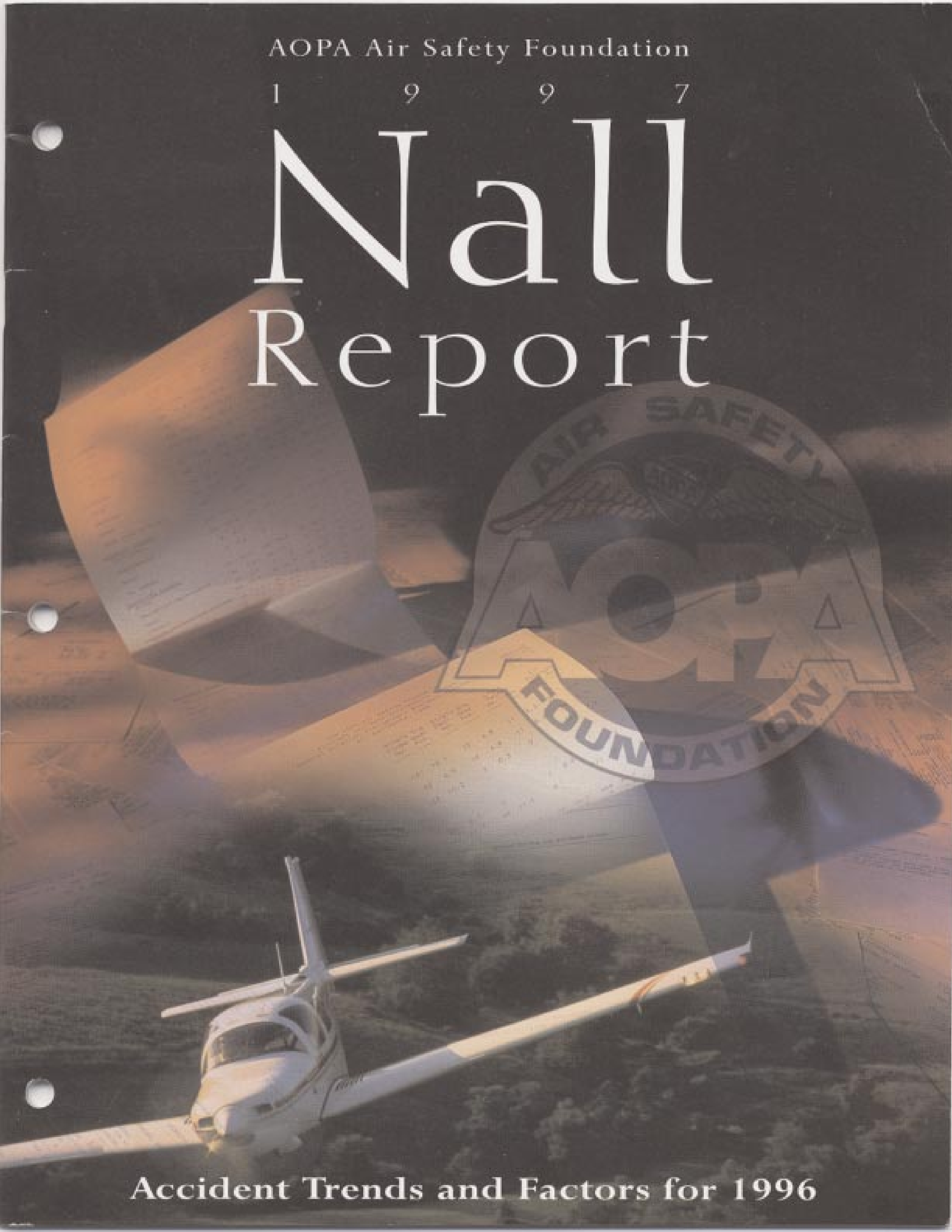
AOPA Air Safety Foundation

1997

Nall Report



Accident Trends and Factors for 1996

Carelessness and overconfidence are usually more dangerous than deliberately accepted risks.

– Wilbur Wright, 1901

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 booklet 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 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 Overview

Constant questions about general aviation safety are: How are we doing? Is anything changing? What is the problem and what can be done about it? The Nall Report answers many of these questions.

The good news is that general aviation had a record-setting year. There were fewer accidents in 1996 than in any year since recordkeeping began in 1938. Even better, fatal accidents were the lowest since 1952. That is truly an achievement, but remember that there was an upturn in accidents just the year before, in 1995. One or even two years does not make a trend, so we won't declare victory just yet.

As in prior years, low-level maneuvering flight and continued VFR into instrument meteorological conditions are the leading problem areas for fatal accidents. The AOPA Air Safety Foundation (ASF) reached out to thousands of pilots last year on both these topics to help everyone understand the risks involved. 1996 was a record year for ASF seminar attendance, so perhaps we may take some small credit for influencing the positive outcome. But it is naïve to think that seminars alone will carry the message to all the pilots who need education. The ASF is experimenting with new media, including having many of our products available on the Internet (www.aopa.org) and, of course, in print. Better training and a better understanding of the risks will make the greatest difference.

Last year brought two high-profile accidents that were largely atypical of the common general aviation accident. Jessica Dubroff's publicity-gathering flight was a wind-shear accident with a certified flight instructor at the controls – highly unusual. The second involved a ground collision at a nontowered airport between a regional airliner and a Beech King Air at Quincy, Illinois. It too was an anomaly, while the same old problems continued to take many more lives, receiving scant attention.

Business flying (individuals flying themselves on business – not professional pilots) and flight instruction enjoy a significantly better safety record than personal flying. Discipline and controlled circumstances seem to make a difference.

As you read these pages, as a flight instructor or pilot, help us think of new ways to influence the judgment of those who err on the side of risk. It might not be anything more than a carefully chosen, tactful remark that helps another pilot see the risk of a particular flight more clearly, or encouragement to attend ASF programs. Flying safely makes a difference, obviously, to the individual pilot, but it has a most beneficial effect on the general aviation industry. That benefits everyone.

Safe Flying,

Bruce Landsberg

Bruce Landsberg
Executive Director
AOPA Air Safety Foundation

Many safety problems in general aviation relate to responsibility and who's in charge. When this question is asked, step up to the plate and say "I am."

– Bruce Landsberg, Executive Director, AOPA Air Safety Foundation

Many safety problems in general aviation relate to responsibility and who's in charge. When this question is asked, step up to the plate and say "I am."

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Background

What Is General Aviation?

General aviation (GA) represents a wide variety of activities including, but definitely not limited to, the recreational flying that typically characterizes this important segment of aviation. In addition to the personal flying that many of us find so enjoyable, general aviation is a valuable component of the nation's transportation system and a means of accomplishing many tasks that could not easily be done by other means. General aviation provides both personal and business transportation and supports diverse activities such as law enforcement, forest fire fighting, freight transportation, air ambulance, and many other vital services. For a breakdown of general aviation activities and their accident statistics, see the "Analysis of Specific Operations" section on page 18.

Total flight hours for general aviation are estimated by the Federal Aviation Administration (FAA), based upon a survey of a sample of aircraft owners and operators. Scheduled air carriers, on the other hand, must report their flight hours, departures, and passengers carried (enplanements).

What Does General Aviation Fly?

Aircraft used in general aviation activities 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 1993 are shown below:

	Air Carrier	Air Taxi	General Aviation
Piston Single-Engine	406	3,043	130,687
Piston Multiengine	315	2,669	16,406
Turboprop Single-Engine	15	321	703
Turboprop Multiengine	1,853	1,662	3,656
Turbojet	4,584	1,020	3,859
Helicopter	124	1,977	4,510
Total	7,297	10,692	159,821

These figures show a comparison of the types of aircraft in the general aviation fleet. This safety report will address accidents in which most of these types of aircraft are involved. Accidents involving turbojet aircraft, aircraft used in airline or scheduled commuter operations, large aircraft weighing more than 12,500 pounds, helicopters, gliders, and balloons are not covered.

How Safe Is General Aviation?

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

In a decision in 1972, the U.S. Supreme Court stated that "safe is not the equivalent of risk free." If freedom from any potential harm were necessary to be considered "safe," few human activities would meet the standard. The only way to completely eliminate risk in any activity is to abstain from engaging in it. Just because there are risks, however, does not mean that harm is inevitable or that we can ignore the risks because they are inherent. Presence of risk does not guarantee injury or make an activity unsafe. By analyzing mishap experience, we can gain valuable knowledge about the risks and take proactive steps to control them. That is the purpose of this safety report.

Statistics

1996 Accident Statistics – An Overview

1996 showed a decrease in the general aviation accident rate per 100,000 flying hours compared to previous years. However, the changes in the accident rate noted in the chart at 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 at right are derived from National Transportation Safety Board (NTSB) preliminary accident reports. 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 from 1992 through 1994 but then rose slightly over the past two years. However, the FAA revised its flight hour estimates for the previous four years downward in 1994, without a corresponding review of its estimates for earlier years.

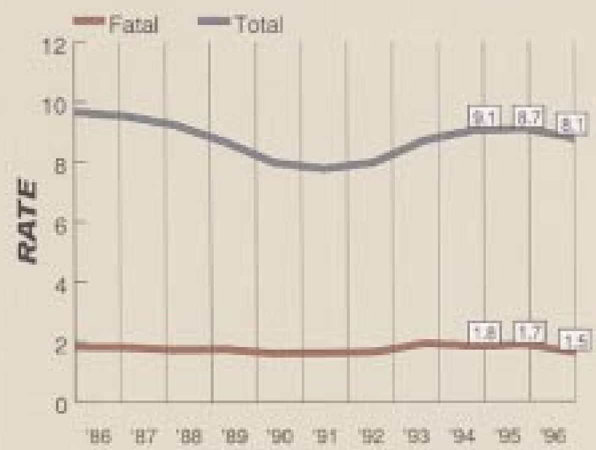
Fatal Accident Rate Lowest in History

The chart at right shows that the overall accident rate per 100,000 flying hours has declined significantly over the past 25 years. However, the decline has slowed in the last half of that period (10 to 12 years), and the chart at right confirms a relatively level trend over the past six years. The fatal accident rate also has declined over those 25 years but has become relatively constant over the past 16 to 17 years. The fatal accident rate and the fatality rate for general aviation aircraft in 1996 were, however, the lowest since 1938, the earliest year in which such accident statistics were reported. General aviation accident rates have always been somewhat higher than those of air carrier operations for a variety of reasons.

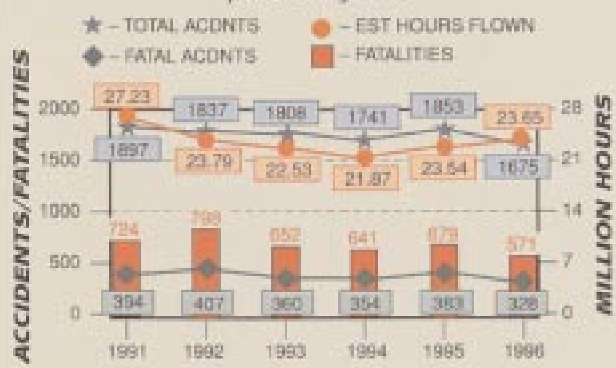
General aviation has risks that other operations do not share. If some of these risks were eliminated, we would lose much of the utility that makes general aviation useful. Some of the important features of general aviation are:

- **Freedom** – Less regulation
- **Facilities** – Often less developed
- **Types of Operations** – Many types of operations are represented in general aviation that have higher risk such as aerial application, law enforcement, banner towing, and training. Also, general aviation aircraft are generally exposed to more takeoffs and landings per flight hour than other aircraft operations, and these are the highest risk phases of any flight.
- **Structure and Controls** – Commercial and military operations have many controls that are not required of general aviation, as well as extensive support structures. General aviation pilots, mechanics, instructors, and managers must discipline themselves to provide the same preparation, attention to detail, and follow-up.
- **Individual Responsibility** – Responsibilities for providing high levels of safety are on individual owners, operators, and pilots.

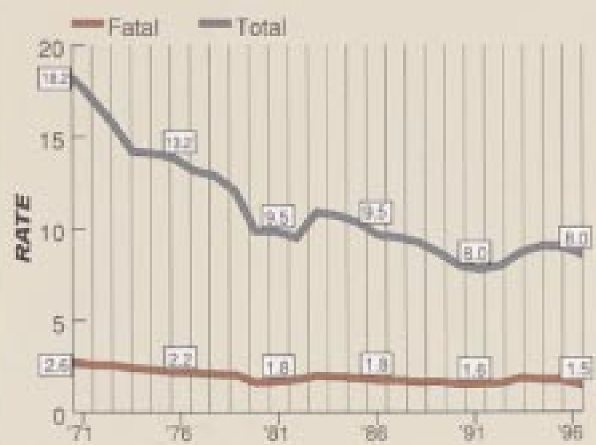
U.S. General Aviation Accidents
per 100,000 hours 1986-96



Accident Statistics
past six years



U.S. General Aviation Accidents
per 100,000 hours 1971-96



Nonetheless, general aviation is safe. The freedoms and flexibility enjoyed by general aviation incur risks, but those risks do not guarantee an accident. They do, however, place additional responsibilities on all participants in the general aviation system. Recognition and active management of risks can go a long way toward minimizing their potential impacts. In these pages, we'll explore some ways in which pilots can make general aviation even safer.

Analysis

Statistical Comparisons of Accident Data – "Apples to Apples"

How do we compare statistics and arrive at meaningful conclusions? Everyone has heard about "the accident rate," but what does this mean? All too often, comparisons are made using raw counts of data; that is, the number of events occurring. To be meaningful, comparisons of events must be made based upon **equal exposure to risk**. The longer we are exposed to a particular risk, or the more times we undertake an activity where risk is involved, the greater the overall risk.

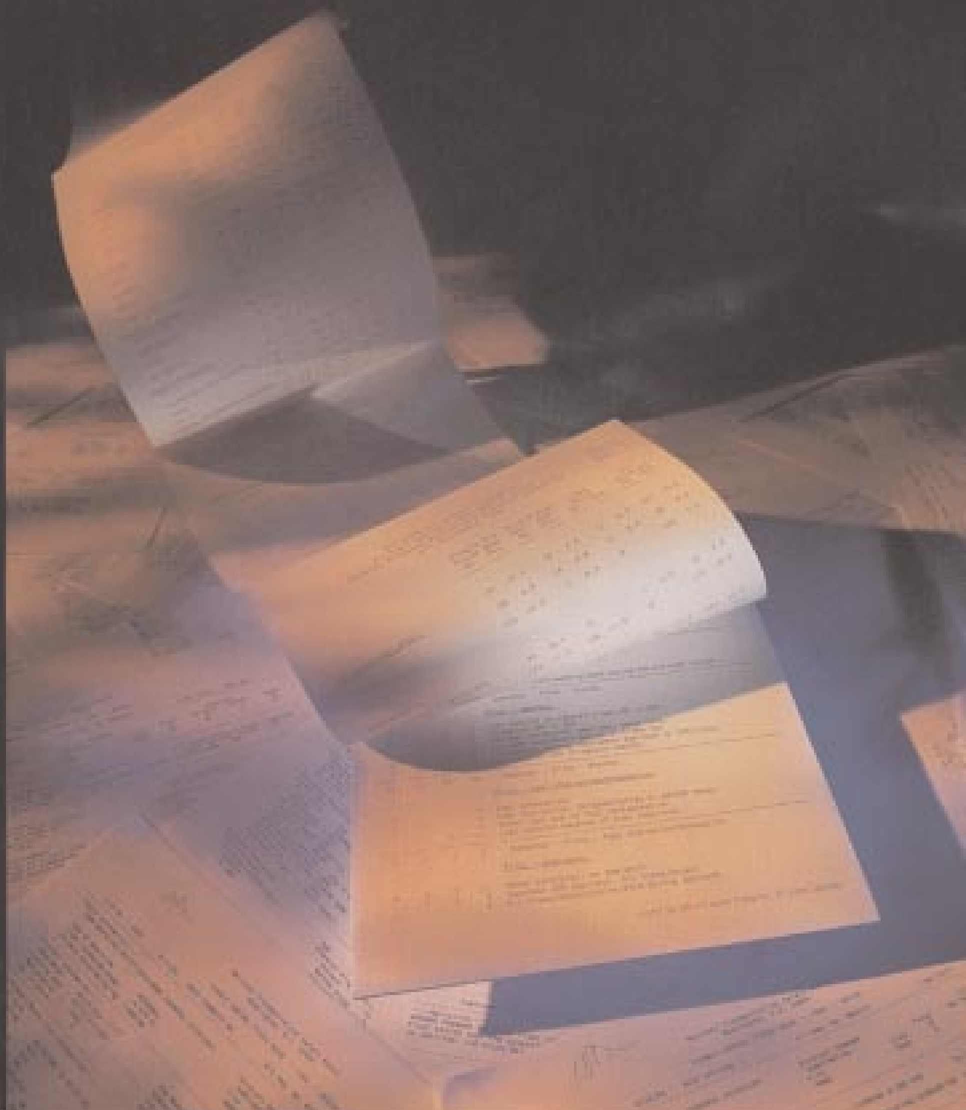
To compare different airplanes, pilots, types of operation, etc., in terms of their accident experience, we must ensure that some measure of equal risk is used. Statisticians call this *normalizing*, or the process of creating a "level playing field" for comparing statistics. The most common normalizing factors for aviation safety are accidents per 100,000 flight hours and accidents per departure (or flight). General aviation data are usually compared using flight hours (accidents per 100,000 hours) because information on departures is not available. Air carrier accident statistics are compared using either hours or departures.

To make truly meaningful comparisons, groups must have approximately equal risk per unit (flight hour or flight). Where this cannot be done, we must recognize what the differences are and evaluate the comparison with these differences in mind. It is also important to realize what normalizing factor is used and what the probable differences between the groups are to accurately interpret comparisons. For example, comparisons made on equivalent data, such as one year's data of general aviation accidents per 100,000 hours versus another year of equivalent general aviation data, are more likely to be accurate than comparisons of general aviation accidents per 100,000 hours versus air carrier accidents per 100,000 hours.

Another type of comparison that is commonly made within a set of data is the comparison of proportions. Comparisons used in this report include the proportion of accidents attributed to particular causes and proportions of accident sequences beginning in a particular phase of flight. These proportions may be used as estimates of what statisticians call *conditional probabilities*. The statement would go something like, "Given an accident that has occurred, what is the probability that it is due to weather, stall/spin, etc." These analyses give us a means of concentrating on the accident factors that produce the greatest risk.

Safe is not the equivalent of risk free.

-U.S. Supreme Court, 1972



Safe is not the equivalent of risk free.

The Accident Setting – Phase of Flight

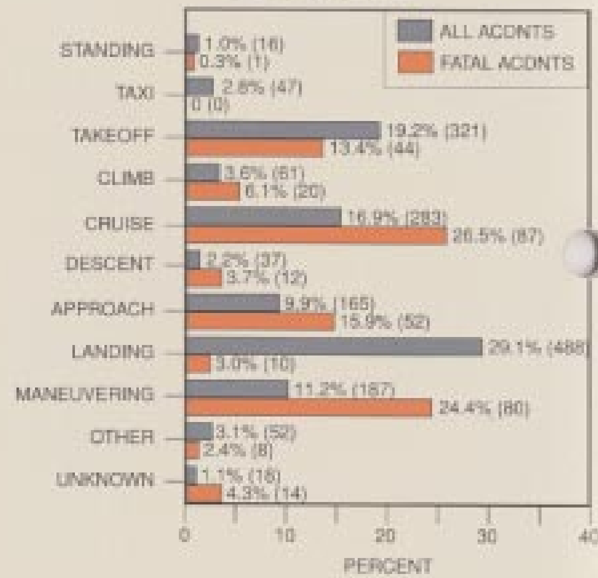
Studies done by the Boeing Commercial Aircraft Company on commercial jet aircraft accidents have estimated the amount of time spent in each phase of a typical flight versus the proportion of accidents that happened during that phase. Takeoff and landing each constitute only one percent of a typical flight, initial climb adds another one percent, and final approach accounts for three 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. General aviation usually performs many more takeoffs and landings per hour of flight than the airlines. For example, instructors and their students may spend entire flight lessons in the traffic pattern. Because general aviation operates in many different environments, its exact proportions are probably different, but the critical relationships 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 chart at 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 an accident during an emergency or precautionary landing. The "emergency phase" of the flight would, therefore, be "cruise" rather than "landing." The majority of accident sequences begin during phases of flight that constitute a minority of the flight time but contain the highest number of critical tasks and the highest task complexity. Compare the proportions of accidents 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.

Sequence of Events and Accident Causality

The Boeing studies also stressed that each accident is usually composed of a sequence of events rather than a single catastrophic event that causes the accident. Their research into air carrier accidents has identified as many as 20 events occurring during a single flight that had a direct impact upon the outcome. The NTSB also breaks down each accident into "occurrences" in a similar methodology. Our emphasis is on identifying the phase of flight in which the sequence of events began (often referred to as the "first occurrence"). This report concentrates on the first occurrence and uses a simpler, single-cause classification scheme. The emphasis is to identify those factors and avoid the problems that began the accident sequence.

Emergency Phase of Flight



Major Cause

As in previous years, pilot-related factors were involved in most general aviation accidents in 1996. Human-factors researchers tell us that between 30 and 80 percent of all serious incidents involving complex systems of all types have human-related causes. Aviation systems are similar in this respect. Preliminary reports for most years show between 60 and 70 percent of accidents are attributable to pilots. Final reports generally show that this grows to between 70 and 80 percent when the investigations are complete.

Specific Pilot-Related Causes

The chart at 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 will then be attributed to fuel management rather than 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 causal category.

Severity *(Probability of Fatalities)*

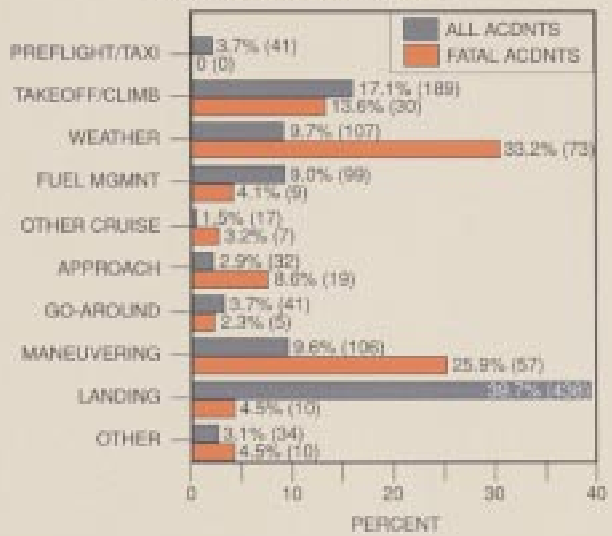
The proportion of fatal accidents compared to total accidents due to a given cause can be used as an estimate of the probability that such an accident will involve fatalities. Fatality rates tend to be higher for single-engine retractable-gear aircraft and higher still for multiengine airplanes. This is most likely a result of their higher speeds at impact.

- **Weather:** Highest fatal to total accident ratio – 68.2 percent (73 accidents) of all weather-related accidents involved fatalities. Most weather-related accidents involve aircraft striking objects or terrain at high airspeed or crashing out of control, sometimes after pilot-induced structural failure.
- **Maneuvering Flight:** 53.8 percent (57 accidents) of maneuvering flight accidents involved fatalities. These accidents also frequently involved collisions with terrain, wires, or towers or aircraft crashing out of control.
- **Approach:** 59.4 percent (19 accidents) of all approach accidents produced fatalities. Besides steep-turn/stall mishaps, one of the largest single problems in this area was "improper IFR approach," which adds another dimension to the weather-related accident count.

It should also be noted that while only 15.9 percent of accidents attributed to takeoff or initial climb-out were fatal, more fatal accidents occurred due to takeoff errors than due to approach mishaps (30 versus 19). The low fatality rate was due to the large number of nonfatal takeoff accidents (189 total, 30 fatal). Large numbers of accidents involving loss of control on takeoff at relatively low speeds kept the fatality rate down in this area while producing a significant number of total accidents.

Accident Causes

Pilot-Related Accidents



Principal Fatal Accident Causes

Based upon severity, the primary causes of fatal accidents across all classes of airplanes for 1996 were:

- **Weather**
- **Maneuvering Flight**
- **Approaches**

As in previous years, the causes of serious accidents were not class-specific but appeared to be closely related to utilization and flight profile (length of trip, IFR/VFR, time of day, purpose of flight, etc.). Multi-engine and single-engine retractable-gear airplanes were involved in a higher proportion of IFR accidents, which would correspond to higher usage for cross-country transportation, while single-engine fixed-gear airplanes were involved in more VFR accidents such as maneuvering. It is significant that almost all types of accidents occurred in some proportion in all classes of airplanes. Good airmanship principles are not class-specific.

Weather

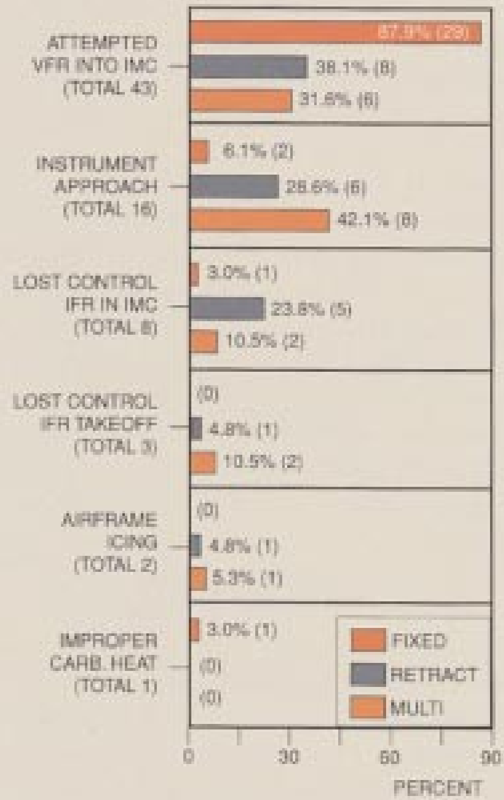
This cause area had the highest overall fatality rate (68.2 percent overall) of any accident cause. Accidents involving weather usually involved controlled flight into terrain or other objects, uncontrolled flight due to spatial disorientation, or pilot-induced structural failure of the aircraft. The high impact forces make these accidents some of the deadliest of all. Other accident causes sometimes include weather as a contributing factor, such as improper IFR approach, which was responsible for an additional five fatal accidents. Factors such as wind shear or crosswinds have caused accidents in VFR weather that could have been avoided by pilots obtaining and heeding weather information.

More than half (58.9 percent) of all fatal weather-related accidents (43 of 73) were due to "attempted VFR flight into instrument meteorological conditions (IMC)." Twenty-nine of these were in single-engine fixed-gear aircraft. This accounted for 87.9 percent of the fatal weather-related accidents in those aircraft. VFR flight into IMC continues to be one of the most significant causes of fatal accidents. For a more detailed analysis of weather accidents, see the AOPA Air Safety Foundation's *Safety Review of General Aviation Weather Accidents*, which is available by calling 1-800-LIFTOFF.

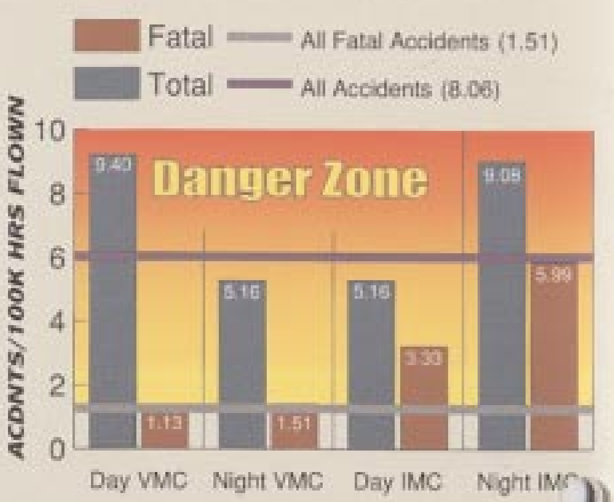
Interaction of Night and Weather

The chart at right shows the interaction between night and IMC. The dashed lines show the total and fatal accidents per 100,000 hours for accidents under all conditions. Bars higher than these reference lines indicate a higher than average accident rate under the indicated condition. The data indicate that IMC conditions produce more accidents and that the combination of night and IMC produces approximately 13 percent more total accidents **per 100,000 hours** and more than four times the **rate** of fatal accidents than the population as a whole.

Fatal Weather Accidents



Weather/Light Conditions



We should know something about weather, what it's made of and how it moves.

Capt. Robert Buck,
Weather Flying

We should know something about weather, what it's made of and how it moves.

Maneuvering

Maneuvering flight continues to be one of the largest single producers of fatal accidents. It is also one of the most preventable. 49.1 percent (28/57) of fatal maneuvering accidents occurred due to "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. They have some inherent risk and demand extreme skill and vigilance on the part of the pilot. In operations where there is a mission other than just operating the aircraft, the task demands of the mission and the task demands of flying can reach their extremes simultaneously, severely taxing the pilot's capability.

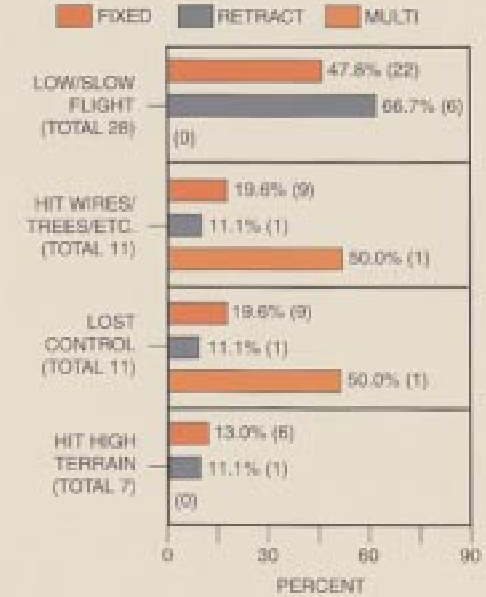
However, a close look at maneuvering accidents by type of operation being conducted at the time of the accident reveals that 52.8 percent of all maneuvering accidents and 63.2 percent of fatal maneuvering accidents occurred during flights described as "personal." A few of these accidents occurred due to inadvertent loss of control by pilots performing common operations. The majority, however, occurred during buzzing or unauthorized aerobatics. Many involved a degree of recklessness that makes it difficult to term them "accidents" in a true sense. These occurrences cannot be prevented through any education or increase in proficiency. Only a change in attitude on the part of the pilots involved can change this. Pilots must refrain from this type of activity and encourage their peers to do the same. These antics are not the mark of a skilled pilot – only a potentially dead one.

Approach

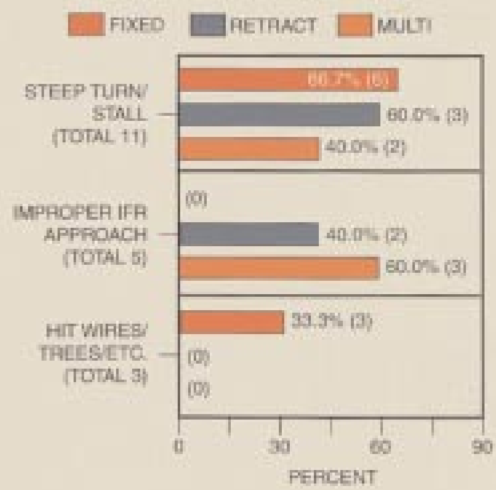
Accidents due to mishandled approaches, although low in number (19), are frequently (60 percent) fatal. Problems were primarily due to stall/mush and failure to follow instrument approach procedures. Steep turns/stalls were the majority (11 fatal accidents). Although no class of aircraft showed significant trends in this cause, neither was any class immune. Skill acquisition and maintenance are important in preventing these accidents. Train and stay current!

Instrument approach fatal accident causes were largely the domain of complex single-engine and multiengine aircraft in 1996 (two single-engine retractable-gear and three multiengine). Another 16 accidents were classified as primarily weather-related with "instrument approach" as their detailed cause. Only two of these were in single-engine fixed-gear aircraft, six were in single-engine retractable-gear airplanes, and eight were in multiengine aircraft. As in previous years, instrument approach problems continue to be responsible for a significant number of fatal accidents in complex airplanes. High task complexity late in a flight in bad weather is a significant factor in causing these accidents. This is especially acute in single-pilot operations. Private, not-for-hire operations (FAR Part 91) are one of the few types of IFR operations that do not require a second pilot or an autopilot.

Fatal Maneuvering Accidents



Fatal Approach Accidents



Studies conducted by NASA and the FAA have indicated that takeoff/initial climb and approach/landing phases have the highest demands of any segment of flight. These studies also show that pilot capabilities erode throughout the flight due to the combined effects of fatigue and the complacency that results from an uneventful flight. The highest task demands are encountered at a time when pilot capability to accomplish complex tasks may be significantly diminished.

Summary of Significant Causes

The proper use of mishap experience is reducing mishap potential.

– U.S. Air Force Guide to Mishap Investigation

Both total and fatal accident counts dropped slightly during 1996 while estimates of flying hours increased slightly. Accident trends showed little change from previous years. The majority of accidents (66 percent total, 67 percent fatal) still were due to pilot-related causes as in previous years. A few key facts are worth remembering:

• Takeoff and landing account for less than five percent of a typical cross-country flight, but 48.3 percent of all accidents occur during these phases (54 percent of the pilot-related accidents occur during takeoff or landing). The majority of these accidents were nonfatal (16.4 percent of fatal accidents occurred during takeoff or landing).

• 33.2 percent of all pilot-related fatal accidents are weather-related. Almost two thirds of fatal accidents in multiengine airplanes and more than 40 percent of all fatal accidents in single-engine retractable-gear airplanes are due to weather. Fatal accidents during instrument approaches add to this total. This is comparable to the proportions found over the past decade as reported in our *Safety Review of General Aviation Weather Accidents.*

• Darkness increases the weather-related accident potential. A significant proportion of weather-related and approach accidents occurred at night.

• Maneuvering flight accidents accounted for 25.9 percent of fatal pilot-related accidents. Most of these accidents involved buzzing or unauthorized low-level flight.

• 65.1 percent of all accidents and 67.7 percent of all fatal accidents occurred during personal flights, even though slightly less than one third of the flight hours are logged on personal flights. More information on accidents versus type of flying is available on page 18 in the Resource Section.

Risk Management and Preventive Strategies

Up to this point, we've looked at several aspects of the accident picture that should give us a pretty clear idea of where the risks lie. We've looked at the flight environment and the various causal factors related to accidents. We've also looked at aspects affecting accident severity – what types of accidents are most likely to cause fatalities and which will result in damage to our airplanes. The remaining question is, what can we do about it? Can we really reduce our accident potential to zero? Probably not, unless we quit flying entirely. We can, however, use our knowledge to reduce the risks.

Former NTSB member Dr. John Lauber stated, "In the real world, one can realistically only alter the probabilities; failure to take action to positively manage these risks also causes accidents." Risk management, therefore, must be an active pursuit. The sources of risk are identified. Now let's develop some preventive strategies.

To prevent accidents, examine what is required for a successful flight. An assessment of "pilot error" is a classical oversimplification. It tells us little more than "the airplane crashed." Human-factors researcher Dr. David Nagel divided pilot activities into three groups:

- Information: Acquiring information from external cues and cockpit displays, exchanging, communicating, and processing information.
- Decision: Weighing up alternatives, planning a course of action, etc.
- Action: Executing a chosen course of action.

Each of the areas above has a distinctly different set of problems. Psychologists often divide human errors into two basic classes — slips and mistakes. (Another category of activity — violations — are described as deliberate deviations from training, procedures, or rules.)

• Slips are errors made in action-type tasks. The correct course of action or procedure has been selected, but errors are made in its execution. These problems are often related to skills or skill maintenance; that is, currency. This type of problem could be viewed as "doing the right things wrong."

• Mistakes are more characteristic of decision errors. In these cases, an inappropriate alternative may have been selected and performed "by the book." It will not, however, solve the problem. This could be viewed as "doing the wrong things right."

Problems in information-processing tasks may have the characteristics of either slips or mistakes. Information problems are closely related to the decision process. The amount and content of information available may affect a decision. A prior decision may also determine what type of information the pilot procures and how it is used for subsequent decisions. This is commonly the case regarding a pilot's analysis and use of weather information to make decisions.

A group of researchers in New Zealand recently analyzed more than 200 general aviation accidents and attributed problems to the task areas (information, decision, action) that were associated with the accidents. They found significant correlation between the error type and the severity of the accident. Only 31 percent of the minor/noninjury accidents and fully 63 percent of the fatal accidents involved decision errors. Forty-eight percent of the noninjury accidents involved action errors, while only 16 percent of the fatal accidents involved these errors. In other words, skill problems were responsible for a large proportion of minor accidents, and decision-making problems predominated more serious accidents.

Kicking a plane around is not essential; thinking is.

John R. Hoyt,
As the Pro Flies

Kicking a plane around is not essential; thinking is.

Applying the results of this research to general aviation accident statistics, some preventive strategies are possible. The phases of flight accounting for the highest proportions of fatal accidents are cruise (26.5 percent of fatal accidents) and maneuvering (24.4 percent of fatal accidents). The highest cause areas are weather (33.2 percent of fatal accidents) and maneuvering (25.9 percent of fatal accidents). While not quantified in the New Zealand study or the statistics computed for this report, a review of the narratives for maneuvering accidents indicates that a large proportion may be associated with violations of regulations, prudent operating practices, or both. These could be viewed as decision problems, although not really "errors" because of their deliberate nature.

Weather-related problems, which cause a large portion of fatal accidents occurring in the cruise phase (as well as the approach phase), often result from mistakes related to improper decisions rather than skill errors. This matches the New Zealand study's finding that decision errors are more often involved with fatal accidents. Good planning and decision making have always been recognized for their importance to aviation safety. They are absolutely crucial for preventing the most serious accidents.

Conversely, 39.7 percent of all accidents occurred during the landing phase, while only 4.5 percent of fatal accidents occurred during this phase. A review of the types of problems encountered in landings shows a high involvement of skill or currency-related slips. The New Zealand study found that action errors were often connected to accidents with minor or no injuries. Maintaining basic piloting skills will go a long way toward preventing these problems.

Training and currency will help to keep us out of the accident statistics but may not always be enough to prevent the more serious accidents if deliberate violations of good operating practice are involved. Many maneuvering accidents involved professional pilots with considerable experience. The answer, to quote a phrase from the popular drug abatement program, is to "just say no." Unfortunately, no amount of training will prevent accidents that were caused by deliberate actions. Decision errors, likewise, may not be fully preventable through training in specific skills. While action slips (skill errors) are common for pilots with lower total time or time in type, decision errors happen to pilots of all experience levels. Training in aeronautical decision making is less tangible than training in specific skills, but it may be more important in reducing the number of serious mishaps. It is also the hardest to conduct and to measure positive results.

Conclusions

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

General aviation is not risk free, just like any other mode of transportation. Reduction of accident potential on an individual basis is, however, a goal for all participants in the aviation system. Pilots and flight instructors should review this report and develop a plan to manage the risks. There will always be accidents as long as we fly, but each pilot can do a great deal to stay out of the statistics. Although statistical theorists and human-factors experts tell us that "zero accidents" is not realizable in practice, it is a worthy goal.

Frequently Asked Questions

Resource Section – Additional Facts and Topics

1.0 Additional Factors

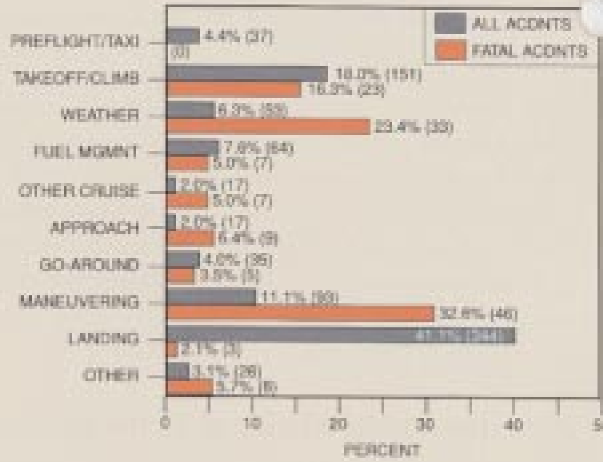
1.1 Breakdown By Aircraft Class

Differences between numbers of accidents in each class of aircraft tended, as in previous years, to follow proportions of utilization of these aircraft. For example, more accidents occurred in single-engine fixed-gear aircraft than in single-engine retractable-gear and multiengine aircraft, not because these aircraft are more dangerous, but because we flew them more. Likewise, more IFR weather-related and IFR approach accidents occurred in single-engine retractable-gear and multiengine airplanes than in single-engine fixed-gear aircraft because these types of operations were more common in the more complex aircraft. Individual differences in overall accident rates were more likely to be caused by differences in exposure to risk than to inherent characteristics of the airplanes in which the accidents occurred.

Increasing complexity of aircraft should not, however, be ignored. Studies have shown that low time in type is often a factor in accident causation. Transitioning to a new aircraft, including aircraft that are simpler but different from the one to which the pilot is accustomed, can cause problems, even for experienced pilots. Likewise, problems such as stalls during VFR approaches and IFR into IMC have affected pilots in all types of airplanes. Pilots can never outgrow the need for basic airmanship.

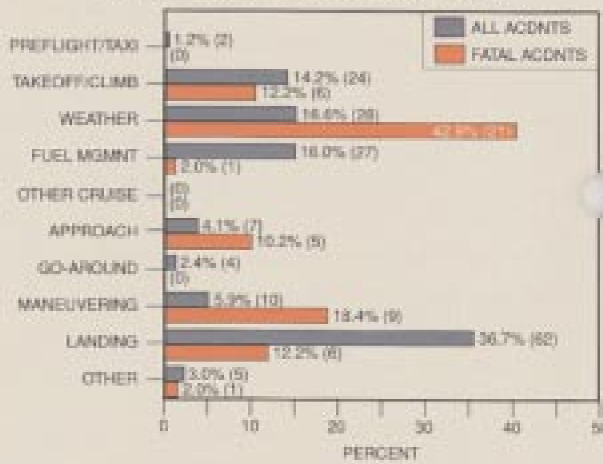
Accident Causes

Single-Engine Fixed-Gear



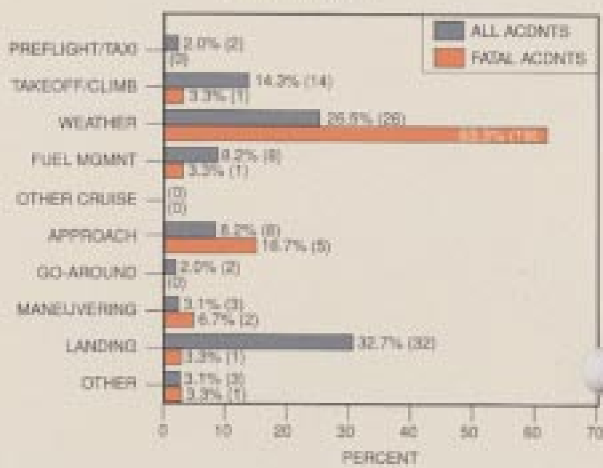
Accident Causes

Single-Engine Retractable Gear



Accident Causes

Multiengine



There's more to know about flying than how to steer an airplane.

Richard Bach,
A Gift of Wings

There's more to know about flying than how to steer an airplane.

1.2 Comparison With Other Years

Were last year's statistics unique? In a word – no. The major problem areas continue to be pilot-related. A substantial number of the accidents classified as "unknown" in preliminary report data become pilot-related once more information is available to investigators and analysts. If these trends continue, the pilot-related problem area for 1996 will grow by five to 15 percent from the number presented in this report. Although there are some minor differences, the majority of accidents are still due to the same causes and at roughly the same rates as over the past several years.

1.3 Seasonal Trends

Beginning with slightly higher monthly accident rates from January through May 1996, total accident rates fell below those seen in 1995 from June throughout the remainder of the year. While May through September saw monthly total accident rates nearly doubling over the earlier months' totals in both years, fatal accidents occurred at a relatively uniform rate throughout both 1995 and 1996. These trends most likely reflect the overall trends in yearly aircraft utilization, influenced by better weather, increased daylight hours, and higher leisure activity during the summer months.

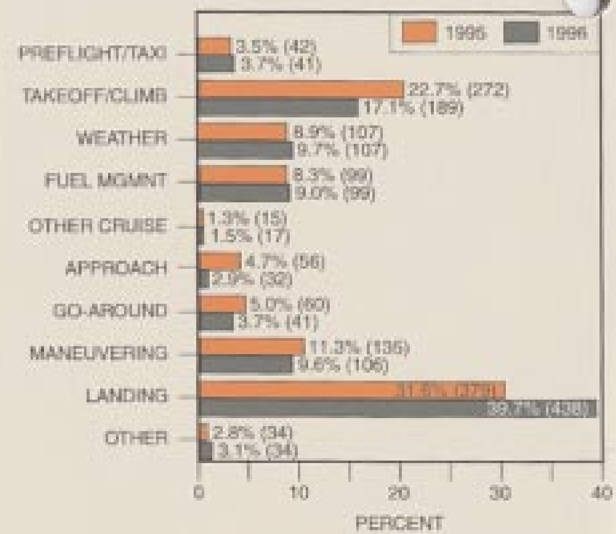
The graph at right shows trend lines for monthly accident rates and fatal accident rates in 1995 versus 1996.

1.4 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 perceived importance of the flight on the part of the pilot. The purpose for which the flight was being conducted 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 examine three of the most common general aviation operations: personal flying, business flying, and flight instruction.

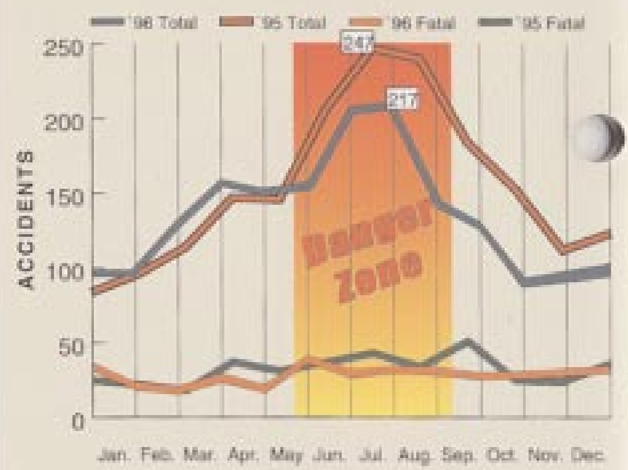
1995-1996 Comparison

Pilot-Related Accidents



Monthly Accident Trend

1995-1996 Comparison



OPERATION	Percent of Flying (1994)	Percent of Total Accidents (1996)	Percent of Fatal Accidents (1996)
On-Demand Air Taxi	5.9	4.4	6.4
Personal	37.7	65.1	67.7
Business	14.9	4.3	5.2
Instruction	19.7	12.4	5.5
Executive/Corporate	6.6	0.2	0.6
Aerial Application	5.4	5.9	2.7
Aerial Observation	6.6	0.7	1.5
Other Work Use	1.1	3.0	4.3
Public Use	*	0.8	1.2
Ferry	*	1.0	1.2
Positioning	*	1.7	1.8
Other/Unknown	2.1	0.9	1.8

A. Personal Flying

Personal flying comprises, by far, the largest proportion of general aviation flying (37.7 percent) of any single type of operation. Accidents during these operations, however, represented an even larger proportion of the total accident picture (65.1 percent of all accidents; 67.7 percent of fatal accidents). The chart at right shows the proportion of accidents due to a particular cause that occurred during personal flights. The index line shows the 37.7 percent proportion. Bars representing individual causes that extend above this line indicate that the accidents in that cause category accounted for more than the personal flying "share" of total accidents. Accidents during personal flights accounted for a greater proportion of accidents than flying hours in all causal areas.

B. Business Flying

The ability to use an airplane provides many business travelers with a flexible, economical way to travel on their own schedules. It also allows them to reach destinations that are impossible or inconvenient to reach via airlines or other modes of travel. Business flights accounted for only 4.3 percent of the total and 5.2 percent of the fatal accidents in 1996. The chart at right shows business travel accident causes. The flying hour proportion reference line (14.9 percent) may be used in the same manner as described above under "Personal Flying." All causal areas of business flight accidents were lower than the proportion of business flying hours to total flying hours in 1996.

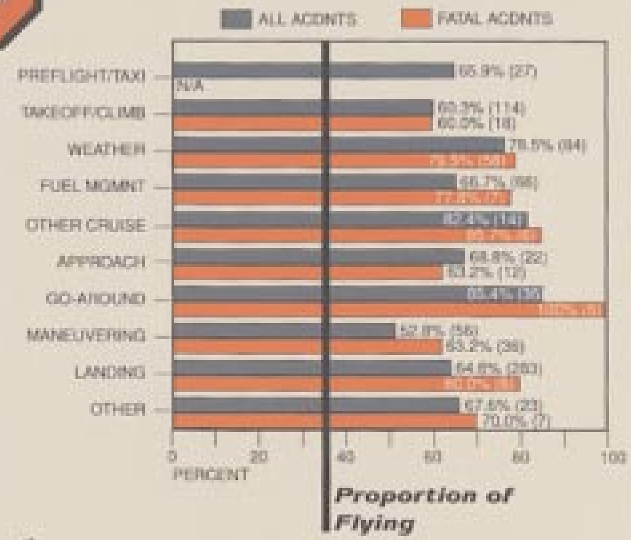
C. Flight Instruction

Flight instruction makes up approximately 19.7 percent of all flying activity. Accidents during flight instruction made up only 12.4 percent of the total and 5.5 percent of fatal accidents. The proportion of fatal to total accidents during instruction is the lowest of any flight operation. Only 8.1 percent (13/160) of pilot-related accidents during instruction resulted in fatalities. This compares to a 19.9 percent (220/1,104) fatal/total accident ratio for pilot-related accidents in all operations. This result indicates that, as expected, a high proportion of instructional accidents are "fender-benders" where aircraft are damaged but serious injuries are avoided.

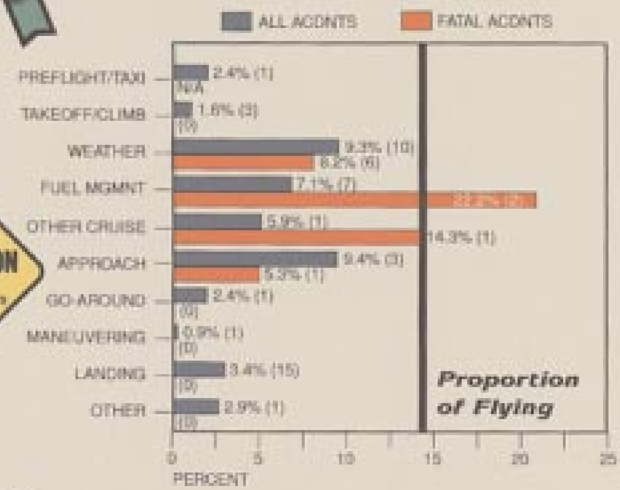
A quick look at the types of instructional accident causes shows that the majority of these accidents are mishaps during landing and go-around, causes that traditionally have a high overall occurrence but a low fatality potential. The relatively higher occurrence of accidents due to these causes is also due to the greater number of landings performed per flight hour during instruction than during other operations.

As in previous years, accidents due to maneuvering flight or encounters with weather during flight instruction are notably low. This is good for the overall accident picture, but particularly in the case of weather, it may also indicate a relatively low degree of exposure to weather hazards during instructional flights. This probably means that many pilots enter into operational flying with relatively little exposure to adverse weather conditions. This is especially important to new private and instrument pilots.

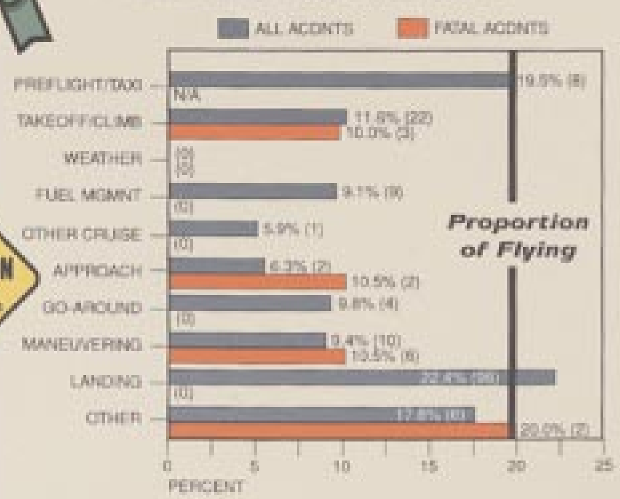
Proportion of Accidents
Attributed to Personal Flying



Proportion of Accidents
Attributed to Business Flying



Proportion of Accidents
Attributed to Flight Instruction



In a study on pilots' actions when faced with adverse weather, researchers at Ohio State University stated, "*Training programs that relegate weather to a minimum percent of instructional time must begin to realize that* cognitive *more than stick and rudder errors initiate general aviation fatalities.*" Pilots must be well grounded in weather theory, but perhaps more importantly, they must be able to apply their knowledge. The AOPA Air Safety Foundation's *Safety Review of General Aviation Weather Accidents* noted that "*instructors should make sure that all types of students – not just those working on instrument ratings – are exposed to marginal VFR and IFR conditions.*"

Positive factors that could also be responsible for these low rates of weather-related accidents are the controlled environment and attention to planning and other details that are parts of the flight instruction environment. The structured rigor that is responsible for much of the excellent safety record of military and commercial aviation is also part of any good flight school operation.

Also note that eight instructional flying accidents in the "pilot-other" cause category were midair collisions (three of which were fatal). The division of attention required in training flights increases the demand for cockpit vigilance on the part of everyone involved. Training flights also spend proportionately more time in the traffic pattern, which increases their collision potential.

2.0 Additional Causes

2.1 Mechanical/Maintenance

By far, the largest proportion of these accidents were due to powerplant/propeller problems (78.6 percent [368] total, 78.4 percent [40] fatal). However, 314 of these accidents were classified as "power loss for unknown reasons." Once the mechanical components are analyzed, it is probable that some of these accidents will be confirmed as being mechanical while others will be reclassified to pilot-related causes such as fuel mismanagement. Pilots should note that several mechanical failure accidents could have been prevented by a thorough preflight. Other accidents resulted when pilots incorrectly performed the procedures in their pilot's operating handbooks when system failures occurred.

2.2 Other Miscellaneous Causes

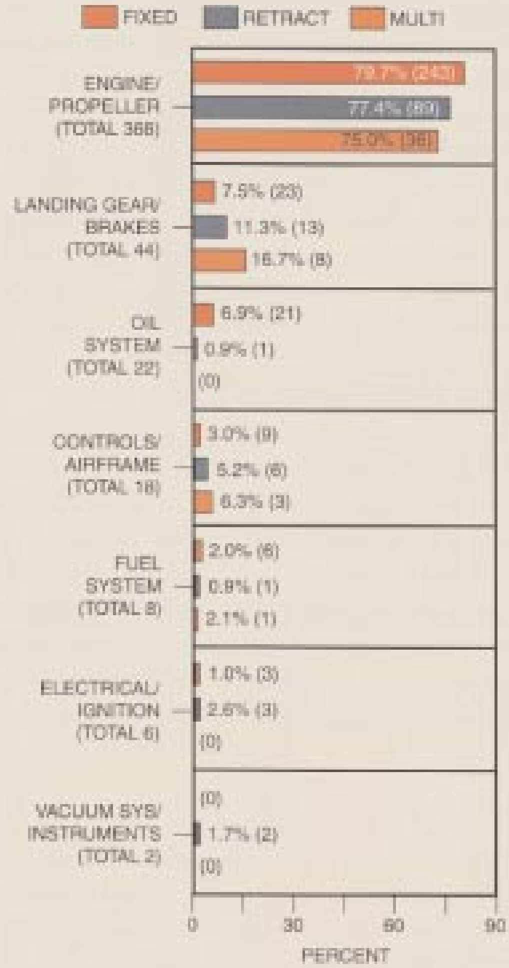
Midair Collisions

During 1996 there were 18 midair collisions involving a total of 31 general aviation aircraft. Five of these accidents were fatal, resulting in 18 fatalities. Midair collisions continue to occur mainly on good VFR days, at low altitude, and close to airports. The graph at right shows the trend in these accidents over the past six years.

A recent AOPA Air Safety Foundation study of midair collisions revealed that almost half 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, while the rest resulted from formation flights or other hazardous activities.

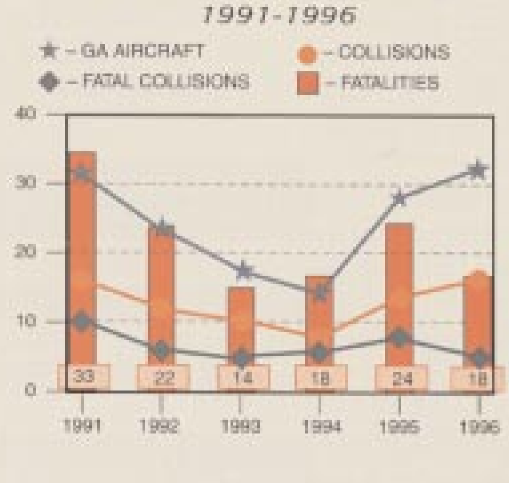
Mechanical/Maint.

All Accidents



Midair Colisions

1991-1996

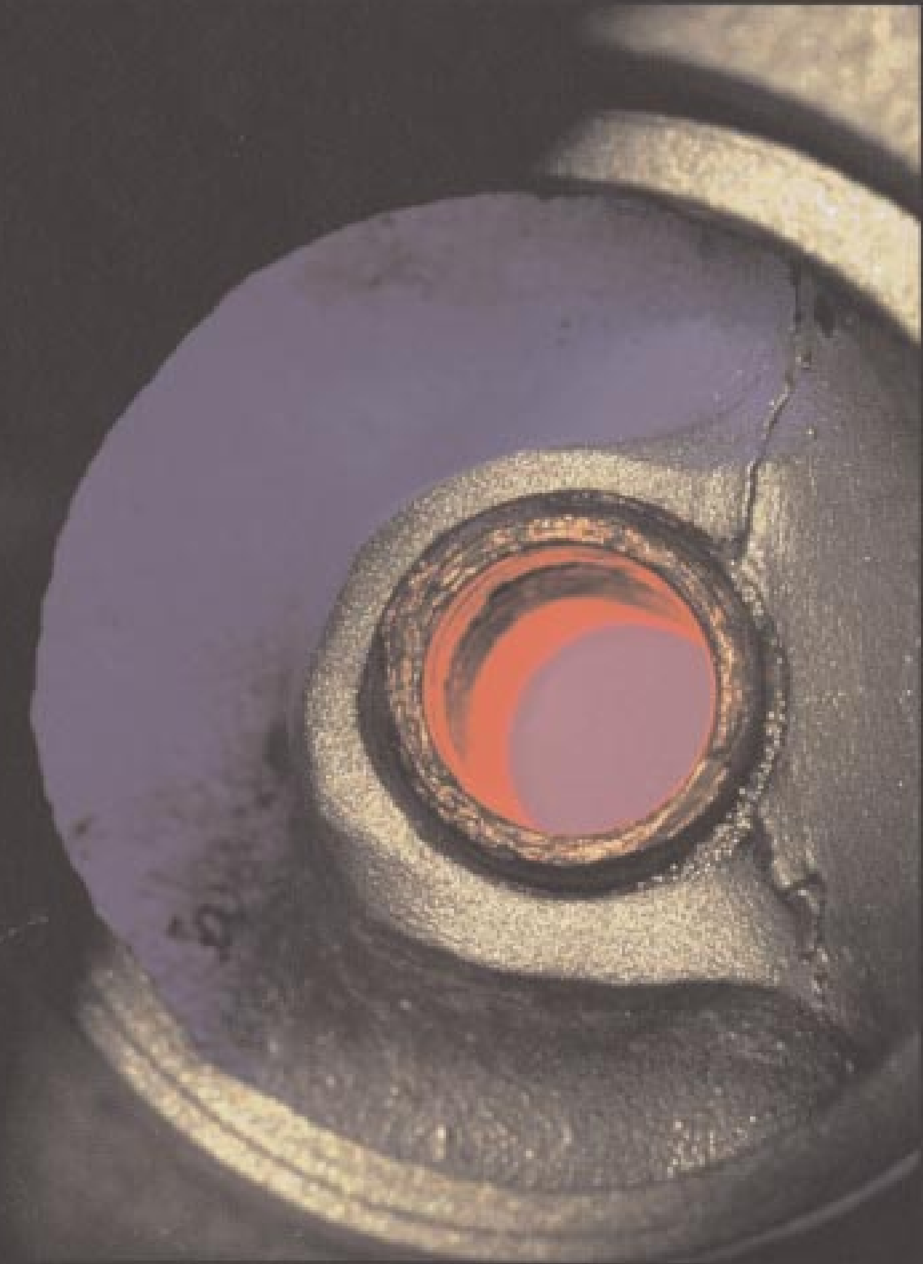


	'91	'92	'93	'94	'95	'96
GA Aircraft	31	22	17	15	29	31
Collisions	17*	11	10*	8*	15*	18*
Fatal Collisions	10	6	5	6	8	5

* Involved other aircraft not counted in GA totals.

Airplanes in their simplest state are complex pieces of machinery; a mechanical fault unaided by human hands is always possible. But it's good to have the odds—and a good mechanic—on the pilot's side.

AOPA Pilot Magazine, December 1977



Above: a crack radiates outward from the valve guide of an aircraft engine.

Airplanes in their simplest state are complex pieces of machinery; a mechanical fault unaided by human hands is always possible. But it's good to have the odds—and a good mechanic—on the pilot's side.

Excluding the latter, 80 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 *Operations at Nontowered Airports Safety Advisor*.

Other Causes

The following other causes were also responsible for accidents in 1996:

- **Alcohol/Drugs:** Only one fatality was attributed to alcohol/drug use by the pilot during 1996. This accident involved a pilot who was apparently using a prescription drug for a medical condition. In 1995, two general aviation aircraft accidents resulted from drug or alcohol abuse, one fatal and one with serious injuries. No other accident had been attributed to suspected alcohol or drug use by the pilot at the time its preliminary report was prepared.

- **Fuel Exhaustion/Starvation:** Fuel exhaustion is engine stoppage due to the depletion of all available fuel on board the airplane. 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 1996, there were 69 accidents caused by fuel exhaustion, of which five were fatal, resulting in six fatalities. Another 13 accidents occurred because of fuel starvation when the pilots failed to switch tanks in time to prevent engine stoppage. Two of these accidents were fatal, with one fatality each. 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 Fatalities:** There was only one accident in 1996 that resulted in any fatalities to persons on the ground off the airport other than to people in the aircraft. This accident involved an aircraft trying to make an emergency landing on a highway. The aircraft struck a car in which two occupants were killed and another was seriously injured. The two pilots in the aircraft were also killed in this accident. This is a significant decrease from 1995, when five people on the ground were killed and three more were seriously injured in off-airport general aviation aircraft accidents.

- **Pilot Incapacitation:** Three general aviation aircraft accidents during 1996 involved pilot incapacitation. Two of these were fatal, with one fatality each. Although there were no such accidents in 1995 or 1994, there were five in 1993, one in 1992, and five in 1991.

- **Propeller Strikes:** Three passengers were struck by turning propellers during 1996. One person was killed, and the other two suffered serious injuries. In 1995, five propeller strikes resulted in two fatalities and three serious injuries.

3.0 Additional Miscellaneous Topics

3.1 Homebuilt Airplanes

Building an airplane can be a satisfying, rewarding experience. It can also avail the builder of advances in aeronautical technology not presently available in factory-built aircraft. In order to take advantage of these advances, however, the builder/pilot assumes much 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 involved through careful planning. Some key points to remember when making decisions regarding homebuilt airplanes:

Design:
- Adherence to the manufacturer's plans or kit instructions.
- Does it qualify as an ultralight vehicle or a homebuilt airplane?

Construction:
- Builder experience and use of experienced help/oversight.
- FAA inspections required.

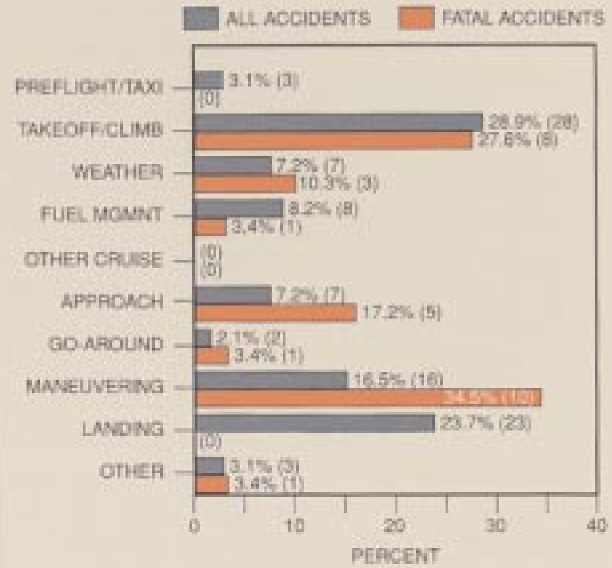
Test Flying:
- Builder planning and precautions for test flights.
- Builder's flight experience and currency.
- Stability and other flight characteristics of high-performance homebuilt aircraft.

For more detailed information about building and flying homebuilt aircraft, an excellent source of information is the Experimental Aircraft Association. 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 certificate requirements.

The charts below and at right show accident causes for homebuilt airplanes and a comparison of accidents in homebuilt versus factory-built airplanes. Some of these accidents resulted from pilots who were apparently unprepared for the peculiarities of their aircraft. Unfortunately, however, most 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. Unauthorized aerobatics, buzzing, improper loading, and taking off in unairworthy aircraft all caused fatal accidents in 1996 in homebuilt, as well as factory-built, airplanes.

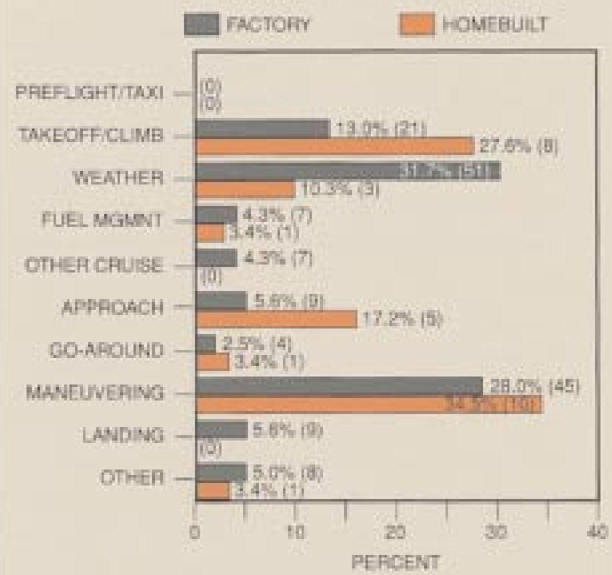
Accident Causes

Homebuilt Aircraft



Homebuilt vs. Factory Aircraft

Fatal Accidents



MAJOR CAUSE	ALL ACCIDENTS	FATAL ACCIDENTS
Pilot	97 (55.4%)	29 (61.7%)
Mechanical/Maintenance	25 (14.3%)	6 (12.8%)
Other	4 (2.3%)	0 (0.0%)
Unknown	39 (28.0%)	12 (25.5%)
Total	**175 (100.0%)**	**47 (100.0%)**

3.2 Risk Management for General Aviation

Risk Management for Pilots

In 1901, Wilbur Wright stated, "Carelessness and overconfidence are usually more dangerous than deliberately accepted risks." It is significant to note that this statement was made two years *before* the Wrights' historic flight at Kitty Hawk. The Wright brothers have long been recognized for their contributions to the technology of flight. Pilots would also be wise to accept the attitude toward risk that made the Wrights successful where others were injured or killed in similar attempts. General aviation flying is not without risk. Pilots can, however, manage the risk to minimize their potential for being involved in an accident. The points below can reduce the risks that we have identified in this report:

• **Maneuvering Flight.** A large portion of maneuvering flight accidents result from pilots conducting unauthorized aerobatics, buzzing, or other low-level flight. The preventative action for this is simple. In the words of the popular anti-drug campaign – just say no. Don't be tempted to show off your "right stuff" for your peers or others. It's only a display of poor judgment and lack of self-discipline. Instead, enroll in an aerobatic course with a qualified instructor and the proper equipment. You can increase your piloting skills and enjoy these maneuvers safely and legally.

• **Weather.** Most weather accidents result from poor decision making on the part of pilots before or during the flight. Remember the old saying, "Plan the flight and fly the plan." Good planning and adherence to a sound plan will go a long way toward preventing weather-related accidents. 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. Remember also that the FARs only provide minimums. Give yourself ample allowance for any deterioration of conditions and make contingency plans in advance. Remember that forecasts are not guarantees.

• **Takeoff and Landing.** These phases of flight produce relatively few serious accidents but a large number of minor accidents. More of these accidents involve skill errors as compared to more serious accidents, which predominantly result from poor decision making. Lack of proficiency in basic operations causes a large proportion of takeoff and landing accidents. Training and currency are the antidote to these problems. Initial and recurrent training should take into account the aircraft and the operating environment in relation to planned operations. Decision making regarding the airplane's and the pilot's capabilities are, therefore, also factors in many takeoff and landing accidents. Pilots must assess the potential impact of aircraft performance, pilot training and currency, and environmental conditions as sources of risk. This may place limitations on destination, load carried, and duration of flight, to name a few. Failure to properly handle windy conditions is a major factor in takeoff and landing accidents.

Risk Management for Passengers and Flying Companions

Nonpilots can also contribute to flight safety. Pilots are trained in a large variety of complex skills, but they may overlook important parts of their preflight and in-flight responsibilities. Often these oversights are related to a desire to make the flight comfortable and convenient for their passengers or business associates. Pilots may also feel pressure to complete a flight or to perform certain operations to please their passengers. This may be true, even when these individuals have not directly communicated any sense of urgency to the pilot. Pilots are usually highly motivated, task-oriented people who may have strong feelings about task accomplishment. Passengers can help by making a safety-conscious attitude clear to the pilot at all times. Passengers, associates, and family members should assert their opinions if a proposed flight is risky and support the pilot if a no-go decision is made on the basis of safety. Conditions of poor weather, night, or pilot unfitness for flight due to ill health or fatigue should be addressed clearly and assertively. Often the pilot only needs to know that you're backing a sound professional decision to operate safely. The following short check list will help nonpilots contribute to air safety:

- **Avoid aerobatic maneuvers and low-level flight – Tell the pilot you're not impressed.**
- **Don't pressure the pilot – Make it clear that you respect good judgment.**
- **Tell the pilot you'll accept a delay if it means a safer flight.**
- **Did the pilot check the weather?**
- **How much can this airplane safely carry?**

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 incident 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 five 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:

<u>Standing</u> – 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.

<u>Taxi</u> – 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.

<u>Takeoff</u> – 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.

<u>Climb</u> – 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.

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

<u>Descent</u> – 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.

<u>Approach</u> – 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).

<u>Landing</u> – 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.

<u>Maneuvering</u> – 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.

<u>Other</u> – 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.

<u>Unknown</u> – The phase of flight could not be determined.

The machine does not isolate man from the great problems of nature, but plunges him more deeply into them.

— Antoine de Saint-Exupéry

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