Safety Foundation *Safety Advisors*

Because we are a nonprofit organization, we ask you to send a self-addressed envelope and $1.00 for each *Safety Advisor* (unless otherwise specified) to cover shipping and handling.

Send to: AOPA Air Safety Foundation, Attn: *Safety Advisor* Fulfillment
421 Aviation Way, Frederick, MD 21701

- ***Single-Pilot IFR***—Item #SA05
- ***Airspace for Everyone***—Item #SA02
- ***Instructor's Guide to the Pre-Solo Written Test***—Item #SA04
- ***GPS Technology***—Item #SA01
- ***Pilot's Guide to the Flight Review***—Item #SA03
- ***Aircraft Icing***—Item #SA11
- ***ASOS***—Item #SA09
- ***PCATD***—Item #SA10
- ***Weather Strategies***—Item #SA12 (Send $2.00)
- ***Weather Tactics***—Item #SA13 (Send $2.00)
- ***Propeller Safety***—Item #SA06
- ***Operations at Towered Airports***—Item #SA07
- ***Operations at Nontowered Airports***—Item #SA08

AOPA Air Safety Foundation Safety Reviews

To order, call Sporty's Pilot Shop at 1-800-LIFTOFF. All Safety Reviews are $22.95 plus shipping and handling.

- Beechcraft Baron Safety Review: M876A
- Beechcraft Bonanza/Debonair Safety Review: M627A
- Cessna 210 Safety Review: M878A
- Cessna P210 Safety Review: M633A
- Mooney M20 Series Safety Review: M877A
- Piper Cherokee/Arrow Safety Review: M634A
- Piper Malibu/Mirage Safety Review: M635A
- Piper PA-38 Tomahawk Safety Review: M743A
- Piper Comanche Safety Review: M576A
- Cessna 310 Safety Review: M705A
- General Aviation Weather Accidents —An Analysis and Preventive Strategies: M904A

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Available from Sporty's Pilot Shop: 1-800-LIFTOFF

- Mountain Flying—M311A — $29.95
- Midair Collision Avoidance—M474A —$19.95
- Stall/Spin: Classic Facts and Myths—M477A— $19.95
- Basic Aviation Weather—M446A—$19.95
- Aviation Weather Theory—M456A—$19.95
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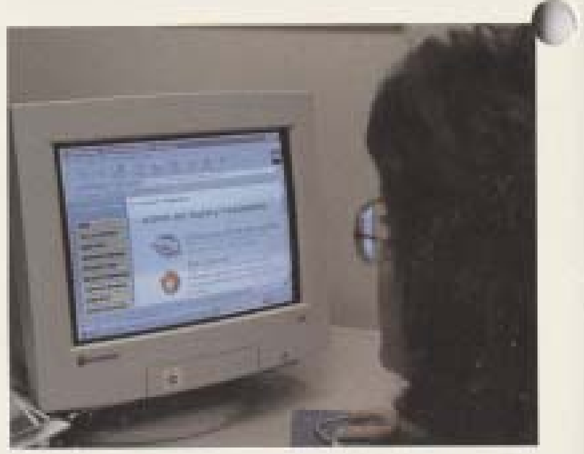

Safe Pilots. Safe Skies.

AOPA Air Safety Foundation

Chartered in 1950, the AOPA Air Safety Foundation is the nation's largest nonprofit organization providing aviation safety education and programs to the general aviation community.

The mission of the Foundation is to save lives and promote accident prevention through pilot education. To serve the nation's 622,000 general aviation pilots, the Foundation:

- Maintains a national aviation safety database that contains NTSB reports on general aviation accidents since 1982.
- Performs accident-trend research to focus Foundation resources on the principal causes of accidents.
- Produces and disseminates aviation education and training videos, *Safety Advisors*, books, and newsletters to increase safety awareness.
- Conducts specialized aviation training courses for students and instructors.
- Provides free public-service aviation safety seminars.

Where the money goes—
Gifts to the Foundation qualify for the federal charitable deduction and take many forms, including cash, appreciated stock, insurance, pledges, real estate, and personal property.

All pilots who contribute $50 or more each year will receive the *Safety Advisor* series on an annual basis. Contact ASF to take advantage of this latest opportunity in safety education and awareness.

An annual report is readily available by writing or calling the Foundation at:

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