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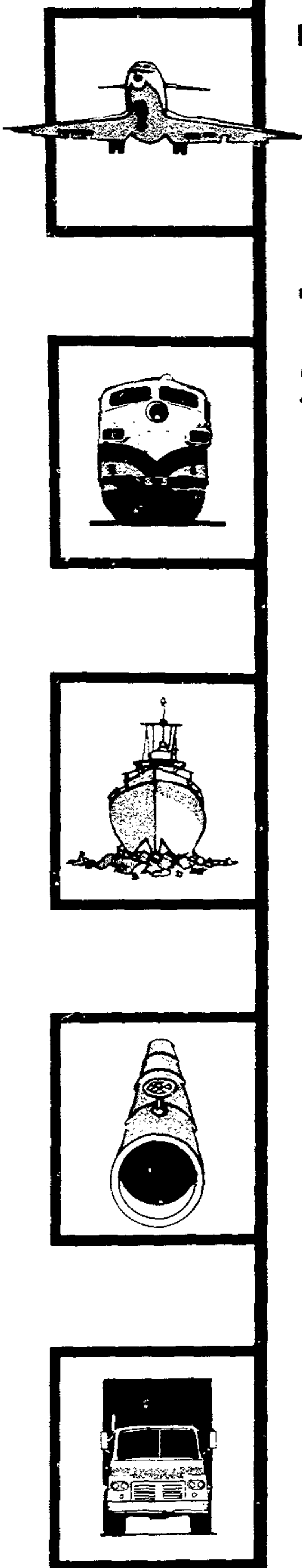

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

SAFETY STUDY

COMMERCIAL EMERGENCY MEDICAL SERVICE HELICOPTER OPERATIONS

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16. Abstract

~~This~~ The study explores the rapidly growing commercial emergency medical services (EMS) helicopter industry and its operations. The Safety Board investigated and evaluated 59 accidents involving EMS helicopter operations that occurred between May 11, 1978 and December 3, 1986. ~~This~~ The study reports on the areas that influence EMS helicopter safety and offers recommendations to correct safety deficiencies. The study concludes with recommendations to the Federal Aviation Administration, the American Society of Hospital-Based Emergency Aeromedical Services, the Helicopter Association International, and the National Aeronautics and Space Administration.

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SAFETY STUDY

Adopted: January 28, 1988

EMERGENCY MEDICAL SERVICE HELICOPTER OPERATIONS

INTRODUCTION

In Dardanelle, California on June 23, 1982, an Aerospatiale SA-316B (an Alouette III) crashed while trying to land at an automobile accident scene. After circling the landing location three times, the helicopter struck a tree about 130 feet above the ground during its approach to land. The helicopter fell to the ground and was destroyed by the postcrash fire. The pilot and two medical personnel were killed in the accident. It was a very dark night and the trees and landing area were illuminated only by spotlights from the responding ground vehicles. The Safety Board determined that the probable cause of this accident was the pilot-in-command's misjudgment of the rotor clearance available (accident No. 16, appendix A). 1/

In Carson, New Mexico, on January 20, 1985, three people were killed when their emergency medical service (EMS)-configured Bell 206L-1 (Longranger) helicopter crashed in reduced visibility at night. The accident report indicated the visibility was 3 miles or less, the cloud ceiling was 100 feet above ground level (agl) and overcast, and fog was present. The pilot was highly experienced and qualified, with 14,000 total hours in both airplanes and helicopters. The pilot held an airline transport pilot rating and had more than 1,500 hours in the Bell 206L-1. The Safety Board determined that the probable cause of this accident was the pilot-in-command's failure to maintain directional control (accident No. 35, appendix A).

Although the first commercial EMS helicopter program in the United States began operation in 1972, the industry did not begin to expand significantly until the end of the decade. Since 1980, commercial EMS helicopter activity has increased sharply. By 1984, the Safety Board began to discern a significant rise in the number of accidents: 7 major EMS helicopter crashes were investigated that year, and 11 were investigated the next year. When it discovered that the 14 major EMS helicopter accidents that occurred in 1986 destroyed or substantially damaged 9 percent of the total commercial EMS helicopter population operating that year, killed 13 EMS helicopter occupants, and caused serious injuries to 5 other occupants, the Safety Board decided to undertake a safety study to examine the accident rates and safety factors relating to commercial EMS helicopter operations.

Scope

This safety study reviews the operational safety of commercial EMS helicopters, identifies those areas that influence EMS helicopter safety, and offers recommendations to appropriate government agencies and industry organizations to correct noted safety deficiencies.

1/ Appendix A provides a listing of all 59 commercial EMS helicopter accidents contained in the Safety Board's data base at the time this report was prepared.

The Safety Board used a variety of information sources in conducting this study. All commercial EMS helicopter accidents investigated by the Safety Board were reviewed to identify common elements in accident causation and severity. The Safety Board visited and flew with nine selected EMS helicopter programs across the country to observe operations and to receive input from pilots, program administrators, and medical personnel. The Safety Board also examined the influence of current Federal regulations on EMS helicopter operations, reviewed EMS industry-recommended guidelines and standards, and conducted an extensive literature search and review.

This study does not include public-use helicopter operators (police departments or State/local government agencies) because of insufficient accident data upon which to base any meaningful conclusions. Public-use aircraft operators are not required to report accidents or incidents to the Federal Aviation Administration (FAA) or the Safety Board. 2/ Therefore, the data and conclusions presented in this report are applicable only to the commercial EMS helicopter fleet.

Use of Helicopters in EMS

The use of helicopters to transport seriously ill or injured patients is a relatively recent phenomenon in the civilian aviation community. The U.S. military, however, has used helicopters for medical transport for more than 35 years. During the Korean war, more than 20,000 wounded soldiers were transported to emergency care facilities; in Vietnam, the total number of wounded soldiers transported exceeded 200,000. 3/ The lower rate of mortality in Vietnam (1 death per 100 casualties) compared to Korea (2.5 deaths per 100 casualties) was due in part to greater use of improved helicopter medical transport. 4/

Police departments in the 1960s and early 1970s used helicopters to transport injured civilians. Their multi-purpose system also included traffic surveillance, police work, and medical response. However, these early public-use EMS systems were little more than "scoop and run" operations. 5/ ("Scoop and run" operations depend on the speed of the helicopter to get the patient to advanced, definitive care, while other operators have the helicopter crewed and equipped to provide advanced life support to the patient.) 6/

2/ Legislation currently before Congress would require that certain public-use aircraft accidents be reported to the Safety Board.

3/ Spurgeon, Colonel Neel, "Army Aeromedical Evacuation Procedures in Vietnam," Journal of the American Medical Association, Volume 204, Number 4, April 22, 1968.

4/ Baxt, William G., M.D. and Moody, Peggy, R.N., "The Impact of a Rotorcraft Aeromedical Emergency Care Service on Trauma Mortality," Journal of the American Medical Association, Volume 249, Number 22, June 10, 1983.

5/ Ibid.

6/ Advanced life support involves providing definitive medical treatment to the patient while en route to the hospital. This treatment can include but is not limited to establishing intravenous lines, administering drugs, inserting an endotrachial tube, or using a cardiac defibrillator. This care is normally provided by registered nurses or physicians. Basic life support does not involve procedures that require physicians or registered nurses; it involves only basic procedures that can be applied by emergency technicians and paramedics. These standards can vary from State to State.

In October 1972, the first commercial EMS helicopter service dedicated to patient transfers and offering advanced life support was started in Denver, Colorado. At the time, this service was unique in that it was affiliated with a hospital, received no special funding, was dedicated to patient transfer, and was operated by the hospital in conjunction with a commercial helicopter operator. 7/

Since then, transporting the injured civilian by helicopter has become increasingly common. Several studies looking at the influence of advanced care and rapid transport on civilian trauma mortality show that EMS helicopters provide reductions in mortality ranging from 52 percent to 21 percent. Other studies do not show conclusively that, overall, EMS helicopter transport has a net benefit. However, there are indications that the higher level of care provided by most EMS helicopter crews may be important in the survival of the patients transported by EMS helicopters. 8/ All of the health care professionals queried during this study believed that that EMS helicopters provided a benefit to many patients they transported. They did acknowledge, however, that this belief has not been substantiated by scientific studies and that the degree of benefit, if any, has not been quantified.

Although public agencies provide helicopters for medical transportation, the majority of EMS helicopter transport today is provided by commercial contractors who lease helicopters and pilots to the hospital or by hospitals who own and operate their own commercial helicopter. During 1986, approximately 95,000 people in medical need were transported by commercial EMS helicopters in the United States. In 1987, this figure was projected to exceed 100,000. 9/ Public-use helicopters transported approximately 10,000 to 15,000 patients in 1986. 10/ Currently, approximately 90 percent of the hospitals with an EMS helicopter (often known as "hospital-based" EMS helicopter programs) transporting 50 or more patients a year use commercial helicopters, with the balance being served by public-use helicopters. 11/

7/ Cleveland, Henry C., M.D. and Miller, Jane A., R.N., "An Air Emergency Service: The Extension of the Emergency Department," Topics of Emergency Medicine, 1:47-54, 1979.

8/ Baxt, William G., M.D. and Moody, Peggy, R.N., "Hospital-Based Rotorcraft Aeromedical Emergency Care Services and Trauma Mortality: A Multicenter Study," Annals of Emergency Medicine, September 1985; Mackenzie, Colin F., M.D. and Shin, Baekhyo, M.D., "Two-Year Mortality in 760 Patients Transported by Helicopter Direct from the Road Accident Scene," The American Surgeon, February 1979; Cleveland, Henry C., M.D. and Bigelow, D. Boyd, M.D., "A Civilian Air Emergency Service: A Report of Its Development, Technical Aspects, and Experience," The Journal of Trauma, June 1976.

9/ Collett, Howard, "Year in Review," Hospital Aviation, January 1987; Collett, Howard, Presentation on EMS Helicopter Accident Statistics, 39th Annual Meeting of the Helicopter Association International, Dallas, Texas, February 25, 1987.

10/ The Aviation Law Enforcement Association (ALEA), whose members represent the majority of law enforcement agencies across the country using helicopters, reports that approximately 25 percent of its members' 470 helicopters are involved in some type of EMS activity. According to ALEA, only a small portion conduct EMS missions full-time; the majority conduct EMS missions only part-time. Most of these agencies fly fewer than 50 EMS missions a year.

11/ "Aeromedical Service Directory," Hospital Aviation, April 1987.

The commercial EMS helicopter industry has grown rapidly since 1978. (See figure 1.) In 1981, there were 42 commercial EMS helicopter programs in operation throughout the country. By December 1986, the total number of commercial EMS programs had more than tripled. An estimated 26 new programs started in 1987 and the total number could double within the next 5 years. 12/ Currently, there are approximately 155 commercial EMS helicopter programs, using approximately 187 helicopters. Almost 10 of these hospital EMS programs own and operate their own helicopters, while the balance of the helicopters and pilots are provided under contract to the hospital by 32 commercial operators.

Most of the pilots flying EMS helicopters received their initial training in the military and have had other civilian helicopter experience before they started flying EMS helicopters. The EMS helicopter medical personnel usually are a flight nurse and paramedic, although some crews include physicians. They are usually highly experienced in trauma and critical patient care and receive extensive training to maintain this proficiency.

Typical EMS missions include transport of trauma victims, cardiac patients, critical medical patients, and neonatal patients. The programs usually fly a combination of scene flights (a flight directly to the scene of the accident or injury) and interfacility flights (from one hospital to another); interfacility transport accounts for approximately 70 percent of all commercial EMS flights. 13/ Some programs' activity level averages as low as 20 patient transports per month, while some average as high as 200 per month. Activity levels are usually higher in the summer, since people are more active and more likely to be injured.

The helicopters used for commercial EMS missions differ in their sophistication and capabilities. Powered by turbine engines, they are either single- or twin-engine helicopters. The most common single-engine helicopter used at the end of 1986 (28 percent of the total fleet) was the Bell model 206 in all variations. 14/ Other popular single-engine helicopters include the Aerospatiale AStar 350 and the Aerospatiale AS 316 Alouette. Many programs are choosing twin-engine helicopters instead of single-engine helicopters: in 1980, only 1 EMS helicopter service used a twin-engine helicopter; by the summer of 1985, 73 twin-engine helicopters (48 percent of the hospital-based EMS fleet) were in use. In 1986, the total percentage of twin-engine machines increased to 54 percent, and this trend is expected to continue. Twin-engine helicopters being used include the Aerospatiale Twin Star 355, Augusta 109A, BO-105, MBB-117, Bell 222, Aerospatiale SA-365N Dauphin 2, the Sikorsky S-76, and the Bell 412. 15/

12/ Collett, Howard, "The 1987 Forecast," Hospital Aviation, December 1986.
13/ "Annual Transport Statistics," Hospital Aviation, March 1987.
14/ "Aeromedical Service Directory," op cit.
15/ Jensen, David, "More Room at the Top: Big Iron Comes to EMS," Rotor and Wing International, November 1986.

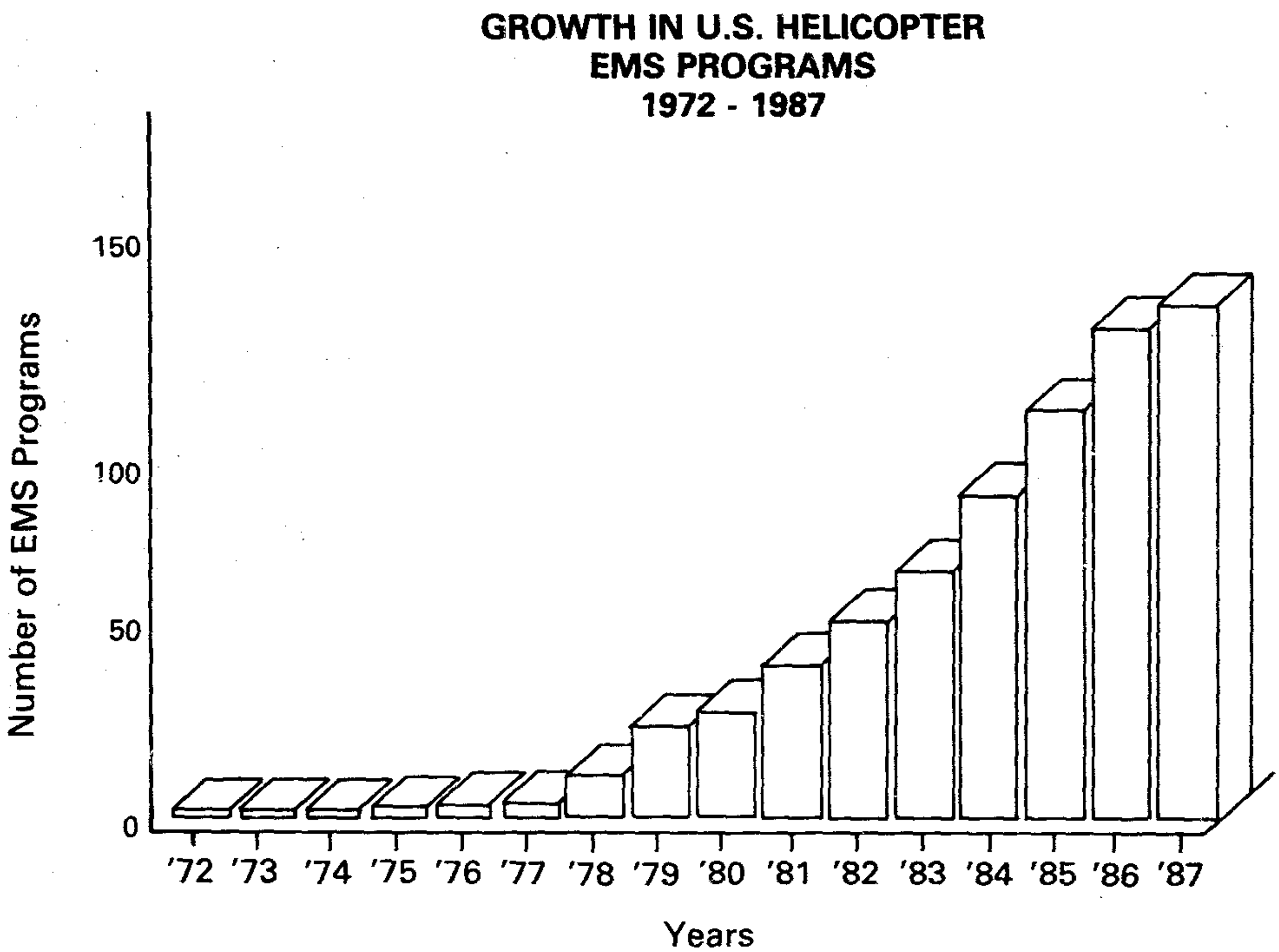

Figure 1.—Growth in U.S. helicopter EMS programs.

ACCIDENT DATA BASE DEFINITION AND ANALYSIS

In conducting this safety study, the Safety Board reviewed and evaluated all 59 commercial EMS helicopter accidents in the Safety Board's accident data base. The first of these occurred on May 11, 1978, and the most recent on December 3, 1986. Commercial EMS helicopter accident experience, defined in terms of accident rate, 16/ has been analyzed by many interested in this topic. Their findings are often not in agreement. This lack of consistency is due, to a great extent, to the inclusion of incorrect accident data in some databases but not others.

During the course of this study, a number of organizations 17/ provided lists of EMS helicopter accidents of which they were aware. When these were compiled into a matrix (see appendix C), so that each was identified by date and location and duplicates were eliminated, a total of 92 industry-reported EMS helicopter accidents emerged, the earliest on July 3, 1971, the most recent on November 30, 1986. As noted, 59 accidents, occurring between May 11, 1978, and December 3, 1986, are in the Safety Board's database. The reasons for the difference are discussed below.

The criteria that define which aviation accidents will be investigated by the Safety Board are set forth at Title 49 Code of Federal Regulations Part 830 (see appendix B). Some of the 92 accidents included in the various industry databases did not meet the Part 830 criteria, and therefore, were not investigated by the Safety Board. The Safety Board normally does not investigate public-use aircraft accidents and no public-use EMS helicopter accidents were found in the Safety Board's database; this accounts for part of the difference between the larger database derived from industry sources and that of the Safety Board (industry accident lists included public-use helicopters).

Furthermore, in order to be considered a true "commercial EMS helicopter accident," for purposes of this study, the following had to be true:

- o The helicopter used was dedicated primarily to the EMS mission, it was configured with at least a patient stretcher, and it had the equipment on board to provide basic life support.
- o The helicopter, when used for EMS missions, had trained medical personnel on board to care for the patient.
- o The pilots were employed primarily to fly the dedicated helicopter on EMS missions, although other duties such as public relation flights or personnel transfers may also be required of them at times.

One or more of these conditions was not true of a number of the accidents referred to by the industry sources.

16/ Accident rate is a standardized measure of the accident experience of a particular population. In aviation, the accident rate is usually reported as the average number of accidents occurring per 100,000 hours of flight time (exposure). In order to determine the accident rate accurately, the total number of accidents occurring during a specified time (usually a year) and the total number of flight hours for that time need to be known.

17/ The American Society of Hospital-Based Emergency Aeromedical Services, the Aviation Safety Institute, Hospital Aviation Magazine, the National Emergency Medical Services Pilots Association, and the FAA's accident/incident data system.

Having thus defined the 59 EMS helicopter accidents from the Safety Board's database, they were further categorized by determining if the accident occurred during an EMS mission or during other activities. An EMS "mission" in the context of this study is a flight conducted for patient transport (including the flight to the patient's location and return). Any aircraft positioning in anticipation of a specific mission was also included. There were 47 of these "EMS mission" accidents among the 59 EMS helicopter accidents in the Safety Board's database. Flights designated as "other" include ferry flights, nonpatient personnel transport flights, public relation flights, training flights, and test flights. There were 12 accidents of this type. All 59 accidents involving EMS-configured helicopters flown by pilots employed to fly EMS missions are included in the study; however, the accident rate data for EMS helicopters were based on only those 47 accidents in which the helicopter was involved in a patient transport at the time the accident occurred.

Accident Rate

The commercial EMS helicopter industry had an estimated accident rate of 12.34 accidents per 100,000 hours flown from 1980 through 1985. 18/ This rate is almost twice the estimated accident rate of 6.69 experienced by the nonscheduled Part 135 helicopter air taxi operations during the same period and slightly more than 1 1/2 times the accident rate of 7.35 experienced by all turbine-powered helicopters during the same period.

The estimated rate of fatal accidents for commercial EMS helicopters (where one or more of the occupants were fatally injured) was 5.40 from 1980 through 1985. This rate is approximately 3 1/2 times the fatal accident rates of 1.60 for Part 135 nonscheduled air taxi helicopters and 1.53 for all turbine-powered helicopters. 19/

The estimated rate of accidents in which injuries but no fatalities occurred (injury accidents) for commercial EMS helicopters from 1980 through 1985 was 2.31--slightly less than the estimated injury accident rates of 2.45 for Part 135 nonscheduled air taxi helicopters and 2.68 for all turbine-powered helicopters for the same period.

These accident rates are based on several sources. The rates for Part 135 nonscheduled helicopters and air taxis and for all turbine-powered helicopters were determined using information provided by the FAA on hours flown per year by specified segments of the aviation fleet. The accident data were from the Safety Board's accident database for calender years 1980 through 1985. The EMS helicopter accident rate was

18/ Information on the 1986 commercial EMS helicopter accident rate is provided in appendix D. This information is not included in the accident rate comparison to the Part 135 nonscheduled air taxi helicopters and all turbine-powered helicopters since information on hours flown for 1986 was not available for the comparative populations on which to base the accident rate. In 1986, commercial EMS helicopters were involved in 13 accidents while on patient transport missions. Four of these accidents were fatal and five produced injuries. The commercial EMS helicopter fleet flew approximately 95,000 hours in 1986, resulting in a total accident rate of 13.68, a fatal accident rate of 4.21, and an injury accident rate of 5.26. The three EMS helicopter accidents contained in the Safety Board's database that occurred before 1980 (accidents Nos. 1, 2, and 3; appendix A) were not used in accident rate calculation since no hours flown (exposure) estimate for the EMS helicopter fleet is available for those years.

19/ A fatal accident is an accident in which one or more occupants are fatally injured. Although other occupants may survive the accident, the accident is still classified as a fatal accident and is not considered an injury-producing accident.

determined by using exposure data (hours flown) based on information provided by industry sources. (As noted earlier, the EMS helicopter accidents used in determining the accident rate involved only those aircraft involved in an accident while on a patient transport mission.)

The non-EMS Part 135 helicopter operators operating nonscheduled air taxis were chosen as one population for comparison with the commercial EMS industry's accident rate because both segments operate under the same regulations and use the same general type of aircraft. The accident rate for all turbine-powered helicopters is also provided since commercial EMS helicopters are all turbine-powered.

The standard measure of exposure used in aviation accident analysis--hours flown per year--was used. Additional information on the methods used to determine the accident rates and graphical depiction of the accident rates are contained in appendix D.

Accident Analysis

The fact that the accident rate for EMS helicopters involved in patient transports is approximately twice the rate experienced by Part 135 nonscheduled helicopter air taxis and 1 1/2 times the rate for all turbine-powered helicopters may be because EMS helicopters routinely operate in poor weather and at night, land and take off from unimproved landing areas, and depart on missions with little advance notice. Of particular interest to the Safety Board is the fact that the fatal accident rate for EMS helicopters is approximately 3 1/2 times the rate experienced by Part 135 air taxis and all turbine-powered helicopters, but the injury accident rates are approximately equal. This may indicate that the accidents involving EMS helicopters on patient transport missions tend to be more severe than the accidents involving non-EMS Part 135 unscheduled air taxis helicopter and turbine-powered helicopters in general. Only one EMS helicopter accident was identified in which the patient was the only occupant to die (accident No. 42, appendix A); all the other fatal accidents also involved other occupants.

In addition to analyzing the accident database, the Safety Board examined a variety of literature and research sources, received extensive input from industry, and, perhaps most importantly, undertook to visit and fly with several operating commercial EMS helicopter programs over a 2- to 3-day period each. Based on this effort, several major areas emerged as important to understanding issues in commercial EMS helicopter program safety, and these issues are the subjects of the remainder of this report: the impact of adverse weather on EMS helicopter operational safety; IFR and VFR operations; pilot and crewmember training; pilot scheduling and fatigue; EMS helicopter reliability and design; helicopter crashworthiness and accident survival; and EMS helicopter operator and program management.

WEATHER

EMS helicopter programs normally operate 24 hours a day, 365 days a year. Requests for patient transfers can occur at any time and in any type of weather. There are limitations, of course, to the kinds of weather in which EMS helicopters can be operated safely. When these limitations are exceeded, the risk of an accident increases greatly.

It is clear that poor weather conditions pose the greatest single hazard to EMS helicopter operations. Of the 18 weather-related accidents, the 15 involving reduced visibility and spatial disorientation 20/ alone account for 25 percent of all the EMS helicopter accidents reviewed for this study. The other three weather-related accidents involved heavy winds that resulted in the hard landings. No one was injured in these three accidents. The 15 reduced-visibility accidents all occurred on a mission flight, and 11 resulted in at least one fatality. The single most common factor in fatal EMS helicopter accidents was unplanned entry into instrument meteorological conditions (IMC) 21/ and most of these accidents occurred at night.

This chapter evaluates the specific impact of poor weather on EMS helicopter operational safety. Weather reporting and forecasting capabilities along with pilot interpretation are examined for their influence on weather-related accidents. The abilities of EMS pilots to deal with poor weather conditions are examined, as are the elements that influence their decisionmaking process and judgment. FAA regulations and requirements concerning weather minimums are also reviewed.

FAA Weather Requirements and Regulations

In addition to the operating rules of 14 CFR Part 91, which are of general application to all aircraft, commercial aircraft operators are subject to the rules contained in 14 CFR Part 135, Air Taxi Operators and Commercial Operators. Both Parts 91 and 135 set weather minimums for visual flight rules (VFR) and instrument flight rules (IFR) flight. 22/ (A list of the FAA regulations applicable to EMS helicopter operations

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20/ Spatial disorientation is the pilot's lack of awareness of the helicopters position relative to the earth's surface due to confusing sensory input and occurs when visual input is lost or misinterpreted.

21/ IMC means that the meteorological conditions, expressed in terms of visibility, distance from clouds, and cloud height above ground (ceiling), are less than a specified minimum. When conditions fall below these minimums, the pilot's ability to control the aircraft by outside ground reference becomes very difficult, and special instrumentation in the aircraft is required to provide this reference. An aircraft must be approved or certificated by the FAA to fly legally in IMC.

22/ VFR, defined in Part 91.105, Basic VFR Weather Minimums, require that pilots maintain specified minimum clearance from clouds and minimum visibilities. These requirements are designed to ensure that the pilot can see and avoid other aircraft. VFR also allows much greater flexibility in planning and conducting a flight, since involvement with air traffic control (ATC) is minimized or not required; the pilots provide their own separation from other aircraft visually. (Near large airports or when the pilot desires ATC guidance, a VFR pilot may communicate with ATC.)

are provided in appendix E.) IFR conditions require special equipment and instrumentation within the aircraft and specific pilot training and currency requirements to operate the aircraft in these conditions. 23/

Basic VFR minimums are different for controlled and uncontrolled airspace. 24/ In controlled airspace, for both helicopters and airplanes operating below 10,000 feet, the VFR minimums require a visibility of 3 statute miles and clearance from clouds of 500 feet below, 1,000 feet above, and 2,000 feet horizontal.

In uncontrolled airspace, usually found below 1,200 feet agl, the situation is very different. For airplanes, Part 135 uncontrolled airspace requirements for VFR specify that the weather conditions must be at least 1,000 feet ceiling and visibility of at least 2 miles. However, the uncontrolled airspace requirements for helicopters operating below 1,200 feet agl or within a control zone are less stringent. Part 135.203(b) and 205(b) specify there must be 1/2 mile visibility during the day and 1 mile visibility at night, the helicopter must remain above "congested areas" by at least 300 feet, and it must maintain visual reference with the surface (or with surface light at night). This requirement reflects the ability of helicopters to fly slowly and land if needed.

Airplanes seldom operate below 1,200 feet, since the risks of collision with objects such as towers and antennas are greater and because airplanes tend to be more fuel-efficient at higher altitudes. Furthermore, at 180 mph, an airplane travels 264 feet in 1 second and covers 2 miles in 40 seconds; visual recognition of a hazard and corrective action with 2-mile visibility require close attention and quick reactions. Part 135 helicopter operators, however, experience a significant relaxation in VFR weather minimum requirements by flying in uncontrolled rather than controlled airspace--i.e., below 1,200 feet.

In the 15 low-visibility weather accidents analyzed by the Safety Board, all occurred in the low altitude, uncontrolled airspace environment. One of these accidents however, involved a Bell 222UT that was flying in controlled airspace shortly before the accident (accident no. 56, appendix A). This pilot tried to descend through an underlying overcast of low-visibility conditions and fog and struck a mountain. One other accident occurred as the pilot waited to receive a "special VFR" clearance to enter an airport's controlled

23/ IFR are rules governing the procedures a pilot must follow when conducting an instrument flight. This generally occurs when the pilot is flying without outside reference, as in clouds or fog. The ability to control the aircraft by the instruments alone requires specialized training and tests to ensure an adequate skill level. Pilots wishing to fly legally in the clouds must have an aircraft equipped for instrument flight, have an instrument "rating" on their pilots' certificate or its equivalent, and be IFR "current."

24/ The FAA's Airman's Information Manual defines controlled airspace as "Airspace designated . . . where some or all aircraft may be subject to air traffic control." Uncontrolled airspace is "that portion of airspace . . . in which [ATC] has neither the authority nor the responsibility for exercising control over air traffic." Generally speaking, most of the country's airspace is controlled from 1,200 feet above the ground and higher, and uncontrolled airspace is from 1,200 feet to the surface. Exceptions include areas around airports, certain airways, etc. Controlled airspace is not synonymous with ATC radar surveillance and does not mean the aircraft is "controlled" or issued a clearance by ATC.

airspace from uncontrolled airspace 25/ (accident No. 58, appendix A). Before the pilot could get to the airport, he lost control of the aircraft and crashed. The fact that all 15 of these accidents occurred below 1,200 feet in uncontrolled airspace illustrates the danger of flying VFR at low altitude in low-visibility conditions.

The lower visibility minimums for Part 135 helicopters in uncontrolled airspace are predicated on the fact that helicopters can be flown more slowly and must stay in visual contact with the surface as required by Part 135.207. However, 10 of the 15 low-visibility accidents occurred at cruise speeds, and 9 of these were fatal to at least one passenger or crewmember on board. The other five accidents occurred at speeds slower than cruise, and two of these were fatal. One of these fatal accidents resulted in the death of the already severely-injured patient from additional injuries sustained in the crash; the other accident caused the deaths of the pilot and two medical personnel (no patient was on board).

The effect of speed on the ability of the pilot to recognize a hazard (such as a cloud bank) and to react can be significant. It takes a helicopter pilot an average of 5 seconds to recognize a hazard, to determine what corrective action is needed, and to respond. 26/ A helicopter traveling at 120 kts (138 mph) will cover 1,012 feet in these 5 seconds. If the pilot reverses course and starts the turn, the helicopter continues to move toward the hazard for a distance equal to the radius of the turn; in a 30 degree-banked coordinated turn at 120 kts, this is 2,208 feet. Therefore, a pilot flying at 120 kts who recognizes a hazard and initiates a course reversal will travel 3,220 feet--0.6 of a mile--before starting to move away from the hazard. This assumes the pilot maintains altitude and does not slow down. This is more than the 1/2 mile visibility required by the FAA for daytime VFR for helicopters in uncontrolled airspace. It should also be recognized that a 30 degree-banked turn in marginal visibility can induce spatial disorientation in pilots if they are relying on outside visual cues to control the aircraft. Spatial disorientation is discussed later in this section. Accident data suggest that the EMS pilots involved in low-visibility accidents seldom slow the helicopter in reduced-visibility conditions while on patient transport missions. The possibility that this may be a common occurrence concerns the Safety Board, since a helicopter at cruise speed can easily overrun the pilot's ability to "see and avoid" obstacles or worsening weather.

The VFR uncontrolled airspace rules for helicopters are based on maintaining visual contact with the ground; if that cannot be accomplished, the pilot is in IMC. If the pilot is not trained (and current) to fly the aircraft by reference to instruments, there is great risk of losing control of the aircraft. Even if the pilot is instrument rated, current, and proficient in helicopters, success in coping with inadvertent instrument flight is not guaranteed. The FAA has reported that in tests with qualified instrument pilots, it took as long as 35 seconds for some of the pilots to establish full control of the aircraft by instruments after the loss of visual contact with the surface (and these tests were conducted with fixed-wing aircraft, which are inherently more stable than helicopters). 27/

25/ "Special VFR" operations are operations in airport control zones with less than VFR minimums but not on an IFR flightplan. Such operations must be requested by the pilot and approved by ATC before the pilot is allowed to enter the controlled airspace.
26/ Negrette, Arthur J., "Spatial Disorientation: It Plays No Favorites," Rotor and Wing International, December 1986.
27/ FAA Advisory Circular 60-4A; Pilot Spatial Disorientation 2/9/83.

In September 1986, the pilot of a Bell 222 UT collided with mountainous terrain near Galax, Virginia, while en route to pick up a patient. The pilot had contacted the FAA flight service station (FSS) approximately 4 hours before the flight and had been informed that widespread instrument meteorological conditions were predominant throughout the area. VFR flight was not recommended since the foggy, hazy conditions were forecast to remain throughout the morning.

At 1230 eastern daylight time, the pilot departed the Winston-Salem area without obtaining an updated weather briefing. The local conditions at his time of departure were reported as 1,500 feet scattered cloud cover with visibility 3 miles in fog and haze. The temperature and dewpoint were 72 degrees F and 67 degrees, respectively. 28/

Radar data indicate that the pilot flew direct toward Galax from the Winston-Salem area at an average ground speed of 117 kts. The pilot was about 12 miles from his destination, descending from 4,500 feet altitude, when he struck a rock cliff at the top of a 3,500-foot mountain, 20 feet from its summit. The Safety Board investigator estimated that the helicopter impacted the cliff in a 20 degree-noseup attitude and a 20 degree-right banked turn, at cruise speed. The attitude of the helicopter at impact indicates the pilot was trying to avoid the cliff, but was unable to maneuver in time. The pilot and two medical personnel were killed in the accident, and the helicopter was destroyed. There were no eyewitnesses to the accident, but witnesses in the area indicated that fog had been present in that area all morning. The fog cleared shortly after the accident occurred.

The pilot had 8,085 hours of flight experience, 566 hours of which were in the Bell Model 222 helicopter. The pilot was instrument rated in both helicopters and airplanes but was not current or qualified to operate in IMC conditions. 29/ The helicopter was equipped with the appropriate instrumentation and equipment to fly IFR, including an autopilot, but it is not known if this particular helicopter was approved to do so; it was not operated under IFR. 30/

The Safety Board found that the pilot-in-command continued flight into IMC, made poor decisions, and did not maintain proper altitude. Other factors identified included fog, self-induced pressure by the pilot and others to take the mission, and rising mountainous terrain.

This reduced-visibility accident illustrates the need for an increase in daytime visibility minimums. Spatial disorientation, weather information and interpretation, and pilot judgment were frequently found to be associated factors in the reduced-visibility accident.

28/ Temperature/dewpoint spread is the measure between the ambient temperature and the temperature when the water vapor suspended in the air can no longer be suspended and is condensed and becomes visible moisture or "dew." This visible moisture can also form as rain, fog, mist, etc. The closer the temperature to the dewpoint, the greater the probability of visible (vision obscuring) moisture such as fog.

29/ The instrument currency requirements specified in Part 61.57(e) state, "No pilot may act as pilot-in-command under IFR . . . unless he has within the past six months . . . logged at least six hours of instrument time under actual or simulated conditions, at least three of which were in the category of aircraft involved, including at least six instrument approaches, or passed an instrument competency check in the category of aircraft involved."

30/ Attitude indicating instrumentation allows the pilot to control the aircraft's attitude or position relative to the horizon by inside reference. This instrumentation is mandatory when flying without outside visual reference.

Spatial Disorientation

The ability to control the aircraft depends on the pilot's ability to sense accurately the attitude or motion of the aircraft in relation to the earth's surface (orientation). The three sensory systems necessary for orientation are the visual system, the motion sensing system in the inner ear (vestibular system), and the position sensing system involving nerves in the skin, muscles, and joints (proprioceptor system). These systems work together, but visual cues are of primary importance in aircraft control. In the absence of reliable external visual cues, such as when flying in fog or cloud, pilots are generally unable to maintain aircraft control; other sensory inputs do not provide sufficient, reliable information in these circumstances.

Spatial disorientation or vertigo can be so overpowering that even when pilots are aware that it is occurring and are trained to rely on instrumentation, they may have difficulty in controlling an aircraft. 31/ As pointed out earlier, it may take as much as 35 seconds for even experienced and current instrument pilots to reestablish control of the aircraft by reference to the instruments when unplanned entry to IMC is experienced. Spatial disorientation compounds this delay. The importance of spatial disorientation cannot be overstated, since 90 percent of general aviation accidents involving disorientation as a cause or factor are fatal. Special training and proficiency maintenance are required to reduce the risks involved in flying in IMC.

Flying into weather that obscures visibility is usually the first step in developing spatial disorientation. It has been reported that EMS helicopter pilots experience unintentional flight into IMC an average of 1.3 times per year. 32/ The risk of developing spatial disorientation and losing control of the aircraft is great in this situation. However, as the FAA states, "Surface references and the natural horizon may at times be obscured, although visibility may be above VFR minimums. Lack of natural horizon or surface reference is common on overwater flights, at night, and especially at night in extremely sparsely populated areas or in low visibility conditions." 33/ Tests and experience have shown that noninstrument-trained pilots or nonproficient pilots are rarely successful in overcoming spatial disorientation. Most helicopters require some form of autopilot system in addition to appropriate navigation equipment and instrumentation in order to be approved and certificated for single-pilot flight into instrument conditions. Without this help, even if the helicopter has appropriate instrumentation, pilots will have a difficult time controlling the helicopter if they lose visual reference, since helicopters are unstable in flight and require constant input from the pilot to remain under control. 34/

31/ FAA, Instrument Flying Handbook, Chapter 2. Advisory Circular 61-27C, 1980, U.S. Government Printing Office, Washington D.C. 20402.
32/ "Single Pilot IFR Flight Survey," Hospital Aviation, June 1986. This article was based on a survey sent to 130 pilots; 82 pilots (63 percent) responded.
33/ FAA, Advisory Circular 60-4A, Pilot Spatial Disorientation.
34/ "Unstable" in this context means that the helicopter will not maintain a heading or altitude for very long without pilot input. The helicopter will likely "roll off" its heading into a banked turn and start a descent. This is why artificial stability systems like autopilots or stability augmentation system are required for IFR flight in the ATC system; they allow the pilot to focus on other activities such as tuning navigation and communication radios, communicating with ATC, and selecting appropriate charts for flying in the instrument environment.

The pilots involved in the 15 reduced-visibility accidents in this study had extensive experience — a median of 5,550 hours. All but two had an instrument rating in helicopters or airplanes. (Only one flew helicopter IFR regularly and was current at the time of the accident; he impacted terrain in IFR conditions in an IFR helicopter as he tried to land at an airport VFR and was not using the IFR guidance available.) Indeed, an American Society of Hospital-Based Emergency Aeromedical Services (ASHBEAMS) survey of the EMS helicopter industry indicated 80 percent of the currently employed EMS helicopters pilots are instrument-rated (there was no indication if this rating was for helicopters or airplanes or both). However, only 28 percent of these instrument-rated pilots were reported instrument-current. 35/

It is clear that most EMS pilots are highly experienced and ought to be aware of the dangers inherent in unplanned IMC flight, yet the evidence shows that unplanned IMC flight is not an uncommon experience. Other factors that influence pilots to take flights that result in unplanned entry to IMC need to be explored in order to understand better why these questionable flights are undertaken.

Weather Information

Thirteen of the 15 pilots involved in reduced-visibility accidents received some form of weather briefing before the accident. According to ASHBEAMS, 96 percent of the EMS helicopter programs use the FAA's FSS network to provide current weather reports. Many EMS helicopter pilots believe that FSS weather reports are often not very effective in providing timely information to EMS helicopter pilots.

For example, many FSS are closed during late evenings hours. The FAA developed plans to modernize the weather reporting stations with automated reporting systems, but installation of these new systems has fallen behind schedule. However, in anticipation of the new automated stations, manned stations continue to be closed, and 70 of the remaining 200 stations have been placed on "emergency part-time" basis. At times, pilots may have to wait for a briefer because of the large geographic weather area that FSS personnel must cover. 36/ Briefing requests often become more numerous when the weather conditions worsen; thus, when EMS helicopter pilots most need a complete briefing, they most likely have difficulty getting it. Many pilots expressed frustration at having to wait 5 or 10 minutes to get a weather briefing when they know that timely response to a flight request is of the essence.

In some cases, pilots do not wait to receive a full weather briefing; in their haste to depart to the scene of the accident, pilots sometimes fail to request a complete weather forecast for the flight, or they leave because they cannot reach a briefer. This further increases the possibility of encountering poor weather, especially at night. Part 91.5, Preflight Action, states that the pilot-in-command shall, before beginning a flight, obtain

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35/ The survey sample consisted of 130 ASHBEAMS member orgainization; 113 (87 percent) responded. ASHBEAMS has estimated that it represents 95 percent of all dedicated EMS helicopter programs. They reported that 28 percent of all pilots surveyed maintained instrument currency. However, this is not consistent with other data; for example, only 12 percent of programs operate IFR. Part of this discrepancy may be due to such factors as the maintenance of currency by outside flying activity such as military reserve. The discrepancy could also be due to a survey error, since the survey was completed by program administrators who may not fully appreciate what "IFR current" involves.

36/ Aircraft Owners and Pilots Association, Perspective on the Future Flight Service Station Automation Program, Presentation to the FAA, March 23, 1987.

certain types of information. For flights conducted under IFR, or (cross-country) flights not in the vicinity of an airport (heliport), the pilot-in-command must obtain weather reports and forecasts for that flight. This regulation, however, does not specify where the pilot-in-command should receive this weather information. Part 135.213, Weather Reports and Forecasts, also requires that the pilot-in-command receive a weather briefing before undertaking certain flights, but only under certain conditions. This regulation states that whenever a person operating an aircraft under Part 135 is required to obtain a weather briefing, the weather information shall come from the U.S. National Weather Service or from a source approved by the FAA. This regulation also states, however, that "for operations under VFR, the pilot-in-command may, if such a [weather] report is not available, use weather information based on the pilot's own observations." Literal interpretation of Part 135.213 would allow EMS helicopter pilots to depart on VFR cross-country flights with 1/2-mile visibility during the day and 1-mile visibility at night without a weather briefing if they could not get in touch with a briefer. Review of the 15 reduced-visibility accidents reveals that two accident pilots did not obtain a current weather briefing before the accident flight, and two of the accident pilots chose to terminate the briefing before it was completed. One of these two pilots was warned that IFR conditions were forecast for his route of flight.

Some commercial EMS operators have obtained commercial weather services that are accessed through personal computers. These systems vary in capability and cost, but can provide both realtime and forecast weather to the users without the delay that is usually associated with the FSS system. These systems can provide graphic display of the current weather (often in color), print the current weather, and forecast weather so pilots can take it with them on the flight. These weather reporting services can also be optimized for the local operating and weather conditions of an EMS helicopter operator. For example, one program that has such a system has the computer programmed to provide the pilot with a "big picture" and a "little picture" of the weather. The "big picture" provides weather for a circular area 250 miles from the hospital; the "little picture" provides the same information for an area approximately 125 miles from the hospital. The pilot can obtain current and forecast weather and also the three most recent reports. The three most recent reports allow pilots to identify trends in the weather that may help them determine the accuracy of the forecast. The pilots at this program are very pleased with the system and do not have a need to access the FSS system.

Another problem associated with accurately determining the weather for EMS helicopter operations regardless of the source of weather information is the VFR minimums which apply. The weather conditions of 1 mile, 1/2 mile, and no visibility are difficult to predict, especially if the temperature/dewpoint spread is small. The weather reporting system is not capable of providing this kind of detail over a large area--which is why the "chance of" or "occasional" qualifiers or warnings are included in the briefing.

While the pilots involved in EMS helicopter operations are all experienced, it cannot be assumed that they understand weather and weather patterns. Effective use of weather reports and forecasts requires the pilot's assessment of the weather for each flight. As the person holding final authority, pilots must evaluate the meaning of the weather briefing and determine if a flight is safe. Yet many EMS operators do not provide either initial or recurrent weather interpretation courses for their EMS helicopter pilots. (This topic is addressed in more detail in the chapter on Pilot and Medical Personnel Training.) The fact that EMS pilots report that they fly into unexpected IMC on the average 1.3 times per year highlights the need for better weather information and for more training in interpretation of such information.

The Safety Board believes that all EMS pilots must use the most current weather information available before embarking on a flight. The Safety Board also believes that EMS operators must ensure that their pilots are provided the capability to obtain timely accurate weather briefings.

Judgment

Sound pilot judgment is central to safe flight operations. Since EMS pilots have a mean flight-time of approximately 6,000 hours, it is reasonable to assume that EMS pilots will use their hours of flight experience to make carefully reasoned and sound judgments to avoid adverse weather conditions. However, factors unique to EMS helicopter operations--such as the influence of the mission itself, program competition, and EMS program management perspectives--can drastically influence pilot judgment during the EMS mission.

Mission Influence.--Some operators believe that the importance of the EMS mission --transporting seriously ill or injured patients--can affect the pilot's good judgment. The power of the mission itself to influence and perhaps override an EMS pilot's judgment is enhanced by the lack of a strong managerial structure to support the pilot in the working environment. Often the pilot's direct supervisory management is not resident at the hospital and may even be located in a distant city. One chief pilot stated:

> Far too many EMS programs operate through absentee management. When a helicopter operator accepts a job geographically displaced from his home office, he may have unsupervised crews working in difficult environments. Helicopter pilots are basically "can-do" type people who, if given a challenge, will do everything possible to get the job done. The attitude, coupled with the life saving mission, will in many cases affect sound judgment. The pilot must remember and the hospital must accept the fact that the pilot has the responsibility of the flight, and therefore, has the unquestioned final say as to whether the flight goes or not. The operator's management owes it to the pilot and the hospital to make frequent visits and stay visible. 37/

The isolation from management forces the pilot to look for structure and guidance from other sources, most notably the hospital's EMS program administrator and medical personnel. As a result, close relationships between the medical personnel and the pilots develop. A research psychologist who has studied EMS pilots states:

> In EMS air ambulance operations, situations frequently arise where strong professional personalities are interdependent upon each other to accomplish a life/death mission. The team must rely on each other's skills and abilities to achieve maximum performance. The shared experiences of saving lives, coupled with the ever present danger of flight operations, provides a strong emotional glue to bond the flight crew together. 38/

37/ Albert, Vern, "The EMS Frontier," Vertiflight, January/February 1987.
38/ Cauthorne, Catherine V., R.N., Ph.D. and Fedorowicz, Richard, B.S., CFI, CFII, ATP, "The Sociological Impacts of Work/Rest Schedules on Pilots and Their Perceptions of Performance," unpublished paper.

This strong team attitude can encourage a "can do" approach that may compromise the pilot's objectivity on flight safety. A good example is the attitude expressed by a paramedic who was on an EMS helicopter which crashed in poor weather when the pilot, who was aware and concerned about the very poor weather, decided to transport the injured patient anyway (accident No. 42, appendix A). The paramedic, who was severely injured in the accident, stated, "I would in the same circumstances fly as we did that night without concern. I feel that the pilot acted very cautiously in this situation, and [I] have no reservations about his capabilities or his judgment." The paramedic's statement is of particular interest because it demonstrates the team loyalty he felt despite his severe injuries which resulted from the pilot's error in judgment.

Hospital management, the EMS medical personnel, and the dispatchers can all intentionally or unintentionally put pressure on the pilots to take a flight in marginal weather conditions. The reasons for these pressures include misunderstanding or lack of understanding of weather-related considerations, genuine zeal to get a job done, or even competition between EMS programs. When the Safety Board visited EMS programs, many pilots acknowledged that EMS program administrators and medical personnel have not always been sensitive to the limitations of the helicopters and pilots. These pilots stated that they have experienced pressure, ranging from mild to extreme, to complete a flight when they felt conditions were not safe. The pilots believed that this problem can be minimized by educating EMS helicopter program management about the limitations of the helicopters and pilots.

The relative influence of these factors on the pilot's judgment and decisionmaking process is hard to measure. Clearly defined and enforced procedures and management practices would help to ensure that the pilot is encouraged to make good decisions. Education of hospital EMS program administrators to these concerns and their observance of these procedures and guidelines would further eliminate many negative pressures the pilot may experience during the decisionmaking process. Additional discussion of management influence is discussed in the last chapter.

<u>Program Competition.</u>--Competition between EMS helicopter programs can also lead to pressures to fly when conditions are not safe. It is not unusual for on-scene emergency response crews to call a second EMS operator for patient transport when the first EMS operator declines to fly because of poor weather. It is also not unusual for hospitals that want a patient transported to call several EMS operators in the hope that one will accept the call.

The Safety Board visited five programs that had competitors in the same metropolitan area. When questioned about the local competition, one of these hospital EMS program administrators replied that there was no real problem with the other program, but the other program was "not as experienced" as his. Another said the competitor program in his area was "not as conscientious in turning down flights due to weather" as his program was. A third administrator said his competitor's program was "not as advanced" as his. These answers indicate that while competition was not directly cited as a problem, many program administrators had developed a sensitivity to the issue.

One reason EMS helicopter programs may accept marginal weather flights is related to the perceived benefit derived from such flights. It is generally acknowledged that EMS helicopter patient transport operations are not profitable on the basis of patient transport charges alone. A 1986 survey of average transport charges nationwide versus the cost of flying the patient indicated that only about 75 percent of the transport costs are covered by the charges to the patient. 39/ The remaining 25 percent comes from charges associated with the advanced care the helicopter patient normally receives at the hospital. According to one hospital administrator, the real advantages to the hospital that operates a helicopter EMS program are the following:

- o enhanced hospital image;
- o revitalization of overall hospital marketing effort;
- o increased referrals of patients who require critical care; and
- o increased admission of nonemergency patients who want to go to the "hospital where the helicopter is." 40/

One example of how competition between programs and the resulting "shopping" among EMS programs can impact safety was discovered during the course of this study. The Safety Board visited an EMS helicopter program that operated a fully certificated IFR helicopter with instrument-rated and current pilots. The IFR capability was used primarily for long distance flights to outlying airports where seriously ill or injured patients would be transported to the metropolitan area. Most of the local flights were flown VFR. The second program in this metropolitan area was relatively new, and it was a VFR-only program.

Program 1 (the IFR program) received a call for a flight to an accident scene in the local area but declined because the weather--300 feet overcast, 1 mile visibility in rain and fog--did not meet their VFR minimums. 41/ The transport requester then called program 2 (the VFR-only program); the weather met its and the FAA's very low VFR minimums, so program 2 accepted the call. 42/ The flight was successfully completed.

Although program 2 did not violate the FAA regulations for VFR flight in uncontrolled airspace, they did set the stage for future conflicts when transport calls are received during marginal weather conditions: the transport requester has received the "message" that program 2 will fly even when program 1 will not. In the future, program 1 may feel pressure to accept calls that they normally would not, because they know program 2 will; program 2 may feel pressure to continue accepting these calls because they know they can increase their activity during these marginal conditions since program 1 will not accept them. (Since this episode, program 2 has increased their minimums to 500 feet ceiling and 1 mile visibility.)

39/ Collett, Howard, "1986 Transport Charge Survey," Hospital Aviation, June 1986.
40/ Tye, Joe, "Should Competing Hospitals Have Competing Emergency Helicopter Programs?" Hospital Aviation, July 1982.
41/ This program's daytime local VFR weather minimums are cloud ceiling 500 feet and visibility 2 miles.
42/ Program 2 used daytime local VFR minimums of cloud ceiling of 300 feet and 1 mile visibility. The FAA's weather minimums are absolute minimums and do not take into account local weather conditions or terrain. This is why many EMS programs have established weather minimums for their operation that are more restrictive than FAA requirements.

Many EMS helicopter programs across the country have recognized the negative impact on safety this competitive pressure can cause and have taken steps to reduce its influence. For example, two competitor programs interviewed by the Safety Board described their informal agreement not to accept flights in marginal weather without checking with each other. These programs' VFR minimums are quite similar; they stay in communication with each other in making decisions about flight acceptance to ensure they are not being "played off" against each other. This approach effectively eliminates "pushing minimums" as a competitive strategy between programs. Steps to eliminate "transport shopping" and the conflict it causes help to minimize exposure to hazardous situations.

In conclusion, based on review of EMS helicopter accidents and input from the EMS helicopter industry, the Safety Board believes that the reduced visibility accident is the most serious and easily prevented type of EMS helicopter accident. It is clear that highly experienced and skilled pilots are making decisions to fly in weather unsuitable for safe flight. It is also clear that a noncurrent instrument rating significantly increases the possibility of a pilot experiencing spatial disorientation or loss of control when unplanned entry to IMC occurs.

The Safety Board believes that clearly defined and enforced flight procedures and management practices would help to ensure that the pilot is not encouraged to make unwise decisions. Additionally, education of hospital EMS program administrators about flight safety concerns and their observance of these procedures and guidelines would further eliminate many negative pressures the pilot may experience during the decisionmaking process. The Safety Board also believes that EMS pilots should receive additional training in low-level weather interpretation.

IFR/VFR EMS HELICOPTER OPERATIONS

IFR Operations

There is little question that EMS helicopters can be operated safely under VFR if the program management is safety conscious and enforces realistic VFR weather minimums. Some EMS programs have decided, however, that IFR EMS helicopters provide greater safety and allow the pilot to complete some missions that could not be completed safely with VFR. They also believe that the IFR helicopter provides the EMS helicopter pilot with more options for dealing with bad weather if it is encountered. This perspective was reinforced by a conversation the Safety Board had with the vice president of a major aviation insurance firm. This firm will insure VFR-only EMS helicopter programs, but only after they review the program's operating rules and weather minimums. They normally require weather minimums to be higher than FAA requirements because they do not believe the current FAA weather minimums are high enough. This firm encourages EMS programs to obtain IFR capability because they believe it increases safety. This vice president said that he personally feels that the EMS helicopter mission requires a two-pilot, twin-engine IFR helicopter to conduct year-round day and night operations safely.

According to "Hospital Aviation" magazine, approximately 12 percent of EMS operators use IFR-certificated aircraft in daily operations. Opinions are mixed in the EMS helicopter industry on the need for and value of fully IFR-equipped helicopters. When the National EMS Pilot's Association (NEMSPA) surveyed their membership on this point, 50 percent responded that "single-pilot IFR operation has its place in EMS operations," and 50 percent responded that it does not. 43/ At the time of this study, the Safety Board found only one operator that was operating two-pilot IFR EMS helicopters.

Objections to IFR aircraft in EMS operations center on the claim that the IFR capability cannot be easily used in the EMS mission, and therefore, it is not cost effective, since certifying the aircraft and keeping the pilots current add tens of thousands of dollars to the cost of operating the aircraft. Other reasons for the claim that IFR capability cannot be easily used in the EMS mission included:

> Accident scenes and hospital helipads do not have instrument approach systems and are not part of the ATC [air traffic control] system. 44/
>
> Helicopter VFR minimums (300 feet ceiling, 1/2 mile visibility daytime) are lower than many instrument approach minimums.

43/ "Single Pilot IFR Flight Survey," Hospital Aviation, June 1986. Review of the Safety Board database revealed only one weather-related accident that involved an IFR EMS helicopter (accident No. 37, appendix A). The crew in this accident did not use the IFR capability in the poor weather conditions.

44/ Instrument approach systems are ground-based navigation systems that guide the pilot to the landing area in instrument conditions. The precision approach systems provide the pilot with both horizontal and vertical guidance to the landing area. Nonprecision systems provide only horizontal guidance; the pilot provides vertical guidance by not descending below a minimum altitude called the minimum descent altitude. Instrument approach systems are usually located only at public landing areas due to their expense and complexity. Typical approach minimums are precision approach--1/2 mile visibility; nonprecision approach--1 mile visibility.

It takes too much time to file and enter the ATC system for an EMS mission.

It is too expensive.

It will give the pilots a false sense of security; they will fly VFR missions in worse weather since they can always go IFR when they run into IFR weather.

The ATC system is optimized for fixed wing operations, not for helicopters.

The benefits cited for IFR capability in EMS operations are:

IFR results in better pilot training.

It provides an option for the pilot when the weather conditions worsen while in flight, rather than having to stay low near the terrain trying to remain in VFR.

Better aircraft equipment available for the pilot in VFR conditions, such as autopilot or SAS [stability augmentation system] would help greatly.

Trips can be completed safely that otherwise would not be conducted.

The Safety Board visited two programs that operated full IFR helicopters. In both programs, the pilots and the program administrators felt that the IFR capability allowed them to make patient transfer flights that they would not have been able to make any other way. The program administrators also felt that the IFR capability, in their particular situation, was cost effective.

The first program, located in Tenneessee in the center of a mountainous area operates two Bell 222s. (Since the Safety Board's visit, they have replaced these B222s with a full IFR Bell 412.) Approximately 23 percent of this program's flights are scene-related; the remaining 77 percent are interfacility transfers. According to their records, 32 percent of their flights involve some IFR flying where the pilot is in the ATC system.

Typical flight scenarios in which the IFR capability of the helicopter and pilot are used include responses to requests from an outlying hospital in a rural area for a patient transport to the helicopter's home base hospital. If the conditions are less than the program's VFR cross country minimums (day: 800 feet ceiling and 2 miles visibility; night: 1,000 feet and 3 miles), or if there is some question about their ability to maintain these minimums, the pilot will file an IFR flightplan. Filing IFR flightplans is simple in this case because most of the common trip routings and other pertinent information are contained in a desktop computer; the pilots usually need only identify the routing they want.

The requesting facility prepares the patient for transport while the helicopter is en route. If the weather permits, the pilot cancels IFR on reaching the hospital area, and flies to the hospital helipad VFR; otherwise, the pilot conducts the IFR approach to the local airport. The requesting hospital is usually aware if the helicopter will need to land at the airport and will have the patient waiting there in that event. The reverse procedure is used for the return trip.

The IFR capability is also used by this program for isolated segments of a flight. A typical flight for this profile is to a small city hospital about 60 miles away on the other side of a mountain range. Often the weather is good VFR at both the departure and destination heliports, but the mountains are enveloped in fog. In these circumstances, the pilot will file for IFR, cross the mountains, descend under ATC control until reaching VFR conditions, and then complete the trip VFR. The reverse is used for the trip home.

Another IFR program reviewed by the Safety Board operates a single-pilot twin-engine Bell 222 and a single-engine Bell 206; both are IFR-certificated. The Bell 206, however, is limited in its ability to fly IFR due to FAA limitations on single-engine aircraft flying IFR under Part 135 (see appendix E, Operational Federal Aviation Regulations). The Bell 222 is not restricted from flying planned en route IFR, since it is a twin-engine helicopter.

The weather conditions experienced by this program located near the Rocky Mountains are quite different from those of the first IFR program discussed. This area experiences temperature inversions in the winter which can result in IFR conditions near the surface but with clear weather only 1,000 feet agl. 45/ This program uses IFR capability primarily to climb through this inversion layer and fly to their destination; en route IMC is relatively rare. The VFR minimums used by this program for local flights are day: 1 mile visibility and 500 feet ceiling; night: 2 miles visibility and 800 feet ceiling. For cross country flights, the minimums for day are: 500 feet ceiling and 2 miles visibility; night: 1,000 feet ceiling and 3 miles visibility. These minimums must exist not only at the departure and destination locations, but also en route; if there is any doubt, the pilot must file IFR.

The EMS operator for this program provides helicopters to a total of six hospitals. All of these helicopters and flight crews are certificated and current for IFR flight. The company president states:

> Is IFR [capability] worth the expense and added weight? [Our company] has taken the stand that it is not only worth it; it is mandatory. All [our] helicopters are IFR-equipped, and all [our] helicopter pilots are IFR-rated. A helicopter does not have to fly in clouds to lose ground reference. Just lifting off from an accident site at night with lots of car lights and other activity, then turning into the wind or toward the destination and suddenly be in darkness that is solid black is as difficult an IFR problem [due to visibility] as any pilot will ever find. 46/

Although, as discussed earlier, IFR capability in EMS operations is not always beneficial or easily used, those involved in such programs indicated that they had no wish to return to VFR-only capability. Many operators, however, expressed concern over the limitations imposed on helicopter IFR flight by the FAA regulations. The FAA regulations on IFR flight require a pilot anticipating an IFR trip to plan other ways to complete the trip in case bad weather at the destination airport makes a safe approach and landing impossible even with IFR. These rules are referred to as the alternate airport requirements.

45/ Temperature inversions occur when the temperature increases rather than decreases with altitude. Ground-based inversions favor poor visibility in low levels of the atmosphere.
46/ Morgan, Roy, "Second Opinion Response," Hospital Aviation, May 1983.

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45/ Temperature inversions occur when the temperature increases rather than decreases with altitude. Ground-based inversions favor poor visibility in low levels of the atmosphere.

46/ Morgan, Roy, "Second Opinion Response," Hospital Aviation, May 1983.

Due to their speed and endurance, fixed-wing aircraft can fly to their destination, fly another 100 miles to an alternate airport, and then fly 45 minutes at cruise with little difficulty—the capability called for by the IFR alternate airport requirements. A helicopter, however, would have difficulty meeting these requirements; it is a relatively slow aircraft with limited endurance due to its high fuel consumption. Thus, the IFR alternate airport requirements are one major reason why many EMS helicopter programs are reluctant to invest in IFR-capable aircraft and pilots.

A second argument against helicopter IFR is that VFR minimums for helicopter flight in uncontrolled airspace (1/2 mile visibility during the day) are often lower, and therefore, less restrictive than the IFR minimums required to conduct IFR approach to an airport in an IFR-equipped helicopter.

The FAA has been petitioned by an IFR EMS helicopter operator for an exemption from the alternate airport requirements. After discussing the difficulty in conducting IFR flights, the petitioner stated.

> Many more EMS flights could have been flown; however, the 2,000 feet and 3-mile requirement [alternate airport requirements] prevented us from initiating an instrument flight because of the combined distance to destination and alternate [airport] requirement. This creates a fuel problem due to the slow speed and range of the helicopter. In many cases, trips were flown VFR in less than desirable weather conditions because of the constraints placed on the pilots by the present [IFR] criterion to name an alternate airport. The mission can be flown with our [program] cross country minimums of 800 feet and 2 miles, when it would be more desirable to file and fly the mission IFR. 47/

The petition requested that the requirement to file for an alternate airport be changed for helicopters, from a 2,000 feet ceiling and 3 miles visibility requirement to 400 feet above the highest IFR approach minimum descent altitude (MDA) at the airport and 1 mile visibility. According to the petitioner, this proposal was based on the fact that between April 1, 1974, and March 31, 1979, the U.S. Army experienced no IFR helicopter accidents (due to unforecast weather) using alternate airfield planning minimums of 400 feet above MDA and 1 mile visibility. At this time, the FAA has not issued a final determination on the request; the agency has requested additional substantiation and rationale from the petitioner. The petitioner has stated that the additional information the FAA wants is so detailed that he does not have the resources to respond.

The Safety Board believes there is merit in the argument that the current alternate airport requirements, while appropriate for airplanes, are overly restrictive for helicopters; in the case of EMS helicopters, these restrictions, coupled with the lower VFR minimums applicable to these operations, result mainly in discouraging the wider use of IFR-capable helicopters.

47/ Norman, Dan, Chief Pilot, UT Lifestar, letter to FAA, December 11, 1986.

VFR Operations

Approximately 88 percent of all commercial EMS programs in the United States operate VFR-only. According to the ASHBEAMS survey, the vast majority of operators use VFR minimums that are higher than the FAA minimum requirements. The most commonly used minimums are:

> Day, local: 48/ Forty percent of the respondents use 500 feet ceiling and 1 mile visibility; 21 percent use 1/2 mile visibility (FAA minimums) with various ceilings (300 feet to 500 feet). The other 39 percent of respondents use minimums greater than 500 and 1.
>
> Day, cross country: 49/ The most common minimums reported are 1,000 feet and 1 mile (27 percent) and 1,000 feet and 3 miles (20 percent). Only 4 percent of the programs use a 1/2 mile visibility requirement. The other 49 percent of the respondents use ceiling and visibility minimums less than 1,000 feet and 3 miles.
>
> Night, local: Forty percent of the respondents use minimums of 1,000 feet ceiling and 3 miles visibility. Only 6 percent use visibility minimums of 1 mile; 28 percent use visibility minimums of 2 miles with various ceiling limitations, and 18 percent use 800 feet ceiling and 2 miles visibility.
>
> Night, cross country: A ceiling requirement of 1,000 feet and visibility of 3 miles was the most common requirement, with 31 percent of the respondents using these minimums; 26 percent use minimums of 2,000 feet and 5 miles. Six percent of the respondents use minimums lower than 1,000 feet ceiling and 3 miles visibility, while 13 percent had minimums described as other (no value given). The remaining 24 percent use minimums with a variety of ceilings and visibilities, but generally these were reported to be greater than 1,000-foot ceilings and 3 miles visibilty.

Several industry organizations have developed their own guidelines for EMS helicopter VFR weather minimums; all are similar except for a few differences in recommended ceilings:

	Day/Local	Day Cross Country	Night/Local	Night Cross Country
ASHBEAMS */	500 ft/1 mile	1,000 ft/1 mile	800 ft/2 miles	1,000 ft/3 miles
HAI **/	500 ft/1 mile	1,000 ft/1 mile	800 ft/2 miles	1,000 ft/3 miles
NEMSPA	500 ft/1 mile	800 ft/2 miles	500 ft/2 miles	1,000 ft/3 miles

*/ Interim Safety Guidelines
**/ Guidelines prepared by Helicopter Association International's (HAI) EMS Safety Committee.

48/ "Local" is generally considered to be within a 25-mile diameter of the helicopter's home helipad at the hospital.
49/ "Cross country flight" is flight conducted from the home base hospital outside the local flying area.

The ASHBEAMS survey indicates that very few EMS programs use the FAA weather minimums (300 feet over congested areas and 1/2 mile visibility during the day, and 300 feet over congested areas and 1 mile at night). Most of the operators use minimums more conservative than the FAA requirements because they recognize that the FAA minimums are too low for their operating area and higher minimums are required to ensure the safety of their operations. 50/ The FAA is considering developing an Advisory Circular (AC) to provide recommended VFR weather minimums for EMS helicopters.

In early 1987, the FAA conducted a 60-day review of all commercial EMS helicopter programs nationwide. Based on its findings and information from EMS helicopter industry representatives, the FAA has developed a proposed draft AC dealing with EMS helicopters titled "Helicopter Emergency Medical Evacuation Services." (ACs are only advisory in nature--compliance is not required.) The FAA anticipates that the AC will be published in the Federal Register for public comment in early 1988. The FAA has indicated the AC will address many EMS operational concerns including guidelines for EMS helicopter operators on how to develop program VFR weather minimums.

The fact that a program has officially set higher weather minimums, however, does not guarantee that these minimums will be followed in all cases. Official program weather minimums are subject to interpretation by both pilots and program management itself, and these interpretations sometimes differ.

For example, a VFR program visited used program minimums which (for both local and cross country flights) were 600 feet ceiling with 1 mile visibility during the day and 800 feet ceiling and 2 miles visibility at night or pilot's discretion. When asked what "pilot's discretion" means, one of the pilots said that these minimums are flexible and that pilots must use judgment to determine when a flight can be made safely; it was conceivable that a flight could be launched with worse than program minimums if the pilot felt it could be done safely.

However, the chief of operations said that the pilots are not supposed to launch on an EMS mission if either the actual conditions or the forecast weather was worse than the program minimums. When informed about this pilot's perception of what the minimums mean, the chief of operations was not surprised. He agreed that poor communication may be the source of this discrepancy. The phrase "at pilot's discretion," in his view, refers to the option the pilot has to turn down a flight when the weather is better than the minimums, but the pilot believes, based on other information, that the weather precludes a safe flight. The hospital program administrator, on the other hand, when asked about her perception of the program minimums, said she believes the minimums are absolute and not open to interpretation.

In another example, the Safety Board discussed program weather minimums with a VFR-only program which has been in operation many years and has had no serious weather-related accidents. This program's VFR weather minimums are:

Day/local: 500 feet ceiling, 1 mile visibility
Day/cross country: 1,000 feet, 1 mile

50/ Based on information from operators during field research, the NEMSPA safety conference in Fort Worth, Texas, February 5-6, 1987, and HAI Annual Trade Show.

Night/local: 800 feet, 2 miles
Night/cross country: 1,000 feet, 3 miles

The program administrator said these minimums were not open to discussion or compromise, and that all pilots must abide by the minimums.

However, when a line pilot on duty at 2:00 a.m. was asked about program weather minimums, he responded, "We use FAA minimums [lower minimums than those described by the program administrator]." When questioned further about the stated program minimums and his response, the pilot said that the program minimums were only guidelines and the pilot could accept a flight with lower (FAA) minimums if he felt it could be safely completed.

The difference betweem the pilot's perception of the operating limitations and those stated by the program adinistrator could have arisen through misunderstanding, poor communication, or other factors Regardless of the reason, it is likely that the pilot will not be disciplined or penalized for breaking the program minimums since there are no records of weather conditions at the time of dispatch. The only way a violation of the program minimums would be discovered would be if the pilot had an accident or incident or if someone reported such a violation. The pilot may even be encouraged, unofficially, not to abide by the program minimums. The pilot's option to use his discretion to break the program minimums was, in fact, contained in the operator's Part 135 operations manual, and therefore, was applicable to all the hospital programs to which this operator provides services.

The two examples cited indicate that in some EMS helicopter programs communication and compliance with basic safety practices, such as program weather minimums, may be deficient. This is one area that should be made clear to all involved. The effect on safety by the misunderstanding or misinterpretation of weather minimums is hard to measure; however, according to the ASHBEAMS safety survey, 30 percent of the programs surveyed allow some variation from the program minimums.

The Safety Board believes that pilot management is responsible for ensuring accurate understanding of the program's weather minimums. These weather minimums should be developed in conjunction with the hospital program management. The operator should not set VFR minimums for a program and then allow or even encourage pilots to break these minimums. The pilots are operating without close management supervision and are being asked to make difficult decisions. By not providing clear guidance and supporting the pilot on such an important issue as weather minimums, management seriously compromises the intent of setting weather minimums.

One commercial EMS program reviewed by the Safety Board had a very simple and effective system for communicating policy on weather minimums. First, the VFR weather minimums are understood by everyone and are enforced--there are no exceptions. Second, when pilots arrived for duty, they obtain a weather briefing. If the forecast is such that no flights can be made, the pilot tells dispatch who displays a red tag from the dispatch door, meaning no flights until the weather improves. If the weather forecat is such that all flight requests can be completed, a green tag is shown When there is some question, a yellow tag is shown for the dispatcher and other employees; in this event, the pilot must obtain a current weather briefing and evaluate each flight request at the time it is made.

VFR EMS helicopter programs can be and are operated safely; however, marginal weather conditions and inadvertent flight into IMC remain the most serious hazards that VFR EMS helicopters will encounter. Program VFR weather minimums should be used for the local weather patterns that are likely to be experienced and should be understood and enforced. The risk of an accident due to inadvertent flight into IMC is too great for safety-conscious programs to compromise this very important standard.

The Safety Board believes that although the IFR system is not designed optimally for IFR helicopters and the nature of the EMS helicopter mission further complicates this problem, the safety advantages offered by IFR EMS helicopters flown by current and proficient pilots are great enough that EMS programs should seriously consider obtaining this capability.

PILOT AND MEDICAL PERSONNEL TRAINING

EMS helicopter pilots, even those newly hired, are highly experienced pilots. The median flight time of the pilots involved in the 59 accidents reviewed in preparation of this study was 5,300 hours. NEMSPA reports that its members have an average experience level of 6,000 hours. 51/ ASHBEAMS found that the average flight time of a newly-hired EMS pilot was approximately 2,500 hours. 52/ However, the Safety Board believes that high flight time alone may not be enough to ensure the pilot is prepared to handle all the demands of EMS flight operations.

Of the 15 pilots involved in low-visibility weather accidents reviewed for this study, all but 1 held an instrument rating. The skills required for instrument flight, however, are slowly lost unless a pilot regularly flies solely by reference to the instruments or receives recurrent training to maintain these skills. Of the 14 pilots who were instrument rated, only 1 was current to fly instruments in helicopters. It is unclear whether these pilots would have been able to avoid the accident if they had been current to fly instruments, but it is clear that when dealing with poor weather an instrument rating is of limited value if the pilot is not current.

Also, low flight time in an unfamiliar helicopter may be a factor in EMS helicopter accidents. On June 4, 1984, an Alouette III was substantially damaged after it entered ground resonance during landing (the pilot and two passengers were not injured). 53/ The pilot had more than 8,800 hours of helicopter experience, but he had only 20 hours of experience in this make and model helicopter. The Safety Board investigator cited the pilot's low flight hours in this helicopter as a factor relating to the cause of the accident (accident No. 28, appendix A).

FAA Training Requirements

Title 14 CFR 135.341, Pilot and Flight Attendant Crew Member Training Program, requires commercial aircraft operators to have an approved training program for pilots, with ground (classroom) and flight training curricula in initial, transition, upgrade, differences, and recurrent training. These regulations, however, do not require instruction in all these topics, since only those items "applicable to their [pilots] duties" need be addressed. The determination of what needs to be addressed is made by the FAA principal operations inspector (POI) after reviewing the operator's proposed training manual. Issues such as low-visibility meteorology, visual cues for instrument approaches, and instruction for instrument approach procedures, for example, will likely not be required if the EMS program does not fly under IFR. Further, other issues unique to EMS flying--interpretation of marginal weather information, unfamiliar landing zones, en route navigation without planning--may also not be required if the POI is not sensitive to their importance in EMS operations.

51/ NEMSPA provided the average pilot hours reference.
52/ ASHBEAMS survey, op. cit.
53/ Ground resonance occurs when certain vibrations in the main rotor system increase while the helicopter sits on the ground. This causes the helicopter to 'rock' either fore-and-aft or sideways which in turn increases the abnormal vibration of the rotor system. If unchecked, the helicopter can roll over and be destroyed. Helicopters with tires and soft landing gear appear to be more likely to experience ground resonance than helicopters with skid landing gear.

The requirements for flight training (Part 135.345) are specified in the operator's FAA-approved training program curriculum and are approved on a case-by-case basis by the FAA office in which an operator's POI is located. Title 14 CFR 135.351 requires pilots to receive recurrent ground and flight training every 12 months; the recurrent ground training involves reviewing the topics covered in initial ground training and passing a written examination on these topics. The recurrent flight training requirement can be waived if the pilot has successfully completed a flight check (often referred to as a "135 check ride") during the preceding 12 months. Flight recurrency training is often limited to a couple of hours practice of flight maneuvers in anticipation of the flight check. Successful completion of the test check qualifies the pilot for 12 more months of commercial flying.

Other Training Guidelines

Many industry organizations have drafted recommended guidelines for EMS pilot training that are more specific than the FAA Part 135 requirements. In its book, "Safety Guideline for Pilots, Aircraft and Operations," NEMSPA recommends a minimum flight experience of 3,000 hours in helicopters, 1,000 hours of which are in turbine-powered helicopters and 300 hours are at night. NEMSPA also states, "A minimum experience level requirement for EMS pilots is necessary because of the type of missions being performed. More than aircraft handling proficiency is demanded in EMS flying; a well developed judgment in operational decisionmaking, based on long and varied experience, is necessary as well."

For initial training, NEMSPA recommends that a pilot with less than 100 hours in the aircraft type to be used by the EMS program should receive factory school training or its equivalent, 54/ and an additional 25 hours in the aircraft as pilot-in-command before conducting EMS missions. If the pilot has more than 100 hours experience in the aircraft to be used, NEMSPA recommends a Part 135 check ride and 5 hours of local orientation. For pilots with less than 1 year of EMS operating experience, NEMSPA recommends that the pilot spend 12 duty days at the hospital and participate in a structured training program in an EMS environment. If the pilot has more than 1 year of EMS experience, 6 duty days at the hospital are recommended.

ASHBEAMS' recommended guidelines, "Interim Safety Guidelines," suggest a minimum experience level of 2,000 hours in helicopters as pilot-in-command; the recommendations for less-than-100-hour pilots and more-than-100-hour pilots are identical to NEMSPA's. ASHBEAMS recommends that recurrency training be done at least annually; semi-annual training is encouraged. The recurrency training should cover flight by reference to instruments, a factory refresher course, and competency training in emergency procedures. Orientation of the program must be provided for relief pilots who are not part of the pilot staff involved in day-to-day EMS operations.

ASHBEAMS recommends that pilot competency and quality assurance be reviewed monthly either by program personnel or by outside organizations, and remedial training must be undertaken as deficiencies are identified.

54/ A factory school is an initial or recurrent training program offered by a manufacturer for its helicopter, normally with extensive classroom study in which the pilot learns about the aircraft and its systems, performance, and differences relative to other helicopters. The training also includes extensive flight training.

HAI's Emergency Medical Services Guidelines recommend that pilots hired for EMS activities have a minimum experience level of 2,000 hours in helicopters and have an instrument rating in helicopters. Pilots should receive familiarization training specific to their assigned mission and area of operations. The recommended topics include Part 135 training requirements, local routine operating procedures, flight by reference to instruments, regional weather phenomena, IMC recovery procedures, area terrain hazards, confined area (scene) procedures, EMS communication requirements, and orientation to each respective hospital/prehospital health care system. Recurrent training should be accomplished at least semi-annually to assure pilot flight competency and knowledge of operating procedures specific to the EMS mission.

Many States have developed guidelines for EMS helicopter operations in their State, but these guidelines do not normally cover pilot experience and training. These guidelines normally cover the quality of care provided to patients. One exception, however, is the standards being proposed by Tennessee.

The Tennessee Department of Health and Environment has developed draft minimum guidelines for pilot training and experience for EMS helicopter pilots operating in Tennessee. Each pilot must have 3,000 hours of flight experience, 2,000 hours of which must be in helicopters. The pilot must have an instrument rating along with 200 hours of night experience (100 hours of which must be in helicopters). Training requirements for new pilots will include 5 hours of area orientation for pilots-in-command; 2 hours of which need to be at night. Tennessee would also require that pilots maintain instrument proficiency with at least an instrument-proficiency checkride every 6 months. Tennessee's proposed standards, if adopted, would apply to all EMS helicopter operations conducted in that State.

The difference between what these industry organizations recommend and what the EMS operators actually provide their pilots is often quite substantial, as described in the next section.

EMS Training Practices

The training standards in various EMS programs differ markedly. The training approval system of the FAA allows a Part 135 operator to organize a training program which considers such variables as pilot experience or area of operation that are unique to the particular operation. EMS operators meet the training requirements of Part 135 in different ways to match their operating philosophy.

For example, one EMS operator has new pilots attend factory school and participate in an extensive orientation program. In contrast, another operator sends its pilots to factory school if it is available, but for some aircraft types, a factory school equivalent course is provided. Most of the VFR-only programs reviewed do not provide instrument training to help maintain instrument skills; they do provide flight training in anticipation of the annual Part 135 "check ride."

The programs which use IFR-certificated helicopters normally have a flight check with the pilots every 6 months to ensure that the instrument currency required by Part 61.57(e) is maintained.

One operator has developed a recurrency training program in which the pilots are sent annually to a major flight training center. The center's newly developed program covers instrument recurrency, EMS ground school, practical cockpit management, and simulator or flight training. The training lasts 5 days and is designed specifically for the EMS pilots.

In contrast, many other EMS operators observed have well-defined training programs on paper, but the actual training given does not address the operational environment actually experienced by the pilots. This dichotomy was highlighted by an occurrence witnessed by the Safety Board while flying with an EMS program.

The helicopter departed the hospital for response to an inner-city location on a clear and calm night. On arrival at the landing area (a city street intersection), the pilot conducted a straight-in approach and landing. The pilot soon discovered that the aircraft was surrounded by obstacles with little main rotor clearance. To the front of the helicopter were powerlines, to the left rear was a large tree, and to the right rear was a large street sign. Clearances between these obstacles and the main rotor did not exceed 10 feet in any direction. The patient was loaded and the pilot executed a backing departure to clear the obstacles.

When questioned later about the suitability of such a landing zone, and why he had not conducted an aerial survey before landing, the pilot responded that he "really did not feel a need to." There was no company policy to conduct a prelanding survey nor were such procedures practiced in training. The pilot said that maximum performance takeoffs were practiced, but little attention was paid during the annual Part 135 check ride to determine landing zone suitability.

Another small operator visited by the Safety Board had been in operation for more than a year, providing 24-hour service to a small hospital. This operation's training program was still in draft form and was not yet approved by the local FAA flight standards district office (FSDO). The proposed flight training program was little more than a "boiler plate" copy of a generic training program for Part 135 operations and had no training specifically designed for the operational environment of EMS helicopters.

Although the FAA requires that Part 135 operators notify the FAA when they open a new base, this is not always done. Additionally, the FAA requires that POIs or a designated FAA representative conduct an inspection at each Part 135 location at least once a year. According to EMS helicopter operators and the FAA, however, it is not unusual for these inspections to be missed occasionally due to the rapid growth of the industry and the uncertainty as to where new programs are located.

Many EMS helicopter operators visited by the Safety Board had training programs that did not address many of the operational factors involved with EMS helicopter operations. Training for weather forecasts and interpretation, for example, was often not addressed in detail. There was also a lack of any formal procedures or flight training for unplanned entry to IMC and for specific procedures to be followed at unsurveyed landing areas. One operator stated in a letter to hospital management on pilot staffing, "Many U.S. programs do not have sufficient flight utilization [for the pilots] to maintain proficiency with four pilots." Yet none of the programs with low utilization levels offers pilots a minimum amount of flight training to maintain required proficiency levels. The fact that an EMS program that had been in operation for a year without an approved training program indicates that some operators and the FAA have not paid enough attention to training for EMS helicopter pilots.

EMS training programs may satisfy the requirements specified in Part 135, but they often fall short of providing training that is needed to deal with the EMS operational environment. In fact, the lack of adequate training has resulted in some pilots who are unable to fly the full range of EMS missions safely. To ensure the safety of the EMS mission, a multitude of skills are required, including recognition of marginal weather conditions, unfamiliar landing zone operations, restricted visibility operations, en route navigation with no prior planning, and good judgment skills. The pilots' skills and judgment are their tools, and they need to be developed and maintained through adequate training. Very few EMS helicopter pilot training programs reviewed by the Safety Board addressed the unique operational environment experienced by EMS helicopter pilots. This problem is compounded by the fact that very few POIs are experienced in EMS operations and, therefore, are unable to fully ensure that pilot training programs prepare pilots properly for their job.

The Safety Board believes that the FAA should provide specific guidance on minimum training standards for EMS helicopter pilots and these standards should include: weather reporting and briefing procedures and interpretation; basic low-altitude meteorology and local weather patterns; emergency procedures to be followed if unplanned entry to IMC occurs; initial training in EMS helicopter operations and EMS program orientation for newly-hired pilots before they act as pilot-in-command; scene-related, maximum performance, and maximum weight takeoffs; and pilot responsibilities in regard to landing zone security and pilot/crewmember coordination. This guidance should also provide for requiring demonstrated skill in basic control of the helicopter by reference to instruments and unplanned entry to IMC procedures.

Medical Personnel Training

EMS helicopters seldom fly without medical personnel (sometimes called medical crewmembers) on board. The medical personnel historically have not been considered required crewmembers either by the FAA when reviewing a Part 135 certificate holder's training program or by the Safety Board when an accident occurs. The FAA defines the term crewmembers in CFR Part 1 as "a person assigned to perform duty in an aircraft during flight time." Medical personnel have normally been considered passengers, since they have no direct responsibility for the operation of the helicopter or for its control during flight.

Actual experience, however, indicates that medical personnel do assume crewmember functions and assist the pilots in their duties. EMS-industry sources indicate that medical personnel often help the pilot avoid obstacles on approach and departure; scan for other air traffic while in cruise flight; conduct routine radio calls to hospital dispatch on aircraft position; shut down aircraft power and fuel in the event of pilot incapacitation after an accident; and conduct "Mayday" communications to the dispatch center if an emergency that endangering the crew occurs in flight.

Since the medical personnel on EMS helicopters are not considered crewmembers by the FAA, they are not required to receive the training specified in Part 135 for nonpilot crewmembers. Part 135 specifies that the operator must provide training to nonpilot crewmembers on their basic duties, including basic aircraft indoctrination and emergency procedures. It also requires instruction in the following areas:

- o location, function, and operation of emergency equipment, (ditching equipment, first-aid equipment, portable fire extinguishers);
- o fire in flight or on the surface, and smoke control procedures;
- o ditching and evacuation;

- o illness, injury, or other abnormal situations involving passengers or crewmembers; and

- o hijacking and other unusual situations.

Part 135 also requires review of the operator's previous aircraft accidents and incidents involving actual emergency situations. Additionally, each crewmember is required to gain practical experience during training in: ditching, if applicable; emergency evacuation; fire extinguishment and smoke control; operation and use of emergency exits; and donning and inflation of life vests and the use of other flotation devices, if applicable. Crewmembers must receive recurrent training in these topics every 12 months.

ASHBEAMS reports that most programs already provide medical personnel with training in aviation physiology, aircraft familiarization, safety in and around aircraft, emergency egress, emergency landing procedures, radio operations, emergency frequencies, and aircraft fuel and power systems shutdown. Many of the programs also provide instruction on emergency locator transmitter location and operation, survival training, and water rescue. 55/ This training is usually provided primarily by the hospital with input from the operator.

The Safety Board believes that all medical personnel who routinely fly on EMS helicopter missions need to receive specific training on their functions and duties in the helicopter since they often assume many of the responsibilities of crewmembers. This training, in addition to their medical training requirements, should address those items required by Part 135.331, Crewmember Emergency Training. This training should also address, as applicable, those areas of responsibility that are nonmedical, such as medical personnel and pilot communications, aircraft fuel and systems shutdown, landing zone obstacle avoidance, air traffic avoidance, landing zone safety, and radio communications. This training program should be developed jointly by the hospital EMS program management and the EMS helicopter operator management.

Training for Nonflight Personnel

EMS helicopter operations often involve personnel other than those actually on board the helicopter in the day-to-day operations of the program. For example, public safety and emergency response personnel are usually involved when the helicopter lands at an accident scene. Their knowledge of EMS helicopter operations in particular can have a major impact on the safety of that operation.

When a helicopter is requested at an accident location, a determination has already been made by the responding emergency units that they believe injuries are serious enough to justify the helicopter's response. It is these same emergency response personnel who often select a landing site, secure the area from curious observers, and brief the pilot on the landing zone; this job is especially complicated at night.

The ability to manage the landing zone selection and to mark the site accurately is a serious responsibility requiring training and judgment. Once the helicopter has landed, it is no less important for the landing area to be well secured, since many EMS programs will not shut down the helicopter engine for patient loading (since the engine(s) normally require a cool-down period before they can be shut down). The rotor systems on most helicopters cannot be disconnected from the drive train, and therefore, they will continue to turn; the hazards associated with loading a helicopter with the rotors turning ("hot loading") are obvious.

55/ ASHBEAMS, survey, op. cit.

ASHBEAMS reports that 98 percent of all EMS programs responding to their safety survey said they conduct training programs on EMS helicopter operations and site selection for public safety and emergency response personnel. According to the EMS programs visited by the Safety Board, these training programs have been very successful and are enthusiastically supported by the participants. EMS program personnel, including the pilots, design and conduct the training. Topics normally covered include: landing zone selection (size, wind direction, surface condition, obstacles, marking for day and night operations, and approach and departure paths); nighttime operations; assisting the crew; landing zone security; and helicopter ground safety.

Most EMS programs have also developed procedures for calling the EMS helicopter and setting up the landing zone. These guidelines were published and provided to the public safety/emergency response agencies for use by their employees.

NEMSPA has issued a publication on how to set up a landing zone, "Preparing A Landing Zone," which is small enough to be carried easily on-scene. Reed Stenhouse, an insurance brokerage firm, has published a booklet, "Be Alert Around the Helicopter," that provides general safety considerations and procedures to be followed when near helicopters.

PILOT FATIGUE—FLIGHT TIME/DUTY TIME

Pilot fatigue has been suggested by some in the EMS helicopter industry to be the primary cause of the industry's poor safety experience. While fatigue can have a negative impact on pilot performance, its presence is often difficult to substantiate. Fatigue is insidious, and this is its most dangerous aspect, since the pilot's abilities, once compromised by fatigue, may not be sufficient to meet the demands of even routine flights. Fatigue can also affect the pilots' perception of their own performance capabilities. NEMSPA states:

> In no other area is there such a flagrant disregard for safety as staffing [inadequate staffing leading to fatigue]. More pilots than I care to recall have told us, 'This schedule is killing me.' . . . Everything else pales by comparison to this neglected area. The most sophisticated aircraft and all the regulations in the world cannot solve the problems of a fatigued pilot. 56/

In its Safety Guidelines for Pilots, Aircraft and Operations Duty Time Limitations, NEMSPA further states, "As fatigue cannot always be self-determined, and in most cases it may not be apparent until serious errors are made, it is necessary to avoid the environment that would promote these conditions." NEMSPA recommends that a minimum staffing level of four pilots per aircraft along with a maximum shift of 12 hours for each pilot is needed to minimize the effect of fatigue on the EMS pilot.

Accident Experience

In the 59 EMS helicopter accidents reviewed for this study, 40 (68 percent) involved pilot factors or poor judgment as part of the probable cause. While it is difficult to substantiate, it is reasonable to believe that many of these accidents could have involved pilot fatigue as a contributing factor. Of the 59 EMS helicopter accidents in the Safety Board's database, only 1 explicitly listed fatigue as a factor (accident No. 21, appendix A). The report states:

> The pilot belonged to the Utah Army National Guard and was on duty with them from 0800-1710 and 0830-1730 on the 9th and 10th of [April] respectively . . . After his duty with the National Guard on the 8th, 9th, and 10th of [April], he reported for duty at the University of Utah hospital to stand by as a helicopter pilot for medical emergencies. His on-call duty hours at the hospital were from 1900 on the 9th and 10th to 0700 the next morning ([April] 10th and 11th). . . . The investigation revealed that the pilot would usually rest but would seldom go to sleep for an extended period of time even when he was working the night shift. Additionally, the pilot was enrolled as a student at Westminster College in Salt Lake [City] and last attended class on Friday morning, the 8th of [April]. From [April] 7th, beginning at 0700, and ending at 0545 on [April] 11th, the pilot was either on duty, flying, or going to school for a total of about 74 hours during a period of about 95 hours. During this time he flew about 6 hours. His average rest during this period was about 5 hours.

56/ Einhorn, Tom and Wright, Don, "The Final Authority," Hospital Aviation, October 1986.

It is not difficult to conclude in this case that fatigue was a factor in the pilot making inappropriate choices that led to the accident. However, in the other 58 accidents, investigators were not able to establish a clear relationship between fatigue and the accident. This does not mean that fatigue was not a factor in these accidents; it simply means that the evidence was not clear enough for the investigator to cite it as a causal factor.

Origins of Fatigue

The EMS helicopter pilot must launch on a mission quickly, often with little or no advanced notification and little time for flight planning. The pilot will rarely know the condition of the landing area if it is a scene flight, nor will the pilot know how well the landing zone has been selected and set up by the ground personnel. The weather conditions may be marginal and the flight may be conducted at night. In addition, the pilot will have the additional stress of transporting a seriously ill or injured patient and will have little help from the medical personnel on the return trip, since they will likely be busy with the patient. In this environment of quick response, inability to preplan, uncertainty, and stress, the pilot must make accurate judgments quickly as situational information becomes available. All of these factors, in combination with normal flight requirements, can increase the pilot's stress levels and, thereby, increase the fatigue experienced by the pilot. 57/ Furthermore, if the pilot is already fatigued, these inherently difficult factors may become close to unmanageable for the pilot.

During the Safety Board's research, many EMS pilots were asked to describe how they perceive the EMS flight environment relative to their other flight experiences. The majority of EMS pilots responded that next to combat flying, the EMS flight environment is the most stressful and challenging. One pilot even compared it to combat flying. Some pilots admitted that it was this very challenge that attracted them to EMS flying. It is clear that the ordinary operational stresses of flight induce fatigue to some degree; 58/ the additional unique stresses of EMS flying certainly contribute further to fatigue.

Fatigue is often categorized as either acute or chronic, and is defined as:

> [Fatigue is] primarily induced by excessive mental and/or physical activity and its symptoms are related to specific factors in the work situation. It is normally dissipated by a period of sleep or of rest and recreation. However, if not relieved, such fatigue is prolonged from day to day and can lead eventually to a state of chronic fatigue. For an individual suffering from chronic fatigue, the sensation of fatigue is intense and characteristically persists into the non-work period and not infrequently is present before work commences, despite a period of sleep. Fatigue can also be induced by sleep loss or poor quality of sleep. 59/

While any type of fatigue can affect pilot performance, chronic fatigue poses an especially serious threat, since recovery for pilots is much more difficult and they may report to work already fatigued. The symptoms of chronic fatigue are a general weakness

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57/ Cauthorne, Catherine, Ph.D. and Fedorowicz, Richard, "Work/Rest Schedules and their Potential Impact on Flight Crew Performance," Hospital Aviation, March 1985.
58/ Rayman, Russell B., Aerospace Medicine, Chapter 13: Aircrew Health Care Maintenance, Philadelphia, 1985.
59/ Perry, I.C., ed., "Helicopter Aircrew Fatigue," Advisory Group for Aerospace Research and Development, Report No. 69, Technical Editing and Reproduction Ltd., Hartford House, 7-9 Charlotte Street, London, W1P1HD.

in drive and loss of initiative; a tendency to depression associated with unmotivated worries; and increased irritability and intolerance, occasionally with unsociable behavior. 60/

Fatigue degrades decisionmaking, judgment, and physiological functions such as motor skills, coordination, visual perception, etc. However, it is difficult to determine accurately and objectively when fatigue has compromised a pilot's skills and judgment sufficiently to make a particular pilot unsafe for flying. Certain aspects of EMS helicopter operation inherent to the mission and its environment induce fatigue and cannot be eliminated. Therefore, until fatigue can be accurately measured, the risk of fatigue must be reduced by preventive measures. The insidious nature of fatigue and its cumulative effect on flight safety require that EMS helicopter pilots work in an environment in which avoidable fatigue is minimized. One of the potentially productive areas to minimize fatigue is to adjust the work/rest cycle of the EMS pilot. 61/

The National Aeronautics and Space Administration (NASA) at the Ames Research Center in California has developed methods to measure the influence of pilot fatigue and workload on helicopter pilot performance. NASA has found that the impact of fatigue, stress, and workload on pilot performance in the flight environment can be objectively measured by looking at physiological factors (body temperature, heart rate, etc.). Additionally, significant information can be obtained by subjective measurements such as pilot alertness, communication ability, etc. Currently, many of these techniques are being applied by NASA in a research project involving the California Highway Patrol, "Helicopter Crew Workload and Coordination: Law Enforcement." Application of these techniques in a research program to measure the effect of stress, fatigue, and workload on EMS helicopter pilot performance would provide much needed information on the most effective ways to minimize the negative impact of stress and fatigue on the EMS helicopter pilot.

Work/Rest Cycles

A recent survey of 250 EMS helicopter pilots in this country concluded that sleep loss "has a profound impact on safety in performance as a function of work/rest schedules. If pilots are able to obtain a sufficient amount of quality sleep, their perceived levels of flight/job performance rise. Maintaining alertness and adequate motor skills, such as precise hand-eye coordination, is also related to sleep to a significant degree." 62/

EMS helicopter pilots and other professionals involved with health care work on shift schedules. Most EMS helicopter programs provide 24-hour service, 365 days a year, which requires that there always be a pilot on duty. Shift work, however, can disrupt the normal sleep/rest cycles. Circadian rhythm 63/ disruption and the resulting fatigue is complex and difficult to substantiate for shift workers. Yet the negative impact of factors such as sleep loss disruption in pilots has been recognized for many years, and the FAA has developed regulations for flight time and duty time designed to provide a minimum standard of protection against such factors. Unfortunately, these regulations do not take into account circadian (time of day) issues. Title 14 CFR 135.267, Flight Time Limitations and Rest Requirements, specifies that a pilot must receive 10 consecutive hours of rest in any 24-hour period if the combined duty and rest periods total 24 hours. Furthermore, each flight crewmember must have 13 rest periods of at least 24 consecutive hours every 90 days.

60/ Ibid.
61/ Perry, op. cit.
62/ Rayman, op. cit.
63/ Circadian rhythms are biological rhythms that have a period of approximately 24 hours.

However, Part 135.271, Helicopter Hospital Emergency Medical Evacuation Service, 64/ requires that the EMS pilot must receive 8 hours of consecutive rest every 24 hours and 10 hours of consecutive rest before reporting to the hospital for availability for flight time. An EMS pilot may not be on duty longer than 72 hours.

Although the flight time/duty time rules provide standards for the number of hours EMS air crew can be on duty, they provide no guidance on how the EMS pilot schedules are arranged. Due to the need for 24-hour service, many EMS programs have pilots working 24-, 36-, 48-, and even 72-hour shifts. 65/ These are often very disruptive to the pilot's normal rest and sleep patterns. Additionally, without time for pilots to recover from and adjust to the shift work, chronic fatigue can set in and pilots may not recover until they receive adequate rest.

When the internal and external cues which regulate the circadian rhythm system begin to function on different schedules, a condition called "transient internal desynchronization" (TID) occurs. TID causes many fatigue-related problems, since the metabolic processes of the body and energy production are all affected. 66/

In their study on the work/rest cycles of pilots and the potential impact on flight performance, Cauthorne and Fedorowicz recommended several factors be considered when designing a pilot shift schedule:

1. When shift changes occur, they should be phase-delayed (days to nights), since rhythm adaptation has been shown to be quicker. Phase-advance changes (nights to days) should be avoided unless personnel have sleep time set aside to help with adaptation during the night shift.

In this situation, it is easier to adapt from a schedule change of days on (12 hours)/nights off (12 hours) to nights on/days off (phase-delay) than to have a schedule change of nights on/days off to days on/nights off (phase-advance).

2. The time off between shift change should be as long as possible to allow re-entrainment of rhythms. This is particularly important for someone working more than one consecutive night.

3. Minimize the total number of phase shifts as much as possible, because they result in TID. This effect can be reduced through the availability of sleep during the shift. If phase changes occur, they should follow a work period that is short in order to minimize TID.

64/ Part 135.271 was developed specifically for EMS helicopter operators because it was discovered that most EMS programs had received exemptions from Part 135.267, allowing them greater flexibility in setting flight time/duty time schedules for their pilots. However, Part 135.271 was intended to apply only to emergency flights; EMS operators nationwide have apparently been applying the less stringent Part 135.271 rule to all operations.

65/ Cauthorne and Fedorowicz, "Work/Rest Schedules and their Potential Impact on Flight Crew Performance," Hospital Aviation, March 1985. ASHBEAMS' safety survey of the EMS helicopter industry found that the most common pilot schedule is 24 hours on duty two to three times a week (27 percent of all programs); the second most common is 48 hours on duty one to two times a week (18 percent of all programs); 12 percent of the programs use a 12-hour duty period four to five times a week. Only one program reported a 72-hour duty period.

66/ Ibid.

4. The schedule which appears to be most compatible with circadian rhythms involves a rapid rotation using phase-delay, with extended intervals between each rotation—for example, three 12-hour days on, three 12-hour nights off, followed by two 24-hour days off; change to nights on/days off for 3 days, followed by three 24-hour days off, then the schedule repeats. Since day to night adjustment (phase-delay) is relatively easy, only 2 days are needed to adjust to the night schedule; nights to days (phase-advance) adjustment requires more time, so 3 days are days off for the pilot. The adjustment time between rotations should be, at a minimum, equal to the number of nights worked.

Cauthorne and Fedorowicz state that, in their opinion, following these four recommendations when designing pilot work shifts is one way to minimize the influence of TID that accompanies the varying shifts the pilots work.

Number of Pilots

According to ASHBEAMS' survey, the most common staffing plan for single-pilot helicopter, 24-hour EMS service is three pilots; each pilot has to be on duty 240 hours a month. In contrast, NEMSPA recommends, as an optimum, a minimum of four pilots for each single-pilot helicopter scheduled for service 24 hours each day. A four-pilot program requires that each pilot be on duty 180 hours per month. In a four-pilot program it is easier to design work shifts that cause less disruption of the pilots' work/rest cycles. NEMSPA's recommendations, however, do not take into account the activity level of the program.

When the Safety Board visited nine operating EMS helicopter programs, investigators noted varied pilot staffing levels. Five of the programs had three pilots for their single aircraft, while the other four programs had more than three pilots. One program had seven pilots and two helicopters--one helicopter was available 24 hours, one was available 16 hours. Pilots expressed little dissatisfaction with their shift schedules at eight of the programs. The one program whose pilots did express dissatisfaction was a very busy program staffed by only three pilots. The operator of this program had elected to go to 12-hour shifts for the pilots because the 24-hour shift rest requirement was often violated and required that the standby pilot be called. These pilots described the situation as very difficult and fatiguing.

Most of the program administrators interviewed stated that if they operate 60 to 80 flights per month, meeting the FAA flight time/duty time limitations would require adding a fourth pilot in order to continue providing 24-hour service. If the programs approach an activity level of 130 to 150 flights per month, then even with four pilots, it would be necessary to consider adding a second helicopter.

A typical schedule for a three-pilot program providing 24-hour coverage assumes the pilots work 24-hour shifts. In this situation, a pilot is on duty 24 hours, remains on standby for the next 24 hours, and then is off for 24 hours. There are several combinations to this schedule, such as 24 on/24 standby for 6 days, followed by 3 days off. It is clear, however, that a major proportion of the pilot's time is on standby. This standby status is required because if on-duty pilots do not get 8 hours of consecutive rest in this 24-hour duty period or if they fly more than 8 hours during that period, they must be relieved by the standby pilot. As a program's activity increases, on-duty pilots will require standby relief more often. Ultimately, the program can no longer ensure 24-hour coverage and must hire another pilot. This problem will become more common at lower activity levels, since the FAA will no longer allow the more lenient Part 135.271 flight time/duty time rules (that require only 8 hours of rest) to apply to both nonmission and mission-related EMS helicopter operations. The 10-hour rest requirement in Part 135.267 will apply to all flights except emergency evacuation flights (i.e., necessary patient transport flights).

Industry Standards

Many EMS helicopter industry groups have developed recommendations and guidelines to EMS programs for pilot staffing and duty-time requirements. NEMSPA states that single-helicopter programs should have four pilots (or four crews if the helicopter is a two-pilot helicopter). Additionally, a relief pilot (or crew) should be available to cover holidays, sick days, vacation, etc. For programs that have more than one helicopter, it is recommended that one additional pilot (or crew) be provided above the minimum requirement for each helicopter (for two helicopters--nine pilots or crew). For duty time, NEMSPA's guidelines recommends that pilots work a maximum 12-hour shift and no more than four shifts in a row (12 hours on/12 hours off) or an average of 42 hours duty time in any 7-day period. NEMSPA also recommends limited rotation between days and nights.

ASHBEAMS' Interim Safety Guidelines state, "The pilot's mental and physical ability and readiness to safely conduct an aeronautical mission must be assured. Staffing and scheduling requirements must assure that the FAR [Federal Air Regulations] 135 requirement for eight hours of continual uninterrupted rest in any twenty-four hour period is always adhered to." 67/

ASHBEAMS recommends a minimum staffing of three pilots per aircraft, supported by relief pilots, assuring sufficient coverage for scheduled and unscheduled absences as well as an on-call system for immediate response. ASHBEAMS also encourages that 12-hour shifts and four pilots per aircraft be explored as a staffing and duty-time alternative.

The HAI EMS Safety Committee recommends a minimum staffing level of three pilots per aircraft, along with sufficient relief pilots to assure pilot coverage for scheduled and unscheduled absences. Regarding pilot duty time, HAI's EMS Guidelines simply state, "It is the pilot's responsibility to maintain physical agility and mental alertness prior to accepting a flight mission." HAI recommends that all EMS programs use a 10-consecutive-hour rest requirement in any 24-hour period and disregard the 8-hour rest provision of Part 135.

The Tennessee Department of Health and Environment has proposed mandatory State regulations for helicopters flying EMS missions in Tennessee. The proposal requires a minimum of four permanently assigned pilots per regularly deployed aircraft and relief pilots for adequate coverage; no pilot is to work any shift greater than 48 hours (72 hours are permitted by the FAA); and all pilots are to receive 8 hours of uninterrupted rest every 24 hours. 68/

67/ The interpretation of the duty time/rest time requirements has been changed by the FAA since the interim standard was established. The 8-hour requirement for rest applies only if the pilot is involved exclusively in emergency transfer flights. A 10-hour rest requirement exists if the pilot is involved in other nonemergency EMS flights.

68/ State of Tennessee: Department of Health and Environment, proposed rule 1200--Emergency Medical Services.

Although fatigue has been suggested by industry representatives as the main cause of EMS helicopter accidents, this was not substantiated by review of the 59 EMS helicopter accidents in the Safety Board database. The Safety Board believes, however, that EMS helicopter pilots work in an environment and operate on a schedule that are conducive to acute and chronic fatigue that can influence the pilots' ability to operate the aircraft safely.

EMS pilots feel that lack of adequate sleep is the primary reason they become fatigued. Ensuring adequate rest, however, in the EMS environment is difficult because most EMS programs operate 24 hours a day, 365 days a year. This schedule requires that pilots fly a rotating shift schedule that can cause circadian rhythm disruption, sleep loss, and fatigue. Research has shown that it is difficult to design a work schedule to minimize the circadian rhythm disruption with only three pilots; however, many EMS programs do not have activity levels which economically justify the addition of a fourth pilot.

The Safety Board believes that the best indicator of the number of pilots required is the individual program's activity level. Additional pilots should be added before the current pilots are unable to maintain the required continuous rest period (if using 24-hour or longer shifts) specified by the FAA. Additionally, the Safety Board believes that both the hospital EMS program management and the EMS operator management need to recognize the influence of chronic fatigue on EMS helicopter pilot performance and should seek input from pilots and from experts in the construction of work/rest cycles and the optimum pilot staffing levels.

EMS HELICOPTER RELIABILITY AND DESIGN

The helicopters used in commercial EMS operations were designed and marketed for civilian activities. Their complexity ranges from relatively uncomplicated single-engine helicopters (the Bell 206) to very large and sophisticated twin-engine helicopters (the Bell 412 or Sikorsky S-76). They are equipped for EMS missions primarily by interior modifications for patient care and by the addition of search lights and communication equipment. A particular helicopter's performance, operating limitations, and other characteristics, however, remain essentially unchanged by these interior changes.

Often these interior modifications are completed to design-approval standards which can vary from one FAA regional office to another. The influence of various approval standards on EMS helicopter safety is evaluated in this chapter. First, however, EMS helicopter mechanical reliability is reviewed and compared with other segments of the commercial helicopter fleet.

Mechanical Reliability

A review of the 59 EMS helicopter accidents used in this study shows that 15 (25 percent) were related to mechanical failure. Mechanical failure EMS helicopter accidents, however, were the least likely to produce fatalities or serious injuries; only 2 of the 15 mechanical-related accidents produced fatal injuries. The two fatal mechanical-related accidents constituted only 3 percent of all fatal EMS helicopter accidents; the four serious injury mechanical-related accidents constituted approximately 7 percent of all the serious injury EMS helicopter accidents.

The nature of mechanical-related EMS helicopter accidents varies. Of the 15 accidents, 3 were directly attributable to improper maintenance procedures (accident Nos. 9, 11, and 31, appendix A). Nine were due to engine failure or failure of an essential component which would cause the engine to lose power (accident Nos. 1, 4, 7, 17, 19, 24, 27, 49, and 54, appendix A). Two accidents occurred because of tail rotor failure (accident Nos. 36 and 57, appendix A), and one occurred because of a hydraulic system failure (accident No. 47, appendix A). In all but two of the accidents, the pilots of these aircraft managed to execute successful emergency landings. One of the two fatal accidents occurred when the pilot experienced an engine failure at low altitude at night while on a downwind approach (accident No. 4, appendix A). The other occurred when the pilot misidentified the mechanical problem and shut down the remaining operating engine (on a twin-engine helicopter) and impacted rugged terrain (accident No. 27, appendix A).

Maintenance

Maintenance of EMS helicopters is usually conducted by the EMS operator at the hospital or nearby. The operator typically assigns to each helicopter a mechanic whose sole responsibility is the maintenance of that helicopter. In its safety survey of EMS operators, ASHBEAMS reports that more than 95 percent of all EMS programs have one or more mechanics assigned to their helicopter(s), and typically, these mechanics are factory-trained for the aircraft (86 percent of all respondents) and are on-call 24 hours a day (97 percent of all respondents). These mechanics usually perform most of the normal scheduled and unscheduled maintenance on the helicopter, but send major overhauls and component rebuilds to specialty overhaul shops. (Normally, this type of "heavy" maintenance is scheduled in advance, and the operator provides the hospital with a backup aircraft while the primary aircraft is out of service.)

Maintenance procedures reviewed during the Safety Board's visits to EMS programs generally seemed well designed and comprehensive. Many of the programs used a progressive maintenance schedule that helped reduce aircraft downtime. Pilots and program management interviewed were generally pleased with their maintenance programs and had confidence in their mechanics' ability to maintain the helicopter. There was some variability in program administrators' opinions, however, about the relative mechanical reliability of some specific aircraft models.

EMS Helicopter Interior Design

The FAA provides guidance and standards for modifying aircraft to ensure that aircraft safety is not compromised. However, the lack of specific standards for EMS helicopter interiors and the variability of local FAA officials' interpretation of the standards have resulted in different perceptions of what is acceptable. In addition, there are no technical design standards for individual components, no design requirements for the patient care systems, and no standardization in the FAA modification approval process. No accidents have been attributed to interior design inadequacies, but industry representatives including EMS helicopter operators, aircraft modification representatives, and FAA representatives have expressed concern over the broad variation in interior configurations being completed. Many hospitals specify interior configurations based on criteria developed by the hospital. These hospital requirements result in vastly different and sometimes hazardous EMS interiors.

Many helicopters have the ability to carry two patients, but the lack of cabin space limits the amount of "full body" attention a patient can receive if both litters are occupied. Other provisions for patient care include AC and DC electrical power, oxygen systems, and suction. This additional equipment is usually installed with permanent plumbing and patient sidewall outlets for quick connection and disconnection. Additional, equipment may include high-intensity lighting, cardiac monitor/defibrillator, IV pumps, ventilators, and in-cabin storage for a large variety of medical supplies (drugs, oxygen masks, pillows, dressings, gloves, etc.). There may also be a barrier between the patient and the pilot and flight controls or other arrangements specified by the hospital. 69/

Some of the interior configurations reviewed for this study were designed using a systems approach in which the medical equipment interfaces with the systems of the aircraft. By identifying potential hazards where a component failure or sequence of events could compromise the patient's and/or the helicopter and crew's safety, methods could be devised to prevent their occurrence. In other programs reviewed, however, medical equipment designed for ground ambulances had been installed without considering its suitability for the helicopter environment where high vibration levels, weight limitations, and the need to interface with other aircraft systems, such as the avionics and power supplies, could affect performance and safety.

Consider, for example, the design of the oxygen system in two different helicopters studied by Safety Board investigators. The first helicopter was a single-engine Bell model 206L-1 in which the patient's oxygen system was located in the baggage compartment. Four medical oxygen bottles in a rack fed into a reduction manifold which then fed the oxygen to a line into the cabin. The high-pressure oxygen (1,800 psi) flowing through this line was reduced to 50 psi for patient oxygen delivery in the cabin. Before a flight in which oxygen use was anticipated, a crewmember would have to open the baggage compartment, turn the valve "on" at each bottle, and then close the baggage door. This

69/ Collett, Howard, "Helicopter Configuration," Hospital Aviation, August 1986.

would pressurize the high-pressure line. Once in flight, there is no way to turn off the oxygen at the source or to depressurize the high-pressure line. The valves on the bottles were the type in which a "yoke" slips over the valve and is tightened, compressing a nylon O-ring. Although this EMS program had previously experienced oxygen leakage at these valves, the operator did not consider the leakage to be particularly hazardous.

Oxygen leaking into a small, unventilated compartment poses an explosion hazard. Electric motors for the suction equipment, as well as blankets and pillows, were located in this compartment. Thus, the baggage compartment contained all the elements for a catastrophic fire. There were no warning devices or provisions for disabling the system to prevent such an occurrence.

Compare this system to the oxygen system installed in a Bell model 222UT reviewed by the Safety Board. The designer of the EMS system for this aircraft put the oxygen bottle where the retractable tricycle landing gear of the earlier model Bell 222 had been (the B222UT has landing skids instead). The oxygen bottle had a regulator to reduce the pressure from 1,875 psi to 50 psi, the working pressure for the patient oxygen system. None of the oxygen lines involved in the system were high pressure, since the pressure was reduced right at the bottle. The bottle itself was approved for use in aircraft and was designed for a pressure of 5,000 psi. The pilot had an oxygen pressure gauge at his left knee on the console to keep track of how much oxygen remained, and he also had a T-handle to turn off the oxygen flow manually at the bottle. The medical personnel in the rear also had pressure gauges available to indicate the amount of oxygen remaining and the pressure of the oxygen being delivered. The oxygen compartment was vented outside the aircraft and had an overpressure relief system that automatically emptied the oxygen to the outside of the aircraft if overpressure occurred. The system was filled from outside the aircraft using an oxygen fill system normally used for aircraft onboard oxygen systems. According to the operator, this procedure minimizes the handling of the oxygen bottle and associated hardware and the risk of damage to these pressurized components.

The systems approach to the design of this system identified many of the hazards of an onboard oxygen system and incorporated features to minimize or eliminate these hazards. The other mechanical systems involved in this EMS interior received the same attention to hazard elimination and good design. (This operator had obtained a supplemental type certificate (STC) for this interior; an STC requires the FAA to complete an engineering review.)

While there is currently no single design standard for the interior of EMS helicopters, several organizations provide guidance on what patient-care capabilities should be provided; but they offer little guidance on the technical aspects of materials, system design, and safety considerations of interior modifications.

The American Society of Testing and Materials (ASTM), however, is developing minimum standards for EMS helicopters covering equipment, personnel and training, facilities, communication, and organization and management. 70/ The subcommittee addressing EMS equipment guidelines is composed of EMS helicopter operators, aircraft modification shops, and other EMS helicopter industry representatives and has developed draft guidance on rotary wing basic and advanced life support transport units, rotary wing specialized medical transport units, and a resource and specification guide. This document will provide specific guidance on the technical design standards to be used for

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70/ Lunas, Craig J., "ASTM and EMS Standards," Hospital Aviation, January 1986.

EMS helicopter interior components and systems. (These guidelines will not specify how the installations are designed or approved, and since they will only be guidelines, they are not required by regulations.)

Modifying Interiors Under FAA Procedures

Alterations to aircraft can be accomplished and approved in a number of different ways. The FAA procedures for EMS helicopter interior modification and approval include the STC and the "major repair and alteration" process (FAA Form 337).

When an aircraft manufacturer designs an aircraft and satisfies the FAA requirements (14 CFR Part 21, Certification Procedures for Products and Parts), the manufacturer is awarded a "type certificate" that allows production of the type-certificated aircraft. Proposed alterations to the type-certificated aircraft must be reviewed to determine if the alterations compromise the safety of the original design.

An STC is required any time an aircraft is modified by a major change. For example, before a manufacturer can market wire-strike protection for a particular helicopter, it must prove to the FAA that the modification to the airframe (where the wire cutters are attached) does not compromise the structural strength of the aircraft or its flight characteristics. The FAA will determine the effectiveness of the system through tests and analysis. When the manufacturers are awarded the STC, it applies only to the aircraft type-approved by the FAA. Therefore, obtaining an STC can be an expensive, complex, and time-consuming procedure (and why many helicopters do not have wire strike protection systems--the market is not large enough to justify the expense of obtaining an FAA approval).

STCs can also be awarded on a one-time basis. Aircraft owners may want a fairly complex modification of their own aircraft, but have no desire to market this modification. For example, adding extra fuel tanks is a complex modification that can alter the flight characteristics of the aircraft and will need to be approved by the FAA if an STC does not already exist for the desired changes. In this case, applying for a one-time STC that will apply only to that one aircraft is less expensive to obtain than the full STC, but limits the modification to one specific airframe.

A less restrictive method of receiving approval to modify aircraft is under the standards applicable to "major alterations and repair" of an aircraft. Often called a "337" approval (FAA Form 337), this process is used when modifications are made that will not adversely affect the performance, structural integrity, or safety of the aircraft--for example, addition of a communications radio to an aircraft. The local FAA inspector or FAA designated inspector, who is not required to be an engineer, can approve such an installation.

Many EMS interior modifications are completed under 337 approvals. Since no engineering review need be conducted, there is no assurance that these EMS modifications meet the intent of the applicable rules and regulations. This is further complicated by the fact that many of the items being installed in the EMS helicopter are not reviewed for suitability in the aviation environment--for example, cardiac monitors/defibrillators, suction systems, I/V pumps, and neonatal isolettes. There are no technical standards for using these devices in the aviation environment. If such equipment was installed through a process that requires an engineering review, it is possible that questionable equipment and potential hazards could be identified and avoided.

The poorly designed oxygen system discussed earlier was installed on the basis of a 337 approval. This system violated the intent of 14 CFR 27.1309, Equipment, Systems, and Installations, that requires that the equipment, systems, and installations (including oxygen systems) be designed to prevent hazards to the helicopter in the event of a probable malfunction or failure. A thorough engineering review of the oxygen system described earlier would have discovered inadequacies in the design of this system.

The problems caused by the lack of specific standards for the design of the EMS interiors are further compounded by the varied interpretations of the requirements that are applied by each separate FAA region. One region may require that all EMS interiors receive STC or one-time STC approval, while another region may allow full interior modification based on 337 approval. The lack of technical design standards for EMS interiors and associated equipment and inconsistent FAA interpretation of the applicable rules have resulted in a wide variety of EMS interior designs that are based primarily on hospital requirements and are not necessarily well engineered and safe.

The Safety Board believes that the FAA should develop minimum EMS helicopter equipment and performance standards including interior, auxiliary, and oxygen system designs and that EMS helicopter interior designs should be reviewed and approved through an engineering review process before installation.

EMS HELICOPTER CRASHWORTHINESS AND ACCIDENT SURVIVAL

Aviation safety is primarily concerned with preventing accidents, and great strides have been made in achieving this goal; new aircraft are extremely reliable and sophisticated and are easier to fly, and in many cases the pilots are better trained. In spite of this progress, however, accidents continue to occur. Therefore, aviation safety also involves developing ways to enhance the possibility that the aircraft crew and passengers will survive an accident when it does occur, primarily through aircraft design to improve the aircraft's crashworthiness.

This chapter analyzes the influence of aircraft crashworthiness and protective equipment for the EMS crew on survivability and injury prevention. Aircraft design criteria, modification standards, restraint systems, and seat design are included in this analysis. Current FAA requirements, manufacturer crashworthiness options, and U.S. Army criteria are all discussed.

Accident Dynamics

As many as 84 percent of all helicopter accidents occur during the approach or departure phase when aircraft speeds are relatively slow. Helicopter crashes normally have a relatively high vertical acceleration component in comparison to the more horizontal acceleration component of fixed-wing aircraft crashes, and these crashes can crush fuel tanks beneath the aircraft floor and release the fuel in a fine mist. Rotor action will often cause the helicopter to roll over or beat itself apart structurally. Due to the misting fuel, a postcrash fire can be immediate, allowing occupants little time to escape; it has been estimated that occupants in a typical helicopter accident have as little as 17 seconds to escape if a postcrash fire occurs, 71/ and helicopters experience postcrash fires in approximately 9 percent of all accidents. 72/ Injuries commonly experienced in helicopter accidents occur primarily to the head, spine, torso, and neck (approximately 70 percent of all serious and fatal injuries), 73/ and all can be life-threatening. These injuries often prevent the occupant from escaping the aircraft if postcrash fire occurs. These types of injuries occur in all types of helicopters, including EMS helicopters.

U.S. Army Crashworthiness Standards

The U.S. Army operates one of the largest helicopter fleets in the world. Recognizing that many of their pilots were dying in otherwise survivable accidents, the Army initiated an aggressive research program in the late 1960s to improve crashworthiness. The Army's research focused on four main areas: aircraft design and energy absorption; seat and restraint system design; protective clothing and equipment; and elimination or reduction of postcrash fire. The research findings, contained in the Aircraft Crash Survival Design Guide, have been applied to the Army's helicopter fleet and have proven extremely successful.

71/ Knapp, Stanley C., "Helicopter Crashworthy Fuel Systems and Their Effectiveness in Preventing Thermal Injury," USAARL Report No. 81-4, July 1981.

72/ Special Study--"Review of Rotorcraft Accidents, 1977-1979" (NTSB-AAS-81/1).

73/ U.S. Army Aircraft Crash Survival Design Guide, TR 77-22, January 1980. Head injuries account for 31.7 percent; neck injuries account for 12.1 percent; torso injuries account for 12.5 percent; and spinal injuries account for 16.5 percent.

The Army recognized that the aircraft structure itself could absorb much of the energy involved in the crash impact. Proper design of landing gear and subfloor structure could help reduce the acceleration forces ("G" forces) experienced by the passengers in a high-impact vertical crash by absorbing the crash energy before it reaches the occupants. The Army designed its new helicopters to absorb as much of this energy as possible.

The energy absorption characteristics were also applied to seat and restraint system designs. The Army found that lap and shoulder harness combination restraint systems were much more effective in protecting the occupant than lap belts alone. Large increases in "G" tolerance are obtained by the use of combination shoulder harnesses and lap belts. Of particular interest is the fact that a lap and shoulder harness combination can result in a threefold increase in longitudinal force resistance and the sixfold increase in vertical force resistance without injury (compared to the lap belt alone). The Army combined these harness systems with seating systems designed to absorb additional vertical crash loads.

Army aviators are further protected from crash forces and postcrash fire by the clothing and equipment they wear. The Army requires that a full "Nomex" flight suit be worn, along with "Nomex" gloves, heavy boots, and flight helmet. 74/ The "Nomex" flight suit, boots, and gloves help prevent disabling thermal injuries in a postcrash fire and give the wearer additional time to escape the fire. The helmet protects the wearer's head during the impact sequence and also provides some thermal protection during the escape from the aircraft.

The last element of the Army's program to help prevent helicopter postcrash fire was to eliminate or minimize fuel spillage during an otherwise survivable accident. Modifications included replacing rigid fuel tanks with flexible fuel cells, designing the fuel lines to separate at probable high-stress areas, installing automatic "breakaway" fuel shut-off valves at these locations, and including high-strength fuel tank attach fittings. Claiming success, the Army states, "It is shown that the helicopter crashworthy fuel system essentially eliminated postcrash fatalities and injuries in accidents involving helicopters equipped with the new [crashworthy fuel] system." 75/

Incorporating these modifications did not occur without a price: the modifications to the aircraft's structure and fuel system increased the complexity of the aircraft and increased its empty weight, thereby reducing payload. These same penalties could be expected if these features were incorporated into civilian helicopters.

Many of these crashworthiness features are technically feasible in the civilian helicopter fleet. Bell Helicopter has developed a crashworthy fuel system for the Bell 222, along with passenger shoulder harnesses and energy attenuating seats. Because these options would add 83 pounds to the empty weight of this helicopter, purchasers of these helicopters have not generally been interested in availing themselves of these options. Bell has chosen, however, to incorporate fuel system crashworthiness features in all 2? 412, and 214 model helicopters.

74/ "Nomex" is a fire resistant material which dramatically increases the wearer's chance of surviving the initial phases of a postcrash fire.
75/ Knapp, op. cit.

FAA Crashworthiness Standards

The current FAA crashworthiness standards that apply to EMS helicopters do not require any of the improvements used by the U.S. Army. The rotorcraft emergency landing conditions are addressed in 14 CFR 27.561 and 29.561:

> The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a minor crash landing when proper use is made of seats, belts, and other safety design provisions; . . .[when] the occupant experiences the ultimate inertia forces relative to the surrounding structures of: upward 1.5G; forward 4.0G; sideward 2.0G; and downward 4.0G, or any lower force that will not be exceeded when the rotorcraft absorbs the landing loads resulting from impact with an ultimate descent velocity of five feet per second. 76/

The FAA also requires that items of mass that could injure an occupant be restrained to meet these "G" loading requirements.

In 14 CFR 27.785, Seats, Berths, Safety Belts and Harnesses, the FAA specifies that only the pilot and co-pilot seats need have shoulder harnesses and lap belts; all other seating locations are required only to have lap belts, unless the environment around that seat would require a shoulder harness to prevent occupants from striking their heads on an injurious object; therefore, medical personnel are not required to have shoulder harnesses available.

Safety Board Past Recommendations

The FAA's crashworthiness requirements provide protection for the occupants only in minor crash landings. On October 1, 1985, the Safety Board issued three recommendations to the FAA to improve helicopter crashworthiness:

> A-85-69
>
> Amend the helicopter certification standards contained in 14 CFR Parts 27 and 29 for seats, restraint systems, fuel systems, and structures to incorporate the crash design guidelines developed by the U.S. Army and the civilian helicopter fleet crash loads recommended in the Federal Aviation Administration study (DTFA03-81-C-00035) performed by Simula, Inc.
>
> A-86-70
>
> Amend 14 CFR Parts 27 and 29 to require that all helicopters manufactured after December 31, 1987, have shoulder harnesses installed at all seat locations.
>
> A-86-71
>
> Amend the appropriate subparts of 14 CFR Parts 27 and 29 to require multi-axis dynamic testing for seats, restraint systems, fuel systems, and energy-absorbing structures in newly type-certificated helicopters, and issue corresponding Technical Standard Orders.

76/ *The Army requires that no serious injuries occur to the crew or passengers at vertical impact velocities up to 42 feet per second.*

In June 1987, the FAA issued a notice of proposed rulemaking (NPRM), "Occupant Restraint in Normal and Transport Category Rotorcraft" (52 FR 20938, June 3, 1987). Except for fuel system crashworthiness, this proposed rule change addresses the Safety Board recommendations for improved crashworthiness. The FAA proposes to change the "G" loading requirements now specified in Parts 27.561(b) and 29.561(b) to the following:

	Current Standard	Proposed Standard
upward	1.5G	4.0G
forward	4.0G	16.0G
sideward	2.0G	8.0G
downward	4.0G	20.0G

Additionally, it proposes more stringent standards for the restraint of items of mass within the aircraft interior. Finally, the NPRM also proposes that lap belt/shoulder harness restraint systems be installed at every seat.

These improved standards, however, would be applicable only to newly designed and type-certificated helicopters. Those being built now--or in the future--on an already-approved type certificate will not be subject to any of these requirements, nor would there be any requirement to retrofit aircraft already flying. This means that it will be many years before these crashworthiness improvements appear in the helicopter fleet.

EMS Helicopter Crashworthiness

EMS helicopters are built to the emergency landing requirements of the current standards: 1.5G upward, 4.0G forward, 2.0G sideward, and 4.0G downward. They are not required to have shoulder harnesses except for the pilot and co-pilot positions.

Little information is available concerning nonpilot injuries and fatalities. It was, therefore, difficult to determine accurately the survivability of the individuals in the accidents in this study. However, some accident reports provided enough information on crash survival issues to offer some insight.

For example, in one accident, the pilot executed an auto rotation after the engine failed. The aircraft impacted in a 30 degree-banked right turn with a 5 degree-nose low attitude. The pilot received a comminuted fracture in the L-3 lumbar vertebra; the flight nurse sustained transverse fractures in the L-3, L-4, and L-5 lumbar vertebrae and a sprain of the left ankle. The paramedic sustained a fracture of the T-12 thoracic vertebra, sternal fracture, right arm and left posterior auricular lacerations. The pilot did not have a shoulder harness, nor did the two medical personnel. The rear four-person seat had been shortened to a two-person seat during the modification of the interior to an EMS configuration, and the forward support legs were not secured to the floor (the investigator could not find approval for this modification in the aircraft's records) (accident No. 24, appendix A).

The pilot and two medical personnel all received serious injuries. However, with properly worn shoulder harnesses, and the seat properly secured to the floor, injuries sustained may have been reduced in severity.

In another hard landing accident, a Bell 222 experienced a forced landing. During the impact, the helicopter struck an automobile before it crashed in the street. When the helicopter hit the automobile, a fuel drain valve on the bottom of the fuselage was broken off, and a small amount of fuel immediately caught fire.

All the occupants except one (the EMS program administrator) were restrained by lap and shoulder harnesses, which helped prevent serious crash injury; the one unrestrained occupant hit his head on the instrument panel, walls, and ceiling many times, loosening some teeth. He believes his injuries would have been much more severe if he had not been wearing a helmet (the other occupants also wore helmets). The pilot stated that the crashworthy fuel system worked very well to prevent a large amount of fuel from escaping (despite the ruptured fuel valve) (accident No. 31, appendix A).

These accidents demonstrate how designing for the survivable accident can dramatically increase the odds for survival. This helicopter was equipped with shoulder harnesses, and its crashworthy fuel system minimized the magnitude of the postcrash fire. It should also be noted that the modified interior cabin was designed to be "clean" and secure in an impact; it did not have protruding I/V hooks, oxygen bottles, exposed framing, or loosely stored or mounted equipment. 77/

Restraint Systems.--During the review of EMS programs, the Safety Board observed that the restraint systems in most EMS helicopters did not include shoulder harnesses at nonpilot positions. Several operators said that they do not provide the shoulder harness restraint systems because medical personnel would not or could not wear these restraint systems during patient care because of the need to reach the patient to provide life support. However, the Safety Board observed that many patients transported by EMS helicopters did not need uninterrupted life-sustaining treatment. In these the medical personnel could easily wear lap/shoulder belts during takeoff and landing. Inertia reel shoulder harnesses would provide the medical personnel with additional flexibility in attending the patient when seated, while still providing restraint protection when the medical attendant sits upright.

Protective Clothing and Equipment.--As discussed earlier, the U.S. Army requires Army aviators to wear protective helmets, fire-resistant flight suits (with natural fiber underwear), and high-top leather boots. This type of protective equipment has not been worn routinely by civilian EMS helicopter pilots and medical personnel.

The Army's helicopter accident experience has shown that 31.7 percent of all life-threatening injuries occur to the head and face of helicopter occupants. 78/ This accident experience has also shown that the average severity of head injuries in survivable accidents, as measured by the Abbreviated Injury Scale (AIS) 79/ for those wearing helmets was 2 to 3 (moderate to serious), although 24 percent of this group received no head injuries at all. Determining the severity of head injuries of those not wearing helmets is difficult in survivable accidents since all Army helicopter pilots and crew wear helmets. Some insight can be gained by looking at the injuries sustained by those who had their helmets come off in the accident sequence during or after initial impact. In this group, the average AIS score was 4 to 5 (severe to critical) with only 5 percent

77/ In this accident, those on board were also wearing flame-resistant cotton flightsuits and heavy ankle-high boots. One occupant suffered third-degree burns on her legs because her suit--although flame-resistant--caught fire and melted her synthetic pantyhose. This program now uses "Nomex" suits. The case illustrates why natural fiber undergarments should be worn under fire-protective clothing.

78/ U.S. Army Aircraft Crash Survival Design Guide; USARTL-TR-79-22D, June 1980.

79/ AIS is a standardized, universally accepted system for assessing impact injury severity by coding individual injuries on a scale of 1 to 6 with 1 being no injury and 6 being virtually unsurvivable. Other numbers (7-9) indicate injury unknown or extent of injury unknown.

experiencing no injuries. Of this group, 67 percent experienced injury scores of 5 to 6 (critical to virtually unsurvivable). 80/ The severity of these injuries was clearly greater than those experienced by aviators whose helmets remained on during the accident sequence.

In those accidents in which postcrash fire occurs, the fire can reach maximum intensity in 20 seconds with temperatures exceeding 2,000 degrees F. Occupants who have survived the impact must exit the helicopter before this point. Flight suits made of flame-resistant fabrics, such as "Nomex," can provide added protection against thermal injury for survivors as they exit the helicopter. Effective use of the flight suits require that natural fiber undergarments be worn because the outer flame-resistant garment can become hot enough to burn exposed skin underneath or to melt synthetic undergarments.

Protective footwear is also important to EMS medical personnel and pilots in day-to-day operations and in emergency situations. Boots provide protection at accident scenes where broken glass and sharp metal can be a problem. Boots also can support the ankle in rough terrain and provide thermal protection during a postcrash fire.

Most EMS programs require their medical personnel and pilots to wear uniforms--one-piece jumpsuits, or slacks and shirts--for easy identification of the medical personnel. However, according to ASHBEAMS' safety survey, only 11 percent of the respondents require that the uniforms be made of fire-retardant materials. In addition, only 5 percent of those responding indicated that helmets for pilots and medical personnel are required. The most common reason cited for not requiring helmets was that "it scares the patients." The Safety Board talked to medical personnel who do wear helmets, and they indicated that "scaring patients" has not proven to be a problem in their opinion. One nurse said that at first she was uncomfortable with the helmet, but now she would not fly without one. She felt that the protection provided by the helmet was more beneficial than the minor discomfort of wearing it. The use of protective footwear appears to be more widespread. Approximately 50 percent of the programs surveyed by ASHBEAMS require that special footwear be worn, 47 percent do not. The Safety Board believes that helmets, flame-resistant uniforms, and protective footwear can help reduce or prevent serious injury or death of pilots and medical personnel in survivable accidents. For commercial EMS operations, this is particularly important since 9 percent of the active fleet were involved in reported accidents in 1986.

EMS Interior Crashworthiness.--Interior design can also have an impact on crashworthiness and accident survival. Parts 27.785(a) and 29.785(a), Seats, Berths, Safety Belts, and Harnesses, require that each seat must be free of potentially injurious objects, sharp edges, and protruding and hard surfaces so that an occupant will not suffer serious injury in an emergency landing. If a shoulder harness is not provided, the area within the striking radius of the head must be free of injurious objects, and each projecting object that could injure persons seated or moving about in the helicopter during normal flight must be padded.

Based on observations made by the Safety Board, these standards are often compromised by EMS programs. The EMS helicopter interior is the work environment for health care professionals who are often involved in dramatic efforts to save lives. The helicopters are used regularly and items often break or are damaged. One program, for example, had a cardiac monitor/defibrillator unit (which weighs approximately 10 pounds)

80/ U.S. Army USAARL Report No. 85-1 SPH-4, U.S. Army Flight Helmet Performance, 1972-1983, November 1984.

"secured" on a side shelf at seated-head level and directly above the patient stretcher with a seat belt strap through its handle. It is questionable whether this arrangement meets the CFR requirement for installed equipment to withstand a 4.0G longitudinal deceleration (the handle on the unit being the weak link). This same aircraft had an extra oxygen cylinder stored next to the flight nurse's side-facing seat with a 1-inch-square valve protruding from the top of the bottle. The danger during a crash impact is easy to perceive.

Some EMS helicopter interiors observed by the Safety Board were well designed with smooth walls and ceilings and secure storage for all the equipment. These program managers expressed a sensitivity to the hazards of improperly stored or secured equipment and did not want to compromise the helicopter crashworthiness by installing or using equipment which could not be properly stored or secured.

Accident investigations indicate that EMS helicopter crashworthiness can be improved, even with current FAA standards, through the inclusion of lap/shoulder harness restraint systems for every seat and interior design features to minimize occupant injury during impact. The Safety Board believes that all EMS helicopter seating locations should be equipped with shoulder harnesses in addition to lapbelts. This modification could easily be incorporated when the helicopter's interior is modified for the EMS mission. EMS program management and EMS helicopter operator management must also be aware that improperly stored and secured equipment can severely compromise the helicopter's crashworthiness and needs to be considered when additional modifications to the helicopter's interior are made. Finally, the Safety Board believes that commercial EMS helicopter pilots and medical personnel who routinely fly EMS missions should wear protective helmets, flame-resistant uniforms, and protective footwear.

EMS HELICOPTER PROGRAM MANAGEMENT

EMS helicopter program management for most hospital-based programs is a hybrid combination of two management structures that provides few advantages and many potential problems. Most EMS helicopter programs lease a helicopter and its pilot crews from a Part 135 commercial operator. The hospital, when it awards this contract, receives a helicopter, the pilots to fly the helicopter, and, in theory, none of the associated problems of owning and running a commercial helicopter business. The hospital relies on the operator to take care of these issues. The hospital, in turn, provides the medical personnel and the facility for the helicopter and takes care of the administrative tasks associated with running an emergency medicine department with an EMS helicopter as part of that service.

Normally, the EMS helicopter contract is "up for bid" every year or every few years. During this time, a hospital may solicit bids from other helicopter operators, or if they are satisfied with the current helicopter operator, the hospital will renegotiate the contract with them. Most of the EMS contracts are awarded to helicopter operators who have EMS experience and provide helicopters and crews to many different hospitals. Approximately 128 of the 138 EMS programs in existence at the end of 1986 had helicopters and crews provided by Part 135 operators, 81/ the other 10 programs were actually owned and operated by the hospital.

The regulation regarding commercial helicopter operator management structure and responsibilities, 14 CFR 135.37(a), requires a chief pilot, director of operations, and director of maintenance. These management personnel are usually located at the company's corporate headquarters and not at the EMS program. Many operators have recognized this fact and usually designate one of the line pilots as a "lead pilot." The lead pilot position is normally not a management position, but is a line representative for the company with no management autonomy. This pilot normally assists in the administrative functions associated with the pilots at that particular program and serves as a point of contact for the pilots.

The hospital EMS program management is usually composed of a chief nurse and/or a physician who has extensive experience in trauma and critical care. The person is part of the hospital management structure and performs typical management functions such as hiring and firing staff, conducting staff performance reviews, arranging schedules, developing financial reports, etc. They are hospital employees and have no direct management or supervisory responsibilities over the pilot staff. Furthermore, their knowledge of helicopter operations varies: some are very knowledgeable about helicopter operations, usually because they are licensed pilots and understand the technical aspects of helicopter operations. One hospital system chose to hire a program administrator who was once an EMS helicopter pilot himself. However, there are also hospital program administrators who have little or no aviation knowledge and depend solely on the helicopter operators for advice on issues relating to helicopter operations and safety.

The two separate management structures occasionally have objectives that conflict and thus adversely impact safety. The helicopter operator's objectives are to provide a service to a hospital and to make a profit. Since contracts are usually renewed annually, it is important that in order to maintain the contract, the operator must keep the hospital satisfied with their service. Hospital-based EMS helicopters are acknowledged

81/ Safety Board conversation with the editor of Hospital Aviation, August 10, 1987.

not to make a profit for the hospital; the hospital uses the helicopter to provide a service to the community, enhance the hospital image, revitalize the hospital's marketing effort, and increase referrals of patients who require critical care. 82/ Pilots and management have sometimes conflicting interests that can exacerbate the conflict between the hospital and operator management objectives.

The pilot is an employee of the helicopter operator. When assigned to a hospital program, the pilot normally must move to the area where the hospital is located. Many of the pilots interviewed for this study indicated that once they got "settled in" and comfortable with the job and people with whom they were working, they were reluctant to leave. Many of the pilots have extensive flight experience and are in their late 30s or older. In the process of getting this experience, they have often been required to relocate. Most expressed concern about relocating to another program and getting to know a new group of people. NEMSPA reports in its Safety Guidelines that it takes most pilots 4 to 6 months to get comfortable with a new program. The bonds established between the pilots and the other crewmembers and EMS staff can become quite strong. All of these factors can result in pilots with a vested interest in their company not losing the next bid on the hospital contract.

Conflict in this situation can occur because pilots are required to make judgments that directly influence the safety of every EMS flight, yet, if they make a judgment that displeases the hospital program administrator (such as canceling a flight due to weather, especially a flight which a competing program subsequently completes), it could be used against their employer when the contract is renewed. This problem is further complicated by the fact that pilots usually have no on-site management from whom they can seek guidance. Pilots may even receive criticism of their judgment from the operator management when the hospital program administrator calls the EMS helicopter management and complains. If the operator management does not back up pilots' decision, pilots may feel compelled to complete a flight trip in spite of their discomfort with a proposed mission.

During this study, the Safety Board had the opportunity to observe and interact with EMS helicopter operators, hospital EMS program administrators, pilots, medical personnel, industry associations and organizations, and others interested in EMS helicopter safety. There were very few issues discussed in which the method of program management did not influence the day-to-day operations and overall program philosophy and their relationship to safety. A case in point is an EMS program in the southeastern United States that serves a rural area around a medium-sized city. The program operates an IFR helicopter and employs four pilots; the hospital obtained a Part 135 certificate on its own and bought its own helicopter. The pilots are employed by the hospital as is the program mechanic. The program administrator is a physician skilled in emergency medicine and an accomplished pilot. The chief pilot, director of maintenance, and director of operations are all located on the premises.

This program was one of the most impressive visited by the Safety Board. It was very safety-oriented, and the management was well organized, cohesive, and able to respond to difficulties or unusual circumstances quickly. These factors were the result of a single management structure colocated with the EMS program that controlled the day-to-day operations.

82/ Tye, *op. cit.*

This approach is in contrast to the opinion of a director of operations who stated, "The hospital should take care of the medical flight crew, and I'll take care of the pilots." This director of operations felt that the hospital was paying his company to provide the helicopter, pilots, and expertise to run the operation safely. He believed that the separate management structures could co-exist and that their responsibilities did not overlap or conflict. His opinion may be valid for his company, since they provide helicopters and programs to many hospitals and they have experienced no accidents. There have been, however, pilot misunderstandings of this company's policy and directives which were not discovered until pointed out by the Safety Board.

The issue of resident and nonresident managements is difficult to relate directly to safety problems experienced by the EMS helicopter industry. The purpose of EMS helicopter management must be to operate the program safely and not require pilots to make decisions that should have been made by management, such as establishing absolute weather minimums, determining that pilots actually have the final say on when not to go (if weather is above minimum), refusing a landing scene, and determining if and when a flight is safe. The chief pilot of one large operator stated, "The point is to take the pilot off the hook . . . safety begins with management. When contracts are signed, they are signed by those who want a service and those who are willing to provide that service. That is where safety must begin." 83/ Effective communication between the two management structures is required to determine program safety priorities.

One method used by some EMS helicopter programs to improve communication between the two management structures and staff is the formation of a committee that meets monthly. Normally, the lead pilot or a designated safety officer (usually a pilot) represents the operator during these meetings. The administrator of one program reviewed by the Safety Board which had a functioning safety committee stated that it helped to improve communication. She felt that the process could be improved further by the participation of an operator management representative, such as the chief of operations or chief pilot, on a quarterly or semiannual basis. There is no regulation requiring safety committees, but many EMS helicopter programs have recognized their benefit and are incorporating such committees in their programs.

The FAA has recognized that safety can be influenced by management perspectives and has initiated a program to provide guidance on issues that need to be considered by EMS management. The FAA has awarded a contract to an aeronautical training consulting firm to develop a training package for aeronautical decisionmaking for air ambulance helicopter operations. Training manuals will be developed for EMS helicopter risk management, hospital program administrators, and EMS helicopter pilots.

The risk management manual will address administrative policies regarding flight operations, helicopter operator procedures, and pilot/crew interpersonal skills. Those elements that have been identified as common EMS risk elements will be defined and discussed. This manual will be designed for EMS operator management and hospital program administrators.

The aeronautical decisionmaking manual for hospital program administrators will address hazardous administrative policies, procedures, and attitudes as will the risk elements present in EMS helicopter accidents. The responsibility of the hospital program administration and sharing of liability for decisions impacting safety will also be discussed. Additionally, incentives and impediments to safe flight operations will be evaluated. This manual will provide hospital administrators with information on EMS helicopter safety and how they can improve it.

83/ Albert, op. cit.

The pilot decisionmaking manual will be optimized for the EMS helicopter pilot. It will focus on evaluating typical accident scenarios and on defining risks relative to mission purpose and various flight segments. The goal of this manual will be to educate EMS pilots to the factors that can negatively influence their judgment and to highlight those situations where this is most likely to happen. The manual will supplement the current aeronautical decisionmaking manual for helicopter pilots.84/ The FAA expects all these documents to be available by the fall of 1988.

EMS helicopter safety is related directly to management's commitment to safety and the emphasis placed on running a safe program. If an EMS program has two separate management structures with poor communication between them, the pilots can be put in an untenable position of having to make judgments concerning EMS flights based on concerns other than flight safety (such as pressure of competition). The hospital EMS program management has a significant role in ensuring the program is run safely, since the EMS operator management is only required to meet the safety regulations specified by the FAA (minimum requirements) unless the hospital specifies otherwise. The hospital's specifications for minimum levels of "safety performance" are usually contained in the contract signed with the EMS helicopter operator.

The Safety Board believes that for EMS programs to operate safely when two separate management structures are involved, effective and regular communication on safety issues between separate managements and the employees is mandatory. One method to achieve this goal is a monthly safety meeting in which safety-related issues are discussed and resolved.

The Safety Board also believes that hospital EMS program management should become knowledgeable about safety issues in EMS helicopter operations because they often become de facto management for the pilots when the pilot management structure is located away from the hospital. Additionally, the Safety Board believes it is necessary for both management teams to develop procedures to isolate flight operation decisions from medical decisions.

84/ Aeronautical Decision Making for Helicopter Pilots, February 1987, DOT/FA/PM-86/45, available from the FAA.

CONCLUSIONS

1. The number of hospital-based commercial EMS programs has more than tripled between 1981 and 1986. Forty-three EMS helicopter programs were operating in 1981 and more than 136 programs were in operation by the end of 1986. An estimated 26 programs will start in 1987, and the total number could double within the next 5 years.

2. The accident rate for commercial EMS helicopters involved in patient transport missions is slightly less than twice the accident rate of 14 CFR Part 135 nonscheduled air taxi helicopter operators, and approximately 1 1/2 times the accident rate of all turbine helicopters from 1980 through 1985; the fatal accident rate for EMS helicopters for this period is approximately 3 1/2 times that of 14 CFR Part 135 nonscheduled helicopter air taxis and of all turbine helicopters; the injury accident rate for EMS helicopters is slightly less than that of commercial air taxis and of all turbine helicopters.

3. From 1978 through 1986, the Safety Board investigated 59 commercial EMS helicopter accidents; 19 of these were fatal accidents in which a total of 53 persons died; 19 were pilots, 28 were medical personnel, and 6 were patients.

4. Weather-related accidents are the most common and most serious type of accident experienced by EMS helicopters, and are also the most easily prevented. Twenty-five percent of the 59 accidents investigated by the Safety Board (1978-86) involved reduced visibility/spatial disorientation as a factor; 73 percent of these were fatal. Reduced-visibility accidents account for 61 percent of all fatal commercial EMS helicopter accidents. All of the reduced-visibility accidents in the Safety Board's database occurred during a patient transport mission.

5. The median flight time of pilots involved in reduced-visibility accidents was more than 5,500 hours; 13 of the 15 pilots involved in these accidents had instrument ratings, but only one was current for instrument flight in helicopters. Instrument ratings provide no assurance that a noncurrent pilot will be capable of controlling a VFR helicopter in IFR conditions.

6. All of the 15 reduced-visibility weather-related accidents occurred in uncontrolled airspace at low altitude.

7. Mechanical failure caused 15 accidents; of these 15, only 2 were fatal; and 3 produced serious injuries. The remaining 10 had no or minor injuries. Twelve accidents involved obstacle strikes; all but 1 occurred during approach or departure.

8. Helicopters currently used for EMS operations at cruise speeds preclude the pilot from executing a 180!-course reversal in a distance of less than 1/2 mile, the day VFR visibility minimum for commercial helicopter operators.

9. Many EMS operators do not provide initial or recurrent weather interpretation training for the pilots. Thirteen of the 15 pilots involved in weather-related accidents received accurate weather briefings before departing on the accident flight.

10. The FAA FSS system weather reporting and forecasting capability cannot always provide detailed weather information suitable for planning marginal weather, low altitude, VFR helicopter flights.

11. Pilot staffing is normally related to EMS program activity.

12. Pilot fatigue has been identified as a factor in only one commercial EMS helicopter accident. However, commercial EMS helicopter pilots work in a high-stress environment with rotating shifts; this predisposes them to acute and chronic fatigue.

13. Approximately 12 percent of all commercial EMS helicopter programs operate IFR-certificated helicopters with IFR-rated and current pilots. The alternate airport requirements specified by the FAA for IFR flight and the lower VFR minimums for helicopters make the use of EMS helicopters in IFR conditions difficult which encourages pilots to conduct missions VFR which they would rather complete IFR.

14. Program VFR weather minimums are sometimes misunderstood by pilots, regarded as guidelines only, or disregarded.

15. EMS helicopter flying is both a challenging and a stressful occupation. Pilots are often under self-imposed and externally-imposed pressure to complete EMS missions. These pressures can negatively influence pilot judgment.

16. Most hospitals participate in the EMS interior configuration design and specify the type of medical equipment installed. The suitability of this equipment for the aviation environment is often not considered, since no technical design standards or performance standards relative to the aviation environment exist for this equipment.

17. There are no industry-accepted design standards for EMS helicopter interiors. The FAA-approval for EMS interior modifications can be obtained through either of two procedures: a supplemental type certificate, which requires an engineering review, or a "major repair and alteration" approval (FAA Form 337) which requires a field review by an FAA inspector. Variations exist between FAA regions on the approval process used.

18. Training provided to the EMS helicopter pilot varies from operator to operator. The FAA POI approve the Part 135 operator's training program. The POI rarely requires that the operator optimize the training for the operational environment experienced by the EMS helicopter pilot.

19. The FAA does not inspect every EMS helicopter program on an annual basis.

20. An EMS operator's FAA POI may not have a thorough knowledge of EMS helicopter operations.

21. Most EMS pilots receive recurrent training once a year in preparation for the annual Part 135 check ride. Pilots who fly for an IFR EMS helicopter program usually receive recurrency training every 6 months.

22. The medical personnel who routinely fly on EMS helicopters are not considered crewmembers by the FAA, although these personnel often assume crewmember functions and responsibilities. There are no requirements that these personnel receive training in flight safety, crew coordination, or emergency procedures.

23. It was not possible to accurately determine the survivability of EMS helicopter accidents contained in the Safety Board's database. However, use of shoulder harnesses with lap belts and appropriate design of EMS interiors to minimize injury by hazardous objects in a crash landing would reduce the severity of injuries and improve survivability.

24. EMS helicopter program management is often composed of two structures: the 14 CFR Part 135 operator, which manages the pilots, and the hospital, which manages the medical personnel and day-to-day operations. The interface of these two management structures is less than ideal, since pilot management is often not on-site and the hospital program management has no control over the pilots.

25. Hospital EMS program management can have significant impact on the program's safety. Effective communication between the helicopter operator management and the hospital EMS program management is essential to safe EMS helicopter operations.

26. Competition between EMS helicopter programs can adversely impact safety of the programs' operations.

RECOMMENDATIONS

Based on the results of this study, the National Transportation Safety Board made the following recommendations:

--to the Federal Aviation Administration:

Amend the Air Carrier Operations Inspectors Handbook to provide specific guidance to principal operations inspectors on review and approval of initial and recurrent training requirements for emergency medical service helicopter pilots. This guidance should include minimum levels of instruction on poor weather operations, including pilot knowledge of weather, emergency procedures for unplanned entry to instrument meteorological conditions, and demonstrated control of the aircraft in simulated instrument meteorological conditions. This guidance should also specify the minimum training acceptable for accident scene operations, including takeoff and landing. (Class II, Priority Action) (A-88-1)

Require that the material being developed for the emergency medical service (EMS) pilot supplement to the Aeronautical Decision Making manual for helicopter pilots be incorporated into EMS pilot initial and recurrent training. (Class II, Priority Action) (A-88-2)

Amend Title 14 Code of Federal Regulations 135.205 paragraph (b), Visual Flight Rules (VFR): Visibility Requirements, to restrict emergency medical service helicopters to a day VFR visibility minimum of 1 mile. (Class II, Priority Action) (A-88-3)

Review Title 14 Code of Federal Regulations 135.223, Instrument Flight Rules (IFR): Alternate Airport Requirements, to determine the feasibility of allowing the helicopter pilot, without designating an alternate airport, to file IFR with a lower destination weather forecast than is currently specified. (Class II, Priority Action) (A-88-4)

Develop procedures for priority handling of emergency medical service pilot calls to flight service stations requesting weather briefings for patient transfer flights. (Class II, Priority Action) (A-88-5)

Amend Title 14 Code of Federal Regulations Parts 91 and 135 to require that persons who intend to operate helicopters for emergency medical service activities obtain initial approval for this purpose from the appropriate Federal Aviation Administration district office, and require persons seeking such approval to present sufficient evidence to permit the evaluation of the following:

- o that the interior modification of the helicopter is based on an engineering design which ensures that medical subsystems are designed and installed to prevent hazards to the aircraft and crew in the event of failure and that the modifications meet the intent of Title 14 Code of Federal Regulations 27.1309 and 29.1309;

- o that the proposed portable medical equipment is suitable for the helicopter environment and poses no hazard to the helicopter and crew; and

- o that the interior modification does not compromise the helicopter's crashworthiness.

(Class II, Priority Action) (A-88-6)

Develop minimum emergency medical service helicopter equipment installation and performance standards. These standards should include guidance on interior design, including but not limited to: crashworthiness, oxygen system design, patient location and restraint, and medical system design. (Class II, Priority Action) (A-88-7)

Require that shoulder harnesses be installed at all medical personnel and passenger seats on all helicopters when they are newly modified for emergency medical service (EMS) operations or when an existing EMS helicopter undergoes major interior modification or overhaul. (Class II, Priority Action) (A-88-8)

Require that those personnel classified as required crewmembers operating emergency medical service helicopters wear protective clothing and equipment to reduce the chance of injury or death in survivable accidents. This clothing and equipment should include protective helmets, flame- and heat-resistant flight suits, and protective footwear. (Class II, Priority Action) (A-88-9)

Develop and conduct a research program to measure the effect of emergency medical service (EMS) pilot workload, shift lengths, and circadian rhythm disruptions on EMS helicopter pilot performance. This research program should be conducted in cooperation with the National Aeronautics and Space Administration which has developed techniques to measure the influence of workload and fatigue on helicopter pilot performance. This research should include evaluation of one- and two-pilot crews. The results of this research should be used to evaluate the effectiveness of the current flight time/duty time regulation in providing EMS pilots adequate rest. (Class II, Priority Action) (A-88-10)

Develop guidance for emergency medical service (EMS) helicopter operators and hospitals operating EMS helicopter programs on recommended training for medical personnel who routinely fly on EMS helicopter missions. This guidance should be developed in conjunction with the American Society of Hospital-Based Emergency Aeromedical Services and the Helicopter Association International. Topics that should be addressed include:

- o Flightcrew and medical personnel coordination and communication including terminology to be used;

- o Helicopter emergency fuel and systems shutdown, landing zone safety and obstacle avoidance, air traffic recognition and avoidance, and radio communications; and

- o Emergency training on the topics listed in Title 14 Code of Federal Regulations Part 135.331, Crewmember Emergency Training.

(Class II, Priority Action) (A-88-11)

—to the American Society of Hospital-Based Emergency Aeromedical Services:

In coordination with the Helicopter Association International, provide specific guidance to each member emergency medical service (EMS) helicopter program on the need for and methods to develop a safety committee composed of representatives from the hospital EMS program administration, the commercial EMS helicopter operator, the pilot and medical personnel, helicopter dispatch (if applicable), and local public safety/emergency response agencies. The safety committee should meet monthly, with management representatives from the operator and hospital attending frequently. One objective of the safety committee should be the elimination of any negative influence caused by competition between EMS helicopter services that operate in the same area. (Class II, Priority Action) (A-88-12)

Develop guidance for hospital emergency medical service (EMS) program administrators on safety issues involved in helicopter EMS operations. Topics addressed should include pilot-in-command authority, marginal weather operations, and pilot-crewmember coordination and communication. (Class II, Priority Action) (A-88-13)

Encourage members who operate emergency medical service (EMS) programs to provide medical personnel, who routinely fly EMS helicopter missions, with protective clothing and equipment to reduce the chance of injury or death in survivable accidents. This clothing and equipment should include protective helmets, flame- and heat-resistant flight suits, and protective footwear. (Class II, Priority Action) (A-88-14)

Develop guidance for members who operate emergency medical service (EMS) programs on recommended training for medical personnel who routinely fly on EMS helicopter missions. This guidance should be developed in conjunction with the Federal Aviation Administration and the Helicopter Association International. Topics that should be addressed include:

- o Flightcrew and medical personnel coordination and communication including terminology to be used;

- o Helicopter emergency fuel and systems shutdown, landing zone safety and obstacle avoidance, air traffic recognition and avoidance, and radio communications; and

- o Emergency training on the topics listed in Title 14 Code of Federal Regulations Part 135.331, Crewmember Emergency Training.

(Class II, Priority Action) (A-88-15)

—to the Helicopter Association International:

Encourage all members who operate commercial emergency medical service (EMS) helicopters to develop visual flight rules weather minimums for each EMS helicopter program based on local terrain and weather patterns. These weather minimums should be communicated to the pilots in writing, and deviation below the program minimums should be prohibited. (Class II, Priority Action) (A-88-16)

In coordination with the American Society of Hospital-Based Emergency Aeromedical Services, encourage members that operate commercial emergency medical service (EMS) helicopters to establish safety committees at each EMS program, composed of representatives from the hospital EMS program administration, the commercial EMS helicopter operator, the pilot and medical personnel, helicopter dispatch (if applicable), and local public safety/emergency response agencies. One objective of the safety committee should be the elimination of any negative influence caused by competition between EMS helicopter services that operate in the same area. (Class II, Priority Action) (A-88-17)

Develop guidance for members who operate commercial emergency medical service (EMS) helicopters on recommended training for medical personnel who routinely fly on EMS helicopter missions. This guidance should be developed in conjunction with the Federal Aviation Administration and the American Society of Hospital-Based Emergency Aeromedical Services. Topics that should be addressed include:

o Flightcrew and medical personnel coordination and communication including terminology to be used;

o Helicopter emergency fuel and systems shutdown, landing zone safety and obstacle avoidance, air traffic recognition and avoidance, and radio communications; and

o Emergency training on the topics listed in Title 14 Code of Federal Regulations Part 135.331, Crewmember Emergency Training.

(Class II, Priority Action) (A-88-18)

—to the National Aeronautics and Space Administration:

Develop and conduct a research program in cooperation with the Federal Aviation Administration to measure the effect of emergency medical service (EMS) pilot workload, shift lengths, and circadian rhythm disruptions on EMS helicopter pilot performance. (Class II, Priority Action) (A-88-19)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ PATRICIA A. GOLDMAN
Vice Chairman

/s/ JOHN K. LAUBER
Member

/s/ JOSEPH T. NALL
Member

/s/ JAMES L. KOLSTAD
Member

January 28, 1988

APPENDIXES

APPENDIX A

COMMERCIAL EMS HELICOPTER ACCIDENT LISTING CONTAINED IN SAFETY BOARD DATA BASE

No.	Date	Location	Aircraft Registration	Aircraft Type	NTSB File #	Fatal	Injuries	Mission Type	Accident Type	Comments
1	5/11/78	Portland, OR	N5954	SA316B	3-1825	None	None	PR	Mechanical	Accident occurred during the day, engine failure at 120 ft. AGL followed by Autorotation.
2	5/30/79	Denver, CO	N48065	SA319B	3-3382	None	None	MR	Weather Related	Pilot collided with wires as he followed police patrol car down interstate. This was arranged due to lack of visibility.
3	12/ 7/79	Near Baxter, IA	N90825	SA319B	3-3624	None	None	MR	Loss of Control	Loss of control occurred at 5 ft. hover prior to departure. Cyclic control slammed back and forth, cause undetermined.
4	3/ 3/80	Webster City, IA	N353RM	AS350D	3-1184	3	None	MR	Mechanical	Accident occured at night - Engine lost power on downwind approach at 150 ft AGL
5	8/30/80	Near Red Lodge, MT	N8030	B206A/B	3-3764	3	1 Ser.	MR	Weather Related	Accident occurred at night. On lift off in blowing snow pilot experienced fogged up windshield, became disoriented.
6	10/13/80	Houston, TX	N35928	SA316B	3-2516	None	None	FF	Loss of Control	On approach at night loss of control occurred - aircraft rolled over on touchdown, cause undetermined.
7	4/11/81	Edmond, OK	N88WR	AS350D	3-0990	None	None	MR	Mechanical	At night engine lost power due to fuel control failure - autorotated to landing.
8	5/29/81	Beaumont, CA	N874	S-55	3-2413	6	None	MR	Weather Related	Accident occurred at night, pilot flew into area of fog and low ceiling, possibility of pilot impairment due to alcohol.
9	9/20/81	Iowa City, IA	N352RM	AS-350D	3-2199	None	None	MR	Improper Maintenance	Accident occurred at night. Aircraft lost power due to drive-shaft disconnect due to improper maintenance.
10	11/13/82	West Mifflin, PA	N72590	SA316B	2710	None	None	RFO	Loss of Control	Accident occurred during day - during hover power check - cyclic control lost - hard landing, cause undetermined.
11	1/ 2/82	Chamblee, GA	N5745Y	B206L-1	12	None	None	RFO	Improper Maintenance	Accident occurred at night - loss of engine control during landing - service bulletin not complied with
12	2/10/82	Urbana, IL	N2256G	UH-19S	69	None	None	MR	Hard Landing	Low time pilot (291 hours rotorcraft) misjudged altitude and distance resulting in hard landing
13	4/ 2/82	McKinney, TX	N112CF	BO-105	2451	3	None	TR	Loss of Control	Training in EMS aircraft for EMS pilots. Loss of control during climbing right turn - daylight.
14	4/27/82	New Ringgold, PA	N1022H	BO-105	3226	4	None	MR	Weather Related	Landed at scene at night - Crashed shortly after departure in fog and rain with searchlight on
15	5/ 7/82	Jacksonville, FL	N90825	SA-319B	803	None	None	RFO/PR	Loss of Control	During participation in civilian disaster response drill, loss tail rotor due to cargo strap coming out of cabin

No.	Date	Location	Aircraft Registration	Aircraft Type	NTSB File #	Fatal	Injuries	Mission Type	Accident Type	Comments
16	6/23/82	Dardanelle, CA	N6456	SA-316B	3062	3	None	MR	Obstacle Strike	On landing at scene, hit tree on approach with mainrotor at 134 ft. AGL - spotlights used to light obstacles
17	7/ 4/82	Crafton, PA	N8259	SA-316B	2055	None	None	MR	Mechanical	Engine lost power due to turbine failure, autorotated to hard landing at night
18	11/20/82	Kalispell, MT	N5011G	B206B	2686	None	None	MR	Weather Related	Aircraft se[illegible] with strong tailwind at night re[illegible]g in a hard landing - storm cell approaching.
19	12/ 4/82	Long Beach, CA	N235A	AS316B	LAX-83-F-A044	None	3 Minor	MR	Mechanical	Hard landing at night due to engine failure. Autorotation completed.
20	3/26/83	Wauseon, OH	N6226B	AS316B	93	None	None	MR	Weather Related	Pilot lost control at landing due to heavy winds - excessive sink rate not arrested, hard landing.
21	4/11/83	Salt Lake City, UT	N5759D	B206L-1	1480	1	None	MR	Weather Related	At night pilot entered fog and rain showers and lost control of aircraft. Fatigue referenced in report.
22	6/23/83	Nantucket, MA	N2908U	BO-105	623	None	1 Minor	PR	Loss of Control	After EMS demo, aircraft configuration change - resulted in cyclic stick movement interference - hard landing.
23	9/17/83	Pittsburgh, PA	N72590	SA316B	2499	None	None	MR	Loss of Control	Pilot lost control during flare to land - struck building, hard landing.
24	11/21/83	Sweet Springs, MO	N5778X	AS350D	2378	None	3 Serious	FF	Mechanical	Engine failure on approach - auto-rotation from low altitude.
25	11/27/83	Albuquerque, NM	N20702	B206L-1	2037	None	None	RFO	Obstacle Strike	Pilot stated he experienced partial power loss - decided to land on road - hit pole.
26	12/ 1/83	Ardmore, OK	N2005A	B206L-1	640	None	2 Minor	MR	Weather Related	In fog and rain at night, pilot impacted terrain - was decelerating and descending at this time - following another helicopter.
27	12/ 7/83	Black Mountain, NV	N57901	AS355F	2920	3	None	MR	Mechanical	Engine governor failure, engine over temp., inop temp. gauge, wrong engine shut down, impacted, non-survivable daylight.
28	6/ 3/84	Alcova, WY	N4997A	SA316B	1962	None	None	MR	Loss of Control	On touchdown pilot lost control of aircraft - lack of experience in type aircraft cited as factor.
29	6/12/84	Salem, VA	N222LH	B222	698	None	None	MR	Obstacle Strike	Tailrotor strike during pedal turn at hover - Movement of ground ambulance startled pilot.
30	7/14/84	Rehoboth, MA	N105CP	BO-105C	2247	2	2 Serious	MR	Fuel Starvation	At night aircraft exhausted available fuel, pilot mismanagement - hit power lines while on autorotation cited as cause.

No.	Date	Location	Aircraft Registration	Aircraft Type	NTSB File #	Fatal	Injuries	Mission Type	Accident Type	Comments
31	9/ 1/84	Knoxville, TN	N22299	B222	3049	None	4 Minor 1 Serious	RFO	Improper Maintenance	During climb attempt aircraft settled - engine torque control unit misadjusted
32	10/20/84	Pascagoula, MS	N33929	B222	2899	None	4 Minor	MR	Loss of Control	In heavy winds aircraft went to pick up patient on barge - aircraft struck by barge in heavy sea.
33	10/22/84	Orlando, FL	N29144	BO-105	5061	None	None	MR	Loss of Control	On approach to landing the pilot could not raise collective due to hand held radio blockage of collective - hard landing.
34	4/29/84	Dillon, CO	N608RM	SA316B	492	None	None	MR	Weather Related	At 12,500 ft. in mountaneous terrain pilot experienced reduced visibilities and strong downdraft - experienced hard landing.
35	1/20/85	Carson, NM	N40TE	B206L-1	1472	3	None	MR	Weather Related	Helicopter struck terrain next to power lines in reduced visibility and low ceiling conditions at night.
36	1/30/85	Galt, CA	N67081	SA316B	298	None	1 Serious	MR	Mechanical	Lost tail rotor control in cruise flight - due to materials failure.
37	2/19/85	Houma, LA	N31223	S-76A	413	None	2 Minor	RFO	Weather Related	The IFR certificated crew and helicopter impacted short of the runway in IFR conditions at night on their VFR approach.
38	5/20/85	Duluth, GA	N403DC	B206L	1050	2	1 Serious 1 Minor	MR	Obstacle Strike	Pilot struck light pole on takeoff from hospital parking lot in the day time.
39	6/13/85	Silver Springs, FL	N49550	SA316B	1494	None	None	MR	Weather Related	Pilot tried to maintain VFR in IFR conditions - got too low and struck trees - substantial damage.
40	7/ 6/85	Pittsburgh, PA	N83CJ	BO-105	2150	None	2 Minor	MR	Loss of Control	Pilot allowed RPM to decay - aircraft settled, hit fence, turned over.
41	7/15/85	Saginaw, TX	N32GT	B206L-1	2762	None	2 Serious	MR	Obstacle Strike	Struck lines after liftoff from accident scene during daylight conditions.
42	10/31/85	Mansfield, MO	N27689	B206L-1	1852	1	1 Serious 1 Minor	MR	Weather Related	Tried to maintain VFR in deteriorating weather conditions - struck power lines at night.
43	12/10/85	Adrian, MI	N5800H	SA365N	2768	2	1 Serious	MR	Weather Related	Pilot experienced deteriorating weather enroute - lost control and struck terrain at night.
44	12/20/85	Ainsworth, NE	N110LG	B206L	2571	3	None	MR	Weather Related	In freezing rain and wet snow the aircraft struck the terrain in a nose low attitude at night.
45	12/24/85	Monument Valley, UT	N10UB	B206L-3	2846	1	2 Serious	MR	Obstacle Strike	Struck wires after takeoff from hospital helipad.

No.	Date	Location	Aircraft Registration	Aircraft Type	NTSB File #	Fatal	Injuries	Mission Type	Accident Type	Comments
46	1/26/88	Santa Ana, CA	N31776	B222UT	62	None	2 Minor	MR	Obstacle Strike	On liftoff from the accident scene the pilot did not see the cable which he struck. Accident occurred at night.
47	1/ 7/86	Tulsa, OK	N67102	SA319B	98	None	None	MR	Mechanical	Hydraulic damper failed - main rotor blades struck tail boom.
48	1/27/86	Missoula, MT	N5019K	B206L-1	498	None	None	MR	Obstacle Strike	Snow ski equipped skid hung on bolt during lift off, during recovery rotor hit building.
49	4/ 5/86	Pittsburgh, PA	N2354	SA316B	NYC-86-LA-100	None	None	MR	Mechanical	Engine failure on liftoff - hard landing.
50	4/25/86	Chicago, IL	N660DD	B222B	CHI-86-FA-129	None	None	RFO?	Obstacle Strike	Tail rotor strike on helipad aircraft rolled over.
51	5/ 9/86	LaJolla, CA	N2784N	BO-105	LAX86LA-214	None	1 Serious 2 Minor	MR	Loss of Control	On takeoff pilot lost control or experienced a mechanical malfunction which resulted in a hard landing on interstate.
52	6/ 2/86	Peterson, AL	N114BH	BO-105	1611	3	None	MR	Obstacle Strike	Aircraft was observed flying low down the river and struck unmarked power lines.
53	7/10/86	Augusta, GA	N5733X	B206B	910	None	None	MR	Obstacle Strike	On takeoff from the accident scene the aircraft struck wires. The pilot made a precautionary landing.
54	7/21/86	Chaple Hill, NC	N222DU	B222UT	ALT86FA-203	None	1 Minor	MR	Mechanical	Catastrophic engine failure caused second engine to fail followed by hard landing.
55	8/10/86	Grangeville, ID	N1083Z	B206L-1	1587	None	5 Minor	MR	Obstacle Strike	During a sudden turn after takeoff tailrotor struck a tree and resulted in the aircraft striking other trees.
56	9/23/86	Galax, VA	N251CC	B222UT	ATL-86-FA-264	3	None	MR	Weather Related	Pilot struck mountain while in cruise flight in fog.
57	11/ 7/86	Billings, MT	N3889S	B2061-1	DEN-87-FA018	None	2 Serious 1 Minor	MR	Mechanical	Antitorque control was lost on takeoff - IFR conditions prevailed - a hard landing followed.
58	12/ 3/86	Pendleton, OR	N7EC	B2064-3	SEA-87-F-AO34	3	None	MR	Weather Related	Returning to airport at night the pilot entered a fogbank and declared mayday - the aircraft crashed out of control.
59	12/ 3/86	Jamestown, TN	N3398U	B206L-1	ALT-87-MA035	4	None	MR	Weather Related	After picking up patient the aircraft departed the hospital helipad and crashed in mist and fog shortly thereafter.

Mission Type
MR = Mission Related
PR = Public Relations
FF = Ferry Flight
RFO = Refueling/Other
TR = Training

APPENDIX B

TITLE 49 CODE OF FEDERAL REGULATIONS 830

TITLE 49—TRANSPORTATION
CHAPTER VIII—NATIONAL TRANSPORTATION SAFETY BOARD

REVISED: SEPTEMBER 14, 1987

NATIONAL TRANSPORTATION SAFETY BOARD

PART 830—NOTIFICATION AND REPORTING OF AIRCRAFT ACCIDENTS OR INCIDENTS AND OVERDUE AIRCRAFT, AND PRESERVATION OF AIRCRAFT WRECKAGE, MAIL, CARGO, AND RECORDS

Authority: Title VII, Federal Aviation Act of 1958, as amended, 72 Stat. 781, as amended by 76 Stat. 921 (49 U.S.C. 1441 et seq.), and the Independent Safety Board Act of 1974. Pub. L. 93—633, 88 Stat. 2166 (49 U.S.C. 1901 et seq.).

Subpart A—General

§ 830.1 Applicability.

This part contains rules pertaining to:

(a) Notification and reporting aircraft accidents and incidents and certain other occurances in the operation of aircraft when they involve civil aircraft of the United States wherever they occur, or foreign civil aircraft when such events occur within the United States, its territories or possessions.

(b) Preservation of aircraft wreckage, mail, cargo, and records involving all civil aircraft in the United States, its territories or possessions.

§ 830.2 Definitions.

As used in this part the following words or phrases are defined as follows:

"Aircraft accident" means an occurence associated with the operation of a aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or seroius injury, or in which the aircraft receives substantial damage.

"Fatal injury" means any injury which results in death within 30 days of the accident.

"Incident" means an occurence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations.

"Operator" means any person who causes or authorizes the operation of an aircraft, such as the owner, lessee, or bailee of an aircraft.

"Serious injury" means any injury which (1) requires hospitalization for more than 48 hours, commencing wihtin 7 days from the date of the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, muscle, or tenaon damage; (4) involves any internal organ; or (5) involves second or third-degree burns, or any burns affecting more than 5 percent of the body surface.

"Substantial damage" means damage or failure which adversely affects the structural strength, performance, or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected component. Engine failure or damage limited to an engine if only one engine fails or is damaged, bent fairings or cowling, dented skin, small punctured holes in the skin or fabric, ground damage to rotor or propeller blades and damage to the landing gear, wheels, tires, flaps, engine accessories, brakes, or wingtips are not considered "substanial damage" for the purpose of this part.

Subpart B—Initial Notification of Aircraft Accidents, Incidents, and Overdue Aircraft

§ 830.5 Immediate notification.

The operator of an aircraft shall immediately, and by the most expeditious means available, notify the nearest National Transportation Safety Board (Board), field office[1] when:

(a) An aircraft accident or any of the following listed incidents occur:

(1) Flight control system malfunction or failure;

(2) Inability of any required flight crewmember to perform normal flight duties as a result of injury or illness;

(3) Failure of structural components of a turbine engine excluding compressor and turbine blades and vanes;

(4) In-flight fire; or

(5) Aircraft collide in flight.

(6) Damage to property, other than the aircraft, estimated to exceed $25,000 for repair (including materials and labor) or fair market value in the event of total loss, whichever is less.

(7) For large multiengine aircraft (more than 2,500 pounds maximum certificated takeoff weight):

(i) In-flight failure of electrical systems which requires the sustained use of an emergency bus powered by a back-up source such as a battery, auxiliary power unit, or air-driven generator to retain flight control or essential instruments;

(ii) In-flight failure of hydraulic systems that results in sustained reliance on the sole remaining hydraulic or mechanical system for movement of fight control surfaces.

(iii) Sustained loss of the power or thrust produced by two or more engines; and

(iv) An evacuation of an aircraft in which an emergency egress system is utilized.

(b) An aircraft is overdue and believed to have been involved in an accident.

§ 830.6 Information to be given in notification.

The notification required in § 830.5 shall contain the following information, if available:

(a) Type, nationality, and registration marks of the aircraft;

(b) Name of owner, and operator of the aircraft;

(c) Name of pilot-in-command;

(d) Date and time of the accident;

(e) Last point of departure and point of intended landing of the aircraft;

(f) Position of the aircraft with reference to some easily defined geographical point;

(g) Number of persons aboard, number killed and number seriously injured;

(h) Nature of the accident, the weather and the extent of damage to the aircraft, so far as is known; and

(i) A description of any explosives, radioactive materials, or other dangerous articles carried.

[1] The National Transportation Safety Board field offices are listed under U S Government in the telephone directories in the following cities: Anchorage, Alaska, Atlanta, Ga; Chicago, Ill, Denver, Colo, Fort Worth, Tex, Kansas City, Mo., Los Angeles, Calif.; Miami, Fla., New York, N.Y.; Seattle, Wash.

Subpart C—Preservation of Aircraft Wreckage, Mail, Cargo, and Record

§ 830.10 Preservation of aircraft wreckage, mail, cargo, and records.

(a) The operator of an aircraft involved in an accident or incident for which notification must be given is responsible for preserving to the extent possible any aircraft wreckage, cargo, and mail aboard the aircraft, and all records, including all recording mediums of flight, maintenance, and voice recorders, pertaining to the operation and maintenance of the aircraft and to the airman until the Board takes custody thereof or a release is granted pursuant to § 831.10(b).

(b) Prior to the time the Board or its authorized representative takes custody of aircraft wreckage, mail, or cargo, such wreckage, mail, or cargo may not be disturbed or moved except to the extent necessary:

(1) To remove person injured or trapped;

(2) To protect the wreckage from further damage; or

(3) To protect the public from injury.

(c) Where it is necessary to move aircraft wreckage, mail or cargo, sketches, descriptive notes, and photographs shall be made, if possible, of the original position and condition of the wreckage and any significant impact marks.

(d) The operator of an aircraft involved in an accident or incident shall retain all records, reports, internal documents, and memoranda dealing with the accident or incident, until authorized by the Board to the contrary.

Subpart D—Reporting of Aircraft Accidents, Incidents, and Overdue Aircraft

§830.15 Reports and statements to be filed.

(a) *Reports.* The operator of an aircraft shall file a report on Board Form 6120.1 or Board Form 6120.2[2] within 10 days after an accident, or after 7 days if an overdue aircraft is still missing. A report on an incident for which notification is required by § 830.5(a) shall be filed only as requested by an authorized representative of the Board.

(b) *Crewmember statement.* Each crewmember, if physically able at the time the report is submitted, shall attach a statement setting forth the facts, conditions and circumstances relating to the accident or incident as they appear to him. If the crewmember is incapacitated, he shall submit the statement as soon as he is physically able.

(c) *Where to file the reports.* The operator of an aircraft shall file any report with the field office of the Board nearest the accident or incident.

Note.—The reporting and recordkeeping requirements contained herein have been approved by the Office of Management and Budget in accordance with the Federal Report Act of 1942

Signed at Washington D.C., on August 4, 1987
Jim Burnett,
Chairman.

[FR Doc. 87-18443 Filed 8-13-87; 8:45 am]

[2]Forms are obtainable from the Board field offices (see footnote 1), the National Transportation Safety Board, Washington, D.C. 20594, and the Federal Aviation Administration, Flight Standards District Office.

APPENDIX C

INDUSTRY-REPORTED EMS ACCIDENT MATRIX

1971 — 1979

Date	Location	Aircraft Type (f: Number)	Fatalities Injuries	NTSB File Number	Accident Cause	Reporting Source* 1	2	3	4	5	6
7/ 3/71	Rosedale, MD	Jetranger	None	Not on file	—			✓			
10/28/72	Queenstown, MD	Jetranger	2 Fatal	Not on file	—			✓			
7/ 4/75	Loma Linda, CA	S-55	3 Fatal	3-2072	Hit, ridge/wire at cruise, day, marginal weather	✓	✓	✓		✓	
? /? /77	Pensacola, FL	Alouette	None	Not on file	t/o - day, fuel, control failure	✓	✓	✓		✓	
5/11/78	Portland, OR	Alouette	None	3-1825	Power loss, t/o day	✓	✓	✓		✓	✓
5/30/79	Denver, CO	Alouette	1 Minor	3-3382	Wire strike - departure at night - marginal weather	✓	✓	✓		✓	✓
12/07/79	DesMoines, IA	Alouette	None	3-3624	Hydraulic failure, landing at night	✓	✓	✓		✓	✓

*** Reporting Source**
1 — American Society of Hospital Based Emergency Aeromedical Services (ASHBEAMS)
2 — Aviation Safety Institute
3 — Hospital Aviation Magazine
4 — FAA Accident/Incident Data System
5 — National Emergency Medical Services Pilots Association (NEMSPA)
6 — NTSB Accident Data Base

1980

Date	Location	Aircraft Type (N Number)	Fatalities Injuries	NTSB File Number	Accident Cause	Reporting Source* 1	2	3	4	5	6
3/ 3/80	DesMoines, IA	AS-350D (N353RM)	3 Fatal	3-1184	Power loss - approach - at night	✓	✓			✓	✓
8/ 8/80	Billings, MT	B-206B (N8030)	3 Fatal 1 Serious	3-3764	Hit lake on departure, day VMC - snow	✓	✓	✓		✓	✓
10/13/80	Houston, TX	Alouette	None	3-2516	Hit landing pad edge - dusk - during landing	✓	✓	✓		✓	✓

*** Reporting Source**
1 — American Society of Hospital Based Emergency Aeromedical Services (ASHBEAMS)
2 — Aviation Safety Institute
3 — Hospital Aviation Magazine
4 — FAA Accident/Incident Data System
5 — National Emergency Medical Services Pilots Association (NEMSPA)
6 — NTSB Accident Data Base

1981

Date	Location	Aircraft Type (N Number)	Fatalities Injuries	NTSB File Number	Accident Cause	Reporting Source* 1	2	3	4	5	6
? /? /81	Gainsville, FL	B206-L	None	Not on file	Hard landing - day Precautionary	✓	✓	✓		✓	
? /? /81	San Diego, CA	Aloutte	None	Not on file	Blade strike, cargo door separation, cruise, day	✓	✓	✓		✓	
? /? /81	Dallas, TX	B206-L	1 Minor	Not on file	Hit ground - landing - day	✓	✓	✓		✓	
4/11/81	Oklahoma City, OK	AS-350 (N88WR)	2 Minor	3-0990	Fuel control failure cruise - night	✓	✓	✓		✓	✓
5/30/81	Loma Linda, CA	S-55 (N874)	6 Fatal	3-2413	Hit ridge - cruise night - IMC, fog	✓	✓	✓		✓	✓
9/20/81	Iowa City, IA	AS-350 (N352RM)	None	3-2199	Engine shaft failure approach - night	✓	✓	✓		✓	✓

*** Reporting Source**
1 — American Society of Hospital Based Emergency Aeromedical Services (ASHBEAMS)
2 — Aviation Safety Institute
3 — Hospital Aviation Magazine
4 — FAA Accident/Incident Data System
5 — National Emergency Medical Services Pilots Association (NEMSPA)
6 — NTSB Accident Data Base

1982

Date	Location	Aircraft Type (N Number)	Fatalities Injuries	NTSB File Number	Accident Cause	Reporting Source* 1	2	3	4	5	6
1/ 2/82	Atlanta, GA	B-206L (N5745Y)	None	12	Fuel control failure approach - night	✓	✓	✓		✓	✓
2/10/82	Homer, IL	UH19B (N2256G)	None	69	Main rotor blade struck fuselage			✓			✓
4/ 2/82	Dallas, TX	BO-105	3 Fatal	2451	Flt. training - day	✓					✓
4/27/82	Allentown, PA	BO-105 (N1022H)	4 Fatal	3226	Lost control - departure night marginal weather	✓	✓	✓		✓	✓
5/ 7/82	Jacksonville, FL	Alouette (N90825)	None	803	FOD and tail rotor failure - cruise - day	✓	✓	✓		✓	✓
6/23/82	Modesto, CA	Alouette (N6456)	3 Fatal	3062	Hit trees on approach - at night	✓	✓	✓		✓	✓
7/ 4/82	Pittsburgh, PA	Alouette	None	2055	Engine bearing cruise - night	✓	✓	✓		✓	✓
7/ 4/82	Toledo, OH	Alouette	None	Not on file	Lost control landing day windshear	✓	✓	✓		✓	
11/20/82	Missoula, MT	B-206B	None	2686	Hit ground - night - landing - blizzard	✓	✓	✓		✓	✓
12/ 4/82	Long Beach, CA	Alouette	1 Serious	LAX83FAO44	Oil line failure cruise - night - ground fog	✓	✓	✓		✓	✓
? /? /82	Las Vegas, NV	Alouette	None	Not on file	Blade strike taxi - night	✓	✓	✓		✓	

*** Reporting Source**
1 — American Society of Hospital Based Emergency Aeromedical Services (ASHBEAMS)
2 — Aviation Safety Institute
3 — Hospital Aviation Magazine
4 — FAA Accident/Incident Data System
5 — National Emergency Medical Services Pilots Association (NEMSPA)
6 — NTSB Accident Data Base

1983

Date	Location	Aircraft Type (N Number)	Fatalities Injuries	NTSB File Number	Accident Cause	Reporting Source* 1	2	3	4	5	6
1/ 2/83	Tucson, AZ	B-206L	2 Fatal	Not in file	Hit ground cruise - night - MVMC	✓	✓	✓		✓	
3/26/83	Toledo, OH	Alouette (N62268)	None	93	Landing - dusk - wind	✓		✓			✓
4/11/83	Salt Lake, UT	B-206L (N5759D)	1 Fatal	1480	Hit mountain - cruise night - IMC - fog rain	✓	✓	✓		✓	✓
4/7 /83	Oklahoma City, OK	B-206L	1 Serious 2 Minor	Not in file	Hit ground - cruise night - fog	✓	✓	✓		✓	
6/23/83	Nantuckett, MA	BO-105 (N2908U)	1 Minor	623	Loss of control - day						✓
7/7 /83	Phoenix, AZ	A-109	None	Not in file	Blade strike - taxi night	✓	✓	✓		✓	
9/17/83	Pittsburgh, PA	Alouette	2 Minor	2499	Lost control - landing day - windshear	✓	✓	✓		✓	✓
11/21/83	Columbia, MO	AS-350	3 Serious	2378	Engine failure - approach Day	✓	✓	✓		✓	✓
11/27/83	Alburquerque, NM	N2070Z (BROGL-1)	None	2037	Power loss - emergency landing - blade strike						✓
12/ 1/83	Ardmore, OK	B206L-1 (N2005A)	2 Minor	640	Flight into terrain						✓
12/ 7/83	Las Vegas, NV	AS-355 (N57901)	3 Fatal	2920	Loose cowling - cruise day - shut down wrong engine	✓	✓	✓		✓	✓

*** Reporting Source**
1 — American Society of Hospital Based Emergency Aeromedical Services (ASHBEAMS)
2 — Aviation Safety Institute
3 — Hospital Aviation Magazine
4 — FAA Accident/Incident Data System
5 — National Emergency Medical Services Pilots Association (NEMSPA)
6 — NTSB Accident Data Base

1984

Date	Location	Aircraft Type (N Number)	Fatalities Injuries	NTSB File Number	Accident Cause	Reporting Source* 1	2	3	4	5	6
4/29/84	Denver, CO	Alouette (N608RM)	None	492	Lost control - day cruise - downdraft	✓	✓	✓		✓	✓
6/ 3/84	Casper, WY	Alouette (N4997A)	None	1962	Lost control - landing - day	✓	✓	✓	✓	✓	✓
6/12/84	Roanoke, VA	B-222 (N222LH)	None	698	Hit post - hover - day	✓	✓	✓		✓	✓
7/14/84	Worchester, MA	BO-105 (N105CP)	2 Fatal 2 Serious	2247	Fuel starvation cruise - day	✓	✓	✓	✓	✓	✓
9/ ?/84	Knoxville, TN	B-222 (22299)	1 serious 4 Minor	3049	Torque limit failure hover - day	✓	✓	✓		✓	✓
9/12/84	West VA	B-206B (N81SP)	3 Fatal	Not in file	Icing - cruise	✓	✓	✓		✓	
10/20/84	New Orleans, LA	B-222A (N38929)	4 Minor	2899	Main rotor hit tailboom landing - dusk - high wind	✓	✓	✓	✓	✓	✓
10/22/84	Orlando, FL	BO-105 (N29144)	None	5061	FOD in collective landing - day	✓	✓	✓		✓	✓
? /? /84	New Orleans, LA	A-109	None	Not in file	Blade strike - landing night	✓	✓	✓		✓	

*** Reporting Source**

1 — American Society of Hospital Based Emergency Aeromedical Services (ASHBEAMS)
2 — Aviation Safety Institute
3 — Hospital Aviation Magazine
4 — FAA Accident/Incident Data System
5 — National Emergency Medical Services Pilots Association (NEMSPA)
6 — NTSB Accident Data Base

1985

Date	Location	Aircraft Type (N-Number)	Fatalities Injuries	NTSB File Number	Accident Cause	Reporting Source* 1	2	3	4	5	6
1/20/85	Albuquerque, NM	B-206L (N401E)	3 Fatal	1472	Hit mountain - departure night - IMC - fog	✓	✓	✓	✓	✓	✓
1/30/85	Sacramento, CA	Alouette III (N67081)	1 Serious	298	Engine failure cruise - day	✓	✓	✓	✓	✓	✓
2/19/85	Houma, LA	S-76A (N31223)	2 Minor	413	Ground contact on approach fog						✓
6/13/85	Gainsville, FL	Alouette III (N49550)	None	1494	Hit trees - night thunderstorms	✓	✓	✓		✓	✓
7/ 6/85	Pittsburgh, PA	BO-105 (N83CJ)	2 Minor	2150	Power loss - takeoff night	✓	✓	✓		✓	✓
7/ 9/85	Austin, TX	B-206III		Not in file	Wire strike - takeoff day	✓	✓	✓		✓	
7/ 9/85	Brackenridge	B206L III	None	Not in file	Wire strike on liftoff		✓				
7/15/85	Dallas, TX	B-206L II (N32GT)	2 Serious 1 Minor	2762	Wire strike - take off	✓	✓	✓		✓	✓
8/27/85	Aurora, CO	B-206L III	None	Not in file	Tail rotor strike - take off - day	✓		✓		✓	
9/ 3/85	St. Paul, MN	B-222LLT (N3198L)	None	Not in file	Sudden power loss - take off - day	✓	✓	✓		✓	
9/ 4/85	Denver, CO	B-222	None	—	Engine failure - takeoff - day	✓					
9/30/85	Denver, CO	B-206L	None	Not in file	Tail rotor strike takeoff - day	✓					

1985

Date	Location	Aircraft Type (N Number)	Fatalities Injuries	NTSB File Number	Accident Cause	Reporting Source* 1	2	3	4	5	6
10/31/85	West Plains, MO	B-206L (N 27689)	1 Fatal 1 Serious	1852	Wire strike - cruise - night fog - IMC	✓	✓	✓	✓	✓	✓
11/11/85	Phoenix, AZ	TS-355	None	Not in file	Main rotor hit light take off - day	✓	✓	✓			
11/? /85	Toledo, OH	Dauphin (N5800H)	None	Not in file	Wire strike - landing	✓	✓	✓		✓	
12/10/85	Toledo, OH	Dauphin (N5800H)	2 Fatal 1 Serious	2768	Hit ground - cruise night - IMC - icing	✓	✓	✓		✓	✓
12/24/85	Grand Junction, CO	B-206L (N10UB)	1 Fatal/ 2 Serious	Not in file	Wire strike (tailrotor) take off night - IMC	✓	✓	✓	✓	✓	

*** Reporting Source**

1 — American Society of Hospital Based Emergency Aeromedical Services (ASHBEAMS)
2 — Aviation Safety Institute
3 — Hospital Aviation Magazine
4 — FAA Accident/Incident Data System
5 — National Emergency Medical Services Pilots Association (NEMSPA)
6 — NTSB Accident Data Base

1986

Date	Location	Aircraft Type (N Number)	Fatalities Injuries	NTSB File Number	Accident Cause	Reporting Source* 1	2	3	4	5	6
1/ 7/86	Tulsa, OK	SA319B (N67102)	None	98	Lateral vibration caused main rotor to hit tail		✓		✓		✓
1/19/86	Baltimore, MD	B-206	2 Fatal	Not in file	Hit trees - cruise night - rain - fog	✓	✓	✓			
1/26/86	Santa Ana, CA	B-222UT (N3177G)	1 Serious 2 Minor	62	Tail rotor wire strike take off night	✓	✓	✓	✓		✓
1/27/86	Missoula, MT	B-206L (N5019K)	—	498	Tail rotor struck building hover - day	✓	✓	✓	✓		✓
2/23/86	Mt. Baldy, ID	B206L-1 (N16800)	1 Minor		Struck trees ground IFR attitude indicator failure		✓		✓		
4/ 5/86	Pittsburgh, PA	Alouette III (N2354)	None	NYC86LA100	Engine failure take off - day	✓	✓	✓	✓		✓
4/19/86	Los Angeles, CA	A-109 (N1EQ)	None	Not in file	Main rotor struck fence, taxi day	✓	✓		✓		
4/25/86	Chicago, IL	B222B (N66ODD)	None	CHI86FA129	Tail rotor strike light takeoff		✓		✓		✓
5/ 4/86	Galveston, TX	AS355 (N500HH)	None	Not in file	Luggage door separated from aircraft in flight		✓				
5/ 9/86	San Diego, CA	BO-105 (N2784N)	1 Serious 2 Minor	LAX86LA214	Hard landing - cruise night - clear	✓	✓	✓	✓		✓
5/22/86	Norcross, GA	A535OD	None	Not in file	Engine failure		✓				
6/ 2/86	Jackson, MS	BO-105 (N114BH)	3 Fatal	1611	Wire strike - cruise - day clear	✓	✓	✓	✓		✓
6/18/86	Oklahoma City, OK	B206L-I	None	Not in file	Rocked back and forth tail hit ground	✓	✓	✓	✓		
7/ 2/86	Houston, TX	AS355F (N200HH)	None	Not in file	Test hop - r. engine cowling came off and struck three main rotor blades		✓				
7/ 5/86	Lake Charles, LA	B222U	None	Not in file	During landing at accident scene - tail rotor struck fence				✓		

1986

Date	Location	Aircraft Type (N Number)	Fatalities Injuries	NTSB File Number	Accident Cause	Reporting Source * 1	2	3	4	5	6
7/ 8/86	Houston, TX	AS355F (N200HH)	None	Not in file	Hover - blade strike - ferry flight		✓				
7/10/86	Augusta, GA	N5733X B206	None	910	Struck wire on takeoff - night	✓	✓	✓	✓		✓
7/21/86	Greenville, NC	B206L-1	None	Not in file	Hydraulic failure		✓				
7/21/86	Duke, NC	B222UT	1 Minor	ATL86FA203	Double engine failure day - clear weather	✓	✓	✓			✓
8/11/86	Great Falls, MT	B206L-III	None	Not in file	Autoacceleration of engine power landing		✓				
8/29/86	Gulfbreeze, FL	B0105 (N911BH)	None	Not in file	Engine failure on approach (twin engine)		✓				
9/23/86	Winston-Salem, NC	B222UT (N2516C)	3 Fatal	ATL86FA264	Hit ground cruise day marginal weather	✓	✓	✓	✓		✓
11/ 2/86	Ugak Island, AK	H-3F H-3F	6 Fatal	Not in file	Coast Guard helicopter on aeromedical flight - struck hill - IMC		✓				
11/ 5/86	Lewistown, PA	BO-117 (N117LF)	1 Minor	Not in file	Bird strike - cruise at 130 kts.		✓				
11/ 7/86	Billings, MT	B206L-III (N38895)	2 Serious 1 Minor	DEN87FA018	Left snow covers on cruise day marginal	✓	✓	✓			✓
11/27/86	Houston, TX	AS355F	None	Not in file	Engine failure - compressor		✓				
12/ 3/86	Pendleton, OR	B206L-III	3 Fatal		Hit ground - cruise - night - fog	✓	✓	✓			✓
12/ 3/86	Nashville, TN	B206L-1	4 Fatal		Struck cruise night marginal weather	✓		✓			✓

*** Reporting Source**
1 — American Society of Hospital Based Emergency Aeromedical Services (ASHBEAMS)
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APPENDIX D

ACCIDENT RATE DETERMINATION

The EMS helicopter industry had an accident rate of 12.34 accidents per 100,000 hours flown during the period 1980 through 1985. This rate is almost twice the accident rate of 6.69 experienced by the nonscheduled Part 135 helicopter air taxi operations during the same period and slightly more than 1 1/2 times the accident rate of 7.35 experienced by all turbine-powered helicopters during the same period.

The rate of fatal accidents for commercial EMS helicopters (where one or more of the occupants were fatally injured) was 5.4 for the period 1980 through 1985. This rate is approximately 3 1/2 times the fatal accident rate of 1.6 for nonscheduled Part 135 helicopter air taxis and 1.53 for all turbine-powered helicopters.

The rate of accidents in which injuries occurred but no fatalities occurred for commercial helicopters for the period 1980 through 1985 was 2.31; slightly less than the injury accident rate of 2.45 for nonscheduled Part 135 air taxis and the rate of 2.68 for all turbine powered helicopters for the same period.

These accident rates are based on several sources. The rates for Part 135 nonscheduled helicopters, air taxis, and for all turbine powered helicopters, were determined using information provided by the FAA on hours flown per year by specified segments of the aviation fleet. 1/ The accident data were from the Safety Board's accident data base for calender years 1980 through 1985. The EMS helicopter accident rate was determined by using exposure data (hours flown) based on information provided by industry sources. The accident data were from the Safety Board's accident data base for calendar years 1980 through 1985. 2/ The EMS helicopter accidents used in determining the accident rate involved only those aircraft which were involved in an accident while on a patient transport mission.

1/ The FAA provides the estimated activity data in the General Aviation Activity and Avionics Survey Annual Summation Report. Table 2.4: General Aviation Total Hours Flown in All Regions by Aircraft Type and Primary Use, was the source of the hour estimates for the Part 135 nonscheduled air taxis and for all turbine powered helicopters. The actual reports used were: FAA-MS-81-5; 1980, FAA-MS-81-5; 1981, FAA-MS-83-5; 1982, FAA-MS-84-5; 1983, FAA-MS-85-5; 1984, and FAA-MS-86-5; 1985. At the time of this study the 1986 summary report was not yet available from the FAA.

2/ Information on the 1986 commercial EMS helicopter accident rate is provided in figures 1 through 6. This information is not included in the accident rate comparison to the Part 135 nonscheduled air taxi helicopters and all turbine powered helicopters since information on hours flown for 1986 was not available for the comparative populations on which to base the accident rate. In 1986, commercial EMS helicopters were involved in 13 while on patient transport missions. Four of these accidents were fatal and five produced injuries. The commercial EMS helicopter fleet flew approximately 95,000 hours in 1986 resulting in a total accident rate of 13.68; a fatal accident rate of 4.21; and an injury accident rate of 5.26.

The editor of "Hospital Aviation" Magazine stated in a 1986 presentation that, based on his experience while employed by a large EMS helicopter provider, each patient transported represented 1.0 to 1.1 hours of flight time. 3/ This estimate is supported by the results of an industry survey reported in the March 1987 issue of "Hospital Aviation." A transport survey sent to 137 hospital-based EMS helicopter programs nationwide indicated that the average one-way trip length for an EMS mission was 61 miles (122 miles round trip). Most helicopters used for EMS require about 1 hour of flight time to complete this length round trip. 4/ Since, the vast majority of trips involves one patient, knowing either total patients flown or total trips provides an estimate of the total hours flown. In this study, the total EMS helicopter hours flown were based on the number of patients transported from 1980 through 1986. 5/ This information is presented in table 1.

Comparative Populations

The non-EMS Part 135 helicopter operators, operating nonscheduled air taxis, were chosen as one population for comparison with the EMS industry's accident rate, since both segments operate under the same regulations and use the same general type of aircraft. The major difference appears to be the well-defined rapid response mission of the EMS helicopter versus the varied activities of the general nonscheduled Part 135 operators. Typical activities for non-EMS air taxis include sightseeing trips, off-shore transport and support (oil fields), seismic surveys, traffic reporting, etc. Accident rate information for all turbine powered helicopters is also included since both segments often operate the same type of helicopters. The category of all turbine helicopters, however, includes the private use and corporate use of helicopters which do not have to meet the specifications contained in Part 135 since these helicopters are not being operated for commercial purposes.

Exposure was measured in hours per year since this is the standard exposure measure used in aviation accident analysis. Some helicopter industry representatives have argued that this is a misleading measure for helicopters since most helicopter flights are short, and these aircraft experience many more takeoff and landing cycles per flight hour than the fixed wing fleet. (For both fixed wing and helicopters, the greatest risk of an accident is during the takeoff and landing phase.) Industry representatives believe a better exposure measure for helicopters would be accidents per 100,000 departures, rather than per 100,000 flight hours. 6/

While this point is arguable when comparing fixed-wing accident rates to helicopter accident rates, it is not a concern relevant to this study. Hours of exposure in this case is a valid measure for comparing commercial EMS and non-EMS data because of the similarity of the equipment used. Additionally, the regulations for Part 135 non-scheduled air taxis and commercial EMS operators are the same.

3/ Collett, Presentation on EMS Helicopter Statistics, 39th Annual Meeting of the Helicopter Association International, Dallas, Texas, February 25, 1987.

4/ Although some helicopters are capable of maximum cruise speeds approaching 145 knots (167 mph), very seldom are they flown that fast. When computing average speed from takeoff to landing, acceleration and deceleration times must be considered. Normally, a correction factor of 0.85 x maximum cruise speed is used to take these factors into consideration. Average cruise speeds for EMS helicopters are 120 to 130 kts (138 to 150 mph).

5/ Collett, Howard, "Aeromedical Accident Trends," Hospital Aviation, February 1987.

6/ Fox, Roy G., "Relative Risk, The True Measure of Safety," 28th Corporate Aviation Safety Seminar, Flight Safety Foundation, April 17-19, 1983.

Table 1 provides a comparison of accident statistics for EMS helicopters, Part 135 nonscheduled helicopter air taxis, and all turbine powered helicopters for 1980 to 1985. 7/ Figures 1 through 6 display the accident rates for commercial EMS helicopters for Part 135 nonscheduled helicopter air taxis and for all turbine powered helicopters.

7/ The three accidents contained in the Safety Board data base which occurred in 1978 and 1979 were not displayed in table 1, nor used in accident rate determination for EMS because no exposure data were available for those years. These accidents occurred on May 11, 1978 in Portland, Oregon; on May 30, 1979 near Denver, Colorado; and on December 7, 1979 near Baxter, Idaho, for additional information on these accidents see appendix A.

Table 1
Accident Statistics
Commercial EMS Helicopters, Title 14 CFR Part 135 Nonscheduled
Air Taxi Helicopters, and all Turbine Powered Helicopters
1980 through 1985*

	1980	1981	1982	1983	1984	1985	Total
Total accidents (EMS)	2	3	6	5	6	10	32
Total accidents (Part 135)**	47	47	32	25	43	27	221
Total accidents (All Turbine)	126	124	129	124	140	116	759
Fatal accidents (EMS)	2	1	2	2	1	6	14
Fatal accidents (Part 135)**	17	8	9	4	7	8	53
Fatal accidents (All Turbine)	34	17	29	21	23	34	158
Injury accidents (EMS)	0	0	1	1	1	3	6
Injury accidents (Part 135)**	10	21	10	8	21	11	81
Injury accidents (All Turbine)	39	58	43	38	56	43	299
Hours flown (EMS)	20,750	28,071	36,764	45,233	56,516	71,831	259,165
Hours flown (Part 135)**	423,277	320,369	709,381	546,713	873,270	429,760	3,302,770
Hours flown (All Turbine)	1,602,852	1,754,422	1,771,174	1,699,65[illegible]	1,903,315	1,590,315	10,321,669

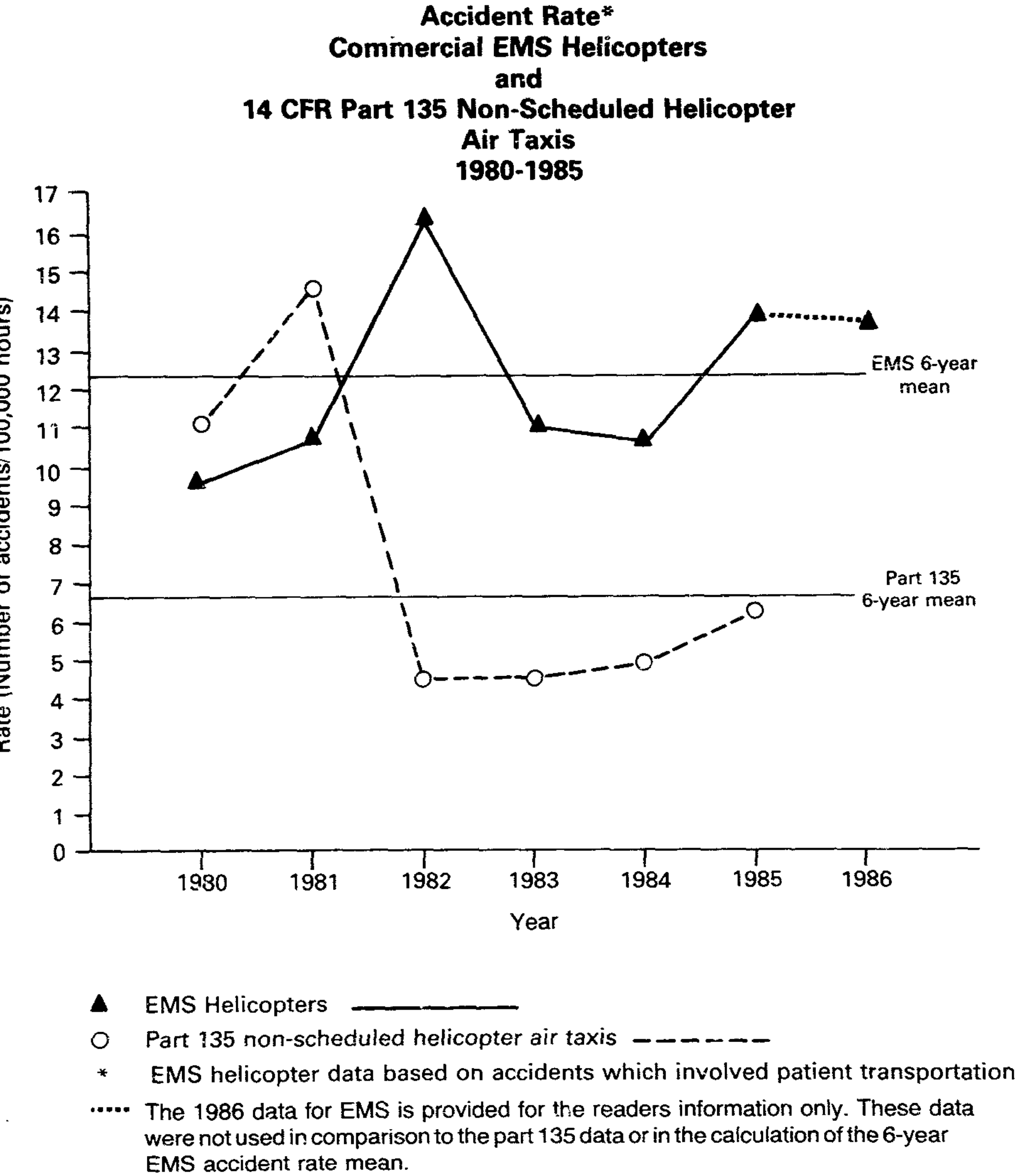
	1980	1981	1982	1983	1984	1985	6-Year Mean
Total accident rate (EMS)	9.63	10.68	16.32	11.05	10.61	13.92	12.34
Total accident rate (Part 135)**	11.10	14.67	4.51	4.57	4.92	6.28	6.69
Total accident rate (All Turbine)	7.86	7.06	7.28	7.29	7.35	7.29	7.35
Fatal accident rate (EMS)	9.63	3.56	5.44	4.42	1.76	8.35	5.40
Fatal accident rate (Part 135)**	4.01	2.49	1.26	0.73	0.80	1.86	1.60
Fatal accident rate (All Turbine)	2.12	.96	1.63	1.23	1.20	2.13	1.53
Injury accident rate (EMS)	0.00	0.00	2.72	2.21	1.76	4.17	2.31
Injury accident rate (Part 135)**	2.36	6.55	1.40	1.46	2.40	2.55	2.45
Injury accident rate (All Turbine)	2.43	3.30	2.42	2.23	2.94	2.70	2.68

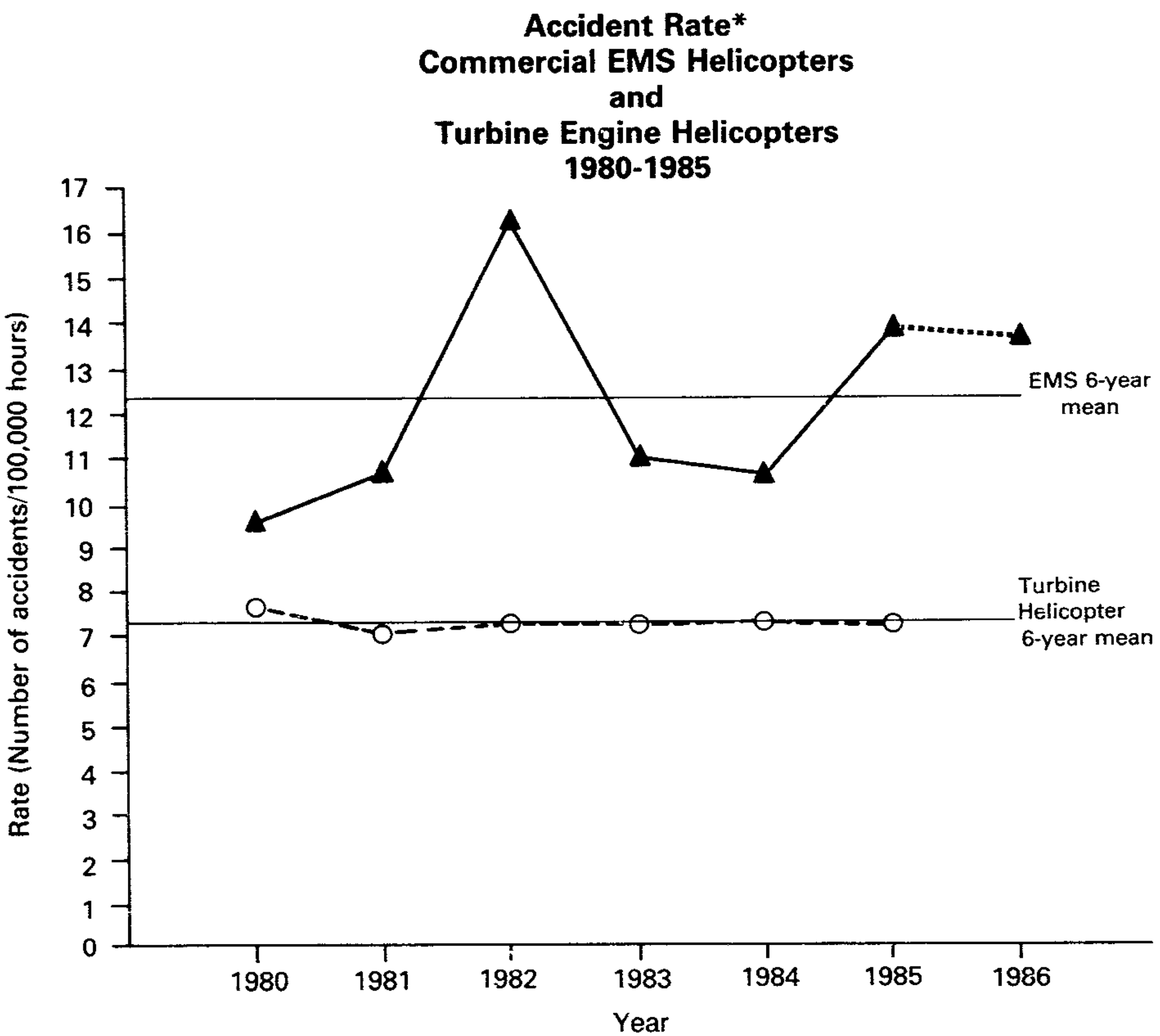
* EMS accidents and accident rate are based on only EMS helicopters involved in accidents while on a patient transport mission.

** Title 14 CFR Part 135 nonscheduled air taxi helicopters.

Information on the EMS accident date for 1986 is contained in footnote 2 in this appendix.

Source: Accident data derived from Safety Board accident database; exposure data derived from FAA General Aviation Activity and Avionics Annual Report 1980-1985 and industry estimates.


Accident Rate*
Commercial EMS Helicopters
and
14 CFR Part 135 Non-Scheduled Helicopter
Air Taxis
1980-1985
Rate (Number of accidents/100,000 hours)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
EMS 6-year mean
Part 135 6-year mean
1980
1981
1982
1983
1984
1985
1986
Year
EMS Helicopters
Part 135 non-scheduled helicopter air taxis
* EMS helicopter data based on accidents which involved patient transportation
The 1986 data for EMS is provided for the readers information only. These data were not used in comparison to the part 135 data or in the calculation of the 6-year EMS accident rate mean.



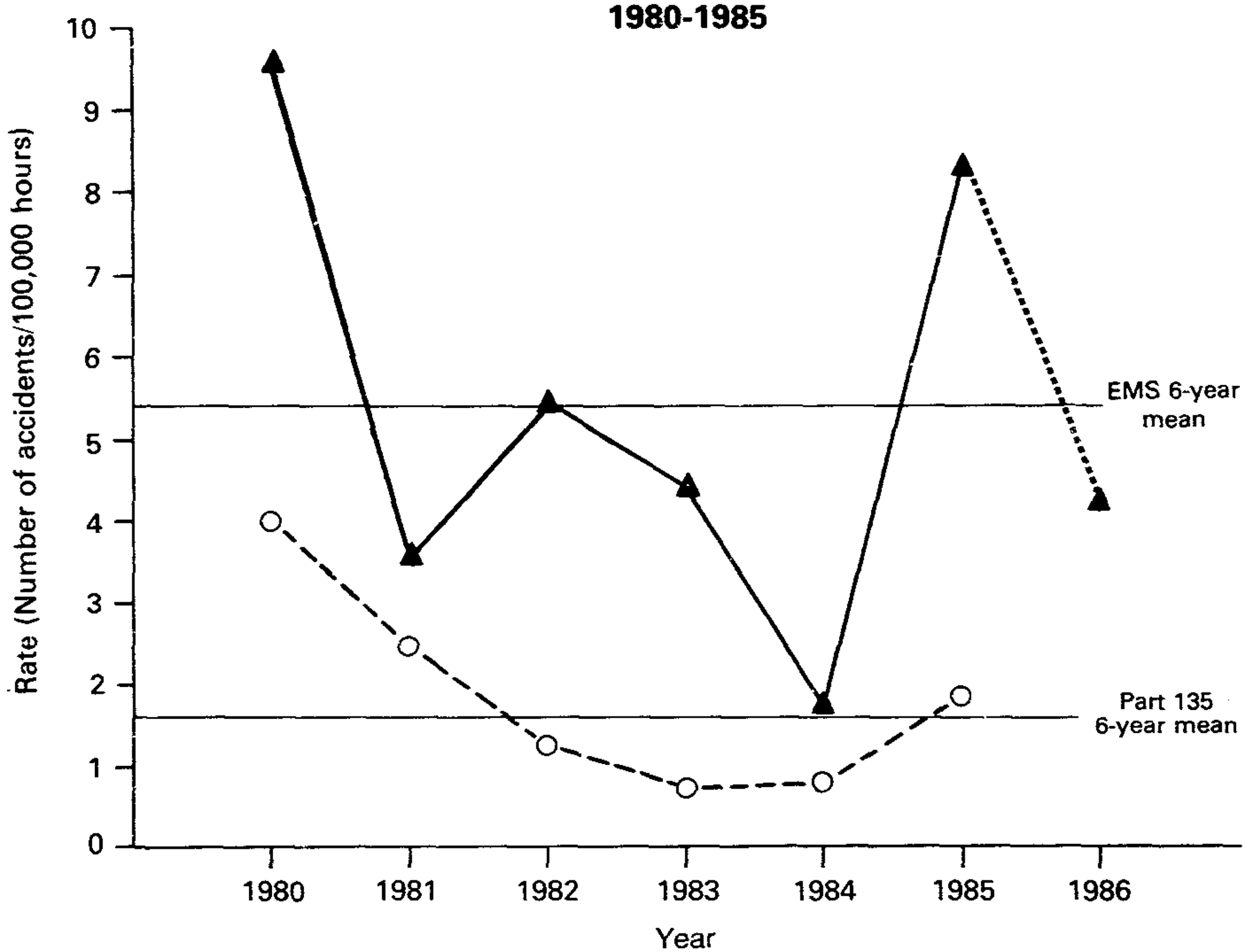
▲ EMS Helicopters ————

○ Tubine Engine Helicopters — — — —

* EMS helicopter data based on accidents which involved patient transport

.... The 1986 data for EMS is provided for the readers information only. These data were not used in comparison to the part 135 data or in the calculation of the 6-year EMS accident rate mean.

Fatal Accident Rate*
Commercial EMS Helicopters
and
14 CFR Part 135 Non-Scheduled Helicopter
Air Taxis
1980-1985

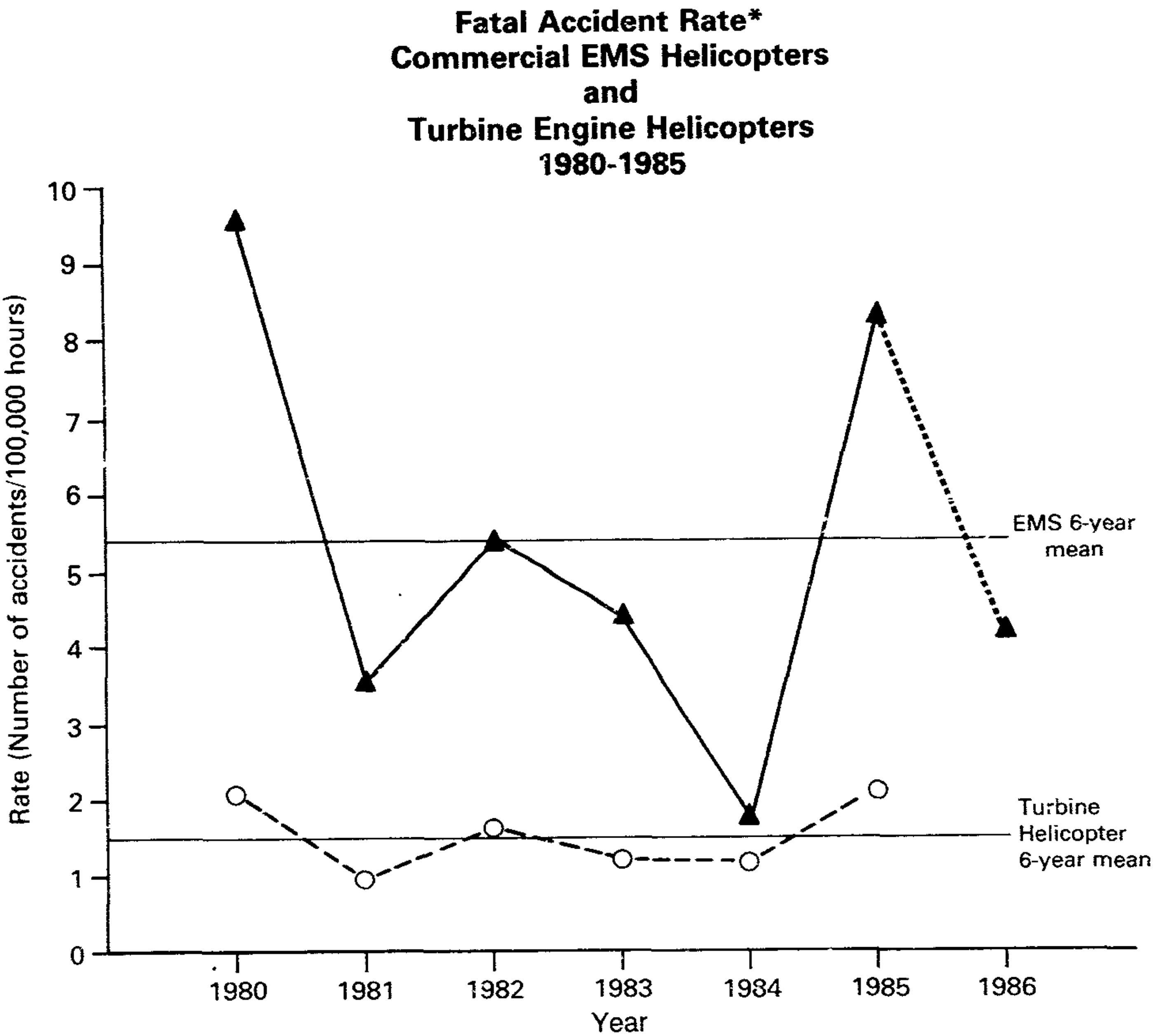


▲ EMS Helicopters ————————

○ Part 135 non-scheduled helicopter air taxis — — — — — —

* EMS helicopter data based on accidents which involved patient transport

···· The 1986 data for EMS is provided for the readers information only. These data were not used in comparison to the part 135 data or in the calculation of the 6-year EMS accident rate mean.



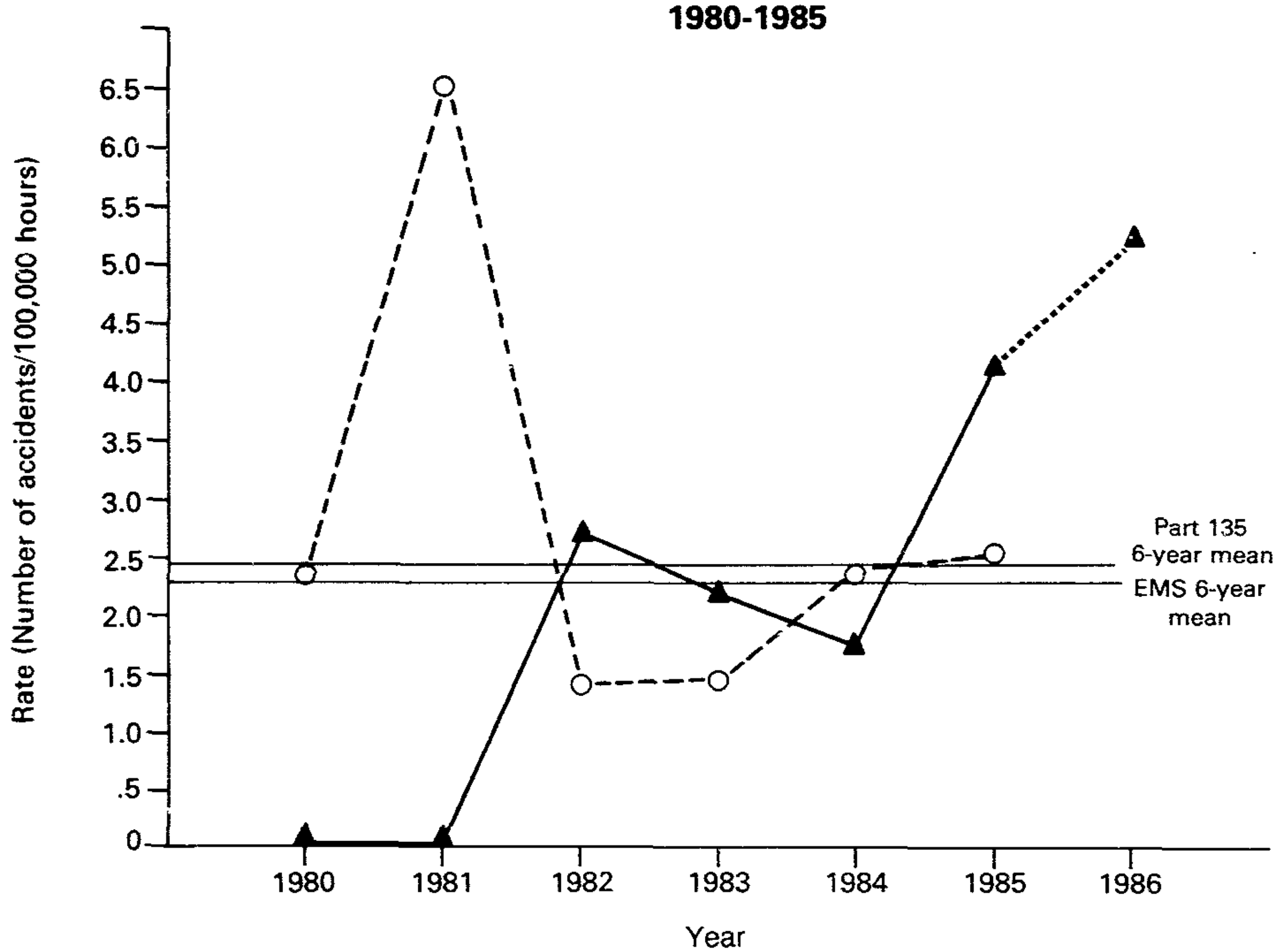
▲ EMS Helicopters ————————

○ Tubine Engine Helicopters – – – – – –

* EMS helicopter data based on accidents which involved patient transport

..... The 1986 data for EMS is provided for the readers information only. These data were not used in comparison to the part 135 data or in the calculation of the 6-year EMS accident rate mean.

Injury Accident Rate*
Commercial EMS Helicopters
and
14 CFR Part 135 Non-Scheduled Helicopter
Air Taxis
1980-1985



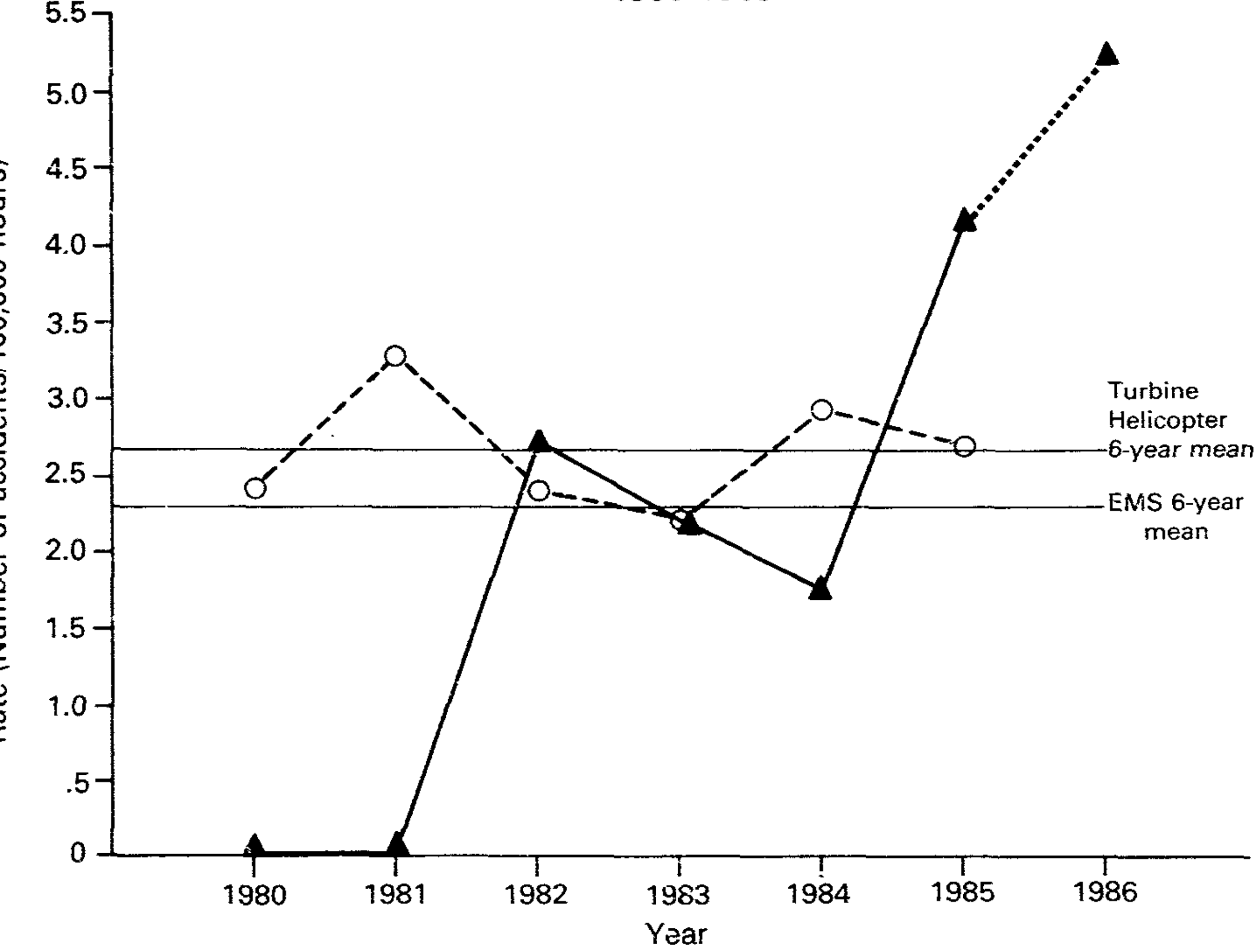
▲ EMS Helicopters ————————

○ Part 135 non-scheduled helicopter air taxis — — — — — —

* EMS helicopter data based on accidents which involved patient transport

•••••• The 1986 data for EMS is provided for the readers information only. These data were not used in comparison to the part 135 data or in the calculation of the 6-year EMS accident rate mean.

Injury Accident Rate*
Commercial EMS Helicopters
and
Turbine Engine Helicopters
1980-1985



▲ EMS Helicopters ————————

○ Turbine Engine Helicopters – – – – – – –

* EMS helicopter data based on accidents which involved patient transport

•••••• The 1986 data for EMS is provided for the readers information only. These data were not used in comparison to the part 135 data or in the calculation of the 6-year EMS accident rate mean.

APPENDIX E

OPERATIONAL FEDERAL AVIATION REGULATIONS (FARS)

The rules controlling aviation activity in the United States are contained in the Code of Federal Regulations, Title 14; Aeronautics and Space. Chapter 1 contains the rules that address civilian aviation, and these rules are administered and enforced by the Federal Aviation Administration (FAA). The rules contained in Chapter 1 are often called the Federal Aviation Regulations (FARs).

This appendix provides a listing and summary statement of the rules contained in Chapter 1 that control the operations of commercial EMS helicopters. In most instances, specific rules are listed, but in other cases, larger sections are listed and summarized. In each case, the specific part of Chapter 1 is identified, and then applicable rules from that part are listed. Not all rules are listed; copies of the Code of Federal Regulations, Title 14, Chapter I, - Federal Aviation Administration can be obtained from:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402-9325
(202) (783-3238)

Part 61 - Certification:
Pilots and Flight Instructors. This part provides the requirements for pilot training and testing to obtain pilot certification.

61.23 - Duration of Medical Certificates:
This rule specifies the duration of a pilot's medical certificate.

61.53 - Operations During Medical Deficiency:
Requires pilots not operate an aircraft if it is known pilots have a medical deficiency that will invalidate their medical certificate.

62.57 - Recent Flight Experience - Pilot in Command:
Provides the recent flight requirements for a pilot to act as pilot-in-command. Provides requirements for general experience, night experience, and instrument experience. If the currency requirements are not met, the pilot is not allowed to act as pilot-in-command until currency in that requirement area is obtained.

61.65 - Instrument Rating Requirements:
Specifies the instruction and experience required for a pilot to add an instrument rating to their pilot certificate.

Part 67 - Medical Standards and Certification:
This part prescribes the medical standards for issuing medical certificates for airmen.

Part 91 - General Operating and Flight Rules:
This part describes rules governing the operation of aircraft in the United States. These rules are applicable to all aircraft unless more restrictive rules apply (such as those for commercial air taxis or air carriers).

91.3 - Responsibility and Authority of the Pilot in Command:
The rule specifies that the pilot-in-command is directly responsible for and is final authority as to the operation of that aircraft.

91.5 - Preflight Action:
This rules requires that each pilot-in-command obtain certain information before undertaking flight. This information includes weather, fuel requirements, and takeoff and landing distances.

91.9 - Careless or Reckless Operation:
This rule specifies that no person may operate an aircraft in a careless or reckless manner.

91.11 - Alcohol or Drugs:
This rules defines that a pilot is not allowed to operate an aircraft when under the influence of alcohol or drugs. The rule also states when pilots are required to submit to tests for intoxication by appropriate authorities.

91.14 - Use of Safety Belts and Shoulder Harnesses:
This rule requires that each passenger be briefed on how to use their safety harness and that the safety harness be fastened for takeoff and landing.

91.22b - Fuel Requirements for Flight Under Visual Flight Rules (VFR):
This rule specifies that no person may begin a flight in a rotorcraft under VFR unless there is enough fuel to fly to the intended destination and then fly at normal cruising speed for another 20 minutes.

91.23 - Fuel Requirements for Flight in IFR Conditions:
This rule requires that the pilot planning to conduct a flight under IFR must plan to have enough fuel to fly to the destination airport, then fly to a preplanned alternate airport, and then fly for an additional 30 minutes (for helicopters), unless the weather is forecast to be ceiling 2,000 feet above the airport elevation and visibility 3 miles or better for 1 hour before and after the estimated time of arrival.

91.30 - Inoperable Instruments and Equipment for Multiengine Aircraft:
This regulation specifies that multiengine aircraft cannot be operated when certain equipment or instruments are inoperative, or unless a minimum equipment list is specified.

91.33 - Powered Civil Aircraft With Standard Category U.S. Airworthiness Certificates; Instrument and Equipment Requirements:
This regulation specifies the minimum equipment and instruments that a powered civil aircraft must have.

91.52 - Emergency Locator Transmitters:
This rule specifies what aircraft are required to have emergency locator transmitters installed and how often they must be serviced.

91.73 - Aircraft Lights:
This rule specifies what lights an aircraft must have to fly at night.

91.75 - Compliance with Air Traffic Control Clearances and Instructions:
This regulation requires that pilots comply with air traffic control clearances except in an emergency.

91.83 - Flight Plan; Information Required:
The regulation specifies what information will be included in both IFR and VFR flight plans. This rule also specifies the IFR alternate airport requirements.

91.90 - Terminal Control Areas (TCA):
This rule defines what TCAs are and the operating rules for aircraft which enter them.

91.105 - Basic VFR Weather Minimums:
This regulation describes the basic VFR weather minimums for all U.S. airspace users.

91/107 - Special VFR Weather Minimums:
This regulation specifies under what conditions special VFR flight can be conducted.

91.116 - Takeoff and Landing Under IFR:
This rule defines the criteria for takeoff and landing in IFR conditions.

91.119 - Minimum Altitudes for IFR Operations:
The rule specifies the minimum altitudes for en route IFR flight.

Part 135 - Air Taxi Operators and Commercial Operators:
This part prescribes rules for aircraft operators that operate aircraft for hire. The rules in this section cover flight operations, aircraft and equipment, VFR/IFR operating limitations and weather requirements, flight crewmember requirements, pilot flight time/rest requirements, training and maintenance requirements. Although Part 135 and Part 91 cover many of the same topics, those in Part 135 are normally more restrictive since Part 135 operators provide services for compensation. Part 135 covers a variety of commercial operators including nonscheduled and scheduled air taxi operators and commuter airlines.

135.21 - Manual Requirements:
This rule requires that such Part 135 certificate holder (operator) who employees more than one pilot must keep a manual outlining procedures and policies.

135.23 - Manual Contents:
This section specifies what will be contained in the manual required by Part 135.21.

135.37 - Management Personnel Required:
This rule requires that a Part 135 operator must designate a director of operations, a chief pilot, and a director of maintenance.

135.39 - Management Personnel Qualifications:
This rule specifies the minimum acceptable qualifications for the management personnel required by 135.37.

135.63 - Recordkeeping Requirements:
This rule requires that certain records be kept by the Part 135 certificate holder (operator). Included in this requirement are records on pilots experience and training, load manifests, a current list of aircraft used, and a current list of the operations specifications.

135.65 - Reporting Mechanical Irregularities:
This rule requires that a maintenance log be carried on each aircraft, and the pilot is required to note mechanical problems in the log.

135.79 - Flight Locating Requirements:
This rule requires that when flight plans are not filed, procedures must be established for locating that flight, if necessary.

135.83 - Operating Information Required:
This rule requires that the operator must provide certain information in the aircraft for the pilot. This information includes checklists, emergency procedures lists, and pertinent aeronautical charts.

135.92 - Oxygen for Medical Use by Passengers:
This rule specifies how medical oxygen is to be stored and used by passengers on board aircraft operated under Part 135.

135.97 Aircraft and Facilities for Recent Flight Experience:
This rule requires each operator to provide aircraft and facilities to enable each of its pilots to maintain their ability to conduct their pilot duties.

135.100 - Flight Crewmember Duties:
This rule requires that pilots not perform any other function during a critical phase of flight other than those duties required for the safe operation of the aircraft.

135.117 - Briefing of Passengers Before Flight:
This rule requires that passengers receive preflight briefings and identifies the specific briefing topics.

135.123 - Emergency and Emergency Evacuation Duties:
This rule specifies that each Part 135 required crewmember shall have specific responsibilities during emergency evacuation and the operator shall ensure that they are capable of accomplishing these tasks.

135.155 - Fire Extinguishers, Passenger Carrying Aircraft:
This rule requires handheld fire extinguishers in the passenger cabin.

135.203 - VFR; Minimum Altitudes:
This rule specifies minimum altitudes for aircraft operating VFR under Part 135.

135.205 - VFR; Visibility Requirements:
This rule specifies minimum visibilities for aircraft operating VFR under Part 135.

135.207 - VFR; Helicopter Surface Reference Requirements:
This rule equires that the pilot operating a helicopter VFR have visual surface reference sufficient to safely control the helicopter.

135.209 - VFR; Fuel Supply:
This rule specifies the minimum fuel allowable for VFR flight.

135.213 - Weather Reports and Forecasts:
This rule specifies when pilots operating an aircraft under Part 135 are required to obtain a weather briefing.

135.215 - IFR; Operating Limitations:
This regulation specifies in what type of airspace IFR flight is authorized.

135.219 - IFR; Destination Airport Weather Minimums:
This rule requires that the weather forecast at the destination airport be at or above the IFR approach minimums for the flights estimated time of arrival.

135.223 - IFR; Alternate Airport Requirements:
This rule specifies how much fuel needs to be carried for IFR flight and the weather conditions that require naming an alternate airport.

135.225 - IFR; Takeoff, Approach and Landing Minimums:
This rule specifies the minimums for conducting IFR takeoffs, approaches, and landings.

135.227 - Icing Conditions, Operating Limitations:
This rule prohibits flight in an aircraft with snow, ice or, frost on critical components or flight in known icing conditions unless approved for such operations.

135.243 - Pilot in Command Qualifications:
This rule specifies the minimum qualifications acceptable for a pilot to act as pilot-in-command of aircraft operated under Part 135.

135.244 - Operating Experience:
This rule specifies minimum flight time required in different types of aircraft before a pilot can act as pilot-in-command.

135.263 - Flight Time Limitations and Rest Requirements, All Certificate Holders:
This rule specifies the general rest and flight time limitations for all pilots employed by a Part 135 certificate holder.

135.267 - Flight Time Limitations and Rest Requirements , Unscheduled One- and Two-pilot Crews:
This rule specifies the maximum duty and flight time a pilot can work in different periods.

135.271 - Helicopter Hospital Emergency Medical Evacuation Service (HEMES):
This rule specifies less restrictive flight time/duty time limitations for HEMES pilots than those specified in 135.267. This rule only applies for those flights involving emergency patient transports.

135.293 - Initial and Recurrent Pilot Testing Requirements:
This rule requires that pilots employed by Part 135 certificate holders be tested on specific topics every 12 months.

135.297 - Pilot in Command, Instruument Proficiency Check Requirements:
This rule prohibits a pilot acting as pilot-in-command under IFR conditions unless in the preceding 6 months the pilot has received an instrument proficiency check.

135.299 - Pilot-in-Command, Line Checks, Routes, and Airports:
This rule requires that pilots who acts as pilot-in-command for Part 135 certificate holders receive a flight check in the aircraft type used in commercial operations in the preceding 12 months.

135.321 - Applicability and Terms Used:
This regulation defines the various terms and definitions used when discussing pilot training for pilots employed by Part 135 certificate holders.

135.323 - Training Program, General:
This rule requires that every Part 135 certificate holder develop training programs to ensure their employees are adequately trained to perform their assigned duties.

135.325 - Training Program and Revision, Initial and Final Approach:
This requirement specifies that the Part 135 certificate holders must have their training program approved by the FAA. This regulation also specifies that changes to the training program must also be approved.

135.329 - Crewmember Training Requirements:
This rule requires that the training program have certain initial and transition ground training for each required crewmember.

135.331 - Crewmember Emergency Training:
This rule specifies that the training program must provide emergency training for each aircraft type for each crewmember. Specific training topics are listed in the rule.

135.345 - Pilots, Initial, Transition, and Upgrade Ground Training:
This rule provides specific guidance on the issues to be addressed during pilot's ground (classroom) training. A list of topics is provided.

135.347 - Pilot, Initial, Transition, Upgrade, and Differences Flight Training:
This rule requires that flight training include the maneuvers and procedures in the approved training program curriculum.

APPENDIX F

ACCIDENT CATEGORIES AND SELECTED ACCIDENT BRIEFS

During the initial analysis of the 59 commercial EMS helicopter accidents contained in the Safety Board's database it became clear that human error was involved in 68 percent of the accidents. As the accidents were studied further, however, it became clear that certain other elements were common to most of the accidents: 30 percent involved some type of adverse weather (the majority were reduced visibility), 25 percent involved mechanical failure, 21 percent involved obstacle strikes, and the remaining 24 percent, involved a variety of factors; the most common being loss of control.

Although the EMs accidents fell naturally into these categories, the study focused on the human error aspects of why these accidents occurred. These accidents are discussed and analyzed in the study within the context of the human error that precipitated the accident.

This appendix provides a brief summation of the accidents contained in these four categories. It also contains representative briefs of 15 of the 59 accidents contained in the Safety Board's database.

Weather-Related Factors.--Eighteen of the 59 accidents (30 percent) involved adverse weather, including windshear, ice, snow, rain, fog, or reduced visibility (historically, weather is the most common factor involved in general aviation accidents as well). Three of the 59 accidents involved adverse winds and windshear and resulted in the pilot losing control of the helicopter and experiencing unintentional ground contact (no one was seriously injured or killed in these three accidents).

Fifteen of the weather accidents involved reduced visibility and occurred during an EMS mission; 11 of these were fatal accidents. In 3 of these 11 fatal reduced visibility accidents, some occupants survived although they received serious injuries. Thirteen of the 15 reduced-visibility accidents (81 percent) occurred during the hours of darkness; 9 of these 13 accidents (69 percent) produced fatalities. Two of the 15 (14 percent) reduced-visibility accidents occurred during the day; both resulted in fatalities.

Mechanical Failure.--Fifteen of the accidents (25 percent) were attributable primarily to mechanical failure. Of the 15 mechanical failure accidents, only 2 were fatal, while 4 resulted in serious injuries.

- o Nine (60 percent) were caused by failure of the engine or in various engine systems whose failure would cause engine stoppage; two of these accidents were fatal.

- o Incorrect maintenance was the cause of three of the 15 mechanical-related accidents (19 percent). None of these resulted in fatalities, although there was one serious injury.

- o Control malfunctions because of mechanical failure accounted for one accident. This accident did not cause any fatalities or injuries.

- o Tail rotor failure was responsible for two of the 15 mechanical failure accidents (13 percent). Three serious injuries occurred as a result of these accidents.

Obstacle Strikes.--Obstacle strikes usually involved either the main rotor or tail rotor coming into contact with obstacles (trees, wires, buildings, etc.). Most occurred during hover or low-speed flight as the helicopter arrived at or departed from a landing area. Obstacle strikes also occurred during cruise. Of the 12 accidents involving obstacle strikes:

- o 5 (41 percent) occurred at night--of these, 2 were fatal;

- o 7 (59 percent) occurred during the day--1 of these was fatal when a helicopter struck a wire while in cruise flight; 1/

- o 3 of the 12 accidents were fatal

- o 9 involved main rotor contact with the obstacle, while 3 involved the tail rotor striking the obstacle.

Miscellaneous.--The remaining 14 accidents involved a variety of factors not easily included in the other categories:

- o Two of these 14 accidents were fatal; 1 involved fuel starvation and 1 involved loss of control during pilot training.

- o Two of the accidents involved fuel starvation (one was fatal); one of these resulted from a failure to comply with a service bulletin from the manufacturer, and one was due to pilot error.

- o The remaining 10 accidents involved some element of control loss: 1 involved tail rotor damage caused by a foreign object; 2 involved the pilot controls being jammed by loose equipment in the cabin; and the remaining 7 accidents involved loss of control for undetermined reasons.

1/ One accident, No. 2 (see appendix A), involved a wire strike at night which was secondary to poor visibility as a factor.

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 12 1/02/82 CHAMBLEE,GA A/C Reg. No. N5745Y Time (Lcl) - 1837 EST

----Basic Information----

Type Operating Certificate-AIR CARRIER
ON-DEMAND AIR TAXI
Type of Operation -NON SCHED,DOMESTIC,PASSENGER
Flight Conducted Under -14 CFR 135
Accident Occurred During -LANDING

Aircraft Damage: SUBSTANTIAL
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	0	0	0	1
Pass	0	0	0	0

----Aircraft Information----

Make/Model - BELL 206L-1
Landing Gear - SKID
Max Gross Wt - 4000
No. of Seats - 5

Eng Make/Model - ALLISON 250-C28B
Number Engines - 1
Engine Type - TURBOSHAFT
Rated Power - 435 HP

ELT Installed/Activated - YES/NO
Stall Warning System - NO
Weather Radar - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - UNK/NR
Method - UNK/NR
Completeness - UNK/NR
Basic Weather - VMC
Wind Dir/Speed- 090/010 KTS
Visibility - 10.0 SM
Cloud Conditions(1st) - NONE
Cloud Conditions(2nd) - UNK/NR
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - NIGHT (DARK)

Itinerary
Last Departure Point
DECATUR,GA
Destination
CHAMBLEE,GA

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - NONE

Airport Proximity
ON AIRPORT

Airport Data
Runway Ident - 34
Runway Lth/Wid - 5001/ 100
Runway Surface - ASPHALT
Runway Status - DRY

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL
HELICOPTER

Age - 37
Biennial Flight Review
Current - YES
Months Since - 0
Aircraft Type - UNK/NR

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)
Total - 5060
Make/Model- 326
Instrument- 422
Last 24 Hrs - 4
Last 30 Days- UNK/NR
Last 90 Days- 75
Rotorcraft - 5060

Instrument Rating(s) - HELICOPTER

----Narrative----

WHILE RETURNING TO REFUEL FROM AN AIR AMBULANCE FLIGHT THE HELICOPTER YAWED LEFT AND N2 DROPPED TO ABOUT 92% APPROXIMATELY ONE MILE FROM THE AIRPORT. AT 30-50 FEET WITH AIRSPEED AT ABOUT 20 KNOTS THE AIRCRAFT YAWED VIOLENTLY TO THE LEFT WITH CORRESPONDING DROPS IN N2 TO 55-60% THEN SURGED BACK TO 102-105%. THE PILOT ENTERED AUTOROTATION AND TOUCHED DOWN HARD 300 YARDS SHORT OF HIS INTENDED LANDING POINT. DETROIT DIESEL ALLISON COMMERCIAL ENGINE BULLETIN(CEB) A-73-2020 DATED 9/7/81 & REVISED 10/5/81 ADVOCATES DISARMING THE N2(ELECTRONIC) OVERSPEED CONTROL SYSTEM BECAUSE OF REPORTED INTERMITTENT AND SPURIOUS ACTIVATION OF THAT SYSTEM. THE SYSTEM WAS ONLY PARTIALLY DEACTIVATED IN COMPLIANCE WITH BELL ALERT SERVICE BULLETIN(ASB) 206L-81-24 DATED 9/11/81 DUE TO THE OPERATOR'S MAINTENANCE PERSONNEL REPORTING THAT THEY HAD NOT RECEIVED THE REFERENCED CEB AS OF THE DATE OF THE ACCIDENT.

Brief of Accident (Continued)

File No. - 12 1/02/82 CHAMBLEE,GA A/C Reg. No. N5745Y Time (Lcl) - 1837 EST

Occurrence #1 LOSS OF POWER(PARTIAL) - MECH FAILURE/MALF
Phase of Operation APPROACH - VFR PATTERN - FINAL APPROACH

Finding(s)
1. FUEL SYSTEM,FUEL CONTROL - ERRATIC
2. *MAINTENANCE,SERVICE BULLETINS - NOT RECEIVED - COMPANY MAINTENANCE PSNL*
3. AIRCRAFT/EQUIPMENT,INADEQUATE DESIGN(STANDARD/REQUIREMENT),AIRCRAFT COMPONENT - MANUFACTURER

Occurrence #2 FORCED LANDING
Phase of Operation APPROACH - VFR PATTERN - FINAL APPROACH

Finding(s)
4. *AUTOROTATION - INITIATED - PILOT IN COMMAND*

Occurrence #3 HARD LANDING
Phase of Operation LANDING - FLARE/TOUCHDOWN

Finding(s)
5. LIGHT CONDITION - DARK NIGHT

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 2

Factor(s) relating to this accident is/are finding(s) 1,3,5

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 3226 4/27/82 NEW RINGGOLD,PA A/C Reg. No. N1022H Time (Lcl) - 2355 EDT

----Basic Information----

Type Operating Certificate-NONE (GENERAL AVIATION)
Type of Operation -OTHER
Flight Conducted Under -14 CFR 91
Accident Occurred During -CRUISE

Aircraft Damage
DESTROYED
Fire
ON GROUND

Injuries	Fatal	Serious	Minor	None
Crew	3	0	0	0
Pass	1	0	0	0

----Aircraft Information----

Make/Model - MBB BO-105C
Landing Gear - SKID
Max Gross Wt - 5291
No. of Seats - 3

Eng Make/Model - ALLISON 250-C20B
Number Engines - 2
Engine Type - TURBOSHAFT
Rated Power - 400 HP

ELT Installed/Activated - YES-UNK
Stall Warning System - NO
Weather Radar - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - FSS
Method - TELEPHONE
Completeness - FULL
Basic Weather - IMC
Wind Dir/Speed- UNK/NR
Visibility - 1.000 SM
Cloud Conditions(1st) - UNK/NR OVERCAST
Cloud Conditions(2nd) - UNK/NR
Obstructions to Vision- FOG
Precipitation - RAIN
Condition of Light - NIGHT (DARK)

Itinerary
Last Departure Point
SAME AS ACC/INC
Destination
ALLENTOWN,PA

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - NONE

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL,CFI
SE LAND
HELICOPTER

Age - 27
Biennial Flight Review
Current - YES
Months Since - 0
Aircraft Type - UNK/NR

Medical Certificate - VALID MEDICAL-WAIVERS/LIMIT

Flight Time (Hours)

Total	- 1913	Last 24 Hrs -	2
Make/Model-	75	Last 30 Days-	UNK/NR
Instrument-	UNK/NR	Last 90 Days-	33
Multi-Eng -	UNK/NR	Rotorcraft -	UNK/NR

Instrument Rating(s) - NONE

----Narrative----

THE HELICOPTER WAS LEASED BY THE ALLENTOWN SACRED HEART HOSPITAL. AT 2236 EDT, THE PILOT, WHO WAS STANDING BY FOR DUTY, OBTAINED A WEATHER BRIEFING. LATER, AT 2312, THERE WAS A REQUEST FOR A MED-EVAC HELICOPTER TO RESPOND TO A CAR ACCIDENT. THE HELICOPTER DEPARTED 10 MIN LATER AND LANDED AT THE SITE AT 2343 EDT. A SHORT TIME LATER, THE HELICOPTER LIFTED OFF WITH A PATIENT, TWO NURSES AND A PILOT ON BOARD. AT THAT TIME, THE WEATHER CONDITIONS WERE VERY RAINY WITH A MILD BREEZE. REPORTEDLY, THE HELICOPTER DEPARTED TOWARD THE SOUTHEAST WITH THE SEARCHLIGHT ON. A SHORT TIME LATER, IT IMPACTED ON RISING TERRAIN IN A STEEP NOSE DOWN ATTITUDE AND IN A RIGHT BANK. A WITNESS REPORTED SEEING THE HELICOPTER CROSS OVER TREES WITH THE SEARCHLIGHT ON, POINTING DOWN, BEFORE IMPACT. THE AIRCRAFT WAS DESTROYED BY IMPACT AND FIRE. ROTATIONAL DAMAGE WAS FOUND IN BOTH ENGINE. AN FAA FORM 337, DATED 4/27/82, REVEALED THAT A NIGHTSUN SEARCHLIGHT HAD BEEN INSTALLED AND THE WEIGHT AND BALANCE HAD BEEN ADJUSTED FOR THE INSTALLATION.

Brief of Accident (Continued)

File No. - 3226 4/27/82 NEW RINGGOLD,PA A/C Reg. No. N1022H Time (Lcl) - 2355 EDT

Occurrence #1 LOSS OF CONTROL - IN FLIGHT
Phase of Operation CRUISE

Finding(s)
1. LIGHT CONDITION - DARK NIGHT
2. WEATHER CONDITION - LOW CEILING
3. WEATHER CONDITION - RAIN
4. IN-FLIGHT PLANNING/DECISION - IMPROPER - PILOT IN COMMAND
5. IMPROPER DECISION,LACK OF TOTAL INSTRUMENT TIME - PILOT IN COMMAND
6. FLIGHT INTO KNOWN ADVERSE WEATHER - CONTINUED - PILOT IN COMMAND
7. IMPROPER USE OF EQUIPMENT/AIRCRAFT,VISUAL/AURAL DETECTION - PILOT IN COMMAND
8. AIRCRAFT HANDLING - NOT MAINTAINED - PILOT IN COMMAND
9. IMPROPER USE OF EQUIPMENT/AIRCRAFT,SPATIAL DISORIENTATION - PILOT IN COMMAND

Occurrence #2 IN FLIGHT COLLISION WITH TERRAIN
Phase of Operation DESCENT - UNCONTROLLED

Finding(s)
10. TERRAIN CONDITION - MOUNTAINOUS/HILLY
11. TERRAIN CONDITION - RISING

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 8,9

Factor(s) relating to this accident is/are finding(s) 1,2,3,4,5,6,7,10,11

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 2686   11/20/82   NEAR KALISPELL,MT   A/C Reg. No. N5011G   Time (Lcl) - 2230 MST

----Basic Information----

Type Operating Certificate-AIR CARRIER ON-DEMAND AIR TAXI
Type of Operation -NON SCHED,DOMESTIC,PASSENGER
Flight Conducted Under -14 CFR 135
Accident Occurred During -MANEUVERING

Aircraft Damage SUBSTANTIAL
Fire NONE

Injuries	Fatal	Serious	Minor	None
Crew	0	0	0	1
Pass	0	0	0	3

----Aircraft Information----

Make/Model - BELL 206B
Landing Gear - SKID
Max Gross Wt - 3200
No. of Seats - 5

Eng Make/Model - ALLISON 250-C20B
Number Engines - 1
Engine Type - TURBOSHAFT
Rated Power - 317 HP

ELT Installed/Activated - YES/NO
Stall Warning System - UNK/NR
Weather Radar - UNK/NR

----Environment/Operations Information----

Weather Data
Wx Briefing - NO RECORD OF BRIEFING
Method - N/A
Completeness - N/A
Basic Weather - VMC
Wind Dir/Speed- 270 -UNK/NR
Visibility - 5.0 SM
Cloud Conditions(1st) - 4000 FT OVERCAST
Cloud Conditions(2nd) - UNK/NR
Obstructions to Vision- BLOWING SNOW
Precipitation - SNOW
Condition of Light - NIGHT (DARK)

Itinerary
Last Departure Point
CLINTON,MT
Destination
MISSOULA,MT

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - NONE

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL,CFI
SE LAND
HELICOPTER

Age - 39
Biennial Flight Review
Current - YES
Months Since - 0
Aircraft Type - UNK/NR

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)
Total - 5080
Make/Model - 2580
Instrument - 103
Last 24 Hrs - 1
Last 30 Days - UNK/NR
Last 90 Days - 32
Rotorcraft - 3770

Instrument Rating(s) - AIRPLANE

----Narrative----

ACFT DEPARTED HOSPITAL AT MISSOULA IN GOOD WX TO ASSIST HIGHWAY ACCIDENT VICTIM 5 MI EAST OF CLINTON. VICTIM WAS PLACED ABOARD HELICOPTER ON STRETCHER FOR EMERGENCY FLIGHT TO HOSPITAL. ABOUT 5-6 MI EAST OF MISSOULA PLT NOTICED LIGHT SNOW FALLING & OBSERVED A LARGE STORM CELL BETWEEN HIS POSITION & MISSOULA, & EXECUTED AN IMMEDIATE RIGHT TURN AWAY FROM THE STORM. DURING A SECOND TURN TO ASSESS THE WX SITUATION & AS THE ACFT'S TAIL WAS TO THE CELL, THE ACFT SETTLED WITH POWER FROM ABOUT 400 FT AGL.

Brief of Accident (Continued)

File No. - 2686 11/20/82 NEAR KALISPELL,MT A/C Reg. No. N5011G Time (Lcl) - 2230 MST

Occurrence #1 IN FLIGHT ENCOUNTER WITH WEATHER
Phase of Operation MANEUVERING

Finding(s)
1. WEATHER CONDITION - SNOW
2. WEATHER CONDITION - OBSCURATION
3. WEATHER CONDITION - TAILWIND
4. WEATHER CONDITION - UNFAVORABLE WIND

Occurrence #2 LOSS OF CONTROL - IN FLIGHT
Phase of Operation MANEUVERING

Finding(s)
5. LIGHT CONDITION - DARK NIGHT
6. AIRCRAFT HANDLING - INADEQUATE - PILOT IN COMMAND

Occurrence #3 IN FLIGHT COLLISION WITH TERRAIN
Phase of Operation MANEUVERING

Occurrence #4 ROLL OVER
Phase of Operation MANEUVERING

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 3,4,6

Factor(s) relating to this accident is/are finding(s) 1,2,5

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 2499 9/17/83 PITTSBURGH,PA A/C Reg. No. N72590 Time (Lcl) - 1041 EDT

----Basic Information----

Type Operating Certificate-ON-DEMAND AIR TAXI
Name of Carrier -ROCKY MOUNTAIN HELICOPTER
Type of Operation -NON SCHED,DOMESTIC,PASSENGER
Flight Conducted Under -14 CFR 135
Accident Occurred During -LANDING

Aircraft Damage: DESTROYED
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	0	0	0	3
Pass	0	0	0	1

----Aircraft Information----

Make/Model - SUD AVIATION SA316B
Landing Gear - TRICYCLE-FIXED
Max Gross Wt - 4850
No. of Seats - 5

Eng Make/Model - TURBO MECA ARTOUSTE IIIB
Number Engines - 1
Engine Type - TURBOSHAFT
Rated Power - 562 HP

ELT Installed/Activated - YES/YES
Stall Warning System - YES

----Environment/Operations Information----

Weather Data
Wx Briefing - FSS
Method - TELEPHONE
Completeness - WEATHER NOT PERTINENT
Basic Weather - VMC
Wind Dir/Speed- 260/010 KTS
Visibility - 7.0 SM
Lowest Sky/Clouds - 1200 FT SCATTERED
Lowest Ceiling - NONE
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
MONOGAHELA,PA
Destination
PITTSBURGH,PA

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - UNK/NR

Airport Proximity
UNK/NR

Airport Data
Runway Ident - UNK/NR
Runway Lth/Wid - UNK/NR
Runway Surface - GRASS/TURF
Runway Status - DRY

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
PRIVATE,COMMERCIAL
SE LAND
HELICOPTER

Age - 31
Biennial Flight Review
Current - YES
Months Since - 1
Aircraft Type - SA316B

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)
Total - 2432
Make/Model- 30
Instrument- 98
Last 24 Hrs - 2
Last 30 Days- 30
Last 90 Days- 30
Rotorcraft - 2279

Instrument Rating(s) - HELICOPTER

----Narrative----

THE HELICOPTER WAS ON A FLT TO TRANSPORT AN ACUTELY ILL PATIENT FROM ONE HOSPITAL TO ANOTHER. THE AIRCREW CONSISTED OF A PLT & TWO FLT NURSES. DURING ARRIVAL AT THE DESTINATION, THE PLT BEGAN AN APCH TO AN ATHLETIC FIELD THAT WAS SURROUNDED BY TALL BLDGS & A POWER LINE. THE PLT SAID THE APCH WAS MADE ON A SOUTHEASTERLY HEADING WITH THE WIND FROM 230 DEG AT 7 KTS. AT ABOUT 45 FT AGL WITH AN AIRSPEED OF APRX 25 KTS, TRANSLATIONAL LIFT WAS LOST & THE HELICOPTER YAWED LEFT. THE APPLICATION OF FULL RIGHT ANTI-TORQUE PEDAL FAILED TO STOP THE YAW. THE HELICOPTER TOUCHED DOWN IN A LEFT YAW & THE PLT APPLIED COLLECTIVE. IT BECAME AIRBORNE AGAIN, STILL IN A LEFT YAW, THEN THE NOSE GEAR STRUCK THE GROUND & THE ROTOR BLADES STRUCK A BRICK WALL OF A BUILDING ON THE SOUTH SIDE OF THE FIELD. AN EXAM OF THE WRECKAGE REVEALED NO PREIMPACT DESCREPANCIES. THE FLT NURSES REPORTED THAT THE APCH SEEMED HIGHER & FASTER THAN NORMAL. APRX 7 MI NNW AT PITTSBURG, PA, THE WIND WAS FROM 260 DEG AT 10 KTS. THE PLT HAD APRX 30 HRS WITH CLOCKWISE/FRENCH ROTOR SYS.

Brief of Accident (Continued)

File No. - 2499 9/17/83 PITTSBURGH,PA A/C Reg. No. N72590 Time (Lcl) - 1041 EDT

Occurrence #1 LOSS OF CONTROL - IN FLIGHT
Phase of Operation APPROACH - VFR PATTERN - FINAL APPROACH

Finding(s)
1. TERRAIN CONDITION - HIGH OBSTRUCTION(S)
2. WEATHER CONDITION - UNFAVORABLE WIND
3. PROPER DESCENT RATE - NOT MAINTAINED - PILOT IN COMMAND
4. REMEDIAL ACTION - DELAYED - PILOT IN COMMAND
5. ROTOR RPM - NOT MAINTAINED - PILOT IN COMMAND
6. AIRCRAFT HANDLING - NOT MAINTAINED - PILOT IN COMMAND
7. IMPROPER USE OF EQUIPMENT/AIRCRAFT,LACK OF TOTAL EXPERIENCE IN TYPE OF AIRCRAFT - PILOT IN COMMAND
8. IMPROPER USE OF EQUIPMENT/AIRCRAFT,SELF-INDUCED PRESSURE - PILOT IN COMMAND

Occurrence #2 HARD LANDING
Phase of Operation LANDING

Occurrence #3 ON GROUND COLLISION WITH OBJECT
Phase of Operation LANDING

Finding(s)
9. OBJECT - BUILDING(NONRESIDENTIAL)

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 4,5,6

Factor(s) relating to this accident is/are finding(s) 1,2,3,7,8,9

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 640 12/01/83 ARDMORE,OK A/C Reg. No. N2005A Time (Lcl) - 2320 CST

----Basic Information----

Type Operating Certificate-NONE (GENERAL AVIATION)
Type of Operation -FERRY
Flight Conducted Under -14 CFR 91
Accident Occurred During -DESCENT

Aircraft Damage: SUBSTANTIAL
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	0	0	0	1
Pass	0	0	2	0

----Aircraft Information----

Make/Model - BELL 206L-1
Landing Gear - SKID
Max Gross Wt - 2000
No. of Seats - 6

Eng Make/Model - ALLISON 250-C28B
Number Engines - 1
Engine Type - TURBOSHAFT
Rated Power - 435 HP

ELT Installed/Activated - NO -N/A
Stall Warning System - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - FSS
Method - TELEPHONE
Completeness - UNK/NR
Basic Weather - IMC
Wind Dir/Speed- 150/008 KTS
Visibility - UNK/NR
Lowest Sky/Clouds - UNK/NR
Lowest Ceiling - 500 FT OVERCAST
Obstructions to Vision- FOG
Precipitation - RAIN
Condition of Light - NIGHT(DARK)

Itinerary
Last Departure Point
SAME AS ACC/INC
Destination
OKLAHOMA CITY,OK

ATC/Airspace
Type of Flight Plan - UNK/NR
Type of Clearance - UNK/NR
Type Apch/Lndg -

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL,ATP,CFI
SE LAND,ME LAND
HELICOPTER

Age - 35
Biennial Flight Review
Current - YES
Months Since - 10
Aircraft Type - UNK/NR

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)

Total -	3411	Last 24 Hrs -	UNK/NR
Make/Model-	260	Last 30 Days-	UNK/NR
Instrument-	205	Last 90 Days-	71
Multi-Eng -	57	Rotorcraft -	2590

Instrument Rating(s) - AIRPLANE,HELICOPTER

----Narrative----

THE PLT STATED THAT BEFORE HE TOOK OFF FROM OKLAHOMA CITY, OK, HE CALLED THE OKLAHOMA CITY FSS & OBTAINED A WX BRIEFING. THE BRIEFING CALLED FOR LIGHT RAIN SHOWERS, MINIMUM CEILING OF 1800 FT, VISIBILITY OF 3 TO 5 MILES & NO CHANCE OF FOG, EXCEPT IN LOW LYING AREAS. HE AND ANOTHER PLT TOOK OFF IN A FLT OF 2 HELICOPTERS TO TRANSPORT A PATIENT FROM ARDMORE, OK TO OKLAHOMA CITY. AFTER ARRIVING AT ARDMORE, THE MISSION WAS CANCELLED WHEN THE PATIENT DIED. ABOUT 1 HR & 20 MIN AFTER ARRIVING AT ARDMORE, THEY DEPARTED FOR THE RETURN FLT AFTER RECEIVING ARDMORE ATIS. THE OTHER HELICOPTER WAS EQUIPPED WITH A RADAR ALTIMETER & LED THE WAY OVER MOUNTAINOUS TERRAIN. THE PLT OF N2005A WAS FOLLOWING ABOUT 3/4 MI BEHIND WHEN THE CEILING & VISIBILITY DETERIORATED TO ABOUT 500 FT & 1 MI. THE PLT SAID THAT HE HAD CLOSED ON THE LEAD HELICOPTER & WAS DESCENDNG & DECELERATING WHEN HIS ACFT COLLIDED WITH THE GROUND. IMPACT OCCURRED ON BANKED TERRAIN BESIDE A HIGHWAY.

Brief of Accident (Continued)

File No. - 640   12/01/83   ARDMORE,OK   A/C Reg. No. N2005A   Time (Lcl) - 2320 CST

Occurrence #1   IN FLIGHT ENCOUNTER WITH WEATHER
Phase of Operation   CRUISE - NORMAL

Finding(s)
1. PLANNING-DECISION - IMPROPER - PILOT IN COMMAND
2. LIGHT CONDITION - DARK NIGHT
3. TERRAIN CONDITION - HIGH TERRAIN
4. WEATHER CONDITION - LOW CEILING
5. WEATHER CONDITION - FOG
6. WEATHER CONDITION - RAIN
7. VFR FLIGHT INTO IMC - CONTINUED - PILOT IN COMMAND

Occurrence #2   IN FLIGHT COLLISION WITH TERRAIN
Phase of Operation   DESCENT

Finding(s)
8. TERRAIN CONDITION - MOUNTAINOUS/HILLY
9. PROPER ALTITUDE - NOT MAINTAINED - PILOT IN COMMAND

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 7,9

Factor(s) relating to this accident is/are finding(s) 1,2,3,4,5,6,8

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 2920 12/07/83 BLACK MOUNTAIN,NV A/C Reg. No. N57901 Time (Lcl) - 1229 PST

----Basic Information----

Type Operating Certificate-ON-DEMAND AIR TAXI
Name of Carrier -CRAIG HUNTINGTON
Type of Operation -NON SCHED,DOMESTIC,PASSENGER
Flight Conducted Under -14 CFR 135
Accident Occurred During -LANDING

Aircraft Damage: DESTROYED
Fire: IN FLIGHT

Injuries	Fatal	Serious	Minor	None
Crew	3	0	0	0
Pass	0	0	0	0

----Aircraft Information----

Make/Model - AEROSPATIALE AS 355F
Landing Gear - SKID
Max Gross Wt - 5070
No. of Seats - 3

Eng Make/Model - ALLISON 250-C20F
Number Engines - 2
Engine Type - TURBOSHAFT
Rated Power - 420 HP

ELT Installed/Activated - YES/NO
Stall Warning System - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - NO RECORD OF BRIEFING
Method - N/A
Completeness - N/A
Basic Weather - VMC
Wind Dir/Speed- CALM
Visibility - 75.0 SM
Lowest Sky/Clouds - 25000 FT
Lowest Ceiling - 25000 FT OVERCAST
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
LAS VEGAS,NV
Destination
NEEDLES,CA

ATC/Airspace
Type of Flight Plan - COMPANY (VFR)
Type of Clearance - NONE
Type Apch/Lndg - FORCED LANDING

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
ATP,CFI

HELICOPTER

Age - 39
Biennial Flight Review
Current - YES
Months Since - 1
Aircraft Type - AS 355F

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)
Total - 5300
Make/Model- 400
Instrument- UNK/NR
Multi-Eng - UNK/NR
Last 24 Hrs - UNK/NR
Last 30 Days- 30
Last 90 Days- 90
Rotorcraft - 5300

Instrument Rating(s) - HELICOPTER

----Narrative----

THE HELICOPTER TOOKOFF ON AN AIR AMBULANCE FLT AT ABOUT 1219 PST. ACCORDING TO TOWER PERSONNEL, THE DEPARTURE APPEARED NORMAL. RADAR SERVICE WAS TERMINATED AT 1227 & THERE WAS NO FURTHER RADIO CONTACT WITH THE HELICOPTER. LATER, THE HELICOPTER WAS FOUND WHERE IT HAD CRASH LANDED ON STEEP MOUNTAINOUS TERRAIN, ROLLED OVER & BURNED. AN INVESTIGATION REVEALED AN OPEN LOGBOOK ENTRY THAT THE #1 TORQUE TRANSMITTER WAS INOP. A PERSON NEAR THE DEPARTURE POINT NOTICED THE L ENG COWLING WAS LOOSE. A SHORT TIME LATER, A 3' X 4' PIECE OF ENG COWLING WAS OBSERVED TO FALL FROM THE HELICOPTER. THERE WAS NO INDICATION IN THE AIRCREW'S RADIO TRANSMISSIONS THAT THEY WERE AWARE OF THE COWLING PROBLEM. AN EXAM REVEALED EVIDENCE THAT THE COWLING STANDOUT TUBE FOR THE L ENG HAD RUBBED AGAINST THE FREE WHEELING TURBINE GOVERNOR CABLE. AEROSPATIALE PSNL SAID THIS COULD DECREASE FUEL FLOW TO THE L ENG; AT HI POWER, THE R ENG GOVERNOR WOULD THEN INCREASE ITS FUEL FLOW & EXCEED LIMITS UNLESS PLT COMPENSATED. R FUEL SHUTOFF VALVE WAS FOUND NEAR ITS CLOSED POSITION.

Brief of Accident (Continued)

File No. - 2920 12/07/83 BLACK MOUNTAIN,NV A/C Reg. No. N57901 Time (Lcl) - 1229 PST

Occurrence #1 AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation TAKEOFF - INITIAL CLIMB

Finding(s)
1. ENGINE INSTRUMENTS,TORQUEMETER - INOPERATIVE
2. MAINTENANCE,REPLACEMENT - NOT PERFORMED -
3. COOLING SYSTEM,COWLING - UNDETERMINED
4. COOLING SYSTEM,COWLING - SEPARATION
5. TURBOSHAFT ENGINE,FREE TURBINE GOVERNOR - FALSE INDICATION

Occurrence #2 FORCED LANDING
Phase of Operation LANDING

Finding(s)
6. EMERGENCY PROCEDURE - IMPROPER - PILOT IN COMMAND
7. WRONG ENGINE SHUTDOWN - PERFORMED - PILOT IN COMMAND
8. AUTOROTATION - PERFORMED - PILOT IN COMMAND

Occurrence #3 ROLL OVER
Phase of Operation LANDING - FLARE/TOUCHDOWN

Finding(s)
9. TERRAIN CONDITION - MOUNTAINOUS/HILLY
10. TERRAIN CONDITION - ROUGH/UNEVEN

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 6,7

Factor(s) relating to this accident is/are finding(s) 1,2,3,4,5,9,10

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 698 6/12/84 SALEM,VA A/C Reg. No. N222LH Time (Lcl) - 1950 EDT

----Basic Information----

Type Operating Certificate-ON-DEMAND AIR TAXI
Name of Carrier -LIFE GUARD OF AMERICA,INC
Type of Operation -NON SCHED,DOMESTIC,PASSENGER
Flight Conducted Under -14 CFR 135
Accident Occurred During -HOVER

Aircraft Damage: SUBSTANTIAL
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	0	0	0	1
Pass	0	0	0	3

----Aircraft Information----

Make/Model - BELL 222
Landing Gear - TRICYCLE-RETRACTABLE
Max Gross Wt - 14300
No. of Seats - 6
Eng Make/Model - LYCOMING LTS-10-650C-3
Number Engines - 2
Engine Type - TURBOSHAFT
Rated Power - 684 HP
ELT Installed/Activated - NO -N/A
Stall Warning System - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - NO RECORD OF BRIEFING
Method - N/A
Completeness - N/A
Basic Weather - VMC
Wind Dir/Speed- 225/005 KTS
Visibility - 8.0 SM
Lowest Sky/Clouds - 5000 FT SCATTERED
Lowest Ceiling - NONE
Obstructions to Vision- HAZE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
ROANOKE,VA
Destination
LOCAL

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - FORCED LANDING

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL
SE LAND,ME LAND
HELICOPTER

Age - 35
Biennial Flight Review
Current - UNK/NR
Months Since - UNK/NR
Aircraft Type - UNK/NR

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT
Flight Time (Hours)
Total - 5792
Make/Model- 85
Instrument- UNK/NR
Multi-Eng - UNK/NR
Last 24 Hrs - 1
Last 30 Days- UNK/NR
Last 90 Days- UNK/NR
Rotorcraft - UNK/NR

Instrument Rating(s) - AIRPLANE,HELICOPTER

----Narrative----

THE HELICOPTER WAS FLOWN TO THE SITE OF AN AUTO ACCIDENT TO TRANSPORT AN INJURED PERSON. AFTER LANDING, THE PATIENT WAS LOADED WITHOUT SHUTTING DOWN THE ENG. DUE TO THE POSITION OF POWER LINES, THE AIRCREW HAD TO DEPART IN THE OPPOSITE DIRECTION. WHILE PREPARING TO DEPART, THE PLT BROUGHT THE HELICOPTER TO A HOVER & BEGAN A PEDAL TURN. AS THE ACFT WAS TURNING, AN AMBULANCE DRIVER BEGAN BACKING HIS VEHICLE TOWARD THE HELICOPTER. THE PLT INSTINCTIVELY PULLED AFT ON THE CYCLIC. THIS RESULTED IN THE TAIL ROTOR CONTACTING A LOW ROAD BARRIER POST. THERE WAS A LOSS OF TAIL ROTOR EFFECTIVENESS, SO THE PLT RETARDED THE THROTTLE TO THE OFF POSITION & MADE A HOVER AUTOROTATION.

Brief of Accident (Continued)

File No. - 698 6/12/84 SALEM,VA A/C Reg. No. N222LH Time (Lcl) - 1950 EDT

Occurrence #1 IN FLIGHT COLLISION WITH OBJECT
Phase of Operation HOVER

Finding(s)
1. TERRAIN CONDITION - HIGH OBSTRUCTION(S)
2. OBJECT - VEHICLE
3. VISUAL LOOKOUT - INADEQUATE - DRIVER OF VEHICLE
4. CREW/GROUP COORDINATION - INADEQUATE - PILOT IN COMMAND
5. OBJECT - FENCE
6. CLEARANCE - NOT MAINTAINED - PILOT IN COMMAND

Occurrence #2 FORCED LANDING
Phase of Operation LANDING

Finding(s)
7. AUTOROTATION - PERFORMED - PILOT IN COMMAND

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 3,4,6

Factor(s) relating to this accident is/are finding(s) 1,2,5

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 2247 7/14/84 REHOBETH,MA A/C Reg. No. N105CP Time (Lcl) - 2250 EDT

----Basic Information----

Type Operating Certificate-ON-DEMAND AIR TAXI
Name of Carrier -OMNI FLIGHT AIRWAYS INC.
Type of Operation -NON SCHED,DOMESTIC,CARGO
Flight Conducted Under -14 CFR 135
Accident Occurred During -LANDING

Aircraft Damage: DESTROYED
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	2	1	0	0
Pass	0	1	0	0

----Aircraft Information----

Make/Model - MBB BO-105C
Landing Gear - SKID
Max Gross Wt - 5070
No. of Seats - 4

Eng Make/Model - ALLISON 250-C20B
Number Engines - 2
Engine Type - TURBOSHAFT
Rated Power - 420 HP

ELT Installed/Activated - YES/YES
Stall Warning System - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - NO RECORD OF BRIEFING
Method - N/A
Completeness - N/A
Basic Weather - VMC
Wind Dir/Speed- 260/009 KTS
Visibility - 10.0 SM
Lowest Sky/Clouds - CLEAR
Lowest Ceiling - NONE
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - NIGHT(BRIGHT)

Itinerary
Last Departure Point
MARTHA'S VINEYD,MA
Destination
WORCESTER,MA

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - TRAFFIC ADVISORY
Type Apch/Lndg - FORCED LANDING

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
MARTHAS VINEYARD
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - DIRT
Runway Status - HIGH VEGETATION

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
ATP
HELICOPTER

Age - 35
Biennial Flight Review
Current - YES
Months Since - 1
Aircraft Type - BO-105

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT
Flight Time (Hours)
Total - 4728
Make/Model- UNK/NR
Instrument- UNK/NR
Multi-Eng - UNK/NR
Last 24 Hrs - UNK/NR
Last 30 Days- UNK/NR
Last 90 Days- UNK/NR
Rotorcraft - 4728

Instrument Rating(s) - HELICOPTER

----Narrative----

THE MESSERSCHMITT-BLOHM-BOELKOW BO-105C WAS ON AN AIR AMBULANCE FLT WITH A PLT, 2 ADDITIONAL CREWMEMBERS (DOCTOR & NURSE) & A PASSENGER (PATIENT) ON BOARD. DURING FLT, THE PLT RADIOED THAT HE HAD LOST POWER IN 1 ENG, THEN ABOUT 14 SEC LATER, HE RADIOED THAT THE OTHER ENG HAD ALSO LOST POWER. DURING A FORCED LANDING/AUTOROTATION TO A ROAD AT NIGHT, THE HELICOPTER COLLIDED WITH POWER LINES & CRASHED. NO FUEL WAS FOUND IN THE RIGHT SUPPLY TANK & ONLY ABOUT 1 GAL OF FUEL WAS FOUND IN THE LEFT SUPPLY TANK. THE MAIN TANK HAD 15.4 GAL REMAINING, BUT THE RESPECTIVE FUEL BOOST PUMP SWITCHES WERE FOUND IN THE "OFF" POSITION. THE REAR MAIN FUEL TANK HAD ONLY SLIGHTLY OVER 1 GAL REMAINING. ALSO, AN ELECTRICAL WIRE IN THE LOW FUEL WARNING CIRCUIT WAS NOT CONNECTED. THE FUEL SUPPLY TO EACH ENG IS FROM THE FUEL SUPPLY TANKS, WHICH ARE INDEPENDENT OF EACH OTHER.

Brief of Accident (Continued)

File No. - 2247 7/14/84 REHOBETH,MA A/C Reg. No. N105CP Time (Lcl) - 2250 EDT

Occurrence #1 LOSS OF POWER(TOTAL) - NON-MECHANICAL
Phase of Operation CRUISE - NORMAL

Finding(s)
1. WARNING SYSTEM(OTHER) - DISCONNECTED
2. FUEL BOOST PUMP SELECTOR POSITION - IMPROPER - PILOT IN COMMAND
3. FLUID,FUEL - STARVATION
4. FUEL SYSTEM - IMPROPER USE OF - PILOT IN COMMAND
5. AIRCRAFT PERFORMANCE,TWO OR MORE ENGINES - INOPERATIVE

Occurrence #2 FORCED LANDING
Phase of Operation LANDING

Finding(s)
6. AUTOROTATION - PERFORMED - PILOT IN COMMAND

Occurrence #3 IN FLIGHT COLLISION WITH OBJECT
Phase of Operation LANDING - FLARE/TOUCHDOWN

Finding(s)
7. LIGHT CONDITION - NIGHT
8. OBJECT - WIRE,TRANSMISSION

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 2,3,4

Factor(s) relating to this accident is/are finding(s) 1,7,8

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 3049 9/01/84 KNOXVILLE,TN A/C Reg. No. N22299 Time (Lcl) - 1715 EDT

----Basic Information----

Type Operating Certificate-NONE (GENERAL AVIATION)

Type of Operation -BUSINESS
Flight Conducted Under -14 CFR 91
Accident Occurred During -LANDING

Aircraft Damage
DESTROYED
Fire
ON GROUND

Injuries	Fatal	Serious	Minor	None
Crew	0	0	1	0
Pass	0	1	2	0
Other	0	0	1	0

----Aircraft Information----

Make/Model - BELL 222
Landing Gear - TRICYCLE-RETRACTABLE
Max Gross Wt - 7850
No. of Seats - 5

Eng Make/Model - LYCOMING LT101-650C3A
Number Engines - 2
Engine Type - TURBOSHAFT
Rated Power - 620 HP

ELT Installed/Activated - NO -N/A
Stall Warning System - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - NO RECORD OF BRIEFING
Method - N/A
Completeness - N/A
Basic Weather - VMC
Wind Dir/Speed- CALM
Visibility - 15.0 SM
Lowest Sky/Clouds - CLEAR
Lowest Ceiling - NONE
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
KNOXVILLE,TN
Destination
SAME AS ACC/INC

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - NONE

Airport Proximity
OFF AIRPORT/STRIP

Airport Data

Runway Ident - N/A
Runway Lth/Wid - 200/ 200
Runway Surface - GRASS/TURF
Runway Status - DRY

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
ATP
SE LAND,ME LAND
HELICOPTER

Age - 34
Biennial Flight Review
Current - YES
Months Since - 1
Aircraft Type - 222

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT
Flight Time (Hours)

Total -	4564	Last 24 Hrs -	UNK/NR
Make/Model-	3	Last 30 Days-	UNK/NR
Instrument-	397	Last 90 Days-	36
Multi-Eng -	1700	Rotorcraft -	2700

Instrument Rating(s) - AIRPLANE,HELICOPTER

----Narrative----

THE HELICOPTER WAS IN A HOVER WHEN A RT PEDAL TURN WAS INITIATED AND A CLIMB ATTEMPTED. PLT STATED, "I WAS UNABLE TO CLIMB, AND THE AIRCRAFT BEGAN TO LOSE ROTOR RPM. I INCREASED POWER TO 100% MRTQ. THE ACFT WAS SETTLING." UNABLE TO SUSTAIN FLT, A LANDING WAS MADE AT A ROAD INTERSECTION DURING WHICH 3 VEHICLES WERE DAMAGED. THE ACFT WAS SUBSTANTIALLY DAMAGED BY FIRE. INSPECTION & TESTING REVEALED THE TORQUE CONTROL UNIT, P/N 222-360-010-101, WHICH LIMITS THE AMT OF COMBINED ENG TORQUE DELIVERED TO THE MAIN TRANSMISSION, WAS ADJUSTED TO 46.0 PSI. ACCORDING TO BELL MAINTENANCE MANUALS, THE UNIT SHOULD BE SET AT 48.5 PSI (+1.5/-0.0). THE UNIT WAS INSTALLED IN THE ACFT ON 3/1/82. IT COULD NOT BE DETERMINED IF THE UNIT WAS ADJUSTED AT THE TIME OF INSTALLATION OR AFTER.

Brief of Accident (Continued)

File No. - 3049 9/01/84 KNOXVILLE,TN A/C Reg. No. N22299 Time (Lcl) - 1715 EDT

Occurrence #1 LOSS OF POWER(PARTIAL) - MECH FAILURE/MALF
Phase of Operation CLIMB

Finding(s)
1. MISC ROTORCRAFT - PRESSURE TOO LOW
2. MAINTENANCE - INADEQUATE -

Occurrence #2 FORCED LANDING
Phase of Operation DESCENT - UNCONTROLLED

Occurrence #3 IN FLIGHT COLLISION WITH OBJECT
Phase of Operation APPROACH - VFR PATTERN - DOWNWIND

Finding(s)
3. OBJECT - VEHICLE

Occurrence #4 FIRE
Phase of Operation LANDING - FLARE/TOUCHDOWN

Finding(s)
4. FUEL SYSTEM,DRAIN - OVERLOAD
5. FUEL SYSTEM - FAILURE,PARTIAL

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 2

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 5061 10/22/84 ORLANDO,FL A/C Reg. No. N29144 Time (Lcl) - 1715 EDT

----Basic Information----

Type Operating Certificate-ON-DEMAND AIR TAXI
Name of Carrier -OMNI FLIGHT AIRWAYS
Type of Operation -NON SCHED,DOMESTIC,PASSENGER
Flight Conducted Under -14 CFR 135
Incident Occurred During -LANDING

Aircraft Damage: MINOR
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	0	0	0	3
Pass	0	0	0	1

----Aircraft Information----

Make/Model - MESSERSCHMITT BO-105
Landing Gear - SKID
Max Gross Wt - 4629
No. of Seats - 4

Eng Make/Model - ALLISION 250-C20B
Number Engines - 2
Engine Type - TURBOSHAFT
Rated Power - 420 HP

ELT Installed/Activated - YES/YES
Stall Warning System - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - NO RECORD OF BRIEFING
Method - N/A
Completeness - N/A
Basic Weather - VMC
Wind Dir/Speed- 110/007 KTS
Visibility - 7.0 SM
Lowest Sky/Clouds - 3500 FT SCATTERED
Lowest Ceiling - NONE
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
LEESBURG,FL
Destination
ORLANDO,FL

ATC/Airspace
Type of Flight Plan - COMPANY (VFR)
Type of Clearance - NONE
Type Apch/Lndg - STRAIGHT-IN
FULL STOP
FORCED LANDING

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
ORLANDO HELIPORT
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - CONCRETE
Runway Status - DRY

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL,ATP
SE LAND,ME LAND
HELICOPTER

Age - 35
Biennial Flight Review
Current - YES
Months Since - 1
Aircraft Type - BO-105

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)
Total - 4563
Make/Model- 51
Instrument- 107
Multi-Eng - 11
Last 24 Hrs - 2
Last 30 Days- UNK/NR
Last 90 Days- 45
Rotorcraft - 4440

Instrument Rating(s) - AIRPLANE,HELICOPTER

----Narrative----

THE PURPOSE OF THE FLT WAS TO TRANSPORT A 76 YR OLD PATIENT, WHO WAS IN CRITICAL CONDITION. THE FLT WAS NORMAL UNTIL IT WAS ON FINAL APCH TO A 7TH FLOOR, ROOFTOP, HOSPITAL HELIPORT. DURING THE APCH, THE PLT ATTEMPTED TO INCREASE THE COLLECTIVE TO SLOW THE RATE OF DESCENT. HOWEVER, THE COLLECTIVE CONTROL WOULD NOT RAISE. THE PLT WAS ABLE TO KEEP THE HELICOPTER FROM HITTING THE SIDE OF THE BUILDING, BUT SUBSEQUENTLY LANDED HARD ON A LOWER ROOFTOP AT THE 2ND FLOOR LEVEL. THERE WAS MINOR DAMAGE TO THE SKID CROSSTUBES, TAIL ROTOR, TAIL BOOM, LEFT HORIZONTAL STABILIZER FIN & AN ANTENNA. AFTER THE INCIDENT, THE PLT NOTED THAT A HAND HELD TYPE RADIO HAD LODGED BEHIND THE COLLECTIVE PITCH CONTROL.

Brief of Incident (Continued)

File No. - 5061 10/22/84 ORLANDO,FL A/C Reg. No. N29144 Time (Lcl) - 1715 EDT

Occurrence #1 LOSS OF CONTROL - IN FLIGHT
Phase of Operation APPROACH - VFR PATTERN - FINAL APPROACH

Finding(s)
1. ROTORCRAFT FLIGHT CONTROL,COLLECTIVE CONTROL - FOREIGN OBJECT
2. PLANNING-DECISION - IMPROPER - PILOT IN COMMAND
3. CONTROL INTERFERENCE

Occurrence #2 HARD LANDING
Phase of Operation DESCENT - EMERGENCY

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this incident is/are finding(s) 1,2,3

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 1472 1/20/85 CARSON,NM A/C Reg. No. N40TE Time (Lcl) - 2315 MST

----Basic Information----

Type Operating Certificate-ON-DEMAND AIR TAXI
Name of Carrier -EMS
Type of Operation -NON SCHED,DOMESTIC,PASSENGER
Flight Conducted Under -14 CFR 135
Accident Occurred During -DESCENT

Aircraft Damage: DESTROYED
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	1	0	0	0
Pass	2	0	0	0

----Aircraft Information----

Make/Model - BELL 206 L-1
Landing Gear - SKID
Max Gross Wt - 4150
No. of Seats - UNK/NR

Eng Make/Model - ALLISON 250C-28B
Number Engines - 1
Engine Type - TURBOSHAFT
Rated Power - 435 LBS THRUST

ELT Installed/Activated - YES/NO
Stall Warning System - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - FSS
Method - ACFT RADIO
Completeness - FULL
Basic Weather - VMC
Wind Dir/Speed- 140/007 KTS
Visibility - 3.000 SM
Lowest Sky/Clouds - 100 FT
Lowest Ceiling - 100 FT OVERCAST
Obstructions to Vision- FOG
Precipitation - NONE
Condition of Light - NIGHT(DARK)

Itinerary
Last Departure Point
ALBUQUERQUE,NM
Destination
TAOS,NM

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - NONE

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
UNKNOWN
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----

Pilot-In-Command Age - 52 Medical Certificate - VALID MEDICAL-WAIVERS/LIMIT

Certificate(s)/Rating(s)
ATP
ME LAND,SE SEA
HELICOPTER

Biennial Flight Review
Current - YES
Months Since - 3
Aircraft Type - 206 L-1

Flight Time (Hours)
Total - 14000
Make/Model- 1500
Instrument- UNK/NR
Multi-Eng - UNK/NR
Last 24 Hrs - 1
Last 30 Days- 13
Last 90 Days- UNK/NR
Rotorcraft - 14000

Instrument Rating(s) - HELICOPTER

----Narrative----

THE HELICOPTER CRASHED IN OPEN TERRAIN DURING A TURN TO REVERSE DIRECTION. WITNESSES STATED THE ACFT WAS HEADING NORTH AND WAS ON A CONVERGING COURSE WITH HIGH TENSION LINES THAT WERE ABOUT 80 TO 100 FT HIGH AND THE BELLY MOUNTED SPOTLIGHT WAS ILLUMINATED WHEN IT PASSED OVERHEAD. THE HELICOPTER IMPACTED SNOW COVERED TERRAIN IN A STEEP DESCENDING BANK TO THE RIGHT AT A HIGH RATE OF SPEED ON A SOUTHERLY HEADING. THE POWER LINES SHOWED NO EVIDENCE OF HAVING BEEN STRUCK. THE ACCIDENT SITE WAS 300 FT EAST OF THE POWER LINES.

Brief of Accident (Continued)

File No. - 1472 1/20/85 CARSON,NM A/C Reg. No. N40TE Time (Lcl) - 2315 MST

Occurrence #1 IN FLIGHT ENCOUNTER WITH WEATHER
Phase of Operation CRUISE

Finding(s)
1. WEATHER CONDITION - LOW CEILING
2. WEATHER EVALUATION - POOR - PILOT IN COMMAND
3. WEATHER CONDITION - FOG
4. LIGHT CONDITION - DARK NIGHT

Occurrence #2 LOSS OF CONTROL - IN FLIGHT
Phase of Operation MANEUVERING - TURN TO REVERSE DIRECTION
5. DIRECTIONAL CONTROL - NOT MAINTAINED - PILOT IN COMMAND

Occurrence #3 IN FLIGHT COLLISION WITH TERRAIN
Phase of Operation DESCENT - UNCONTROLLED

Finding(s)
6. TERRAIN CONDITION - SNOW COVERED

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 5

Factor(s) relating to this accident is/are finding(s) 1,2,3,4,6

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 1050   5/20/85   DULUTH,GA   A/C Reg. No. N403DC   Time (Lcl) - 1930 EDT

----Basic Information----

Type Operating Certificate-ON-DEMAND AIR TAXI
Name of Carrier -METRO AMBULANCE SERVICES,
Type of Operation -NON SCHED,DOMESTIC,PASSENGER
Flight Conducted Under -14 CFR 135
Accident Occurred During -TAKEOFF

Aircraft Damage: DESTROYED
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	2	1	0	0
Pass	0	0	1	0

----Aircraft Information----

Make/Model - BELL 206L
Landing Gear - SKID
Max Gross Wt - 4000
No. of Seats - 4

Eng Make/Model - ALLISON 250-C20B
Number Engines - 1
Engine Type - TURBOSHAFT
Rated Power - 420 HP

ELT Installed/Activated - YES/YES
Stall Warning System - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - NO RECORD OF BRIEFING
Method - N/A
Completeness - N/A
Basic Weather - VMC
Wind Dir/Speed- 200/007 KTS
Visibility - 11.0 SM
Lowest Sky/Clouds - 6000 FT SCATTERED
Lowest Ceiling - 15000 FT BROKEN
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
SAME AS ACC/INC
Destination
CHAMBLEE,GA

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - NONE

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
PRIVATE,COMMERCIAL
SE LAND
HELICOPTER

Age - 35
Biennial Flight Review
Current - YES
Months Since - 4
Aircraft Type - AS 350

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)

Total	- UNK/NR	Last 24 Hrs	- UNK/NR
Make/Model	- UNK/NR	Last 30 Days	- UNK/NR
Instrument	- UNK/NR	Last 90 Days	- UNK/NR
Multi-Eng	- UNK/NR	Rotorcraft	- UNK/NR

Instrument Rating(s) - NONE

----Narrative----

AFTER LOADING A SERIOUSLY BURNED PATIENT IN THE HELICOPTER, THE PLT STARTED THE ENG & LIFTED OFF FROM THE HOSPITAL PARKING LOT. IMMEDIATELY AFTER LIFT-OFF, HE STARTED FORWARD TRANSLATIONAL FLT. ABOUT 65 FT FROM THE LIFT-OFF POINT, AN ADVANCING MAIN ROTOR BLADE STRUCK AN UNMARKED LAMP POST. THE HELICOPTER THEN CRASHED IN THE PARKING LOT, JUST BEYOND THE LAMP POST. THE PLT & ONE MEDICAL ATTENDANT WERE FATALLY INJURED, THE OTHER MEDICAL ATTENDANT WAS SERIOUSLY INJURED. REPORTEDLY, THE PATIENT DID NOT SUSTAIN ANY ADDITIONAL DISCERNIBLE INJURY FROM THE CRASH.

Brief of Accident (Continued)

File No. - 1050 5/20/85 DULUTH,GA A/C Reg. No. N403DC Time (Lcl) - 1930 EDT

Occurrence #1 IN FLIGHT COLLISION WITH OBJECT
Phase of Operation TAKEOFF - INITIAL CLIMB

Finding(s)
1. PREFLIGHT PLANNING/PREPARATION - INADEQUATE - PILOT IN COMMAND
2. OBJECT - UTILITY POLE
3. VISUAL LOOKOUT - INADEQUATE - PILOT IN COMMAND
4. IMPROPER USE OF EQUIPMENT/AIRCRAFT,VISUAL/AURAL DETECTION - PILOT IN COMMAND

Occurrence #2 IN FLIGHT COLLISION WITH TERRAIN
Phase of Operation DESCENT - UNCONTROLLED

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 1,3

Factor(s) relating to this accident is/are finding(s) 2,4

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 2768 12/10/85 ADRIAN,MI A/C Reg. No. N5800H Time (Lcl) - 0411 EST

----Basic Information----

Type Operating Certificate-ON-DEMAND AIR TAXI
Type of Operation -BUSINESS
Flight Conducted Under -14 CFR 91
Accident Occurred During -DESCENT

Aircraft Damage: DESTROYED
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	1	0	0	0
Pass	1	0	0	0

----Aircraft Information----

Make/Model - AEROSPATIALE SA365N
Landing Gear - TRICYCLE-RETRACTABLE
Max Gross Wt - 4900
No. of Seats - 6

Eng Make/Model - TURBOMECA ARRIEL1C
Number Engines - 2
Engine Type - TURBOSHAFT
Rated Power - 660 HP

ELT Installed/Activated - YES/NO
Stall Warning System - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - FSS
Method - TELEPHONE
Completeness - FULL
Basic Weather - IMC
Wind Dir/Speed- CALM
Visibility - .250 SM
Lowest Sky/Clouds - UNK/NR
Lowest Ceiling - 200 FT OBSCURED
Obstructions to Vision- FOG
Precipitation - NONE
Condition of Light - NIGHT(DARK)

Itinerary
Last Departure Point
TOLEDO,OH
Destination
ADDISON,MI

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - NONE

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
ATP,CFI

HELICOPTER

Age - 49
Biennial Flight Review
Current - UNK/NR
Months Since - UNK/NR
Aircraft Type - 365N

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)
Total - 8500
Make/Model- UNK/NR
Instrument- 0
Last 24 Hrs - 1
Last 30 Days- 50
Last 90 Days- 150
Rotorcraft - 8500

Instrument Rating(s) - HELICOPTER

----Narrative----

THE PURPOSE OF THIS FLIGHT WAS TO PICK UP AN INJURED PATIENT AND RETURN HIM TO A MEDICAL CENTER. THE WEATHER WAS ADEQUATE FOR A VFR TAKEOFF. HOWEVER, ENROUTE WEATHER REPORTS INDICATED FOG AND PROBABLE LOW CEILINGS. ACCORDING TO THE SINGLE SURVIVOR OF THE ACCIDENT, THE PILOT FLEW INTO "THICK FOG" SHORTLY BEFORE REACHING THEIR DESTINATION FOR THE PATIENT PICKUP. AGAIN ACCORDING TO THE SURVIVOR, THE PILOT THEN TURNED TO THE LEFT. SHORTLY THEREAFTER, THE HELICOPTER STRUCK TREES AND CRASHED TO THE GROUND. AN EXAMINATION OF THE WRECKAGE AND TEARDOWNS OF BOTH ENGINES REVEALED NO PRE-CRASH MECHANICAL MALFUNCTIONS.

Brief of Accident (Continued)

File No. - 2768   12/10/85   ADRIAN,MI   A/C Reg. No. N5800H   Time (Lcl) - 0411 EST

Occurrence #1 IN FLIGHT ENCOUNTER WITH WEATHER
Phase of Operation CRUISE - NORMAL

Finding(s)
1. WEATHER CONDITION - FOG
2. FLIGHT INTO KNOWN ADVERSE WEATHER - PERFORMED - PILOT IN COMMAND
3. LIGHT CONDITION - DARK NIGHT
4. VFR FLIGHT INTO IMC - INADVERTENT - PILOT IN COMMAND

Occurrence #2 IN FLIGHT COLLISION WITH OBJECT
Phase of Operation MANEUVERING

Finding(s)
5. OBJECT - TREE(S)
6. VISUAL LOOKOUT - REDUCED - PILOT IN COMMAND

Occurrence #3 IN FLIGHT COLLISION WITH TERRAIN
Phase of Operation DESCENT - UNCONTROLLED

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 4,6

Factor(s) relating to this accident is/are finding(s) 1,2,3,5

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 2571 12/20/85 AINSWORTH,NE A/C Reg. No. N110LG Time (Lcl) - 1855 CST

----Basic Information----

Type Operating Certificate-ON-DEMAND AIR TAXI
Type of Operation -POSITIONING
Flight Conducted Under -14 CFR 91
Accident Occurred During -DESCENT

Aircraft Damage: DESTROYED
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	1	0	0	0
Pass	2	0	0	0

----Aircraft Information----

Make/Model - BELL 206L
Landing Gear - SKID
Max Gross Wt - 4150
No. of Seats - 3

Eng Make/Model - ALLISON 250-C20B
Number Engines - 1
Engine Type - TURBOSHAFT
Rated Power - 420 HP

ELT Installed/Activated - YES/NO
Stall Warning System - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - FSS
Method - TELEPHONE
Completeness - PARTIAL,LMTD BY PILOT
Basic Weather - UNK/NR
Wind Dir/Speed- 300/006 KTS
Visibility - 2.000 SM
Lowest Sky/Clouds - UNK/NR
Lowest Ceiling - 2500 FT OVERCAST
Obstructions to Vision- NONE
Precipitation - DRIZZLE
Condition of Light - NIGHT(DARK)

Itinerary
Last Departure Point
KEARNEY,NE
Destination
AINSWORTH,NE

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - NONE

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL
HELICOPTER

Age - 32
Biennial Flight Review
Current - YES
Months Since - 6
Aircraft Type - UN1N

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT
Flight Time (Hours)
Total - 2264
Make/Model- 271
Instrument- 105
Last 24 Hrs - 6
Last 30 Days- UNK/NR
Last 90 Days- 67
Rotorcraft - 2264

Instrument Rating(s) - HELICOPTER

----Narrative----

THIS MED-EVAC HELICOPTER WAS BEING POSITIONED TO PICK UP A PATIENT. THE PLT OBTAINED A WX BRIEFING WHICH INCLUDED A FORECAST FOR A CHANCE OF MARGINAL VMC ALONG THE PLANNED ROUTE, ALTHOUGH AT THE TIME OF THE BRIEFING THE DEST WEATHER WAS VMC. THE FLT DEPARTED AT ABOUT SUNDOWN AND THE DEST WX DETERIORATED WHILE THE FLT WAS ENROUTE. WITNESSES NEAR THE ACDT SITE, WHICH WAS 23 NM SE OF THE DEST. REPORTED FREEZING RAIN AND/OR WET SNOW FALLING AS THE HELICOPTER FLEW PAST THEIR RANCHES AT LOW ALT HEADING NW. IT WAS COMPLETELY DARK AT THE TIME OF THE ACDT AND THE AREA WHERE THE ACDT OCCURRED IS SPARSLEY POPULATED PROVIDING FEW GROUND LIGHTS FOR VISUAL REF. THE HELICOPTER CRASHED IN HILLY, SNOW COVERED TERRAIN IN A NEAR VERTICAL, NOSE LOW ATTITUDE AND WAS DESTROYED.

Brief of Accident (Continued)

File No. - 2571 12/20/85 AINSWORTH,NE A/C Reg. No. N110LG Time (Lcl) - 1855 CST

Occurrence #1 IN FLIGHT ENCOUNTER WITH WEATHER
Phase of Operation CRUISE

Finding(s)
1. WEATHER CONDITION - SNOW
2. VFR FLIGHT INTO IMC - CONTINUED - PILOT IN COMMAND
3. IMPROPER DECISION,PRESSURE INDUCED BY OTHERS - PILOT IN COMMAND
4. WEATHER CONDITION - RAIN
5. LIGHT CONDITION - DARK NIGHT

Occurrence #2 LOSS OF CONTROL - IN FLIGHT
Phase of Operation CRUISE

Finding(s)
6. SPIRAL - INADVERTENT - PILOT IN COMMAND
7. IMPROPER USE OF EQUIPMENT/AIRCRAFT,SPATIAL DISORIENTATION - PILOT IN COMMAND

Occurrence #3 IN FLIGHT COLLISION WITH TERRAIN
Phase of Operation DESCENT - UNCONTROLLED

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 2,6,7

Factor(s) relating to this accident is/are finding(s) 1,3,4,5

National Transportation Safety Board
Washington, D.C. 20594

Commercial EMS Helicopter Accident Brief

File No. - 2846 12/24/85 MONUMENT VALLEY,UT A/C Reg. No. N10UB Time (Lcl) - 2330 MST

----Basic Information----

Type Operating Certificate-ON-DEMAND AIR TAXI

Type of Operation -POSITIONING
Flight Conducted Under -14 CFR 91
Accident Occurred During -DESCENT

Aircraft Damage: DESTROYED
Fire: NONE

Injuries	Fatal	Serious	Minor	None
Crew	1	2	0	0
Pass	0	0	0	0

----Aircraft Information----

Make/Model - BELL 206-L3
Landing Gear - SKID
Max Gross Wt - 4150
No. of Seats - 3

Eng Make/Model - ALLISON 250-C30P
Number Engines - 1
Engine Type - TURBOSHAFT
Rated Power - 650 HP

ELT Installed/Activated - YES/YES
Stall Warning System - NO

----Environment/Operations Information----

Weather Data
Wx Briefing - NO RECORD OF BRIEFING
Method - N/A
Completeness - N/A
Basic Weather - VMC
Wind Dir/Speed- CALM
Visibility - 50.0 SM
Lowest Sky/Clouds - CLEAR
Lowest Ceiling - NONE
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - NIGHT(BRIGHT)

Itinerary
Last Departure Point
SAME AS ACC/INC
Destination
GRAND JUNCTION,CO

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - NONE

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL
SE LAND
HELICOPTER

Age - 37
Biennial Flight Review
Current - YES
Months Since - 1
Aircraft Type - 206-L3

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)
Total - 5489
Make/Model- 3151
Instrument- 323
Multi-Eng - UNK/NR
Last 24 Hrs - 3
Last 30 Days- UNK/NR
Last 90 Days- 28
Rotorcraft - 4923

Instrument Rating(s) - AIRPLANE,HELICOPTER

----Narrative----

THE HELICOPTER CONTACTED POWER LINES AND THE TERRAIN DURING AN ATTEMPTED TAKEOFF FROM A HOSPITAL AFTER A CANCELLED MED-EVAC FLT. THE HOSPITAL IS LOCATED IN A BOX CANYON SURROUNDED BY HIGH TERRAIN AND POWER LINES. THE PLT WAS AWARE OF THE POWER LINE THAT CROSSED THE PROPOSED FLT PATH. A PASSEN GER STATED, AFTER THE ACCIDENT, THAT THE PLT HOVERED BACK TO THE END OF THE LANDING AREA TO INITIATE THE TAKEOFF. THE HELICOPTER STRUCK THE UNMARKED POWER LINES DURING CLIMBOUT AND DESCENDED TO GROUND IMPACT. A WITNESSES DESCRIBED THE WXAS COLD AND CLEAR WITH CALM GROUND WINDS NEAR THE HOSPITAL. THEY ALSO STATED THE NIGHT WAS BRIGHT BECAUSE OF A FULL MOON.

Brief of Accident (Continued)

File No. - 2846 12/24/85 MONUMENT VALLEY,UT A/C Reg. No. N10UB Time (Lcl) - 2330 MST

Occurrence #1 IN FLIGHT COLLISION WITH OBJECT
Phase of Operation CLIMB

Finding(s)

1. PROPER ALTITUDE - NOT MAINTAINED - PILOT IN COMMAND
2. OBJECT - WIRE,TRANSMISSION
3. CLEARANCE - NOT POSSIBLE - PILOT IN COMMAND
4. LIGHT CONDITION - NIGHT
5. REMEDIAL ACTION - NOT POSSIBLE - PILOT IN COMMAND

Occurrence #2 IN FLIGHT COLLISION WITH TERRAIN
Phase of Operation DESCENT - UNCONTROLLED

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are finding(s) 1,3,5

Factor(s) relating to this accident is/are finding(s) 2,4

*U.S. GOVERNMENT PRINTING OFFICE:1988-201-610:60065