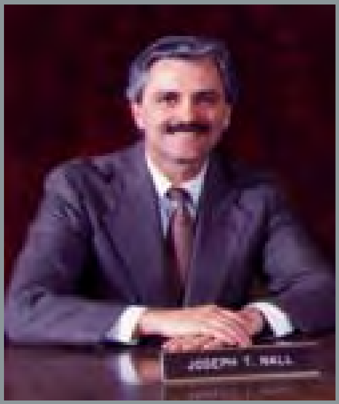
2005 NALL REPORT

Accident Trends and Factors for 2004

AOPA AIR SAFETY FOUNDATION



Dedication

The Joseph T. Nall Report is the AOPA Air Safety Foundation's annual review of general aviation aircraft accidents that occurred during the previous year. The report is dedicated to the memory of Joe Nall, an NTSB Board member who died as a passenger in an airplane accident in Caracas, Venezuela, in 1989.

Final vs. Preliminary Statistics

This report is based on NTSB reports of accidents involving fixed-wing general aviation aircraft weighing 12,500 pounds or less. To provide the pilot community with the most current safety information, ASF gathered NTSB data on 2004 accidents throughout 2005. By November 2005, the NTSB had finalized 82.8 percent of the year 2004 reports. The remaining 17.2 percent contained preliminary data.

Prior year comparisons suggest that this mix of preliminary and final data will not significantly change the conclusions presented here when all final reports are analyzed.

As a supplement to the information contained in this report, ASF now offers its accident database online. You may search the database by selecting specific criteria. To view the database, visit www.asf.org/database.

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

- National Transportation Safety Board
- Federal Aviation Administration
- Aircraft Owners and Pilots Association

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Nall Executive Summary

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www.asf.org

General Aviation (GA) accident rates continue gradually down, based on NTSB accident data and the FAA's estimate of flight hours. In 2004, the rate was 6.2 accidents for every 100,000 flight hours, with 1.2 of those fatal. In all, there were 1,413 GA accidents in 2004, with 290 fatal.

A few highlights:

- Total pilot-related accidents are down seven percent from 2003.
- The most likely phase of flight for non-fatal accidents: Landing.
- The most likely phase of flight for fatal accidents: Maneuvering.
- Fatal pilot-related accidents are down 3.4 percent compared to 2003.
- Weather-related accidents: 45 fatal in 2004.
  - *10 involved thunderstorms, and all of the pilots were talking to Air Traffic Control.*
  - *For single-engine fixed-gear aircraft, the majority (90.5 percent) of weather-related accidents were caused by pilots attempting to continue VFR flight into instrument conditions.*

Looking back 10 years, the overall and fatal accident rates are down about 25 percent. That's something to be pleased about, but we shouldn't be too proud. There is still room for improvement. Our record is not nearly as bad as GA detractors would have you believe, and not as good as it could be. There are more landings to be practiced, more weather to be avoided and more good decisions to be made.

In 2005, ASF continued to place a special emphasis on weather education and encouraged pilots to remember basic airmanship. We introduced five new online courses, several mini-courses and multiple new publications, all aimed at inoculating pilots against serious mistakes. The ASF Web site at www.asf.org has become a virtual one-stop shopping center for pilots who are serious about improving their aviation safety.

We've made some changes to the *Nall Report* this year to make it an easier read and to provide the safety information you need for risk assessment and decision making. Regardless of how fat your logbook may be or how many years you have or haven't been flying, the most important flight is your next one. That never changes.

Enjoy and fly safely. We want to see you here next year.

Safe Flights…

Bruce Landsberg

Overview of 2004 Accident Trends and Factors

The AOPA Air Safety Foundation's *Nall Report* is the nation's foremost annual review of general aviation (GA) accident statistics. GA comprises the majority of civil aviation activity in the United States.

These statistics are based on National Transportation Safety Board (NTSB) investigations of accidents that occurred in 2004 involving fixed-wing GA aircraft with a gross weight of 12,500 pounds or less, approximately 90 percent of all GA aircraft. This data will help members of the media, the public, and the aviation community better understand the factors involved in GA accidents.

The data is broken out by accident cause and category, type of operation, class of aircraft, and other factors. This allows the reader to explore the many aspects of GA safety. For instance, pilots can learn more about the accident profile of the particular class of aircraft they fly, or the particular type of flying they do.

The total number of GA accidents is relatively low, but remains significantly higher than the airlines. (See Appendix for an overview of GA vs. airline safety.) This is due largely, to the differences in pilot experience and training, regulatory structure, aircraft, airports, and the more challenging operating environment of GA.

Accident Analysis

In 2004, general aviation safety continued to improve in most major categories (Figure 1) as compared to 2003. There were 6.7 percent fewer total accidents (1,413 vs. 1,514) in fixed-wing aircraft. Fatal accidents declined by 7.1 percent (to 290 from 312), and fatalities were reduced by 8.4 percent (to 510 from 557). These reductions are even more impressive considering that FAA estimated GA flight hours have increased by about 200,000 hours in each of the last three years. As always, exercise caution when using rate numbers, as GA flight hours are estimates.

Accident Statistics

	2000	2001	2002	2003	2004
Total Fixed-Wing GA Accidents	1,595	1,500	1,477	1,514	1,413
Fatal Fixed-Wing GA Accidents	302	300	312	312	290
Total Fixed-Wing GA Fatalities	524	557	518	557	510
Estimated GA Flight Hrs. (millions)	27.8	25.4	25.5	25.7	25.9

Fig. 1

Accident Trends

By themselves, the numbers of accidents and fatalities do not tell the whole story. Accident rates are a more useful tool than raw numbers for analyzing accident trends. In aviation, accident rates are typically calculated as the number of accidents per 100,000 flight hours.

U.S. General Aviation Accidents
per 100,000 Flight Hours 1995-2004

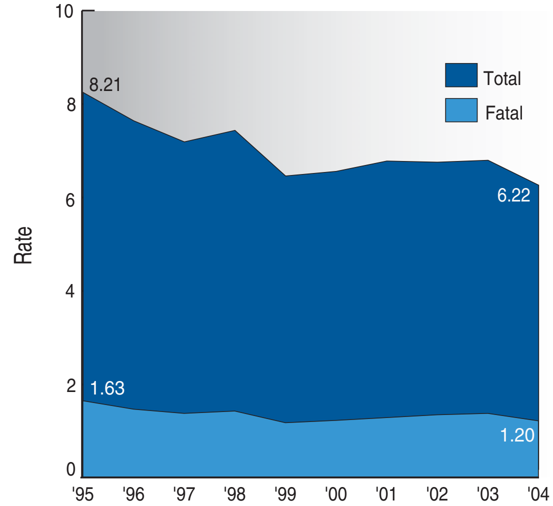


Fig. 2

The total GA accident rate (Figure 2) for 2004 reached a historic low of 6.22 accidents per 100,000 flight hours. The 2004 fatal accident rate of 1.20 per 100,000 hours was bettered only in 1999. Over the past decade, there has been a dramatic reduction in the rates for both total and fatal accidents. While there have been annual variations, the total and fatal GA accident rates have dropped by 24.2 percent and 26.4 percent respectively since 1995.

Accident Causes

In this report, the causes of aircraft accidents have been divided into three groups:

- **Pilot-related** – accidents that arise from the improper action or inaction of the pilot.
- **Mechanical/Maintenance** – accidents that arise from failure of a mechanical component or errors in maintenance.
- **Other/Unknown** – accidents that include causes such as pilot incapacitation, as well as accidents whose cause could not be determined.

The number of 2004 accidents by cause is shown in Figure 3.

General Aviation Accidents 2004

MAJOR CAUSE	All Accidents	Fatal Accidents
Pilot	1067 (75.5%)	228 (78.6%)
Mechanical/ Maintenance	221 (15.6%)	29 (10.0%)
Other/Unknown	125 (8.8%)	33 (11.4%)
TOTAL	**1413**	**290**

Fig. 3

As is the case in all sectors of aviation, the majority are pilot-related, with 75.5 percent (1,067) of the total and 78.6 percent (228) of the fatal accidents. Because GA aircraft are generally very reliable, only 15.6 percent (221) of the total and 10.0 percent (29) of the fatal accidents were attributed to mechanical or maintenance issues. Other or unknown causes accounted for 8.8 percent (125) of the total and 11.4 percent (33) of the fatal accidents.

Accident Category

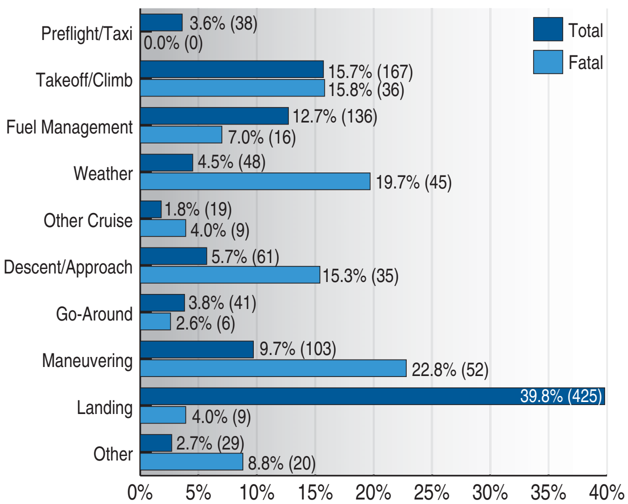
Each of the causes described above can be further divided by accident category. For this report, accident categories are defined by the phase of flight in which the accident occurred (for example, landing or maneuvering), or by primary factor, such as fuel management or weather.

Pilot-Related Accidents

1,067 total/ 228 fatal

As with the overall improvement in GA accident statistics, the number of pilot-related accidents in 2004 declined by 7.0 percent, to 1,067 from 1,147 in 2003 (Figure 4). Fatal accidents decreased less dramatically, dropping by 3.4 percent from 236 in 2003 to 228 in 2004.

Accident Causes - Pilot Related



NOTE: Accident counts for each category are displayed in parentheses.

Fig. 4

The takeoff/climb and landing categories accounted for 55.5 percent of all pilot-related accidents. These two phases of flight occur close to the ground with slow airspeeds, making the maneuvering skills of the pilot critical. Even though these phases accounted for a high percentage of total accidents, they only accounted for 19.8 percent of the fatal pilot-related accidents. The relatively low death rate of takeoff and landing accidents is likely related to slow airspeeds used during these operations and the relative lack of obstructions in the airport environment.

The deadliest pilot-related accident categories were weather, maneuvering, and descent/approach. While weather-related accidents comprised only 4.5 percent of total accidents, they accounted for nearly one in five (19.7 percent) of fatal accidents. These frequently resulted from pilots continuing VFR flight into instrument meteorological conditions (IMC) or from in-flight encounters with thunderstorms. In 2004, there was a significant increase in the number of fatal weather-related accidents, as compared to previous years. Unfortunately, there is no identifiable trend or commonality.

Similarly, maneuvering accidents were only 9.7 percent of all pilot-related accidents, but nearly one in four (22.8 percent) of the fatal accidents. Maneuvering accidents often involve questionable decision making, such as a pilot choosing to engage in buzzing, low passes, or other high-risk activities.

Pilot-related descent and approach accidents accounted for only 5.7 percent of total accidents, but 15.3 percent of the fatal accidents. Such accidents often result from high-speed collisions with the ground, or loss of control due to stall/spin.

Type of Operation

General aviation aircraft are operated for a wide variety of reasons, from recreational and personal flying to commercial operations. Analyzing accidents by the purpose of the flight (Figure 5 *next page*) shows that most 2004 GA flying was for personal (50.1 percent), instructional (19.4 percent), and business (14.4 percent) purposes. Definitions for all types of operations are found in the Appendix.

Personal flights – visiting friends or family, traveling to a vacation home, or for recreation – accounted for seven out of 10 total accidents in 2004 (70.6 percent), and nearly three-quarters (73.8 percent) of fatal accidents, making it more hazardous than all other operations.

Type of Operation

TYPE OF OPERATION	Percent of Flying (2003)	Percent of Total Accidents (2004)	Percent of Fatal Accidents (2004)
Personal	50.1%	70.6%	73.8%
Instructional	19.4%	12.7%	4.1%
Aerial Application	4.4%	4.8%	2.8%
Business	14.4%	3.8%	5.9%
Positioning	*	1.8%	3.5%
Ferry	*	0.4%	0.3%
Other Work Use	1.4%	1.4%	1.7%
Aerial Observation	3.3%	0.6%	0.7%
Exec./Corporate	5.1%	0.4%	0.3%
Other/Unknown	1.9%	3.5%	6.9%

*Included in Other/Unknown

Fig. 5

By contrast, instructional flying is relatively safe. While accounting for one out of every five flight hours, it resulted in just 12.7 percent of all accidents and only 4.1 percent of fatal accidents.

This is due, in part, to the high level of supervision and structure in the training environment.

Business flying – flights made in furtherance of the pilot's own livelihood – is one of the safest operations. It comprised 14.4 percent of GA operations in 2004, but accounted for only 3.8 percent of all accidents and 5.9 percent of all fatal accidents. For business pilots, flying is secondary to their primary business or occupation. This differs from executive/corporate flying, in which professional pilots are hired solely to fly.

Emergency Phase of Flight

In a typical accident scenario, a series of related mistakes and/or failures occurs over time, resulting in the crash. This is called the accident chain. In its investigations, the NTSB tries to determine the phase of flight in which these critical events began. This analysis can be helpful in identifying important safety issues.

Emergency Phase of Flight

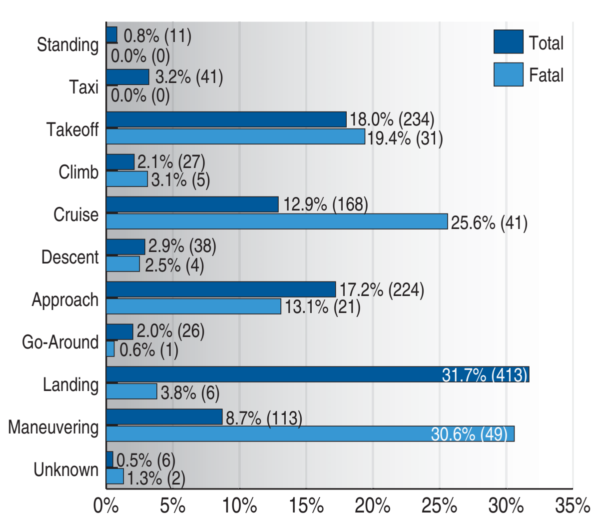


Fig. 6

Note that there is some overlap in the terms used to describe the emergency phase and the accident category. For example, fuel exhaustion during cruise would be categorized as a fuel management accident, but the emergency phase of flight would be listed as cruise.

Figure 6 *(below, left)* depicts pilot-related accidents by the phase of flight in which the accident chain began. In 2004, half started in either the takeoff or landing phase of flight. Significant increases in fatal accidents over 2003 were noted for accidents that began in the takeoff (from 2.9 to 19.4 percent) and maneuvering (from 5.9 to 30.6 percent) phases. The overall number of accidents that started during approach increased from 10.2 to 17.2 percent, and the percentage of those that were fatal dropped from 29.4 to 13.1 percent. Accidents that began during the approach phase were evenly split between VMC and IMC weather conditions, yet significantly more flying is done in visual conditions. While these appear to be significant changes, the 2003 numbers appear to be the anomaly, with 2004 percentages being closer to the historical trends.

Accidents and Aircraft Class

There are three classes of fixed-wing general aviation aircraft covered by this report: single-engine fixed-gear (SEF), single-engine retractable-gear (SER), and multiengine (ME). Aircraft performance, along with the complexity of cockpit instrumentation and aircraft systems, typically increases on each succeeding type. That said, however, the emergence of a new class of advanced SEF aircraft like the Cirrus and Lancair – many of which are capable of speeds comparable to light twins – has changed this hierarchy.

Accident/Fatality Rate by Class

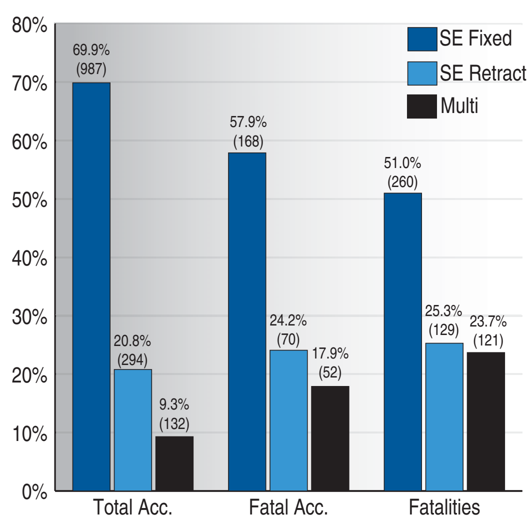


Fig. 7

Figure 7 displays GA accidents by aircraft class. It indicates that the more complex and capable the aircraft, the greater the chance of a fatality in an accident. In 2004, SEF aircraft, which comprise the majority of the GA fleet, accounted for 69.9 percent of all accidents but only 57.9 percent of fatal accidents. SER aircraft had about one out of five of total accidents

(20.8 percent) and almost one out of four (24.2 percent) of fatal accidents.

ME aircraft accounted for only 9.3 percent of all accidents, but a disproportionately high 17.9 percent of fatal accidents. These aircraft are typically operated in a wider range of weather conditions than the other two classes. Also, with their higher performance and stall speeds, they are less forgiving of pilot mistakes. The accident categories for each of these aircraft classes are examined in detail later.

Lethality Index

One method of giving visibility to the severity of accidents is through the creation of a Lethality Index (Figure 8). This chart illustrates the likelihood that pilot-related accidents in each category will result in a fatality.

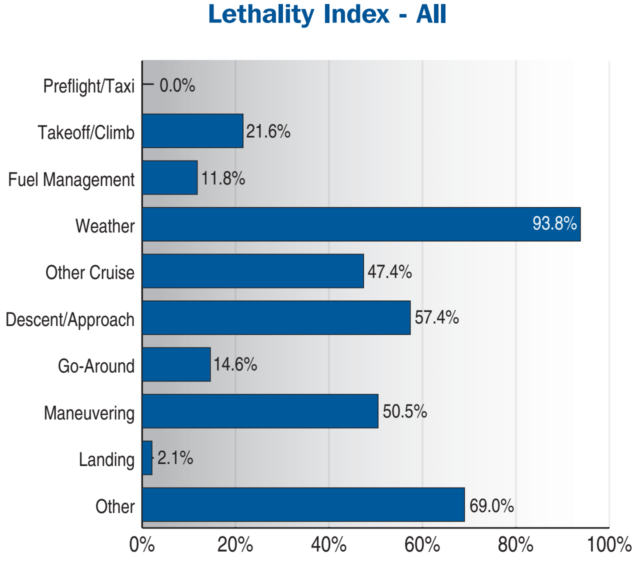


Fig. 8

By a large margin (more than nine out of 10, or 93.8 percent), accidents due to weather were fatal in 2004. Descent/approach accidents also tended to be lethal, ending in fatality nearly six out of 10 times (57.4 percent). These are both large increases from the 71.4 and 48.9 percentage rates, respectively, registered in 2003. Maneuvering accidents resulted in death half (50.5 percent) of the time.

The "other" category also had a high level of lethality, at 69.0 percent. These include accidents for which no cause could be found. This often means the cause could not be determined by investigators due to lack of evidence or witnesses.

The Lethality Index for each class of aircraft is presented as part of the following discussions.

Single-Engine Fixed-Gear Aircraft

788 total/ 137 fatal

Overview

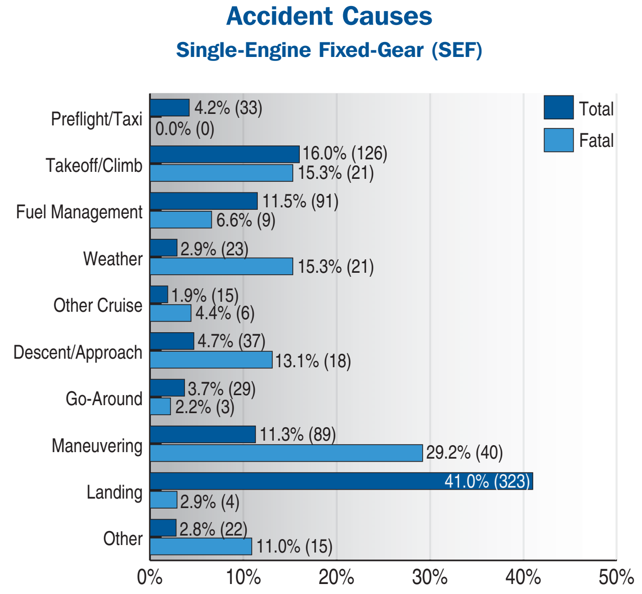


Fig. 9

Single-engine fixed-gear (SEF) aircraft are the largest group in general aviation. They are used for a wide variety of operations, but their relatively low operating costs make them particularly attractive for pleasure flights and instruction.

SEF aircraft accidents in 2004 dropped by 69 (857 in 2003 to 788 in 2004) compared to the previous year. Fatal accidents rose slightly, from 133 to 137 for the same timeframe. The distribution of accidents (Figure 9) was similar to 2003. The top four categories for fatal crashes accounted for a combined 72.9 percent of the total, as shown here:

Maneuvering: 29.2 percent (40)
Takeoff/Climb: 15.3 percent (21)
Weather: 15.3 percent (21)
Descent/Approach: 13.1 percent (10 VMC, 8 IMC)

Fatal Accident Factors

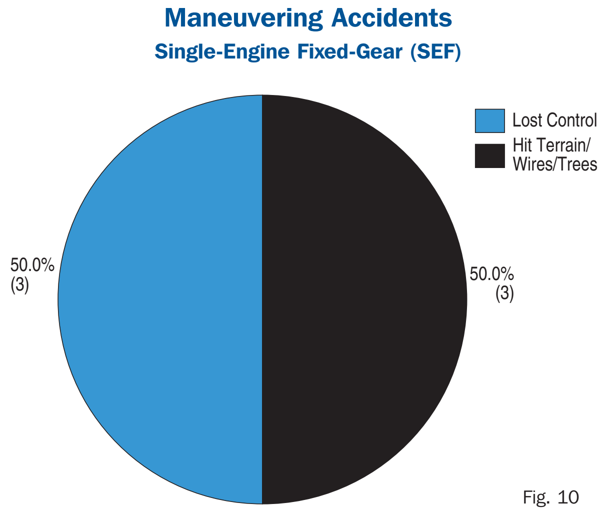


Fig. 10

There were 89 SEF maneuvering accidents in 2004, of which 40 resulted in fatalities. There are three primary reasons for these deaths as shown in Figure 10. Loss of aircraft control was the most common (45.0 percent) followed by hitting terrain, wires, or other obstacles (32.5 percent). Accidents occurring while performing aerobatic maneuvers accounted for 22.5 percent of the SEF fatal maneuvering crashes. Maneuvering accidents are generally preventable through the use of good pilot judgment and decision making.

Of the 21 fatal takeoff and climb accidents, over half (13) were the result of control loss due to failure to attain or maintain airspeed.

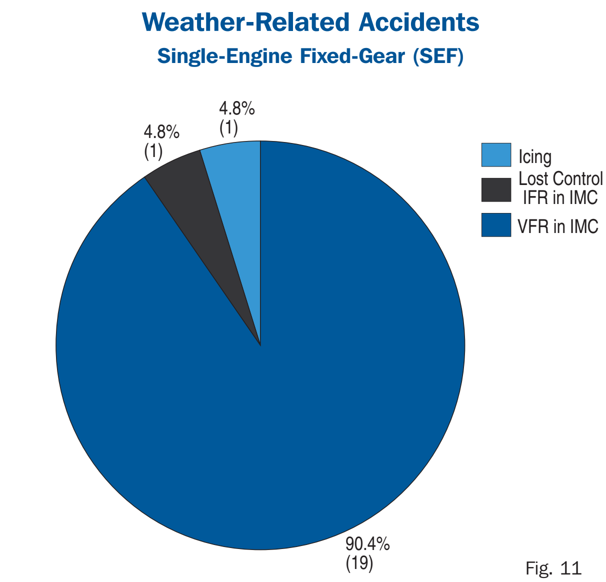


Fig. 11

As in previous years, weather made up only a small portion (2.9 percent) of total SEF accidents, but a relatively large number (15.3 percent) of the fatal ones. Figure 11 shows that 90.4 percent of fatal weather-related accidents in SEF aircraft resulted from continued VFR flight into IMC. In such cases, a pilot flying by reference to outside visual cues flies into clouds or low visibility conditions, and loses control of the aircraft or hits terrain. Pilots must be able to effectively assess weather-related risks to avoid these situations.

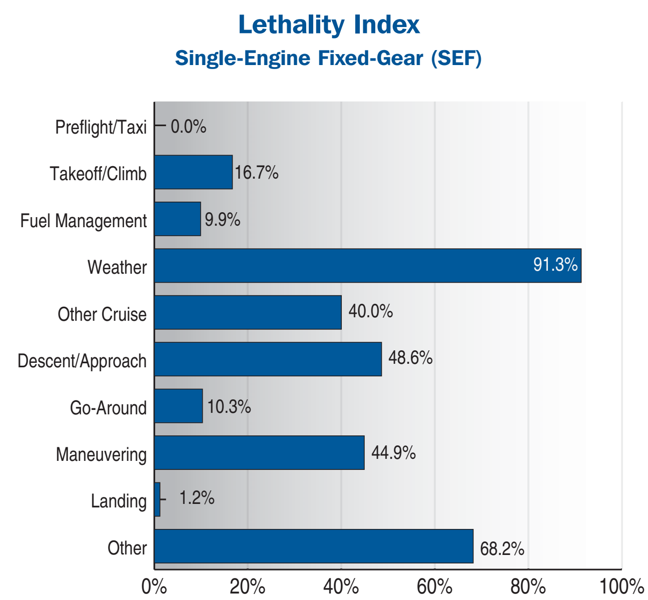


Fig. 12

Figure 12 depicts the Lethality Index for SEF aircraft. It closely resembles the chart of the lethality index for all GA aircraft (Figure 9, page 5) because SEF aircraft represent the majority of the GA fleet.

Instructional Flying

The area of greatest improvement for 2004 was in number of instructional accidents. Instructional flying provides the training and practice that allows pilots to develop and maintain skills, habits, and attitudes that directly contribute to safety. Following a spike in instructional accidents in 2003, the Air Safety Foundation and other industry groups launched initiatives to address the sudden increase. As a result, instructional accidents have returned to their historic low levels. We caution that one-year or even several-year fluctuations do not constitute long-term trends. Causal factors may be addressed, but broad pronouncements of a fundamental shift, based on such limited data, are usually premature.

The total number of instructional accidents decreased 10.4 percent in 2004 (from 173 to 155), while fatal training accidents declined 41.2 percent (from 17 to 10). Figure 13 *(next page)* shows the breakdown of instructional flying accidents by category. Some noteworthy points regarding 2004 instructional accidents are:

- The proportion of go-around accidents attributed to instructional flying increased from 19.0 percent in 2003 to 29.3 percent in 2004, although none in 2004 were fatal. These go-around accidents were split evenly between dual and solo operations.

Proportion of Accidents - Instructional Flying

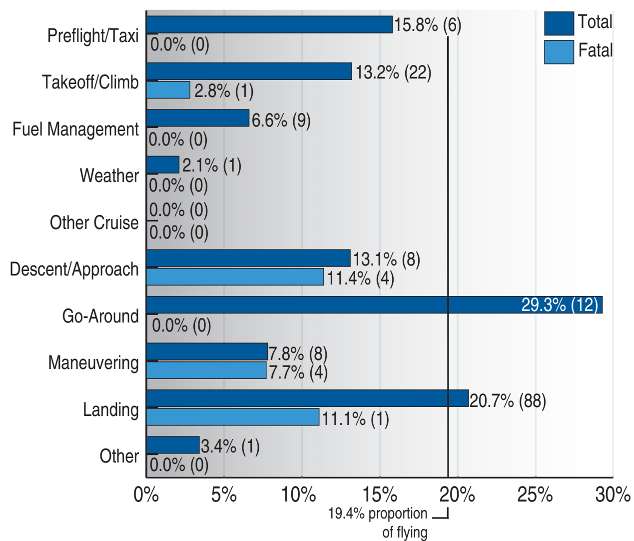


Fig. 13

- There was a significant reduction in the proportion of preflight/taxi (from 25.8 to 15.8 percent) and takeoff/climb (from 20.5 to 13.2 percent) accidents that occurred during instructional flights.

Single-Engine Retractable-Gear Aircraft

184 total/ 49 fatal

Overview

Accident Causes
Single-Engine Retractable-Gear (SER)

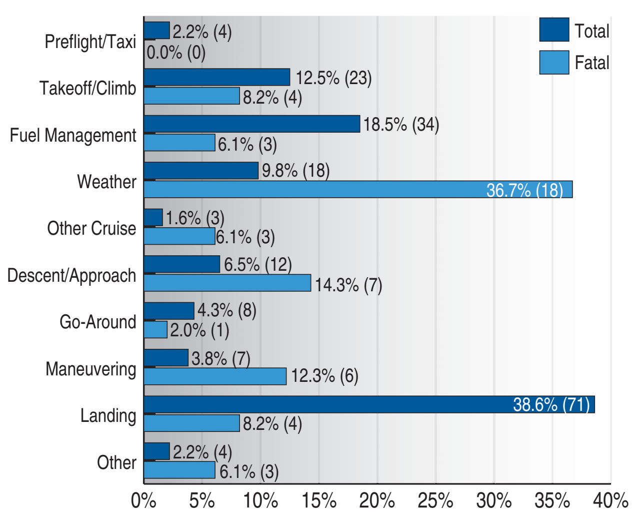


Fig. 14

With their relatively high performance, single-engine retractable-gear (SER) aircraft are popular for personal and business trips. This type of use exposes the pilot to a wider range of weather and operational conditions than pleasure flying.

SER accidents decreased 5.6 percent in 2004 (from 195 to 184), while fatal accidents decreased 25.8 percent (from 66 to 49). Figure 14 charts the data for accidents in this class. The leading causes of SER fatal accidents in 2004 were:

Weather: 36.7 percent (18)
Descent/Approach: 14.3 percent (0 VMC, 7 IMC)
Maneuvering: 12.3 percent (6)

Fatal Accident Factors

Weather-Related Accident Causes
Single-Engine Retractable-Gear (SER)

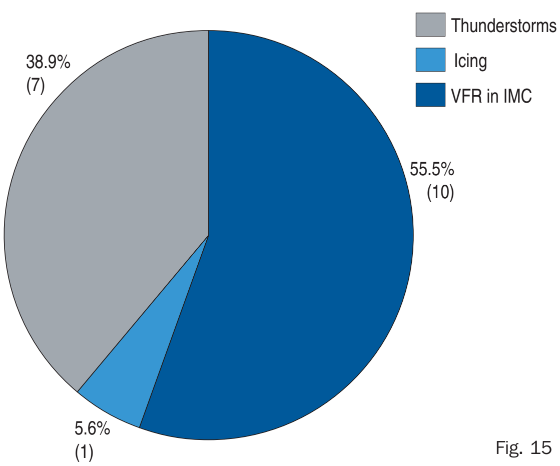


Fig. 15

Weather-related accidents in SER aircraft increased 28.6 percent, to 18 (all fatal) from 14 (12 fatal) the previous year. Figure 15 shows the reasons for these accidents, including the fact that 55.5 percent resulted from continued VFR flight into

IMC. Another 38.9 percent resulted from encounters with thunderstorms, and 5.6 percent were due to in-flight icing.

Descent/approach accident rates in SER aircraft improved dramatically from 2003, dropping from 24.2 percent to 14.3 percent of the total. This high-workload phase of flight can lead to pilot distractions, inducing loss of control or collisions with the ground.

Maneuvering Accidents

Single-Engine Retractable-Gear (SER)

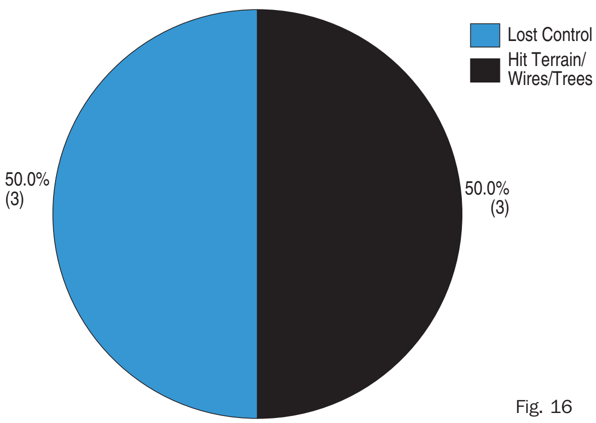


Fig. 16

There were 10 fewer fatal SER maneuvering crashes (six versus 16) (Figure 16) in 2004 than the previous year. The 2004 maneuvering accidents were split evenly between collisions with terrain/obstructions and loss of control.

SER aircraft had higher lethality indexes in most categories than SEF aircraft (Figure 17). The probability of fatal injury was highest for accidents attributable to weather (100 percent), other cruise (100 percent), maneuvering (85.7 percent), and descent/approach (58.3 percent). Accidents with "other" causes were 75 percent lethal.

Lethality Index

Single-Engine Retractable-Gear (SER)

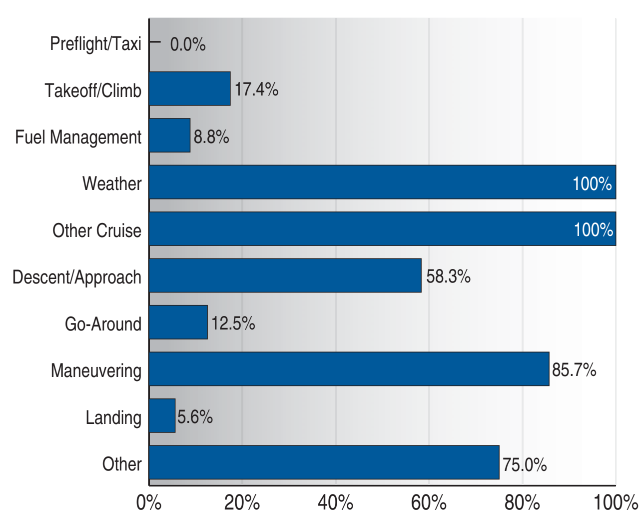


Fig. 17

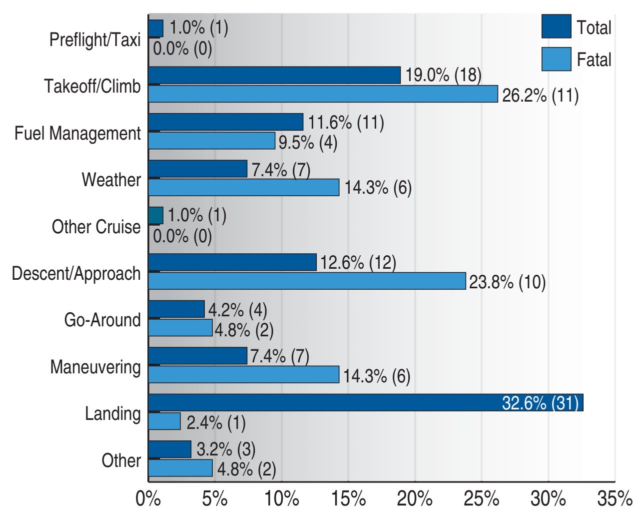
Multiengine Aircraft

95 total/ 42 fatal

Overview

Accident Causes

Multiengine (ME)



NOTE: Accident counts for each category are displayed in parentheses.

Fig. 18

In normal operations, multiengine (ME) aircraft share the high performance of their retractable-gear single-engine cousins. ME aircraft have a potential safety advantage in the second engine, but higher levels of pilot skill are required if one of the engines does fail, particularly during takeoff or initial climb.

The number of accidents in ME aircraft remained the same in 2004 (95) as 2003, while the number of fatal accidents increased 13.5 percent (from 37 to 42). Figure 18 *(previous page)* depicts the data on all pilot-related accidents and fatal accidents in this aircraft class. The leading categories of fatal ME aircraft accidents were:

Takeoff/Climb: 26.2 percent (11)
Descent/Approach: 23.8 percent (5 VMC, 5 IMC)
Weather: 14.3 percent (6)
Maneuvering: 14.3 percent (6)

Fatal Accident Factors

Takeoff/climb accidents accounted for nearly one in five ME accidents overall, and over one fourth of those that resulted in death. A likely contributor to this is the higher takeoff and stall speeds of ME aircraft. Also, in a conventional ME aircraft, loss of power in one engine creates an asymmetrical thrust situation that can challenge an unprepared pilot.

Accidents that occurred during descent/approach accounted for 12.6 percent of the total ME accidents, and nearly one in four (23.8 percent) of fatal ME accidents.

Weather-Related Accident Causes
Multiengine (ME)

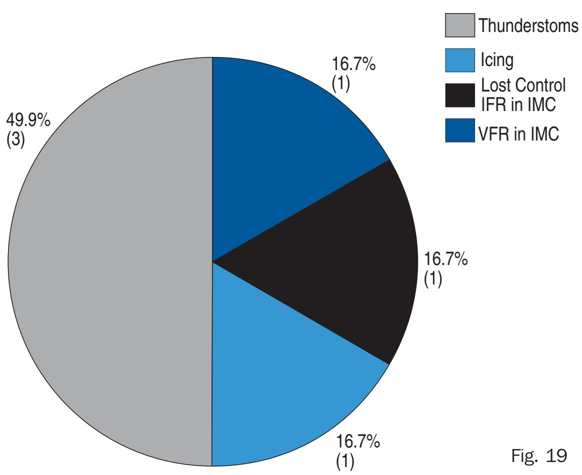


Fig. 19

NOTE: Accident counts for each category are displayed in parentheses.

As with the other aircraft classes, weather was a significant factor in ME aircraft accidents. There were seven weather accidents, six of which were fatal. Figure 19 shows half (three) of these fatal accidents were related to thunderstorms, and one each due to VFR flight into IMC, loss of control while operating IFR in IMC, and icing.

Figure 20 *(above, right)* illustrates the primary reasons for fatal ME maneuvering accidents. Note that the maneuvering accident profile differs from that of single-engine aircraft, with most such ME accidents resulting from loss of control. There was only one maneuvering accident in each of the other groups.

Maneuvering Accidents
Multiengine (ME)

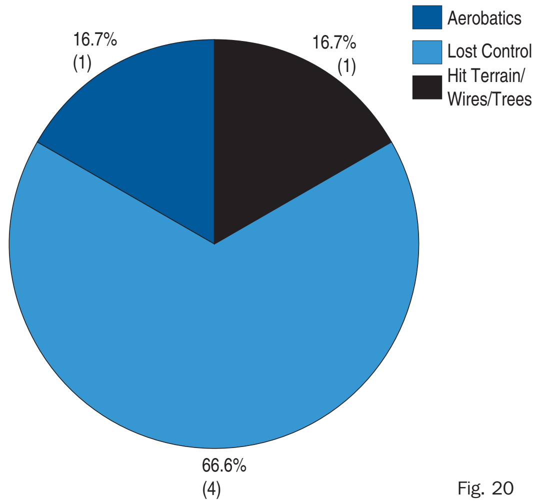


Fig. 20

Figure 21 *(below)* depicts the lethality index for all accident categories in ME aircraft in 2004. With 61.1 percent fatal, ME accidents during takeoff and climb were much more deadly than those in single-engine aircraft. Other highly lethal accident categories included weather (85.7 percent), maneuvering (85.7 percent), and descent/approach (83.3 percent).

Lethality Index
Multiengine (ME)

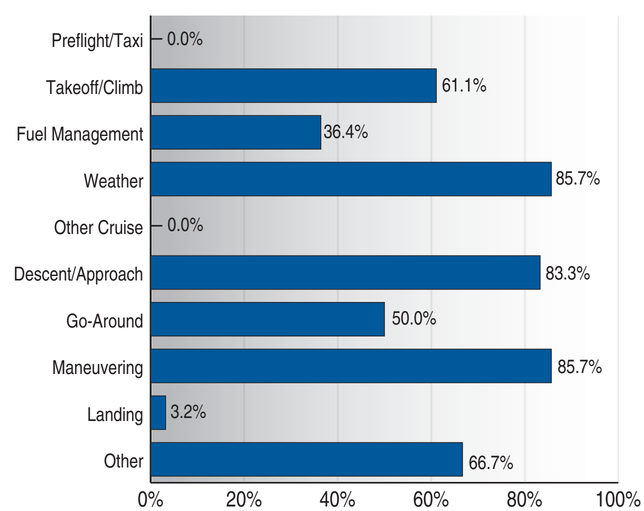


Fig. 21

Pilot-Related Accident Factors

Levels of pilot experience and certification are always of interest. Figure 22 (opposite, above) shows the correlation between accidents and pilot flight hours in 2004. As in previous years, the more experienced the pilot, the less likely he or she is to be involved in an accident. The first 500 hours of a pilot's flying career are the most critical, with 34.4 percent of the total and 28.7 percent of fatal accidents occurring then.

Accident Rates by Hours of Experience

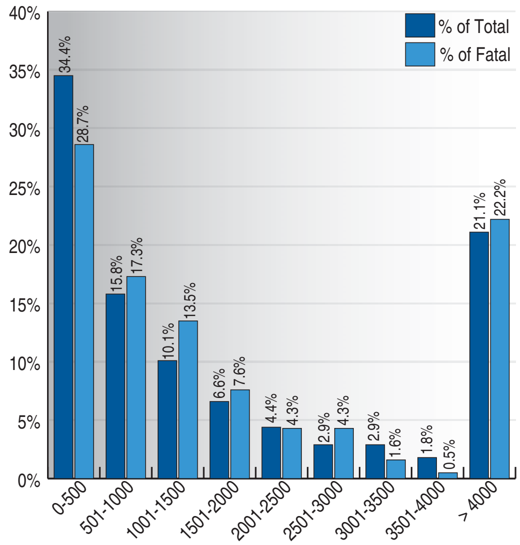


Fig. 22

Time-in-Type

The number of flight hours in a particular type of aircraft (Figure 23) also has an impact on safety. The more time-in-type a pilot has, the less likely he or she is to have an accident in it. More than 44 percent of total 2004 accidents involved pilots with fewer than 100 hours experience in type. Nearly half (48.3 percent) of the fatal accidents were at that level of experience. Total accident rates fall sharply after the first 100 hours of time-in-type. Because the first 100 hours in type is so critical, pilots should fly more conservatively – use longer runways, fly with higher IFR minimums, etc. – until more experience is gained.

Certificate Level

Accident rates can also be analyzed based on the level of pilot certificate held (Figure 24). Student pilots and airline transport pilots (ATP) have the lowest accident statistics relative to their representation in the overall pilot population, while private and commercial pilots both have disproportionately high percentages. Since most personal flying is done by private and commercial pilots, their accident proportion closely mirrors the proportion for personal flying shown in Figure 5 (page 4).

Accident Rates by Time in Type

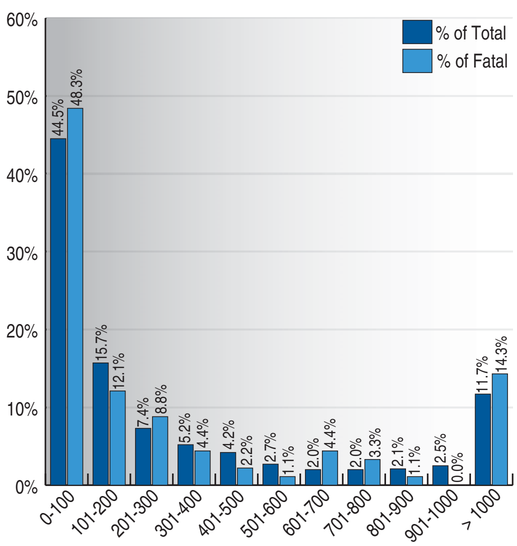


Fig. 23

Accident Rates by Certificate Level

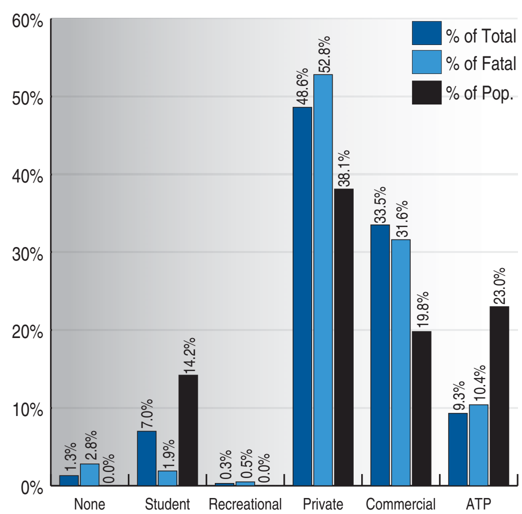
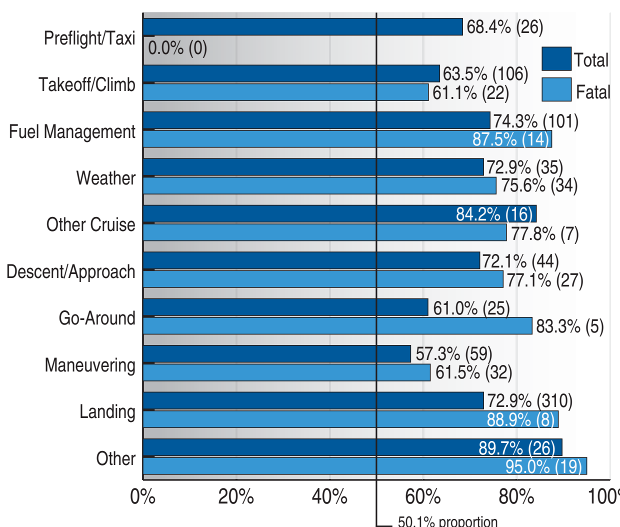


Fig. 24

Personal Flying

748 total/ 168 fatal

Proportion of Accidents - Personal Flying



NOTE: Accident counts for each category are displayed in parentheses.

Fig. 25

Personal flying (for example: visiting friends or family, traveling to a vacation home or for recreation) represents about half (50.1 percent) of all GA flying, but accounts for 73.8 percent of fatal and 70.6 percent of nonfatal accidents (Figure 25).

This type of flying accounted for nearly three-quarters (72.9 percent) of all weather-related accidents, and 75.6 percent of weather-related fatal crashes. Fuel management is another challenge for pilots on personal flights; three out of four of the total, and 87.5 percent of the fatal fuel management accidents occurred during this type of flying. Personal flights also accounted for 72.1 percent of all descent/approach accidents (77.1 percent of the fatals), and 72.9 percent of landing accidents (88.9 percent of the fatals).

Business Flying

38 total/ 12 fatal

Proportion of Accidents - Business Flying

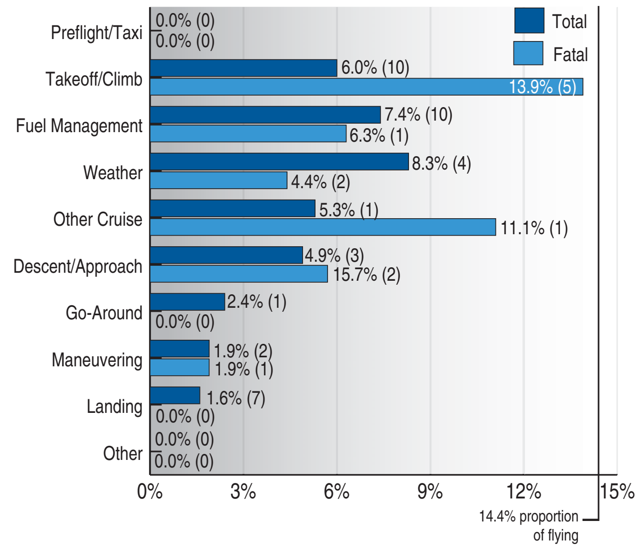


Fig. 26

GA is a key tool in the conduct of business and extends the national transportation system to locations without adequate airline service. While scheduled airlines serve 550 cities nationwide, GA can go directly to about 19,000 landing facilities. Many pilots rely on their aircraft for business transportation, accounting for 14.4 percent of all GA operations in 2004. Figure 26 shows that business operations are proportionally safer than other types of flying.

Business flying accounted for 8.3 percent of GA weather accidents, up from 4.8 percent in 2003. The next highest rates were for fuel management and takeoff/climb accidents, tallying 7.4 percent and 6.0 percent of the GA total and 6.3 and 13.9 percent of GA fatal accidents, respectively. Business "other cruise" accounted for 5.3 percent of the GA total and 11.1 percent of the GA fatal accidents.

Mechanical/Maintenance Accidents

221 total/ 29 fatal

Properly maintained GA aircraft are very reliable. As a result, failures of the aircraft or its systems are relatively rare. Mechanical/maintenance accidents are caused by a mechanical failure that adversely affects the function or performance of the aircraft. Though pilots are responsible for assuring airworthiness, when an equipment failure leads to an accident, it is considered a mechanical/maintenance accident.

Engine and propeller malfunctions accounted for 47.1 percent of all, and 72.4 percent of fatal, mechanical/maintenance accidents in 2004 (Figure 27 *next page*). As might be expected, loss of power can create a very dangerous situation.

Accident Causes - Mechanical/Maintenance

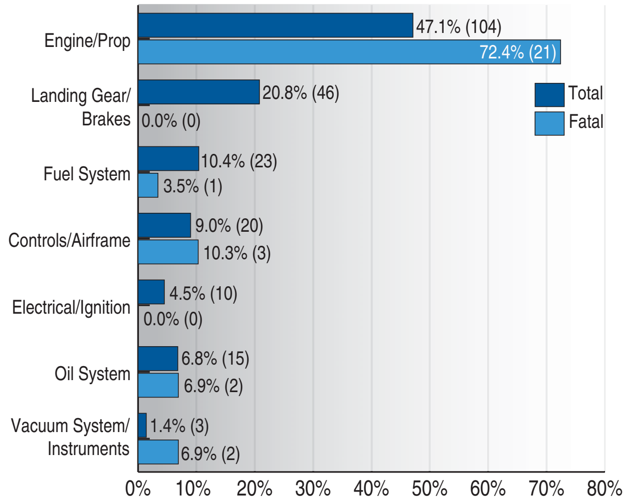


Fig. 27

Similarly, malfunctions involving aircraft controls or the airframe can be hazardous, although fortunately, they are rare. These caused nearly one in 10 (9.0 percent) of all, and 10.3 percent of fatal, mechanical/maintenance accidents. Accidents involving failures of vacuum systems or flight instruments are also rare, but can lead to loss of aircraft control when the failure occurs in IMC. In 2004 there were three such accidents, two of which were fatal.

Over the past six years, the average rate of mechanical/maintenance accidents has continued to decline (Figure 28). 2004's figure of 15.6 percent is consistent with this trend.

Accident Trend - Mechanical/Maintenance

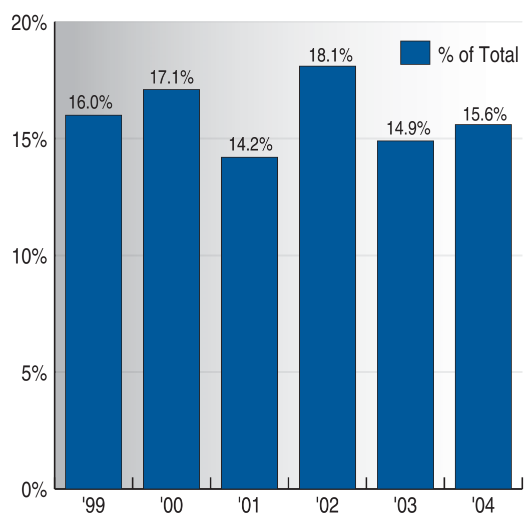


Fig. 28

Night and Weather

Flights conducted at night and in adverse weather are riskier than flights during the day and in VMC. Although there are substantially more accidents in both daytime and VMC conditions, those that occur at night or in IMC are more likely to be fatal. Flights during night IMC are four times more likely to end in fatality than flights during day VMC (3.0 versus 0.7 accidents per 100,000 hours). Figure 29 presents 2004 accidents sorted by basic weather and lighting conditions.

Accident Causes - Weather and Light

CONDITION	Accident Total (Fatal)	Percent Fatal	Accident Rate /100,000 hrs.	Fatal Accident Rate /100,000 hrs.
Day	1118 (152)	13.6%	6.0	0.8
Night	133 (46)	34.6%	5.3	1.8
VMC	1307 (212)	16.2%	6.7	1.1
IMC	97 (71)	73.2%	5.7	4.1
Day VMC	1075 (124)	11.5%	6.2	0.7
Night VMC	99 (21)	21.2%	4.6	1.0
Day IMC	43 (28)	65.1%	4.1	2.7
Night IMC	24 (10)	41.7%	7.2	3.0

Fig. 29

Though the total numbers are lower, accidents at night and in IMC are more likely to be fatal. Only 13.6 percent of daytime accidents resulted in fatalities, but more than one-third (34.6 percent) of all night accidents were fatal. Though only 16.2 percent of accidents in VMC were fatal, in IMC almost three fourths (73.2 percent) claimed a life.

Looking at the combined factors, day VMC accidents had the lowest fatal accident rate of any light/weather condition, with a little more than one in 10 (11.5 percent) resulting in death. Day IMC accidents had the highest fatality rate, at 65.1 percent. At night, one in five accidents in VMC conditions were fatal (21.2 percent), compared to slightly less than half of night IMC accidents (41.7 percent).

Accident Trend - Weather

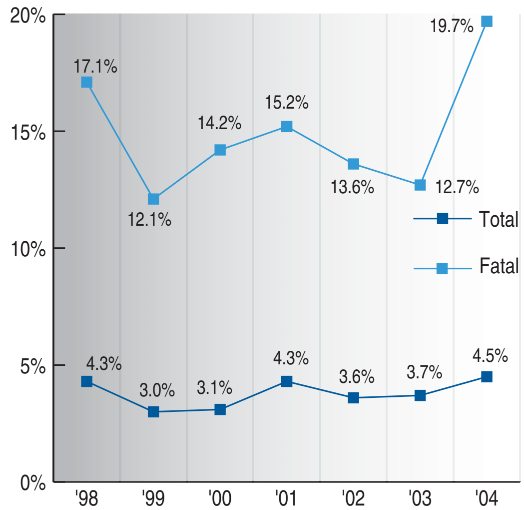


Fig. 30

In general, accidents caused by weather are on the increase, with 2004 weather-related accidents at their highest level in the last six years. Figure 30 charts the trend of weather-related accidents. In 2004, weather was the primary factor in 4.5 percent of all pilot-related accidents, accounting for 19.7 percent of all fatal pilot-related crashes.

Special Emphasis Topic: Thunderstorms and ATC

In 2004, nearly 25 percent of fatal weather-related accidents were due to encounters with thunderstorms. All involved pilots were in contact with ATC, but still flew into severe conditions. These accidents highlight the importance of pilots and controllers sharing an understanding of which thunderstorm avoidance services are, or are not, being provided. The following accident summary illustrates this issue.

In late spring of 2004, a high-performance single-engine aircraft was westbound over Michigan, en route IFR with the pilot and two passengers on board. The airplane had been given a heading to avoid adverse weather by Lansing approach control. Following a handoff and frequency change, the new controller advised the pilot to proceed direct to Milwaukee “when able.” The pilot likely assumed he was clear of the thunderstorm activity, but that was not the case.

About seven minutes after this handoff, the pilot transmitted, "Center…what do you show us in up here?" The airplane had entered a thunderstorm and subsequently entered a flat spin, impacting the terrain below. Everyone aboard died. Aircraft and weather radar data showed that the airplane had flown into an area of Level 6 (extreme) thunderstorms.

Of GA’s 45 fatal weather accidents in 2004, 10 involved thunderstorms. To some degree, each was relying on ATC’s ability to guide them around the violent weather. IFR pilots have long depended on ATC to help them avoid hazardous weather. However, ATC was created for one primary purpose – to keep airplanes from colliding with one another. All other ATC services are on a workload-permitting basis and are NOT automatically provided. This means that pilots are not guaranteed weather avoidance services. Pilots need to confirm what services they are receiving, and renew their request with each controller as they change frequencies. There is currently some discussion on expanding ATC’s role in order to increase safety in the system.

The current generation of ATC radar displays is much better than older equipment at showing weather. ATC’s new weather detection equipment, called Weather and Radar Processing, or WARP, is now installed in all Air Route Traffic Control Centers. This new equipment puts a weather-patterned background derived from the NEXRAD weather radar network behind the radar traffic display, showing the controller severe weather much more clearly than in the past.

In spite of its advances, WARP has limitations. A WARP weather display is six to 11 minutes old by the time it is overlaid on the controller's screen, because of the time required to compile information from more than one NEXRAD radar site.

There are limitations to WARP too detailed to be relayed here, but WARP is a great improvement from a time when controllers would frequently respond with "My radar isn't designed to show weather...."

Terminal Radar Control Facilities (TRACONS) almost universally use ASR-9 or ASR-11, which have special weather depiction circuitry that can be used for weather avoidance. The key to effective use of this equipment is good communication with ATC – ask for deviations and assistance early. We retain the coveted title of Pilot-in-Command so the final decision regarding safety of the aircraft resides with us.

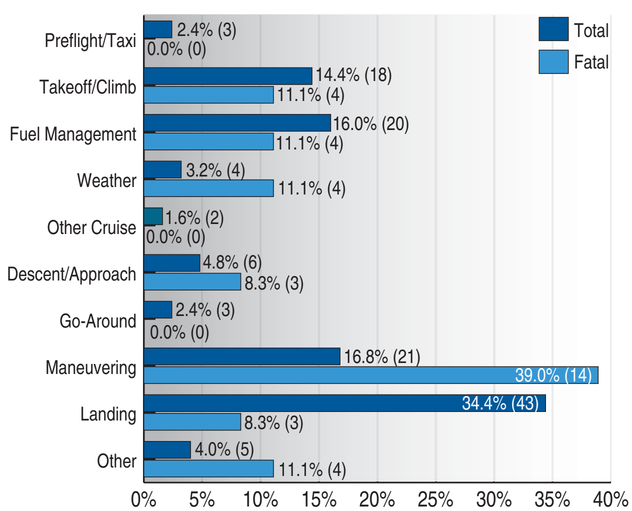
Onboard weather radar, lightning strike detectors, and data link weather displays are valuable resources that pilots can use to remain well clear of thunderstorms. Pilots who do not have this equipment should consider staying visual as much as possible. Getting on top allows a good view of potentially dangerous buildups. *If ceiling and visibility allow*, staying underneath can give a good view of shafts of heavy rain.

In spring of 2006, ASF will release a new training course related to thunderstorms and how to avoid them. Look for it on the ASF Web site, www.asf.org.

Homebuilt Aircraft

125 total/ 36 fatal

Pilot-Related Accident Rates - Homebuilt



NOTE: Accident counts for each category are displayed in parentheses.

Fig. 31

Homebuilt aircraft are a rapidly growing segment of the GA fleet. They include a wide variety of designs and technologies, and cover the full range from simple, low performance pleasure craft to high-tech, high performance models. Most are single engine.

Homebuilt pilots represent the full range of experience and certification.

Pilot-related accidents in homebuilt aircraft decreased 5.3 percent in 2004 (to 125 from 132), with fatal accidents remaining virtually unchanged (to 36 from 35). Figure 31 depicts the leading categories of pilot-related homebuilt accidents. Four categories accounted for 72.3 percent of fatal homebuilt accidents. They were:

Maneuvering: 39.0 percent (14)
Fuel Management: 11.1 percent (4)
Takeoff/Climb: 11.1 percent (4)
Weather: 11.1 percent (4)

Proportion of Accidents - Homebuilt

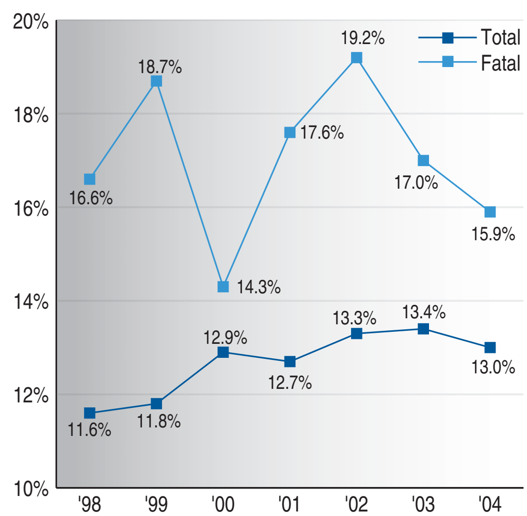


Fig. 32

Figure 32 tracks the proportion of pilot-related accidents in homebuilt aircraft to overall GA accidents over the last seven years. Although the total number of homebuilt accidents is trending upwards, perhaps because the percentage of homebuilt aircraft in the fleet is increasing, the percentage of fatal homebuilt accidents is holding steady.

Other Accident Factors

Fuel Management

136 total/ 16 fatal

Fuel management accidents include fuel exhaustion (the airplane runs out of gas), fuel starvation (fuel remains on board but is prevented from reaching the engine, e.g., failing to switch tanks at the right time), and fuel contamination. In 2004, 79 (four fatal) accidents were a result of fuel exhaustion. Although easily preventable, there were 39 (seven fatal) fuel starvation accidents in 2004. Fuel contamination resulted in 18 (five fatal) accidents.

Midair Collisions

10 total/ 6 fatal

Collisions between aircraft in flight are relatively rare. Most happen in day VFR conditions, frequently in or near an airport traffic pattern. Most in 2004 were at airports that did not have a control tower, although this does not necessarily mean that towered airports are safer, since about 97 percent of U.S. airports do not have a control tower. Total and fatal midair collisions for the year decreased by one each (11 to 10 and seven to six respectively) compared to 2003, and there were 10 fatalities.

Alcohol and Drugs

6 total/ 4 fatal

Alcohol and drug misuse continues to rank low as an accident factor. Historically, these have been cited as a cause or factor in about 1.1 percent of all accidents. As a class, these accidents have a high probability of ending in a fatality. In 2004 six accidents were attributed to drug or alcohol use, with four being fatal. Five of the six pilots involved were impaired by alcohol; the sixth by a prescription medicine.

Many pilots believe that it is safe to fly if they have recently taken an OTC or prescription medication. Depending on the drug, this may not be the case. A list of drugs commonly approved by the FAA is available to AOPA members on the AOPA Web site (www.aopa.org). Also, the AOPA Medical Certification Department offers free counseling to AOPA members on a wide variety of medical issues related to flying.

Pilot Incapacitation

5 total/ 4 fatal

Pilot incapacitation happens very rarely. Five such accidents occurred in 2004, with one resulting from a heart attack, one from carbon monoxide poisoning, and three (one nonfatal) from unknown causes. Only one of these accidents occurred with a passenger aboard.

Ground Injuries: Off-Airport

4 total/ 0 fatal

The fear of airplanes falling out of the sky, causing death or injury on the ground, is a common concern for nonpilots. This concern is often cited as a reason to restrict or close GA airports, even though statistics show it is far more fiction than fact. In 2004 there were no deaths and only four accidents with injuries on the ground outside of the airport environment (off airport) as a result of GA accidents. This is a significant reduction from 2003, when eight bystanders were injured and one died. Put into perspective, these numbers pale in comparison to automotive injuries to bystanders.

Propeller Strike Injuries

1 total/ 0 fatal

Propeller strike injuries usually result from either an attempt to hand prop an airplane, or an individual in the ramp area inadvertently coming into contact with a moving propeller. The number of fatalities from propeller strikes is very low, averaging two per year. Only one propeller strike accident occurred in 2004, when an alcohol-impaired passenger walked into a turning propeller. He survived.

Summary

Between 2000 and 2004, the number of GA accidents has declined nearly 12 percent. Annual GA flight hours have increased by 200,000 for each of the last three years. Thus, the overall GA accident rate per 100,000 flight hours continues its decade-long decline. The AOPA Air Safety Foundation is continuing to work for additional improvements in GA safety.

Here are more highlights of GA accident trends for 2004:

- The accident rates per 100,000 hours for GA aircraft were 6.22 total and 1.20 fatal.

- Pilot-related causes were responsible for three-quarters of all accidents (75.5 percent) and nearly the same percentage of fatal accidents (78.6 percent). Total pilot-related accidents in 2004 declined 7.0 percent (to 1,067 from 1,147); fatal pilot-related accidents dropped 3.4 percent (to 228 from 236) compared to 2003.

- Weather accounted for 4.5 percent of all pilot-related accidents, but 19.7 percent of fatal accidents. The majority of fatal weather accidents in single-engine aircraft resulted from continuing VFR flight into IMC. Single-engine retractable and multiengine aircraft accidents were more likely to have thunderstorm encounters and icing as factors.

- Accidents during personal flying accounted for about seven out of 10 of all accidents (70.6 percent), and nearly three-quarters (73.8 percent) of all fatal accidents. Personal flying accounted for about half of 2003 GA activity (50.1 percent).

- Maneuvering flight was the category with the largest number of pilot-related fatal accidents (52). This category accounted for almost one out of four fatal crashes (22.8 percent) in 2004. Maneuvering flight was also the number one fatal accident category for single-engine fixed-gear aircraft, responsible for almost one-third (29.2 percent) of all SEF fatal accidents.

- Only 13.6 percent of daytime accidents resulted in fatalities, but at night, more than one in three (34.6 percent) were fatal.

Appendix

GA Safety vs. Airlines

GA accident rates have always been higher than airline accident rates. People often ask about the reasons for this disparity. There are several:

- **Variety of missions** – GA pilots conduct a wider range of operations. Some operations, for example, aerial application (crop-dusting in common parlance) and banner towing, have inherent mission-related risks.

- **Variability of pilot certificate and experience levels** – All airline flights are crewed by at least one ATP (Airline Transport Pilot), the most demanding rating. GA is the training ground for most pilots, and while the GA community has its share of ATPs, the community also includes many new and low time pilots, and a great variety of experience in between.

- **More limited cockpit resources and flight support** – GA operations are predominantly conducted by a single pilot, and the pilot typically handles all aspects of the flight, from flight planning to piloting. Air carrier operations require at least two pilots. Likewise, airlines have dispatchers, mechanics, loadmasters, and others to assist with operations.

- **Greater variety of facilities** – GA operations are conducted at about 5,000 public-use and 8,000 private-use airports, while airlines are confined to only about 700 of the larger, public-use airports. Many GA-only airports lack the precision approaches, long runways, approach lighting systems, and the advanced services of airline-served airports. (There are also another 6,000 GA-only landing areas that are not technically airports, such as heliports and seaplane bases.)

- **More takeoffs and landings** – During takeoffs and landings aircraft are close to the ground and in a more vulnerable configuration than in other phases of flight. On a per hour basis, GA conducts many more takeoffs and landings than either air carriers or the military.

- **Less weather-tolerant aircraft** – Most GA aircraft cannot fly over or around weather the way an airliner can, and they often do not have the systems to avoid or cope with hazardous weather conditions, such as ice.

What Is General Aviation?

Although GA is typically characterized by recreational flying, it encompasses much more. Besides providing personal, business, and freight transportation, GA supports diverse activities such as law enforcement, forest fire fighting, air ambulance, logging, fish and wildlife spotting, and other vital services.

What Does General Aviation Fly?

General aviation aircraft are as varied as their pilots and the types of operations flown. The following aircraft categories and classes are included in each year's *Nall Report:*

- Piston single-engine
- Piston multiengine
- Turboprop single-engine
- Turboprop multiengine
- Experimental
- Homebuilt

The following aircraft categories and classes are **not** included in each year's *Nall Report:*

- Turbojets
- FAR Part 121 airline operations
- FAR Part 135 charter operations
- Military operations
- Aircraft weighing more than 12,500 pounds
- Helicopters
- Gliders
- Balloons

The number of GA aircraft, sorted by category and class, registered in 2004 (the most recent year statistics are available from the FAA) to air taxi operators and GA is shown below:

What Does General Aviation Fly?

	Air Taxi	General Aviation
Piston single-engine	2,585	146,613
Piston multiengine	1,355	18,576
Turboprop single-engine	453	2,468
Turboprop multiengine	786	5,912
Turbojet	1,558	9,298
Helicopter	716	7,821
Experimental	56	22,800
Total	**7,509**	**263,488**

Fig. 33

Figure 33 displays the composition of the powered GA fleet, divided by aircraft class and by the type of operation. The aircraft covered in this report comprise 90.6 percent of the GA fleet, if one totals homebuilt aircraft, all singles, and all piston aircraft.

Interpreting Aviation Accident Statistics: What is the accident rate?

Meaningful comparisons are based on equal exposure to risk. However, this alone does not determine total risk. Experience, proficiency, equipment, and flight conditions all have a safety impact. To compare different airplanes, pilots, types of operations, etc., we must first "level the playing field" in terms of exposure to risk. The most common way to do this is to compare accidents per 100,000 flight hours. GA flight hours are estimated using data from an annual aircraft activity survey conducted by the FAA. Whether this survey accurately reports the total hours has been debated for years, but even with likely inaccuracies, the relationships between accident categories will remain constant. For instance, landing accidents will still account for the lion's share of minor injury mishaps, while weather and maneuvering flight will still claim the most lives.

Accident investigators and safety researchers determine the probability that a given accident was the result of a particular cause or sequence of events. This report shows the percentage of accidents attributed to a particular accident category and the percentage of accident sequences that began in a particular phase of flight. Thus we can identify and concentrate on accidents that carry the greatest risk.

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 publications 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 nonoccupant) 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, i.e., 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** 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.

Type 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 FAR Part 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/power line patrol, land and animal surveys, etc. This does not include traffic observation (electronic newsgathering) 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 Flight

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 en route 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 en route descents, emergency descent, auto-rotation descent, and uncontrolled descent.

Approach — From the time the descent ends (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 auto-rotation 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 air work, basic air work, external load operations, etc.

Unknown — The phase of flight could not be determined.

Additional Resources

If you would like additional information about the topics covered in this report, as well as many other topics not covered, visit ASF's Web site: **www.asf.org**.

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Search the AOPA Air Safety Foundation Accident Database and find graphs representing the latest statistical data from the FAA and NTSB. Learn more about General Aviation safety issues with ASF's in-depth analysis, including archived versions of the annual Nall Report and Special Reports you won't find anywhere else.

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Take nothing for granted; do not jump to conclusions; follow every possible clue to the extent of usefulness . . . . Apply the principle that there is no limit to the amount of effort justified to prevent the recurrence of one aircraft accident or the loss of one life.

— *Accident Investigation Manual of the U.S. Air Force.*

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