CRITICAL CARE

BY LINDA WERFELMAN

Frustrated by a cluster of fatal crashes, the U.S. helicopter EMS industry and the government are pressing for safety improvements.

Helicopter emergency medical services (HEMS) operations have increased dramatically in the United States in the past decade, accompanied in recent months by a spate of fatal crashes.

Industry safety experts say that, with investigations still in progress, there appear to be few similarities linking the six fatal HEMS accidents recorded since December 2007 by the U.S. National Transportation Safety Board (NTSB; see "Recent Fatal HEMS Accidents," p. 14).[1] But that hasn't stopped industry representatives from launching a new search for risk reduction tools and procedures.

One of the recent accidents was a midair collision in daytime visual meteorological conditions (VMC) during approach to a hospital helipad; one occurred in night instrument meteorological conditions (IMC); and four occurred in nighttime VMC but in different phases of flight — one accident helicopter was heading to a temporary landing zone to pick up a patient, another was en route to a hospital with a patient aboard, a third had just left a hospital after delivering a patient and was returning to its home base, and the fourth was maneuvering during a voluntary mission to aid in the search for a missing hunter. Two were twin-engine aircraft; the others, single-engine. Two flights were conducted under U.S. Federal Aviation Regulations (FARs) Part 91 for general aviation, and the others under Part 135, air taxi and commuter regulations, which has stricter weather and visibility minimums as well as crew rest requirements.

Three additional HEMS accidents, none involving fatalities, also occurred in the same time period.

The variety of circumstances surrounding the accidents is representative of the industry itself, said Dawn Mancuso, executive director of the Association of Air Medical Services (AAMS), who noted that HEMS operations are conducted

in "such a variety of aircraft, a variety of settings — different topographies, with a variety of patients and crew configurations and all kinds of things."

Christopher Eastlee, AAMS government relations manager, added, "We don't see one single, common causal factor in all these accidents … and we don't see a single … piece of technology on the market — or on the horizon — that would have prevented all or most of these accidents. … You have to say that human factors plays a big role, so no matter what new equipment comes into this operation, training in risk management and proper crew resource management is always going to be a huge concern."

Industry experts, U.S. government regulators and accident investigators have said in several major reports in recent years that HEMS operations are unique because of their emergency nature and because they frequently involve flights to and from unfamiliar locations in inclement weather and low visibility. Their recommendations for increased safety have focused on human factors issues, such as crew resource management and improvements in safety culture, and wider use of technological advances.

'Understanding the Baseline'

In the aftermath of what, at press time, was the most recent fatal HEMS crash — the June 29 midair collision of two Bell 407s in Flagstaff, Arizona — the U.S. Federal Aviation Administration (FAA) and AAMS sponsored safety meetings to discuss immediate and long-term responses to the increased number of accidents.

An AAMS session in Dallas in late July focused on the human element, with the goal of "understanding the baseline of where we are today," said AAMS President Sandy Kinkade. The meeting provided a framework for development of an action plan, she said.

Among the subjects on the agenda was air medical resource management (AMRM) — a variation of crew resource management tailored specifically for EMS operations. Meeting participants discussed standardized AMRM training, including the value of longer training sessions, and the special factors involved in providing AMRM training to a multigenerational work force, Kinkade said.

Also on the agenda were improved communications, including the handling of weather information and traffic avoidance, as well as providing standardized training for communications centers; and standard operating procedures, including the use of checklists and defined, standardized and regionalized weather minimums.

Other topics included the effects on safety of training, including line-oriented flight training (LOFT); safety management systems, including the benefits of a just safety culture; competition within the industry; and other human factors issues.

"There's a consensus that there isn't a silver bullet — there isn't one action that's going to stop there from ever being another accident or incident," Mancuso said. "But what we're trying to do is take measure of what we've done so far and identify things we can do in the future that will mitigate as much risk as possible."

120 Accidents

FAA data indicate that about 750 EMS helicopters are in operation, with most of their flights conducted under FARs Part 135, although operators often ferry and reposition helicopters under Part 91, as long as only flight crewmembers and medical crewmembers — and no patients or other passengers — are aboard.[2]

Data compiled by the International Helicopter Safety Team (IHST) and presented during the AAMS safety meeting showed that, from Jan. 1, 1998, through June 30, 2008, there were 120 accidents involving HEMS aircraft — about 57 percent of which were twin-engine helicopters. Of the 371 people aboard the helicopters, 114 (30.7 percent) were killed.[3]

During the same 10½-year period, the data show that accidents increased from six in 1998 to 17 in 2003, then decreased to between 10 and 13 per year from 2004 through 2007 (Figure 1, p. 15). Fatalities ranged from a low of two in 2001 to a high of 18 in 2004. During just the first six months of 2008, however, there were eight accidents and 17 fatalities.

HEMS flight hours increased every year from about 190,000 in 1998 to about

Recent Fatal U.S. Helicopter EMS Accidents

Dec. 3, 2007 — A Eurocopter BK 117C1 is presumed to have struck the ocean about 3 nm (6 km) east of Whittier, Alaska, during a flight to transport a patient from Cordova to Anchorage. The body of the flight nurse was found, along with some helicopter wreckage, several days after the accident; the pilot, paramedic and patient are missing and presumed also to have been killed. Night instrument meteorological conditions prevailed, and company flight following procedures were in effect for visual flight rules operations. The helicopter was reported missing after the pilot failed to make a routine position report.

Dec. 30, 2007 — The pilot, paramedic and flight nurse were killed and a Bell 206L-3 was destroyed when it struck the ground while maneuvering in night visual meteorological conditions near Cherokee, Alabama. The flight was initiated to locate a missing hunter, who might have been injured or suffering from exposure. The helicopter crewmembers used their searchlight to illuminate the area, located the hunter and planned — with the helicopter 100 to 150 ft (31 to 46 m) above the trees — to shine the light on the hunter until rescue personnel on the ground could find him. The helicopter descended vertically into the woods and crashed.

Feb. 5, 2008 — The pilot, flight nurse and flight paramedic were killed when a Eurocopter AS 350B2 struck water near South Padre Island, Texas, while maneuvering for approach. The helicopter had been en route to pick up a patient at a temporary landing zone. Night visual meteorological conditions prevailed for the positioning flight.

May 10, 2008 — The pilot, flight nurse and physician were killed and a Eurocopter EC 135 was destroyed when it struck a wooded hillside after takeoff from La Crosse (Wisconsin) Airport. The helicopter was being returned to its home base at the University of Wisconsin Hospital Heliport in Madison after being used to transport a patient to a hospital in La Crosse. Night visual meteorological conditions prevailed, and light rain was falling at the time of the crash.

June 8, 2008 — The pilot, flight nurse, flight paramedic and patient were killed when a Bell 407 crashed in a wooded area near Huntsville, Texas, after takeoff from Huntsville Memorial Hospital. The helicopter, which was being operated at night in marginal visual meteorological conditions, was destroyed.

June 29, 2008 — Two Bell 407 EMS helicopters collided while on approach to the Flagstaff (Arizona) Medical Center helipad, killing both pilots, two patients and three medical crewmembers. Daytime visual meteorological conditions prevailed for the flights. A surveillance camera at a hospital parking garage showed one helicopter approaching from the north and the other approaching from the south before the collision, about 0.25 nm (0.13 km) from the hospital.

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Source: U.S. National Transportation Safety Board

420,000 in 2007, the IHST data show. At the same time, the accident rate has fluctuated between about 2.5 per 100,000 flight hours in 2007 to more than 5.5 per 100,000 flight hours in 2003. During the first six months of 2008, the accident rate was 3.8 per 100,000 flight hours In 2007, the accident rate for the entire U.S.-registered helicopter fleet was 6.8 per 100,000 flight hours.

During the first six months of 2008, the individual risk of fatal injury in HEMS operations reached a 10½-year high of 2.6 per 100,000 occupant exposure hours.

The IHST data also show that 54 percent of the 120 accidents occurred at night, 43 percent during the day and 3 percent at dusk. Sixty percent occurred when visibility was 10 mi (16 km) or better, 24 percent occurred with visibility between 3 and 9 mi (5 and 14 km), and 16 percent occurred when visibility was classified as "poor — less than 3 to 9 mi or rain, fog, smoke." At night, however, 35 percent of accidents occurred in conditions of poor visibility.

More accidents occurred en route — 34 percent — than during any other phase of flight, including at the scene of a motor vehicle accident or another off-airport pickup site, 30 percent; at a hospital, 23 percent; or at an airport, 13 percent (Figure 2, p. 16). The pilot was most frequently cited as an accident causal factor — in 65 percent of all HEMS accidents (Figure 3, p. 16).

Piloting and decision-making skills in "outside factors" — for example, continuing a flight after inadvertent entry into IMC, spatial disorientation, aircraft handling and controlled flight into terrain (CFIT) — were responsible for 37.5 percent of all HEMS accidents. "Aircraft strikes" — for example, tail rotor and main rotor strikes, wire strikes and objects from inside a helicopter striking the rotors — accounted for 25 percent. Maintenance and engine or systems failures were responsible for 17 percent of accidents, and "unknown" situations — those that were not understood — accounted for 9 percent.

Government-Industry Partnership

The FAA, in a position statement issued after the Arizona crash, said that there were no immediate

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Accident investigators survey the wreckage of the June 29, 2008, midair collision of two Bell 407 emergency medical services helicopters in Flagstaff, Arizona.

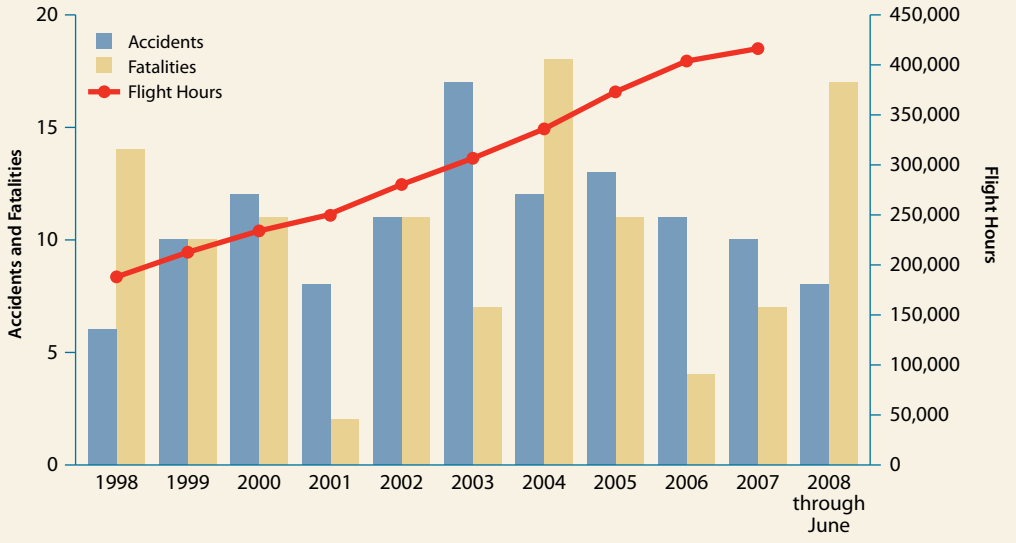
plans for changes in the rules regulating HEMS. Instead, the FAA said its immediate focus would be in areas that required no new rule making:[4]

- Encouraging risk management training to help flight crews make "more analytical" decisions about whether to begin a mission;
- Encouraging improved training for night operations and inadvertent flight into deteriorating weather;
- Providing airline-type FAA oversight of HEMS operators; and,
- Promoting the increased use of technology, including night vision goggles (NVGs), terrain awareness and warning systems (TAWS), and radio altimeters (also called radar altimeters).

Some of these technologies have moved into operation more quickly than others, said Gary Sizemore, president of the National EMS Pilots Association (NEMSPA) and a pilot for an EMS operation in northern Florida.

The FAA has been working since 1994 on projects and design approvals called supplemental type certificates (STCs) involving the installation of NVGs in helicopters and says that it has approved 15 STCs for EMS helicopters. Sizemore estimated that 25 to 28 percent of HEMS operations have NVG programs. His is not among them.

U.S. Helicopter EMS Accidents, Fatalities and Flight Hours



Note: Based on 92% of fleet with average aircraft hours per year ranging from 428 to 478 hours per aircraft.

Source: International Helicopter Safety Team, via Roy G. Fox, Bell Helicopter

Figure 1

"It would make a great deal of difference for us," said Sizemore, who has flown with NVGs in the past. "We fly out one way about 57 miles over nothing but pine forest. The other direction, there's about 70 miles of reclaimed swampland. It's pretty dark out there."

In addition to NVG certification, helicopter operators must have FAA approval of their training program for crewmembers who will use NVGs.

The NTSB has identified a number of accidents that might have been avoided if pilots had been using NVGs, which would have enabled them to see obstacles such as ridgelines and wires. In a 2006 study of 55 EMS accidents in the United States between January 2002 and January 2005, the NTSB found that the use of NVGs and other night visual imaging systems (NVIS) such as thermal imaging equipment, night vision cameras and some head-up displays, might have helped the pilots of 13 accident aircraft "more clearly observe obstacles and take evasive action to avoid the accidents."

For example, the NTSB cited the Dec. 23, 2003, crash of an Agusta A109A, which struck mountains near Redwood Valley, California, during a flight in high winds and heavy rain to pick up a patient. The pilot and two flight nurses were killed, and the helicopter was destroyed. The NTSB said that the probable cause of the accident was the pilot's "improper in-flight planning and decision to continue flight under VFR [visual flight rules] into deteriorating weather conditions, which resulted in an inadvertent in-flight encounter with IMC and a collision with rising terrain while attempting to reverse course."[5]

The NTSB also said that if the Redwood Valley pilot had been using NVIS, he "would likely have been able to identify the walls of the canyon, negotiate the terrain and avoid the accident."

Nevertheless, the board has never recommended requiring the use of NVGs and other types of NVIS because, although they often are highly effective in night VMC, they do not work well in some situations, such as in populated areas with many streetlights or other forms of ambient light. Nevertheless, the NTSB has praised the FAA for encouraging the use of NVIS and has said that it hopes the technology will be more widely used in appropriate settings.

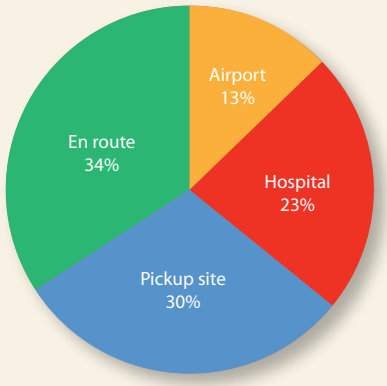
In a 2007 safety recommendation, the NTSB called on the FAA to require HEMS operators to install radio altimeters to increase pilots' awareness of height and prevent an inadvertent descent below a specified height, especially during low-altitude operations or hovering flight at night or in inclement weather. The NTSB cited the fatal Jan. 10, 2005, crash of a Eurocopter EC 135P2 near Oxon Hill, Maryland. The NTSB said that the probable cause of the accident was the pilot's "failure to identify and arrest the helicopter's descent," which resulted in CFIT. A contributing factor was the helicopter's inoperable radio altimeter.[6]

Radio altimeters have become increasingly common, Sizemore said, estimating that they are installed in 95 percent of EMS helicopters today.

Helicopter TAWS units — designed specifically for low-altitude flight environments — remain relatively rare, however, he said.

The NTSB said that of the 55 accidents in its 2006 study, 17 might have been avoided if the EMS airplanes and helicopters had been equipped with TAWS. The report cited the

U.S. Helicopter EMS Accident Locations

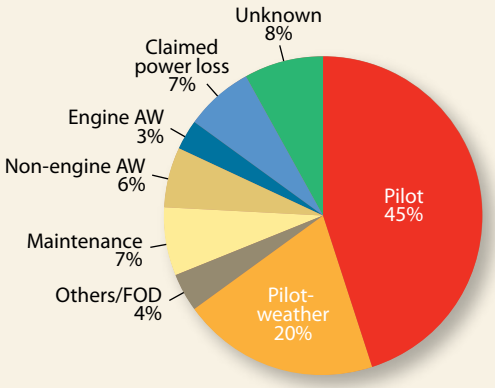


Note: Based on 120 accidents involving U.S.-registered civil emergency medical services helicopters, Jan. 1, 1998–June 30, 2008.

Source: International Helicopter Safety Team, via Roy G. Fox, Bell Helicopter

Figure 2

U.S. Helicopter EMS Causal Factors



AW = airworthiness issue
FOD = foreign object damage

Note: Based on 120 accidents involving U.S.-registered civil emergency medical services helicopters, Jan. 1, 1998–June 30, 2008.

Source: International Helicopter Safety Team, via Roy G. Fox, Bell Helicopter

Figure 3

Aug. 21, 2004, crash of a Bell 407 into mountains 27 nm (50 km) southwest of Battle Mountain, Nevada. The pilot, two medical crewmembers, a patient and the patient's mother were killed, and the helicopter was destroyed. The NTSB said the probable cause of the accident was "the pilot's failure to maintain clearance from mountainous terrain."[7]

The NTSB also said that a reconstructed flight profile indicated that if the helicopter had been equipped with TAWS, aural cautions and warnings would have begun 30 seconds before impact and would have "provided adequate time to allow the pilot to take appropriate action to avoid impact with the terrain."

The FAA, however, said that it has not moved to require TAWS in helicopters because of the "number of issues unique to VFR helicopter operations that must be resolved" including the potential for false alerts and "nuisance warnings" at the low heights at which helicopters typically operate. RTCA (formerly the Radio Technical Commission for Aeronautics) issued minimum operational performance standards earlier this year, and effective HTAWS units have begun to become more widely available.

The NTSB recommendation was included in a special investigative report on EMS operations, also including operations involving airplanes. The report included other recommendations to the FAA that subsequently were incorporated into bills introduced this year in the U.S. Senate and House of Representatives:[8]

- That all EMS flights, including positioning flights, be conducted in accordance with FARs Part 135, if anyone other than the pilots is aboard. The 2006 NTSB study of 55 accidents found that 35 occurred during Part 91 operations with medical crewmembers — but no patient — aboard. "Because Part 135 requirements impose additional safety controls that are not present under Part 91 requirements, the [NTSB] concludes that the safety of EMS operations would be improved if the entire EMS flight plan operated under Part 135," the NTSB said.

- That all EMS operators develop and implement flight risk evaluation programs. The NTSB said that a flight risk evaluation program would require the pilot and possibly one of his or her colleagues to "assess the situation without being influenced by the sense of urgency that can accompany the initial call requesting services."

- That EMS operators establish dispatch and flight-following procedures, including providing current weather information and assistance to flight crews in making in-flight risk-assessment decisions. The NTSB's 2006 study said that formalized flight dispatch procedures might have "mitigated the results" of 11 of the 55 accidents.

In addition, the legislative packages contain provisions to eventually require installation of digital flight data recorders and cockpit voice recorders in helicopters used in EMS operations.

'Absolute, Hard Record'

"For decades, these aircraft have been operating without any recorders at all," said Richard Healing, a member of the NTSB when it first ordered the 2006 special investigation report on EMS operations and now a consultant on transportation issues. "When there's an accident, there's no absolute, hard record of what went on that might have caused the accident."

In addition to the valuable information that digital flight data recorders would provide for accident investigators, Healing said that the HEMS industry as a whole would benefit from flight operational quality assurance (FOQA) programs, which rely on frequent downloads from quick-access recorders to retrieve data recorded during routine flights. The data analyzed are the same types that are stored in flight data recorders for accident investigation.

"The only way the industry will change anything is if there's shared data that indicate that whatever change you anticipate making will result in an improvement," Healing said. "If you don't have data, you never have that evidence and therefore you're not likely to create positive change."

Notes

1. Guzzetti, Jeff. "Recent EMS Accidents: An NTSB Perspective." Presentation to the FAA–AAMS EMS Safety Meeting, Washington, D.C., U.S., July 11, 2008. Guzzetti is the NTSB deputy director of regional operations.
2. FAA. *Fact Sheet: EMS Helicopter Safety*. June 30, 2008. <www.faa.gov/news/fact_sheets/news_story.cfm?newsid=6763>.
3. Fox, Roy G. *10.5-Year U.S. HEMS Safety*. Presentation to the HEMS Safety Summit, Dallas, July 25, 2008. Fox is chief of flight safety for Bell Helicopter Textron and a member of IHST.
4. FAA.
5. NTSB. *Special Investigation Report on Emergency Medical Services Operations*. NTSB/SIR–06/01, Jan. 25, 2006.
6. NTSB. Safety Recommendations A-07-111 and A-07-112, Dec. 21, 2007.
7. NTSB. *Special Investigation Report on Emergency Medical Services Operations*.
8. Ibid.