FLIGHT SAFETY FOUNDATION
HELICOPTER SAFETY
Vol. 20 No. 4 *For Everyone Concerned with the Safety of Flight* July–August 1994

U.S. Hospital-based EMS Helicopter Accident Rate Declines Over the Most Recent Seven-year Period

Emergency medical service (EMS) helicopter accident rates have significantly improved. Nevertheless, the fatal accident rate for EMS helicopters remains high compared with other turbine-powered helicopters, and adverse weather remains the single greatest hazard.

Joel S. Harris
FlightSafety International

During the seven-year period from January 1, 1987 through December 31, 1993, hospital-based emergency medical service (EMS) helicopters' estimated accident rate was 3.14 accidents per 100,000 flight hours, based on data from the U.S. National Transportation Safety Board (NTSB), U.S. Federal Aviation Administration (FAA) and other sources. This is a remarkable improvement when compared with the EMS accident rate for the previous seven years, which was documented in a NTSB study.[1]

In that 1988 study, the NTSB estimated that the EMS helicopter accident rate was 13.42 per 100,000 flight hours during the period 1980–1986. The NTSB found that the commercial EMS helicopter industry had an estimated accident rate more than 1.5 times the accident rate experienced by all turbine-powered helicopters, and a fatal accident rate estimated to be 3.5 times that for all turbine-powered helicopters.

The EMS accident rate during the most recent seven-year period, 1987–1993, also compares favorably with an estimated accident rate of 4.28 for all turbine-powered helicopters during the same period, based on the author's data analysis.

As a follow-up to the NTSB study, this article reviews and analyzes 38 hospital-based EMS helicopter accidents that occurred during the period 1987–1993 since the NTSB study. To make comparison valid, the taxonomy used in the NTSB study was also used in this review.

In its study, the NTSB investigated and evaluated 59 accidents involving EMS helicopters. The NTSB used the definition of an accident contained in Title 49, U.S. Code of Federal Regulations, Part 830. Furthermore, to be considered a "commercial EMS helicopter accident," the following conditions had to be met:

- The helicopter was dedicated primarily to EMS missions;
- The helicopter, when used for EMS missions, had trained medical personnel on board to care for the patient;

Table 1
Emergency Medical Service and All Turbine-powered Helicopter Accident Rates for the Period 1980–1986

Year	1980	1981	1982	1983	1984	1985	1986	Average
EMS accident rate	9.64	10.69	16.32	11.05	10.62	13.92	17.08	13.42
All turbine accident rate	7.86	7.07	7.28	7.30	7.36	7.29	5.47	7.09
EMS fatal accident rate	9.64	3.56	5.44	4.42	1.77	8.35	5.26	5.37
All turbine fatal accident rate	2.12	0.97	1.64	1.24	1.21	2.14	1.55	1.53
Year	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**Total**
Total EMS accidents	2	3	6	5	6	10	13	45
Total all turbine accidents	126	124	129	124	140	116	92	851
Total EMS fatal accidents	2	1	2	2	1	6	4	18
Total all turbine fatal accidents	34	17	29	21	23	34	26	184
Total EMS hours flown	20,750	28,071	36,764	45,233	56,516	71,831	76,110	335,275
Total all turbine hours flown	1,602,852	1,754,422	1,771,174	1,699,652	1,903,315	1,590,315	1,682,000	12,003,730

Source: Joel S. Harris, from data by U.S. National Transportation Safety Board (1988 safety study), except:

- 1986 "all turbine" accidents and fatal accidents were not available at the time of the 1988 NTSB study[1]; the author (Joel S. Harris) has included data from the FAA Accident/Incident Database.
- 1986 "all turbine" hours flown were not available at the time of the NTSB study. These data are from the 1992 FAA *Statistical Handbook of Aviation.*
- The 1986 EMS hours flown are estimated in the NTSB study. Hours flown for 1986 shown here are from the *Air Medical Journal,* July 1992.

- The pilot was employed primarily to fly the dedicated helicopter on EMS missions; and,
- The helicopter was not operated by a public authority (police department or state or local government agency).

The NTSB further categorized an EMS accident by determining whether the accident occurred during an EMS mission or during other activities. An EMS mission was defined as a flight conducted for patient transport, including the flight to the patient's location. An aircraft positioning flight in anticipation of a specific mission was also included. "Other" flights as defined by the NTSB included ferry flights, personnel transport flights, public relations flights, training flights and test flights. Although all 59 accidents were included in the study, the NTSB based EMS accident-rate data on only those 45 accidents in which the helicopter was involved in a patient transport at the time the accident occurred.

The NTSB based its estimate of EMS flight hours on the number of patients transported by hospital-based (nonpublic-service) EMS helicopters. A 1987 survey reported in *Hospital Aviation,* March 1987, cited by the NTSB, indicated that the average one-way trip length for an EMS mission was 61 miles (98 kilometers) or 122 miles (196 kilometers) round trip. The NTSB estimated that most EMS missions require about one hour of flight time to complete a round trip of this length. Because the majority of trips involve one patient, knowing the total number of patients flown provided an estimate of total hours flown. Table 1 shows a synopsis of the accident-rate data presented in the NTSB study.

Recent statistics continue to validate the NTSB's use of patient transport as a measure of flight hours. Therefore, in this study of the 1987–1993 period, the number of EMS helicopter hours flown is based on the number of patients transported. The source for the number of patients transported is the annual survey conducted by, and published in, the *Air Medical Journal.*

Three primary information sources were used to identify EMS helicopter accidents in this study of the 1987–1993 period. The base document was the FAA's Accident/Incident Database (FAA AID) supplied by Air Data Research, San Antonio, Texas, U.S. This data base was cross-checked for accuracy and completeness with the NTSB's EMS accident report briefs and with issues of the *Air Medical Journal* (which also reports on EMS accidents). In some cases, helicopter accidents were not reported as "air ambulance" (EMS) accidents in the FAA data base, although they were reported as such in *Air*

Medical Journal or by the NTSB. In these cases, the information taken from the FAA data base was updated to reflect this information.

Of 38 accidents identified as EMS, 28 occurred during an EMS mission. Therefore, only these 28 accidents are used for accident-rate data in this study of the 1987–1993 period. Table 2 shows a synopsis of these data, and available information on the growth of hospital-based EMS programs and the number of helicopters employed.

Because the total of EMS flight hours reflects the number of patients transported, by combining the data in Table 1 with those in Table 2, it can be seen that since 1980 hospital-based EMS helicopters have transported more than 1.2 million patients. On the conservative assumption that 10 percent of patients transported by EMS would have died had the service not been available, 120,000 patients owe their lives to EMS helicopter transport. During this period (from 1980), there were 73 helicopter accidents while engaged in EMS missions. Thirty-three of these involved at least one fatality.

Figure 1 (page 4) shows a compilation of data for the period 1980–1993, and compares EMS accident-rate data with those of all turbine-powered helicopters.

Fatal Accident Rates Compared

The NTSB study reported that during the period 1980–1986, 18 of a total of 59 accidents (31 percent) involving EMS helicopters resulted in at least one fatality. Eighteen of the 59 accidents (31 percent) were weather related. In

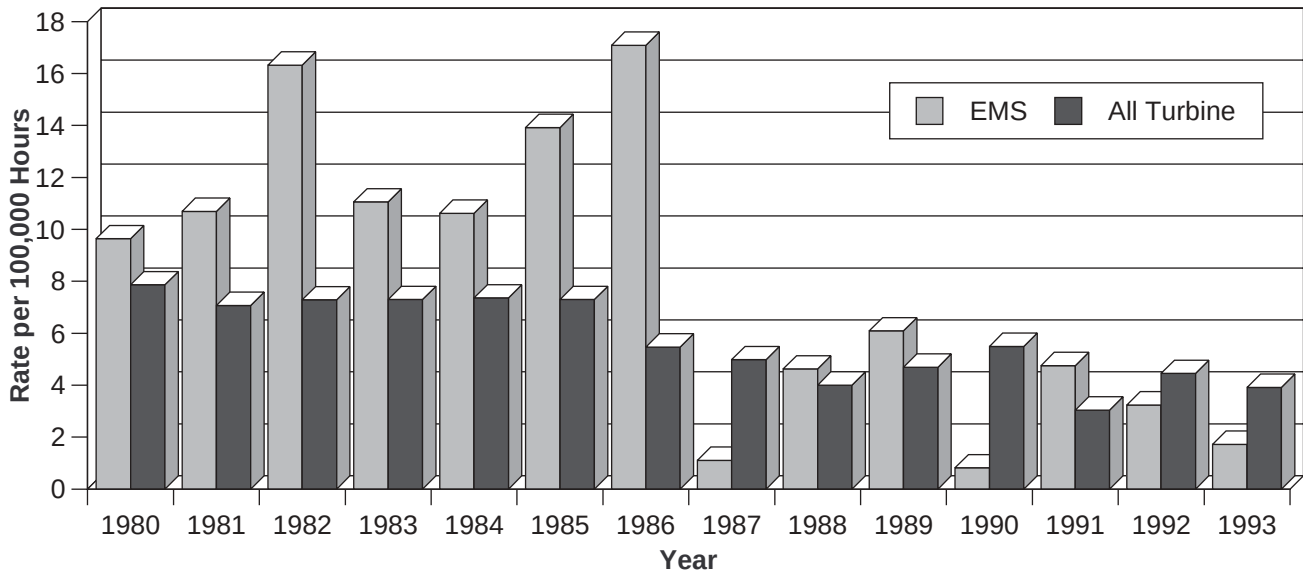
Table 2
Emergency Medical Service and All Turbine-powered Helicopter Accident Rates for the Period 1987–1993

Year	1987	1988	1989	1990	1991	1992	1993	Average
EMS accident rate	1.11	4.62	6.09	0.82	4.75	3.23	1.72	3.14
All turbine accident rate	4.98	4.00	4.69	5.49	3.04	4.45	3.91	4.28
EMS fatal accident rate	1.11	1.85	3.48	0.00	3.17	1.29	1.15	1.68
All turbine fatal accident rate	1.13	0.46	1.15	0.87	0.78	1.23	1.02	0.94
Year	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**Total**
Total EMS accidents	1	5	7	1	6	5	3	28
Total all turbine accidents	75	79	90	82	66	83	73	548
Total EMS fatal accidents	1	2	4	0	4	2	2	15
Total all turbine fatal accidents	17	9	22	13	17	23	19	120
Total EMS hours flown	90,335	108,190	115,005	122,670	126,202	154,682	174,324	891,408
Total all turbine hours flown	1,506,000	1,974,000	1,918,000	1,493,000	2,172,000	1,866,000	1,866,000	12,795,000
Hospital-based programs	145	155	165	174	178	178	199	
Helicopters	184	195	213	231	225	231	N/A	

N/A - Figure not available.

Source: Joel S. Harris, from data by U.S. National Transportation Safety Board except:

- Emergency medical service (EMS) accidents and fatal accidents are from the modified FAA Accident/ Incident Database.
- Total and fatal accidents for all turbines:
  - 1987 to 1990 are from NTSB computer search.
  - 1991 to 1993 are from the Helicopter Association International (HAI). The author (Joel S. Harris) believes these data to be most current.
- Turbine hours flown 1987 to 1992 are from the 1992 FAA *Statistical Handbook of Aviation.*
- 1993 turbine hours are from an HAI estimate provided to the author (Joel S. Harris).
- Number of EMS programs and helicopters are from the *Air Medical Journal,* July 1992, except 1993 program data, which are from the *Air Medical Journal*, May 1994.

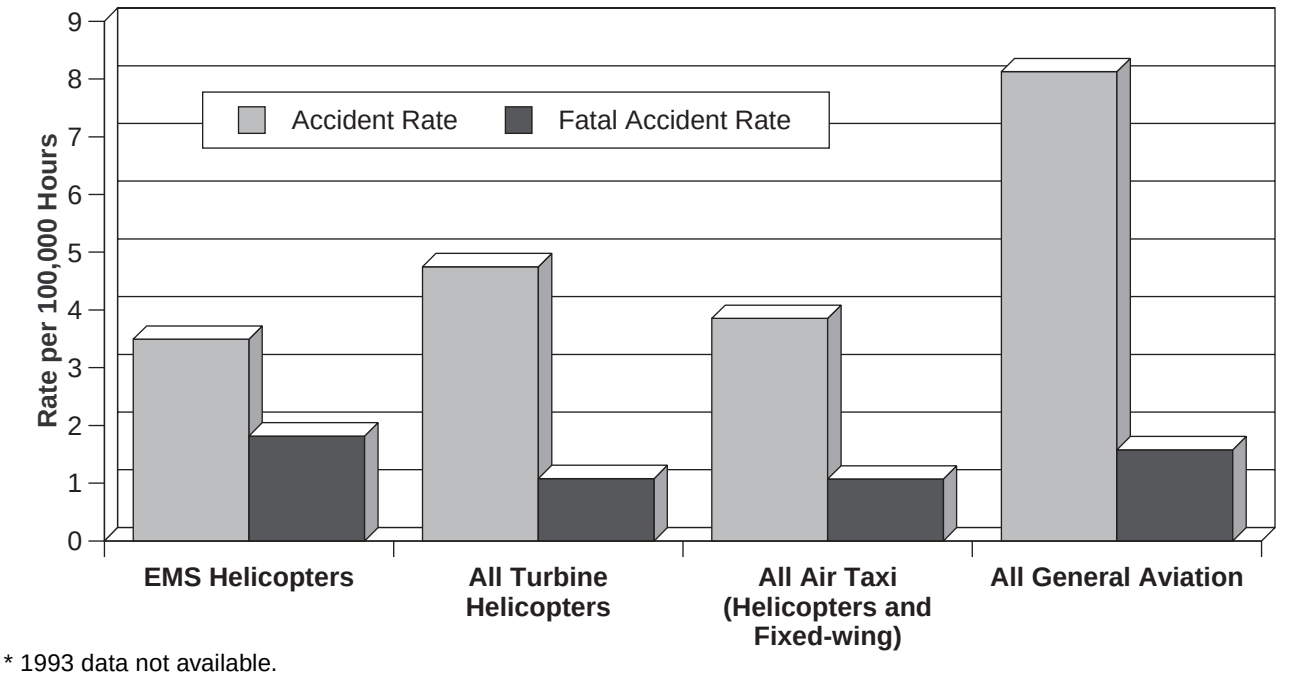


Source: Joel S. Harris, from data by U.S. National Transportation Safety Board, U.S. Federal Aviation Administration, *Air Medical Journal,* Helicopter Association International

Figure 1

its conclusions, the NTSB stated: "It is clear that poor weather conditions pose the greatest single hazard to EMS helicopter operations."

The current FAA AID shows that of a total of 38 EMS accidents from 1987 through 1993, 18 (47 percent) resulted in at least one fatality. The fatal accident rate



* 1993 data not available.

Source: Joel S. Harris, from data by U.S. National Transportation Safety Board, U.S. Federal Aviation Administration, *Air Medical Journal,* Helicopter Association International

Figure 2

Table 3
Total Accidents and Fatal Accidents — 1987–1993

Category	Total Accidents	Fatal Accidents	Percent Fatal
Emergency medical service	38	18	47%
All turbine helicopters	548	120	22%

Source: Joel S. Harris, from data by U.S. National Transportation Safety Board, U.S. Federal Aviation Administration, *Air Medical Journal,* Helicopter Association International

(EMS mission only) is an estimated 1.68 per 100,000 flight hours. Although this is a significant improvement compared with the 1980–1986 data, the fatal accident rate for EMS helicopters remains 1.8 times the rate for all turbine-powered helicopters, and higher than that for U.S. Federal Aviation Regulations (FARs) Part 135 air taxi operators and for general aviation (see Figure 2, page 4). This chart only includes the period from 1987 through 1992, as some 1993 statistics were not yet available. (Air taxi and general aviation data were obtained from the 1992 FAA *Statistical Handbook of Aviation*.)

A high percentage of EMS helicopter accidents result in fatalities. Table 3 shows that when compared with all turbine-powered helicopters, more than twice the percentage of EMS accidents resulted in at least one fatality. Table 4 uses data from 1987 though 1992 and compares EMS with all turbine-powered helicopter, unscheduled FARs Part 135 air taxi and general aviation data. Again, the percentage of EMS accidents resulting in fatalities is high.

Using the NTSB 1988 study classifications, the 1987–1993 accidents are divided into four types: weather/low visibility or spatial disorientation accidents, mechanical malfunction accidents, obstacle strikes and "other." Figure 3 (page 6) shows a breakdown of fatal accidents and all accidents by causal factor. Fifty percent of fatal EMS accidents fall under the causal factor "weather/low visibility or spatial disorientation."

Table 5 divides the accidents by causal factor. As in most aviation accident statistics, pilot error is a leading cause both in all accidents and in fatal accidents. Operational deficiencies are deficiencies other than those caused by pilot or maintenance.

Table 6 (page 6) reveals that 72 percent of fatal accidents, and 50 percent of all accidents, occurred at night. According to the April 1994 *Air Medical Journal,* only about 37 percent of EMS helicopter flights take place at night.

Table 4
Total Accidents and Fatal Accidents — 1987–1992

Category	Total Accidents	Fatal Accidents	Percent Fatal
Emergency medical service	25	13	52%
All turbine helicopters	519	118	23%
Part 135 air taxi	579	161	28%
General aviation	13,430	2,606	19%

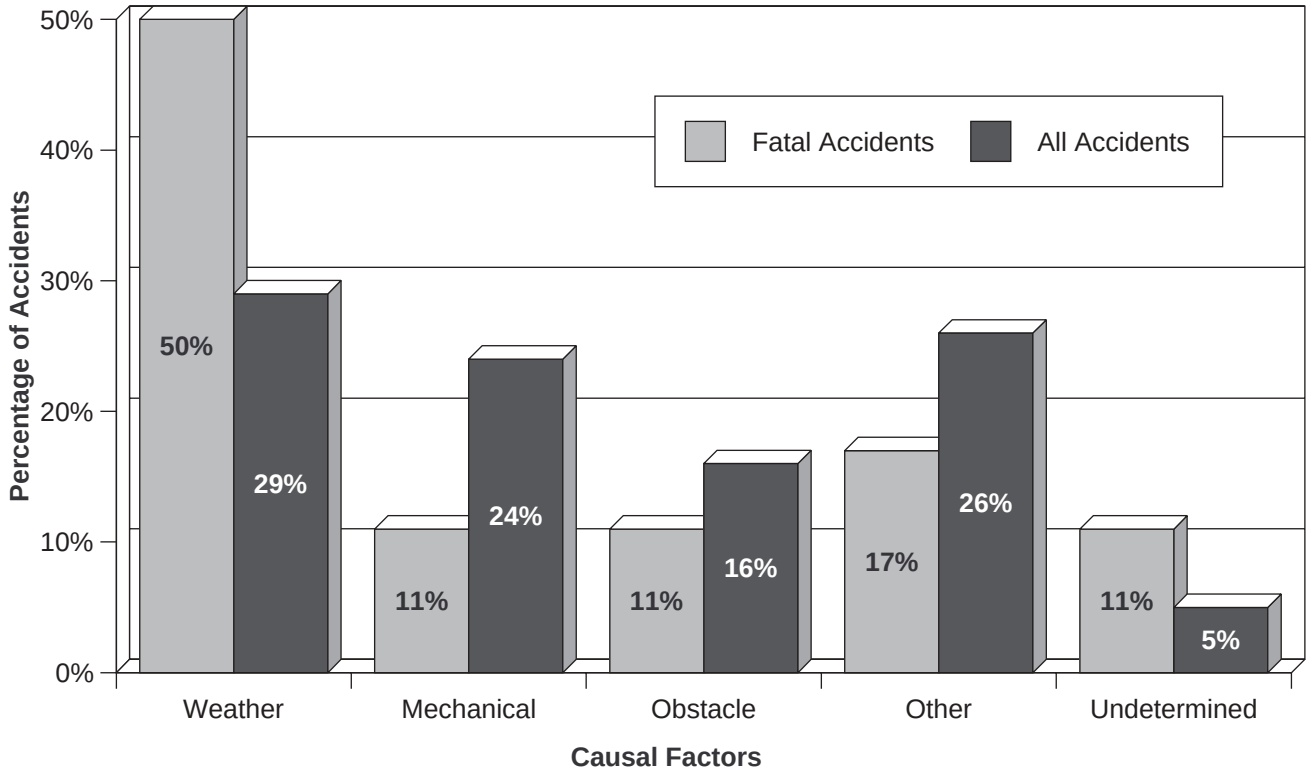
Source: Joel S. Harris, from data by U.S. National Transportation Safety Board, U.S. Federal Aviation Administration, *Air Medical Journal,* Helicopter Association International

Table 5
Causal Factors in Fatal EMS Helicopter Accidents — 1987–1993

Causal Factor	All Accidents	Fatal Accidents
Pilot	25 (66%)	13 (72%)
Pilot and maintenance	4 (11%)	0 (0%)
Inadequate maintenance	4 (11%)	1 (5%)
Operational deficiency	2 (5%)	1 (5%)
Undetermined	3 (8%)	3 (17%)
Total	38	18

Source: Joel S. Harris, from data by U.S. National Transportation Safety Board, U.S. Federal Aviation Administration

Analysis of Causal Factors for 38 Turbine-powered EMS Helicopter Accidents, Including 18 Fatal Accidents for the Period 1987–1993



Source: Joel S. Harris, from data by U.S. Federal Aviation Administration

Figure 3

Table 7 (page 7) delineates flight conditions at the time an accident occurred. Although none of the 38 accidents occurred during a planned flight under instrument flight rules (IFR),[2] 44 percent of the fatal and 32 percent of all the accidents occurred when IFR weather conditions prevailed. FARs are extremely restrictive on helicopter operations conducted under IFR. Because of limited fuel range and available alternate airports that meet the requirements of FARs 91.167, 169 and 135.223, helicopters often legally fly under visual flight rules (VFR) when weather conditions are more conducive to the safer and more structured flight environment provided under IFR.

EMS helicopter safety has vastly improved since the 1988 NTSB study. EMS helicopters have a lower accident rate than all turbine-powered helicopters, Part 135 air taxi aircraft and general aviation aircraft.

Table 6
Lighting Conditions of Fatal EMS Helicopter Accidents — 1987–1993

Lighting Conditions	All Accidents	Fatal Accidents
Day	19 (50%)	5 (28%)
Night	19 (50%)	13 (72%)
Total	38	18

Source: Joel S. Harris, from data by U.S. National Transportation Safety Board, U.S. Federal Aviation Administration

Table 7
Flight Conditions of EMS Helicopter Fatal Accidents — 1987–1993

Flight Conditions	All Accidents	Fatal Accidents
Visual Flight Rules	26 (69%)	10 (56%)
Instrument Flight Rules	12 (32%)	8 (44%)
Total	38	18

Source: Joel S. Harris, from data by U.S. National Transportation Safety Board, U.S. Federal Aviation Administration

The improvement in EMS accident rates can be attributed to several factors, including the impact on industry awareness produced by the original NTSB study.

Following release of the NTSB report, more stringent weather minimums were established, pilot training programs were enhanced and EMS duty time requirements were reduced. (Until 1987, a common interpretation of FAR 135.271 allowed EMS pilots to remain on duty at a hospital for up to 72 consecutive hours. Since then, most EMS pilots have operated under the same duty time restrictions as other Part 135 air crews.)

EMS industry awareness also brought operational changes.

"We decided not to tell pilots why they were going on missions," said Keith McCutheon, chief pilot for Indianapolis Heliport Corp. "We don't tell the pilot he's going to pick up a critically injured two-year-old. We just tell him there is a mission and let him make his go/no go decision based on that."

Equipment upgrading may also have played a role in safer EMS flights. The increased use of twin-engine helicopters with more sophisticated instrumentation and autopilots, said McCutheon, may have contributed to the trend.[3]

But the fatal accident rate for EMS helicopters remains high relative to other categories. Statistics indicate that an accident in an EMS helicopter is much more likely to result in a fatality. As was the case in accidents analyzed in the NTSB's 1988 study, adverse weather conditions and spatial disorientation continue to play a large role in EMS accidents. ♦

Notes

1. U.S. National Transportation Safety Board. *Safety Study — Commercial Emergency Medical Service Helicopter Operations.* Appendix D. January 1988.

2. According to an NTSB preliminary report, a Bell 412 helicopter crashed with four fatalities in Bluefield, West Virginia, U.S., on May 22, 1994. This appears to be the first EMS helicopter accident while operating under IFR.

3. McCutheon, Keith. Telephone interview by Harris, Joel S., August 20, 1994.

About the Author

Joel S. Harris holds an airline transport pilot certificate and a flight instructor certificate with ratings in both helicopters and airplanes. He is an instructor, supervisor and courseware developer at FlightSafety International's West Palm Beach Learning Center in Florida, U.S. He has given more than 10,000 hours of flight, simulator and ground school training to professional helicopter pilots. Harris is the author of numerous articles about helicopter flight.

The Air Transport System — Aircrew and Air Traffic Management Integration

a joint meeting of

FLIGHT SAFETY FOUNDATION

&

FRENCH NATIONAL ACADEMY OF AIR & SPACE

Toulouse, France
November 8–10, 1994

For more information contact J. Edward Peery, FSF.

HELICOPTER SAFETY

Staff: Roger Rozelle, director of publications; Girard Steichen, assistant director of publications; Kate Achelpohl, editorial assistant; Rick Darby, editorial consultant; and Dwyane D. Feaster, production consultant.

Subscriptions: US$60 (United States-Canada-Mexico), US$65 Air Mail (all other countries), six issues yearly. • Include old and new addresses when requesting address change. • Flight Safety Foundation, 2200 Wilson Boulevard, Suite 500, Arlington, VA 22201-3306 U.S. • telephone: (703) 522-8300 • telex: 901176 FSF INC AGTN • fax: (703) 525-6047.

What's Your Input?

In keeping with FSF's independent and nonpartisan mission to disseminate objective safety information, Foundation publications solicit credible contributions that foster thought-provoking discussion of aviation safety issues. If you have an article proposal, a completed manuscript or a technical paper that may be appropriate for *Helicopter Safety*, please contact the director of publications. Reasonable care will be taken in handling a manuscript, but Flight Safety Foundation assumes no responsibility for material submitted. The publications staff reserves the right to edit all published submissions. Payment is made to author upon publication. Contact the Publications Department for more information.