Helicopter Air Ambulance Collision with Terrain Survival Flight Inc. Bell 407 Helicopter, N191SF near Zaleski, Ohio January 29, 2019

Accident Report

NTSB/AAR-20/01
PB2020-101001

National
Transportation
Safety Board

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Adopted May 19, 2020

Aircraft Accident Report

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Survival Flight Inc.
Bell 407 Helicopter, N191SF
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National
Transportation
Safety Board

490 L'Enfant Plaza, S.W.
Washington, D.C. 20594

National Transportation Safety Board. 2020. ***Helicopter Air Ambulance Collision with Terrain, Survival Flight Inc., Bell 407 Helicopter, N191SF, near Zaleski, Ohio, January 29, 2019*****. Air Accident Report NTSB/AAR-20/01. Washington, DC.**

Abstract: This report discusses the January 29, 2019, accident involving a Bell 407 helicopter, N191SF, being operated as a helicopter air ambulance (HAA) flight, which collided with forested terrain about 4 miles northeast of Zaleski, Ohio. The certificated commercial pilot, flight nurse, and flight paramedic died, and the helicopter was destroyed. The helicopter was registered to and operated by Viking Aviation, LLC, doing business as Survival Flight Inc., under Title 14 *Code of Federal Regulations* Part 135. Safety issues identified in this report include Survival Flight's lack of comprehensive and effective flight risk assessment and risk management procedures, the lack of a positive safety culture endorsed by Survival Flight management and the lack of a comprehensive safety management system, the need for flight data monitoring programs for HAA operators, the lack of HAA experience for principal operations inspectors assigned to HAA operations, the lack of accurate terminal doppler weather radar data available on the HEMS (helicopter emergency medical services) Weather Tool, and the lack of a flight recorder. As a result of this investigation, the National Transportation Safety Board makes five new safety recommendations to the Federal Aviation Administration, three new safety recommendations to the National Weather Service, and six new recommendations to Survival Flight.

For more detailed background information on this report, visit the NTSB investigations website and search for NTSB accident ID CEN19FA072. Recent publications are available in their entirety on the NTSB website. Other information about available publications also may be obtained from the website or by contacting—
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Abbreviations

AC	advisory circular
AIRMET	airmen's meteorological information
CFR	*Code of Federal Regulations*
DO	director of operations
ECU	engine control unit
ERT	emergency room technician
FAA	Federal Aviation Administration
FDM	flight data monitoring
FIS-B	flight information service–broadcast
FRA	flight risk assessment
GOM	general operations manual
HAA	helicopter air ambulance
HEMS	helicopter emergency medical services
HTAWS	helicopter terrain awareness and warning system
IFR	instrument flight rules
IIMC	inadvertent IMC
IMC	instrument meteorological conditions
METAR	aviation routine weather report
MRMS	multi-radar/multi-sensor system
MVFR	marginal visual flight rules
nm	nautical miles
NVG	night vision goggles
NWS	National Weather Service
OCC	operations control center
OCM	operational control manager
OCS	operations control specialist
OpSpec	operations specifications
PIC	pilot-in-command
PIREP	pilot weather report

POI	principal operations inspector
SAS	safety assurance system
SIGMET	significant meteorological information
SMS	safety management system
TCDS	type certificate data sheet
TDWR	terminal doppler weather radar
VFR	visual flight rules
VMC	visual meteorological conditions
WSR-88D	weather surveillance radar-1988, doppler

Executive Summary

On January 29, 2019, about 0650 eastern standard time, a single-engine, turbine-powered Bell 407 helicopter, N191SF, being operated as a helicopter air ambulance (HAA) flight, collided with forested terrain about 4 miles northeast of Zaleski, Ohio.[1] The certificated commercial pilot, flight nurse, and flight paramedic died, and the helicopter was destroyed. The helicopter was registered to and operated by Viking Aviation, LLC, doing business as Survival Flight Inc., under Title 14 *Code of Federal Regulations* Part 135. Company flight-following procedures were in effect for the visual flight rules (VFR) flight, which departed Mount Carmel Hospital, Grove City, Ohio, about 0628 and was destined for Holzer Meigs Emergency Department, Pomeroy, Ohio, about 69 nautical miles southeast, to pick up a patient. Night visual meteorological conditions existed at the departure location, but available weather information indicated that snow showers and areas of instrument meteorological conditions (IMC) existed along the route of flight.

On the morning of the accident, before contacting Survival Flight, an emergency room technician at Holzer Meigs Emergency Department contacted two other HAA operators with a request to transport a patient from her facility to OhioHealth Riverside Methodist Hospital, Columbus, Ohio; both operators ultimately turned down the flight request due to poor weather conditions. After speaking with the ERT about the details of the request, the operations control specialist at Survival Flight contacted the Survival Flight pilot on duty (the evening shift pilot) at Base 14 and requested a weather check to determine if the mission could be accepted. About 28 seconds later, the evening shift pilot accepted the flight. Because the request was received around the time the evening shift pilot's shift was ending, he informed the operations control specialist that the day shift pilot (the accident pilot) was 5 minutes away from the base and may take the flight.

When the accident pilot arrived at Base 14, she proceeded directly to the already-started helicopter and departed. There was no record of the accident pilot receiving a weather briefing or accessing any imagery on the weather application (Foreflight). Additionally, neither pilot completed a preflight risk assessment for the flight, as required by Title 14 *Code of Federal Regulations* Part 135.617, and the evening shift pilot stated he expected the accident pilot to complete the assessment after she returned.

On the morning of the accident, station models around the accident site indicated marginal visual meteorological conditions with gusty surface wind from the west between 10 to 20 kts. Visibilities were reported as low as 3 miles at the surface in light snow conditions. There was a 30% to 60% chance of light snow and two airmen's meteorological information advisories had been issued: one for moderate turbulence below 10,000 ft mean sea level (msl) and one for moderate icing conditions below 8,000 ft msl.

Recorded weather radar and flight data monitoring (FDM) data indicate that, about 0628, the helicopter began to gain altitude, reaching a maximum altitude of about 3,000 ft, and traveled

[1] For more information, see the Factual Information and Analysis sections of this report. Additional information can be found in the public docket for this National Transportation Safety Board (NTSB) accident investigation (case number CEN19FA072) by accessing the Accident Dockets link at www.ntsb.gov. For information about our safety recommendations, see the Safety Recommendations Database at the same website.

in a southeast direction for about 22 minutes, flying through two snow bands en route to the destination hospital. During the encounter with the second snow band, the pilot likely encountered instrument meteorological conditions (IMC) due to reduced visibility in snow. Shortly after the encounter with the second snow band, the helicopter flew a path consistent with a 180° descending left turn, which may have indicated the pilot was attempting to perform an escape maneuver to exit inadvertent IMC. However, she did not command the helicopter to climb, and it continued to descend until the last moments of the flight. The helicopter impacted trees on the reciprocal heading of the flightpath.

Probable Cause

The NTSB determines that the probable cause of this accident was Survival Flight's inadequate management of safety, which normalized pilots' and operations control specialists' noncompliance with risk analysis procedures and resulted in the initiation of the flight without a comprehensive preflight weather evaluation, leading to the pilot's inadvertent encounter with instrument meteorological conditions, failure to maintain altitude, and subsequent collision with terrain. Contributing to the accident was the Federal Aviation Administration's inadequate oversight of the operator's risk management program and failure to require Title 14 *Code of Federal Regulations* Part 135 operators to establish safety management system programs.

Safety Issues

The NTSB identified the following safety issues as a result of this accident investigation:

- **Survival Flight's lack of comprehensive and effective flight risk assessment and risk management procedures.** The preflight risk assessment procedure Survival Flight used at the time of the accident did not include identifying prior flight refusals by another HAA operator, including forecast en route weather, or conducting the flight risk assessment before every flight. When the criteria for the accident flight were entered into the exemplar risk assessment worksheet that contained all the components included in Advisory Circular 135-14B, "Helicopter Air Ambulance Operations," the resultant score indicated the flight would have been classified two levels higher than the risk assessment used for the accident flight. However, because of the ineffective flight risk assessment used at Survival Flight, the accident flight was allowed to depart, and the pilot had no knowledge of other operators' previous refusals of the flight or the potential weather along the route of flight.
- **The lack of a positive safety culture endorsed by Survival Flight management and the lack of a comprehensive safety management system (SMS).** The investigation revealed multiple safety-related deficiencies at Survival Flight, including the failure to record accurate duty times, noncompliance with regulations and procedures, the pressure to complete flights, punitive repercussions for safety decisions, and the lack of operational oversight. Additionally, the casual behavior of Survival Flight management regarding risk assessment and safety programs was not indicative of a company with an established SMS program. A comprehensive SMS program has been

recognized in the aviation industry as an effective way to establish and reinforce a positive safety culture and identify deviations from established procedures.

- **Need for FDM programs for HAA operators.** Survival Flight had FDM equipment installed on its helicopters, as required by federal regulations; however, it did not have an FDM program in place. Thus, Survival Flight had the data to evaluate flight performance and identify other flight deviations due to IMC encounters, which Survival Flight was unaware of. An FDM program would have allowed Survival Flight to proactively identify these safety issues and correct them.
- **Lack of HAA experience for principal operations inspectors assigned to HAA operations.** The investigation revealed the Federal Aviation Administration principal operations inspector assigned to oversee Survival Flight's operation had limited helicopter experience, did not hold a rotorcraft rating on his commercial pilot certificate, and had no experience with HAA operations. The investigation found that, although multiple deficiencies in Survival Flight's operations were identified postaccident, the principal operations inspector's previous inspections of Survival Flight did not reveal any deficiencies; the principal operations inspector was unaware of deficiencies that were later identified in Survival Flight's flight risk assessment.
- **Lack of accurate terminal doppler weather radar data available on the HEMS (helicopter emergency medical services) Weather Tool.** The current version of the HEMS Weather Tool does not incorporate terminal doppler weather radar data to display precipitation. Instead weather radar imagery incorporates information from the network of Weather Surveillance Radar-1988 Doppler weather radars, which may have gaps in coverage. As a result, the HEMS Weather Tool does not always show all potential precipitation, and there is no way for a user to know if the data are lacking or if there is, in fact, no precipitation.
- **Lack of a flight recorder.** The helicopter was not required to have a crash-resistant recorder installed. If a recorder system that captured cockpit audio, images, and parametric data had been installed, it would have enabled NTSB investigators to reconstruct the final moments of the accident flight and determine why the accident pilot did not maintain the helicopter's altitude and successfully exit the inadvertent IMC encounter.

Findings

- The pilot likely encountered instrument meteorological conditions inadvertently when the helicopter flew through a snow band, which resulted in decreased visibility.
- In an attempt to recover from the inadvertent instrument meteorological conditions (IIMC) encounter, the pilot began a 180° turn as part of an IIMC escape maneuver, in keeping with standard operating procedures but did not maintain altitude and allowed the helicopter to descend until it impacted terrain.
- None of the following were factors in the accident: (1) pilot qualifications; (2) pilot medical conditions or impairment by alcohol or other drugs; (3) the airworthiness of the helicopter.

- Survival Flight's risk assessment process was inadequate for identifying weather risks for the accident flight as illustrated by (1) consistent failure by Survival Flight operational personnel to complete the risk assessment worksheet before every flight, including the accident flight, and (2) the absence of required elements on the worksheet, including en route weather risks and refusals of previous requests for a flight.
- Survival Flight's lack of a procedure to track pilots' actual duty time contributed to the ineffectiveness of the company's risk management.
- Survival Flight's inconsistent compliance with standard operating procedures and regulations, combined with management's procedural gaps in risk management, advertising of flights in lower weather minimums, pressure to complete flights, and punitive repercussions for safety decisions, were indicative of a poor safety culture at the company.
- Survival Flight's poor safety culture likely influenced the accident pilot's decision to conduct the accident flight without a shift change briefing, including an adequate preflight risk assessment.
- A properly implemented safety management system, consistent with guidance in Title 14 *Code of Federal Regulations* Part 5 and Advisory Circular 120-92B, would have provided Survival Flight with a foundation to develop a positive safety culture and enhanced the company's and the Federal Aviation Administration's ability to identify poor risk management practices and determine mitigations.
- Although helicopter air ambulances are required to be equipped with flight data monitoring (FDM) systems, the lack of a required FDM program for all Title 14 *Code of Federal Regulations* Part 135 operators to analyze these data continues to result in operational risks remaining unidentified and unmitigated, as occurred in this accident.
- The principal operations inspector's oversight of the Survival Flight flight risk assessment (FRA) was inadequate because it failed to identify that the FRA did not meet the requirements of Title 14 *Code of Federal Regulations* 135.617 or comply with the guidance in Advisory Circular 135-14B.
- Both helicopter and helicopter air ambulance (HAA) experience would allow principal operations inspectors assigned to oversee HAA operations to better identify and mitigate associated risks.
- Although sufficient information was available to the evening shift pilot and the operations control specialist to identify the potential for snow, icing, and reduced visibility along the accident flight route, their failure to obtain complete en route information precluded them from identifying crucial meteorological risks for the accident flight.
- The availability of the lower-altitude reflectivity echoes from terminal doppler weather radar data on the HEMS Weather Tool radar overlay would have provided awareness to the operations control specialist, the evening shift pilot, and the accident pilot of the potential for snow along the flight route.

- Without specialized experience or knowledge of an area, users of the HEMS Weather Tool may not be able to determine if the absence of a weather radar return in a particular area is due to a lack of precipitation or a limitation in radar coverage.
- If a recorder system that captured cockpit audio, images, and parametric data had been installed, it would have enabled NTSB investigators to reconstruct the final moments of the accident flight and determine why the accident pilot did not maintain the helicopter's altitude and successfully exit the encounter with inadvertent instrument meteorological conditions.

Recommendations

New Recommendations

To the Federal Aviation Administration

- Require that principal operations inspectors (POI) assigned to helicopter air ambulance (HAA) operations possess helicopter and either HAA experience or experience as an assistant POI under a POI with HAA experience. (A-20-13)
- Review the flight risk assessments for all helicopter air ambulance operators for compliance with Title 14 *Code of Federal Regulations* 135.617 and Advisory Circular 135-14B and require operators to address any deficiencies that are identified. (A-20-14)
- Install the latest software on your terminal doppler weather radars (TDWR) and require the National Weather Service (NWS) to distribute Level II TDWR data to all of its users (as recommended in Safety Recommendation A-20-18 to the NWS) so they will have access to the most accurate precipitation information. (A-20-15)
- Require the National Weather Service (NWS) to add terminal doppler weather radar data to the HEMS Weather Tool overlay (as recommended in Safety Recommendation A-20-19 to the NWS). (A-20-16)
- Require the National Weather Service (NWS) to provide capability in the HEMS Weather Tool to graphically display areas of weather radar limitations, including areas where beams may lack low-altitude coverage, areas that lack radar coverage, and areas of beam blockages (as recommended in Safety Recommendation A-20-20 to the NWS). (A-20-17)

To the National Weather Service

- Distribute Level II terminal doppler weather radar data to all of its users (as recommended in Safety Recommendation A-20-15 to the Federal Aviation Administration) so they will have access to the most accurate precipitation information. (A-20-18)
- Add terminal doppler weather radar data to the HEMS Weather Tool overlay (as recommended in Safety Recommendation A-20-16 to the Federal Aviation Administration). (A-20-19)

- Provide capability in the HEMS Weather Tool to graphically display areas of weather radar limitations, including areas where beams may lack low-altitude coverage, areas that lack radar coverage, and areas of beam blockages (as recommended in Safety Recommendation A-20-17 to the FAA). (A-20-20)

To Survival Flight

- Revise its flight risk assessment procedures to incorporate the elements described by Advisory Circular 135-14B, including procedures for determining prior flight refusals by another helicopter air ambulance operator and forecast en route weather. (A-20-21)

- Require pilots to complete a comprehensive risk assessment before each flight and complete the appropriate paperwork to reflect their assessment as required by Title 14 *Code of Federal Regulations* 135.617. (A-20-22)

- Develop a procedure for tracking actual pilot duty times in compliance with Title 14 *Code of Federal Regulations* 135.267. (A-20-23)

- Develop a process to ensure shift change briefings are performed, to include comprehensive preflight risk assessments, before the acceptance of any flight requests. (A-20-24)

- Establish a safety management system (SMS) program under the Federal Aviation Administration SMS Voluntary Program that includes compliance with Advisory Circular 120-92B, "Safety Management Systems for Aviation Service Providers." (A-20-25)

- Develop and implement a flight data monitoring program independent of a Federal Aviation Administration requirement. (A-20-26)

Previously Issued Recommendations Reiterated and Classified in This Report

As a result of this investigation, the National Transportation Safety Board reiterates and classifies the following safety recommendations to the Federal Aviation Administration:

> After the action in Safety Recommendation A-16-34 is completed, require all Title 14 *Code of Federal Regulations* Part 135 operators to establish a structured flight data monitoring program that reviews all available data sources to identify deviations from established norms and procedures and other potential safety issues (A-16-35).

Safety Recommendation A-16-35 is classified "Open—Unacceptable Response" in section 2.2.4 of this report.

> Require all Title 14 *Code of Federal Regulations* Part 135 operators to establish safety management system programs (A-16-36).

Safety Recommendation A-16-36 is classified “Open—Unacceptable Response” in section 2.2.3 of this report.

Previously Issued Recommendations Reiterated in This Report

As a result of this investigation, the National Transportation Safety Board reiterates the following safety recommendations to the Federal Aviation Administration:

> Require the installation of a crash-resistant flight recorder system on all newly manufactured turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder and a cockpit voice recorder and are operating under Title 14 *Code of Federal Regulations* Parts 91, 121, or 135. The crash-resistant flight recorder system should record cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible, and parametric data per aircraft and system installation, all as specified in Technical Standard Order C197, “Information Collection and Monitoring Systems” (A-13-12).

> Require all existing turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder or cockpit voice recorder and are operating under Title 14 *Code of Federal Regulations* Parts 91, 121, or 135 to be retrofitted with a crash-resistant flight recorder system. The crash-resistant flight recorder system should record cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible, and parametric data per aircraft and system installation, all as specified in Technical Standard Order C197, “Information Collection and Monitoring Systems” (A-13-13).

1. Factual Information

1.1 History of Flight

On January 29, 2019, about 0650 eastern standard time, a single-engine, turbine-powered Bell 407 helicopter, N191SF, being operated as a helicopter air ambulance (HAA) flight, collided with forested terrain about 4 miles northeast of Zaleski, Ohio.[1] The certificated commercial pilot, flight nurse, and flight paramedic died, and the helicopter was destroyed. The helicopter was registered to and operated by Viking Aviation, LLC, doing business as Survival Flight Inc., under Title 14 *Code of Federal Regulations* (*CFR*) Part 135. Company flight-following procedures were in effect for the visual flight rules (VFR) flight, which departed Mount Carmel Hospital, Grove City, Ohio, about 0628 and was destined for Holzer Meigs Emergency Department, Pomeroy, Ohio, about 69 nautical miles (nm) southeast, to pick up a patient (figure 1 shows the departure and intended destination locations). Night visual meteorological conditions (VMC) existed at the departure location, but available weather information indicated that snow showers and areas of instrument meteorological conditions (IMC) existed along the route of flight (see section 1.4 for more information).[2] The helicopter was not equipped, and was not required to be equipped, with any onboard recording devices.[3]

About 0609 on the day of the accident, an emergency room technician (ERT) at Holzer Meigs Emergency Department contacted the Survival Flight operations control center (OCC) requesting transport for a patient to OhioHealth Riverside Methodist Hospital, Columbus, Ohio.[4] Before contacting Survival Flight, the ERT contacted two other HAA operators, MedFlight and HealthNet Aeromedical Services. According to the ERT in a postaccident interview, MedFlight immediately turned down the flight due to weather. The MedFlight pilot stated in a postaccident statement that he declined the flight request because the icing probability at 1,000 ft above ground level (agl) was greater than 75 percent. He also stated that snow squalls were present on the HEMS (helicopter emergency medical services) Weather Tool, which "would reduce visibility and/or ceilings to below [VFR] minimums."

[1] (a) All times in this report are eastern standard time unless otherwise indicated. (b) Supporting documentation for information referenced in this report can be found in the public docket for this accident, which can be accessed from the National Transportation Safety Board's (NTSB) Accident Dockets web page by searching CEN19FA072. Other NTSB documents referenced in this report, including reports and summarized safety recommendation correspondence, can be accessed from the NTSB's Aviation Information Resources web page.

[2] IMC is the flight category that describes conditions that require pilots to fly primarily by reference to instruments, and therefore under instrument flight rules (IFR), rather than by outside visual references under VFR. According to the National Weather Service and the Federal Aviation Administration Aeronautical Information Manual section 7-1-7, IFR is defined as cloud ceiling of 500 ft to less than 1,000 ft above ground level and/or visibility 1 mile to less than 3 miles.

[3] See section 2.5 of this report for information on the need for flight recorders in all turbine-powered, nonexperimental, nonrestricted-category aircraft.

[4] As an HAA operator with more than 10 aircraft, Survival Flight had an OCC as required by 14 *CFR* 135.619, "Operations Control Center." As stated in the operator's General Operations Manual, the OCC is primarily responsible for flight surveillance while providing advisory information affecting the operator's aircraft.

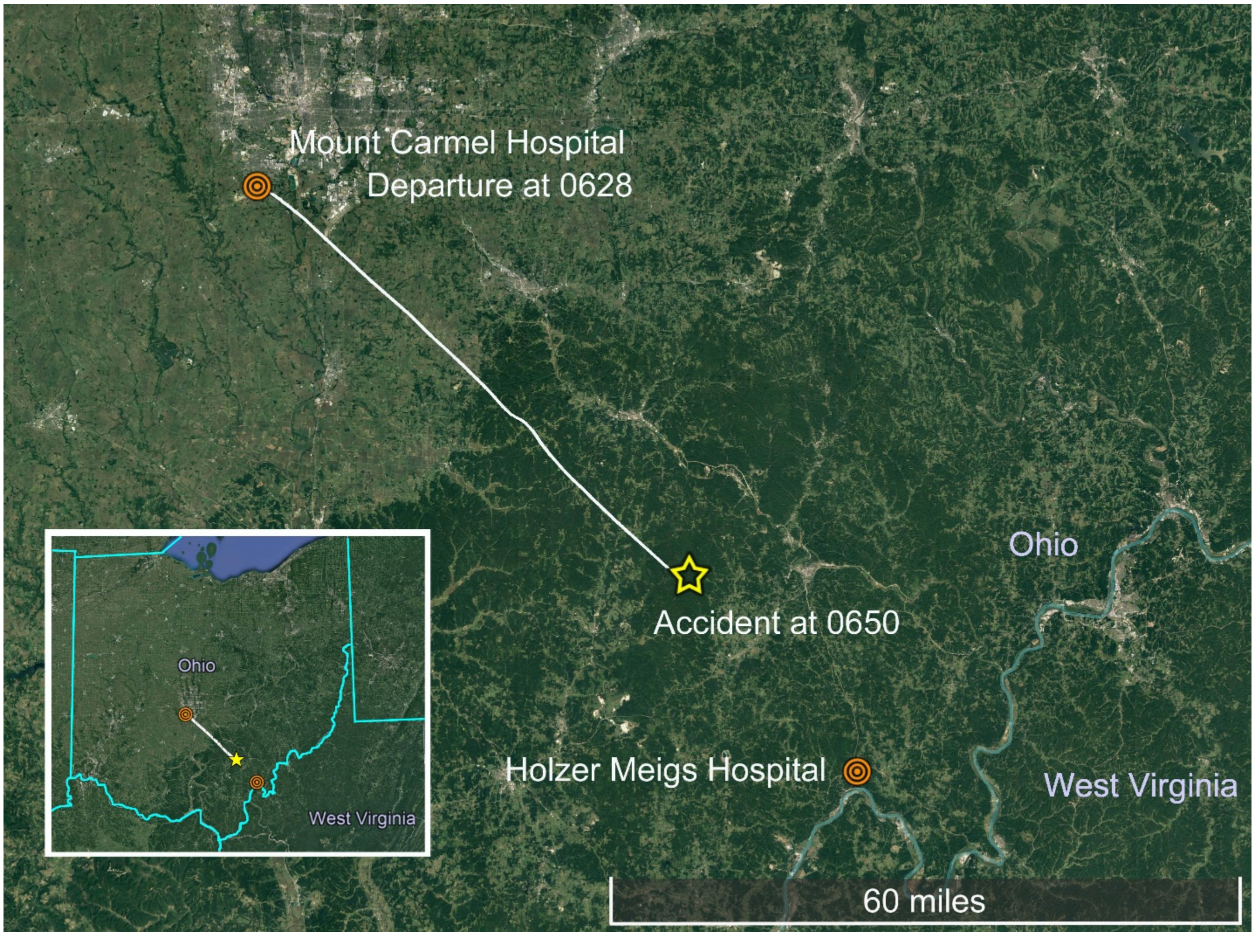

Figure 1. Map showing Mount Carmel Hospital (departure location), accident site, and Holzer Meigs hospital (intended destination).

Upon being contacted for the flight, HealthNet Aeromedical Services informed the ERT that they would perform a "weather check" and get back to her about the request. Before a return call from HealthNet, the ERT contacted Survival Flight, which accepted the flight. The ERT later received a call from HealthNet refusing the flight due to weather. The vice president for HealthNet stated that the pilot declined the request due to low cloud ceilings and icing.[5]

According to OCC communication recordings, about 2 minutes after the ERT contacted Survival Flight, the operations control specialist (OCS) at the Survival Flight OCC contacted the Survival Flight Base 14 pilot on duty (the evening shift pilot) and asked for a weather check to determine if the mission could be accepted.[6] About 28 seconds later, the evening shift pilot accepted the flight and informed the OCS that the day shift pilot (accident pilot) was 5 minutes

[5] The Healthnet vice president also stated that their pilot took 6 minutes to evaluate the weather and decline the flight.

[6] During a postaccident interview, the evening shift pilot stated that he was sleeping when he received the phone call from the OCS.

away from the base and may take the flight.[7] In a postaccident interview, the evening shift pilot recalled the forecast for the route of flight indicated a 2,400-ft ceiling and 7 miles visibility.

According to the evening shift pilot, he contacted the accident pilot while she was en route to the base, briefed her on the mission, and asked her if she wanted to take the flight; she responded that she would take it.[8] In a postaccident interview, the evening shift pilot stated he did not brief the accident pilot on the weather because it was "good weather." The evening shift pilot asked the accident pilot if she needed the night vision goggles (NVG) and she told him that she did not.[9] The evening shift pilot notified the medical crew about the flight request and prepared the helicopter for the flight. When the accident pilot arrived, she proceeded directly to the helicopter where the evening shift pilot had already started the engine.

The helicopter was based at Mount Carmel Hospital and had been on the helipad since the previous day. According to data retrieved from the helicopter's onboard Outerlink Global Solutions IRIS flight data monitoring (FDM) system, the helicopter was started up at 0623 and was stationary on the helipad from 0623 to 0628.[10] OCC communication recordings indicate that, about 0625, the accident pilot contacted the OCS via the onboard satellite radio before departing to confirm the destination for the flight. Two minutes later, the accident pilot contacted OCS again to confirm the coordinates for Holzer Meigs Emergency Department.

FDM data indicate that, about 0628, the helicopter began to gain altitude and traveled southeast; at 0629:32, the OCS called the accident pilot and requested flight release information.[11] She replied, "I'm…green in all categories." The last communication between the pilot and the

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[7] The evening shift pilot stated in an interview that he accepted the flight before contacting the accident pilot. The OCS stated in an interview that after the evening shift pilot accepted the flight, he advised the pilot "that it is a go, and that, you know, we need to go, regardless, if you guys are going to take it, we need to launch for the flight, because it's a launch, it's not a standby."

[8] Due to the safety hazards of distracted driving that the NTSB has found in many highway accident investigations, the NTSB has a long history of recommending that drivers not use cell phones while driving. On March 19, 2020, the NTSB issued two safety recommendations to the federal Occupational Safety and Health Administration: (1) Review and revise your distracted driving initiatives to increase employers' awareness of the need to develop strong cell phone policy prohibiting the use of portable electronic devices while driving. (H-20-5) (2) Modify your enforcement strategies to increase the use of the general duty clause cited in 29 United States Code section 654 against those employers who fail to address the hazards of distracted driving. (H-20-6) The NTSB also issued a recommendation to Apple Inc. to "develop and implement a company policy that bans the nonemergency use of portable electronic devices while driving by all employees and contractors driving company vehicles, operating company-issued portable electronic devices, or using a portable electronic device to engage in work-related communications." (H-20-9) All three recommendations are currently classified "Open—Await Response."

[9] The evening shift pilot further stated that by the time the accident pilot arrived at the base and was ready to go, "she probably figured it was going to be getting light out, which it would have been."

[10] The Outerlink Global Solutions IRIS FDM system stored time, pressure and radio altitude, GPS latitude and longitude, groundspeed, vertical acceleration, lateral acceleration, pitch, roll, magnetic heading, collective, rotor speed, torque, twist grip throttle, and a variety of engine parameters through an onboard recorder. The FDM also sent GPS position and altitude data to a satellite uplink every 11 seconds. The FDM is designed to begin recording from the application of electrical power before takeoff until the removal of electrical power after termination of flight. Additionally, the FDM system was capable of recording cockpit audio via the intercom system. A transcript of the FDM audio can be found in Appendix C of this report.

[11] According to the Survival Flight General Operations Manual, the Flight Release Log (Form 130) documented the risk assessment level at the base (green, amber, amber critical, or red), as determined by the pilot on duty. The Flight Release Log was to be completed for each flight to mirror the pilot-in-command's Risk Assessment Form at the base. Risk assessment procedures will be discussed further in section 1.8.1.5.

OCC was about 0631 after the pilot received patient information and stated that she would provide a flight plan to the OCS.

According to FDM data, from 0629 to 0635, the helicopter climbed steadily until reaching a maximum altitude just below 3,000 ft mean sea level (msl) (an overcast cloud ceiling began at 3,100 ft); its groundspeed during this part of the flight fluctuated between 120 to 140 knots (kts).[12] From 0635 to 0643, the helicopter descended about 1,000 ft before initiating another climb and reaching an altitude of 2,600 ft at 0643:30.[13] Examination of recorded weather data revealed that during this period, the helicopter encountered the first of two snow bands.[14]

By 0647, the helicopter had begun to descend again to an altitude of 2,400 ft (about 1,600 ft agl).[15] About this time, the helicopter encountered a second snow band. Satellite altitude data showed that the helicopter continued to descend until 0647:58 to about 1,975 ft (about 1,000 ft agl). The helicopter's altitude briefly increased about 80 ft before descending at a rate of about 900 ft/minute.

FDM data showed groundspeed decreasing as the altitude continued to decrease about 0649. At 0649:45, the helicopter had descended to 1,300 ft and then began its final climb. It continued to climb through 1,500 ft, at a groundspeed of about 100 kts; the onboard data ended at 0650:08 (figure 2 shows the helicopter's flightpath from Mount Carmel Hospital to the point at which the onboard data ended and figure 3 shows the terrain elevation and accident helicopter's altitude during the pilot's encounter with the snow bands).[16]

[12] The FDM system reported data in msl; therefore, all altitudes are referenced as msl unless otherwise noted.

[13] The terrain in this area varied between 700 ft and 1,100 ft of elevation.

[14] According to the National Weather Service, there are three basic ingredients that are needed in the atmosphere to produce narrow bands of snow: (1) moisture, (2) a front, and (3) atmospheric instability. More information can be found at https://www.weather.gov/fsd/news_bandedsnowfall_20151121.

[15] Due to an error in the Outerlink system, it did not record data from 0647 to 0649; however, satellite data, which recorded the helicopter's position every 11 seconds, were obtained during this time.

[16] Based on discussions with the FDM manufacturer, the reason for the loss of data at the end of the flight could not be determined.

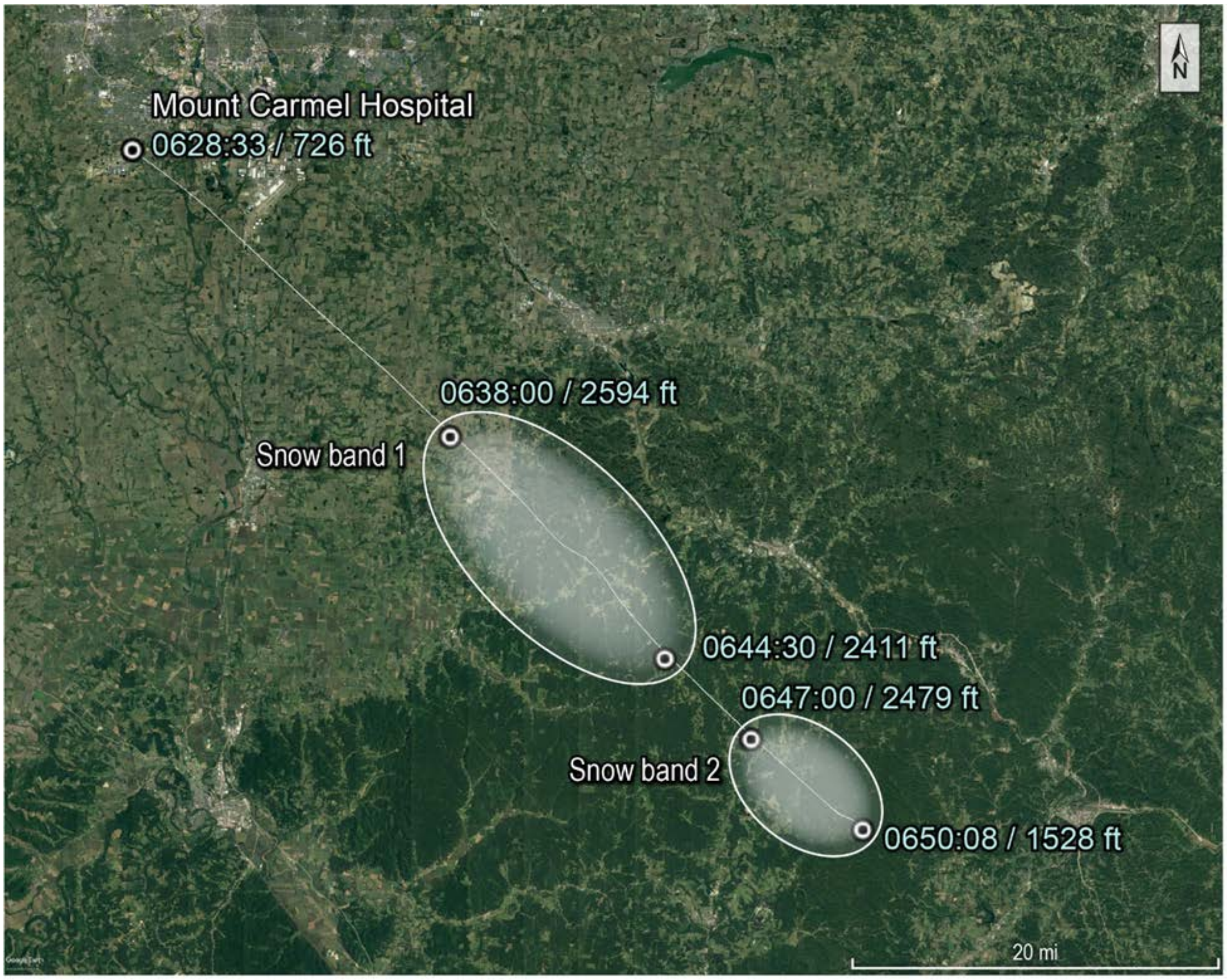


Figure 2. Flightpath of N191SF (white line) depicting the portions of snow bands that surrounded the flightpath.

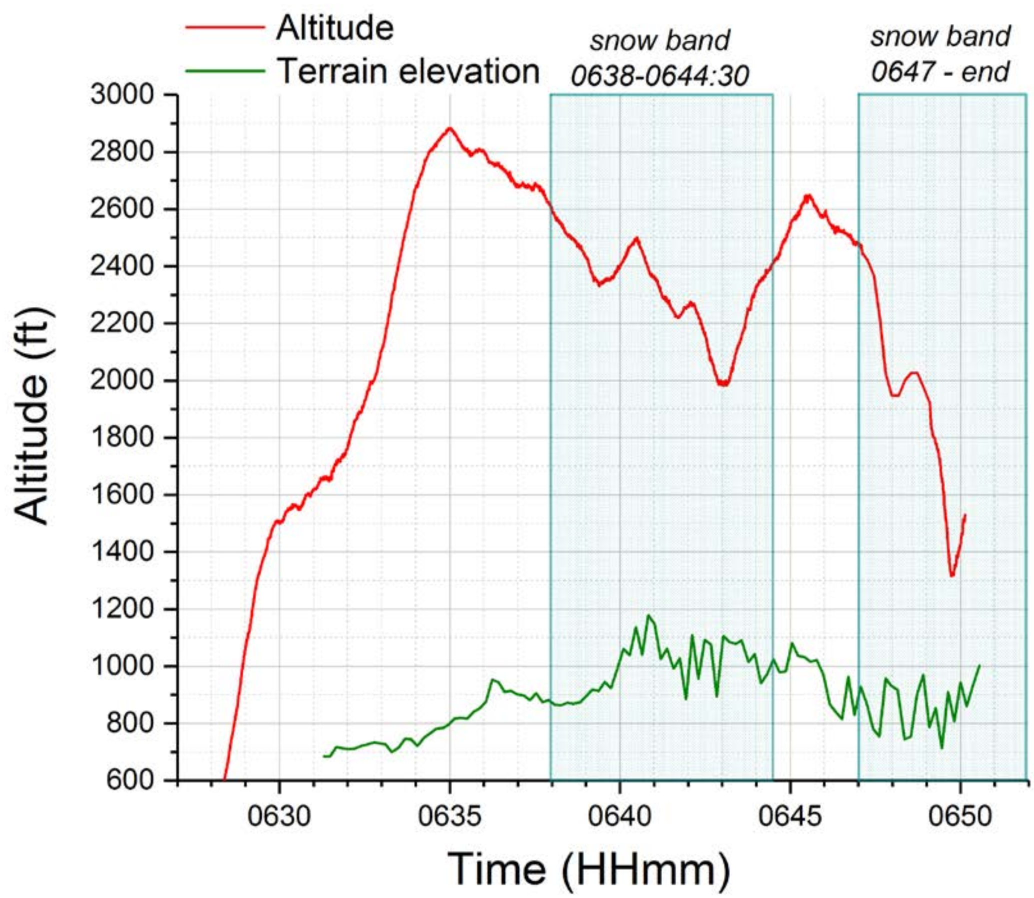


Figure 3. Graph depicting the accident helicopter's altitude (red line), encounter with snow bands (gray shaded areas), and terrain elevation (green line).

The helicopter continued to fly for about 30 seconds after the onboard data ended; two additional satellite data points (the second of which indicated the helicopter had begun to descend again) and the wreckage location were aligned roughly along the arc of a 0.7 nm diameter circle (see figure 4). The wreckage was oriented in the opposite heading of the initial flightpath.

Figure 4. End of N191SF's flightpath (green line) showing the opposite heading orientation of the wreckage location and debris field (orange line).

The OCS, who was following the flight using tracking software in the OCC, reported that, about 15 to 20 minutes after the helicopter departed, he observed the track make a right turn and, shortly after, a sharp left turn as if the helicopter were turning around. He then noticed the helicopter track stop; shortly after, the "no tracking" alarm went off. The OCS then enacted the company emergency action plan.

The helicopter wreckage was located on a tree-covered hill about 4 miles northeast of Zaleski, Ohio.

1.2 Personnel Information

The pilot, age 34, held a commercial pilot certificate with helicopter and instrument helicopter ratings, as well as a private pilot certificate with ratings for airplane-single engine land and instrument airplane. She also held a flight instructor certificate with helicopter and instrument helicopter ratings. The pilot's most recent Federal Aviation Administration (FAA) second-class medical certificate was dated November 14, 2018, with no limitations.

The pilot had been employed by Survival Flight since April 23, 2018. According to company records, at the time she was hired, she had accumulated a total of 1,855 hours of flight experience, which included 589 hours in turbine helicopters; 1,125 hours in piston helicopters; 264 hours at night; and 104 hours of instrument time.[17] Additionally, she had accumulated 14.9 hours in Bell 206 helicopters; there was no record of flight experience in Bell 407 helicopters before she was employed by Survival Flight.

From April 23 to April 27, 2018, the pilot received initial new hire training conducted by Survival Flight that included ground and flight training.[18] At the end of the training, the pilot satisfactorily completed an airman competency/proficiency check in a Bell 206L-3 helicopter. Training records indicated the accident pilot performed one GPS instrument approach procedure, a missed approach procedure, and instrument navigation and communication procedures, as well as unusual attitude recovery, flat light, brownout, and whiteout recovery maneuvers. Upon completion of the training, the pilot was assigned duties as pilot-in-command (PIC) for Bell 206 helicopters.

The pilot conducted all of her training at Survival Flight in the Bell 206. Although she received ground school differences training for the Bell 407, no documentation was provided to reflect completion of in-flight Bell 407 differences training or that she received a competency check in the Bell 407.[19]

According to company flight logs, after completing company flight training, the pilot accumulated 83.3 hours of flight experience, all of which was in the Bell 407. This time also included 57.2 hours during the day and 16.4 hours at night, of which 9.7 hours were flown using NVG.[20] On FAA Form 8710-1, "Airman Certificate and/or Rating Application," completed on September 1, 2016, the pilot indicated she had accumulated 16.2 hours of instrument airplane experience and 52.5 hours of instrument helicopter experience.

For the 6 days before the accident, the pilot had been working day shifts from 0700 to 1900. On the day before the accident, the pilot ended her shift around 1730. According to her fiancé, she spent the evening at home. She planned to arrive earlier than normal on the day of the accident to relieve the evening shift pilot since he arrived earlier than normal the night before to relieve her. No additional information was available regarding the pilot's rest times.

[17] The pilot's flight logbook was not available for review.

[18] Survival Flight used an approved training program as required by 14 *CFR* 135.341, "Pilot and Flight Attendant Crewmember Training Programs."

[19] Although the director of safety and training at Survival Flight stated the accident pilot received in-flight differences training in the Bell 407, Survival Flight provided no documentation that reflected completion of this training.

[20] These flight logs were from May 2018 to December 2018.

1.3 Helicopter Information

The accident helicopter, a Bell 407, was manufactured in 1996 under Type Certificate Data Sheet (TCDS) H2SW (see figure 5).[21] It was powered by one Rolls-Royce (formerly Allison) Model 250-C47B turbine engine.[22] Survival Flight purchased the helicopter in December 2017 and incorporated several modifications, including its air ambulance reconfiguration, in June and July 2018. The helicopter was configured to have the pilot seated in the right cockpit seat. The cyclic and collective controls were removed from the left cockpit seat, but the left seat pedals remained installed and incorporated a pedal “lockout” kit to prevent manipulation of the left-side pedals. Four passenger seats were in the cabin; three forward-facing seats were located on the aft bulkhead and one rear-facing seat was located behind the pilot seat. The patient litter was located on the left side of the cockpit and cabin area and across from the pilot and the rear-facing passenger seat.

Source: The Columbus Dispatch

Figure 5. Photograph of accident helicopter.

At the time of the accident, the helicopter had accumulated 1,179.7 hours total flight time and had 5,058 total landings. It was maintained under an Airframe Progressive Inspection Program in accordance with the Bell 407 maintenance manual.[23] The most recent inspection was performed on December 28, 2018, at an airframe total time of 1,142.1 hours with no anomalies noted.

[21] According to Title 14 *CFR* 21.41, the TCDS is part of a Type Certificate along with the type design, operating limitations, and applicable regulations with which the FAA finds compliance, and any other conditions or limitations prescribed for the product. In addition, FAA Order 8110.4 explains that the TCDS provides a concise definition of a type-certificated product as produced by the original equipment manufacturer.

[22] Allison Engines became Rolls-Royce in 1995.

[23] The Airframe Progressive Inspection Program allows the inspection of aircraft to be conducted in stages, with all stages to be completed in a period of 12 calendar-months.

Avionics installed on the helicopter included a radio altimeter and a dual Garmin GTN 650 system.[24] The Garmin GTN 650 system provided GPS navigational capabilities that allowed a pilot to set a variety of routes between departure and arrival airports and included a helicopter terrain awareness and warning system (HTAWS).[25]Also installed was a Garmin G500H electronic flight information system, which was an integrated display system that presents primary flight instrumentation, navigation, and a moving map. This unit also had the ability to display flight information service–broadcast (FIS-B) weather.[26] Also installed was a Garmin GTS800 traffic collision avoidance system and a Garmin GTX 345R transponder. The helicopter was not equipped, and was not required to be equipped, with a cockpit voice recorder or flight data recorder.[27] The helicopter was also not equipped with an autopilot. Additional equipment on the accident helicopter included a night vision imaging system and an engine inlet snow deflector kit. The helicopter was not certified for instrument flight.

Based on the reported crew weights, equipment loading, and fuel load, the helicopter's weight and center of gravity were within the manufacturer's prescribed limits.

1.4 Meteorological Information

1.4.1 Forecast Weather Information

The graphical area forecast valid before the accident pilot's departure (issued at 0502) forecast marginal visual flight rules (MVFR) conditions at the accident site with an overcast cloud ceiling at 2,200 to 2,800 ft.[28] The forecast included a 30% to 60% chance of light snow or snow shower activity with a westerly surface wind of 10 to 15 kts. Additionally, a winter weather advisory was issued at 0504 and advised of rapidly falling temperatures, flash freeze conditions, scattered snow showers, and up to an inch of snow accumulation possible through 1300 on January 31.

On the morning of the accident, station models around the accident site indicated MVFR conditions with gusty surface wind from the west between 10 and 20 kts.[29] Visibilities were

[24] A radar altimeter uses the reflection of radio waves from the ground to determine the height of an aircraft above the surface.

[25] The Garmin 650 HTAWS provides spatial terrain-awareness information on the terrain page of the Garmin 650 in addition to alerting aurally and visually when terrain or obstacles are predicted to be a hazard for an aircraft. The system's forward-looking terrain awareness provides two levels of alert: a caution alert provides a 30-second lookahead, and a warning provides a 15-second lookahead for potential impact.

[26] FIS-B is a component of automatic dependent surveillance-broadcast technology that provides free graphical National Weather Service products, temporary flight restrictions, and special use airspace information.

[27] Title 14 *CFR* 135.151, "Cockpit Voice Recorders," and 135.152, "Flight Data Recorders," specify the requirements for a cockpit voice recorder and a flight data recorder, respectively. Neither regulation applies to single-engine helicopters.

[28] As defined by the NWS and the FAA *Aeronautical Information Manual* section 7-1-7, MVFR is defined as cloud ceiling from 1,000 to 3,000 ft agl and/or visibility 3 to 5 miles.

[29] These weather observations were noted at Ohio University Airport (8 miles to the southeast), Ross County Airport (34 miles to the west) and Fairfield County Airport (30 miles to the northwest).

reported as low as 3 miles at the surface in light snow conditions at Fairfield County Airport, which was 30 miles to the northwest of the accident site.

A review of pilot weather reports (PIREPs) publicly disseminated to the National Airspace System revealed several reports indicating ice or snow in Ohio and West Virginia on the morning of the accident. One PIREP (provided by the pilot of a Beechcraft Baron) relevant to the accident flight and departure location reported light rime icing at 4,000 ft and a temperature of -15°C at 0553 about 10 miles west of Rickenbacker International Airport.[30] Additionally, two airmen's meteorological information (AIRMET) advisories, issued at 0345 and valid for the accident location and time, warned of moderate turbulence below 10,000 ft and moderate icing conditions below 8,000 ft.

1.4.2 Accident Site Weather Conditions

The closest automated weather observing station to the accident site was located at Ohio University Airport, about 8 miles southeast. At 0655, the reported wind was from 280° at 7 kts, visibility of 10 miles or greater, overcast ceiling at 2,700 ft agl, temperature of -6°C, dew point temperature of -10°C, and an altimeter setting of 29.92 inches of mercury.

Examination of satellite data imagery from 0645 and 0700 revealed overcast cloud cover over the accident site with the cloud cover moving from southwest to northeast.[31] The imagery also indicated low-level cool water clouds and high thick ice clouds.

The closest National Weather Service (NWS) Weather Surveillance Radar-1988, Doppler (WSR-88D), located 69 miles from the accident site, depicted no precipitation between 4,980 and 11,880 ft over the accident site.[32] The Terminal Doppler Weather Radar (TDWR) located in Columbus, Ohio, 45 miles from the accident site, showed scattered echoes of light reflectivity (precipitation) moving from west to east along the flight track as the helicopter departed from Mount Carmel Hospital.[33] In addition, echoes were located along the accident flight's route at 0645 and above the accident site at the time of the accident. TDWR data indicated that the second band of precipitation encountered by the accident helicopter had higher intensity echoes associated with it than the first snow band.

According to the NWS Aviation Weather Center, information valid at 0700 indicated a 20% to 50% probability of trace icing at 1,000 to 3,000 ft and an unknown category of supercooled

[30] This icing encounter was 5 miles west of the helicopter's departure location and 51 miles northwest of the accident site. Additionally, rime icing is defined as a rough, milky, opaque ice formed by the rapid freezing of supercooled water droplets after they strike the aircraft.

[31] Satellite data was captured by the Geostationary Operational Environmental Satellite number 16 and obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison.

[32] WSR-88D, also known as NEXRAD, incorporates a fleet of 160 WSR-88D radars that operate 24/7 to support the weather warning and forecast missions of the NWS, FAA, and Department of Defense. WSR-88D produces three basic types of products: base reflectivity, base radial velocity, and base spectral width. The WSR-88D in Charleston, West Virginia, (KRLX) is 2 miles closer to the accident site but, due to the mountainous terrain surrounding the site, KRLX experienced beam blockage in the direction of the accident site.

[33] The altitude coverage for this radar included base reflectivity images from the 0.1° elevation scans that depicted the conditions between 2,040 ft and 4,960 ft.

large droplets at both 0600 and 0700.[34] Radar track data in combination with weather radar imagery indicated the timing of the helicopter's encounter with the two snow bands along the helicopter's flightpath. The first snow band encounter occurred from 0638-0644:30. The second snow band encounter occurred from 0647 through the accident time.

Astronomical data obtained from the United States Naval Observatory for the accident site indicated sunrise occurred at 0739 and the beginning of civil twilight occurred at 0711. The phase of the moon was waning crescent with 32% of the moon's visible disk illuminated.

1.4.3 Survival Flight Personnel's Evaluation of Weather Information

There was no record of the accident pilot receiving a weather briefing or accessing any imagery on the Foreflight weather application.[35] Based on information from the evening shift pilot, the accident helicopter was equipped with a Garmin 650 navigation device, which had FIS-B installed. The moving map display would have overlaid FIS-B data, including precipitation. The Garmin 650 screen would have also displayed groundspeed, estimated time en route, waypoint name, and distance to the named waypoint. For any of the graphical products, the user (in this case the accident pilot) would have to manually press buttons to highlight other text and graphical information (for example, aviation routine weather reports [METAR], PIREPs, and AIRMETs). The evening shift pilot stated that both he and the accident pilot configured the Garmin 650 the same way and would not change the Garmin 650 settings during flight.

The evening shift pilot stated that he checked the weather between 1800 and 1900 the night before the accident (at the beginning of his shift). He reported that the information at the time indicated the temperature was going to fall during the night and rain and possibly light snow would develop. The precipitation was expected to end around midnight. The evening shift pilot reported that after midnight, temperatures fell below freezing and he noted the ramp became slick. When he received the call requesting the accident flight, he checked the weather again using the HEMS Weather Tool and the SkyVector website.[36] He remembered the cloud ceiling was about 2,400 ft agl and visibility was 7 miles. The evening shift pilot stated that he did not see any precipitation for the requested route of flight and that he did not remember seeing an AIRMET for icing conditions.

The OCS also used the HEMS Weather Tool to check the weather for the accident flight. The OCS recalled the weather as "marginal" with 1,500 ft or higher ceilings and "some light snow reporting on the METAR sites, but nothing that seemed alarming. The weather radar returns to the

[34] These data came from Current Icing Potential and Forecast Icing Potential products, which are created by the NWS Aviation Weather Center and are intended to supplement other icing advisories (for example, AIRMETs and SIGMETs).

[35] Foreflight is a mobile application that can be used for flight planning and accessing approach charts, weather information, and airport information. According to personnel at Foreflight, the accident pilot had a Foreflight account that was accessed at 0632 on the morning of the accident. A "user waypoint" was entered; the latitude/longitude coordinates correlated with the Holzer Meigs Emergency Department, Pomeroy, Ohio.

[36] The evening shift pilot stated that he had the HEMS Weather Tool configured to display the location of the MVFR, instrument flight rules (IFR), and low IFR cloud ceiling and visibility conditions (see section 1.4.4 for more information on the HEMS Weather Tool). The SkyVector site provided a secondary source for METAR information and weather radar (precipitation).

west showed…[a] little patch of snow, but the composite radar on the HEMS Tool does not necessarily always show…what's on the ground." The OCS recalled some light snow reported between Columbus and Pomeroy but nothing that would stand out to him, recalling reported visibilities at 5 miles and above. He stated he was not concerned about icing because the conditions were "pretty dry."[37]

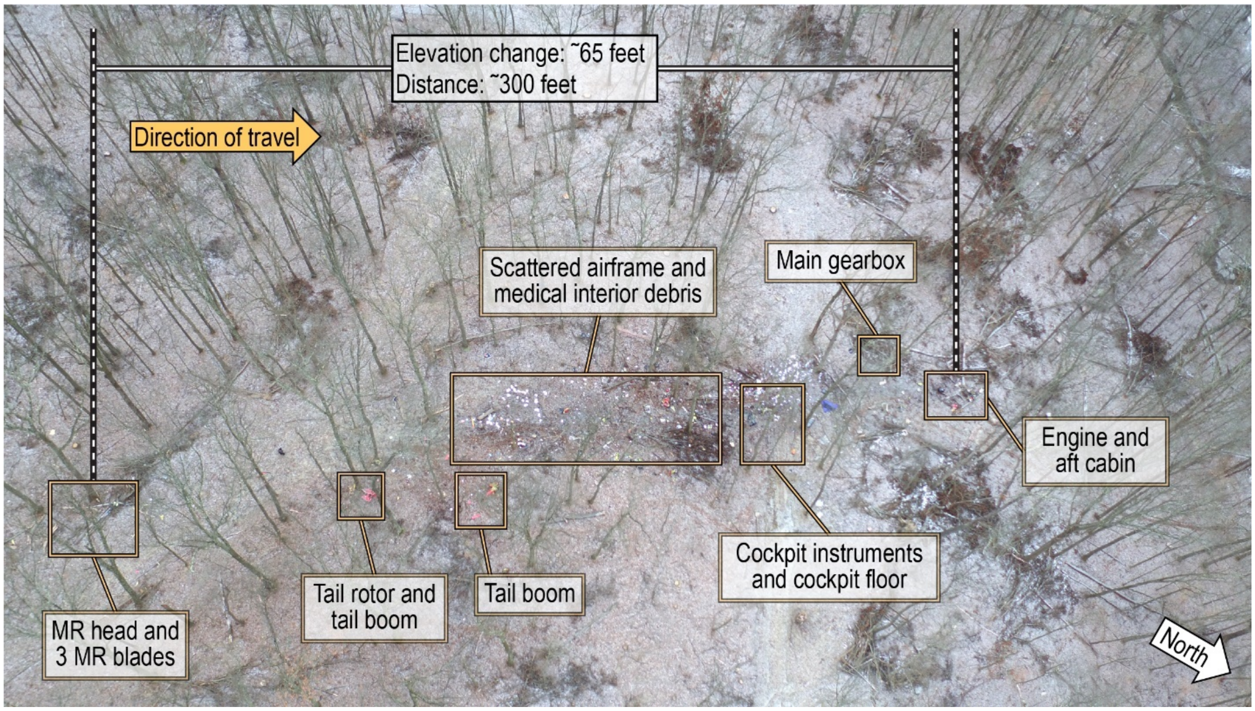
1.4.4 HEMS Weather Tool

The National Oceanic and Atmospheric Administration Aviation Digital Data System's developed a tool for HAA operations (known as the HEMS Weather Tool) to support the demanding environment of HAA operations. The HEMS Weather Tool can overlay multiple fields of interest, including many weather-related ones. The default overlay includes flight category, PIREPs, significant meteorological information (SIGMET), and multi-radar/multi-sensor system (MRMS) weather radar information. The MRMS weather radar information does not take TDWR information into account but does reflect WSR-88D information. Interviews with Survival Flight pilots revealed the tool often had limited weather radar coverage and did not show all precipitation that may be present in southeastern Ohio.

1.5 Wreckage and Impact Information

Examination of the accident site revealed that the helicopter initially collided with a tree at a height about 30 ft above the ground on a heading of about 345°. The wreckage path extended about 600 ft downslope, beginning with the front-left skid tube and followed by the main rotor hub and blades, tail boom and tail rotor, cockpit, cabin, and the engine and transmission deck (see figure 6). Broken tree branches were found near the front-left skid tube. The main rotor hub, with three of the four main rotor blades attached, was found about 300 ft downslope of the front-left skid tube. The fourth main rotor blade was embedded in a tree near the main rotor hub. All components of the helicopter were accounted for at the accident site. There was no evidence of a postcrash fire, and a strong smell of fuel was noted.

[37] The OCS stated he did not have the icing overlay checked on the HEMS weather tool.



Source: Ohio State Highway Patrol; edited by the NTSB.

Figure 6. Aerial view of the accident site detailing the wreckage debris distribution.

The engine was found resting inverted on the aft cabin structure. Several of the first-stage compressor blades exhibited curled leading-edge tips, consistent with ingestion of soft body foreign object debris.[38] The compressor and output shaft were rotatable by hand, confirming continuity throughout the engine. The upper and lower magnetic chip detectors were removed and exhibited no ferrous debris.

The remaining three rotor blades were located adjacent to the main rotor hub along the wreckage path and contained multiple fractures that exhibited a broomstraw appearance.[39] A portion of the main rotor shaft remained installed within the main transmission and exhibited a fracture corresponding to a fracture on the remaining portion of the main rotor shaft that was still installed on the main rotor head wreckage. Both fracture surfaces exhibited signatures consistent with overload. Manual rotation of the main rotor transmission input flange resulted in a corresponding rotation of the main rotor shaft. The damage observed on the rotor system was consistent with engine operation at the time of the accident.

Both tail rotor blade roots remained attached to the tail rotor hub. One of the blades exhibited impact damage on its leading edge, and about two-thirds of the outboard section of the blade was separated. A fractured section located near the blade exhibited a broomstraw appearance. The second tail rotor blade was intact and exhibited opening of its trailing edge near

[38] Soft body impact damage, which results from impacts with pliable objects, is characterized by a large radius of curvature or curling deformation to the blade and can cause curling deformation of the blades in the direction opposite of normal rotation.

[39] Fractures that exhibit a broomstraw appearance are consistent with high tension stress and overload.

its outboard end. Rotation of the tail rotor gearbox input flange resulted in a corresponding movement of the tail rotor.

Examination of the recovered flight control components for the cyclic, collective, and directional (pedal) controls revealed no anomalies that would have precluded normal operation.

Additionally, the engine control unit (ECU) for the Rolls-Royce 250-C47B was found in the wreckage debris path; the ECU contained nonvolatile memory, which recorded faults and exceedances.[40] No faults and two exceedances were recorded during the accident flight: a high torque exceedance (110%) about 3 seconds before the end of recorded data and a torque rate limit exceedance at end of recorded data. The recorded ECU data revealed two instances of torque exceeding 100% (overtorque) at 102% and 110%, about 8 and 3 seconds before the end of recorded data, respectively. These overtorque events correlated with increases in collective position.[41]

1.6 Medical and Pathological Information

The Montgomery County Coroner's Office, Dayton, Ohio, performed an autopsy on the pilot. Her cause of death was multiple blunt force injuries. The examination found no indications of "significant natural disease."

The FAA Forensic Sciences Laboratory performed toxicology testing on specimens from the pilot. The results were negative for ethanol and all tested-for substances.[42]

1.7 Tests and Research

1.7.1 Performance Study

The NTSB used data from the helicopter's Outerlink FDM system, ECU, and automatic dependent surveillance-broadcast system to perform an aircraft performance study of the helicopter's flight. The data revealed that the helicopter flew about 55 miles over 22 minutes in a relatively straight path toward its intended destination. Its groundspeed throughout the flight was between 120 and 140 kts with small fluctuations in pitch and roll and a collective position between 55% and 65% until the last 30 seconds of flight when the onboard data ended.[43] As described

[40] The ECU records data from multiple parameters at 1.2 second intervals.

[41] The Bell 407 Maintenance Manual contains a conversion factor between torque values recorded by the Rolls-Royce ECU and torque values displayed on the cockpit torque gauge, where the ECU torque value is multiplied by 1.0535 to obtain the cockpit torque gauge value, which ranges from 0 to 120%. Thus, ECU torque values of 102% and 110% would display on the cockpit torque gauge as 107% and 115%, respectively. The Bell 407 Rotorcraft Flight Manual defines cockpit torque gauge limits as follows: 0% to 93.5% is the continuous operation range and is green; 93.5% to 100% is the 5-minute takeoff range and is yellow; and 100% is maximum torque and is red.

[42] The FAA Forensic Sciences Laboratory has the capability to test for more than 1,300 substances, including toxins, common prescription and over-the-counter medications, and illicit drugs (FAA 2019).

[43] The collective control changes the pitch angle of all the main rotor blades collectively. Raising the collective control increases the total lift or thrust of the main rotor and subsequently increases altitude or airspeed. Raising collective requires an increase in engine torque.

previously, the helicopter remained at an altitude of 3,000 ft until the last 15 minutes of flight when it went through a series of descents and climbs and flew through two snow bands.

During the final minute of recorded flight, the helicopter attitude was more dynamic and larger control inputs were recorded than earlier in the data but were still within normal bounds of flight. The helicopter's groundspeed changed as the collective was reduced to 30% and then raised to 72%. At the end of the onboard recorded data, the helicopter's groundspeed was 100 kts and the attitude was 20° left and 3° nose-down.

The performance study also examined two additional Outerlink data points that were sent to a satellite uplink and recorded after the loss of onboard data occurred. These data points were recorded at 0650:12 and 0650:23, at altitudes of 1,660 ft and 1,528 ft, respectively. The end of the onboard data, the two satellite data points, and the wreckage location describe a 4,400-ft-long flightpath along an arc with a diameter of 0.7 nm. To complete the flight along this arc in 30 seconds at a groundspeed of 100 kts, the helicopter would be in a left bank of 22°.[44] This was consistent with both the final roll data from the onboard device (20° left bank) and the direction of the debris field, which was recorded along a heading of 345°.

Finally, the performance study examined the possibility of rotor icing by comparing collective pitch to rotor torque. If ice accretion occurred on the rotor blades, the helicopter would record higher torque values without requiring more collective pitch. Examination of the data revealed the relationship between collective pitch and rotor torque did not change throughout the flight. While there was no evidence of rotor icing, the presence of airframe icing could not be determined from the data available.

1.7.2 Sound Spectrum Study

The NTSB conducted a sound spectrum study in an attempt to identify the source of a whining sound recorded on the FDM audio during the accident flight. About 06:48:59, a whining sound was heard and lasted about 10 seconds until the audio data ended. The whining sound was compared to sound frequency information for the main mechanical components of the helicopter, such as the main rotor, tail rotor, and gear box, but the whining sound was not at a frequency associated with any rotating part. Additionally, the main rotor, tail rotor, tail rotor driveshaft, and transmission frequencies remained unchanged throughout the examined recordings.

The study also compared the whining sound with the sound of a bird impacting a helicopter in flight, as recorded by a cockpit voice recorder from another accident. The comparison did not find similarities between the two sounds; the bird impact produced an impulsive broadband signal, not a whining sound. Thus, the whining sound was aerodynamic in nature and the source of the sound was likely (1) air being rammed into a plenum, (2) a horn sound, similar to air across the top of a bottle, or (3) the possibility of air blowing into a window opening.

[44] Based on the analysis of the altitude trends between the satellite data and the ECU data, the helicopter's impact with trees likely occurred 30 seconds after the end of the onboard Outerlink data.

1.8 Organizational and Management Information

1.8.1 Survival Flight

As an on-demand commercial operator, Survival Flight operates in accordance with FAA-approved operations specifications (OpSpecs) for a 14 *CFR* Part 135 operation providing air ambulance services. At the time of the accident, Survival Flight operated 15 bases in Arkansas, Alabama, Illinois, Ohio, Missouri, and Oklahoma. The base that housed the accident helicopter, Base 14, opened in June 2018 and was located in Grove City, Ohio.[45] At the time of the accident, Survival Flight employed 70 pilots, 4 of whom were assigned at Base 14.

According to its OpSpecs, Survival Flight operated 3 Bell 206 helicopters, 13 Bell 407 helicopters and 1 Pilatus PC-12 airplane.[46] The OpSpecs authorized Survival Flight to operate VFR day and night flights using the Bell 206 and Bell 407 helicopters. Instrument flight rules (IFR) day and night operations were authorized using the Pilatus PC-12 airplane.

Survival Flight's director of operations (DO) managed daily operations. Management personnel at Survival Flight who reported directly to the DO included the chief pilot, the OCC manager, the director of safety and training, and the director of maintenance.

1.8.1.1 Survival Flight Operations Control Center

Survival Flight had an OCC (located at the company headquarters in Batesville, Arkansas) as required by 14 *CFR* 135.619 for HAA operators with more than 10 aircraft.[47] As stated in Survival Flight's General Operations Manual (GOM), the OCC's purpose was to assist with operational supervision and control of flights.[48] The OCC was primarily responsible for flight surveillance while providing advisory information affecting company aircraft. Staffing during a shift consisted of an operational control manager (OCM), an OCS, and a communications specialist. The OCM had operational control and was responsible for all actions associated with the OCC. Survival Flight used four OCMs: the DO, the chief pilot, the director of safety and training, and the OCC manager.

The duties of an OCS included analyzing the weather to determine marginal and hazardous conditions for flight and ensuring the pilot completed the risk analysis worksheet. The duties of a communications specialist included receiving flight requests from customers, collecting information regarding prior refusals from the requestor, and providing a communication relay between the OCS and the pilot in flight.

The OCC was configured with multiple workstations available for OCS/communications specialist personnel. Each workstation had multiple monitors, which allowed the

[45] Survival Flight also operated second base of operations in Ohio, Base 13.

[46] The FAA issues OpsSpecs to certificated operators as an authorization to conduct operations and outlines how they will operate while complying with federal regulations.

[47] FAA regulations pertaining to an OCC will be discussed in section 1.8.2.1 of this report.

[48] The GOM contains the procedures and guidance for personnel to conduct day-to-day operations.

OCS/communications specialist to display various screens containing information pertinent to the flights under their control. Weather and tracking information were routinely displayed along with other pertinent information deemed necessary by the OCS. The OCS received incoming flight requests from hospitals and first responders then called the appropriate base. If the pilot on duty accepted a flight request, the OCS informed the requestor and obtained additional details. Once a flight was airborne, the OCS was responsible for tracking it through the Outerlink system.

1.8.1.2 Company Weather Minimums

The weather minimums prescribed for Survival Flight's operations in nonmountainous, non-local areas during the day were cloud ceiling of 800 ft and visibility of 3 miles. The night weather minimums for the same area were cloud ceiling of 1,000 ft and visibility of 5 miles.[49]

1.8.1.3 Procedures for Inadvertent IMC Encounters

The Survival Flight GOM stated that an encounter with IMC is considered an emergency condition because the company helicopters were not certified for IFR flight. The GOM checklist for inadvertent IMC (IIMC) flight instructed pilots to use the "four C's" to exit the conditions: (1) control the aircraft; (2) climb or maintain altitude, obstacle dependent; (3) course (turn the aircraft toward VMC conditions); and (4) communicate (contact air traffic control and declare an emergency).

1.8.1.4 Survival Flight Preflight Risk Analysis

Volume 1, Appendix 3 of Survival Flight's GOM contained the preflight risk analysis Survival Flight used at the time of the accident and indicated four areas of consideration: (1) environmental factors, which included current and forecast weather and lighting conditions; (2) aircraft status, which included documentation required for the flight and preflight planning; (3) personnel and human factors, which included pilot rest and personnel issues that involve all personnel on board; and (4) "flight type, the job, what we do." Each area was to be given a color indicating the level of risk ranging from green (normal conditions) to red (one or more of the areas of concern out of limits), with intermediate levels of risk indicated by amber (one or more areas of concern) and amber critical (one or more areas of concern approaching out-of-limits or unsafe conditions).

According to Survival Flight's GOM, at the beginning of their shift, OCSs were responsible for calling each base to receive an estimated risk assessment level for the shift from the PIC. This estimated risk assessment level would then determine how the OCS responded to flight requests. When a flight request was received, the OCS accepted the flight only under an estimated "green" risk assessment level. Under any other risk assessment level, the OCS accepted the flight only after consultation with the base PIC. An "amber" risk assessment did not require approval from an

[49] The weather minimums prescribed for Survival Flight corresponded with the weather minimums required by 14 *CFR* 135.609, "VFR Ceiling and Visibility Requirements." Additionally, the Survival Flight weather minimums for night flights without night vision goggles were cloud ceiling of 1,000 ft and visibility of 5 miles.

OCM, but it did require all possible risk mitigation strategies to be discussed between the base PIC and OCS.

According to Survival Flight's GOM, a risk assessment of "amber critical" required approval from an OCM, and a risk assessment of "red" meant the flight was not allowed to proceed. If the weather changed during a shift, the base PIC was responsible for updating the risk assessment for the shift and updating the OCC with the new risk assessment. The GOM further specified that Risk Assessment Form 129 was the worksheet to be used by pilots to determine the risk level in a table form, and Survival Flight Risk Assessment Form 130 was to be completed by the OCC for each flight.[50] The GOM did not specify or require that Form 129 or 130 be completed before each flight.[51] According to the evening shift pilot who was going off duty when the accident flight request was received, the accident pilot would have completed the risk assessment worksheet when she returned to the base after the flight since the flight request was received during the shift change.

According to Survival Flight policy, HAA pilots were responsible for making the final decision for flight acceptance based on operational considerations, including weather, duty time limitations, site location, and personal capability. Pilots were required to base the decision to accept or reject the flight based on aviation criteria only. Medical factors were not made available to pilots until after the flight was accepted.

The evening shift pilot selected "A" for amber for his risk assessment value when he began his shift the night before. He elected not to change the value so the OCS would have to call for a weather check, allowing him additional time to evaluate the weather before flight acceptance. Examination of Form 130 (the flight release log) for the accident flight revealed an "A" crossed out for environmental factors and replaced with a "G" for green.[52] The other three categories listed a "G" for the risk assessment category.

When the criteria for the accident flight were entered into the exemplar risk assessment worksheet, which contained all the components listed in Advisory Circular (AC) 135-14B, "Helicopter Air Ambulance Operations" and required by 14 *CFR* 135.617, during the NTSB's investigation, the resultant score indicated the flight would have been classified as "amber critical" using Survival Flight's criteria.[53] This classification meant the OCM would have had to approve the flight. The criteria for the accident flight were also entered into risk assessment worksheets

[50] According to the Survival Flight GOM and interviews conducted with Survival Flight personnel, Form 129 was intended for pilots to conduct their risk assessments, and Form 130 incorporated the information from Form 129 and included other factors, such as aircraft information, personnel duty time, and number of landings. The OCC used Form 130 as the flight release log for each flight.

[51] Title 14 *CFR* 135.617(c) states the following: Prior to the first leg of each helicopter air ambulance operation, the pilot in command must conduct a preflight risk analysis and complete the preflight risk analysis worksheet in accordance with the certificate holder's FAA-approved procedures. The pilot in command must sign the preflight risk analysis worksheet and specify the date and time it was completed.

[52] The first category was for environmental factors such as current and forecast weather, including ambient and cultural lighting.

[53] AC 135-14B was issued March 26, 2015, and was current at the time of this report. (FAA 2015) Survival Flight's flight risk assessment worksheet did not contain all the components listed in the AC.

used by two other Part 135 operators. In both cases, the resultant score would have prevented the accident flight from departing due to the weather conditions.

1.8.1.5 Safety Program

Survival Flight had a safety program led by the director of safety and training and supported by a safety coordinator and a safety representative at each base. According to the Survival Flight Safety Manual, the safety representative's duties included fulfilling base safety training and record-keeping requirements, advising base management on safety-related issues, disseminating urgent and routine safety information to base personnel, responding to the safety concerns of base personnel, forwarding concerns to the safety coordinator, analyzing identified hazards for the purpose of eliminating or mitigating risk to Survival Flight personnel, collecting hazard/incident reports, and forwarding reports to the safety coordinator.[54] The safety coordinator held the overall responsibility for developing and implementing the company safety program and served as an advisor on safety matters throughout the company. This position was unfilled at the time of the accident.

According to the DO, the intent of the safety program was to enhance the operation but not limit it. The objective was to have the safety representative at each base run the safety program "from an SMS [safety management system] point of view where the medical side could participate but they would not be the 'safety driver'." However, the NTSB's investigation found no evidence indicating that Survival Flight had an SMS in place (SMS is discussed further in sections 1.8.2.3 and 2.2.3). The DO recognized the safety program varied from base to base depending on the personality of the safety representative. The accident pilot was the safety representative for Base 14.

The Survival Flight Safety Manual listed several events that required the submission of a hazard report. According to the director of safety and training, he had only received one incident report in the 1 1/2 years he had been in the position. According to the chief pilot, if anyone had a safety concern, they would report it to their safety representative first to resolve it at the base level. If that were not possible, the issue would be elevated to the director of safety and training, who would work with the chief pilot and/or DO to resolve it.

1.8.1.6 Safety Culture

The chief pilot reported that the safety culture at Survival Flight was "good," and safety issues could be brought up to anyone at any time. Similarly, the DO stated he wanted employees to bring their concerns to him so they could "fix it right now." According to the director of safety and training, the safety culture at Survival Flight was "pretty good;" however, he also knew pilots were not comfortable reporting safety issues to management. During an interview, one former pilot reported that it would be "difficult to report to management that management is unsafe…I feel that's a wall that, you know, would be difficult to punch through." A current pilot reported, "I like my job. I like the people I work with. But you get the sense that you're going to be blackballed,

[54] The director of safety and training described the safety program as an "open top safety program," and stated employees could contact anyone in management with their concerns.

you know, if you go against them." Finally, a former Survival Flight paramedic described the culture at Survival Flight as "so damaging and so toxic."

According to interviews with current and former employees, pilots often felt pressure to accept flights.[55] As an example, company management motivated bases to conduct flights by purchasing one massage chair for any base where the pilots flew 30 flights in 1 month.[56] According to the company's monthly summary, the accident flight was the 26th flight for the base in January.

To facilitate patient transfers, Survival Flight developed a "quick reference guide" that was distributed to hospitals and fire departments. The guide stated, in part, "Our weather minimums are different, if other companies turn down the flight for weather–CALL US. If we can fly to you safely and take the patient safely to another facility… WE WILL." (See figure 7.)

Several pilots, paramedics, and nurses reported that Survival Flight had a policy of "three to go, and one to say no," regarding acceptance of a flight.[57] However, this policy was not identified in company manuals or training programs. A former pilot stated in an interview that he had received text messages on "more than one occasion" from current company pilots and medical crewmembers stating they were "scared to fly." One nurse reported she believed the pilots were safe, but the administration and management were unsafe.

Interviews with Survival Flight pilots and medical crewmembers revealed incidents in which they were reprimanded or challenged by senior management or witnessed similar treatment of a pilot for declining a flight. One example involved the accident nurse who submitted a letter to the company human resources department that stated multiple individuals in both Ohio bases experienced "unsafe flights with [the Base 14 lead pilot] and…when we have to abort a flight with [the lead pilot], we get talked to by management, questioned, and we are always made to look like we are just lazy and don't want to do it." This example was consistent with an interview statement made by another medical crewmember regarding pilots turning down flight requests due to weather. He said, "the chief pilot of the company… would call within about 10 minutes and would cuss out our pilots and belittle them, … saying, … we need to take these flights,… he would yell so loud on the phone that you could hear it, … just standing within earshot."

[55] Out of the 23 current and former employees that were interviewed, 11 reported that pilots were pressured to take flights.

[56] In a postaccident interview, when asked if pilots received incentives to accept flights, the DO responded, "Nope. And company provides no disincentives either."

[57] In an HAA operation with one pilot and two medical crewmembers, "three to go, one to say no" is a practice in which any one of the three crewmembers involved in the operation may cancel a flight if they do not feel the flight can be conducted safely. Two pilots and four medical personnel mentioned the "three to go, and one to say no" policy during interviews.

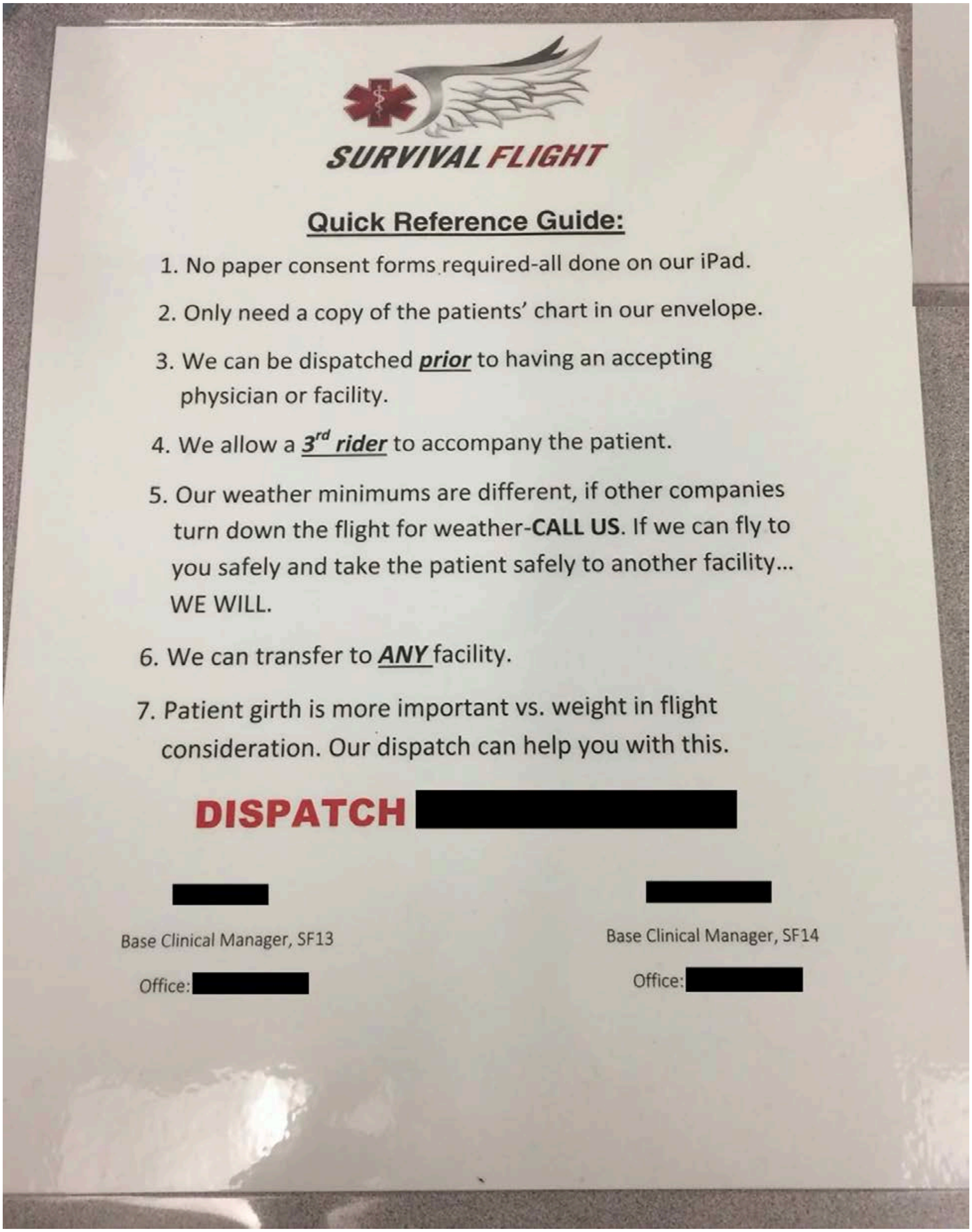


Figure 7. "Quick Reference Guide" distributed by Survival Flight.

Two additional examples of pilot reprimands for turning down flights involved poor weather conditions. In the first example, the pilot denied a flight due to 35- to 50-kt winds and low cloud ceilings. The chief pilot and DO both called the pilot and questioned his decision. The DO also called the medical crewmember who expressed that she was uncomfortable accepting the flight. According to the medical crewmember, the DO stated, "what is this I hear about you not wanting to fly?" He subsequently called the pilot and instructed him to take the flight. A second example involved a pilot who received a call from the OCM when he declined a flight due to low cloud ceilings. According to the pilot, the OCM demanded the pilot "get that helicopter flown back to the [hospital]" because she "wanted [it] back on the helipad for the visual effect."

In addition, two former employees reported they were terminated shortly after voicing safety concerns and turning down flights and one current employee was demoted after voicing his safety concerns. All three employees believed voicing their concerns played a role in their termination. According to the DO, he told everyone he trained that he wants them to be able to go home at the end of the day. He also wanted them to accept every flight they can. The DO described a situation when a pilot did not want to accept a flight, and he asked the pilot to check the weather again. Ultimately, the pilot did not accept the flight and the medical crew voiced their concern that the DO was pressuring the pilot. The DO further stated pilots should fly as close to the weather minimums as they feel comfortable.

During interviews, current and former pilots also expressed concerns that they were not able to issue a "red" risk assessment—which would take a base out of service for reasons related to maintenance, pilot compliance with duty and rest requirements, or weather—without opposition from senior management. Three of the eight pilots interviewed described instances of not being able to issue a "red" risk assessment. They similarly expressed concern that mechanics felt pressure to complete maintenance, including management interference with maintenance decisions, because senior management would not accept an aircraft status that resulted in a "red" risk assessment. One pilot described a situation in which he told the OCS his base was "red" for aircraft maintenance, but the OCS changed his risk assessment to "amber." When he questioned the change, he received a call from the DO asking, "why are you red... that's not the way we do things."

A former Survival Flight pilot reported that he attempted to classify his base as "red" due to an inoperative helicopter so the mechanic wouldn't feel rushed as he was working to return the helicopter to service. However, rather than take the aircraft out of service, the OCM decided to place it on a 20-minute delay, temporarily taking it out of service. The pilot told the mechanic if a flight request were received during the 20-minute period, he would turn it down so the mechanic wouldn't feel rushed. Another former Survival Flight pilot described an example in which a helicopter experienced a hot start that required an engine inspection.[58] Management refused to allow the inspection and, as a result, the mechanic threatened to quit. When management agreed to the inspection to keep the mechanic on staff, the engine was found to be damaged.

When asked to compare Survival Flight's operation to other companies he'd worked for, a former Survival Flight pilot replied that Survival Flight's operation was "subpar." He further stated that "bending regulations wasn't uncommon" and, as an example, described a time when he was

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[58] According to the FAA Airplane Flying Handbook, an engine tendency to exceed maximum starting-temperature limits is termed a hot start. The temperature rise may be preceded by unusually high initial fuel flow, which may be the first indication the pilot has that the engine start is not proceeding normally. Serious engine damage occurs if the hot start continues.

in danger of exceeding his 14-hour duty day limitation.[59] He arranged to have a relief pilot pick up the medical crew at a hospital that was far from base operations so that he could return to base in time to avoid violating the 14-hour duty day limitation. When he returned to the base, the pilot received a phone call from the OCM criticizing his decision and informing him that he "could've made it."

1.8.1.7 Expected Launch Time

Interviews with current and former Survival Flight pilots and staff revealed that company management expected pilots to depart from the helipad within 7 minutes of receiving a call.[60] If pilots were not able to depart within that timeframe, they were expected to complete an "occurrence log" to explain to the DO why they were unable to do so. A former Survival Flight pilot reported that, in one instance, he was criticized by the base lead pilot for waiting on the helipad in cold weather until all engine temperature gauges were "in the green," in accordance with the takeoff checklist, instead of immediately taking off.

The evening shift pilot who accepted the accident flight request reported that 8 to 9 minutes was a more realistic average launch time, particularly when the walk to the helicopter and preflight planning were factored in. He estimated that, for the accident flight request, launch time took about 15 minutes because the flight occurred at the shift change. The director of safety and training also reported that that the 7-minute timeframe was not realistic if pilots needed to complete a weather check.

1.8.1.8 Pilot Duty Times and Shift Change Procedures

According to the Survival Flight GOM, Survival Flight pilots were required to keep the OCS informed of their flight and duty time status, and their flight and duty times were to be recorded in the company's "Pilot Flight & Duty Time Log." Interviews with current and former pilots revealed instances of pilots reporting for shifts before their scheduled start time to receive a briefing from the pilot going off duty. Examination of company records found that this additional time was not reflected in duty time calculations, and there was no process in place to keep track of actual duty times.

During a postaccident interview, when asked what time a pilot's duty log should indicate if the pilot were to arrive at 6:30 in preparation for a scheduled 7:00 start time," the DO replied, "mine would say 7:00 to 7:00." In another interview, when asked if his shift began when he arrived early to receive a shift change briefing or at his scheduled shift start time, a former Survival Flight pilot responded, "personally, I considered it as soon as I walked in the door. That's when my duty day began. The company's attitude was no, it's not. So, there was a point of contention right there."

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[59] Title 14 *CFR* 135.267, "Flight time limitations and rest requirements: Unscheduled one- and two-pilot crews" specifies the maximum number of flight hours a pilot can fly during a 24-hour period as well as the required number of hours of rest between duty periods.

[60] The chief pilot stated he knew there was a specific period during which pilots were expected to launch after receiving a call; however, he could not recall the number of minutes.

According to the Survival Flight GOM, pilots were expected to conduct a shift change briefing at the time of the shift change, which should discuss at a minimum: (1) aircraft status, (2) anticipated/scheduled flights, (3) safety updates, (4) schedule changes, and (5) any other information that is deemed necessary. One pilot reported that this briefing usually took about 10 to 15 minutes. The GOM did not specify who should take the flight if a flight request came in around the time of a shift change. Regarding flight requests that came in during a shift change, a pilot who was interviewed during the investigation reported "there have been cases where…the oncoming pilot and the off-going pilot switch…while the helicopter was running."

1.8.1.9 Helicopter Shopping/Reverse Helicopter Shopping

Helicopter shopping is a practice in which a flight request turned down by one company will be offered to another. To discourage this practice, guidance in AC 135-14B describes the following as an HAA best practice:

> …responsibilities of communications specialists should include ascertaining, from those requesting HAA services, whether another HAA operator has previously declined to carry out a particular flight and, if so, for what reason. The response received should be conveyed to the pilot performing the risk analysis in accordance with *CFR* 135.617.

On the day of the accident, the ERT at Holzer Meigs Emergency Department contacted two other HAA operators before contacting Survival Flight. Both operators refused the flight due to weather. According to the requesting ERT, she told Survival Flight the reason the flight had been refused.[61] However, a review of recorded phone conversations obtained during the investigation revealed the ERT did not report that the flight had been previously refused, and the OCS did not ask.[62]

The OCS also reported that he was monitoring the Weather Turndown website for other flight delays and cancellations and did not observe any for the area of the accident route of flight.[63] Interviews with current and former Survival Flight employees revealed an OCC staff practice of using the Weather Turndown website to obtain flight requests that other operators had turned down (referred to by those interviewed as "reverse helicopter shopping"). One pilot stated, "they [OCS] specifically told me, 'Hey, we were looking at weather turndown and there's one that was turned down out of Pittsfield, Illinois, we were going to call … [to] see if you wanted to take it.'"

1.8.2 FAA Oversight and Regulations

The FAA provided oversight of Survival Flight through the use of its Safety Assurance System (SAS) oversight tool and a certificate management team, which was responsible for

[61] The ERT also stated she was unaware of any policy prohibiting her from contacting multiple HAA operators and that doing so was a standard practice at her facility if a flight was declined.

[62] Survival Flight could not locate a recording of the OCS's return call to the ERT to accept the flight.

[63] The Weather Turndown website describes itself as a "free service allowing medical transport programs to share current information regarding delays or cancellations due to weather." The information on the website must be entered by individual operators; therefore, it is not available immediately after a flight is declined.

verifying legal compliance with FAA rules and regulations.[64] The certificate management team for Survival Flight consisted of a principal maintenance inspector, a principal operations inspector (POI), and a principal avionics inspector. The POI at the time of the accident did not hold a rotorcraft rating, had no previous experience with HAA operations, and reported his rotorcraft experience was limited to about 2 to 3 hours in a Robinson R44 helicopter.[65] The POI reported that because he did not hold a rotorcraft rating, he was not able to monitor helicopter flight training at Survival Flight.[66]

FAA Order 8900.1, Volume 1, Chapter 3, Section 6: Operations Inspector Qualifications and Currency Overview, only lists what category (example: helicopter) and class (example: single-engine) rating a POI must have to perform competency/proficiency checks as well as flight instructor observation.

According to 14 *CFR* 135.617, HAA operators are required to conduct a preflight risk analysis before each flight, which must include (1) flight considerations, including obstacles and terrain along the planned route of flight, landing zone conditions, and fuel requirements; (2) human factors, such as crew fatigue, life events, and other stressors; (3) weather, including departure, en route, destination, and forecast; (4) a procedure for determining whether another HAA operator has refused or rejected a flight request; and (5) strategies and procedures for mitigating identified risks, including procedures for obtaining and documenting approval for the certificate holder's management personnel to release a flight when a risk exceeds a level predetermined by the certificate holder.

To clarify the regulation, AC 135-14B instructs HAA operators to include current and forecast weather when completing the analysis; this includes "ceiling, visibility, precipitation, surface winds, winds aloft, potential for ground fog…and severe weather such as thunderstorms and icing." As mentioned in section 1.8.1.9, AC 135-14B also instructs operators to establish a procedure for determining whether another HAA operator has declined a flight request under consideration and if so, for what reason (for example, weather, maintenance, etc.). The reason for the decline should be factored into the preflight risk analysis.

One of the Survival Flight POI's duties was to approve the company's preflight risk analysis. Postaccident interviews revealed that the POI was unfamiliar with how Survival Flight conducted a preflight risk analysis and completed the risk assessment worksheets. He was also unaware that the worksheet lacked criteria for evaluating en route weather and a procedure for determining whether another HAA operator had refused or rejected a flight request.

During his interview, the POI stated that SAS assigned the number of required inspections for an operator depending on the amount of risk. According to SAS guidance, the amount of risk was dependent on several factors, including the type of operation being performed and the review

[64] The FAA's SAS oversight tool is used to perform certification, surveillance, and continued operational safety. According to the FAA's website, SAS includes policy, processes, and associated software that inspectors use to capture data when conducting oversight. More information can be found at the FAA's SAS information page.

[65] During an interview, the POI reported he had been working as the POI for Survival Flight since 2014.

[66] For more information, see Operations Attachment 17 in the public docket for this accident: FAA Order 8900.1, Volume 1, Chapter 3, Section 6: Operations Inspector Qualifications and Currency Overview.

of safety risk management and safety assurance documentation by the POI. For Survival Flight, surveillance was assigned "every 6 months or 2 quarters." The POI reported that during the 6 months before the accident, he had performed surveillance three times at Survival Flight.[67] Examination of an inspection report revealed that in the 3 years before the accident, 51 surveillance activities were performed with no unfavorable findings.[68]

As a result of the accident, the FAA conducted targeted surveillance with assistance from inspectors with HAA knowledge and expertise, during which inspectors, including the POI, completed 899 data collection tools within the SAS, 26 of which had negative findings.[69] Examples of the negative findings included (1) confusion between pilots and OCSs regarding when and how to document the completion of the preflight risk assessment; and (2) insufficient training for pilots and OCSs regarding preflight risk assessment procedures.

An audit completed in 2015 by the Department of Transportation Office of Inspector General revealed a shortage of helicopter inspectors within the FAA primarily due to inspector qualification standards that required airplane experience rather than helicopter experience.[70] The audit report, dated April 8, 2015, stated, "Because of the unique operating characteristics of HEMS, inspectors with helicopter experience may be better suited to identify HEMS-specific risks."

1.8.2.1 Operations Control Center Requirements and Guidance

According to 14 *CFR* 135.619, an OCC must be staffed by an OCS who, at a minimum, (1) provides two-way communications with pilots; (2) provides pilots with weather briefings, including current and forecast weather along the planned route of flight; (3) monitors the progress of the flight; and (4) participates in the preflight risk analysis required under 14 *CFR* 135.617. Additionally, AC 120-96A, "Operations Control Center for Helicopter Air Ambulance Operations," provides information and recommendations to assist HAA operators with the development, implementation, and integration of an OCC and operational control procedures.[71] According to AC 120-96A, one of the core concepts that defines an effective OCC and enhanced operational control procedures is "joint flight safety responsibility."

As described in the AC, joint flight safety responsibility involves at least one qualified ground staff member who is actively involved in reviewing the PIC's risk analysis in accordance with the required risk analysis program. The AC further states the OCS should continue to provide

[67] The POI reported that one of the three surveillance visits was a follow-up to the two required visits.

[68] These surveillance activities included both airworthiness and operational activities.

[69] Aviation safety inspectors use data collection tools to document assessments of certificate holders' or applicants' design of systems, surveillance of certificate holder performance, identification of safety concerns or statutory/regulatory noncompliance, and any other relevant information. Based on Federal Aviation Regulations, OpSpecs, ACs, and safety attributes, data collection tools are designed to help FAA inspectors determine if a certificate holder or applicant follows procedures, controls, and process measurement for each element.

[70] The Department of Transportation Inspector General report, "Delays in Meeting Statutory Requirements and Oversight Challenges Reduce FAA's Opportunities To Enhance HEMS Safety," can be found at https://www.oig.dot.gov/library-item/32450.

[71] Per 14 *CFR* 1.1, "General Definitions," operational control refers to exercising the authority over initiating, conducting, or terminating a flight.

safety input to the conduct of the flight by monitoring factors affecting flight safety before and during the flight. Finally, the AC states that each OCS should be authorized to exercise operational control to direct a pilot to decline, divert, abort, or reroute a flight.

1.8.2.2 Differences Training/FAA Type Requirements

Regarding the differences between Bell 206 and Bell 407 helicopters, an FAA Flight Standardization Board report stated:[72]

> Although the model [Bell]-407 is a derivative of the [Bell]-206, the main rotor, engine, engine control system…, hydraulic system, drive train, and tail rotor are significantly different from the [Bell]-206. The systems, handling qualities, and characteristics of the [Bell] model 407 itself requires specific training. (FAA 2000)

According to 14 *CFR* 135.293(b), "Initial and Recurrent Pilot Testing Requirements:"

> No certificate holder may use a pilot, nor may any person serve as a pilot, in any aircraft unless, since the beginning of the 12th calendar month before that service, that pilot has passed a competency check given by the Administrator or an authorized check pilot in that class of aircraft, if single-engine airplane other than turbojet, or that type of aircraft, if helicopter, multiengine airplane, or turbojet airplane, to determine the pilot's competence in practical skills and techniques in that aircraft or class of aircraft…For the purposes of this paragraph, type, as to a helicopter, means a basic make and model.

In a postaccident interview, the POI responsible for operational oversight of Survival Flight was unsure if the existing training program satisfied the regulatory requirement for differences training. He also was unaware that the accident pilot did not receive a competency check in the Bell 407.

During the investigation, the NTSB requested a legal interpretation from the FAA regarding whether a competency check in any helicopter model listed on the same TCDS satisfied the "make and model" requirement at 14 *CFR* 135.293(b). The FAA responded that each TCDS is specific to a single type certificate but lists the various models under that type certificate and differences between models. Therefore, aircraft listed on the same TCDS would be under the same type according to the regulatory definition and satisfy the "make and model" requirement. According to a letter dated October 23, 2019, from the Assistant Chief Counsel for Regulations, at the time of the accident, the Bell 206 and Bell 407 helicopters were listed on the same TCDS.

[72] The FAA typically establishes a Flight Standardization Board to: (1) determine the requirements for pilot type ratings for the aircraft in question, (2) develop training objectives for normal and emergency procedures and maneuvers, (3) conduct initial training for the manufacturer's pilots and FAA inspectors, (4) publish recommendations for FAA inspectors to use in approving an operator's training program, and (5) ensure initial flight crewmember competency. More information can be found at https://www.faa.gov/aircraft/air_cert/airworthiness_certification/fsb/.

1.8.2.3 Safety Management System

As mentioned in section 1.8.1.5, although Survival Flight had a safety program, the NTSB's investigation found no evidence that Survival Flight had an SMS in place. According to the FAA's website, "SMS is the formal, top-down business-like approach to managing safety risk, which includes a systemic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures."[73] The goal of SMS is to identify safety hazards, ensure necessary remedial action is implemented to maintain an acceptable level of safety, provide continuous monitoring and regular assessment of the safety level achieved, and continuously improve a company's overall level of safety. When an SMS is implemented, senior management establishes adequate safety resources, develops a safety policy, establishes safety objectives and standards of safety performance, and leads the development of a positive organizational safety culture.

According to the FAA, SMS is comprised of four components: safety policy, safety risk management, safety assurance, and safety promotion. Safety policy establishes senior management's commitment to continually improve safety and defines the methods, processes, and organizational structure needed to meet safety goals. Safety risk management determines the need for, and adequacy of, new or revised risk controls based on the assessment of acceptable risk. Safety assurance evaluates the continued effectiveness of implemented risk control strategies; supports the identification of new hazards. Finally, safety promotion includes training, communication, and other actions to create a positive safety culture within all levels of the workforce.

SMS is an organization-wide approach to managing safety using a structured process based on internal feedback and continuous improvement. An organization's SMS is not static but actively adapts to address emergent hazards, test and reinforce existing mitigations, and ensure that personnel throughout the company are informed and aligned with the overarching safety policy and methods employed.

As part of the FAA-recommended set of base documents for non-Part 121 operators to voluntarily implement an SMS program, AC 120-92B, "Safety Management Systems for Aviation Service Providers," states that an organization's culture is essential to its safety performance.[74] As AC 120-92B describes, a key element of creating a successful safety culture is the designation of the "accountable executive," who has the ultimate responsibility for safety management within the organization. According to AC 120-92B, the "accountable executive" should satisfy the following criteria, regardless of other functions: (1) be the final authority over operations, (2) control the financial resources required for the operation, (3) control the human resources required for the operation, and (4) retain ultimate responsibility for the safety performance of the operations.

[73] More information can be found at the FAA's frequently asked questions on SMS.

[74] AC 120-92B provides guidance for Part 121 air carriers that are required to implement an SMS program in compliance with 14 *CFR* 5. The FAA SMS Voluntary Program also provides non-Part 121 operators a gap analysis tool to identify differences that need to be addressed to comply with the SMS Voluntary Program standard.

1.8.2.4 Flight Data Monitoring

The accident helicopter was equipped with an Outerlink IRIS FDM and satellite communications system, in compliance with 14 *CFR* 135.607, "Flight Data Monitoring System."[75] However, according to the Survival Flight DO, the company only used the data in the past to evaluate unusual maintenance events. The data were not routinely downloaded or used to gain insight on efficiency or safety, and no policy was in place to do so. In an interview, the DO reported it took a long time to download a file and "then I don't know what you'll do with it." Additionally, interviews conducted with Survival Flight employees after the accident revealed several flights in which snow and/or IIMC was encountered, resulting in flight deviations that may have been apparent in FDM data when evaluated within an FDM program.

An effective FDM program can detect outliers to normal operating parameters, and when deviations from normal flight occur, further review of the circumstances would be needed to identify the context for the deviations. For helicopter air ambulance (HAA) operations, routine flight paths are direct and at a set altitude. An FDM program that compared FDM data with intended routes of flight and altitude could identify unusual routes or altitudes if there were numerous changes in heading or altitude.

1.9 Additional Information

1.9.1 Survival Flight Postaccident Actions

Survival Flight Forms 129, "Risk Assessment Worksheet," and 130, "OCC Flight Release Log" were revised after the accident on May 1, 2019. Form 129 became Form 129-RA, "Risk Mitigation Instructions," and no longer contained a worksheet to evaluate risks. In its place were blank lines where concerns could be listed under each of the four categories (environmental/weather, aircraft status, personnel and human factors, and flight type). The instructions included in Form 129-RA did not specify who was required to complete the form; it stated the form was intended to be a living document and a "sample only."

Revised Form 130 became Form 130-RA, "Flight Release Log with Risk Assessment Instructions" and was to be completed by the OCS. Form 130-RA incorporated the risk assessment worksheet from the original Form 129 and added three phrases under the environmental area of concern: "include in this assessment en route weather, weather trends and any additional weather messaging (AIRMETs/SIGMETs)." The instructions on Form 130-RA stated, "the PIC and OCS will verbally confirm that Form 130-RA has been completed."

On November 15, 2019, Survival Flight submitted to the NTSB a letter that it had sent to company personnel to clarify how initial training in the Bell 407 helicopter would be conducted and documented. The letter stated, "every pilot that completes initial training to become a PIC in

[75] Title 14 *CFR* 135.607 states, in part, "After April 23, 2018, no person may operate a helicopter in air ambulance operations unless it is equipped with an approved flight data monitoring system capable of recording flight performance data."

a [Bell] 407 will be checked in the [Bell] 407 with the resulting [Form] 8410."[76] The letter also stated that no Survival Flight pilot had ever performed PIC duties in the [Bell] 407 without the proper training.

[76] FAA Form 8410 is the airman competency/proficiency check form used by inspectors and examiners to document an applicant's performance during an oral test or a flight test.

2. Analysis

2.1 Introduction

This accident occurred when an HAA helicopter operated by Survival Flight collided with forested terrain in snow showers about 4 miles northeast of Zaleski, Ohio, killing the commercial pilot, flight nurse, and flight paramedic and destroying the helicopter.

Earlier that morning, before contacting Survival Flight, an ERT at Holzer Meigs Emergency Department contacted two other HAA operators with a request to transport a patient from her facility to OhioHealth Riverside Methodist Hospital in Columbus, Ohio; both operators ultimately turned down the flight request due to poor weather conditions. One pilot noted snow showers on the HEMS Weather Tool; the other pilot took 6 minutes to review the weather before declining the flight.

After speaking with the ERT about the details of the request, the Survival Flight OCS contacted the Survival Flight pilot on duty (the evening shift pilot) at Base 14 and requested a weather check to determine if the mission could be accepted. About 28 seconds later, the evening shift pilot accepted the flight. The evening shift pilot also informed the OCS that the day shift pilot (the accident pilot) was 5 minutes away from the base and may take the flight.

While the accident pilot was on her way to the base, the evening shift pilot briefed her on the flight request. He then notified the medical crew and prepared the helicopter for the flight. By the time the accident pilot arrived, the evening shift pilot had started the helicopter's engine and was preparing to program the waypoint information into the navigation system. The accident pilot boarded the helicopter and departed. The NTSB's investigation could not determine if the accident pilot checked the weather or received a weather briefing before departing.[77]

After departure, the helicopter traveled southeast toward Holzer Meigs Emergency Department. The helicopter gained altitude for the first 7 minutes of flight until it reached a maximum altitude just below 3,000 ft (an overcast cloud ceiling began at 3,100 ft). Between 0635 and 0643, the helicopter descended about 1,000 ft; the pilot then initiated a climb, reaching an altitude of 2,600 ft at 0643:30. During this descent and climb, the helicopter flew through the first of two snow bands and was in an area of low visibility due to snow.[78]

After reaching 2,600 ft, the helicopter began descending and was at an altitude of 2,400 ft by about 0647. During the following 2 minutes, no data were recorded through the onboard device;

[77] The HEMS weather tool does not archive if a user views graphical data. ForeFlight retains some archive capability if a pilot checked specific graphical weather products while the ForeFlight application was connected to a network. In this case, the accident pilot entered a waypoint using the ForeFlight application on her tablet, but it could not be determined if she reviewed any graphical products. While it is possible the accident pilot could have reviewed text weather products before the accident flight, it is unknown whether any more weather information (text or graphical) was reviewed because the network capability used at the time is unknown.

[78] The terrain in this area varied between 700 ft and 1,100 ft of elevation.

however, satellite data recorded the helicopter's position every 11 seconds.[79] During this time, the helicopter encountered a second snow band, which, according to available weather data, was of higher intensity than the first snow band (see figure 5). Therefore, the NTSB concludes that the pilot likely encountered IMC inadvertently when the helicopter flew through a snow band, which resulted in decreased visibility.

By 0649:45, the helicopter had descended to 1,300 ft and then began climbing again. The onboard data ended 22 seconds later as the helicopter was climbing through 1,500 ft. Interpolation of two additional satellite data points that were recorded after the end of the onboard data revealed the helicopter likely flew a path consistent with a 180° descending left turn at an average groundspeed of 116 kts.

The final satellite and ECU data show that, as the helicopter descended, two overtorque events occurred about 8 and 3 seconds, respectively, before the end of recorded data. The overtorque events correlated with increases in the collective position, which could be consistent with the pilot responding to either an HTAWS alert or perceived imminent ground contact, or both, by attempting to climb.[80] A decrease in collective position was noted after the final overtorque event, which continued until the helicopter impacted trees.[81] The expected pilot response to an overtorque condition would be to reduce collective.

According to Survival Flight's GOM, to recover from an IIMC encounter, pilots should execute a climbing, 180° turn to return to VMC. The accident helicopter's final 180° turn (as reflected in interpolated satellite and ECU data) was consistent with the pilot attempting to follow part of this procedure; however, she allowed the helicopter to descend until it was too late to arrest the descent and execute a climb above the trees. Further, examination of the helicopter and engine revealed no evidence of an inflight mechanical failure and, based on the onboard Outerlink and ECU data, the helicopter responded to the pilot's inputs. [82]

Therefore, the NTSB concludes that in an attempt to recover from the IIMC encounter, the pilot began a 180° turn as part of an IIMC escape maneuver, in keeping with standard operating procedures but did not maintain altitude and allowed the helicopter to descend until it impacted terrain.

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[79] Groundspeed was not recorded during the period of data loss; however, before and after the loss, the groundspeed was about 135 kts.

[80] As mentioned previously, the Garmin 650 HTAWS was designed to provide two levels of terrain awareness alerts: a caution alert was designed to provide a 30-second lookahead for potential impact, and a warning was designed to provide a 15-second lookahead for potential impact. Because of the lack of onboard recorded data during the last 30 seconds of the accident flight, the investigation could not determine if or when the HTAWS alerted.

[81] According to the FAA Helicopter Flying Handbook, when the collective pitch is raised, the load on the engine is increased to maintain desired rpm. When the collective lever is raised, power is automatically increased; when lowered, power is decreased.

[82] Cyclic and tail rotor pedal inputs were not recorded; therefore, the helicopter's lateral responsiveness to input could not be determined.

The following analysis discusses the accident and evaluates the following:

- Survival Flight's flight risk assessment (FRA) procedures and operational risk management (sections 2.2.1 and 2.2.2);
- Survival Flight's overall safety culture, including personnel's intentional noncompliance with regulations, a hazardous attitude towards safety, and incentives for flight completion (section 2.2.2 and 2.2.3);
- The continued lack of a required FDM program for all Part 135 operators, including at Survival Flight, which can result in operational risks remaining unidentified and unmitigated and future accidents (section 2.2.4);
- Inadequate FAA oversight of HAA operations, including the POI's general lack of knowledge regarding HAA operations (section 2.3); and
- Availability of weather products for HAA operations and areas for improvement to enhance safe operations (section 2.4)

Having completed a comprehensive review of the circumstances that led to the accident, the investigation established that the following factors did not contribute to its cause:

- *Pilot qualifications:* The pilot was properly certificated and qualified in accordance with Survival Flight requirements and 14 *CFR* Part 135. Although there was no record of the pilot completing differences flight training for the Bell 407 helicopter, she did receive differences ground training; based on the ground training and her experience in the model, she was likely proficient in the accident helicopter. Additionally, the FAA's legal interpretation of the "make and model" requirement at 14 *CFR* 135.293(b) provided during the investigation indicated that a separate competency check was not required because Bell 407 and Bell 206 helicopters were listed on the same TCDS.
- *Pilot medical conditions*: The pilot held a valid and current medical certificate. A review of the limited information available to the NTSB regarding the pilot's work and sleep schedules and recent activities found no evidence of factors that would have adversely affected her performance on the day of the accident. Additionally, the investigation found no evidence of alcohol or other drug use.
- *Helicopter mechanical conditions*: The helicopter was properly certificated, equipped, and maintained in accordance with 14 *CFR* 135. The investigation found no evidence of any structural, engine, or system failures before impact. All damage observed on the airframe and engine was consistent with the helicopter's impact with the trees and the ground. Although a whining sound was heard on the recorded FDM audio, a sound spectrum study concluded the noise was inconsistent with a bird or object strike that would have compromised the windscreen. Additionally, the helicopter continued to fly for at least a minute after the onset of the sound, indicating the structure was not compromised in such a way to prevent continued flight.

Thus, the NTSB concludes that none of the following were factors in the accident: (1) pilot qualifications; (2) pilot medical conditions or impairment by alcohol or other drugs; (3) the airworthiness of the helicopter.

2.2 Organizational Factors

2.2.1 Flight Risk Assessment

Title 14 *CFR* 135.617 requires that, before each flight, HAA operators conduct a preflight risk analysis that includes an evaluation of weather for the flight (including departure, en route, destination, and forecast weather) and a procedure for determining whether another HAA operator has refused a flight request. To comply with the regulation, Survival Flight policy documented in its GOM required the OCS to call the PIC at each base at the beginning of a shift and obtain an estimated risk assessment level for the entire shift. The estimated risk assessment level was then assigned a color (green, amber, amber critical, or red) ranked from lowest to highest risk.

If weather conditions changed during the shift, PICs were expected to update the OCS with a new risk assessment level. If the risk assessment level were green when a flight request was received, the OCS would accept the flight. For any other risk assessment level, the OCS would consult with the PIC before accepting the flight. According to the Survival Flight GOM, PICs were to use Risk Assessment Form 129 to determine the risk level in a table form, and OCSs were to complete Survival Flight Risk Assessment Form 130 for each flight. The GOM did not specify or require that Form 129 or 130 be completed before each flight.

At the beginning of his shift during the night before the accident, the evening shift pilot estimated an amber risk assessment level due to the current and forecast weather conditions at that time, which included visibility as low as 3 miles and snow forecast for the area. This risk assessment level required the OCS to consult the evening shift pilot before accepting the ERT's request for the accident flight. According to the evening shift pilot, he again checked the weather after receiving the flight request from the OCS and determined the flight could be performed because the weather showed a 2,400-ft cloud ceiling and 7 miles visibility along the route of flight. He did not observe any precipitation on the HEMS Weather Tool and, although an AIRMET valid for the accident location and time forecast moderate icing below 8,000 ft, the evening shift pilot did not remember seeing an AIRMET for icing along the route.

The evening shift pilot did not update the risk assessment because the request was received during a shift change and he expected the accident pilot to complete the risk assessment after she returned. Postaccident review of the flight release log completed by the OCC found that the amber environmental risk factor classification was scratched out and changed to green.

AC 135-14B, which provides guidance to HAA operators on the preparation of preflight risk analyses, instructs HAA operators to include current and forecast weather conditions when completing an analysis. This includes "ceiling, visibility, precipitation, surface winds, winds aloft, potential for ground fog…and severe weather such as thunderstorms and icing." Survival Flight pilots were required to conduct a risk assessment worksheet only at the beginning of a shift or if weather conditions changed; however, they may not be aware of weather changes or motivated to perform a thorough review of the weather immediately before a flight because the risk assessment worksheet had already been completed. Further, they were not required to evaluate the en route weather.

In the case of the accident flight, the evening shift pilot reviewed the weather in 28 seconds, which was likely not sufficient time to conduct a thorough review of each available weather product. He did not recall seeing an AIRMET for icing; however, the HEMS Weather Tool would have shown an AIRMET for moderate icing conditions below 8,000 ft along the route of flight.

AC 135-14B also instructs operators to establish a procedure for determining whether another HAA operator has declined a flight request under consideration and, if so, the reason (weather, maintenance, etc.), which should also be factored into the preflight risk analysis. Neither the evening shift pilot nor the accident pilot were made aware that two other operators had turned down the flight request.[83] One of the pilots who turned down the request stated that he did so because the probability of icing at 1,000 ft agl or greater was more than 75% and he noted snow showers along the route on the HEMS Weather Tool.

Survival Flight's risk assessment worksheet did not require the evaluation of current and forecast weather along the route of flight just before accepting a flight or a report of whether another operator had turned down a request. When the criteria for the accident flight were entered into the exemplar risk assessment worksheet contained in AC 135-14B, the resultant score indicated the flight would have been classified as "amber critical" using Survival Flight's criteria. This classification meant the OCM would have had to approve the flight. Additionally, when the criteria for the accident flight were entered into risk assessment worksheets used by two other Part 135 operators, the resultant score in both cases revealed the accident flight would not have been allowed to depart due to the weather conditions.

The NTSB concludes that Survival Flight's risk assessment process was inadequate for identifying weather risks for the accident flight as illustrated by (1) consistent failure by Survival Flight operational personnel to complete the risk assessment worksheet before every flight, including the accident flight, and (2) the absence of required elements on the worksheet, including en route weather risks and refusals of previous requests for a flight.

Although Survival Flight has updated Form 129, "Risk Assessment Worksheet," and Form 130, "OCC Flight Release Log," since the accident, the NTSB is concerned that these changes are not sufficient. First, the revised risk assessment worksheet still does not require information regarding refusals of previous flight requests or forecast en route weather to include the potential for icing, as AC 135-14B recommends.[84] Second, the instructions do not require the PIC to complete the form, only to verbally confirm that the OCC has completed it. Third, the revised worksheet also lacks a requirement that the assessment be completed before each flight as required by 14 *CFR* 135.617.

Acquiring this information before a flight would better prepare pilots to adequately assess the risks and make informed decisions about whether they can safely complete flights. Therefore, the NTSB recommends that Survival Flight revise its flight risk assessment procedures to

[83] The ERT stated she informed the OCS that the request was previously turned down; however, the OCS stated he did not receive that information.

[84] The risk assessment worksheet from the original Form 129 was incorporated into the new Form 130-RA, "Flight Release Log with Risk Assessment Instructions," and the following phrase was added under the environmental area of concern: "include in this assessment en route weather, weather trends and any additional weather messaging (AIRMETs/SIGMETs)."

incorporate the elements described by AC 135-14B, including procedures for determining prior flight refusals by another HAA operator and forecast en route weather. The NTSB also recommends that Survival Flight require pilots to complete a comprehensive risk assessment before each flight and complete the appropriate paperwork to reflect their assessment as required by 14 *CFR* 135.617.

2.2.2 Operational Risk Management and Safety Culture

Interviews with current and former Survival Flight pilots and mechanics revealed a lack of effective risk management by company personnel, including a lack of tracking of pilots' actual duty and rest times and management pressure both for bases to remain operational and for employees to accept flights. Despite guidance in the Survival Flight GOM indicating that, before assigning flights, OCSs should review each crewmember's individual flight time limitations and rest requirements to ensure compliance with 14 *CFR* 135.267, OCSs only recorded scheduled duty time for pilots. Additionally, company management expected pilots to arrive early to conduct the required shift change briefing and did not count that time against crewmembers' duty and rest time, which was inconsistent with the definition of rest period in the regulations.[85] Examination of company records found that this additional time was also not included in duty time calculations.

Survival Flight had no processes in place to keep track of actual duty times, which was also contrary to federal regulations and undermined the intended safety risk mitigation. Therefore, the NTSB concludes that Survival Flight's lack of a procedure to track pilots' actual duty time contributed to the ineffectiveness of the company's risk management. As a result, the NTSB recommends that Survival Flight develop a procedure for tracking actual pilot duty times in compliance with 14 *CFR* 135.267.

Safety culture is a term used to describe the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management. (Antonsen, 183–191.) According to Survival Flight's director of safety and training, the culture at Survival Flight was "pretty good;" however, he was aware that pilots were not comfortable reporting safety issues to management. Interviews with current and former employees confirmed that Survival Flight had an environment where employees were hesitant to report safety issues. One former employee described an environment where "reporting to management that management is unsafe" would be difficult. Another former employee described the safety culture as "so damaging and so toxic."

For example, several interviewees reported that company management would challenge red risk assessment levels, which would take a base out of service for reasons related to maintenance, pilot compliance with duty and rest requirements, or weather. One pilot described a situation in which he told the OCS his base was "red" for aircraft maintenance, but the OCS changed his risk assessment to "amber." When he questioned the change, he received a call from the DO asking, "why are you red... that's not the way we do things." A former Survival Flight pilot reported that he attempted to classify his base as "red" due to an inoperative helicopter so the

[85] Section 135.273 defines rest period as time "free of all responsibility for work or duty should the occasion arise."

mechanic wouldn't feel rushed as he was working to return the helicopter to service. However, the OCM decided to place the helicopter on a 20-minute delay rather than take it out of service.

Survival Flight management also pressured personnel to accept flights by encouraging the solicitation of hospitals for flights that other operators had previously refused and advertising that Survival Flight would fly in weather that other operators would not fly in.[86] At the time the accident flight occurred, pressure on personnel to accept flights was also evident in a Survival Flight policy where a base would be rewarded with a massage chair one time if its pilots conducted 30 flights in 1 month; the accident flight occurred on the 28th day of the month and was the 26th flight for the base that month.

Interviews with pilots and medical crewmembers also revealed an expectation from Survival Flight management to depart from the helipad within 7 minutes of receiving a call for a flight.[87] At Base 14, the base from which the accident helicopter departed, the departure timeframe included a drive from the housing area to the helicopter pad; at other bases, the timeframe included walking from the housing area to the helicopters. While pilots reported it was possible to depart within 7 minutes if all conditions were normal, additional time was sometimes required to prepare for the flight. The director of safety and training also stated the 7-minute expectation was not realistic if pilots needed to complete a weather check; this expectation also did not allow enough time for a comprehensive preflight risk assessment to be performed. That the evening shift pilot prepared the helicopter for the accident flight and that neither he nor the accident pilot performed a comprehensive weather evaluation or a preflight risk assessment suggest that the pilots likely felt pressured to meet the 7-minute timeframe for takeoff.

According to the Survival Flight GOM, at the time of shift change, outgoing and incoming pilots were expected to conduct a shift change briefing consisting of helicopter status, anticipated flights, safety updates, schedule changes, and any other information deemed necessary. However, no documented shift change procedures were performed before the accident flight; because the accident pilot boarded the already-started helicopter when she arrived for her shift, it is unlikely a shift change procedure was performed, and she may have agreed to the flight based on her trust of the outgoing pilot's risk assessment. Additionally, no guidance was in place for pilots to determine who should take the flight if a flight request came in around the time of a shift change. In the case of the accident flight, this lack of guidance allowed for an outgoing pilot to accept a flight on behalf of an incoming pilot.

Thus, the NTSB concludes that Survival Flight's inconsistent compliance with standard operating procedures and regulations, combined with management's procedural gaps in risk management, advertising of flights in lower weather minimums, pressure to complete flights, and punitive repercussions for safety decisions, were indicative of a poor safety culture at the company. The NTSB also concludes that Survival Flight's poor safety culture likely influenced the accident pilot's decision to conduct the accident flight without a shift change briefing, including an adequate preflight risk assessment. Therefore, the NTSB recommends that Survival Flight develop a process

[86] Survival Flight claimed in an advertisement distributed to hospitals, that they operated at weather minimums different than other operators, and even if other companies turn down flights for weather, if Survival Flight could fly safely within FAA weather minimums, they would.

[87] Four pilots and one medical crewmember mentioned the 7-minute departure expectation during interviews.

to ensure shift change briefings are performed, to include comprehensive preflight risk assessments, before the acceptance of any flight requests. These recommended actions will help Survival Flight improve safety, but these actions alone will not address the overall poor safety culture that existed at Survival Flight at the time of the accident. However, an SMS program has been recognized in the aviation industry as an effective way to establish and reinforce a positive safety culture and to identify deviations from established procedures.

2.2.3 Safety Management Systems

Although the DO stated Survival Flight had an SMS program, no documentation existed to corroborate this statement.[88] Additionally, Survival Flight's operation was not consistent with defined and industry-recognized components of an SMS. For example, while a healthy safety policy establishes senior management's commitment to continually improving safety, Survival Flight's management's behavior toward safety decisions elevated and reinforced operational performance over safety. Although the company had a defined structure for safety personnel and designated safety representatives at each base, safety initiatives were driven from the bottom up and not reinforced from above. The tenuous reporting culture at the company was symptomatic of this dichotomy.

In addition, the safety risk management component of SMS is dependent upon an established process for risk management and is also closely coupled with strong safety assurance methods in its ability to help support the overall management of safety. Survival Flight had neither an established process for risk management nor reliable methods to assess the effectiveness of mitigations. For example, without an FDM program that could provide management with data about how its aircraft were being operated, Survival Flight was dependent on its personnel to provide this information and help to identify both emergent risks as well as information about the effectiveness of mitigations.

However, without a healthy reporting culture, the ability of Survival Flight to actively manage safety consistent with an SMS was compromised. Safety reporting was undermined by punitive repercussions and the company did not have a transparent process for handling safety concerns. Some employees stated they chose not to report safety concerns either because they feared reprisal or because they felt their concerns would not be addressed.

Finally, a company's safety promotion efforts to share safety-related information with its employees helps to reinforce and strengthen its safety culture. For many Survival Flight employees, insight into the company's position on safety came in the form of negative consequences for speaking up, questioning of flight declines by upper management, and lack of acknowledgement of certain safety concerns that were reported. This contradicted, rather than reinforced, any official company safety communications and policy statements. Therefore, the

[88] The director of safety and training, the chief pilot, and the DO all described an environment where employees could report their safety concerns to anyone at any time.

evidence shows that Survival Flight did not have an established safety management system aligned with the guidance in 14 *CFR* Part 5 or AC 120-92B.[89]

An effective SMS program establishes senior management's commitment to continually improve safety and defines the processes and structure needed to meet safety goals. Concerning management structure, an effective SMS program advocates for a safety manager to report directly to top-level management, illustrating the safety department's access to independent reporting and direct lines of communication and ultimately demonstrating the company's prioritization of safety. Similarly, AC 120-92B instructs that a key element of creating a successful safety culture is the designation of the "accountable executive" who has the ultimate responsibility for safety management within the organization. Often, safety initiatives can impact operations; therefore, a safety manager's safety concerns should be considered independently of the DO's operational concerns.

The NTSB has previously advocated for the implementation of SMS programs in commercial operations. As a result of an increase in fatal HAA accidents in 2008, the NTSB recommended that the FAA require all "[HAA] operators to implement [SMS] programs that include sound risk management practices" (A-09-89; NTSB 2009). On February 21, 2014, the FAA issued a final rule, "Helicopter Air Ambulance, Commercial Helicopter, and Part 91 Helicopter Operations," requiring HAA operators to incorporate additional tools and procedures to increase the overall safety of their operations. (FAA 2014)

On September 11, 2014, the NTSB replied to the FAA that although some of the tools and procedures required by the final rule included some of the elements of an effective SMS program, they were not a substitute for a complete program. Consequently, NTSB classified Safety Recommendation A-09-89 "Closed—Unacceptable Action." On September 24, 2014, the FAA replied that its goal was to require SMS for all Part 135 operators, including HAA operators. However, due to staffing limitations, an HAA-specific SMS rule could not be addressed at that time. The FAA also stated that it was developing requirements for participation in its SMS Voluntary Program and that the 21 HAA operators in the program operated 82% of HAA aircraft. In a December 5, 2014, response, the NTSB stated that although the FAA planned to eventually require SMS for all Part 135 operators, including HAA operators, Safety Recommendation A-09-89 remained classified "Closed—Unacceptable Action."

In 2016, the NTSB recommended that the FAA "require all [Part 135] operators to establish [SMS] programs" as a result of the investigation of the November 10, 2015, fatal Part 135 airplane accident involving Execuflight flight 1526, a British Aerospace HS 125-700A (Hawker 700A) (A-16-36; NTSB 2016). In a response dated January 9, 2017, the FAA noted that Part 135 operators could participate in a voluntary SMS program. The FAA also stated its intention to conduct a review and hold meetings to determine if further action was needed on SMS for Part 135 operators.

On April 6, 2017, the NTSB replied that to be consistent with fundamental SMS principles, it is necessary to measure how effective a mitigation is in addressing a safety risk. To satisfy this

[89] The FAA has published numerous resources for the voluntary implementation of SMS programs for non-Part 121 operators. These resources are available at https://www.faa.gov/about/initiatives/sms/specifics_by_aviation_industry_type/air_operators/

recommendation, the FAA's planned determination regarding SMS for Part 135 operators and necessary further action would require information on how many Part 135 operators had voluntarily implemented an SMS program compliant with the FAA's SMS standards. Safety Recommendation A-16-36, was classified "Open—Acceptable Response" pending:

> (1) Determination of whether the FAA's formal voluntary SMS program is being widely implemented by Part 135 operators;
>
> (2) Further effective action if it is determined that the data needed to make this determination are not available; or,
>
> (3) If data are available, additional actions needed to ensure that SMS is widely implemented by Part 135 operators.

On April 13, 2020, the FAA sent a letter to the NTSB referencing current FAA actions surrounding several previously issued NTSB safety recommendations, including safety recommendation A-16-36. The FAA stated that it is continuing to evaluate the feasibility of rulemaking to require SMS for Part 135 operators. In addition, rulemaking schedules are subject to revision and evaluation in accordance with Executive Order 13771, Reducing Regulation and Controlling Regulatory Costs, and Executive Order 13777, Enforcing the Regulatory Reform Agenda.[90]

In the 3 years since the FAA responded to this recommendation and in the 5 1/2 years since the last FAA response to Safety Recommendation A-09-89, the FAA has not taken any action or reported any plans to require an SMS program for all Part 135 operators. The NTSB has since reiterated Safety Recommendation A-16-36 three times as a result of our investigations of other fatal Part 135 operator accidents (NTSB 2017, 2018, 2019).[91] That recommendation is also listed on the NTSB's 2019-2020 Most Wanted List of Transportation Safety Improvements under the issue area of "Improve the Safety of Part 135 Aircraft Flight Operations." Because the FAA has

[90] Executive Order 13771, published on February 3, 2017, requires any executive department or agency that plans to publicly announce a new regulation to propose at least two regulations that will in turn be repealed. Executive Order 13777, published March 1, 2017 requires: (1) each agency head to designate a regulatory reform officer responsible for overseeing the implementation of regulatory reform initiatives and policies; (2) each agency to establish a Regulatory Reform Task Force to evaluate existing regulations and make recommendations to the agency head regarding regulations to repeal, replace, or modify; and (3) each agency listed in 31 US Code paragraph 901(b)(1) to incorporate into its Annual Performance Plan performance indicators to measure progress toward achieving regulatory reform initiatives and policies and identifying regulations to repeal, replace, or modify.

[91] The NTSB's investigation into the 2015 accident involving a de Havilland DHC-3 operated by Promech Air, identified that SMS could help Promech Air learn from incidents such as one involving a collision with a tree and other instances of pilots deviating due to weather. Additionally, the NTSB's investigation into the 2016 accident involving a Cessna 208B, operated by Hageland Aviation Services determined SMS may have helped the operator identify safety issues such as noncompliance with company procedures as well as multiple VFR flights into IMC conditions (Hageland Aviation Services had three accidents in 3 years involving VFR into IMC). Finally, the NTSB's investigation into the 2017 accident involving a Learjet 35A, operated by Trans-Pacific Charter, LLC, determined Trans-Pacific's safety programs did not identify or mitigate the hazards that contributed to the accident. For example, the safety program did not identify the hazard of unapproved (and likely inexperienced) second-in-command pilots acting as the pilot flying. The safety program also did not identify the hazard associated with pairing two pilots who had both exhibited training difficulties together. An SMS program may have identified and mitigated these safety concerns.

not taken any further action to satisfy Safety Recommendation A-16-36, it is classified "Open—Unacceptable Response."

In the case of Survival Flight, an FAA requirement for Part 135 carriers to have an SMS would have (1) held Survival Flight accountable for developing and maintaining a robust safety program that could have mitigated the poor safety culture and noncompliance with standard operating procedures evident in the accident and (2) provided the FAA with streamlined insight into the operator's safety process, enabling them to assess the effectiveness of Survival Flight's safety management and performance.

Specifically, an established SMS program at Survival Flight would have designated the safety manager as an independent position that reported directly to the president rather than to the DO. Such a management structure removes the conflict of interest between operational pressure and safety for the DO; it also mitigates some risk of employees receiving negative repercussions for safety decisions or reports, as was reported by several pilots. Further, this management structure provides all employees, including medical crew in Survival Flight's case, with an established path independent of the chain of command for addressing safety concerns, thereby building a foundation for nonpunitive safety reporting and an effective safety program.

Thus, the NTSB concludes that a properly implemented SMS, consistent with guidance in 14 *CFR* Part 5 and AC 120-92B, would have provided Survival Flight with a foundation to develop a positive safety culture and enhanced the company's and the FAA's ability to identify poor risk management practices and determine mitigations. Therefore, the NTSB reiterates Safety Recommendation A-16-36. Additionally, the NTSB believes that Survival Flight should not wait for the FAA to take action to require an SMS. Therefore, the NTSB recommends that Survival Flight establish an SMS program under the FAA SMS Voluntary Program that includes compliance with AC 120-92B, "Safety Management Systems for Aviation Service Providers."

2.2.4 Flight Data Monitoring

Effective safety risk management at Survival Flight would have provided the opportunity to identify and mitigate risks within their operation, such as flight in adverse weather and noncompliance with risk assessments and shift change procedures. The formal process of risk management introduces accountability into submitted reports and risks that are identified. Safety assurance promotes this process by continually evaluating the effectiveness of any mitigation and identifying further hazards. Therefore, any controls that could have been enacted to improve compliance would have been monitored to ensure that they were effective. For Survival Flight, this could have been accomplished by using the data gathered by existing onboard FDM equipment to evaluate the performance of the operation. Proactively identifying and correcting safety issues would have held Survival Flight accountable for adhering to their own operational procedures.

After its 2009 public hearing on HAA operations, the NTSB concluded that the systematic monitoring of data from HAA flights could provide operators with objective information about the manner in which their pilots conducted those flights and that a periodic review of this information could detect unsafe deviations from company practices. Therefore, the NTSB recommended that the FAA:

> Require helicopter emergency medical services operators to install flight data recording devices and establish a structured flight data monitoring program that reviews all available data sources to identify deviations from established norms and procedures and other potential safety issues. (A-09-90)[92]

The FAA's February 21, 2014, final rule regarding HAA safety included 14 *CFR* 135.607, which required that helicopters used for Part 135 HAA operations be equipped with an approved FDM system capable of recording flight performance data (FAA 2014). However, the final rule did not require that all HAA operators establish an FDM program that would use the data collected by the FDM system to identify safety issues of concern in a company's operations. In a November 1, 2017, response to Safety Recommendation A-09-90, the FAA said that it endorsed using voluntary flight operational quality assurance programs to continuously monitor and evaluate operational practices and procedures. However, because the protections provided in Part 193, "Protection of Voluntarily Submitted Information," pertain only if data are collected by operators as part of a voluntary FAA-approved program, the FAA did not intend to initiate rulemaking to mandate that HAA operators establish FDM programs.

In a January 25, 2018, response, the NTSB pointed out that the intent of Safety Recommendation A-09-90 was for HAA operators to establish an internal program that analyzes recorded FDM system data and monitors trends in their operations. Because the data collected would not need to be shared with the FAA, there would be no need to protect the data. Because the FAA did not require HAA operators to establish an FDM program, the NTSB classified the Safety Recommendation "Closed—Unacceptable Action."

In 2016, as a result of the NTSB's investigation of the Execuflight flight 1526 accident in Akron, Ohio, the NTSB issued Safety Recommendation A-16-35 to the FAA to "require all…Part 135 operators to establish a structured [FDM] program that reviews all available data sources to identify deviations from established norms and procedures and other potential safety issues" (NTSB 2016). The investigation revealed that Execuflight had no means to monitor the daily operation of its airplanes, identify operational deficiencies (such as noncompliance with standard operating procedures), and correct those deficiencies before an accident occurred. Without continual surveillance of an operation through en route inspections by company check airmen, the only means an operator has to consistently and proactively monitor its line operations is through comprehensive data collection over the entirety of its operation, which can be accomplished through a program that uses FDM data.

On January 9, 2017, the FAA replied that it previously considered this issue as a part of its February 2014 final rule and that its voluntary programs are successful for monitoring and evaluating operational practices and procedures. However, the FAA again said that maintaining a voluntary nature is paramount to the success of an FDM. To address Safety Recommendation A-16-35, the FAA planned to review Part 135 certificate holders' level of participation in voluntary programs and evaluate additional actions that can increase awareness and participation.

[92] The HEMS public hearing transcripts can be found at https://www.ntsb.gov/ under News and Events.

On April 6, 2017, the NTSB replied that, based on our review of major aviation accident investigations involving Part 135 on-demand operators, FDM programs are not common among Part 135 on-demand operators; as a result, the NTSB disagreed that the implementation of voluntary programs was successful. The NTSB said that a voluntary program might be the basis for an alternative response to the recommendation but cautioned that an acceptable response must measure the level of voluntary participation in FDM programs and must find that there is widespread participation among Part 135 operators. Pending completion of the FAA's review of its voluntary FDM programs and the identification and implementation of additional activities to encourage and measure Part 135 operators' level of voluntary participation, Safety Recommendation A-16-35 was classified "Open—Acceptable Alternate Response."

In the 3 years since the FAA's last response concerning this recommendation, the NTSB has reiterated Safety Recommendation A-16-35 twice as a result of our findings in other fatal Part 135 operator accidents. Specifically, the NTSB's investigation of an October 2, 2016, accident involving a Cessna 208B operated by Hageland Aviation Services identified two instances of the flight crew's noncompliance with standard operating procedures on the day of the accident. Although the instances were not related to the accident, the investigation noted that the company did not have a process to ensure compliance with standard operating procedures and regulations (NTSB 2018).

The NTSB's investigation of a May 15, 2017, accident involving a Learjet 35A operated by Trans-Pacific Air Charter, LLC found multiple flight-planning failures and procedural deviations by the flight crew (NTSB 2019). Comments made by the flight crew and captured on the cockpit voice recorder indicated that some of the procedural deviations had occurred on previous flights. The NTSB determined that if the accident flight had not ended in an accident, Trans-Pacific would not have had a way to identify the flight crew's deviations from policy and procedures just as it had no way to determine whether the accident (or any) flight crew's previous operations were conducted in accordance with company policies and standard operating procedures.

Safety Recommendation A-16-35 is on the 2019-2020 Most Wanted List under the issue area, "Improve the Safety of Part 135 Aircraft Flight Operations." The NTSB believes that in the 3 years since the FAA's last response to this recommendation, the FAA should have completed its review of Part 135 certificate holders' level of participation in voluntary programs and evaluated additional actions that can increase awareness and participation. However, the FAA has not provided an update; therefore, Safety Recommendation A-16-35 is classified "Open—Unacceptable Response."

The NTSB's investigation of the Survival Flight accident revealed several flights in which snow or IMC was encountered, resulting in flight deviations that would have been apparent in FDM data when examined as part of a robust FDM program.[93] However, Survival Flight did not have an FDM program in place to routinely download or use the data to gain insight on efficiency or safety. An effective FDM program can detect outliers to normal operating parameters, and when deviations from normal flight occur, further review of the circumstances would be needed to identify the context for the deviations. If Survival Flight had an FDM program, company

[93] Survival Flight installed the Outerlink IRIS FDM and satellite communications systems on its helicopters.

management could have identified flight deviations when compared to normal routes of flight and developed mitigations to address why deviations occurred. Instead, according to the DO, the company only used the data to evaluate unusual maintenance events. There was no evidence that Survival Flight company management or safety personnel acknowledged the previous flight deviations due to IMC encounters, which illustrates the lack of effectiveness of Survival Flight's current operational oversight and reinforces the need for the FAA to require operators to establish an FDM program.

Thus, the NTSB concludes that although HAA helicopters are required to be equipped with FDM systems, the lack of a required FDM program for all Part 135 operators to analyze these data continues to result in operational risks remaining unidentified and unmitigated, as occurred in this accident. Therefore, the NTSB reiterates Safety Recommendation A-16-35. Additionally, the NTSB recommends that Survival Flight develop and implement an FDM program independent of an FAA requirement.

2.3 FAA Oversight

At the time of the accident, the POI assigned to the certificate management team overseeing Survival Flight's operation had limited helicopter experience (2 to 3 hours of flight experience in a Robinson R44 helicopter), did not hold a rotorcraft rating on his commercial pilot certificate, and had no experience with HAA operations. One of the POI's duties was to approve the FRA for Survival Flight. Interviews conducted after the accident revealed the POI was unfamiliar with how Survival Flight used the FRA and was also unaware that it did not meet federal regulations because it did not require the evaluation of en route weather or include a procedure for obtaining information about other HAA operators' refusals of flight requests. Further, although unrelated to this accident, the POI was unable to observe Survival Flight's helicopter training, and he likely did not have an appreciation for the risks associated with flying HAA operations in tight spaces, particularly at night.

These were critical deficiencies that affected the OCS's and evening shift pilot's decision to accept the accident flight, as discussed above. The POI's lack of rotorcraft experience and lack of familiarity with HAA operations likely contributed to his lack of awareness concerning the Survival Flight FRA's noncompliance with regulations and its importance in supporting Survival Flight's pilots and OCC in the effective identification and evaluation of risks before each flight.[94] Therefore, the NTSB concludes that the POI's oversight of the Survival Flight FRA was inadequate because it failed to identify that the FRA did not meet the requirements of 14 *CFR* 135.617 or comply with the guidance in AC 135-14B.

According to the FAA's SAS, the POI was required to conduct surveillance tasks "every 6 months or 2 quarters." In the 6 months before the accident, the POI performed surveillance at

[94] Experience with HAA operations would provide a POI with an understanding of some of the risks, such as the nature of the mission, which includes picking up patients at remote sites that may be unfamiliar to pilots, and potential en route or landing site hazards, which includes power lines or steep terrain.

Survival Flight three times.[95] According to an inspection report, 51 surveillance activities were conducted during the 3 years before the accident with no unfavorable findings.

After the accident, the FAA conducted targeted surveillance of Survival Flight with assistance from inspectors with HAA oversight knowledge and expertise. FAA inspectors, including the POI, completed 899 data collection tools within the SAS and identified 26 negative findings. Two examples of the negative findings included: (1) confusion between pilots and OCSs regarding when and how to document the completion of the preflight risk assessment and (2) insufficient training for pilots and OCSs regarding preflight risk assessment procedures.

The increased number of findings identified after the accident as compared to surveillance done before the accident is likely due to the assistance from FAA inspectors with HAA knowledge and expertise. A 2015 audit conducted by the Department of Transportation Office of Inspector General found a shortage of helicopter inspectors within the FAA, primarily due to inspector qualification standards that required airplane experience but not helicopter experience. The audit report stated, "Because of the unique operating characteristics of [HAA], inspectors with helicopter experience may be better suited to identify [HAA]-specific risks." The NTSB agrees with this statement. Thus, the NTSB concludes that both helicopter and HAA experience would allow POIs assigned to oversee HAA operations to better identify and mitigate associated risks.

Therefore, the NTSB recommends that the FAA require that POIs assigned to HAA operations possess helicopter and either HAA experience or experience as an assistant POI under a POI with HAA experience.

Given that the recommended qualifications are currently not required for POIs assigned to oversee HAA operations and the resulting deficiencies of Survival Flight's FRA, the NTSB is concerned that there may be other POIs with a similar lack of HAA experience who have approved HAA operators' FRAs that also do not comply with FAA regulations and guidance. As a result, the NTSB recommends that the FAA review the FRAs for all HAA operators for compliance with 14 *CFR* 135.617 and AC 135-14B and require operators to address any deficiencies that are identified.

2.4 Meteorological Factors

About the time of the accident, multiple weather stations in the area were reporting MVFR conditions in the area of the accident site with gusty surface wind conditions from the west between 10 and 20 kts. Reported visibility was as low as 3 miles at the surface with light snow at Fairfield County Airport, which was located about 30 miles northwest of the accident site. Satellite imagery showed cloud cover moving southwest to northeast over the accident site, and the cloud cover contained low-level, cool water clouds and high, thick ice clouds.

The NWS forecast valid for the accident area for the period before and during the accident flight indicated precipitation and MVFR ceilings along the proposed route of flight. The forecast included AIRMET advisories for moderate turbulence and moderate icing conditions, and a winter

[95] In a postaccident interview, the POI stated he performed surveillance twice on Survival Flight, as required, and the third visit was to follow up on issues identified during one of two required visits.

weather advisory was in effect for the surface that warned of rapidly falling temperatures, flash freeze conditions, scattered snow showers, and up to an inch of possible snow accumulation.

The evening shift pilot, accident pilot, and OCS had multiple resources available to them to check the weather; however, the HEMS Weather Tool was their main weather source for monitoring weather information and trends. Interviews with the OCS and the evening shift pilot revealed they both used the HEMS Weather Tool with the default setting before the accident flight and did not recall seeing any AIRMETs along the route of the flight. They also stated they did not recall seeing precipitation depicted along the route of flight on the HEMS Weather Tool before the accident flight.

While AIRMETs or other en route forecast information are not displayed by default, these sources of information are accessible on the HEMS Weather Tool (see figure 8). To access the graphical AIRMETs, a box must be checked on the HEMS Weather Tool.

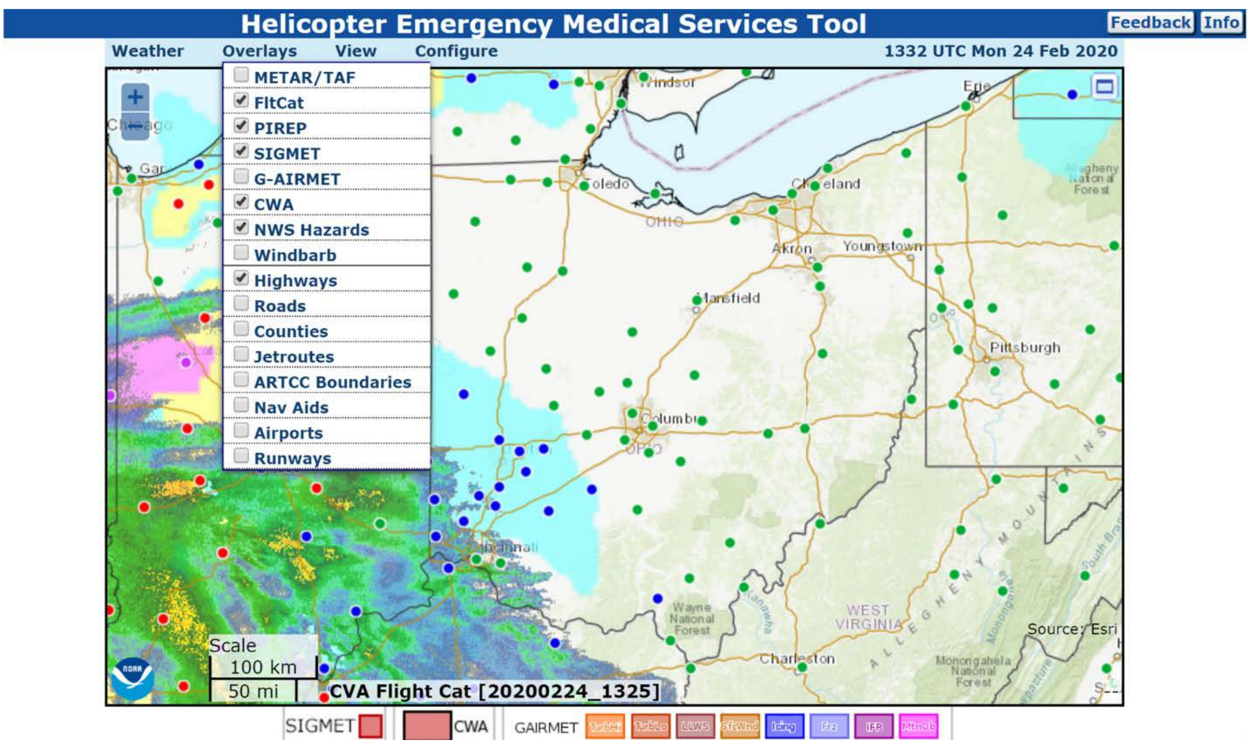


Figure 8. Exemplar HEMS Weather Tool displaying overlay options

The investigation also noted that the default overlay setting for the HEMS Weather Tool includes flight category, PIREPs, SIGMETs, and MRMS weather radar information (see figure 9).

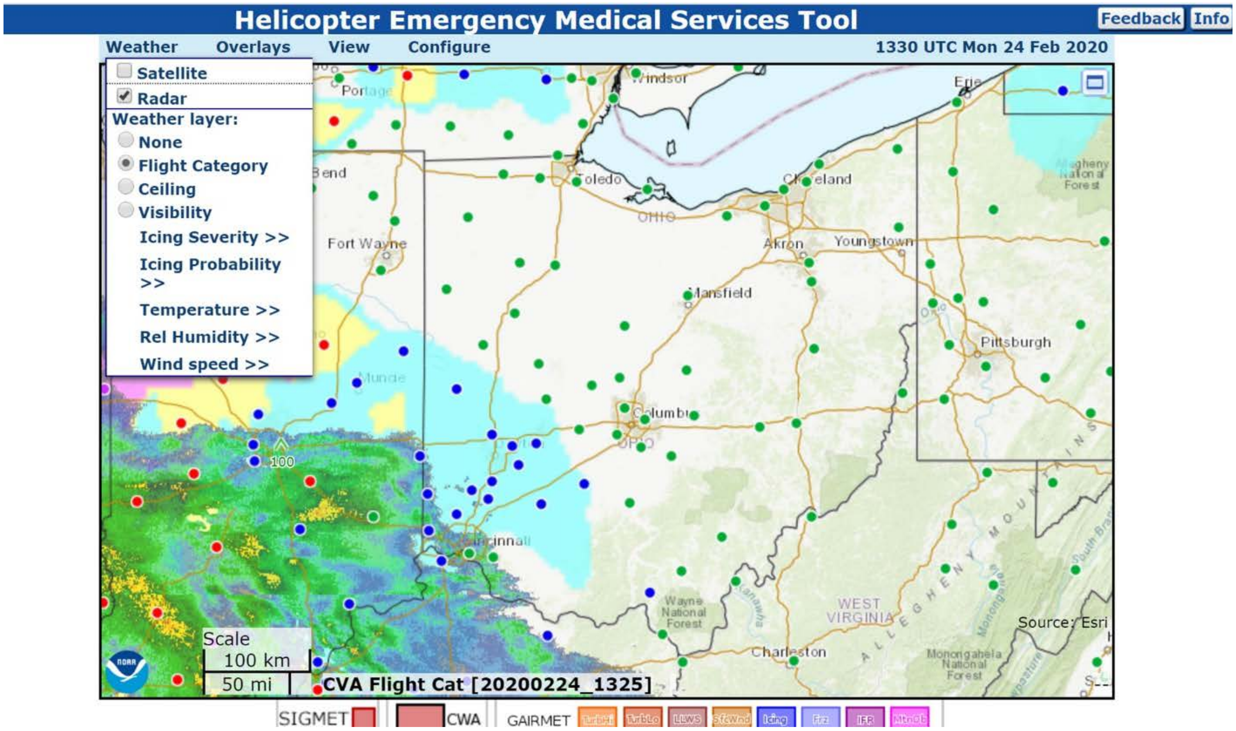
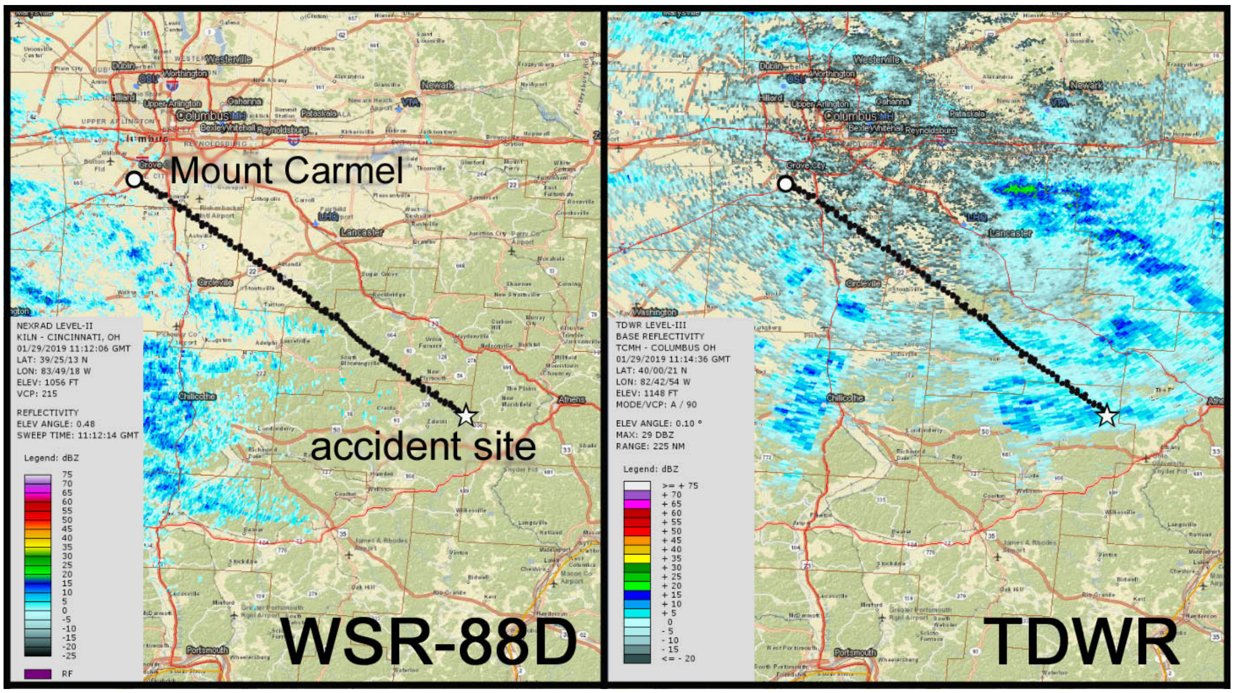


Figure 9. Exemplar HEMS Weather Tool default setting with flight category and radar precipitation selected.

However, MRMS weather radar information does not include TDWR information. The MRMS weather radar imagery incorporates information only from the network of WSR-88D weather radars. Although WSR-88D and TDWR both show precipitation, they use different equipment settings to do so; therefore, the HEMS Weather Tool does not always show all potential precipitation along a flightpath.[96]

[96] WSR-88D and TDWR were designed to aid in several different weather hazard areas.

Because the WSR-88D only covered altitudes between 4,980 ft and 11,880 ft over the accident site, the snow showers identified on the TDWR were not detected or displayed on the HEMS Weather Tool above the accident site. Although recorded data showed that the TDWR from Columbus detected bands of precipitation along the route of flight, this was not an information source available in the HEMS Weather Tool (see figure 10).



Note: The accident helicopter's flightpath is shown in black.

Figure 10. Comparison of WSR-88D data vs. TDWR data at the time of the flight request

Archived WSR-88D data for the accident aircraft's flightpath also did not show any precipitation. However, archived TDWR imagery showed very light reflectivity echoes along the flightpath. Combined with surface observations and satellite data, the TDWR showed a pattern consistent with snow at the accident site, but this information was not displayed on the HEMS Weather Tool. Although the TDWR information was not available on the HEMS Weather Tool, the application could provide weather information in the form of overlays to display forecast weather along the helicopter's intended flightpath, including AIRMETs, SIGMETs, cloud ceiling, visibility, and icing probability.

Therefore, the NTSB concludes that although sufficient information was available to the evening shift pilot and the OCS to identify the potential for snow, icing, and reduced visibility along the accident flight route, their failure to obtain complete en route information precluded them from identifying crucial meteorological risks for the accident flight.

Because the HEMS Weather Tool does not currently have the ability to display TDWR information, which can be vital to evaluate weather along the flight route when combined with other information for pilots and OCC personnel, the NTSB also concludes that the availability of the lower-altitude reflectivity echoes from TDWR data on the HEMS Weather Tool radar overlay would have provided awareness to the OCS, the evening shift pilot, and the accident pilot of the potential for snow along the flight route.

The NTSB is aware that the NWS plans to update weather reporting capabilities with software that processes weather data from all TDWRs and that beta testing was scheduled to begin about March 16, 2020. This new software will allow for the TDWR data to be distributed via the Level II network to all users, and therefore will be more easily integrated into the HEMS Weather Tool for the user community.[97]

Therefore, the NTSB recommends that the FAA install the latest software on your TDWRs and require the NWS to distribute Level II TDWR data to all of its users (as recommended in Safety Recommendation A-20-18 to the NWS) so they will have access to the most accurate precipitation information. The NTSB also recommends to the NWS to distribute Level II TDWR data to all of its users (as recommended in Safety Recommendation A-20-15 to the FAA) so they will have access to the most accurate precipitation information. Additionally, the NTSB recommends that the FAA require the NWS to add TDWR data to the HEMS Weather Tool overlay (as recommended in Safety Recommendation A-20-19 to the NWS).[98] The NTSB also recommends to the NWS to add TDWR data to the HEMS Weather Tool overlay (as recommended in Safety Recommendation A-20-20 to the FAA).

Because there is no indication on the HEMS Weather Tool that weather radar coverage may be lacking in certain areas, the NTSB concludes that, without specialized experience or knowledge of an area, users of the HEMS Weather Tool may not be able to determine if the absence of a weather radar return in a particular area is due to a lack of precipitation or a limitation in radar coverage.

Therefore, the NTSB recommends that the FAA require the NWS to provide capability in the HEMS Weather Tool to graphically display areas of weather radar limitations, including areas where beams may lack low-altitude coverage, areas that lack radar coverage, and areas of beam blockages (as recommended in Safety Recommendation A-20-20 to the NWS). The NTSB also recommends to the NWS to provide capability in the HEMS Weather Tool to graphically display areas of weather radar limitations, including areas where beams may lack low-altitude coverage, areas that lack radar coverage, and areas of beam blockages (as recommended in Safety Recommendation A-20-17 to the FAA).

The NTSB has considered whether the addition of this information to the HEMS Weather Tool could provide too much information to users. The NTSB believes this additional information could be provided in the form of an overlay that could be turned on or off at the user's discretion. Finally, the addition of this information would clarify potentially misleading information.

[97] The Level II network is the method by which NEXRAD Level II data are distributed.

[98] According to FAA Order 7000.2B, dated January 12, 2004, the FAA is responsible for ensuring aviation weather services are provided in the National Airspace System, and NWS is contracted to provide mutually agreed upon aviation weather services.

2.5 Lack of Flight Recorder

Because the helicopter was not equipped with a video recorder, flight data recorder, or cockpit voice recorder, the accident pilot's control inputs during the final 30 seconds are unknown. Additionally, because of the lack of a video recorder, the investigation could not conclusively determine the specific weather conditions encountered. Although FDM data were available to determine the altitude, groundspeed, and flightpath of the helicopter, the data dropped for 2 minutes during the flight and ended about 30 seconds before impact. During the periods when no FDM data were available, the NTSB could only estimate the helicopter's altitude, airspeed, and flightpath based on satellite data.

Therefore, the NTSB concludes that if a recorder system that captured cockpit audio, images, and parametric data had been installed, it would have enabled NTSB investigators to reconstruct the final moments of the accident flight and determine why the accident pilot did not maintain the helicopter's altitude and successfully exit the encounter with inadvertent instrument meteorological conditions.

The NTSB notes that the helicopter was not required to have a crash-resistant recorder installed. Previous NTSB recommendations have addressed the need for recording information on aircraft such as the helicopter involved in this accident. For example, as a result of the NTSB's investigation of the August 26, 2011, fatal accident involving a Eurocopter AS350 B2 helicopter, on May 6, 2013, the NTSB issued Safety Recommendations A-13-12 and A-13-13 to the FAA.[99]

These recommendations proposed the required installation of crash-resistant flight recorder systems in both newly manufactured and existing turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder and a cockpit voice recorder. Specifically, these recommendations proposed that the flight recorder system should record cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible and parametric data per aircraft and system installation, all as specified in FAA Technical Standard Order C197, "Information Collection and Monitoring Systems."[100]

On August 1, 2013, the FAA responded to the recommendations stating it did not intend to mandate the equipage of crash-resistant flight recording systems on all turbine-powered,

[99] Safety Recommendation A-13-12 recommended the FAA require the installation of a crash-resistant flight recorder system on all newly manufactured turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder and a cockpit voice recorder and are operating under 14 *CFR* Parts 91, 121, or 135. The crash-resistant flight recorder system should record cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible and parametric data per aircraft and system installation, all as specified in Technical Standard Order C197, "Information Collection and Monitoring Systems." Safety Recommendation A-13-13 recommended the FAA require all existing turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder or cockpit voice recorder and are operating under Parts 91, 121, or 135 to be retrofitted with a crash-resistant flight recorder system. The crash-resistant flight recorder system should record cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible and parametric data per aircraft and system installation, all as specified in Technical Standard Order C197, "Information Collection and Monitoring Systems."

[100] On November 15, 2010, the FAA published Technical Standard Order C197, "Information Collection and Monitoring Systems," which provides standards for the design and production certification of lightweight recording systems.

non-experimental, non-restricted-category aircraft in part because: (1) the cost estimate to the industry could be as high as $180 million (or $20,000 or more per aircraft); (2) the FAA could not determine a quantitative benefit for mandating these recorders because it had no way of estimating the number of lives that could be saved or the number of accidents that could be prevented; and (3) crash-resistant flight recording systems were primarily used for accident investigation activities and, as early as 2005, the FAA adopted a position of promoting voluntary equipage and use of voluntary and non-punitive FDM programs.

On December 10, 2013, the NTSB classified Safety Recommendations A-13-12 and A-13-13 as “Open-Unacceptable Response” because the FAA stated that it had not found any compelling evidence to require the installation of cockpit image recording systems and planned no further action. The NTSB stated it would be premature to close the recommendations as the lack of image recording systems on aircraft remained an important safety issue.

Despite the FAA’s position, the NTSB continues to investigate accidents in which the benefit of flight recording devices, specifically cockpit image recording systems, has been demonstrated. For example, in the March 30, 2013, accident investigation involving a Eurocopter AS350 B3 helicopter, the NTSB gained valuable information from the helicopter’s onboard Appareo Systems Vision 1000 unit.[101] The helicopter was involved in a search-and-rescue mission when the pilot encountered deteriorating weather conditions, which resulted in the pilot’s spatial disorientation and loss of control.

The images that were captured by the Appareo unit provided information that helped investigators determine precisely how the cockpit navigational displays were configured and that the pilot caged the attitude indicator in flight. This information, along with the wreckage examination, enabled investigators to conclusively determine that icing was not a factor in the accident and that there were no mechanical anomalies with the helicopter.

While the NTSB acknowledges that many operators have voluntarily installed recorder systems, such as FDM systems and Appareo units, they are not required to comply with the crash-resistant requirements outlined in Technical Standard Order C197. Consequently, the NTSB has investigated accidents in which these units were badly damaged during the accident and we were unable to recover data. For example, in the NTSB’s investigation into the July 3, 2015, accident involving an Airbus AS350 B3e helicopter, the NTSB was unable to recover data from the Appareo device due to the impact and fire damage sustained during the accident. The helicopter experienced a hydraulic failure after takeoff, resulting in a loss of control and impact with the ground.

Because the data from the Appareo unit was unable to be recovered, the NTSB could not determine the possible reasons that the pilot did not complete the hydraulic check or perform a hover check. Additionally, the NTSB could not determine the application or duration of flight control inputs and any annunciations on the caution and warning panel.

[101] The Appareo Systems Vision 1000 unit is designed to record cockpit images and two-track audio. It also has a GPS receiver for satellite-based time, position, altitude, and groundspeed information.

The NTSB acknowledges that investigators sometimes have multiple sources of data when investigating an accident; however, a crash-resistant flight recorder system would provide a more conclusive dataset for the discovery of hazards that may otherwise remain undetected in the aviation system. Therefore, the NTSB reiterates Safety Recommendations A-13-12 and A-13-13.

3. Conclusions

3.1 Findings

1. The pilot likely encountered instrument meteorological conditions inadvertently when the helicopter flew through a snow band, which resulted in decreased visibility.

2. In an attempt to recover from the inadvertent instrument meteorological conditions (IIMC) encounter, the pilot began a 180° turn as part of an IIMC escape maneuver, in keeping with standard operating procedures, but did not maintain altitude and allowed the helicopter to descend until it impacted terrain.

3. None of the following were factors in the accident: (1) pilot qualifications; (2) pilot medical conditions or impairment by alcohol or other drugs; (3) the airworthiness of the helicopter.

4. Survival Flight's risk assessment process was inadequate for identifying weather risks for the accident flight as illustrated by (1) consistent failure by Survival Flight operational personnel to complete the risk assessment worksheet before every flight, including the accident flight, and (2) the absence of required elements on the worksheet, including en route weather risks and refusals of previous requests for a flight.

5. Survival Flight's lack of a procedure to track pilots' actual duty time contributed to the ineffectiveness of the company's risk management.

6. Survival Flight's inconsistent compliance with standard operating procedures and regulations, combined with management's procedural gaps in risk management, advertising of flights in lower weather minimums, pressure to complete flights, and punitive repercussions for safety decisions, were indicative of a poor safety culture at the company.

7. Survival Flight's poor safety culture likely influenced the accident pilot's decision to conduct the accident flight without a shift change briefing, including an adequate preflight risk assessment.

8. A properly implemented safety management system, consistent with guidance in Title 14 *Code of Federal Regulations* Part 5 and Advisory Circular 120-92B, would have provided Survival Flight with a foundation to develop a positive safety culture and enhanced the company's and the Federal Aviation Administration's ability to identify poor risk management practices and determine mitigations.

9. Although helicopter air ambulances are required to be equipped with flight data monitoring (FDM) systems, the lack of a required FDM program for all Title 14 *Code of Federal Regulations* Part 135 operators to analyze these data continues to result in operational risks remaining unidentified and unmitigated, as occurred in this accident.

10. The principal operations inspector's oversight of the Survival Flight flight risk assessment (FRA) was inadequate because it failed to identify that the FRA did not meet the

requirements of Title 14 *Code of Federal Regulations* 135.617 or comply with the guidance in Advisory Circular 135-14B.

11. Both helicopter and helicopter air ambulance (HAA) experience would allow principal operations inspectors assigned to oversee HAA operations to better identify and mitigate associated risks.

12. Although sufficient information was available to the evening shift pilot and the operations control specialist to identify the potential for snow, icing, and reduced visibility along the accident flight route, their failure to obtain complete en route information precluded them from identifying crucial meteorological risks for the accident flight.

13. The availability of the lower-altitude reflectivity echoes from terminal doppler weather radar data on the HEMS Weather Tool radar overlay would have provided awareness to the operations control specialist, the evening shift pilot, and the accident pilot of the potential for snow along the flight route.

14. Without specialized experience or knowledge of an area, users of the HEMS Weather Tool may not be able to determine if the absence of a weather radar return in a particular area is due to a lack of precipitation or a limitation in radar coverage.

15. If a recorder system that captured cockpit audio, images, and parametric data had been installed, it would have enabled NTSB investigators to reconstruct the final moments of the accident flight and determine why the accident pilot did not maintain the helicopter's altitude and successfully exit the encounter with inadvertent instrument meteorological conditions.

3.2 Probable Cause

The NTSB determines that the probable cause of this accident was Survival Flight's inadequate management of safety, which normalized pilots' and operations control specialists' noncompliance with risk analysis procedures and resulted in the initiation of the flight without a comprehensive preflight weather evaluation, leading to the pilot's inadvertent encounter with instrument meteorological conditions, failure to maintain altitude, and subsequent collision with terrain. Contributing to the accident was the Federal Aviation Administration's inadequate oversight of the operator's risk management program and failure to require Title 14 *Code of Federal* Regulations Part 135 operators to establish safety management system programs.

4. Recommendations

4.1 New Recommendations

To the Federal Aviation Administration

Require that principal operations inspectors (POI) assigned to helicopter air ambulance (HAA) operations possess helicopter and either HAA experience or experience as an assistant POI under a POI with HAA experience. (A-20-13)

Review the flight risk assessments for all helicopter air ambulance operators for compliance with Title 14 *Code of Federal Regulations* 135.617 and Advisory Circular 135-14B and require operators to address any deficiencies that are identified. (A-20-14)

Install the latest software on your terminal doppler weather radars (TDWR) and require the National Weather Service (NWS) to distribute Level II TDWR data to all of its users (as recommended in Safety Recommendation A-20-18 to the NWS) so they will have access to the most accurate precipitation information. (A-20-15)

Require the National Weather Service (NWS) to add terminal doppler weather radar data to the HEMS Weather Tool overlay (as recommended in Safety Recommendation A-20-19 to the NWS). (A-20-16)

Require the National Weather Service (NWS) to provide capability in the HEMS Weather Tool to graphically display areas of weather radar limitations, including areas where beams may lack low-altitude coverage, areas that lack radar coverage, and areas of beam blockages (as recommended in Safety Recommendation A-20-20 to the NWS). (A-20-17)

To the National Weather Service

Distribute Level II terminal doppler weather radar data to all of your users (as recommended in Safety Recommendation A-20-15 to the Federal Aviation Administration) so they will have access to the most accurate precipitation information. (A-20-18)

Add terminal doppler weather radar data to the HEMS Weather Tool overlay (as recommended in Safety Recommendation A-20-16 to the Federal Aviation Administration). (A-20-19)

Provide capability in the HEMS Weather Tool to graphically display areas of weather radar limitations, including areas where beams may lack low-altitude coverage, areas that lack radar coverage, and areas of beam blockages (as recommended in Safety Recommendation A-20-17 to the Federal Aviation Administration). (A-20-20)

To Survival Flight

> Revise your flight risk assessment procedures to incorporate the elements described by Advisory Circular 135-14B, including procedures for determining prior flight refusals by another helicopter air ambulance operator and forecast en route weather. (A-20-21)

> Require pilots to complete a comprehensive risk assessment before each flight and complete the appropriate paperwork to reflect their assessment as required by Title 14 *Code of Federal Regulations* 135.617. (A-20-22)

> Develop a procedure for tracking actual pilot duty times in compliance with Title 14 *Code of Federal Regulations* 135.267. (A-20-23)

> Develop a process to ensure shift change briefings are performed, to include comprehensive preflight risk assessments, before the acceptance of any flight requests. (A-20-24)

> Establish a safety management system (SMS) program under the Federal Aviation Administration SMS Voluntary Program that includes compliance with Advisory Circular 120-92B, "Safety Management Systems for Aviation Service Providers." (A-20-25)

> Develop and implement a flight data monitoring program independent of a Federal Aviation Administration requirement. (A-20-26)

4.2 Previously Issued Recommendations Reiterated and Classified in This Report

As a result of this investigation, the National Transportation Safety Board reiterates and classifies the following safety recommendations to the Federal Aviation Administration:

> After the action in Safety Recommendation A-16-34 is completed, require all Title 14 *Code of Federal Regulations* Part 135 operators to establish a structured flight data monitoring program that reviews all available data sources to identify deviations from established norms and procedures and other potential safety issues. (A-16-35)

Safety Recommendation A-16-35 is classified "Open—Unacceptable Response" in section 2.2.4 of this report.

> Require all Title 14 *Code of Federal Regulations* Part 135 operators to establish safety management system programs. (A-16-36)

Safety Recommendation A-16-36 is classified "Open—Unacceptable Response" in section 2.2.3 of this report.

4.3 Previously Issued Recommendations Reiterated in This Report

As a result of this investigation, the National Transportation Safety Board reiterates the following safety recommendations to the Federal Aviation Administration:

> Require the installation of a crash-resistant flight recorder system on all newly manufactured turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder and a cockpit voice recorder and are operating under Title 14 *Code of Federal Regulations* Parts 91, 121, or 135. The crash-resistant flight recorder system should record cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible, and parametric data per aircraft and system installation, all as specified in Technical Standard Order C197, "Information Collection and Monitoring Systems." (A-13-12)

> Require all existing turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder or cockpit voice recorder and are operating under Title 14 *Code of Federal Regulations* Parts 91, 121, or 135 to be retrofitted with a crash-resistant flight recorder system. The crash-resistant flight recorder system should record cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible, and parametric data per aircraft and system installation, all as specified in Technical Standard Order C197, "Information Collection and Monitoring Systems." (A-13-13)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III
Chairman

JENNIFER HOMENDY
Member

BRUCE LANDSBERG
Vice Chairman

THOMAS CHAPMAN
Member

Report Date: May 19, 2020

Board Member Statement

Chairman Sumwalt filed the following concurring statement on May 25, 2020; Vice Chairman Landsberg and Members Homendy and Chapman joined in this statement:

"Denial is the enemy of change."

Those were words spoken by me in the Board Meeting for this accident, and they were in direct reference to Survival Flight management's attitude toward the facts surrounding this tragedy.

The day before the Board Meeting, I had a video conference with Survival Flight management, which included their CEO, their chief pilot, and outside counsel that they had apparently retained. There, they invoked a common, but ineffective, strategy: they attacked the credibility of those who made discrediting remarks about the way Survival Flight conducted business. They attributed such remarks to "disgruntled employees" and "former employees who had an axe to grind."

In fact, of the 23 former and current company employees whom NTSB investigators interviewed, 19 were employed by Survival Flight at the time of their interview. While it is possible that some were unhappy current or former employees, when you have a large number of reports from several different people – many of whom were neither disgruntled nor former employees – and each citing similar concerns, it is likely that there is some level of truth to what is being reported.

The safety culture discussions in this report are replete with examples of Survival Flight management pressuring pilots to fly. There are references to management belittling pilots when flights were turned down, along with management yelling and cussing at pilots. Three of the eight interviewed pilots stated that they would receive opposition from management when they attempted to issue a "red" risk assessment -- which, at that risk level, effectively prevented flying. One pilot recalled to investigators that "bending regulations wasn't uncommon."

This information was made public when the NTSB opened the public docket in November 2019 – a full six months before the May 2020 Board Meeting. Instead of properly investigating such claims and correcting the problems, Survival Flight management's response was to deny that those conditions existed. "That's not who we are. That's not us," they insisted.

Denial was on display in its fullest form.

As long as Survival Flight's management remains in denial, they will not change. And, unless they change, they are putting their employees and medical patients at risk of another deadly crash.

Safety culture, as defined by the US Regulatory Commission, "is the core values and behaviors resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment."[1] There is widespread evidence that Survival Flight failed to place safety over the competing goals of flying revenue flights.

The Board unanimously concluded that, "Survival Flight's inconsistent compliance with standard operating procedures, and regulations, combined with management's procedural gaps in risk management, advertising of flights in lower weather minimums, pressure to complete flights, and punitive repercussions for safety decisions, were indicative of a poor safety culture at the company."

There are other indications that further reinforce Survival Flight's safety culture was lacking. In his work on organizational accidents, Dr. James Reason stated that a safety culture needs certain elements, among them, a just culture, a reporting culture, and a learning culture.[2] There is indisputable evidence that these components were absent here.

Just Culture: Dr. Reason explained that Just Culture is "an atmosphere of trust in which people are encouraged (even rewarded) for providing safety-related information, but in which they are also clear about where the line must be drawn between acceptable and unacceptable behavior."[3] In his interview with NTSB investigators, Survival Flight's director of operations told investigators that he tried to have people explain Just Culture to him. "I'm not sure how it works." He believed it was where you "create an environment by which everyone felt more equal in the decision making." Not only was his description of Just Culture badly mistaken, but further demonstrating its absence at Survival Flight was management's actions of yelling at pilots and cussing at them for declining flights.

Reporting Culture: With a Reporting Culture, employees are open and encouraged to report safety problems. They have assurances that the information will be acted upon, and further assurances that they will not be ridiculed for reporting such concerns. At Survival Flight, one employee told investigators that he knew of no official way to report safety concerns. In fact, according to the director of safety and training, they had only received one incident report in the 1 1/2 years that he had been in that position. Furthermore, he told investigators that he knew pilots were not comfortable reporting safety issues to management. A culture of fear and a culture of safety cannot coexist.

Informed Culture: Organizations striving for an Informed Culture are fastidious about collecting and analyzing data to stay informed about the safety health of the organization. Despite having flight recording capability onboard its aircraft, Survival Flight did not attempt to analyze these data. The director of operations told investigators that it took a long time to download a file and "then I don't know what you'll do with it." Collecting data without analyzing it provides zero safety feedback, yet that's the way Survival Flight operated.

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[1] *See* https://www.nrc.gov/about-nrc/safety-culture.html

[2] Reason, J. (1997). *Managing the risks of organizational accidents*. Burlington, VT: Ashgate Publishing Company

[3] *Ibid*

Another way of being informed about the functionality of one's operation is through employing outside audits. The Commission on Accreditation of Medical Transport Systems (CAMTS) provides such audits. CAMTS offers accreditation for those medical transport organizations that pass their audit and agree to abide by certain best practices which are usually more stringent than those required by regulations. Most helicopter air ambulance programs in the US are CAMTS-accredited programs. Furthermore, the US Department of Defense requires CAMTS accreditation for civilian contracts. Despite this being the "gold standard" for auditing and accrediting helicopter air ambulances, Survival Flight was not CAMTS accredited.

When viewed objectively, there can be no legitimate denial that Survival Flight seriously lacked a positive safety culture. The only ones denying it at this point are the only ones who can fix it: Survival Flight management.

Appendixes

Appendix A: Investigation

The National Transportation Safety Board (NTSB) was notified of this accident on January 29, 2019, and members of the investigative team arrived on scene the following day.

Investigative groups were formed to evaluate operations, human performance, airworthiness, meteorology, and onboard recorders.

The Federal Aviation Administration, Survival Flight, Rolls-Royce Engines and Woodward, Inc. were parties to the investigation. In accordance with the provisions of Annex 13 to the Convention on International Civil Aviation (ICAO), the Transportation Safety Board (TSB) of Canada served as an accredited representative to the investigation as the state of manufacturer of the helicopter. Bell Textron Inc. participated in the investigation as the technical advisor to the TSB.

Appendix B: Consolidated Recommendation Information

Title 49 *United States Code* (*USC*) 1117(b) requires the following information on the recommendations in this report.

For each recommendation—

(1) a brief summary of the NTSB's collection and analysis of the specific accident investigation information most relevant to the recommendation;

(2) a description of the NTSB's use of external information, including studies, reports, and experts, other than the findings of a specific accident investigation, if any were used to inform or support the recommendation, including a brief summary of the specific safety benefits and other effects identified by each study, report, or expert; and

(3) a brief summary of any examples of actions taken by regulated entities before the publication of the safety recommendation, to the extent such actions are known to the Board, that were consistent with the recommendation.

To the Federal Aviation Administration

A-20-13

Require that principal operations inspectors (POI) assigned to helicopter air ambulance (HAA) operations possess helicopter and either HAA experience or experience as an assistant POI under a POI with HAA experience.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.3 FAA Oversight. Information supporting (b)(1) can be found on pages 45-46; (b)(2) and (b)(3) are not applicable.

A-20-14

Review the flight risk assessments for all helicopter air ambulance operators for compliance with Title 14 *Code of Federal Regulations* 135.617 and Advisory Circular 135-14B and require operators to address any deficiencies that are identified.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.3 FAA Oversight. Information supporting (b)(1) can be found on pages 45-46; (b)(2) is not applicable and (b)(3) can be found on page 46.

A-20-15

> Install the latest software on your terminal doppler weather radars (TDWRs) and require the National Weather Service (NWS) to distribute Level II TDWR data to all of its users (as recommended in Safety Recommendation A-20-18 to the NWS) so they will have access to the most accurate precipitation information.

Information that addresses the requirements of 49 USC 1117(b), as applicable, can be found in section 2.4 Meteorological Factors. Information supporting (b)(1) can be found on pages 46-50; (b)(2) and (b)(3) are not applicable.

A-20-16

> Require the National Weather Service (NWS) to add terminal doppler weather radar data to the HEMS Weather Tool overlay (as recommended in Safety Recommendation A-20-19 to the NWS).

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.4 Meteorological Factors. Information supporting (b)(1) can be found on pages 46-50; (b)(2) and (b)(3) are not applicable.

A-20-17

> Require the National Weather Service (NWS) to provide capability in the HEMS Weather Tool to graphically display areas of weather radar limitations, including areas where beams may lack low-altitude coverage, areas that lack radar coverage, and areas of beam blockages (as recommended in Safety Recommendation A-20-20 to the NWS).

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.4 Meteorological Factors. Information supporting (b)(1) can be found on pages 46-50; (b)(2) and (b)(3) are not applicable.

To the National Weather Service

A-20-18

> Distribute Level II terminal doppler weather radar data to all of your users (as recommended in Safety Recommendation A-20-15 to the Federal Aviation Administration) so they will have access to the most accurate precipitation information.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.4 Meteorological Factors. Information supporting (b)(1) can be found on pages 46-50; (b)(2) and (b)(3) are not applicable.

A-20-19

> Add terminal doppler weather radar data to the HEMS Weather Tool overlay (as recommended in Safety Recommendation A-20-16 to the Federal Aviation Administration).

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.4 Meteorological Factors. Information supporting (b)(1) can be found on pages 46-50; (b)(2) and (b)(3) are not applicable.

A-20-20

> Provide capability in the HEMS Weather Tool to graphically display areas of weather radar limitations, including areas where beams may lack low-altitude coverage, areas that lack radar coverage, and areas of beam blockages (as recommended in Safety Recommendation A-20-17 to the Federal Aviation Administration).

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.4 Meteorological Factors. Information supporting (b)(1) can be found on pages 46-50; (b)(2) and (b)(3) are not applicable.

To Survival Flight

A-20-21

> Revise your flight risk assessment procedures to incorporate the elements described by Advisory Circular 135-14B, including procedures for determining prior flight refusals by another helicopter air ambulance operator and forecast en route weather.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.2.1 Flight Risk Assessment. Information supporting (b)(1) can be found on pages 35-37; (b)(2) is not applicable; and (b)(3) can be found on page 36.

A-20-22

> Require pilots to complete a comprehensive risk assessment before each flight and complete the appropriate paperwork to reflect their assessment as required by Title 14 *Code of Federal Regulations* 135.617.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.2.1 Flight Risk Assessment. Information supporting (b)(1) can be found on pages 35-37; (b)(2) is not applicable; and (b)(3) can be found on page 36.

A-20-23

Develop a procedure for tracking actual pilot duty times in compliance with Title 14 *Code of Federal Regulations* 135.267.

Information that addresses the requirements of 49 USC 1117(b), as applicable, can be found in section 2.2.2 Operational Risk Management and Safety Culture. Information supporting (b)(1) can be found on pages 37-39; (b)(2) and (b)(3) are not applicable.

A-20-24

Develop a process to ensure shift change briefings are performed, to include comprehensive preflight risk assessments, before the acceptance of any flight requests.

Information that addresses the requirements of 49 USC 1117(b), as applicable, can be found in section 2.2.2 Operational Risk Management and Safety Culture. Information supporting (b)(1) can be found on pages 37-39; (b)(2) and (b)(3) are not applicable.

A-20-25

Establish a safety management system (SMS) program under the Federal Aviation Administration SMS Voluntary Program that includes compliance with Advisory Circular 120-92B, "Safety Management Systems for Aviation Service Providers."

Information that addresses the requirements of 49 USC 1117(b), as applicable, can be found in section 2.2.3 Safety Management Systems. Information supporting (b)(1) can be found on pages 39-42; (b)(2) is not applicable; and (b)(3) can be found on page 40.

A-20-26

Develop and implement a flight data monitoring program independent of a Federal Aviation Administration requirement.

Information that addresses the requirements of 49 USC 1117(b), as applicable, can be found in section 2.2.4 Flight Data Monitoring. Information supporting (b)(1) can be found on pages 42-45; (b)(2) is not applicable; and (b)(3) can be found on page 43.

Appendix C: Onboard FDM Device – Audio Transcript

Transcript of an Outerlink IRIS FDM device, serial number 00254/DCP00251, installed on a Bell 407 which crashed near Zaleski, Ohio.

LEGEND

CAM	Cockpit area microphone
FV	Female Voice
OCC	Communications transcribed from the Operations Control Center
OFV	Secondary female voice (Other Female Voice)
Pilot-OCC	Pilot communicating electronically to OCC
-?	Voice unidentified
*	Unintelligible word
#	Expletive
@	Non-pertinent word or a person's name
( )	Questionable insertion
[ ]	Editorial insertion

Note 1: Times are expressed in local time (EST).

Note 2: Generally, only radio transmissions to and from the accident aircraft were transcribed.

Note 3: Words shown with excess vowels, letters, or drawn out syllables are a phonetic representation of the words as spoken.

Note 4: A non-pertinent word, where noted, refers to a word not directly related to the operation, control or condition of the aircraft.

Time and Source	Intra-Aircraft Communication & Sounds	Time and Source	Operations Control Center (OCC) Audio
0623:12.4 **START OF RECORDING START OF TRANSCRIPT**			
06:23:28.0 **FV**	hey guys.		
06:23:29.4 **OFV**	* * *.		
06:23:33.0 **FV**	what?		
06:23:38.5 **FV**	oh (hey ben/that's not bad) - (oh that's bad)		
06:23:41.5 **FV**	I was just (textin'/touchin') you		
06:23:46.1 **FV**	yeah - right onnn.		
06:23:49.6 **FV**	(alright good to meet) *.		
06:23:56.0 **FV**	this is fun I know * * *.		
06:24:00.4 **FV**	(does it/that's it) - what the hell's * * *		
06:24:04.9 **FV**	no that's what (we're after) * * *.		
06:24:08.3 **FV**	that's what he said I think.		

Time and Source	Intra-Aircraft Communication & Sounds	Time and Source	Operations Control Center (OCC) Audio
06:24:11.2 **FV**	Ohhh.		
06:24:14.6 **FV**	(yeah I thought that's what he said but - (let me uh - not very strong * * *.		
06:24:27.2 **FV**	just wanted to confirm you're going to * * (for today).		
06:24:41.9 **FV**	you guys (want) * * * .		
06:24:49.0 **FV**	oh umm I think (it) --		
06:24:56.0 **FV**	so it's (supposed/usually) down at the (blade/lake) * * *.		
06:25:03.7 **FV**	but yeah.		
06:25:23.5 **FV**	* * operator * * *.	06:25:23.5 **Pilot-OCC**	and operations fourteen - just want to confirm what city that's in.
		06:25:31.0 **OCC**	survival fourteen that is in Pomeroy - Pomeroy- Ohio for Holzer Meigs- uhhh - looks like its a heading of one forty one by sixty nine.
06:25:47.5 **FV**	copy that * * *.	06:25:47.5 **Pilot-OCC**	copy that - fourteen.

Time and Source	Intra-Aircraft Communication & Sounds	Time and Source	Operations Control Center (OCC) Audio
06:25:52.5 **FV**	alright *.		
06:26:15.8 **FV**	yeah.		
06:26:17.0 **FV**	there's a * * *.		
06:26:28.0 **FV**	* * *.		
06:26:36.6 **FV**	* * *.		
06:26:47.5 **CAM**	[Sound similar to an increase in engine power.]		
		06:27:29.0 **Pilot-OCC**	operations - fourteen - can I get some coordinates from you?
06:27:34.5 **CAM**	[Sound similar to engine power at in a flight power setting.]		
		06:27:38.0 **OCC**	* fourteen - absolutely - uhh looks like its gunna be north three niner zero three - two eight - by west - eight two zero zero eight eight.
06:27:59.4 **FV**	* * *.	06:27:59.4 **Pilot-OCC**	copy that – fourteen.
06:28:17.0 **CAM**	[Sound similar to takeoff.]		

Time and Source	Intra-Aircraft Communication & Sounds	Time and Source	Operations Control Center (OCC) Audio
		06:29:19.0 **OCC**	(go) fourteen (off).
		06:29:28.9 **Pilot-OCC**	go for fourteen.
		06:29:32.1 **OCC**	fourteen - at your earliest convenience - uh just go ahead and give me your flight release.
06:29:46.7 **FV?**	* * *.	06:29:46.7 **Pilot-OCC**	ohh copy that I'm uhhh green in all categories - same crew as last night - aaand uhh - no P Rs or maintenance.
		06:30:05.0 **OCC**	copy that – green across the board – no P Rs no maintenance – same crew gulf hotel and I'll get you the O-C- M when you land.
		06:30:26.7 **Pilot-OCC**	copy that we're ready for patient information.
		06:30:39.0 **OCC**	copy that - patient's in the E R at Holzer Meigs - going to the E R at Riverside Methodist - we are responding to a [Patient information has been redacted.]
06:31:05.6 **FV**	* * *.	06:31:05.6 **Pilot-OCC**	copy that - fourteen - and I'll give you my flight plan - we got three on board - seven sixty on fuel and twenty-eight minutes.
		06:31:14.7 **OCC**	copy that. three seven sixty and twenty-eight.

Time and Source	Intra-Aircraft Communication & Sounds	Time and Source	Operations Control Center (OCC) Audio
06:31:50.0 **FV**	* * * (yeah) * * *		
06:32:03.1 **FV**	* * *.		
06:32:54.8 **FV?**	* * *.		
06:33:45.8 **FV?**	* * *.		
06:37:32.9 **FV**	[Sound similar to raised female voice.]		
06:38:25.2 **FV**	* * *.		
06:39:49.5 **?**	* * *.		
06:40:37.2 **?**	* * *.		
06:43:25.1 **FV**	* * *.		
06:43:48.0 **FV**	* * *.		

Time and Source	Intra-Aircraft Communication & Sounds	Time and Source	Operations Control Center (OCC) Audio
06:46:35.1 **CAM**	[Sound similar to main rotor blade slap.][1]		
06:46:57.4 **FV**	let's uh * * (we're going to/we're gunna) alter (our/the) heading * * *.		
06:48:05.4 **FV**	* * *.		
06:48:27.5 **CAM**	[Sound similar to main rotor blade slap.]		
06:48:58.7 **CAM**	[Whining sound, potentially aerodynamic in nature. Lasts until the end of the recording. See Sound Spectrum Study for additional information.]		
0649:08.94 **END OF TRANSCRIPT**	**END**		

[1] Rotor blade slap, also known as *blade vortex interaction*—The Journal of Sound and Vibration, Vol. 4, Issue 3, defines Helicopter Blade Slap as "*the sharp increase in helicopter rotor noise, at the blade passing frequency, that is characteristic of certain model helicopters during some regimes of flight*." This condition can occur within the normal operating regime of a helicopter's flight.

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