National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 7, 2006

In reply refer to: A-06-12 through -15

Honorable Marion C. Blakey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

Emergency medical services (EMS) aviation operations (conducted with either helicopters or fixed-wing aircraft) provide an important service to the public by transporting seriously ill patients or donor organs to emergency care facilities. The pressure to safely and quickly conduct these operations in various environmental conditions (for example, inclement weather, at night, and unfamiliar landing sites for helicopter operations) makes EMS operations inherently dangerous, and the hazards associated with EMS operations are resulting in an increasing number of accidents.

Between January 2002 and January 2005, 55 EMS aircraft accidents occurred in the United States[1] (this number of EMS accidents had not been seen since the 1980s);[2] these accidents resulted in 54 fatalities and 18 serious injuries. Although the number of flight hours flown by EMS helicopter operations has increased from about 162,000 in 1991 to an estimated 300,000 in 2005,[3] the average accident rate has also increased from 3.53 accidents per 100,000 flight hours between 1992 and 2001 to 4.56 accidents per 100,000 flight hours between 1997 and 2001.[4] As a result, the National Transportation Safety Board initiated a special investigation[5] of these 55 accidents and identified the following recurring safety issues: 1) less

[1] Of these 55 EMS aircraft accidents, 41 were helicopter EMS accidents, 16 of which were fatal, resulting in a total of 39 fatalities and 13 serious injuries; 14 were airplane EMS accidents, 5 of which were fatal, resulting in 15 fatalities and 6 serious injuries. Since the initiation of this special investigation in January 2005, 9 additional EMS aircraft accidents have occurred, resulting in 8 fatalities.

[2] Comprehensive activity data regarding EMS operations (for example, exposure rates and missions flown) are limited because the sources for these data are generally poor. On May 12, 2005, the Safety Board issued Safety Recommendations A-05-11 through -13 to the Federal Aviation Administration to address the integrity of general aviation flight activity data. Information about these safety recommendations can be found at the Board's Web site at <http://www.ntsb.gov>.

[3] "Improving Safety in Helicopter Emergency Medical Services (HEMS) Operations," Helicopter Association International (Alexandria, VA: August 2005).

[4] Ira J. Blumen, "A Safety Review and Risk Assessment in Air Medical Transport." Supplement to the *Air Medical Physician Handbook*, Salt Lake City, Utah, November 2002, p. 35.

[5] For more detailed information, see National Transportation Safety Board, *Special Investigation Report on Emergency Medical Services (EMS) Operations*, Special Investigation Report NTSB/SIR-06/01 (Washington, DC: NTSB, 2006).

stringent requirements for EMS operations conducted without patients onboard, 2) a lack of aviation flight risk evaluation programs for EMS operations, 3) a lack of consistent, comprehensive flight dispatch procedures for EMS operations, and 4) no requirements to use technologies such as terrain awareness and warning systems (TAWS) to enhance EMS flight safety. Of the 55 accidents, seven were considered to provide the best examples of the safety issues involved and are specifically cited, where applicable, in this letter's discussion of each safety issue.

The Safety Board examined similar safety issues after the occurrence of 59 EMS accidents between May 1978 and December 1986 and concluded in a 1988 safety study[6] that many areas of EMS operations needed improvement, including weather forecasting, operations during instrument meteorological conditions (IMC), personnel training requirements, design standards, crashworthiness, and EMS operations management. As a result of its findings, the Board issued 19 safety recommendations to the Federal Aviation Administration (FAA) and others, which have since been closed.[7] Most of the recommendations to the FAA were closed as a result of the June 20, 1991, issuance of Advisory Circular (AC) 135-14A, "Emergency Medical Services/Helicopter (EMS/H)."[8] Although the Safety Board expressed concern at the time that the FAA chose to issue an AC instead of regulations, the number of EMS accidents was decreasing, thus the recommendations were closed.[9] Despite the guidance provided in AC 135-14A and AC 135-15, EMS aircraft accidents have continued to occur in significant numbers.

The Safety Board is aware that the FAA has recently taken positive steps[10] to improve EMS operation safety; however, the FAA has not yet imposed any requirements for all aircraft EMS operators regarding the safety issues identified during the Board's special investigation. The Board is concerned that, without requirements, some EMS operators will continue to operate in an unsafe manner, which could lead to further accidents.

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[6] National Transportation Safety Board, *Commercial Emergency Medical Service Helicopter Operations*, Safety Study NTSB/SS-88-01 (Washington, DC): NTSB, 1988.

[7] For more detailed information about these recommendations and their classifications, see appendix G in NTSB/SIR-06/01.

[8] AC 135-14A addressed equipment, training, crew resource management, decision-making, flight-following procedures, weather minimums, and the development of safety programs for EMS helicopter flights operating under Part 135.

[9] On November 19, 1990, the FAA issued AC 135-15, "Emergency Medical Services/Airplane," which contained guidance information similar to AC 135-14A. However, the recommendations from the 1988 study focused on EMS helicopter operations, so the closure of these recommendations was based on the issuance of AC 135-14A.

[10] In August 2004, the FAA convened a Helicopter Air Ambulance Accident Task Force to make recommendations to reduce helicopter EMS accidents; to date the task force has not issued any recommendations or rule changes. On January 28, 2005, the FAA released Notice N8000.293, "Helicopter Emergency Medical Services Operations;" on August 1, 2005, the FAA released Notice N8000.301, "Operational Risk Assessment Programs for Helicopter Emergency Medical Services;" and on September 27, 2005, the FAA released Notice N8000.307, "Special Emphasis Inspection Program for Helicopter Emergency Medical Services." For more detailed information about these notices, see appendixes D through F in NTSB/SIR-06/01. The FAA also issued two handbook bulletins for air transportation (HBAT) on January 24, 2006: HBAT 06-01, "Helicopter Emergency Services; OpSpec A021/A002 Revisions," and HBAT 06-02, "Helicopter Emergency Medical Services (HEMS) Loss of Control (LOC) and Controlled Flight Into Terrain (CFIT) Accident Avoidance Programs."

Requirements for EMS Operations Conducted Without Patients On Board

While carrying patients or organs for transplant, EMS flights are required to be conducted in accordance with the operator's 14 *Code of Federal Regulations* (CFR) Part 135 regulations.[11] However, when flights are conducted without patients aboard (positioning flights), they are permitted to operate under the provisions of 14 CFR Part 91,[12] which are less stringent than the provisions of Part 135. Positioning flights often carry medical personnel who, although classified as "crew members," are primarily responsible for helping the patient and not operating the flight. The Safety Board notes that 35 of the 55 EMS accidents studied during this investigation occurred with medical crewmembers but no patient on board and were conducted under Part 91. A November 2002 study by the Air Medical Physician Association (AMPA)[13] found that more EMS accidents occurred when a patient was not on board the flight than at any other time during flight.

Requirements regarding weather/visibility minimums differ significantly between Part 135 and Part 91. Section 91.155, "Basic VFR [visual flight rules] Weather Minimums," stipulates only that helicopters must remain "clear of clouds" when operating below 1,200 feet above the surface under VFR. In contrast, Safety Board staff's review of the Part 135 operations specifications for several EMS helicopter operators revealed that the specifications require weather/visibility minimums of at least 1,000-foot ceilings and 3 miles visibility.

The circumstances of some of the accidents investigated demonstrate that adverse weather conditions are often key factors in these accidents. For example, the Salt Lake City, Utah,[14] accident flight was conducted at night as a Part 91 positioning flight in weather conditions below Part 135 VFR minimums. The helicopter eventually crashed in an area where visibility was reported at 1/16 of a mile with fog and vertical visibility was 200 feet.[15] EMS positioning flights are often conducted in accordance with Part 91 minimums, thus the flights may operate in weather/visibility conditions that are below Part 135 minimums because they are not required to meet the more stringent Part 135 requirements.

Part 135 and Part 91 also differ regarding crew rest requirements. The provisions of Part 135 require that the flight crew obtain adequate rest before conducting an EMS flight with a patient on board, calling for a maximum duty time of 14 hours. In contrast, Part 91 has no duty time restrictions. Fatigue has been shown to impair performance and diminish alertness,[16] both of

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[11] Title 14 CFR Part 135 prescribes rules governing commuter or commercial on-demand operations.

[12] Title 14 CFR Part 91 prescribes rules governing the operation of aircraft within the United States, including the waters within 3 nautical miles of the U.S. coast.

[13] Ira J. Blumen, "A Safety Review and Risk Assessment in Air Medical Transport." Supplement to the *Air Medical Physician Handbook*, Salt Lake City, Utah, November 2002.

[14] On January 10, 2003, an EMS helicopter crashed into terrain while maneuvering in dense fog on an aborted mission to pick up a patient. The pilot and flight paramedic were killed, and the flight nurse was seriously injured. The description for this accident, FTW03FA082, can be found on the Safety Board's Web site at <http://www.ntsb.gov>. Also see appendix A in NTSB/SIR-06/01.

[15] Vertical visibility is the distance that can be seen upward into a surface-based obscuration (for example, fog), or the maximum height from which a pilot in flight can recognize the ground through a surface-based obscuration.

[16] National Transportation Safety Board, *Evaluation of U.S. Department of Transportation Efforts in the 1990s to Address Fatigue*, Safety Report NTSB/SR-99/01 (Washington, DC: NTSB, 1999), p. 6.

which are critical to safe flight operations. If a pilot has delivered a patient and has worked the maximum duty time under Part 135 requirements but returns the helicopter to departure base (a Part 91 flight), the hours flown for the Part 91 flight with no patient on board currently do not count toward his duty time restrictions.[17] This situation could result in a pilot flying in a fatigued condition during the Part 91 leg of the flight or not getting adequate rest during his time off, leaving him fatigued when he returns to duty the following day. If the return flight were conducted under Part 135 requirements, the pilot could request that his duty hours be extended to reposition the flight, but a longer rest period before returning to duty would be required. Further, the hours that a pilot flies under Part 91 do not count toward the total duty time the pilot is permitted to fly under Part 135 requirements. If a pilot were to conduct lengthy flight operations under Part 91, this flight time would not be indicated in his duty record and his eligibility to fly Part 135 flights would not be affected.

The Safety Board also notes that when pilots are permitted to proceed under Part 91 requirements in minimal weather conditions or near the end of their duty time (if their Part 91 and Part 135 duty hours were combined) to pick up a patient, the patient's critical condition might significantly influence pilots to complete the mission and transport the patient to a hospital even though the flight would not be permissible under Part 135 requirements. It is critical that EMS aircraft arrive safely at patient pick-up or drop-off locations. If the flight is unable to operate safely under Part 135 requirements, then the mission should not be attempted. Transporting a patient to the hospital is of utmost importance; however, if a flight is unable to safely reach the patient, the safety of the entire operation is compromised, and it may be to the patient's benefit to be transported by some other means, such as ground transportation. Of the 55 accidents investigated from January 2002 to January 2005, 10 flights were operating under the less stringent requirements of Part 91 and would not have met authorized weather minimums if they had been required to operate under Part 135.

The Safety Board does not believe that EMS operations should be permitted to continue to operate under the less strict requirements of Part 91 simply because a patient is not on board. An EMS positioning flight does not fit the traditional definition of a positioning flight, which involves flying an empty aircraft from one location to another for future operations. Rather, a positioning flight in EMS operations is a critical part of transporting medical personnel to a patient's location or returning from a patient drop-off; therefore, the positioning legs of flights should not be separated from the patient-transportation leg. All three of these flight functions comprise the EMS mission and should not be differentiated. Because Part 135 requirements impose additional safety controls that are not present under Part 91 requirements, the Safety

[17] The Safety Board issued Safety Recommendation A-94-194, which asked the FAA to revise the regulations contained in 14 CFR Part 135 to require that pilot flight time accumulated in all company flying conducted after revenue operations—such as training and check flights, ferry flights, and repositioning flights—be included in the crewmember's total flight time accrued during revenue operations. The recommendation is currently classified "Open—Unacceptable Response" because of the FAA's inaction. The Board also issued Safety Recommendation A-95-113 to the FAA to finalize the review of current flight and duty time regulations and revise the regulations, as necessary, within 1 year to ensure that flight and duty time limitations take into consideration research findings in fatigue and sleep issues. This recommendation also asked that the new regulations prohibit air carriers from assigning flight crews to flight conducted under 14 CFR Part 91 unless the flight crews meet the flight and duty time limitations of 14 CFR Part 121 or other appropriate regulations. The recommendation is also classified "Open—Unacceptable Response." These recommendations are on the Safety Board's Most Wanted List of Safety Improvements.

Board concludes that the safety of EMS operations would be improved if the entire EMS flight plan operated under Part 135 operations specifications; 35 of the 55 accidents in the Board's special investigation occurred with crewmembers on board but no patients on board.

Further, the Safety Board is aware that some certificate holders may train medical personnel to perform duties that loosely relate to the operation of the aircraft, such as looking outside the aircraft for possible obstructions or evaluating a landing site, so that these personnel are classified as flight crewmembers, which permits positioning flights to be operated under Part 91.[18] The Board does not consider the assignment of limited operational duties to medical personnel to provide a sufficient basis for operating under the less rigorous requirements of Part 91, which provides inadequate safety controls for the transport of these medical personnel passengers. Without specific flight training (which medical personnel generally do not receive),[19] medical personnel cannot be expected to meaningfully participate in the decision-making process to enhance flight safety or to significantly contribute to operational control of the flight; therefore, regardless of any operational duties medical personnel may be assigned, they should be considered passengers on all EMS flights. The Safety Board concludes that the minimal contribution of medical personnel to the safe operation of EMS flights is not sufficient to justify operating EMS positioning flights under the less stringent Part 91 requirements.

The Safety Board notes that, because all EMS operators already fly under Part 135 operations specifications when patients are on board, little change would be required regarding the way they operate flights under Part 135 operations specifications when only medical personnel are on board. Because of the frequency with which EMS aviation accidents continue to occur while operating under Part 91 provisions, the Safety Board believes that the FAA should require all EMS operators to comply with Part 135 operations specifications during the conduct of all flights with medical personnel onboard.

Aviation Flight Risk Evaluation Programs for EMS Operations

Much of the EMS mission has associated risks. Pressure to take or complete a mission, weather, nighttime flight, spatial disorientation resulting from lack of visual cues, and pilot training and experience were all identified as risk factors in the Safety Board's 1988 safety study of commercial EMS helicopter operations. The 2002 AMPA study cited additional risks, such as unprepared landing sites, complacency, and situational stress. Safely operating in such a high-risk environment calls for the systematic evaluation and management of these risks. According to AMPA's study, an effective flight risk evaluation program acknowledges and identifies threats, evaluates and prioritizes the risks, considers the probability that a risk will materialize, and

[18] According to FAA Order 8400.10, "Air Transportation Operations Inspector's Handbook," volume 4, chapter 5, medical personnel may or may not be considered crewmembers at the operator's discretion. The order states, in part, "if the operator desires to consider the medical personnel crewmembers, the medical personnel must complete initial and recurrent crewmember training programs [and]…must perform some duty in an aircraft that relates to the operation of that aircraft." A note in the order states, "when only crewmembers are on board the aircraft, the flight may be conducted under FAR Part 91. When a patient or passenger is on board the aircraft, the flight must be conducted under FAR Part 135."

[19] According to AC 135-14A, "Emergency Medical Services/Helicopter (EMS/H)," medical personnel need only to be trained in the use of aviation terminology, physiological aspects of flight, aircraft evacuation, and patient loading and unloading.

mitigates loss. The Safety Board's investigation determined that, in the EMS environment, conducting a flight risk evaluation would require the pilot and possibly another person (a manager, a flight dispatcher, or another flight crewmember) to assess the situation without being influenced by the sense of urgency that can accompany the initial call requesting services. The Board's investigation of recent EMS accidents found that all of the operators involved did not have an established aviation flight risk evaluation program that would assist pilots in making an objective determination of the risks that would be present.

For example, Intermountain Health Care (IHC) Health Services, Inc., the operator involved in the January 2003 Salt Lake City accident, did not have an established aviation flight risk evaluation program when the accident occurred. If an aviation flight risk evaluation program had been in place, the pilot would likely have been required to complete a standardized flight risk evaluation matrix before the flight, including assessing weather minimums and the route of flight. The poor nighttime weather conditions would have raised the risk rating for the mission, requiring further consideration of the flight risks. A previous pilot who aborted his attempt at the mission informed the accident pilot of the weather conditions, but the accident pilot decided to take the flight anyway. A systematic evaluation of the flight risks might have prevented the flight.

The Safety Board has learned that IHC Health Services implemented a risk management program after the January 2003 accident; the program includes a risk matrix form that pilots begin filling out when their shift begins. When an EMS call is received, the pilot completes the remainder of the form and calculates the flight risk. The risk matrix also contains standardized flight procedures that require a flight dispatcher's agreement so that the pilot is alleviated of the sole responsibility for deciding whether to attempt a mission. In addition, IHC Health Services developed a safety awareness program for its EMS operations and, along with other EMS operators in Salt Lake City, developed and instituted a policy letter concerning communications between operators during adverse weather and hazardous conditions.

If the operator involved in the Battle Mountain, Nevada, accident[20] had an established flight risk evaluation program, a different route may have been chosen before the accident flight. The pilot chose to take a direct route over a remote area of rugged mountainous terrain with little lighting instead of a slightly longer route that followed an interstate highway and avoided the highest terrain. The pilot might have felt additional pressure to take the direct route because the patient was an infant. If a risk management program had been in place, the dark night conditions and the mountainous route of flight might have raised the risk rating for the mission, which might have led the pilot to make an alternative decision regarding the flight (such as taking a less mountainous route) to lower the risk. Thirteen of the 55 accidents studied during this

[20] On August 21, 2004, an EMS helicopter crashed into mountainous terrain at night and in deteriorating weather conditions while transporting a patient along a direct route through mountainous terrain rather than taking an indirect route around the high terrain. The pilot, two medical crewmembers, patient, and patient's mother were killed. The description for this accident, SEA04MA167, can be found on the Safety Board's Web site at <http://www.ntsb.gov>. Also see appendix A in NTSB/SIR-06/01.

investigation might not have occurred if flight risk evaluation programs had been in place because the flights might have been rejected or the risks might have been mitigated.[21]

The Safety Board is aware that Notice N8000.301, "Operational Risk Assessment Programs for Helicopter Emergency Medical Services," recommends that company procedures manuals contain procedures for maintaining operational control and conducting risk assessment and management. The Board is pleased that this notice, which was issued in 2005, is more detailed than AC 135-14A, which was issued in 1991 and had similarly addressed the need to consider judgment and decision-making in the development of safety programs for EMS operation. However, the Board is not confident that the new guidance will be any more widely adopted by EMS operators than the old guidance because most operators examined during this investigation did not have a decision-making or a risk evaluation program in place (as suggested in the 1991 guidance) when accidents involving their aircraft occurred. Because aviation risk evaluation programs include training and procedural requirements that promote the risk evaluation of each flight in a systematic manner and consultation with others trained in EMS flight operations if the risks reach a predefined level, the Safety Board concludes that the implementation of flight risk evaluation before each mission would enhance the safety of EMS operations. Therefore, the Safety Board believes that the FAA should require all EMS operators to develop and implement flight risk evaluation programs that include training, procedures that support the systematic evaluation of flight risks, and consultation with others trained in EMS flight operations if the risks reach a predefined level.

Flight Dispatch Procedures

The Safety Board's investigations revealed that many EMS operators lack a consistent, comprehensive flight dispatch procedure, which—as part of a flight risk evaluation program—would help EMS pilots determine whether it is safe to accept or continue a mission. In commercial, passenger-carrying (Part 121) operations, flight dispatchers are responsible for authorizing the release of a flight based on, among other factors, the airworthiness of the aircraft, weather conditions, and the satisfactory operation of communication and navigation facilities along the route of flight, such as expected route, landing information, and notices to airmen (NOTAM). Flight dispatchers for Part 121 operations are also responsible for providing flight-following and updated information the pilot may not otherwise have access to during the flight, such as weather and routing.

Currently, most Part 135 EMS operations specifications permit the pilot to be notified of an assignment by the local 911 dispatch system or emergency hospital staff, yet 911 dispatch or hospital staff do not have expertise in or an understanding of the requirements of flight or landing procedures, particularly at night or in adverse conditions. When a pilot is dispatched by someone other than a flight dispatcher[22] and accepts the flight, the pilot would typically check[23]

[21] Safety Board investigators analyzed the facts, conditions, and circumstances of all 55 accidents and applied the general criteria described in FAA Notice N8000.301, "Operational Risk Assessment Programs for Helicopter Emergency Medical Services," to reach this determination.

[22] The Safety Board makes the distinction between a 911 or hospital dispatcher, who generally works for the local government or hospital and dispatches all emergency services, and a flight dispatcher, who generally works for or under contract to an aviation operator and has specific aviation knowledge, including the effects of weather, mechanical reliability, and operational needs of the flight.

the most accessible source of weather information available (usually via computer, using sources that are not necessarily specific to aviation[24]) and begin the flight. The pilot would then have limited access to updated information. Safety Board staff found that, in many instances, 911 dispatchers or emergency hospital staff did not provide, nor were they expected to provide, EMS operators or pilots with more than minimal information concerning expected route, landing information, weather updates, or NOTAMs before or during a flight. For several accidents, the missing information was critical and could have helped avoid the accident.

Formalized flight dispatch procedures may have mitigated the results of 11 of the 55 accidents examined during the Safety Board's assessment.[25] For example, in the Pyote, Texas, accident,[26] the pilot contacted the hospital dispatcher at the destination hospital only after he had departed Alpine, Texas, with the patient on board. He did not obtain a weather briefing before departure as he should have. If he had obtained a briefing, he would have been informed of expected thunderstorm activity in the area. A Convective Significant Meteorological Information (SIGMET) bulletin issued about 0154 (22 minutes before the accident) indicated an area of thunderstorms predicted for the accident site. Other weather information obtained from satellites and the National Weather Service also indicated thunderstorm activity surrounding the accident site at the time of the accident. Although the pilot took off about 15 minutes before the SIGMET was issued, he might not have continued the flight if he had been in contact with a flight dispatcher with knowledge of and access to this weather information.

For the Salt Lake City accident, the 911 and company dispatchers might not have been aware of the kind of information that is critical to flight safety when dispatching a flight. A transcript of the conversation between the IHC Health Services pilot and his company's flight dispatch center suggested that the pilot was frustrated with the 911 dispatcher's request to fly the mission, even though the 911 dispatcher knew that another company had aborted its flight because of low visibility. Despite this apparent frustration, the pilot and his company's flight dispatch center operator accepted the flight. The transcript showed that his company's dispatcher provided little support other than encouraging the pilot to accept the flight. The pilot was primarily responsible for obtaining weather, coordinating with the on-scene rescue personnel, and maintaining visual flight. Based on reports from the company that had just aborted its flight,

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[23] For Part 91 flights, 14 CFR 91.103, "Preflight action," states the following, "each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight. This information must include - (a) For a flight under [instrument flight rules] or a flight not in the vicinity of an airport, weather reports and forecasts." For Part 135 flights, 14 CFR 135.213, "Weather/reports and forecasts," states in part, "Whenever a person operating an aircraft under this part is required to use a weather report or forecast, that person shall use that of the U.S. National Weather Service, a source approved by the U.S. National Weather Service, or a source approved by the Administrator. However, for operations under VFR, the pilot in command may, if such a report is not available, use weather information based on the pilot's own observations or on those of other persons competent to supply appropriate observations."

[24] Nonaviation-specific weather sources do not contain or analyze information that is important to flight safety, such as visibility, winds, and temperature/dew point spread.

[25] Safety Board investigators analyzed the facts, conditions, and circumstances of all 55 accidents and applied the procedures used by Part 121 flight dispatchers as outlined in the Federal Aviation Regulations to reach this determination.

[26] On March 21, 2004, an EMS helicopter crashed into terrain while maneuvering in reduced visibility conditions while transporting a patient. The pilot, flight paramedic, patient, and patient's mother were killed, and the flight nurse was seriously injured. The description for this accident, FTW04FA097, can be found on the Safety Board's Web site at <http://www.ntsb.gov>. Also see appendix A in NTSB/SIR-06/01.

it should have been clear that the IHC flight should not have been attempted. A flight dispatcher with specific knowledge of flight requirements would likely have been able to more fully comprehend the importance of the other company's aborted flight, independently gather pertinent weather information from all available sources, recognize that the available weather information was severe enough to not even attempt the mission, and provide sound advice to the mission pilot.

An effective dispatch combined with a flight risk evaluation program (as discussed previously) enhances the safety of these often-difficult missions, and, for example, might have prevented the Newberry, South Carolina, accident.[27] Three EMS flight crews had declined this mission because of weather conditions that were not conducive to safe flight. During postaccident interviews, the first pilot stated that he took off from Columbia, South Carolina, for the flight but canceled because of developing fog conditions. The second pilot, who was located in Greenville, South Carolina, indicated that based on his experience and observation of the fog conditions and lack of a temperature/dew point spread, he classified the weather conditions as "red."[28] The third pilot, located in Columbia, declined the mission once he learned that the first pilot returned to the airport due to fog conditions. The accident pilot, located in Spartanburg, South Carolina, was not informed by the Spartanburg County 911 dispatcher that the first pilot had attempted but had not completed the mission or that the other two pilots had refused it. If a flight dispatcher who understood the weather risks based on the other pilots' refusals to take the mission were involved and relayed these risks to the accident pilot, or if a flight risk evaluation program had been in place, the accident pilot might also have rejected the mission.

Dispatch can also track flights to provide updated weather and terrain information or, if necessary, provide flight-locating services. In the Battle Mountain accident, the lack of a comprehensive flight dispatch and flight-following system resulted in the helicopter not being reported overdue until about 4 hours after its departure for a 1 hour, 20 minute flight. The EMS operator used local county 911 dispatch systems for flight-following. As the flight crossed from one county into another, flight-following responsibility moved from one 911 dispatch center to another. However, the 911 dispatch centers did not directly communicate with one another about the progress of a flight; instead, the pilot was responsible for initiating these communications when changing county dispatch centers. When the accident pilot failed to make his required 15-minute position report after departing Battle Mountain, the Battle Mountain 911 dispatcher took no action, likely because she was not expecting another report from this pilot as he traveled into the next county. The helicopter was not reported overdue until personnel at the hospital in Reno, Nevada, became concerned when the patient did not arrive. Although this accident was not survivable, in other situations, flight-following and immediate notification would result in more timely search and rescue operations, which could have potentially life-saving benefits.

The Safety Board is aware that some EMS operators have company-trained dispatchers on staff who communicate with hospital emergency personnel or on-scene emergency services

[27] On July 13, 2004, an EMS helicopter collided with trees shortly after picking up a passenger from an accident site on an interstate. The pilot, flight nurse, flight paramedic, and patient were killed. The description for this accident, CHI04MA182, can be found on the Safety Board's Web site at <http://www.ntsb.gov>. Also see appendix A in NTSB/SIR-06/01.

[28] A "red" classification is a designation used by the pilot's company indicating that the pilot would not take off until the weather conditions improved.

and notify the EMS pilot of flight assignments. These flight dispatchers obtain weather information for a pilot before a flight and, after a flight begins, they obtain updated weather information if requested by a pilot. These flight dispatchers also file a company flight plan and monitor the flight so that it can be quickly located if it is involved in an accident. This function is an important aspect of safe flight operations, and the safety of EMS operations would be enhanced if formalized dispatch procedures were used.

Formalized dispatch procedures would include a person knowledgeable in flight operations, weather, maintenance, and flight-following who would be able to evaluate all flight risks and advise a pilot about whether to accept or continue a mission in changing weather situations. Because the flight dispatcher would be detached from the emergency itself (the flight dispatcher would not be the 911 or hospital dispatcher), the flight dispatcher would be less susceptible to making flight decisions based on the urgency of the situation and would be able to obtain an overall perspective of the mission's safety. The Safety Board concludes that formalized dispatch and flight-following procedures, including a dedicated dispatcher with aviation-specific knowledge and experience, would enhance the safety of EMS flight operations by providing the pilot with consistent and critical weather information, assisting in go/no go decisions, and monitoring the flight's position. Therefore, the Safety Board believes that the FAA should require EMS operators to develop and use formalized dispatch and flight-following procedures that include up-to-date weather information and assistance in flight risk assessment decisions.

Use of Technology to Assist in EMS Flight Operations

Terrain Awareness and Warning Systems

The study by AMPA found that controlled flight into terrain (CFIT) is a common factor in helicopter EMS accidents, in particular during the takeoff or landing sequence.[29] During low flight over terrain or flight over variable terrain, the use of TAWS could provide valuable information to pilots who are trained in instrument flight but do not completely or properly use all of their instruments, as well as those pilots who are not instrument-trained.[30] TAWS can substantially reduce pilot workload and improve the margin of safety during limited visibility conditions, which are often encountered during EMS operations. The FAA has already recognized the benefit of TAWS by requiring these systems on turbine-powered airplanes with six or more passenger seats. Requiring TAWS for EMS aircraft would extend this benefit to the patients and medical personnel traveling on EMS flights.

The use of TAWS might have helped the pilot in the Battle Mountain accident avoid the terrain. According to data supplied by a U.S. manufacturer of TAWS equipment, the

[29] Blumen, MD and the UCAN Safety Committee. 2002. p. 8.

[30] Although similar in purpose, TAWS functionality is different from that of a radio altimeter, which uses the reflection of radio waves from the ground to determine the height of an aircraft above the surface. On October 7, 2002, the Safety Board issued Safety Recommendation A-02-35, asking the FAA to "require the installation of radar altimeters in all helicopters conducting commercial, passenger-carrying operations in areas where flat light or whiteout conditions routinely occur." In a September 6, 2005, response, the FAA indicated that an Aviation Rulemaking Committee has discussed requiring "radio altimeters in helicopters and will recommend the installation in aeromedical operations." The FAA also stated that it would solicit comments on whether radio altimeters should be installed in all helicopters conducting commercial passenger-carrying operations when it publishes a notice of proposed rulemaking.

reconstructed flight profile of the accident helicopter indicated that if the helicopter had been equipped with TAWS, a "caution terrain" aural message would have sounded 30 seconds before impact, and a "warning terrain" aural message would have sounded 25 seconds before impact and continued to the end of the flight. These warnings would have provided adequate time to allow the pilot to take appropriate action to avoid impact with the terrain. Further, the Safety Board's investigation found that, for 17 of the 55 accidents, TAWS might have helped the pilots avoid terrain.

The Safety Board concludes that the use of TAWS would enhance EMS flight operations by helping to prevent CFIT accidents that occur at night or in adverse weather conditions. Although FAA Notice 8000.293 encourages operators to consider installing TAWS for nighttime operations, merely encouraging the use of a technology is not sufficient; operators should be required to incorporate systems and practices that will improve the safety of their operations. Additionally, as TAWS becomes more widely used, its cost will continue to decrease.[31] Therefore, the Safety Board believes that the FAA should require EMS operators to install TAWS on their aircraft and to provide adequate training to ensure that flight crews are capable of using the systems to safely conduct EMS operations.

Night Vision Imaging Systems

Safety Board staff found that some EMS operators use night vision imaging systems (NVIS),[32] which enhance a pilot's ability to see and avoid obstructions at night. However, most EMS operators do not use such equipment because of its relatively recent introduction into the nonmilitary community; the expense of the system, training, and aircraft modifications; and the fact that the equipment cannot be used in locations that have ambient light, such as populated areas. An FAA study found that "[w]hen properly used, NVGs [night vision goggles] can increase safety, enhance situational awareness, and reduce pilot workload and stress that are typically associated with night operations."[33] The study by AMPA found that collision with objects poses a problem for EMS helicopters and that wires are the most common obstacles (NVGs can help pilots see wires). The study also noted that although 38 percent of all helicopter EMS flights were at night, 49 percent of accidents occurred during nighttime hours.[34]

The FAA allows Part 135 operators to use NVIS to aid in night flight during visual meteorological conditions (VMC), but they are not to be used during IMC; therefore, VFR weather minimums must be complied with during a flight. The FAA's Technical Standard Order-C164 describes the minimum performance standards NVGs must meet for design approval. The FAA also issued Flight Standards Handbook Bulletin for Air Transportation 04-02, "Night Vision Imaging Systems," which guides principal operations inspectors in the evaluation of operations, training, currency, and equipment after an operator's request to use NVIS.

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[31] Current market cost for TAWS installation is about $30,000.

[32] NVISs most commonly refer to night vision goggles but can also include technology such as thermal imaging equipment, night vision cameras, and heads-up displays. NVISs can enhance vision in dark conditions by amplifying available light several hundred times.

[33] W.T. Sampson, G.B. Simpson, and D.L. Green. 1994. *Night vision goggles in Emergency Medical Services (EMS) Helicopter*, FAA report DOT/FAA/RD-94/21, Federal Aviation Administration, Washington, DC.

[34] Blumen, MD and the UCAN Safety Committee. 2002. p. II.

The use of NVIS might have helped the pilots involved in the Battle Mountain and Redwood Valley, California,[35] accidents. If the Battle Mountain pilot had been using an NVIS, he would likely have seen the ridgeline and been able to avoid the impact. In the Redwood Valley accident, the pilot was flying at night in a narrow canyon and would not have been able to see any outside cues about his location in relation to the terrain around him as he tried to reverse course to return to his departure base. If this pilot had been using an NVIS, he would likely have been able to identify the walls of the canyon, negotiate the terrain, and avoid the accident. The Safety Board notes that, among other improvements to its operations, the EMS operator involved in the Salt Lake City accident expedited the implementation of an NVG program after the accident.

The Safety Board's investigation found that, for 13 of the 55 accidents, NVIS might have helped the pilots more clearly observe obstacles and take evasive action to avoid the accidents. The Board concludes that if used properly, NVIS could help EMS pilots identify and avoid hazards during nighttime operations. The Safety Board is pleased that the FAA has encouraged the use of NVIS in EMS operations and hopes that this technology will be more widely used. Currently, the Safety Board is not recommending that NVIS be required for all EMS operators because NVIS are not feasible in some situations, such as populated areas with ambient light and numerous streetlights. The required use of NVIS needs to be made on an individual operator basis. However, the Safety Board will monitor the effectiveness of the FAA's recommendation that operators use NVIS to determine whether this recommendation is sufficient to implement NVIS use on a more widespread basis or if a requirement is necessary.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Require all emergency medical services operators to comply with 14 *Code of Federal Regulations* Part 135 operations specifications during the conduct of all flights with medical personnel onboard. (A-06-12)
>
> Require all emergency medical services (EMS) operators to develop and implement flight risk evaluation programs that include training all employees involved in the operation, procedures that support the systematic evaluation of flight risks, and consultation with others trained in EMS flight operations if the risks reach a predefined level. (A-06-13)
>
> Require emergency medical services operators to use formalized dispatch and flight-following procedures that include up-to-date weather information and assistance in flight risk assessment decisions. (A-06-14)
>
> Require emergency medical services (EMS) operators to install terrain awareness and warning systems on their aircraft and to provide adequate training to ensure

[35] On December 23, 2003, an EMS helicopter was en route to pick up a patient when it collided with mountainous terrain while operating in high winds and heavy rain. The pilot, flight nurse, and paramedic were killed. The description for this accident, LAX04FA076, can be found on the Safety Board's Web site at <http://www.ntsb.gov>. Also see appendix A in NTSB/SIR-06/01.

that flight crews are capable of using the systems to safely conduct EMS operations. (A-06-15)

Acting Chairman ROSENKER and Members ENGLEMAN CONNERS, HERSMAN, and HIGGINS concurred with these recommendations.

[Original Signed]

By: Mark V. Rosenker
Acting Chairman