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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 29, 1988

In reply refer to: A-88-1 through -11

Honorable T. Allan McArtor
Administrator
Federal Aviation Administration
Washington, D.C. 20591

The National Transportation Safety Board investigated and evaluated 59 emergency medical service (EMS) helicopter accidents that occurred between May 11, 1978, and December 3, 1986. While exploring this rapidly growing commercial EMS industry and its operations, the Safety Board concentrated on the influence of weather on EMS operations, EMS helicopter operations under instrument flight rules/visual flight rules (IFR/VFR), pilot and medical personnel training requirements, and EMS helicopter design standards and aircraft reliability. In addition, the Safety Board reviewed EMS helicopter crashworthiness and its influence on accident survival and the influence of EMS helicopter program management on safety. 1/

The Safety Board used a variety of information sources in conducting the 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.

The study did 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 the report are applicable only to the commercial EMS helicopter fleet.

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

1/ For more detailed information, read Safety Study "Emergency Medical Service Helicopter Operations" (NTSB/SS-88/01).
2/ Legislation currently before Congress would require that certain public-use aircraft accidents be reported to the Safety Board.

projected to exceed 100,000. 3/ Public-use helicopters transported approximately 10,000 to 15,000 patients in 1986. 4/ 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. 5/

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.

Title 14 Code of Federal Regulations (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.

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.

3/ 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.

4/ 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.

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

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."

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 instrument meteorological conditions (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 have any experience in, or knowledge of, 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;

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.

Approximately 88 percent of all commercial EMS programs in the United States operate VFR-only. According to the American Society of Hospital-Based Emergency Aeromedical Services (ASHBEAMS) survey, the vast majority of operators use VFR minimums that are higher than the FAA minimum requirements (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 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. 7/ 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." 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.

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.

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.

Although 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.

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.

7/ Based on information from operators during field research, the National Emer[illegible]cy

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.

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 flight service station (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. 8/ 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 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.

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.

8/ Aircraft Owner's and Pilot's Association, Perspective on the Future Flight Service Station Automation Program, Presentation to the FAA, March 23, 1987.

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. While 14 CFR 27.1309, Equipment, Systems, and Installations, requires that the equipment, systems, and installations be designed to prevent hazards to the helicopter in the event of a probable malfunction or failure, 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.

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.

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 "Supplemental Type Certificate" (STC) and the "major repair and alteration" process (FAA Form 337). Since no engineering review need be conducted for 337 approvals, 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 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.

Aviation safety is primarily concerned with preventing accidents, and great strides have been made in achieving this goal; new aircraft are extremely reliable and

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.

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 crewmember 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 situations, 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 crewmember sits upright.

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 to minimize occupant injury during impact. The Safety Board believes that all EMS helicopter crewmembers 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.

Although 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. 9/ This accident experience has also shown that the average severity of head injuries in survivable accidents, as measured by the Abbreviated Injury Scale (AIS) 10/ 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 experiencing no injuries. Of this group, 67 percent experienced injury scores of 5 to 6 (critical to virtually unsurvivable). 11/ 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 posterash 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

9/ U.S. Army Aircraft Crash Survival Design Guide; USARTL-TR-79-22D, June 1980.
10/ 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.
11/ U.S. Army USAARL Report No. 85-1 SPH-4, U.S. Army Flight Helmet Performance, 1972-1983, November 1984.

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.

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.

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.

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 [illegible]

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 12/ 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 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 endangers 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;

12/ Circadian rhythms are biological rhythms that have a period of approximately

- 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.

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.

Therefore, the National Transportation Safety Board recommends that 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)
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> 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)
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> 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)
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> 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

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:

- 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;
- that the proposed portable medical equipment is suitable for the helicopter environment and poses no hazard to the helicopter and crew; and
- 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 [illegible] of the current flight time/duty time regulation in [illegible] 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)

Also as a result of its investigation, the Safety Board issued Safety Recommendations A-88-12 through -15 to the American Society of Hospital-Based Emergency Aeromedical Services, A-88-16 through -18 to the Helicopter Association International, and A-88-19 to the National Aeronautics and Space Administration.

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER, NALL, and KOLSTAD, Members, concurred in these recommendations.

By: Jim Burnett
Chairman