

BY CLARENCE E. RASH

Downward Trends

Data show a decline in U.S. helicopter accidents in 2001–2010, with an accident rate of 5.7 per 100,000 flight hours.





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While the advantages of helicopters have encouraged their use, they also have contributed to hazards. The ability to operate low to the ground and in confined areas increases the probability of loss of control caused by dynamic rollover; collision with wires, trees and other objects; and loss of situational awareness resulting from brownout (blowing dust) or whiteout (blowing snow). Frequent takeoffs and landings at unprepared landing sites present an additional, substantial hazard.

Historically, helicopter accident rates in the United States have been as high as 38.4 accidents per 100,000 flight hours — for the period from

1963 through 1970. In the most recent decade (2001–2010), accident rates stabilized and declined to 5.7 per 100,000 flight hours — down from 7.8 per 100,000 flight hours recorded in 1991–2000 — due in large part to improvements in pilot training, maintenance and overall helicopter design (Figure 1, p.36).¹

At the start of the decade, in 2001, the world's civil aviation helicopter fleet was estimated at 27,000, with 46 percent of those in North America.² By 2010, the estimate had increased to 36,000 helicopters worldwide, with 50 percent in North America. The next largest concentration of helicopters is in the European

Accident Rates Involving U.S.-Registered Helicopters, 1963–2010



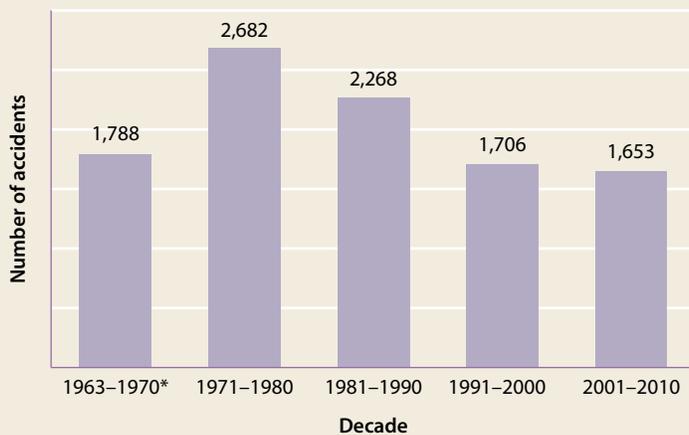
*The first helicopter accidents in the U.S. National Transportation Safety Board database occurred in 1963.

** Estimated flight hours

Source: Clarence E. Rash

Figure 1

Accidents Involving U.S.-Registered Helicopters, 1963–2010



*The first helicopter accidents in the U.S. National Transportation Safety Board database occurred in 1963.

Source: Clarence E. Rash

Figure 2

Union, which has an estimated 17 percent of the world’s total.^{3,4}

The Past

From 1963 — the date of the first helicopter accident recorded in the U.S. National Transportation Safety Board (NTSB) database — through

2010, there were 10,097 accidents involving helicopters registered in the United States (Figure 2).⁵ Of these, 1,653 accidents occurred from 2001 through 2010. The number represents an approximate 38 percent decrease from the historic high of 2,682 accidents, recorded for 1971–1980, and a 3 percent decrease from 1991–2000.

The total number of accidents in any period is influenced by the number of aircraft in operation and the total number of flight hours, both of which have increased significantly over the decades. Estimated total flight hours (Figure 3) have increased from 4.65 million for 1963–1970 (an annual average of 581,538) to 28.93 million for 2001–2010 (an annual average of 2.89 million).

Ups and Downs

For 2001–2010, NTSB data show an increasing trend in both accident frequency (Figure 4) and accident rate (Figure 5, p. 38) in the first three years (2001–2003), followed by a decrease and stabilization trend over the latter half of the decade.

Of the 1,653 accidents recorded during the decade, 265 (16 percent) were fatal accidents, resulting in a total of 520 fatalities. The average number of accidents each year during the decade was 165.3, and the average annual accident rate was 6.1 per 100,000 flight hours.⁶

The worst year in the decade for both the number of accidents — 203 — and the accident rate — 9.5 per 100,000 flight hours — was 2003. The deadliest year was 2008, with 76 fatalities, including seven that resulted from the midair collision of two Bell 407s, both on emergency medical services flights, in Flagstaff, Arizona (ASW, 7/09, p. 21).⁷

Accident Analyses

An individual accident can be categorized by a number of parameters, including the aircraft model, engine type, phase of flight, and lighting and meteorological conditions at the time of the accident, as well as causal factors. Analyses based on one or more of these parameters can help identify trends in the accident data.

For 2001–2010, an accident analysis by engine type shows an approximately equal frequency of accidents involving reciprocating (48.2 percent) and turbine shaft (50.9 percent) engine aircraft.

In general, about a third of all helicopters in operation today are reciprocating models, and the remaining two-thirds are single- or twin-engine turbine models.⁸ This implies that aircraft with reciprocating engines are involved in a disproportionately higher percentage of accidents (48.2 percent). One explanation may be the average older age of reciprocating-engine aircraft; another consideration is the turbine engine’s greater available power, which allows easier recovery from precarious flight situations.

Eighty-nine percent of accidents for the decade occurred in daytime conditions. Eight percent occurred at night, and 3 percent occurred in dawn and dusk lighting conditions. This was a consistent annual trend (Figure 6, p. 38).

Phase of Flight

The NTSB database also categorizes accidents by phase of flight (Table 1, p. 39).

With the exception of years when a significant number of accidents did not have phase of flight identified, maneuvering was the most common phase, and 30 percent of accidents occurred then. Landing was the second most common phase of flight for an accident, with 16 percent. Thirteen percent occurred during cruise, and 12 percent occurred during takeoff.

In the latter part of the decade, while maneuvering still was the most common phase of flight for an accident to occur, the number of accidents in the

cruise phase decreased dramatically. Caution must be exercised in interpreting these data, however, because on average, a third of all accidents in these later years were not identified as to phase of flight.

Overall, in an annual average of 13 percent of the accidents, the phase of flight was not recorded and could not be determined.

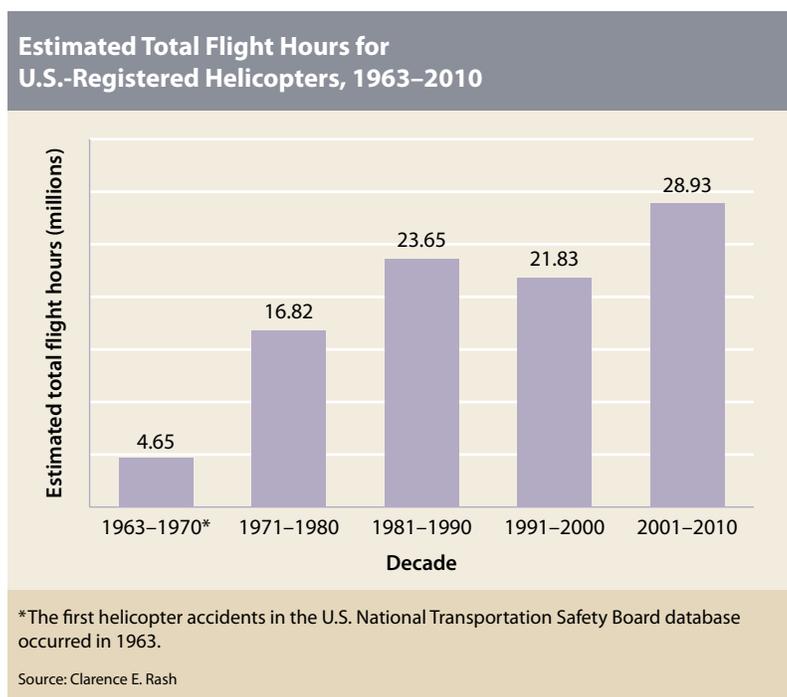


Figure 3

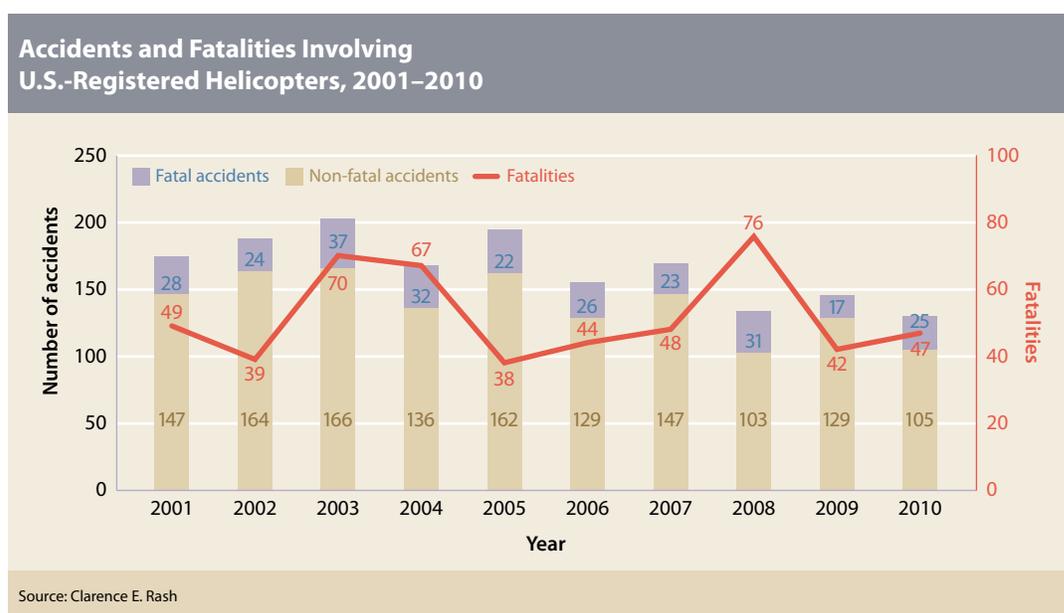
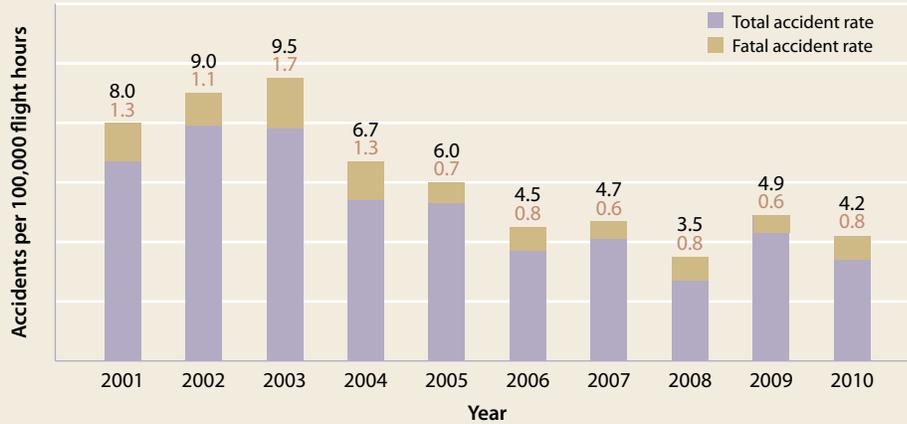


Figure 4

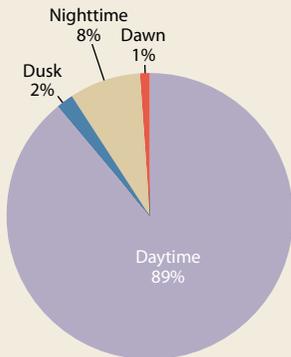
Accident Rates for U.S.-Registered Helicopters, 2001–2010



Source: Clarence E. Rash

Figure 5

U.S.-Registered Helicopter Accidents by Lighting Condition, 2001–2010



Source: Clarence E. Rash

Figure 6

and undetermined factors.

Pilot error was the leading causal factor for every year (Table 2), with NTSB narratives consistently opening with phrases such as “The pilot’s failure to ...” or “The pilot’s inadequate ...”. The second most common accident causal factor was a material factor, followed by maintenance error.

For the decade as a whole, annual averages

showed that pilot error was the first event causal failure in 69 percent of all accidents; material factor in 11 percent; and maintenance error in 4 percent. The NTSB database did not list a determined causal factor for 11 percent of the decade’s accidents.

Although there is no such thing as a typical accident, the analyses of helicopter accidents for 2001–2010 identified the most common accident as one involving a reciprocating engine aircraft, and occurring during a maneuvering phase of flight, under daytime lighting conditions and as a result of pilot error. 🌀

*Clarence E. Rash is a research physicist with 35 years experience in military aviation research and development and the author of more than 200 papers on aviation display, human factors and protection topics. His latest book is *Helmet-Mounted Displays: Sensation, Perception and Cognition Issues*, U.S. Army Aeromedical Research Laboratory, 2009.*

Causal Factors

Perhaps the most important analysis that can be performed on the NTSB accident data involves causal factors, as the results of this analysis can play the greatest role in preventing future accidents.

Although the NTSB database does not categorize accidents by causal factor, it provides a narrative stating the conclusions of the accident

investigation. Causal factor analyses, such as presented here, assign a first event causal factor to various categories using an acceptable category scheme. Such schemes may vary but generally conform to the following: pilot error; material failure, in which a component of the aircraft fails or does not function as intended; maintenance error; manufacturer fault; environmental factor, including weather or a bird strike; other factors such as an error by air traffic control, ground crewmembers or passengers;

Notes

1. Fox, R.G. *The History of Helicopter Safety*. Presented at the International Helicopter Safety Symposium, Montreal, Sept. 26–29, 2005.
2. Helicopter History Site, <helis.com>, retrieved 12 July 2011.
3. *Helicopter Fact Sheet*, Vertical Flight Society, <vstol.org/helifact.html>, retrieved 12 July 2011.

U.S.-Registered Helicopter Accidents by Phase of Flight, 2001–2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Annual Average
Approach	8%	8%	7%	5%	9%	5%	8%	4%	6%	4%	6%
Climb	2%	4%	0%	0%	1%	2%	2%	1%	0%	2%	1%
Cruise	18%	22%	20%	18%	12%	21%	14%	2%	1%	2%	13%
Descent	3%	2%	2%	3%	4%	1%	1%	2%	1%	1%	2%
Go-around	1%	0%	0%	0%	0%	1%	0%	0%	1%	0%	0.3%
Landing	15%	16%	16%	19%	18%	19%	19%	10%	17%	13%	16%
Maneuvering	35%	28%	34%	38%	38%	35%	18%	19%	29%	27%	30%
Standing	5%	4%	2%	4%	2%	4%	5%	2%	7%	3%	4%
Takeoff	9%	15%	13%	12%	13%	10%	15%	9%	10%	10%	12%
Taxi	1%	1%	3%	1%	2%	1%	2%	1%	3%	1%	2%
Other	1%	1%	0%	0%	0%	1%	0%	0%	0%	1%	0.4%
Unknown	1%	0%	1%	0%	2%	1%	18%	49%	25%	37%	13%

Note: Some columns do not total 100 percent because of rounding.

Source: Clarence E. Rash

Table 1

U.S.-Registered Helicopter Accidents by Causal Factor, 2001–2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Annual Average
Pilot error	67%	70%	69%	68%	74%	66%	71%	75%	71%	58%	69%
Material failure	14%	12%	15%	8%	10%	13%	12%	13%	8%	5%	11%
Maintenance error	2%	6%	3%	5%	2%	6%	4%	1%	4%	4%	4%
Manufacturer fault	2%	1%	0%	0%	1%	3%	0%	3%	1%	0%	1%
Environment	0%	1%	2%	1%	2%	1%	2%	1%	1%	2%	1%
Other	5%	2%	2%	5%	3%	3%	5%	1%	3%	2%	3%
Undetermined	11%	8%	8%	13%	8%	8%	6%	5%	12%	29%	11%

Note: Some columns do not total 100 percent because of rounding.

Source: Clarence E. Rash

Table 2

- Aircraft Owners and Pilots Association Air Safety Institute. *The 2010 Joseph T. Nall Report of Accident Trends and Factors*. <www.aopa.org/asf/publications/nall.html>.
- Harris, F.D.; Kasper, E.F.; Iseler, L.E. *U.S. Civil Rotorcraft Accidents, 1963 Through 1997*, NASA/TM-2000-209597. December 2000.
- The average annual accident rate of 6.1 per 100,000 flight hours is not the same as the decade average of 5.7 per 100,000 flight hours, shown in Figure 1, because of slight differences in methods of calculation.
- The NTSB — in accident report DEN08MA116A — said that pilots of the two 407s failed to see and avoid each other’s helicopter as both were approaching the Flagstaff, Arizona, Medical Center helipad in daytime visual meteorological conditions on June 29, 2008. Everyone aboard both helicopters was killed, and both aircraft were destroyed.
- General Aviation Manufacturers Association. *General Aviation Statistical Databook and Industry Outlook, 2010*. <libraryonline.erau.edu/online-full-text/books-online/GamaDatabookOutlook.pdf>.