Rapid Descent Into Terrain
Island Express Helicopters Inc.
Sikorsky S-76B, N72EX
Calabasas, California
January 26, 2020

Accident Report

NTSB/AAR-21/01
PB2021-100900

National
Transportation
Safety Board

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Notation 66515
Adopted February 9, 2021

Aircraft Accident Report

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

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Abstract: This report discusses the January 26, 2020, accident involving a Sikorsky S-76B helicopter, N72EX, being operated by Island Express Helicopters Inc. as a Title 14 *Code of Federal Regulations* (*CFR*) Part 135 on-demand flight, that crashed into terrain in Calabasas, California. The pilot and the eight passengers died. Safety issues identified in this report include the pilot's preflight weather and flight risk planning, the flight's entry into instrument meteorological conditions and the pilot's inadequate adverse weather avoidance, the pilot's spatial disorientation, influences on the pilot's decision to continue the flight into adverse weather, Island Express' incomplete implementation of its safety management system (SMS), the benefits of a mandatory SMS, the benefits of flight simulation devices for pilot training in adverse weather avoidance, the benefits of a flight data monitoring program, and the value of crash-resistant flight recorder systems in preventing future accidents. As a result of this investigation, the National Transportation Safety Board makes two new safety recommendations each to the Federal Aviation Administration and Island Express.

For more detailed background information on this report, visit http://www.ntsb.gov/investigations/dms.html and search for NTSB accident ID DCA20MA059. Recent publications are available in their entirety on the Internet at http://www.ntsb.gov. Other information about available publications also may be obtained from the website or by contacting:

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Abbreviations

ADS-B	automatic dependent surveillance-broadcast
agl	above ground level
AIRMET	airmen's meteorological information
ATC	air traffic control
BUR	Bob Hope Airport, Burbank, California
CFR	*Code of Federal Regulations*
CMA	Camarillo Airport
CVR	cockpit voice recorder
DAFCS	digital automatic flight control system
DO	director of operations
EuroSafety	EuroSafety International LLC
FAA	Federal Aviation Administration
FDM	flight data monitoring
FDR	flight data recorder
fpm	feet per minute
GOM	General Operations Manual
I-5	Interstate 5
IFR	instrument flight rules
IIMC	inadvertent instrument meteorological conditions
IMC	instrument meteorological conditions
Island Express	Island Express Helicopters Inc.
kts	knots
msl	mean sea level
nm	nautical miles
NTSB	National Transportation Safety Board
NWS	National Weather Service
OpsSpecs	operations specifications
POI	principal operations inspector
SCT	Southern California terminal radar approach control

SMS	safety management system
SNA	John Wayne Airport-Orange County
SR 118	State Route 118
SVFR	special visual flight rules
TAF	terminal aerodrome forecast
TSB	Transportation Safety Board of Canada
TSO	Technical Standard Order
US 101	US Route 101
USHST	United States Helicopter Safety Team
VFR	visual flight rules
VMC	visual meteorological conditions
VNY	Van Nuys Airport

Executive Summary

On January 26, 2020, about 0946 Pacific standard time, a Sikorsky S-76B helicopter, N72EX, entered a rapidly descending left turn and crashed into terrain in Calabasas, California. The pilot and eight passengers died, and the helicopter was destroyed. The on-demand flight was operated by Island Express Helicopters Inc. (Island Express), Long Beach, California, under visual flight rules and the provisions of Title 14 *Code of Federal Regulations* Part 135. The flight departed from John Wayne Airport-Orange County (SNA), Santa Ana, California, about 0907 and was destined for Camarillo Airport (CMA), Camarillo, California, about 24 miles west of the accident site.

After the helicopter departed from SNA, it flew at altitudes that remained below 1,700 ft mean sea level (msl) and generally between 400 to 600 ft above ground level (agl), and the flight's progress through controlled airspace en route to CMA was uneventful. Weather conditions reported to the pilot by air traffic controllers during the flight included an overcast ceiling at 1,100 ft agl, visibility of 2.5 miles with haze, and cloud tops at 2,400 ft msl.

At 0944:34 (about 2 minutes before the accident), while the helicopter was flying west at an altitude of about 1,370 ft msl (450 ft agl) over US Route 101 (US 101) and rising terrain, the pilot announced to an air traffic control facility that he was initiating a climb to get the helicopter "above the [cloud] layers," and the helicopter immediately began climbing at a rate of about 1,500 ft per minute. About the same time, the helicopter began a gradual left turn, and its flight path generally continued to follow US 101 below. About 36 seconds later and while still climbing, the helicopter began to turn more tightly to the left, and its flight path diverged from its overflight of US 101.

The helicopter reached an altitude of about 2,370 ft msl (about 1,600 ft agl) at 0945:15, then it began to descend rapidly in a left turn to the ground. At 0945:17 (while the helicopter was descending), the air traffic controller asked the pilot to "say intentions," and the pilot replied that the flight was climbing to 4,000 ft msl. A witness near the accident site first heard the helicopter then saw it emerge from the bottom of the cloud layer in a left-banked descent about 1 or 2 seconds before impact.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the pilot's decision to continue flight under visual flight rules into instrument meteorological conditions, which resulted in the pilot's spatial disorientation and loss of control. Contributing to the accident was the pilot's likely self-induced pressure and the pilot's plan continuation bias, which adversely affected his decision-making, and Island Express Helicopters Inc.'s inadequate review and oversight of its safety management processes.

Safety Issues

The investigation evaluated the following safety issues:

- **The pilot's preflight weather and flight risk planning.** The pilot completed a flight risk analysis form about 2 hours before the accident flight's departure. Based on the form's risk scoring criteria, the pilot's score for the accident flight was within the company's low-risk category. Updated weather information available at the time the accident flight departed included conditions that met the criteria for the form's risk items that would have required the pilot to seek input from the director of operations and to provide an alternative plan. However, company guidance was unclear as to whether the accident pilot was expected to complete an updated form (and he did not do so).
- **The flight's entry into instrument meteorological conditions (IMC) and the pilot's inadequate adverse weather avoidance.** At the time the pilot took action to initiate a climb, the helicopter had already begun penetrating clouds. Although the pilot's adverse-weather-avoidance training emphasized avoiding entry into IMC by slowing the helicopter and maneuvering or landing, there was no evidence that he attempted to do so.
- **The pilot's spatial disorientation.** As the helicopter climbed rapidly into the cloud layer and IMC while in a gradual left turn, the pilot's associated loss of outside visual references made him susceptible to experiencing vestibular illusions (in which the vestibular system in the inner ear produces a false sense of helicopter attitude and trajectory) that can lead to spatial disorientation.
- **Influences on the pilot's decision to continue the flight into adverse weather.** The pilot's continuation of the accident flight into IMC was inconsistent with his typical judgment and decision-making behavior and was likely influenced by his self-induced pressure, lack of an alternate plan, and plan continuation bias.
- **Island Express' incomplete implementation of its safety management system (SMS).** The company had an SMS that was neither required by the Federal Aviation Administration (FAA) nor part of the company's FAA-approved or -accepted programs. Although the company used some SMS tools, it did not implement the entire program and did not perform any safety assurance evaluations, such as those that could have ensured the effectiveness of the flight risk analysis forms.
- **The benefits of a mandatory SMS.** Had Island Express' SMS been required by the FAA, it would have been subject to FAA oversight to inspect the SMS for alignment with FAA objectives and to provide feedback to help the company implement the entire program.
- **The benefits of flight simulation devices for pilot training in adverse weather avoidance.** Flight simulation devices can present pilots with representations of deteriorating weather conditions that cannot be realistically duplicated during flight training conducted in helicopters in visual meteorological conditions. The use of simulation devices during scenario-based helicopter pilot training has the potential to

improve pilots' abilities to accurately assess weather and make appropriate weather-related decisions.

- **The benefits of a flight data monitoring (FDM) program.** FDM involves the recording and analysis of flight-related information to help pilots, instructors, or operators improve performance and safety. An FDM program, which can be integrated into an SMS, has the potential to provide important information regarding pilot performance during flights, which may be particularly beneficial for operators like Island Express that conduct single-pilot operations and, thus, have little opportunity to directly observe their pilots in the operational environment.

- **The value of crash-resistant flight recorder systems in preventing future accidents.** Certain circumstances of this accident could not be conclusively determined, including the visual cues associated with the adverse weather and the pilot's focus of attention in the cockpit following the flight's penetration of clouds and entry into IMC. A crash-resistant flight recorder system capable of capturing audio and images could have provided this valuable information, possibly enabling the identification of additional safety issues and the development of safety recommendations to prevent similar accidents.

Findings

- None of the following safety issues were identified for the accident flight: (1) pilot qualification deficiencies or impairment due to medical condition, alcohol, other drugs, or fatigue; (2) helicopter malfunction or failure; or (3) pressure on the pilot from Island Express Helicopters Inc., the air charter broker, or the client to complete the flight.

- Although the air traffic controller's failure to report the loss of radar contact and radio communication with the accident flight was inconsistent with air traffic control procedures, this deficiency did not contribute to the accident or affect its survivability.

- Had the pilot completed an updated flight risk analysis form for the accident flight that considered the weather information available at the time the flight departed, the flight would have remained within the company's low-risk category but would have required the pilot to seek input from the director of operations and to provide an alternative plan.

- At the time that the pilot took action to initiate a climb, the helicopter had already begun penetrating clouds, and the pilot lost visual reference to the horizon and the ground. The loss of outside visual reference was possibly intermittent at first but likely complete by the time the flight began to enter the left turn that diverged from its route over US Route 101.

- The pilot's poor decision to fly at an excessive airspeed for the weather conditions was inconsistent with his adverse-weather-avoidance training and reduced the time available for him to choose an alternative course of action to avoid entering instrument meteorological conditions.

- The pilot experienced spatial disorientation while climbing the helicopter in instrument meteorological conditions, which led to his loss of helicopter control and the resulting collision with terrain.

- The pilot's decision to continue the flight into deteriorating weather conditions was likely influenced by his self-induced pressure to fulfill the client's travel needs, his lack of an alternative plan, and his plan continuation bias, which strengthened as the flight neared the destination.

- Island Express Helicopters Inc.'s lack of a documented policy and safety assurance evaluations to ensure that its pilots were consistently and correctly completing the flight risk analysis forms hindered the effectiveness of the form as a risk management tool.

- A fully implemented, mandatory safety management system could enhance Island Express Helicopters Inc.'s ability to manage risks.

- The use of appropriate simulation devices in scenario-based helicopter pilot training has the potential to improve pilots' abilities to accurately assess weather and make appropriate weather-related decisions.

- Objective research to evaluate spatial disorientation simulation technologies may help determine which applications are most effective for training pilots to recognize the onset of spatial disorientation and successfully mitigate it.

- A flight data monitoring program, which can enable an operator to identify and mitigate factors that may influence deviations from established norms and procedures, can be particularly beneficial for operators like Island Express Helicopters Inc. that conduct single-pilot operations and have little opportunity to directly observe their pilots in the operational environment.

- A crash-resistant flight recorder system that records parametric data and cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible could have provided valuable information about the visual cues associated with the adverse weather and the pilot's focus of attention in the cockpit following the flight's entry into instrument meteorological conditions.

Recommendations

New Recommendations

To the Federal Aviation Administration

Require the use of appropriate simulation devices during initial and recurrent pilot training for Title 14 *Code of Federal Regulations* Part 135 helicopter operations to provide scenario-based training that addresses the decision-making, skills, and procedures needed to recognize and respond to changing weather conditions in flight, identify and apply mitigation strategies for avoiding adverse weather, practice the transition to the use of flight instruments to reduce the risk of spatial disorientation, and maintain awareness of a variety of influences that can adversely affect pilot decision-making. (A-21-5)

Convene a multidisciplinary panel of aircraft performance, human factors, and aircraft operations specialists to evaluate spatial disorientation simulation technologies to determine which applications are most effective for training pilots to recognize the onset of spatial disorientation and successfully mitigate it, and make public a report on the committee's findings. (A-21-6)

To Island Express Helicopters Inc.

Participate in the Federal Aviation Administration's Safety Management System Voluntary Program. (A-21-7)

Install flight data recording devices capable of supporting a flight data monitoring (FDM) program on each helicopter in your fleet and establish an FDM program that reviews all available data sources to identify deviations from established norms and procedures as well as other potential safety issues. (A-21-8)

Previously Issued Recommendations Reiterated in This Report

To the Federal Aviation Administration

After the action in Safety Recommendation A-16-34 is completed, require all 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)

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

To Airbus Helicopters, Bell, Leonardo Helicopter Division, MD Helicopters, Robinson Helicopter Company, and Sikorsky, a Lockheed Martin Company

Provide, on your existing turbine-powered helicopters that are not equipped with a flight data recorder or a cockpit voice recorder, a means to install a crash-resistant flight recorder system that records 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." The recorder system installation should be considered essential equipment that remains installed for the life of the helicopter and have provisions to ensure it remains operational during each flight. (A-20-29)

Previously Issued Recommendations Classified and Reiterated in This Report

To the Federal Aviation Administration

Require all 14 *Code of Federal Regulations* Part 135 operators to install flight data recording devices capable of supporting a flight data monitoring program. (A-16-34) Classified "Open—Unacceptable Response"

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 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) Classified "Open—Unacceptable Response"

1. Factual Information

1.1 History of the Flight

On January 26, 2020, about 0946 Pacific standard time, an Island Express Helicopters Inc. (Island Express) Sikorsky S-76B helicopter, N72EX, was destroyed after it entered a descending left turn and crashed into terrain in Calabasas, California.[1] The pilot and the eight passengers died. Island Express operated the helicopter as a Title 14 *Code of Federal Regulations* (*CFR*) Part 135 on-demand flight under visual flight rules (VFR) and with a company flight plan filed.[2] (See figure 1.) The flight departed from John Wayne Airport-Orange County (SNA), Santa Ana, California, about 0907 and was destined for Camarillo Airport (CMA), Camarillo, California, about 24 miles west of the accident site.[3]

Source: Island Express

Figure 1. Preaccident photograph of the accident helicopter.

[1] (a) All times in this report are Pacific 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's) Case Analysis and Reporting Online query tool by searching DCA20MA059. Other NTSB documents referenced in this report, including other accident reports and summarized safety recommendation correspondence, can also be found using the query tool.

[2] Flights operated under VFR are prohibited from penetrating clouds. See section 1.9.1.1 for more information about the regulatory and company weather minimums that apply to the accident flight.

[3] All references to miles in this report are statute miles unless otherwise indicated.

1.1.1 Preflight Coordination and Flight Risk Analysis

According to Island Express' vice president, the accident flight was requested by an air charter broker a few weeks in advance; the flight was originally booked for a 0945 departure, but a request to change it to 0900 was made the night before the flight. She said that, when Island Express flew the accident flight's client, all personnel associated with his travel, including herself, the pilot, personnel from the air charter broker, and the drivers, communicated via group text to maintain awareness of the client's location and schedule so that the air charter broker could coordinate the client's ground transportation and other needs.

A flight risk analysis form completed by the pilot at 0657 for the accident flight showed that he checked the box for the weather risk item for a cloud ceiling "less than 2,000 ft" above ground level (agl).[4] This item, combined with the pilot's other checked items (none of which were weather related), resulted in a total trip score of 12, indicating a low-risk flight (a score of 45 was the elevated-risk threshold, see section 1.9.5.1 for more information).

According to Island Express' director of operations (DO), he checked the weather the morning of the accident and believed that the flight could be completed safely with, at worst, a departure delay of 30 minutes to an hour. He said he did not communicate his thoughts to the accident pilot (who was also the company's chief pilot) because he believed the pilot was "more than capable of making his own decisions."

The owner of the air charter broker said that, before the flight departed from SNA, the accident pilot discussed weather information with him and said that the flight could proceed. This conversation occurred sometime after 0837, which was when the pilot arrived at SNA with the helicopter to pick up the passengers.[5] He said the pilot had a color-coded ForeFlight map on his cell phone that depicted "blue" weather conditions for Long Beach, Santa Monica, and Malibu Pass and "red" weather conditions over downtown Los Angeles, Burbank, and Van Nuys. According to the air charter broker owner, the red conditions were due to clouds, and the pilot told him he was going to go "up and around" the weather on a route to "go east and north of the clouds." He said the pilot used the map to point out to him that he planned to go north to Dodger Stadium (in Los Angeles), around Burbank, and follow State Route 118 (SR 118).[6]

[4] Company records showed that the flight risk analysis form, flight plan, passenger manifest, and helicopter weight and balance calculations for the accident flight were filed electronically (via the internet) and available to the director of operations, vice president, and flight-locating personnel.

[5] The pilot had repositioned the helicopter from Long Beach/Daugherty Field, Long Beach, California, which was about a 10-minute flight.

[6] ForeFlight (an integrated flight planning application for pilots) displays weather conditions in color-coded format, with "blue" indicating a ceiling from 1,000 to 3,000 ft agl and/or visibility from 3 to 5 miles and "red" indicating a ceiling from 500 to less than 1,000 ft agl and/or visibility from 1 to less than 3 miles (ForeFlight 2019, 117). Data provided by ForeFlight for the accident pilot's account revealed that its servers detected two devices associated with the accident pilot on the day of the accident: an iPad Mini 5 at 0731:12 and an iPhone 11 Pro at 0802:12. The ForeFlight application did not collect data that could be used to determine what information the pilot may have accessed during those times but there was no record that any formal weather briefings were ever created for the pilot's account. Leidos, the flight services provider, reported no record of any formal weather briefings created for the pilot (from either itself or any of its third-party vendors) on the day of the accident or the day before.

1.1.2 Flight Route

When the flight departed from SNA (elevation 56 ft above mean sea level [msl]), the reported visibility was 4 miles with mist and an overcast ceiling at 1,000 ft agl. Automatic dependent surveillance-broadcast (ADS-B) data showed that, after the flight departed at 0907, it flew northwest.[7] A helicopter performance study (see section 1.8.1) determined that the flight initially climbed to an altitude about 1,000 ft msl (950 agl) about 0910 before descending to about 600 ft msl (500 ft agl) about 0913. As the helicopter continued northwest, it again climbed to about 1,000 ft msl, maintaining altitudes of about 400 to 600 ft agl over the rising terrain and maintaining a groundspeed of about 140 to 150 knots (kts).[8]

At 0920:14, when the helicopter was flying about 800 ft msl about 8.5 miles southeast of Bob Hope Airport (BUR), Burbank, California, the pilot contacted the BUR air traffic control (ATC) tower controller to request special visual flight rules (SVFR) clearance through the BUR class C airspace to follow US Route 101 (US 101), which extended west through the BUR airspace toward CMA.[9] The controller advised the pilot to hold outside of the BUR airspace due to traffic (see section 1.5 for more information about ATC communications). The pilot requested a cloud tops report, and the controller replied that the last reported cloud tops were at 2,400 ft msl.

Between about 0921 and 0932, the helicopter circled outside of the BUR airspace on the southeast side near US 101 at altitudes that varied between about 900 to 1,100 ft msl (400 to 650 ft agl over varied terrain heights), and its groundspeed varied between about 40 and 70 kts. At 0927:52, the BUR ATC tower controller advised the pilot that, due to multiple airplanes departing the Van Nuys Airport (VNY), Van Nuys, California, to the south, the pilot could expect to head north to follow Interstate 5 (I-5) before crossing the VNY airspace to head west toward CMA, and the pilot replied, “no problem” (see figure 2).

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[7] The ADS-B equipment on board the helicopter broadcasted the time, helicopter location, pressure altitude, geometric altitude, and inertial speeds, among other information.

[8] All references to the helicopter’s altitudes (in msl and agl) and groundspeed in this report are derived from the helicopter performance study.

[9] An SVFR clearance, which a pilot must request and a controller must approve, refers to an ATC authorization for a flight that is not operating under instrument flight rules to fly in specified controlled airspace (generally, that which is within the lateral boundaries of airspace designated for certain airport surface areas) in weather conditions that are less than those required for operations under basic VFR. Basic VFR weather minimums (per 14 *CFR* 91.155) applicable to helicopter operations in class C or D airspace require, in part, visibility of at least 3 miles. At the time of the pilot’s request, weather conditions at BUR (elevation 778 ft msl) included 2.5 miles visibility and a ceiling of 1,100 ft agl.

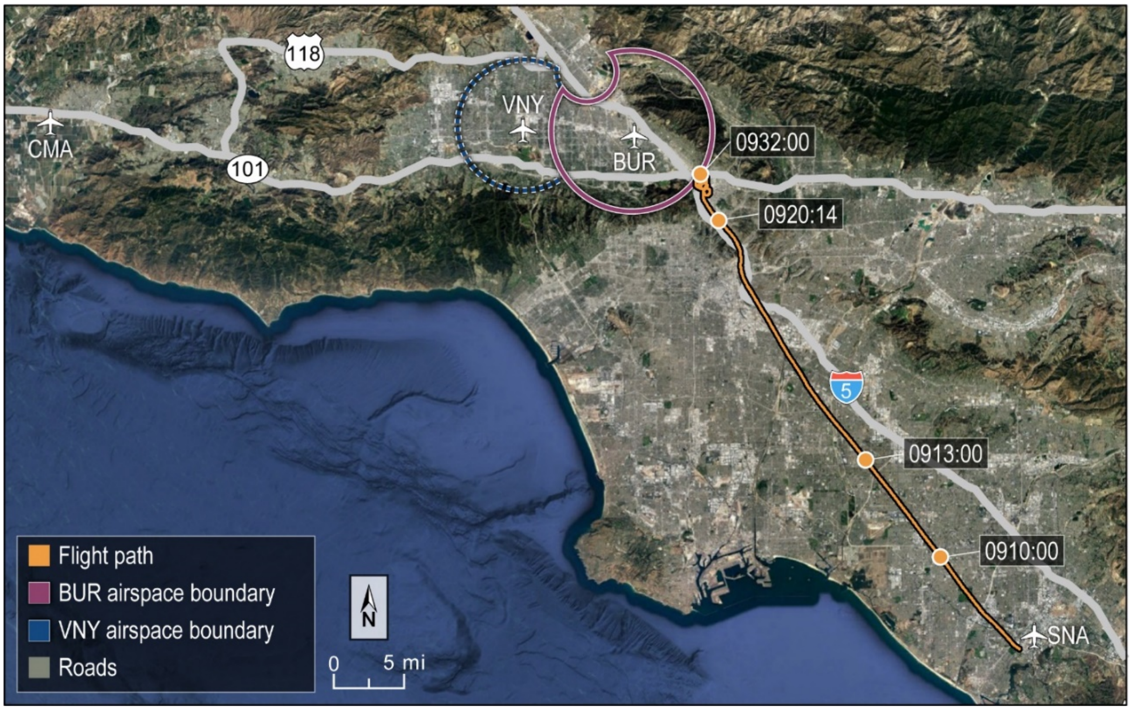

Figure 2. Accident flight's departure from SNA and holding turns southeast of BUR until 0932.

At 0932:17, the controller provided the pilot with an SVFR clearance for the flight to follow I-5 northwest through the BUR airspace, which the pilot acknowledged. The controller also advised the pilot that the weather conditions at BUR included calm wind, visibility of 2.5 miles, haze, and an overcast ceiling of 1,100 ft agl and that VNY was reporting nearly identical conditions. About 0934:41, when the helicopter was about a mile from the BUR airport center, the pilot advised that he would like to follow SR 118 around VNY, then follow US 101, which the controller acknowledged.[10]

At 0935:35, the pilot contacted the VNY ATC tower controller, requested an SVFR transition, and reported that the flight was at 1,400 ft msl; at the time, the helicopter was flying about 1,320 ft msl (520 ft agl). The controller cleared the flight to transition to the VNY class D airspace at or below 2,500 ft msl along SR 118, and the pilot acknowledged.[11]

About 0939, the helicopter started a turn to the south along the outer boundary of the VNY airspace, and the VNY ATC tower controller instructed the pilot to contact the southern California terminal radar approach control (SCT) facility.[12] At 0940:09, the pilot contacted SCT and advised the controller that the flight was transitioning in "VFR conditions" at 1,500 ft msl to CMA; at the

[10] The BUR ATC tower controller then coordinated with the VNY ATC tower controller to advise of the pilot's intentions, which the VNY controller acknowledged.

[11] The controller also advised the pilot that the weather at VNY (elevation of 802 ft msl) included visibility of 2.5 miles and an overcast ceiling at 1,100 ft agl.

[12] (a) After exiting the VNY airspace, the helicopter was operating in class G airspace. (b) SCT provides radar air traffic approach control services to all arriving and departing aircraft for most airports in Southern California.

time, the helicopter was flying about 1,520 ft msl (570 ft agl). An SCT controller (the first of two who handled the flight) asked the pilot if he planned to "stay down low…all the way to [CMA]," and the pilot replied, "yes sir, low altitude." The controller advised the pilot that radar and radio contact with the flight would likely soon be lost and instructed the pilot to "squawk VFR" (set the helicopter's transponder code to 1200) and contact the CMA tower once closer to the airport, and the pilot acknowledged.[13] According to the helicopter performance study, the helicopter maintained an altitude of 400 to 600 ft agl while remaining below 1,700 ft msl.

At 0942:45, the helicopter reached US 101 and began to follow it west toward CMA while flying about 1,420 ft msl (550 ft agl). According to the helicopter performance study, the helicopter's groundspeed was about 140 kts. A witness who saw the helicopter flying over US 101 reported fog and overcast cloud conditions that varied with "heavy low clouds" in some places and areas where the clouds were "quite high." She saw the helicopter flying "below or at the cloud line" before it "disappeared into heavy clouds" that she described as a "thick wall." Based on ADS-B data, the helicopter was at the location the witness described about 0944:32 and was at an altitude of about 1,370 ft msl (450 ft agl) (see figure 3).

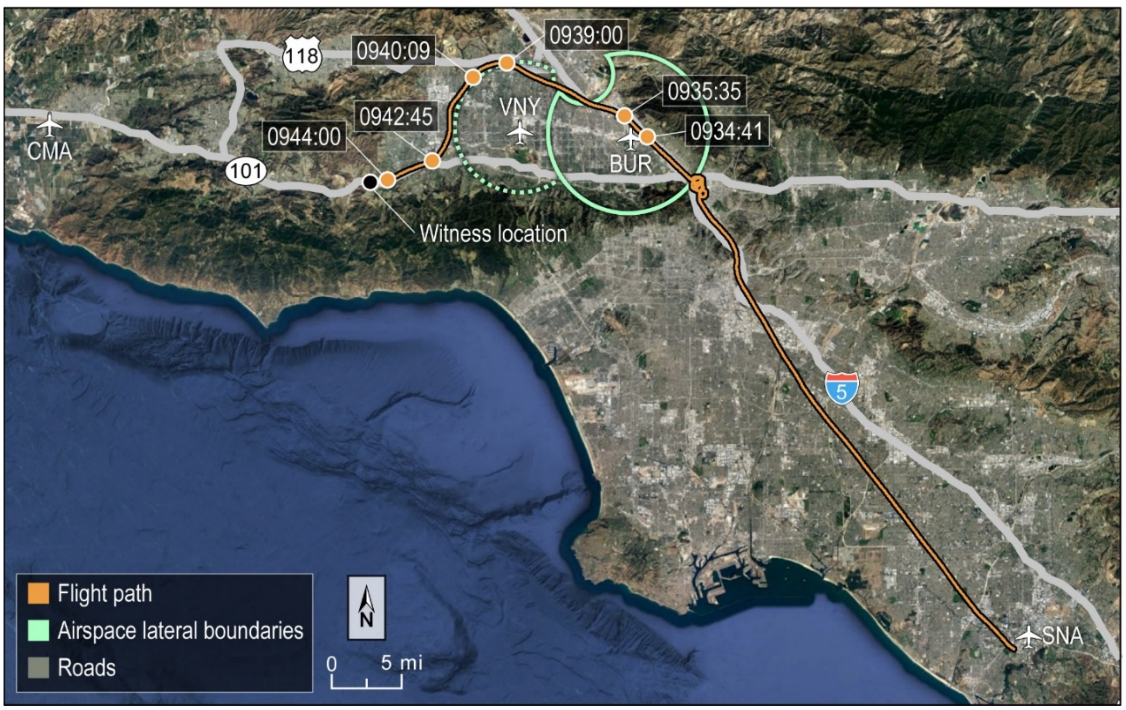

Figure 3. Accident flight's path up to 0944:32 and location of ground witness.

At 0944:34, the pilot communicated on the SCT frequency that the flight was "gonna go ahead and start our climb to go above the, uh, layers, and, uh, we can stay with you here." The helicopter performance study determined that, at that time, the helicopter immediately began climbing at a rate of about 1,500 ft per minute (fpm) and began a gradual left turn while remaining generally over US 101. Another SCT controller (who had taken over the position from the previous

[13] The VFR transponder code of 1200 is used for aircraft that are operating under VFR without ATC radar advisory service (FAA 2019b, 5-2-4). See section 1.5 for more information.

controller who had communicated with the pilot) asked the pilot his position, and the pilot replied that the flight was just west of VNY. At 0944:55, the controller asked the pilot to "ident," which the pilot acknowledged.[14] After noting that the helicopter's transponder code was showing 1200, the controller asked the pilot if he was requesting flight following (a type of ATC radar advisory service), to which the pilot replied, "yes sir."

About 0945:10, as the helicopter continued its climb, it started a left turn away from US 101 and reached its maximum altitude of about 2,370 ft msl (about 1,600 ft agl) about 0945:15 before it began to descend rapidly while remaining in the left turn. At 0945:17 (while the helicopter was descending), the SCT controller asked the pilot to "say intentions," and the pilot replied that the flight was climbing to 4,000 ft msl. The controller asked the pilot his plans once at that altitude but received no further communication from the pilot. The last ADS-B data point for the flight was recorded at 0945:36, and the accident site was about 500 ft east of this point at an elevation of about 1,100 ft msl in hilly terrain (see figure 4).

Figure 4. Accident flight's climb, left turns, rapid descent, and wreckage location.

According to a ground witness who was bicycling on trails near the accident site, the area was surrounded by mist at the time of the accident. He heard what he described as the normal sound of a helicopter flying for about 20 seconds, then he suddenly saw the descending helicopter emerge from the clouds and roll to the left. He estimated that he saw the helicopter for about 1 to 2 seconds before it struck the terrain and erupted into flames about 200 ft from his location.

[14] By saying "ident," the controller was asking the pilot to activate a feature on the helicopter's transponder that would result in a more conspicuous depiction of the helicopter's data tag on the controller's display, enabling the controller to quickly identify the helicopter's location (see section 1.5 for more information).

He approached the accident site and found no survivors. He provided a digital still image he captured with his camera about 3 minutes after the accident (see figure 5).

Figure 5. Image of accident site taken by witness about 3 minutes after the crash.

1.2 Pilot Information

The pilot, age 50, held a commercial pilot certificate with rotorcraft-helicopter and instrument ratings and a Federal Aviation Administration (FAA) second-class airman medical certificate issued July 3, 2019, with the limitation "must have available glasses for near vision."[15] At the time of the accident, the pilot had about 8,577 hours flying experience, which included about 1,250 hours in Sikorsky S-76-series helicopters and about 75 hours of instrument flying time, at least 68.2 hours of which were accumulated while flying under simulated instrument meteorological conditions (IMC).[16] In the 90 days, 30 days, and 24 hours before the accident, the pilot accumulated about 61 hours, 15 hours, and 1.5 hours flying time, respectively.

A review of FAA records revealed that the pilot had one violation for an event on May 11, 2015, in which he operated a helicopter in class B airspace without an ATC clearance in violation of 14 *CFR* 91.131(a)(1). The FAA inspector who investigated the violation with the pilot and Island Express management determined that there were no indications that such a deviation was a trend with the pilot or any other company personnel. As a result, the FAA inspector reviewed Island Express' training program and counseled the pilot on "operating in class B airspace, SVFR weather minimums, proper planning, reviewing weather, and anticipating required action." According to the FAA record, Island Express provided the pilot with additional ground and flight training, and the investigator planned additional surveillance of the company to ensure that its pilots were familiar with the requirements of 14 *CFR* 91.131 (class B airspace), 91.155 (basic VFR weather minimums), and 91.157 (SVFR weather minimums).

1.2.1 Preaccident Activities

Information about the pilot's sleep and wake activities in the days before the accident was derived from his company schedule, records of cell phone activity (consisting of incoming and outgoing calls and texts), and interviews with persons familiar with his schedule. According to the pilot's girlfriend, the pilot typically awoke around 0600, went to sleep between 2200 and 2230, and occasionally took naps on his days off.

On the day of the accident, the pilot awoke about 0600, and cell phone activity began at 0755. Activity during the accident flight consisted only of incoming texts.

On the day before the accident (January 25), the pilot awoke about 0600, flew charter flights between 0825 and 1634, and went to bed about 2230. Cell phone activity began at 0646 and ended at 0024 on January 26, with breaks in activity (gaps lasting more than 1 hour) from 0945 to 1059 and from 1106 to 1753.[17]

The pilot did not fly any flights on January 24 and 23. On January 24, he awoke about 0600, met his girlfriend for lunch, shopping, and a movie, and went to bed between 2200 and 2230. Cell phone activity began at 0747 and ended at 2114, with breaks in activity (gaps lasting more than 1 hour) occurring from 1329 to 1527, from 1527 to 1651, and from 1953 to 2114. On

[15] He also held a flight instructor certificate with rotorcraft-helicopter and instrument ratings, as well as a ground instructor certificate with an instrument rating.

[16] IMC refers to a visibility, ceiling height, or aircraft distance-from-cloud condition that is less than the applicable minimum for the flight to operate under VFR. Generally, in the training environment, simulated IMC entails a loss of visual reference to the horizon reference and/or visual contact with the ground, which can be simulated through the use of a view-limiting device.

[17] The activity at 0024 on January 26 was an incoming call that the pilot did not answer.

January 23, he awoke about 0600, met his girlfriend for dinner and to watch television, and went to bed between 2200 and 2230.

1.2.2 Career at Island Express

Island Express hired the pilot in 2011, and company records showed the pilot completed the company's initial ground training in May and initial flight training in June of that year. The pilot initially flew the company's Airbus AS350-series helicopters then completed transition training for Sikorsky S-76-series helicopters in December 2014.

The pilot completed his most recent competency check in accordance with 14 *CFR* 135.293 (which specifies initial and recurrent pilot testing requirements) and line check in accordance with 14 *CFR* 135.299 (which specifies required flight route checks) on June 21, 2019, in the accident helicopter. The checks included demonstrating satisfactory use of the autopilot and completion of the flying maneuvers required for "inadvertent IMC" (IIMC).[18] In preparation for these checks, the pilot successfully completed training in the accident helicopter on May 8 through 10, 2019; the training form for the pilot showed satisfactory performance in a variety of flying procedures, including recovery from IIMC and unusual attitudes (see section 1.9.2 for more information about Island Express' training curriculum).

The pilot completed ground and flight training to become a flight instructor in Sikorsky S-76-series helicopters in January 2016 and became the company's chief pilot on May 12, 2016. He completed ground and flight training to become a check airman for the company in July 2016, to evaluate company pilots during competency checks in the Sikorsky S-76-series helicopters. The pilot's most recent check airman check in accordance with 14 *CFR* 135.339 (which specifies initial and transition training and check requirements for check airmen) for Sikorsky S-76-series helicopters occurred August 9, 2018.[19] During this check airman check, the pilot demonstrated satisfactory performance in checking another company pilot's performance (during that pilot's 14 *CFR* 135.229 line check) in a variety of flying procedures in the accident helicopter, including autopilot use and maneuvers by reference to instruments.

A company training record showed that the pilot completed training for the company's safety management system (SMS, see section 1.9.5 for more information) on June 5, 2018.

1.2.2.1 Experience Flying Accident Client

According to the vice president of Island Express, the client who was a passenger on the accident flight was "very particular" about which pilot flew his flights and always requested the

[18] The pilot completed competency checks for unusual attitude recovery, inadvertent entry into IMC, or both during numerous previous checks in Sikorsky S-76-series helicopters in 2014, 2016, 2017, and 2018, and in Airbus AS350-series helicopters in 2019.

[19] During his career at Island Express, the pilot also flew the company's Airbus AS350-series helicopters (since May 2011), for which he was the company's check airman from 2017 to 2018. He had flown the company's Bell 206 helicopters from December 2016 until those helicopters were removed from the company's certificate in 2018.

accident pilot.[20] She said that the accident pilot had been flying this client for years and that, in the last year, the accident pilot had flown him 10 times between SNA and CMA, including the day before the accident. She described the relationship between the accident pilot and the client having "turned into like a friendship" and said the client trusted the pilot to fly his children by themselves.

According to the operations manager for the air charter broker who requested the flight for the accident client, the accident pilot was the preferred pilot on the client's list of "approved" pilots and was requested almost exclusively. She said that pilots could be removed from the approved list by Island Express, the air charter broker, or the client. She said that, whenever Island Express needed to cancel or delay the client's flight for any reason (including weather or maintenance), she would communicate that cancellation via text or phone call to the client's representative. She said she never received any pressure from the client or client's representative to push Island Express to complete such flights.[21] Company records showed one weather-related flight cancellation for the accident client, which occurred February 20, 2019.

1.2.2.2 Perceptions from Other Pilots

Island Express' safety officer described the accident pilot as very professional with extensive experience in the Los Angeles-area airspace. He said the pilot had extensive knowledge in how to handle emergency procedures, stressful situations, and weather situations over the ocean with no visual references. He said that the pilot was very knowledgeable and experienced with weather scenarios and always made good decisions.

The DO said the accident pilot, both in his role as pilot and as chief pilot, was "exemplary" and the most "passionate, dedicated, hard-working, [and] safe" pilot with whom he had ever worked. He said the pilot was completely professional and was a competent instructor pilot who would provide coaching and reevaluation to any trainee who failed a maneuver.

Interviews with three company pilots revealed generally favorable opinions of the accident pilot's skill and proficiency at the time of the accident. The company's operations were single-pilot flights, and the other pilots had little opportunity to observe the accident pilot directly other than when he was acting as check airman for one of their flights.

None of the three pilots reported witnessing any risk-taking behavior from the accident pilot, but one pilot said that he had heard "stories" (from another pilot or pilots) that the accident pilot would take chances. This pilot also said the accident pilot once told him that he had flown a charter flight with minimum fuel and tried to get under the clouds but could not find a hole, so he decided to fly offshore where there were no obstacles, then he descended through the clouds. The pilot said he did not know whether the story was true or used by the accident pilot to try to convey

[20] She said it was not unusual for certain clients to request specific pilots, but sometimes the company could not accommodate such requests due to scheduling conflicts, such as a pilot's day off. She said that sometimes, to accommodate a client's request, pilots would volunteer to work and take a different day off.

[21] The DO stated that he was not aware of any client or the air charter broker ever pressuring any pilots to complete flights that needed to be delayed or canceled.

some sort of message to him.[22] The other two company pilots interviewed said they had not heard of this story.

A flight instructor who provided training to the accident pilot since 2013 or 2014 (first in the Airbus AS350-series helicopters and then in Sikorsky S-76-series helicopters) said that the pilot always performed really well in training, was very proficient, and always demonstrated sound judgment. He said he did not identify any particular weaknesses with the pilot.

1.3 Helicopter Information

The accident helicopter was a Sikorsky S-76B helicopter manufactured in 1991 and equipped with two Pratt & Whitney Canada PT6B-36A turboshaft engines, which were manufactured in 1990, a four-bladed main rotor, a four-bladed tail rotor, and retractable landing gear. The helicopter, as equipped, was certified for single-pilot VFR and instrument flight rules (IFR) operations.[23]

Island Express purchased the accident helicopter in August 2015, completed interior modifications in March 2016, and added it to the company's operating certificate in April 2016. The interior modifications included a seating configuration for the pilot and up to nine passengers.[24] During the accident flight, the pilot was seated in the front right seat, and the eight passengers occupied the two four-place bench seats in the cabin. (The front left seat, which could be used by a passenger or copilot, was vacant.)

The accident helicopter was equipped with a Honeywell SPZ-7000 digital automatic flight control system (DAFCS), which was a four-axis (pitch, roll, yaw, and collective) flight control system that combined autopilot and flight director functions. Depending on the level of automation selected by the pilot (by using the autopilot controller and flight director mode selector), the DAFCS functions ranged from providing stability augmentation during manual flight to providing fully automatic flight path control.

The DAFCS was integrated with the helicopter's Honeywell EDZ-705 electronic flight instrument system, which provided attitude director indicator and horizontal situation indicator information to both the pilot's and copilot's displays. The helicopter's instruments also included two airspeed indicators, two altimeters, a standby attitude indicator, and two Mode S transponders with GPS and ADS-B "out" capabilities. The relative locations of select instruments for the pilot (right side of the cockpit) and a transponder are shown in figure 6.

[22] This pilot said that his relationship with the accident pilot (in his role as chief pilot) had suffered after the accident pilot had become angry with him over a mistake he made during a charter flight with a client on board, which required him to return for fuel. He said that, thereafter, the accident pilot's attitude toward him changed, and the accident pilot did not let him do as many charter flights. He said that, when he asked the accident pilot when he would trust him to do charters again, the accident pilot told him the story about flying offshore with minimum fuel.

[23] The helicopter was fully equipped and certified to operate under IFR per 14 *CFR* 91.205; the most recent altimeter and transponder checks were completed in March 2019.

[24] The accident helicopter was initially equipped with a Fairchild A100 cockpit voice recorder when it was delivered from Sikorsky to the initial operator. It was subsequently removed by Island Express, as permitted by FAA regulation, during the interior modifications.

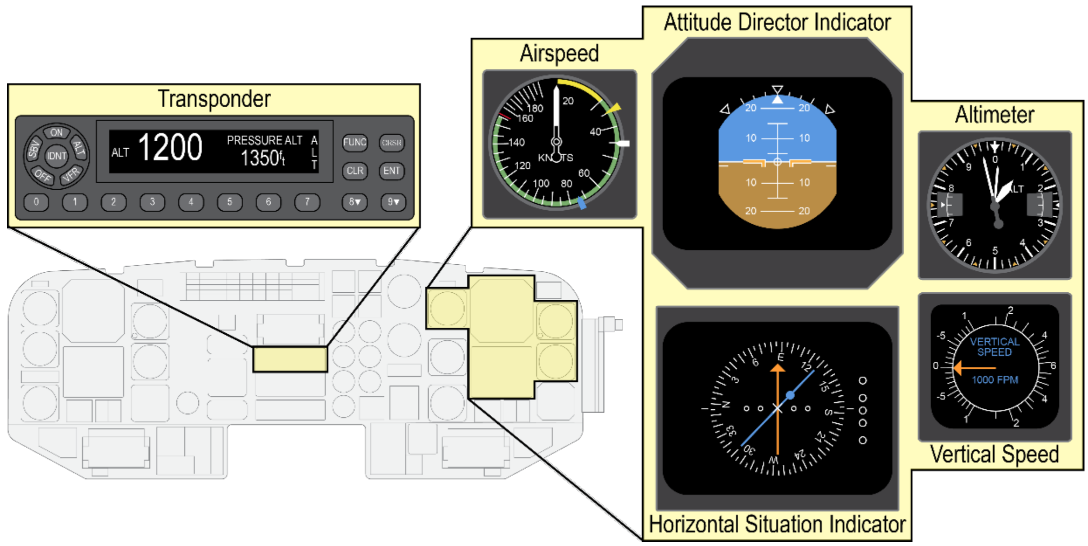

Figure 6. Exemplar instruments and transponder.

Maintenance records showed that, at the time of the accident, the airframe had accumulated 4,717 total flight hours, the left engine had 4,506 total flight hours with 1,009 hours since overhaul, and the right engine had 4,681 total flight hours with 1,226 hours since overhaul.

1.4 Meteorological Information

1.4.1 Reports and Forecasts from Aviation Weather Information Sources

Surface weather observations reported at SNA, BUR, VNY, and CMA (elevation 77 ft msl) during times surrounding the accident flight included, in part, the following visibility and ceiling information (see table 1).

Table 1. Visibility and ceiling information reported by stations along the accident flight route.

Station	Time of observation	Visibility and obscuring phenomena (if any)	Ceiling type and height
SNA	0753	4 miles, mist	Overcast at 1,000 ft agl
	0853	4 miles, mist	Overcast at 1,000 ft agl
BUR	0753	3 miles, haze	Overcast at 800 ft agl
	0853	3 miles, haze	Overcast at 1,100 ft agl
	0916	2.5 miles, haze	Overcast at 1,100 ft agl
VNY	0751	2.5 miles, mist	Overcast at 900 ft agl
	0821	2.5 miles, haze	Overcast at 1,100 ft agl
	0851	2.5 miles, haze	Overcast at 1,100 ft agl
	0951	2.5 miles, haze	Overcast at 1,300 ft agl
CMA	0755	4 miles, haze	Overcast at 1,300 ft agl
	0855	4 miles, haze	Overcast at 1,400 ft agl
	0905	4 miles, haze	Overcast at 1,600 ft agl

Aviation weather forecast products issued before the accident flight's departure provided information about expected conditions along the anticipated route. Terminal aerodrome forecasts (TAFs) for SNA, BUR, VNY, and CMA issued before the accident flight's departure and valid for times surrounding the accident flight included, in part, the following forecasted visibility and ceiling information (see table 2).

Table 2. Forecasted visibility and ceiling information for locations along the accident flight route.

Location	Time issued	Valid period	Forecasted visibility and obscuring phenomena (if any)	Forecasted ceiling type and height
SNA	0340	0700 to 0930	6 miles, haze	Broken at 1,000 ft agl
BUR	0345	0900 to 1100	5 miles, haze	Broken at 1,300 ft agl
	0746	0900 to 1100	5 miles, haze	Broken at 1,300 ft agl
	0856	0900 to 1100	3 miles, mist	Overcast at 1,100 ft agl
VNY	0403	0900 to 1100	4 miles, haze	Broken at 1,200 ft agl
	0746	0900 to 1100	4 miles, haze	Broken at 1,200 ft agl
	0858	0900 to 0930	2 miles, mist	Overcast at 1,000 ft agl
		0930 to 1100	4 miles, haze	Broken at 1,200 ft agl
CMA	0403	0400 to 1000	4 miles, mist	Overcast at 1,700 ft agl
		0600 to 0800 (temporary)*	3 miles light drizzle, mist	Overcast at 800 ft agl
		1000 to 1300	greater than 6 miles	Broken at 1,800 ft agl
	0858	1000 to 1300	greater than 6 miles	Broken at 1,800 ft agl

*Temporary conditions refer to fluctuations in forecasted conditions, each of which are expected to last less than 1 hour and, in aggregate, occur during less than half of the indicated period.

At 0645, the National Weather Service (NWS) Aviation Weather Center issued airmen's meteorological information (AIRMET) Sierra advisories that forecasted "IFR conditions" in mist and fog and mountain obscuration due to clouds and mist for areas that included the accident location and time.[25]

According to the NWS forecaster at the local weather forecast office in Oxnard, California, the presence of a deep marine layer across the region near the accident site was uncommon for January.[26] He said the near-surface relative humidity near Calabasas was still 100% at 1000, noting that it typically decreased earlier in the morning.[27]

Also, the NWS warning coordination meteorologist at the local weather forecast office said that, the day before the accident, a shallow marine layer was present due to a high-pressure overhead that suppressed the moisture closer to the ground. He said that, on the day of the accident, the high-pressure area had shifted eastward, allowing a deeper layer of moisture. He said he could

[25] An AIRMET is a concise description of the occurrence or expected occurrence of specified en route weather phenomena that may affect the safety of aircraft operations. An AIRMET Sierra provides information about potentially hazardous en route IFR conditions (which, in weather products, refers to a ceiling below 1,000 ft agl and/or visibility below 3 miles) and/or widespread mountain obscuration that are of particular concern to pilots without instrument ratings. (FAA 2019c, 5-16 and -19).

[26] He said that his records for the previous 10 years showed that a marine layer was present in the area 7 days each January (on average) and that the depth was greater than 1,000 ft for 3 days each January (on average). He noted that, in contrast, a marine layer was present in the area 27 days each June (on average) with an average depth of 2,000 ft.

[27] NWS plots of near-surface relative humidity values for an area near the accident site (and overflown by the accident helicopter when it was over US 101) were showing 100% humidity values as of 0700, 0800, 0900, and 0945.

not recall a day in any January in which low clouds persisted as long as they did on the accident day. He said that, generally, low clouds are gone by 1000 or 1100 at the latest.

1.4.2 Witnesses' Observations and Ground-Based Camera Imagery

Numerous ground witnesses located throughout the area near the accident flight's route during the time of the flight (including the two witnesses who also saw the helicopter, as discussed in section 1.1.2) provided reports that generally described overcast cloud conditions. Various cameras throughout the area captured videos and photographs during the time of the accident flight.[28] Generally, the imagery provided by these sources showed overcast cloud conditions obscuring terrain peaks above about 1,300 ft msl to 1,400 ft msl near the accident site and areas of reduced visibility beneath the clouds.

A west-facing video camera operated by the City of Calabasas located about 1.8 miles northeast of the accident site on US 101 captured the accident helicopter in video imagery between 0944:16 and 0944:22 as it flew west (away from the camera). According to the helicopter performance study, the helicopter was flying at an altitude of about 1,400 ft msl (300 to 400 ft agl over varied terrain) during the time it was within the camera's view. The study determined that its height above the terrain was about 325 ft agl at 0944:20 (see figure 7) and 300 ft agl (its minimum cruising height) 1 second later.

Figure 7. Image from a camera on US 101 at 0944:20 of the accident helicopter (circled in red).

Note: A city representative determined that the camera's time stamp was 59 minutes 37 seconds behind the actual time.

[28] Sources included wildfire-spotting and security cameras, a dash-mounted camera in a vehicle traveling west on US 101, and cameras operated by ground witnesses.

A ground witness located about 0.25 mile west of the accident site at the time of the accident reported hearing the helicopter flying then seeing the wreckage and flames on the hillside after it crashed. (A friend of this witness immediately called 911.) The witness provided a still image reportedly taken about 2 minutes after the accident while facing east toward the accident site. The image showed that the tops of two peaks (elevation 1,375 and 1,425 ft msl) near the accident site were not visible (see figure 8).

Figure 8. Images taken about 2 minutes after the accident (top) and on a clear day (bottom).

A privately owned, networked weather camera located about 1.9 miles east of the accident site at an elevation of 1,320 ft msl captured a west-facing, still image at 0947 (see figure 9).

Figure 9. Image taken by a west-facing camera 1.9 miles east of the accident site at 1,320 ft msl.

Three cameras located at baseball fields about 1.8 miles north of the accident site captured videos that the National Transportation Safety Board (NTSB) used to estimate the visibility near the accident site (see section 1.8.2 for more information about the NTSB visibility study).

1.4.3 Localized Phenomena Previously Observed near Accident Site

The local NWS forecaster said that visibilities along US 101 near the accident site were commonly lower than what is observed in the surrounding regions when VNY had ceilings of 1,000 ft agl (about 1,800 ft msl) or lower. He said that this would occur because the mountainous area near the accident site can have lower temperatures than the valley area to the east from which the accident flight came. He said that a lower elevation area in the mountains, in which relatively cool air tends to sink and pool at night, was located on US 101 almost directly under the accident helicopter's flightpath and less than a mile northwest of the accident site. He said that, when such cool air approaches (or reaches) saturation, visibility can become lower. Based on his evaluation of the available information, the forecaster concluded that, if such conditions existed at the time of the accident, the area near the accident site would have had lower ceilings and visibilities than those reported at VNY and CMA.

A private pilot who resided near and frequently drove along US 101 near the accident site said the topography in the area tended to channel fog up from the coast (from the west) that would stack up against the hills in that area. He said such fog would accumulate along US 101 west of Mureau Road (the approximate high point on US 101 in that area) and would be particularly dense in the area near Las Virgenes Road. He said that, under such conditions, a pilot flying VFR west above US 101 would likely enter dense fog rather suddenly near Mureau Road and then very quickly lose visual contact with US 101 as the road descends down the hillside west of that location (see figure 10).

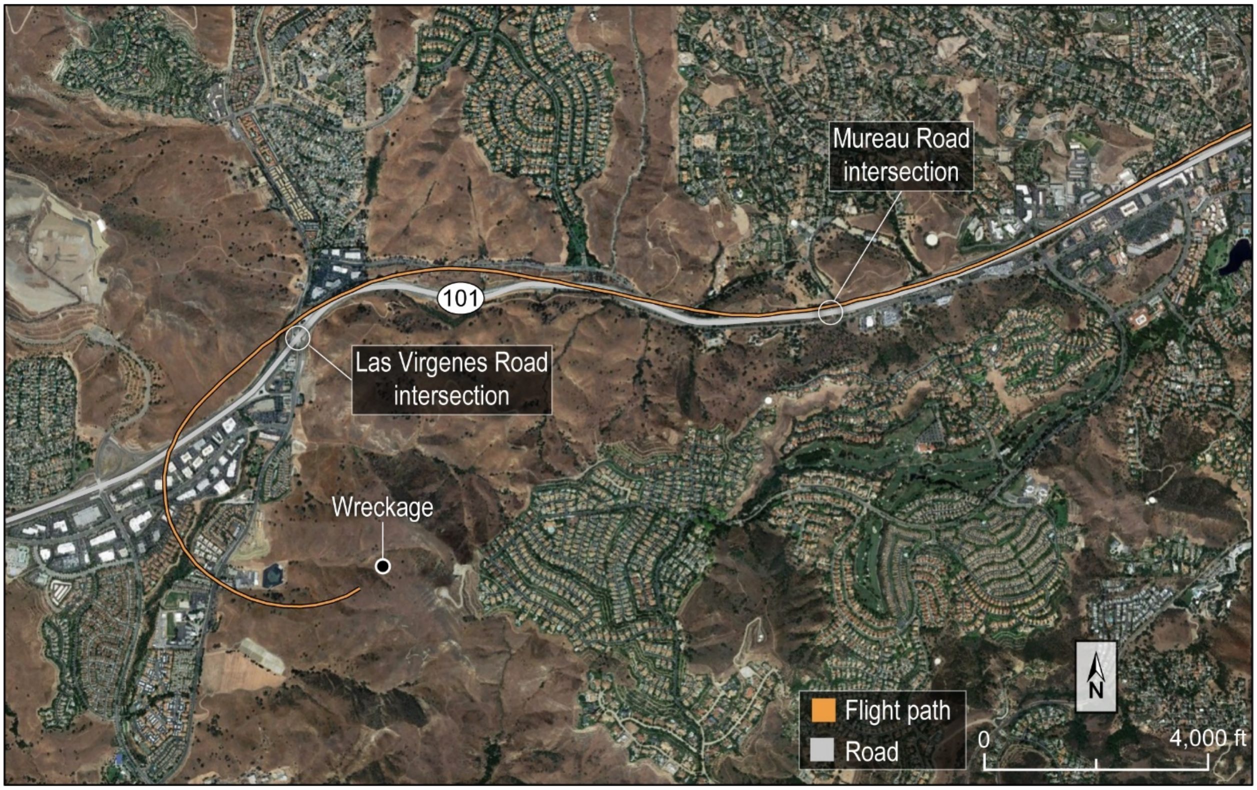

Figure 10. Area near the accident site reportedly subject to localized reduced visibility.

1.5 Air Traffic Control Communications and Services

After the accident flight departed from SNA, the SNA tower controller advised the pilot that the flight was in "radar contact" at 0907:08.[29] About a minute later, once the flight was outside

[29] The term "radar contact" is used by controllers to inform a pilot that the aircraft is identified using an approved ATC surveillance source on the controller's display and that the controller will provide radar flight following until advising that radar service is terminated (FAA 2019b, PG R-2). FAA ATC procedures specified that a controller must inform an aircraft of radar contact when initial radar identification of the aircraft is established (FAA 2019b, 5-3-7). Location and transponder code information for the accident helicopter depicted on the controllers' displays was derived from primary returns (electronic signals broadcast from ground-based radar equipment that are reflected by an aircraft back to the radar antenna) and secondary returns (signals transmitted by an aircraft's transponder in response to interrogator signals broadcast from radar sites). Controllers issue pilots discrete transponder codes for aircraft operating under IFR and SVFR, as well as for VFR aircraft that are receiving ATC radar advisory service, such as flight following and separation from other aircraft (FAA 2019b, 3-9-3, PCG R-3).

the SNA class D surface area, the controller advised the pilot that radar services were terminated, instructed him to squawk VFR, and advised that a radio frequency change was approved.

When the accident pilot subsequently contacted the BUR tower controller to request SVFR clearance through the BUR class C airspace west along US 101 to CMA, the controller advised the pilot to hold outside of the BUR airspace due to traffic, which included an IFR flight conducting a missed approach to the south and an IFR flight inbound from the north. ATC procedures specify that aircraft operating under IFR have priority over those operating under SVFR.[30]

While the accident flight was holding, the BUR controller contacted the VNY tower controller to coordinate the accident pilot's request, which was to transition through the VNY airspace south of that airport. The VNY controller advised that multiple IFR flights were departing VNY to the south, and the controllers agreed to have the accident flight instead transition the VNY airspace north of the airport. After advising the pilot of this routing, the BUR controller assigned the pilot a discrete transponder code (which the pilot acknowledged) and issued the SVFR clearance for the flight to transition through the BUR airspace.

Before the flight entered the VNY airspace, the BUR controller advised the pilot that radar service was terminated and instructed him to maintain the assigned transponder code and contact the VNY tower controller. During a postaccident interview, the BUR controller said that the accident flight's transition through the BUR airspace was routine and that (when looking out the window) he could see the helicopter flying beneath the cloud layer.

The VNY tower controller who handled the accident flight's SVFR clearance through the VNY airspace said (in a postaccident interview) that the transition was routine and that the route taken by the accident helicopter was one of the typical SVFR routes.[31]

The first SCT controller who handled the accident flight said that, based on the pilot's reported intentions to fly under VFR at a low altitude to CMA, he expected to be unable to maintain radar contact and radio communication with the flight.[32] He advised the pilot to squawk VFR and contact the CMA tower once closer to the airport and had no further communication with the pilot. He was subsequently relieved from his position; he said that he used a checklist to complete his relief briefing with the second SCT controller (which was recorded) and that he remained plugged in for the overlap.[33]

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[30] FAA ATC procedures specify that a controller should give first duty priority to "separating aircraft and issuing safety alerts" and that, operationally, "IFR aircraft must have priority over SVFR aircraft" (FAA 2019b, 2-1-2 and -3). The procedures state that a controller should inform a pilot of "the anticipated delay when an SVFR clearance cannot be granted because of IFR traffic" (FAA 2019b, 7-5-1).

[31] VNY was not a radar facility and provided no radar services to the flight.

[32] The controller said he typically lost radar and radio surveillance with flights below 3,000 ft msl in the area west of VNY where the accident flight was headed. According to ATC procedures, such limitations may preclude a controller from providing various ATC services. (FAA 2019b, 2-1-1 and -2).

[33] SCT local directives specified that, after providing a position relief briefing (which must use the required checklist and be recorded), the controller being relieved must remain plugged in for a minimum of 2 minutes with the relieving controller to ensure all pertinent information and traffic situations are communicated and understood (FAA SCT 2018, 3-1-8).

The second SCT controller said that, when he received his first radio communication from the accident pilot (when the pilot advised that he was starting a climb to go above the layers), the pilot spoke as if the flight were receiving ATC radar advisory services (which it was not). To identify the flight, the controller requested that the pilot "ident," observed the flight's location and 1200 transponder code, and asked the pilot for information about his intentions.[34] During this exchange, the controller lost radar contact and radio communication with the flight.

According to the controller, he was not providing flight-following service to the flight at the time he lost contact with it because he had not received enough information from the pilot to complete the flight's entry into the system. He said he did not report losing radio communication and radar contact with the flight because such losses were routine with low-flying aircraft in that area due to spotty radio and radar coverage in the mountains.[35] When asked if he expected that the pilot's reported climb to 4,000 ft msl would be conducted in visual meteorological conditions (VMC), the controller said the pilot would have to do so, and he assumed the flight was climbing through a hole in the clouds.

1.6 Wreckage and Impact Information

The wreckage was located at an elevation of about 1,100 ft msl on 36° sloping terrain. Wreckage pieces were scattered within 175 ft generally downslope of the initial impact point, which was a 2-ft deep ground crater, 24 ft long and 15 ft wide. The crater contained a 10-ft section of a main rotor blade, fragments of the collective control, pieces of helicopter belly skin, and other components. A slash mark on the ground near the ground crater contained fragments of rotor blade skin and core. A strong fuel odor was detected near the crater with no evidence of fire at the crater or on the debris it contained.

The main wreckage, which included the fuselage, cabin (including part of the cockpit instrument panel, some instruments, and some flight control components), both engines, and tail boom, came to rest about 95 ft downslope from the initial impact crater and showed fire damage. The accessory gearbox (made of magnesium alloy) and the inlet case (made of aluminum alloy) of each engine were thermally consumed. The main rotor head, main rotor shaft, swashplates, and main gearbox were found further downslope from the main wreckage, and the vertical pylon and horizontal stabilizer were found separated in the vicinity of the impact crater. All major helicopter components were identified at the accident site, and about 95% of the fragmented main rotor blades were recovered.

Postaccident examination of the recovered airframe, engines, rotor blades, flight controls, rotor drive, main rotor, and tail rotor system components identified no evidence of preimpact malfunction or failure that would have precluded normal operation. Both engines displayed

[34] ATC procedures specified that, before providing radar service, a controller should establish and maintain radar identification of the flight. To accomplish this, a controller must either request that the pilot activate the "ident" feature of the transponder and observe the identification on the display; or request that the pilot change to a specific transponder code and observe the code change on the display (FAA 2019b, 5-3-2 and -3).

[35] ATC procedures specified that a controller should consider an "unexpected loss of radar contact and radio communications with any IFR or VFR aircraft" to be an aircraft emergency, which requires informing the rescue coordination center or the air route traffic control center (FAA 2019b, 10-2-5).

rotational damage signatures and resolidified metal deposits consistent with powered operation at impact.

Postaccident examination of the recovered instruments, avionics, and annunciator panels revealed substantial impact or fire damage (or both) to most of the components. Those components recovered from the accident site for examination in the NTSB laboratory included the standby attitude indicator, Nos. 1 and 2 vertical gyros (for the DAFCS), Nos. 1 and 2 yaw rate gyros (for the DAFCS), the pilot's (right side) master warning panel, caution/advisory panel, autopilot controller, and a flight director mode selector, all of which showed significant impact and fire damage. In addition, the Nos. 1 and 2 directional gyros (for the DAFCS) were examined during the wreckage layout, and the nonvolatile memory from the flight management system navigation computer unit was downloaded. Examinations of each component and a review of the downloaded data identified no evidence of any preimpact malfunction or failure that would have precluded normal operation.

1.7 Medical and Pathological Information

The pilot reported no medical conditions on his most recent FAA airman medical application. The FAA Forensic Sciences Laboratory performed toxicology testing on postmortem muscle and liver specimens from the pilot. The results were negative for ethanol and all tested-for substances.[36] The Los Angeles County Department of Medical Examiner-Coroner, Los Angeles, California, performed an autopsy on the pilot. The pilot's cause of death was blunt force trauma.

1.8 Tests and Research

1.8.1 Helicopter Performance Study

The NTSB used the flight's ADS-B data, ATC communications, area topography, and weather information to develop a helicopter performance study. The study applied corrections to the ADS-B-broadcasted pressure altitude data to determine the helicopter's altitude in ft msl and used ADS-B flight path data to calculate the helicopter's estimated bank angle and rate of climb or descent.

The study determined that, when the pilot informed the SCT controller at 0944:34 that he was starting to climb the helicopter "to go above the [cloud] layers," the helicopter was at an altitude of about 1,370 ft msl (450 ft agl). The helicopter immediately began climbing at a rate of about 1,500 fpm, and its forward speed slowed. The study determined that, about the same time, the helicopter began to bank to the left, and the ADS-B data showed that its flight path began a gradual left turn that generally continued to follow US 101 below. Just after 0945:10, while the pilot was communicating with the controller, the helicopter began to enter a steeper bank to the left, and its flight path entered a tighter left turn that diverged from overflying US 101. About 5 seconds later, the helicopter reached its maximum altitude of about 2,370 ft msl (about

[36] The FAA Forensic Sciences Laboratory has the capability to test for a variety of substances including toxins, common prescription and over-the-counter medications, illicit drugs, and ethanol (FAA 2019a). Ethanol is the type of alcohol found in beer, wine, and liquor.

1,600 ft agl) then began to descend and accelerate while continuing to bank to the left. About the time that the pilot reported to ATC that the flight was climbing to 4,000 ft msl, the helicopter's descent rate was rapidly increasing.

1.8.2 Visibility Study

The NTSB performed a visibility study using videos captured by three generally south-facing cameras located at baseball fields about 1.8 miles north of the accident site. Based on the imagery, sound spectrum analysis of the audio, and ADS-B data for the accident flight, the study determined that, between 0944:35 and the time of the accident, segments of the accident flight passed within the field of view of one or more of the cameras (see figure 11).[37]

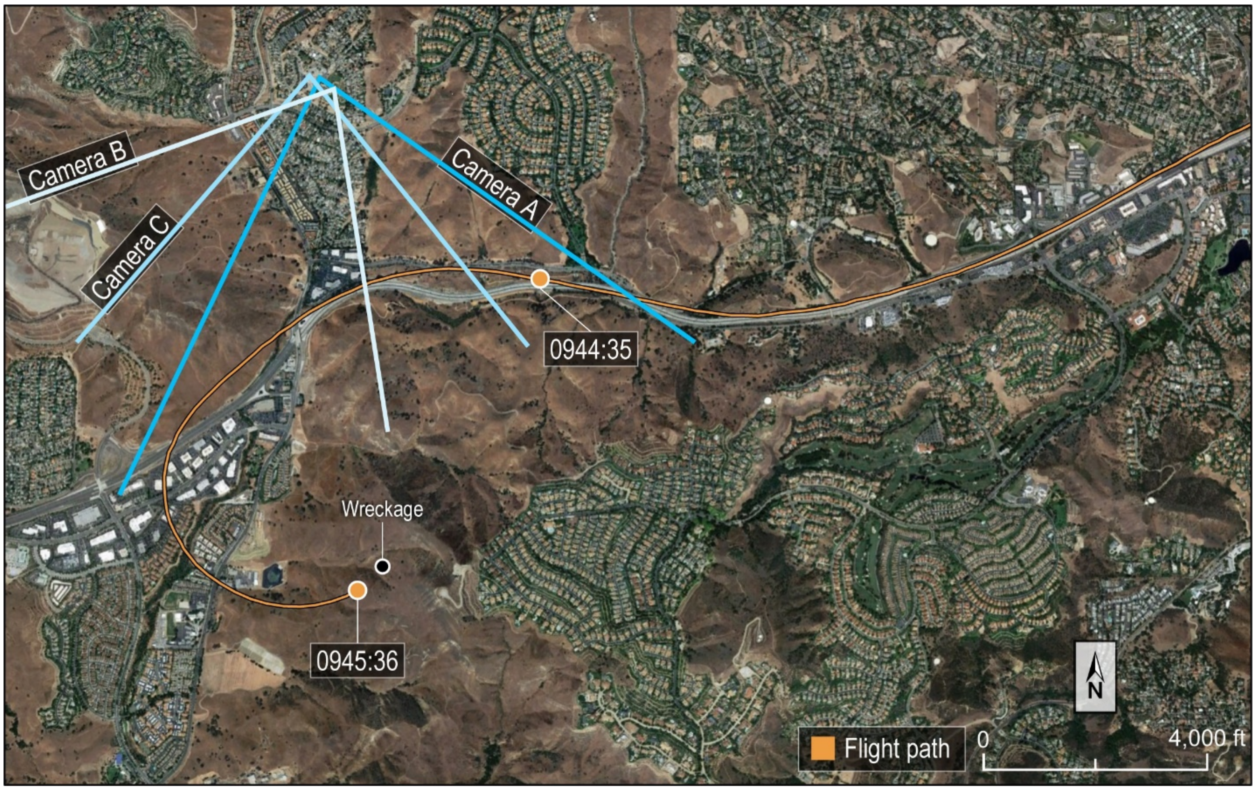

Figure 11. Relative locations of camera fields of view to the accident flight and accident site.

Video from all three cameras captured audio that was attributed to the accident helicopter in flight, but the helicopter was not seen in any of the imagery. Based on the study's determination of distances from each camera to discernable terrain details in the imagery at the times when the helicopter would have been within each camera's field of view, the study estimated that the visibility beneath the clouds in the vicinity of the accident site was between 1 and 1.5 miles (about 5,000 ft and 8,000 ft respectively, see figure 12).

[37] The study applied corrections for the cameras' wide-angle lens distortion and inaccurate time stamps. In addition, in some cases, an obstruction, such as terrain or trees, was between a camera and the accident flight's location, precluding the capture of imagery of segments of the flight that would otherwise be within the camera's field of view.

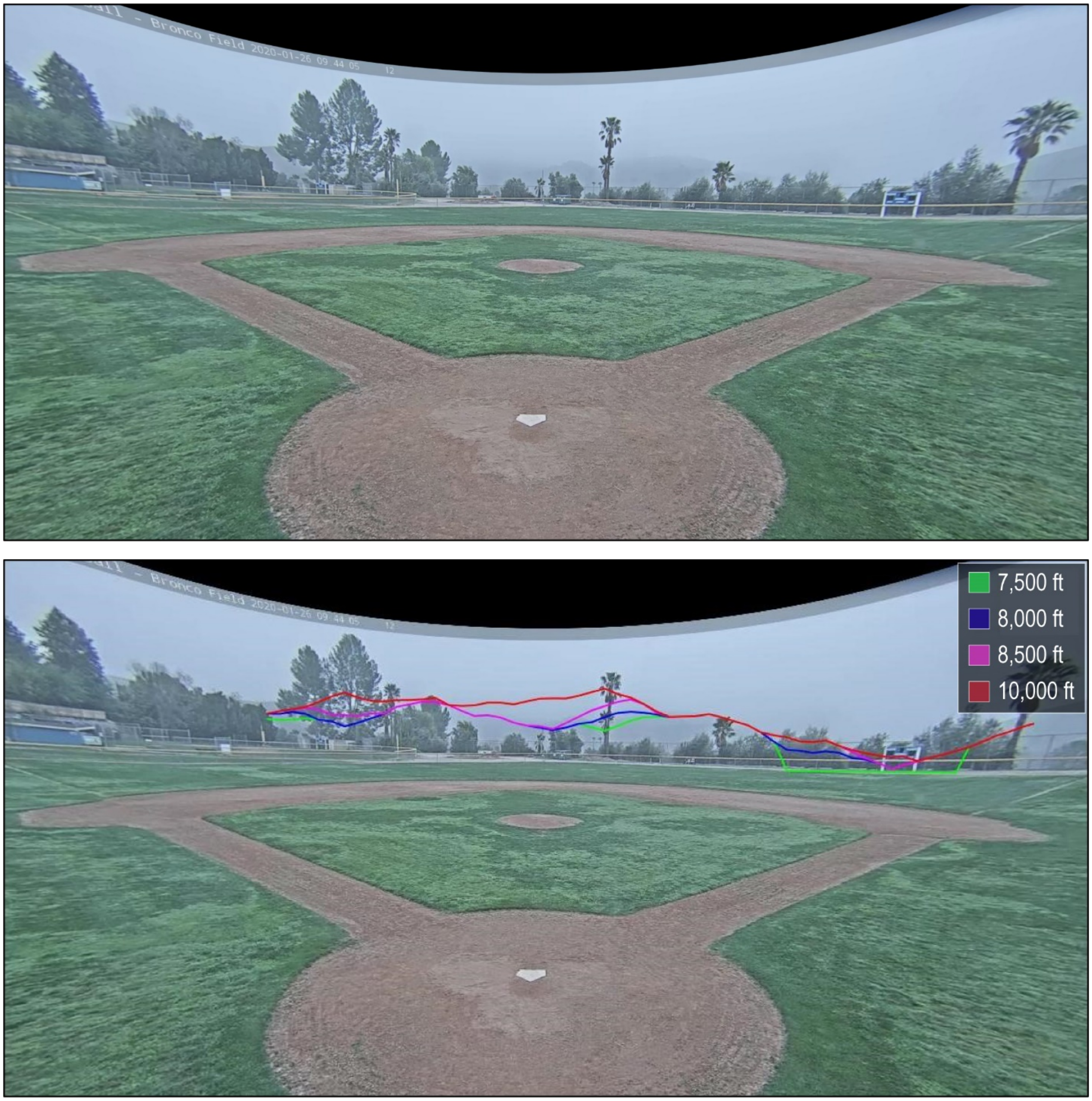

Figure 12. A distortion-corrected image from video captured by Camera A at the accident time (top). Terrain outline curves are superimposed on the same image for the specified computed visibility ranges (bottom).

1.9 Organizational and Management Information

Island Express, which had a main office in Long Beach, California, held an operating certificate that authorized VFR-only day and night Part 135 on-demand passenger (charter) and cargo operations.[38] According to its FAA-approved operations specifications (OpsSpecs), Island

[38] A review of FAA data revealed that 476 certificate holders were authorized for Part 135 helicopter operations and that, of these, 411 were VFR-only operators.

Express' required policies and procedures were outlined in its FAA-accepted *General Operations Manual* (*GOM*). The company had an FAA-approved training program, which was outlined in its FAA-approved *Training Manual.*

Per the OpsSpecs, the DO, the director of maintenance, and the chief pilot (the accident pilot) were the authorized management personnel for the operating certificate. Per the *GOM*, the chief pilot reported to the DO and was responsible for, in part, supervising all pilots and their training activities, assisting the DO in formulating operations policies, and coordinating operations and training. The company also had a safety officer who, per the *GOM*, reported to the DO and was, in part, responsible for scheduling safety meetings (see section 1.9.3 for more information), encouraging the reporting of incidents and following up on actions arising from the reports, and encouraging the submission of comments and suggestions for improving safety procedures.[39]

Island Express had 25 employees, including 6 pilots and 2 mechanics (1 of whom was the director of maintenance). The company operated three Sikorsky S-76-series helicopters (one S-76A and two S-76Bs) and three Airbus AS350-series helicopters (one AS350 BA and two AS350 B2s). According to the vice president, in 2019, Island Express flew about 495 charter flights, each of which represented an individual reservation that may have included multiple flight legs, such as round-trip flight. Twenty-eight of the charter flights had been requested by the air charter broker that handled the accident flight's client, including 13 flights for the accident client.

Island Express received individual charter flight requests from the air charter broker and did not have any contractual agreement with the company. The air charter broker held an operating certificate to conduct helicopter operations under Part 135. According to the broker's operations manager, the accident client initially approached her company because he liked its work ethic, but she said that OC Helicopters did not have a helicopter big enough to suit his needs, so she began looking for an operator for him. She said she first approached Island Express because its work ethic was similar, and her company used Island Express exclusively for the accident client's local transport requests and had not identified any other operator that met the client's vetting requirements or her company's standards for the client.[40]

The FAA principal operations inspector (POI) for Island Express said he had been assigned to the operator since February 2016.[41] He described the company as a relatively small operation for which the DO is on site and involved in day-to-day operations. He estimated that, since 2018, he interacted with the DO about 70 times, including phone calls, e-mails, meetings, and inspections. The POI said that his interactions with the company involved various routine compliance inspections, ongoing surveillance, competency checks, and approvals for such things as manual revisions and minimum equipment lists. He said that the company met FAA standards and noted that it hired a safety officer, which he said not every operator does.

[39] Company documents also refer to the safety officer as the safety manager.

[40] She said her company began brokering charter flights for the accident client beginning about 2015 and located operators that could meet the client's vetting requirements, which included a security verification process for the pilots and the use of dual-engine helicopters.

[41] The POI had been with the FAA since February 2014 and was the inspector assigned to investigate the accident pilot's May 2015 airspace violation.

Island Express used an outside training vendor to provide its pilots with supplemental ground and flight training outside the scope of its FAA-approved training program; this supplemental training included preparation for required FAA proficiency checks (see section 1.9.2 for more information). Island Express also had an SMS that was neither required by the FAA nor part of the company's FAA-approved or -accepted programs (see section 1.9.5 for more information). The POI said he was aware of the supplemental training and SMS but was not involved with their development or oversight.

1.9.1 Procedures and Guidance

1.9.1.1 Company Weather Minimums

The *GOM* stated that all flights were to be accomplished in accordance with federal regulations, VFR flight plans, company OpsSpecs, and policies and procedures set forth in the *GOM*. Per the *GOM*, for daytime VFR flights, pilots were required to maintain a minimum altitude of 300 ft agl, with the recommended altitude between 500 and 1,000 ft agl (or any altitude published or required by the FAA), and a minimum flight visibility of 1 nautical mile (nm), which was more conservative than the 0.5-mile regulatory requirement, while remaining clear of clouds.[42]

The *GOM* stated that, in the interest of safety, "both ground and flight staff will closely monitor weather during periods that may lead to weather minimums being less than those [required by the company]. If the weather is deteriorating or has fallen below any of the above, flight operations will be stopped and not resume until weather has improved." The *GOM* specified that pilots "will never take an aircraft into IMC…or into weather that, in their opinion, will deteriorate into IMC."

Company records showed that, in 2019, Island Express logged 150 flight cancellations due to weather (including one for the accident client) and that there were 13 cancellations for weather in January 2020, all of which occurred on January 24 and 25. Minutes from several company safety meetings documented company support for pilots' authority to cancel or terminate a flight (see section 1.9.3 for more information on the company's safety meetings). The vice president said pilots could also decline to accept a charter flight request due to weather.[43]

According to the DO, the company would delay a flight until the weather improved or cancel it. He said that the company would issue refunds for flights canceled due to weather and offer the clients other options, such as arrangements for ground transportation or a flight (with another operator) on an IFR-capable airplane instead. According to the DO, he personally terminated a flight in progress when he encountered deteriorating weather that was worse than

[42] Regulations applicable to Part 135 helicopter operations specified that daytime, VFR flights conducted in class G airspace at an altitude of 1,200 ft agl or less or within the lateral boundaries of the surface areas of class B, C, D, or E airspace designated for an airport must be flown in visibility of at least 0.5 mile (14 *CFR* 135.205[b][1]). The regulation also required that the helicopter be flown at an altitude of at least 300 ft agl (14 *CFR* 135.203[b]) and with visual surface reference sufficient to safely control the helicopter (14 *CFR* 135.207).

[43] The vice president said that, when she received a charter flight inquiry (either directly or through an air charter broker), she would determine who was available, assign a pilot, and wait for the assigned pilot to check the weather and respond whether or not the flight could be flown.

forecast. He said he landed the helicopter midflight, arranged for ground transportation for the clients, and booked a hotel room for himself.

Three company pilots interviewed said they felt supported by the company when deciding to either cancel or delay a flight due to weather.

1.9.1.2 Operational Control and Preflight Weather Briefing

According to Island Express' OpsSpecs and its *GOM*, the DO was responsible for determining the currency and eligibility of pilots and airworthiness of helicopters assigned for a flight and could appoint the chief pilot, director of maintenance, or another employee to make that determination. Both the OpsSpecs and the *GOM* specified that the pilot assigned to any flight conducted under Part 135 had operational control over the flight, which included determining whether the flight could be initiated, conducted, or terminated safely in accordance with regulations and company policies and procedures.

The *GOM* specified that the pilot's responsibilities included, in part, obtaining a weather briefing from the approved weather sources; preparing (or supervising the preparation of) a flight plan, considering such factors as altitude, terrain, weather (among others); and filing the flight plan. According to the OpsSpecs, pilots were authorized to use information from weather reporting facilities operated by the NWS (or a source approved by the NWS) and specified military sources. The *GOM* noted, "in the absence of approved weather sources, pilots will utilize whatever sources are available."

1.9.2 Pilot Training: Avoiding and Recovering from an Inadvertent Encounter with Instrument Meteorological Conditions

According to Island Express' *Training Manual*, basic indoctrination ground training curriculum included, in part, modules for pilot duties and responsibilities, regulations, and instrument procedures, with specific items for weather requirements, aeronautical decision-making and judgment, IIMC, and spatial disorientation. The ground training curriculum for Sikorsky S-76-series pilots included an "adverse weather practices" module with an item for reduced visibility, fog, and smog. The flight training curriculum for Sikorsky S-76-series pilots contained an instrument maneuvers module, which included items for straight-and-level flight, climbs, descents, turns, unusual attitudes, and IIMC, and a company-specific mission training module, which included a judgment item.[44]

The initial and recurrent pilot testing requirements in 14 *CFR* 135.293 specified, in part, that a pilot must satisfactorily demonstrate knowledge of meteorology, including the procedures for recognizing and avoiding severe weather situations (and recovering from entry into severe weather situations in case of inadvertent encounters) and must pass a competency check that includes "a demonstration of the pilot's ability to maneuver the rotorcraft solely by reference to

[44] As a company check airman, the accident pilot received additional FAA-approved ground and flight training to enable him to instruct and evaluate the competence of other pilots in performing their duties and operating the helicopter to the training standards, including detecting any personal characteristics in a pilot that could adversely affect safety.

instruments. The check must determine the pilot's ability to safely maneuver the rotorcraft into [VMC] following an inadvertent encounter with IMC."[45]

According to the POI, when he evaluated Island Express' Sikorsky S-76-series pilots (including the accident pilot) during initial and recurrent testing and check flights, he would discuss a scenario such as a deteriorating weather situation to see if the pilot would respond with the proper steps to avoid an inadvertent encounter with IMC, such as diverting, returning to base, or landing the helicopter. He said that, after he and the pilot discussed the maneuvers, he would have the pilot put on a view-limiting device while flying and ask the pilot to take the appropriate action to recover from entry into IMC. He said that he would next have the pilot (while wearing the view-limiting device) perform the procedures for recovering from unusual attitudes, then conduct an instrument approach.

Island Express used EuroSafety International LLC (EuroSafety) to provide its pilots with supplemental ground and flight training outside the scope of the company's FAA-approved training program; the pilots participated in the training annually in preparation for their FAA proficiency checks. According to the EuroSafety flight instructor who provided training to Island Express pilots (including the accident pilot), such ground and flight training covered the items needed to ensure that the pilots were proficient and ready to pass the checkride. All flight training was performed using company helicopters.

The instructor said the flight training emphasized the importance of not entering IMC and included performing the established IIMC recovery actions that the FAA would evaluate during the checkride. He said that, for the Sikorsky S-76-series pilots, the procedures for recovering from an unusual attitude following IIMC (simulated using a view-limiting device) involved adjusting the pitch and roll to achieve straight-and-level flight, adjusting the power to about 70% to 75% torque and pitch attitude to establish a positive climb rate at an airspeed of about 75 to 80 kts, maintaining the current heading, and turning only to avoid known terrain or obstacles. He taught the pilot trainees that, once they had the helicopter established in a stabilized climb, they should transition to using the autopilot (by selecting heading, airspeed, and vertical speed) then communicate with ATC. For pilots who fly in the Los Angeles area, he taught them that the best choice was to climb above the cloud layer, fly visually to an airport, and land under VFR, if possible, or perform a precision instrument approach, which he practiced with them.

The instructor said he taught the pilots how to perform the recovery procedures using both manual manipulation of the flight controls and the use of the autopilot so they could become familiar with each technique. He said initial recovery should be performed using manual control manipulation because it is faster, but the use of autopilot functions could be useful in regaining helicopter stability if the pilot were confused. He also demonstrated the limitations of the autopilot at low airspeeds to the pilots.

[45] VMC refers to visibility, ceiling height, and aircraft distance-from-cloud conditions that meet or exceed the applicable minimums for the flight to be operated under VFR.

One company Sikorsky S-76-series pilot said that, for avoiding entry into reduced visibility or clouds, he would slow the helicopter from its normal cruise airspeed of 140 kts and instead fly it about 60 to 100 kts, depending on the conditions and terrain.

1.9.3 Safety Meetings

According to the *GOM*, the safety officer's responsibilities included scheduling safety meetings. Company records showed that, during calendar years 2018 and 2019, the company held numerous safety meetings (13 for the pilot group, 17 for the maintenance group, and 6 for ramp personnel). During the meetings, attendees discussed a variety of safety topics relevant to Island Express operations (including pilots' personal accounts of safety-related experiences, NTSB accident reports, and safety videos and articles), hazard report reviews, company best practices, and new procedures. The safety officer prepared the minutes for each safety meeting, which documented the in-person and call-in attendees and the topics discussed, distributed them to the pilots via e-mail, and posted them in the company office.

Topics discussed at some meetings emphasized company support of a pilot's decision to cancel a flight and for its SMS. This is reflected in the minutes from the following three meetings, each of which was held via conference call and attended by the DO, safety officer, accident pilot and other pilots:

- October 30, 2019: "At any time, if you feel the flight cannot be flown safely and professionally, then it's a [no-go]."
- May 24, 2019: A pilot meeting documented that the DO discussed a Helicopter Association International safety article, as well as statements by the DO concerning "weather deviation with passengers on board. If you must divert, then do it. Land [the helicopter and] call a taxi for the passengers. If the pilot has to get a hotel room, then get [the] room."[46]
- February 25, 2019: An item among a variety of safety topics stated, "Please all pilots…it's important that we have everyone's participation in these pilot meetings and our SMS."

1.9.4 Safety Culture

Island Express' vice president said that the company's safety culture "starts from the top and goes all the way to the bottom" and that she reinforced that message to the clients daily. She said any safety issues were handled immediately, either by herself, the DO, the safety officer, or the accident pilot (in his role as chief pilot). She interacted with the safety officer daily about safety

[46] As noted in section 1.9.1.1, the DO once terminated a flight in progress due to weather, arranged for ground transportation for the passengers, and stayed in a hotel. The referenced article discussed a variety of helicopter accidents scenarios (including flight into "less-than-desirable weather conditions") and asked, "[W]hy don't pilots exercise one of the most unique and valuable capabilities of vertical flight—namely, land the…helicopter!" (Zuccaro 2013).

topics and was unaware of any “drastic safety issues” within the company. She said no clients had ever expressed safety concerns about any pilot.

Interviews with three company pilots revealed that two said the company had a good safety culture. One of these two pilots said the monthly safety meetings enabled pilots to bring up safety issues to be addressed, and he described an incident with a passenger exiting the helicopter unassisted; he said he brought it up at a safety meeting, and the company implemented a policy change to mitigate the risk. The third pilot said the safety culture could have been better. He said he expected company leadership (including the accident pilot, in his role as chief pilot) to communicate expectations regarding weather minimums, but they did not.

1.9.5 Safety Management System

Island Express had an SMS that was neither required by the FAA nor part of the company’s FAA-approved or -accepted programs. Island Express developed its SMS in 2013 with the assistance of a vendor using both FAA and international guidance. The provisions for the SMS and its training curriculum were outlined in the company’s *Safety Management System Manual* (*SMS Manual)*, which was neither FAA-accepted nor -approved (and was not required to be). According to the *SMS Manual*, the DO was the designated accountable executive who reported to the company’s president and had ultimate responsibility for the SMS. When interviewed, the president said he was aware of the SMS but was not involved with it or in the company’s day-to-day flight operations.

According to the *SMS Manual*, the structure of the SMS included safety policy, risk management, safety assurance, and safety promotion. Safety policy included the guidance set forth in the *SMS Manual*; risk management involved hazard identification and risk assessment and mitigation; safety assurance involved continuous monitoring, internal evaluation, corrective action, and safety performance measurement; and safety promotion included training and communication of safety objectives.

The SMS vendor provided computer-based, internet-accessible training and a variety of other tools (such as internet-accessible forms and templates) to support the company’s SMS functions. Company records show that its pilots (including the accident pilot), mechanics, and other employees completed the SMS training.[47]

A review of the *SMS Manual* and interviews with the DO, safety officer, and other company personnel revealed that Island Express used select SMS tools provided by the vendor, including the flight risk analysis forms with which its pilots developed flight risk profiles during preflight planning.[48] The company did not implement the entire program as outlined in its *SMS Manual*.

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[47] The training curriculum covered topics that included SMS principles, safety policy, safety documentation, reporting hazards, risk management, flight risk analysis, internal evaluation, SMS improvement, and safety culture, among others.

[48] Island Express also used risk analysis forms for mechanics and ground crewmembers as well as a hazard reporting form that enabled employees to report any hazards (anonymously, if desired) to the safety officer for corrective action.

1.9.5.1 Risk Assessment Tools: Flight Risk Analysis Form

The flight risk analysis form was an SMS tool company pilots used to document any risks and associated mitigations for a flight, including weather, mission-specific, equipment, and pilot health and fatigue considerations.[49] According to the DO, pilots were expected to complete a flight risk analysis form (which was internet accessible) before their flight and any time there was a “significant change” in weather, schedule, or other factors.[50]

Once completed, the flight risk analysis form provided a total score for the flight based on the pilot’s selected risks and mitigations. The form included 15 weather risk items, including an item for “[Ceiling] less than 1,000 [ft agl],” which would add five points to the overall trip score; an “SVFR En route (CAUTION)” item, which would add eight points to the score and require the pilot to include a “Plan B” alternative; and a “Visibility under 3 [miles]” item, which would add nine points to the score and require calling the chief pilot or DO to “help assess the weather to make a safe decision.” According to the form, calling the chief pilot or DO to discuss the weather for a go/no-go decision subtracted eight points from the score.

The form used numeric thresholds for determining low-, elevated-, and high-risk scores, with the latter two requiring additional levels of evaluation (and automatically generating e-mail notifications to the DO and safety officer) before the pilot could proceed. Flights scoring below the low-risk threshold (45 points) did not require management notification or evaluation.

Elevated-risk flights (scoring 45 to 59) required mitigation and management concurrence, and high-risk flights (scoring 60 or higher) required the same with the possibility of a “no-go” decision if the risk could not be mitigated. Guidance for the form specified that, for elevated- or high-risk flights that required DO or chief pilot approval, neither the DO nor the chief pilot could approve their own flights. A review of company records from November 2019 to January 2020 revealed no forms reflecting an elevated risk or high risk. The DO said he was not aware of any pilot ever completing a form that reflected a high risk.

The DO said he occasionally did a spot check to determine if pilots were completing the flight risk analysis forms and would call or text pilots who did not complete them. One pilot who did not fill out the form recalled in an interview that the DO or safety officer reiterated the need to complete the form, which the pilot subsequently did. The DO said that, in 2019, pilots forgot to fill out the forms three or four times. According to one company pilot interviewed, he completed the flight risk analysis form once a day if he had multiple flights and when he knew the weather was bad. Two company pilots said they were not aware of any guidance on when to complete a flight risk analysis form.

[49] The DO and the safety officer (along with input from the SMS vendor) developed the company’s flight risk analysis form, which pilots could complete and submit using a computer or an application on their cell phones or tablets. The DO said the form was continuously monitored and updated, as needed. The most recent revision occurred on November 29, 2019, to include changes to the risk criteria and scoring values.

[50] These expectations were not contained in any SMS guidance materials for the form.

1.9.5.2 Safety Assurance Functions and Audits

Per the *SMS Manual*, the intention of the safety assurance aspect of the SMS was for the company to use historic risk trends (derived from periodic evaluation of completed flight risk analysis forms) to update the company risk profile and help determine training strategies. There were no records to indicate that Island Express opted to perform these functions.

Island Express received external audits from three companies as part of those companies' consideration of using Island Express. According to the DO, the audit findings were generally favorable, and Island Express was not required to address all the noted items.

One of these companies provided Island Express with copies of its audit reports.[51] The report for an August 2018 audit noted, in part, that the company was not using all of the available SMS tools, particularly the safety committee meetings, formal tools to measure the effectiveness of the SMS, and other measures to manage change process. It also noted that the safety officer lacked formal SMS training.[52] The report for an October 2019 audit noted, in part, that the company did not perform internal evaluations or any proactive hazard analysis using the completed flight risk analysis forms and that no flight simulators were used for pilot training, only company helicopters were used. The company that performed these audits opted to use Island Express for certain day VFR onshore and offshore helicopter operations when flown by the DO, the accident pilot, or one other approved company pilot.

According to the *SMS Manual*, findings from external audits were to be combined with internal evaluation results to establish trends and evaluate the organization.[53] Results from external audits were to be subjected to the same corrective action process as internal audit findings.[54] There were no records to indicate that Island Express opted to perform these functions.

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[51] According to a representative from the company that did not provide Island Express with a copy of its audit report, its November 2019 audit found nothing that would preclude the use of Island Express for transporting passengers. The representative expressed the opinion that Island Express was moving in the right direction and should keep up the good work. The DO named another company that also performed an audit and decided not to use Island Express because of the age and type of helicopters.

[52] The safety officer said that, after transitioning from his line pilot position to safety officer in late 2017 or early 2018, he received guidance and coaching for the position from the DO, chief pilot, and other staff, and he learned from reading various safety articles. He also took online training from the SMS vendor. According to vendor records, the safety officer received SMS training during three sessions in 2018 and 2019 that included an SMS overview and training in the use of the various SMS support tools provided by the vendor.

[53] Island Express did not perform any internal evaluations or related activities.

[54] Per the *SMS Manual*, this process would involve continuously measuring the effectiveness of safety risk controls, assessing company system and process performance, and identifying hazards and deficiencies. Assurance checks were to be performed 90 and 120 days after corrective action to verify its effectiveness. The results of internal evaluations were to be analyzed for performance trends with the safety officer to prepare a quarterly safety performance report for the DO.

1.10 Additional Information

1.10.1 Previous Day's Flight

The day before the accident, the pilot flew the accident client and passengers from SNA to CMA and back. ADS-B data for the outbound flight showed that it departed SNA about 1000, and the routing turned west when the helicopter was just south of Los Angeles, then it proceeded nearly directly to CMA. The flight overflew the Santa Monica mountains at an altitude of about 2,000 ft msl (remaining about 600 ft to 1,000 ft agl) and joined US 101 over Calabasas (about where the accident flight crashed). Surface weather observations reported at SNA, BUR, VNY, and CMA about 1000 included visibilities ranging from 2.5 to 5 miles and ceilings from 1,300 to 1,700 ft agl, and the conditions generally improved throughout the day.

1.10.2 Postaccident Actions

On March 6, 2020, Island Express revised the Sikorsky S-76-series maneuvers section of its *Training Manual* to include items for brownout, whiteout, or flat light conditions; unusual attitude recovery; and IIMC avoidance and recovery.

On that same date, the company issued a Sikorsky S-76-series *Maneuvers Guide*, which the FAA approved on March 17, 2020. The guide included items for IIMC and unusual attitude recovery following IIMC. The guide also emphasized that avoiding the adverse weather was the preferred option, noting that, "When faced with deteriorating weather, planning and prevention, not recovery, are the best strategies to eliminate unintended IMC-related accidents and fatalities."

2. Analysis

2.1 Introduction

The accident occurred when a Sikorsky S-76B helicopter entered a rapidly descending left turn and crashed into terrain about 24 miles from its destination of CMA, killing the pilot and eight passengers and destroying the helicopter. The on-demand flight was operated by Island Express, Long Beach, California, under VFR and the provisions of Part 135.

After the helicopter departed from SNA, it flew at altitudes that remained below 1,700 ft msl and generally between 400 to 600 ft agl, and the flight's progress through the BUR and VNY airspace en route to CMA was uneventful. Weather conditions reported to the pilot by air traffic controllers at BUR and VNY during the flight included an overcast ceiling at 1,100 ft agl and visibility of 2.5 miles with haze.

At 0944:34 (about 2 minutes before the accident), while the helicopter was flying west at an altitude of about 1,370 ft msl (450 ft agl) over US 101 and rising terrain, the pilot announced to an ATC facility that he was initiating a climb to get the helicopter "above the [cloud] layers," and the helicopter immediately began climbing at a rate of about 1,500 fpm. About the same time, the helicopter began a gradual left turn, and its flight path generally continued to follow US 101 below. About 36 seconds later and while still climbing, the helicopter began to turn more tightly to the left, and its flight path diverged from its overflight of US 101.

The helicopter reached an altitude of about 2,370 ft msl (about 1,600 ft agl) at 0945:15, then it began to descend rapidly in a left turn to the ground. At 0945:17 (while the helicopter was descending), the air traffic controller asked the pilot to "say intentions," and the pilot replied that the flight was climbing to 4,000 ft msl. A witness near the accident site first heard the helicopter then saw it emerge from the bottom of the cloud layer in a left-banked descent about 1 or 2 seconds before impact.

The following analysis discusses the accident sequence and evaluates the following safety issues:

- The pilot's preflight weather and flight risk planning (section 2.2.1);
- The flight's entry into IMC (section 2.2.2), and the pilot's inadequate adverse weather avoidance (section 2.2.2.2);
- The pilot's spatial disorientation (section 2.2.3);
- Factors influencing the pilot's decision to continue the flight into adverse weather, including his self-induced pressure, lack of an alternate plan, and plan continuation bias (section 2.3);
- Island Express' incomplete implementation of its SMS (section 2.4), including its lack of safety assurance evaluations, such as those that could have ensured the effectiveness of the flight risk analysis forms (section 2.4.1);
- The benefits of a mandatory SMS (section 2.4.2);

- The benefits of flight simulation devices for pilot training in adverse weather avoidance (section 2.5);
- The benefits of a flight data monitoring (FDM) program (section 2.6); and
- The value of crash-resistant flight recorder systems in preventing future accidents (section 2.7).

Having completed a comprehensive review of the circumstances that led to the accident, the investigation identified none of the following safety issues for the accident flight:

- *Pilot qualification deficiencies or impairment due to medical condition, alcohol, other drugs, or fatigue*. The pilot was certificated, current, and qualified in accordance with federal regulations and company requirements to conduct the VFR flight. There was no evidence the pilot had any preexisting medical condition, and postmortem toxicology testing revealed negative results for alcohol and other tested-for substances, such as various potentially impairing prescription, over-the-counter, and illicit drugs. A review of information about the pilot's recent activities revealed adequate sleep opportunities in the days before the accident and no evidence of acute or chronic sleep loss or circadian disruption.
- *Helicopter malfunction or failure*. Examinations of the helicopter's structures, engines, systems, and instruments identified no evidence of preimpact malfunction or failure that would have precluded normal operation.
- *Pressure on the pilot from the company, air charter broker, or client to complete the flight*. Island Express' policy (as specified in the *GOM*) stated that, if weather conditions began to deteriorate such that a pilot could not maintain the company minimum flight altitude and visibility (300 ft agl and 1 nm, respectively) flight operations will be stopped and not resume until the weather has improved. Minutes from company safety meetings showed repeated company support for these policies, including the DO's emphasis that pilots should divert and land when faced with adverse weather, even if it meant transporting the passengers by taxi and getting a hotel room. Both the DO and the safety officer expressed confidence in the accident pilot's judgment and ability to make sound weather-related decisions. Regarding the accident client, in the event that a pilot needed to decline accepting, cancel, or delay a flight, the pilot or other company personnel would notify the air charter broker, and the air charter broker would notify the client (or his representative). There was no evidence to suggest that the air charter broker or the client (or any client representative) ever challenged any Island Express pilot's decision to delay, cancel, or terminate a flight.

Thus, the NTSB concludes that none of the following safety issues were identified for the accident flight: (1) pilot qualification deficiencies or impairment due to medical condition, alcohol, other drugs, or fatigue; (2) helicopter malfunction or failure; or (3) pressure on the pilot from Island Express, the air charter broker, or the client to complete the flight.

The ATC services provided by the SNA and VNY tower controllers and the BUR tower controller before the flight entered the BUR class C airspace were unremarkable and in accordance with FAA procedures. Although the BUR tower controller did not inform the pilot that radar contact was established with the flight, this procedural deviation did not affect the flight's transition through the BUR airspace.

Later, as the flight proceeded west of VNY, the first SCT controller's decision not to provide radar services to the flight, which was based on his awareness of the radar and radio coverage limitations for low-flying aircraft in the area, was consistent with FAA procedures. When the controller advised the pilot of the radar and radio limitations and told him to squawk VFR, the pilot acknowledged and complied, taking no exception when the controller did not provide flight-following service. Thus, the controller would have no expectation of any further involvement with the flight, which the pilot had reported was in "VFR conditions."

However, about 4 minutes later, the pilot announced on the SCT radio frequency (reaching the second SCT controller who had relieved the first from the position) that he was going to climb the helicopter above the cloud layers. Considering that the SCT facility was not providing any flight-following services to the flight at the time, the second SCT controller's actions to identify the flight, which included asking the pilot to "ident," and determine the pilot's intentions were consistent with ATC procedures. The pilot requested flight-following services; however, before the controller could obtain all the necessary information to accommodate this request, the helicopter crashed, resulting in the controller's simultaneous loss of radar contact and radio communication with the flight.

According to ATC procedures, a controller should consider an unexpected loss of radar contact and radio communication with a flight to be an aircraft emergency and report it to the rescue coordination center or air route traffic control center. However, the second SCT controller did not do so for the accident flight due to his incorrect assessment that the losses occurred because the helicopter was flying in an area of spotty coverage for low-flying aircraft. Although the controller's reporting failure precluded an ATC initiation of search-and-rescue activities, the accident was not survivable, and ground witnesses who saw the helicopter's impact and postcrash fire immediately called 911 to initiate the first response. Thus, the NTSB concludes that, although the air traffic controller's failure to report the loss of radar contact and radio communication with the accident flight was inconsistent with ATC procedures, this deficiency did not contribute to the accident or affect its survivability.

2.2 Accident Sequence

Island Express required that pilots obtain a weather briefing from approved sources when determining if a flight could be completed in accordance with regulations and company policy. Regulations applicable to the accident flight required visibility of at least 0.5 mile, visual reference to the surface, and a minimum flight altitude of at least 300 ft agl. Island Express' 1-nm visibility requirement was more conservative than the regulation and, although the company had the same minimum flight altitude, it recommended that pilots maintain flight altitudes between 500 and 1,000 ft agl.

2.2.1 Pilot's Preflight Weather and Flight Risk Planning

There was no record that the pilot obtained a formal preflight weather briefing for the accident flight either directly from the flight services provider, through his ForeFlight application, or from a third-party vendor. No data were available to determine what weather information the pilot may have accessed using his ForeFlight application (including during his preflight discussion with the air charter broker owner) or some other source.

The flight risk analysis form the pilot completed about 2 hours before the accident flight's departure included the weather risk item for a ceiling less than 2,000 ft agl. Although it is not known what weather information the pilot may have reviewed before completing the form (or what specific route he may have intended to fly from SNA to CMA), this ceiling risk item was consistent with the ceiling information provided in the TAFs for SNA, BUR, VNY, and CMA applicable to the time of the accident flight and available at the time the pilot completed the form. Based on the form's risk scoring criteria, the pilot's score of 12 for the accident flight was in the company's low-risk category (the maximum score for a flight to remain in the low-risk category was 45).

According to the owner of the air charter broker, before departing from SNA, the pilot told him that he planned to fly north to Dodger Stadium, around Burbank, and follow SR 118 to go "up and around" the weather. (This described route went generally east and north around downtown Los Angeles, Burbank, and Van Nuys.) During the time the pilot was on the ground at SNA, weather observations for VNY included visibility of 2.5 miles (reported at 0751 and 0851), which was less than what had been forecasted in the TAFs available at the time the pilot completed the flight risk analysis form and would have required an SVFR clearance to transit.

Although the DO stated that he expected pilots to complete a flight risk analysis form before a flight and any time there was a significant change in weather, this expectation was not contained in any company guidance, and the accident pilot did not complete a new form before departing from SNA. (See section 2.4.1 for further discussion about company oversight of the flight risk analysis forms.)

Per the flight risk analysis form, visibility below 3 miles (a nine-point risk item) would require the pilot to call the DO to discuss the weather, and en route SVFR (an eight-point risk item) would require the pilot to list an alternative plan for the flight. Thus, the NTSB concludes that, had the pilot completed an updated flight risk analysis form for the accident flight that considered the weather information available at the time the flight departed, the flight would have remained within the company's low-risk category but would have required the pilot to seek input from the DO and to provide an alternative plan. The role of a lack of an alternative plan in the pilot's decision-making process is discussed in section 2.3.

2.2.2 Flight's Entry into Instrument Meteorological Conditions

2.2.2.1 Regional Weather Conditions and Localized Phenomena

The pilot had flown the same passengers to the same destination the previous morning, having been able to fly a more direct route from SNA to CMA and at a higher altitude. However, on the day of the accident, an unusually thick marine layer was present across the region, such that clouds associated with it extended up to 2,400 to 2,500 ft msl. Further, near-surface relative humidity near the accident site was still 100% at 1000, whereas it usually decreased earlier. In the type of low-level weather environment that existed that day, the cloud bases may not have been distinct (that is, the locations of the bases were not easy to visually identify). Also, the altitudes of the cloud bases likely would have varied across the area.

As described previously, the flight's departure from SNA and its progress through the BUR and VNY airspace en route to CMA were uneventful. At 0942:45 (about 3 minutes before the accident), the helicopter reached US 101 and began to follow it west toward CMA at an altitude of about 1,400 ft msl (550 ft agl) and groundspeed of about 140 kts. As the helicopter proceeded west over US 101, it was captured in video from a City of Calabasas video camera (between 0944:16 and 0944:22).

According to an NWS forecaster and another local person (a private pilot), the area it was approaching at that time often had cloud ceilings and visibilities that were lower than the areas to the east when regional weather conditions like those that existed on the day of the accident were present. According to the NWS forecaster, relatively cool air would tend to sink and pool at night in a lower-elevation area in the mountains less than a mile northwest of the accident site, resulting in reduced visibility in that area. The local pilot said the fog that moved inland would stack up against the hills and accumulate along US 101 such that a pilot of a westbound flight could quickly lose visual contact with US 101 as the road descends down the hillside west of that location.

About the time that the helicopter began to enter this location (less than 2 minutes before the accident), it was observed by a witness who saw it flying below or at the cloud line before it disappeared into the clouds. Based on ADS-B data, the helicopter was at the location the witness described about 2 seconds before the pilot announced and initiated the helicopter's climb from 1,370 ft msl (450 ft agl), reaching about 2,370 ft msl (1,600 ft agl) before it began its rapid descent.

According to the NTSB visibility study, visibility beneath the clouds in the vicinity of the accident site was between 1 and 1.5 miles. Weather data, images from various cameras, and the witness report provided evidence that cloud bases were between 1,300 and 1,400 ft msl and possibly lower in some areas near the accident site. Due to the likely variations in the cloud bases at the lower level of the marine layer, it could not be determined at which points along the helicopter's flight path below about 2,000 ft msl the ceiling and restrictions to visibility from the cloud bases may have been optically thin or broken, such that the pilot could have maintained intermittent visual contact with the ground. However, the cloud layer would have been more optically thick from about 2,000 ft msl to the top of the marine layer.

Thus, the NTSB concludes that, at the time that the pilot took action to initiate a climb, the helicopter had already begun penetrating clouds, and the pilot lost visual reference to the horizon and the ground. The loss of outside visual reference was possibly intermittent at first but likely complete by the time the flight began to enter the left turn that diverged from its route over US 101.

2.2.2.2 Pilot's Inadequate Adverse Weather Avoidance

Although the regional weather conditions that the accident flight encountered were atypical for January, there was no evidence that any dynamic or rapidly deteriorating weather phenomena were present that would have prevented the pilot from discontinuing the flight or changing his planned route and maneuvering the helicopter to remain in VMC. According to FAA guidance, when approaching IMC, slowing the helicopter can reduce the closure rate between the helicopter and the adverse weather conditions (FAA 2019e, 11-25). This can allow a pilot more time to safely maneuver the helicopter to avoid the conditions.

A EuroSafety instructor who provided supplemental training to the accident pilot taught this procedure, and one company pilot said that airspeeds as low as 60 kts would be appropriate, depending on the weather conditions and the terrain, to allow time to maneuver. According to the POI who evaluated the accident pilot during checkrides, appropriate adverse-weather-avoidance maneuvers may include diverting, returning to base, or landing the helicopter.

The helicopter performance study determined that, while the flight was over US 101, the helicopter's groundspeed remained about 140 kts. The helicopter's flight path did not diverge from overflying US 101 until after the pilot had penetrated clouds and climbed into what was likely solid IMC. Although the pilot's adverse-weather-avoidance training emphasized avoiding entry into IMC by slowing the helicopter and maneuvering or landing, there was no evidence that he attempted to do so. Thus, the NTSB concludes that the pilot's poor decision to fly at an excessive airspeed for the weather conditions was inconsistent with his adverse-weather-avoidance training and reduced the time available for him to choose an alternative course of action to avoid entering IMC.

2.2.3 Pilot's Spatial Disorientation

As described previously, the pilot's 0944:34 announcement to the SCT controller that he was initiating a climb occurred about 2 seconds after the helicopter began penetrating clouds. According to the helicopter performance study, the helicopter immediately began climbing at a rate of about 1,500 fpm and began to bank to the left. The ADS-B data showed that, at first, the helicopter's flight path turned gradually left, generally continuing to follow US 101 below. However, as the helicopter continued to climb into the cloud layer and IMC, the pilot's associated loss of outside visual references would have required him to transition his focus to the helicopter's flight instruments for reference to maintain awareness of the helicopter's flight profile, including its pitch attitude, bank angle, and climb or descent rate.

FAA guidance notes that the need to use outside visual references is natural for helicopter pilots and that avoiding entering IMC during a VFR flight is critical for even instrument-rated pilots in IFR-equipped helicopters. The guidance considers a VFR flight's encounter with IMC, during which the pilot may be unprepared for the loss of visual reference, to be a life-threatening emergency (FAA 2019e, 11-24 and -25). This is because, following the loss of visual cues in flight, pilots are susceptible to experiencing vestibular illusions, which can lead to spatial disorientation and a loss of control of the aircraft.[55]

Vestibular illusions occur when the human vestibular system of the inner ear produces a false sense of helicopter attitude and trajectory. The vestibular system allows a person to have a

[55] One study of US Army helicopter operations found that sudden loss of visual cues preceded about 25% of helicopter accidents attributed to spatial disorientation (Braithwaite et al. 1998, 1031-7).

sense of balance and spatial orientation. However, the vestibular system cannot distinguish between accelerations and tilt. Additional sensory inputs, such as visual cues, are needed for a person to correctly perceive attitude, bank angle, and acceleration. In the absence of outside visual references, a pilot's misperception of any of these flight conditions can result in spatial disorientation. A pilot's consistent scan and correct interpretation of the flight instruments and belief in their representation while operating in IMC can enable the pilot to resist reacting to compelling vestibular illusions and prevent spatial disorientation.

The accident pilot was trained that, to recover from entry into IMC, he should first adjust the helicopter's pitch and power to establish a stabilized, positive rate of climb at an airspeed of about 75 to 80 kts, then transition to using the autopilot before communicating with ATC. FAA guidance stated, in part, the following:

> Once the helicopter is stabilized, the pilot should declare an emergency with [ATC]. It is imperative that the pilot commit to controlling the helicopter and remember to aviate, navigate, and finally communicate. Often communication is attempted first, as it is natural to look for help in stressful situations. This may distract the pilot from maintaining control of the helicopter. (FAA 2019e, 11-25)

As described previously, the helicopter was flying about 1,370 ft msl with a groundspeed of about 140 kts and was already penetrating clouds at the time that the pilot initiated the rapid, 1,500-fpm climb and spontaneously announced it to an ATC facility that was neither providing any services to the flight nor expecting any further contact with the pilot. The excessive airspeed and rapid climb rate the pilot used were inconsistent with his training for recovering from an entry into IMC. Also, the pilot did not declare an emergency, possibly because he did not want to confess to the controller that the flight was no longer in compliance with regulations for VFR flight and he did not expect to be in the clouds for very long. The pilot knew (based on the BUR controller's response to his previous request for a cloud tops report) that the cloud tops in the area were about 2,400 ft msl.

During the climb in IMC, the helicopter entered a steady left turn that was conducive for the pilot to experience a vestibular somatogyral illusion called the "leans," in which the pilot's vestibular system would lead him to incorrectly perceive that the helicopter was flying straight and level when, in reality, it was in a banked left turn.[56] In addition, the pilot's initiation of communication with the controller introduced a task load that continued for the remainder of the flight as the controller attempted to obtain the information necessary to identify the flight and accommodate the pilot's subsequent request for radar service. After the controller received the pilot's response to his query about the flight's location, at 0944:55 (about 21 seconds into the

[56] When an aircraft enters a turn, the pilot's vestibular system will usually detect the initial rolling and turning movement. However, once the aircraft is stabilized in a steady rate of turn and angle of bank (usually around 30 seconds), the vestibular system will "catch up" with the aircraft, and the pilot will sense that the aircraft is straight and level when it is not (SKYbrary 2020 and FAA 2003, 4).

climb), the controller asked the pilot to "ident," which the pilot acknowledged.[57] Based on ATC radar data, the pilot pushed the IDENT button about 2 seconds after the controller asked that he do so.[58]

The pilot's tasks associated with communicating with the controller and pushing the IDENT button introduced distractions from his primary task of monitoring the flight instruments while the helicopter was climbing in IMC. Such interruptions in the pilot's instrument scan, as well as the introduction of head movements, would make him more vulnerable to misleading vestibular cues that could adversely affect his ability to effectively interpret the instruments and maintain control of the helicopter. These vestibular cues presented themselves as the helicopter banked and accelerated.

At 0945:10 (about 36 seconds into the left-banked, rapid climb and about 13 seconds after the pilot pushed the IDENT button), the helicopter began to bank more steeply to the left, and it entered a tighter left turn that diverged away from US 101. The helicopter's entry into the more steeply banked left turn would exacerbate aspects of the leans illusion and the pilot's incorrect perception of the helicopter's bank. Further, as the helicopter began to also rapidly descend while in the steep left bank, it began to accelerate. This acceleration was conducive for the pilot to experience a vestibular somatogravic illusion, in which he would incorrectly perceive that the helicopter was climbing when, in reality, it was descending.[59]

The accident pilot's lack of awareness of the helicopter's actual flight profile was evident when, about 2 seconds into the helicopter's rapid descent, he advised the controller that it was climbing. Based on the pilot's declared intent to climb the helicopter above the cloud layer and his expectation that the top of the layer was about 2,400 ft msl, the pilot's attention may have been focused on looking out the windscreen in anticipation of soon reacquiring outside visual reference once the helicopter emerged through the top of the cloud layer.

As the helicopter continued in its steep descent, the pilot either was not referencing the helicopter's instruments or was having difficulty interpreting or believing them due to the compelling vestibular illusions, and he did not successfully recover the helicopter. Thus, the NTSB concludes that the pilot experienced spatial disorientation while climbing the helicopter in IMC, which led to his loss of helicopter control and the resulting collision with terrain.

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[57] Although the pilot did not declare an emergency, the controller's actions to identify and provide service to the accident flight were nearly identical to the initial actions specified for responding to an emergency. ATC procedures for responding to a pilot-declared emergency specify, in part, that the controller obtain the minimum information required to provide assistance, including the aircraft identification and type, nature of the emergency, and the pilot's desires (FAA 2019b, 10-2-1). These minimum information criteria are nearly identical to the information the controller requested from the accident pilot.

[58] Even though the pilot was familiar with the flight deck layout, to perform the task of pushing the IDENT button, he needed to direct his gaze, likely accompanied by head movement, to the center panel where the button was located. He also needed to remove his left hand from the helicopter's collective control to reach toward the center panel to push the IDENT button while his right hand remained on the cyclic control.

[59] When an aircraft accelerates, the pilot's vestibular system will detect the linear acceleration and lead to the incorrect perception that aircraft is climbing when it is not. Also, the forces the pilot experiences when the aircraft is in a turn can also give the illusion that the aircraft is climbing (SKYbrary 2020).

2.3 Influences on Pilot's Decision to Continue Flight into Adverse Weather

As discussed in section 2.1, there was no evidence to suggest that Island Express, the air charter broker, or the client placed any pressure on the accident pilot to accept the charter flight request or complete the flight in adverse weather. However, a number of factors were present that may have influenced the pilot to place pressure on himself (self-induced pressure) to complete the flight. For example, the accident pilot was the client's preferred pilot, whom the client trusted to fly his children. Also, the air charter broker used Island Express exclusively for the accident client's local helicopter transport needs because Island Express was the only operator that met the air charter broker's standards for the client, and the client reportedly appreciated the relationship between the two companies. The accident pilot likely took pride in these positions of trust both with the client directly and within Island Express. Further, the pilot's relationship with the client was friendly, and he likely did not want to disappoint the client by not completing the flight.

In addition, before the accident flight departed, the pilot had discussed with the air charter broker's owner his plan to fly the route around BUR and VNY before joining US 101 to fly west to CMA. However, as described in section 2.2.1, the pilot did not complete an updated flight risk analysis form, which would have required him to list an alternative plan based on the weather information available at the time of departure. Devising an alternative plan before departure would have aided the accident pilot's decision-making in flight concerning whether to continue the flight as originally planned or divert and land at an alternate destination.

The pilot's continuation of the accident flight into IMC was inconsistent with his typical judgment and decision-making behavior observed by the DO, safety officer, and company pilots interviewed.[60] However, the pilot may have experienced plan continuation bias, which is an unconscious cognitive bias to continue with the original plan despite changing conditions (Woods 2020, 10). At the time that the flight began entering IMC, it was only about 25 miles from CMA (the destination), which had been reporting weather conditions above the basic VFR minimums since before the accident flight departed. With plan continuation bias, the closer the pilot gets to the destination, the stronger the bias becomes (Woods 2020, 10). Plan continuation bias (also often referred to as "get-there-itis" or plan continuation error) is known to negatively affect aeronautical decision-making, and it is addressed in various FAA guidance, training, and testing materials for pilots.

Thus, the NTSB concludes that the pilot's decision to continue the flight into deteriorating weather conditions was likely influenced by his self-induced pressure to fulfill the client's travel needs, his lack of an alternative plan, and his plan continuation bias, which strengthened as the flight neared the destination.

[60] The one company pilot who said he heard negative "stories" about the accident pilot's decision-making did not personally witness any risk-taking behavior.

2.4 Incomplete Implementation of Safety Management System

2.4.1 Company Oversight of Flight Risk Analysis Forms

Island Express had an SMS that was neither required by the FAA nor part of the company's FAA-approved or -accepted programs. As such, the SMS did not receive (and was not required to receive) any FAA oversight. Although the provisions in the *SMS Manual* stated that the DO was the accountable executive who reported to the company president, there was no evidence that the president was actively involved with the SMS or mandated any company compliance with it. The company used some SMS risk management tools but did not implement the entire SMS as outlined in its *SMS Manual*.

One SMS tool that company pilots used was the flight risk analysis form. The flight risk analysis forms were intended to document the risks associated with each flight, provide specific mitigations for certain risk items, and ensure that company management evaluated any planned flight that met the elevated- or high-risk criteria. Although the DO said he expected pilots to complete a flight risk assessment form before a flight and any time there was a "significant change," the company provided no documented policy or procedure regarding expectations such as how far in advance of a flight pilots could complete the form, how many flights could be reflected on one form, or what criteria would require completion of a new form.

The DO monitored the flight risk analysis form for necessary updates (the most recent revision to risk criteria and scoring items occurred in November 2019) and followed up with pilots who forgot to submit forms for their flights. However, there was no evidence that the company performed any internal evaluations or proactive hazard analysis using the information from completed forms, as outlined in the *SMS Manual*. Although the company was not required to comply with the manual, such evaluations could help determine the effectiveness of the forms, including whether the pilots were completing the forms correctly (such as accurately reflecting weather risk items) and whether additional company policy changes, training, or corrective action were needed.

As discussed in section 2.2.1, the accident pilot submitted only one flight risk assessment form, which he completed about 2 hours before the accident flight, even though he discussed weather information with the air charter broker owner within 30 minutes before departure. In the absence of documented company policy, it is unclear if the updated weather information available to the pilot before departure would have met the DO's expectations for submitting a new flight risk assessment form. However, as discussed previously, if the accident pilot had completed a new form that reflected the available updated weather information, the weather conditions would have required the accident pilot to discuss the flight with the DO and list an alternative plan.

The DO said he reviewed the weather the morning of the accident, determined that the flight could be completed, and did not discuss this with the accident pilot because he had confidence in the pilot's ability to make safe weather-related decisions. Based on this statement, it is unlikely that the DO would have canceled the flight had the accident pilot called him. However, the accident pilot may have benefitted from discussing his plans for the flight with the DO, and the development of an alternative plan for the flight might have helped the pilot decide to divert rather than continue the flight into IMC. Thus, the NTSB concludes that Island Express' lack of a documented policy and safety assurance evaluations to ensure that its pilots were consistently and correctly completing the flight risk analysis forms hindered the effectiveness of the form as a risk management tool.

2.4.2 Benefits of a Mandatory Safety Management System

The SMS internal evaluation and proactive hazard analysis functions associated with the flight risk analysis form were just a few of several provisions outlined in Island Express' *SMS Manual* that the company did not use and was not required to use because its SMS was not required by the FAA. The NTSB has long advocated that the FAA require SMS for various Part 135 operations, having issued our first associated recommendation (Safety Recommendation A-09-89, which applied to helicopter air ambulance operations) in 2009.[61] Although the FAA published a final rule in 2014 that required helicopter air ambulance operators to implement tools and procedures that the FAA believed contained elements of an effective SMS, the rule did not require the complete SMS that we recommended.[62] In our September 11, 2014, response to the FAA, we noted that "elements of an SMS…are not an acceptable substitute for the complete program," and we classified Safety Recommendation A-09-89 "Closed—Unacceptable Action."

On November 3, 2016, we issued Safety Recommendation A-16-36 to the FAA to require all Part 135 operators to implement an SMS.[63] Due to our ongoing interest in this area and the importance of this recommendation, we included it in the NTSB's 2019-2020 Most Wanted List of Transportation Safety Improvements for the issue area, "Improve the Safety of Part 135 Aircraft Flight Operations."

In the FAA's January 9, 2017, response, it stated that it had a formal SMS Voluntary Program in which Part 135 operators could participate. The FAA's SMS Voluntary Program included provisions by which a Part 135 operator could apply for FAA recognition of its SMS and receive FAA assistance with implementing and validating it. An SMS developed within the FAA's SMS Voluntary Program would also be subject to ongoing FAA oversight and compliance monitoring to ensure conformance with safety policy, safety risk management, safety assurance, and safety promotion functions, which operators were expected to fully implement (FAA 2019d, 17-3-1-1 through -13). The FAA also said it would conduct a review and hold meetings to determine whether further action was needed, such as whether the recently implemented final rule that required 14 *CFR* Part 121 operators to implement an SMS should be expanded to also cover Part 135 operators.

For 3 years, we received no further response from the FAA, but on April 13, 2020, the FAA informed us that it was still evaluating the feasibility of rulemaking to take the recommended actions. The FAA said that, in light of the delays experienced by this and several other rulemaking projects addressing NTSB recommendations, as well as the impact of Executive Orders 13771 and

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[61] Safety Recommendation A-09-89, issued September 24, 2009, recommended that the FAA require SMS for helicopter air ambulance operations. See appendix C for more information.

[62] The final rule, "Helicopter Air Ambulance, Commercial Helicopter, and Part 91 Helicopter Operations," was published on February 21, 2014.

[63] See appendix C for more information.

13777 (requiring the removal of two regulations for every new regulation implemented), it was considering potential alternate courses of action to address Safety Recommendation A-16-36.

In the 4 years since the FAA's initial response, we have reiterated this recommendation four times based on our findings from investigations of other fatal accidents involving Part 135 operators that did not have a fully implemented SMS subject to FAA oversight (NTSB 2017b, 2018, 2019, and 2020a). As a result of the FAA's lack of responsive action, we classified Safety Recommendation A-16-36, "Open—Unacceptable Response."

On October 27, 2020, the FAA administrator said during a speech at the FAA's Rotorcraft Safety Conference that the FAA was hoping to publish a proposed SMS rule in 2022 that will apply to "air taxis," "air tour operators," and others (FAA 2020). We are also aware that the Office of Management and Budget's Fall 2020 Unified Agenda of Regulatory and Deregulatory Actions (published December 9, 2020) listed the FAA's "Safety Management System (SMS) for Parts 21, 91, 135, and 145," as a "long-term action" item (OMB 2020).[64]

We note that, although the FAA has promoted Part 135 operators' participation in its SMS Voluntary Program in advance of any potential rulemaking, the participation level has been low. A review of FAA data showed that, currently, of 1,940 certificate holders authorized to conduct Part 135 operations, only 17 have an FAA-accepted SMS and 158 others, whose SMSs are in various stages of development, have applied for FAA acceptance. Thus, although we are encouraged by the FAA's reported intent for rulemaking, until the FAA requires SMS for Part 135 operators, Safety Recommendation A-16-36 remains classified "Open—Unacceptable Response."

As the circumstances of this accident show, Island Express had the SMS tools and guidance available that outlined the safety assurance functions that could have helped the company ensure the effectiveness of its flight risk analysis forms. Had the SMS been required by the FAA, it would have been subject to FAA oversight to inspect the SMS for alignment with FAA objectives and to provide feedback to help the company implement its program. Thus, the NTSB concludes that a fully implemented, mandatory SMS could enhance Island Express' ability to manage risks. Therefore, the NTSB reiterates Safety Recommendation A-16-36. Additionally, the NTSB believes that Island Express should not wait for the FAA to take action on requiring SMS for Part 135 operators before fully implementing its SMS. Therefore, the NTSB recommends that Island Express participate in the FAA's SMS Voluntary Program.

2.5 Benefits of Simulation Devices for Pilot Training

According to FAA guidance, an actual encounter with IMC during a VFR flight, which may occur gradually or suddenly, has no simple procedural exit and generally is not realistically duplicated during flight training conducted in helicopters in VMC (FAA 2019e, 11-24). Fatal accident scenarios illustrate that the transition to using the helicopter's instruments to maintain awareness of the helicopter's flight profile following a loss of outside visual references can be difficult for even instrument-rated pilots in helicopters equipped for IFR flight. Thus, training that

[64] A long-term action is an item that an agency has under development but does not expect to have a regulatory action within 12 months. The Unified Agenda of Regulatory and Deregulatory Actions lists long-term actions separately from active rulemakings, which are in either the prerule, proposed rule, or final rule stage (RISC 2020, 8-9).

emphasizes IMC avoidance and provides pilots with the decision-making and skills preparation to effectively avoid IMC is critical.

All of Island Express' pilot training was conducted in company helicopters. According to the EuroSafety instructor and the POI (who evaluated pilots during 14 *CFR* 135.293 initial and recurrent tests and competency checks), pilots were expected to wear a view-limiting device (to simulate entry into IMC) while performing the procedures to recover from IIMC and to recover the helicopter from unusual attitudes in IMC. Island Express' pilot training did not include, and was not required to include, the use of a simulation device.

On April 27, 2020, the United States Helicopter Safety Team (USHST), a voluntary team of government and industry stakeholders formed to improve the safety of civil helicopter operations, issued recommended practices to suggest scenario-based training intended to improve pilot decision-making as it relates to avoiding unintended flight into IMC, among other situations. The recommended practices, which were based on the USHST's review of the circumstances of fatal accidents, encouraged the greater use of simulation at all levels of fidelity, including aviation training devices, flight training devices, and full flight simulators, during both initial and recurrent helicopter training (USHST 2020, 2). Also, industry developments in simulation technology continue to advance, developing beyond the research stage such options as augmented reality helmets; the helmets provide visual simulations of changing weather conditions to enable the pilot to practice weather decision-making and avoidance procedures during training flights in an actual aircraft.

The NTSB has long recognized the value of cue-based and scenario-based pilot training content to help reduce the risk of accidents involving continuation of flight under VFR into adverse weather. Between 2007 and 2018, we issued numerous safety recommendations to the FAA, based on our investigations, to require such pilot training for certain commercial air tour and Part 135 operations in Hawaii and Alaska, helicopter air ambulance operations, and law enforcement search and rescue missions.[65] The use of appropriate simulation devices during such training can present pilots with representations of deteriorating weather conditions that cannot be realistically duplicated during flight training conducted in helicopters in VMC. This can provide opportunities for pilots to safely practice the decision-making, skills, and procedures needed to recognize and respond to changing weather conditions in flight, identify and apply mitigation strategies for avoiding adverse weather, practice the transition to the use of flight instruments to reduce the risk of spatial disorientation, and maintain awareness of a variety of influences that can adversely affect pilot decision-making.

The USHST noted that aviation training devices are popular and affordable for many pilot schools (operated in accordance with 14 *CFR* Part 61 or 141) and that training centers (operated in accordance with 14 *CFR* Part 142) are more likely to use flight training devices and full flight simulators (USHST 2020, 2). Thus, the NTSB concludes that the use of appropriate simulation devices in scenario-based helicopter pilot training has the potential to improve pilots' abilities to accurately assess weather and make appropriate weather-related decisions. Therefore, the NTSB recommends that the FAA require the use of appropriate simulation devices during initial and recurrent pilot training for Part 135 helicopter operations to provide scenario-based training that

[65] See appendix C.

addresses the decision-making, skills, and procedures needed to recognize and respond to changing weather conditions in flight, identify and apply mitigation strategies for avoiding adverse weather, practice the transition to the use of flight instruments to reduce the risk of spatial disorientation, and maintain awareness of a variety of influences that can adversely affect pilot decision-making.

In addition to adverse weather avoidance, another important facet of preventing spatial disorientation-related accidents involves training pilots to successfully maneuver the helicopter while referencing only the flight instruments following a VFR flight's encounter with IMC. This includes training pilots to reference the instruments and recover the helicopter from unusual attitudes, which can occur when a pilot becomes spatially disoriented. For civilian pilots, these skills are taught and evaluated (per 14 *CFR* 135.293 initial and recurrent pilot testing requirements) primarily in an actual helicopter while the pilot wears a view-limiting device.

Training performed in an actual helicopter while wearing a view-limiting device enables the pilot to experience the vestibular sensations associated with actual accelerations, banking, and other maneuvers during flight. This type of flight training is beneficial because it allows pilots to experience the adverse effects of vestibular and visual illusions, which can help them develop the skills needed to detect the onset of spatial disorientation and apply flight control corrections and other response mitigations. However, for obvious safety reasons, this type of training is limited in the extent to which it can realistically demonstrate spatial disorientation scenarios. As the circumstances of this accident shows, the unintended flight profiles that can result from spatial disorientation can not only develop rapidly but can also include unusually rapid climbs, steep descents, and other inflight upsets (such as extreme pitch, bank, or airspeeds) that cannot safely be demonstrated in an actual helicopter.

To improve the effectiveness of spatial disorientation recognition and recovery training for helicopter pilots, the USHST has established goals for promoting the wider use of spatial disorientation simulation technology, among other initiatives (USHST 2019, 1). One type of simulation technology that can enable pilots to experience both visual and vestibular illusions in a safe, ground-based environment is the spatial disorientation demonstrator (FAA 2003, 10). Research has shown that pilots who were presented with sensory illusions in a spatial disorientation demonstrator experienced significant performance degradation (Boril et al. 2020, 767-75). According to the FAA, this type of simulation technology (which enables pilots to experience sensory illusions) can help prepare pilots for recognizing the onset of spatial disorientation and applying the appropriate response mitigations (FAA 2011). However, the use of such devices to supplement pilot flight training is not required, and only a limited number of devices—which vary in design, capabilities, and cost—are available for civilian pilot use.[66]

The NTSB notes that the increased use of spatial disorientation simulation technology to supplement pilot training shows potential for helping pilots develop skills to detect and recover from vestibular illusions that could lead to spatial disorientation. Such skills are important for pilots of all types of aircraft because spatial disorientation accidents are not limited to only

[66] According to the USHST, although commercially available devices exist, they are too limited in number to enable widespread use by a large segment of the pilot population (USHST 2019, 2). The FAA has two spatial disorientation demonstrators (each of a different design) available for civilian pilot use (FAA 2003 and 2011).

helicopter operations, and most accidents that involve spatial disorientation are fatal.[67] However, we recognize that any such technology, if intended for widespread incorporation into civilian pilot training curricula, must consider and address a variety of challenges to ensure positive training outcomes; these challenges include providing sufficient simulator fidelity with respect to aircraft motion, visual depictions of VMC into IMC scenarios, and emulation of vestibular illusions, among other considerations.

Thus, the NTSB concludes that objective research to evaluate spatial disorientation simulation technologies may help determine which applications are most effective for training pilots to recognize the onset of spatial disorientation and successfully mitigate it. Further, making the results of this research broadly available to the civil aviation operator community would increase the likelihood that operators would invest in the use of the technologies most beneficial in preventing spatial disorientation as part of their pilot training programs. Therefore, the NTSB recommends that the FAA convene a multidisciplinary panel of aircraft performance, human factors, and aircraft operations specialists to evaluate spatial disorientation simulation technologies to determine which applications are most effective for training pilots to recognize the onset of spatial disorientation and successfully mitigate it, and make public a report on the committee's findings.

2.6 Benefits of Flight Data Monitoring Program

Island Express did not have and was not required to have an FDM program, which involves the recording and analysis of flight-related information to help pilots, instructors, and operators improve performance and safety. An FDM program, which can be integrated into an SMS, has the potential to provide important information regarding pilot performance during flights, which may be particularly beneficial for operators like Island Express that conduct single-pilot operations and, thus, have little opportunity to directly observe their pilots in the operational environment.

FDM programs typically involve the use of an onboard device that is capable of recording various flight parameters or video installed on each aircraft in an operator's fleet. Periodic review of the recorded data enables an operator to identify deviations from company procedures, established norms, and other potential safety issues. For example, data reviews from company flights may help a company identify deviations, gather information to better understand the context of those deviations, and take proactive measures to implement mitigations and corrective action before an accident occurs.

The NTSB has long recognized the value of an FDM program, starting with Safety Recommendation A-09-90, issued in 2009, which recommended that the FAA require helicopter air ambulance operators to establish a structured FDM program and install recording devices capable of supporting it. The FAA's February 21, 2014, final rule, "Helicopter Air Ambulance, Commercial Helicopter, and Part 91 Helicopter Operations," required helicopter air ambulance

[67] A review of NTSB aircraft accident investigation data revealed that, during 2010 through 2019, we investigated 198 aircraft accidents—184 of which were fatal—in which spatial disorientation played a role or was cited in the investigative findings. Helicopters were involved in 24 of these accidents, 20 of which were fatal. (Note: These totals include only accidents that occurred in the United States and for which the investigations were completed as of January 14, 2021.)

operators to equip their fleet with recording devices but did not require them to establish an FDM program. In our September 11, 2014, letter to the FAA, we noted that a mandate for FDM programs was needed to identify deviations from established norms and procedures and to identify other potential safety issues, and we asked the FAA to provide details of its plans for addressing this part of the recommendation.

In its November 1, 2017, response, the FAA expressed concerns that, because the protections of Part 193, "Protection of Voluntarily Submitted Information," are available only if the data are collected by operators as part of a *voluntary* FAA-approved program, it did not intend to mandate the programs. In our response to the FAA, we emphasized that the intent of our recommendation was for operators to establish internal FDM programs, which would not share collected data with the FAA, and, thus, the data would not need protections. However, based on the FAA's response that it would not mandate FDM programs as we recommended, we classified Safety Recommendation A-09-90 "Closed—Unacceptable Action."[68]

On November 3, 2016, we issued Safety Recommendation A-16-34, which recommended that the FAA require all Part 135 operators to install flight data recording devices capable of supporting an FDM program (NTSB 2016). On the same date, we issued Safety Recommendation A-16-35, which recommended that the FAA, after the action in Safety Recommendation A-16-34 is completed, 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.[69] Due to our ongoing interest in this area and the importance of these recommendations, we included them in the NTSB's 2019-2020 Most Wanted List of Transportation Safety Improvements for the issue area, "Improve the Safety of Part 135 Aircraft Flight Operations."

In response to Safety Recommendation A-16-34, on January 9, 2017, the FAA said it would conduct a review to determine the feasibility of requiring all Part 135 certificate holders to install FDM recording devices on their aircraft. The FAA noted that it had conducted a similar review when considering the development of the helicopter air ambulance final rule and determined that a requirement for such devices did not meet the cost-benefit requirements for safety. However, Congress mandated the equipment requirement in Section 306(a) of the FAA Modernization and Reform Act of 2012, which stated that revised regulations should apply only to Part 135 certificate holders providing air ambulance services. As a result of the Congressional mandate, the February 21, 2014, helicopter air ambulance final rule contained the mandate for the FDM equipment on helicopter air ambulances. Regarding the FAA's new review for Safety

[68] In our January 25, 2018, reply to the FAA, we noted that Safety Recommendation A-09-90 did not intend for the FAA to require helicopter air ambulance operators to establish a safety program that shares data with the FAA and for which the Part 193 protections do not apply (such as the flight operations quality assurance program for Part 121 operators, which share de-identified aggregate information with the FAA). The intent of the recommendation was for helicopter air ambulance operators to establish an internal program by which they analyze their recorded FDM data and monitor trends within their operations. We informed the FAA that, because the collected data would not need to be shared with the FAA, we did not see the need for protecting it. We classified Safety Recommendation A-09-90 "Closed—Unacceptable Action" on January 25, 2018. See appendix C for more information.

[69] See appendix C for more information.

Recommendation A-16-34, the FAA noted that a key focus would be to determine the feasibility of achieving a favorable cost-benefit ratio.

On April 6, 2017, we replied that we reviewed the regulatory evaluation of the February 21, 2014, final rule. We noted that the regulatory evaluation showed costs of approximately $20.4 million over a 10-year period and that we were surprised to see that the benefits amounted to $0. We issued Safety Recommendation A-16-34 because an FDM program, which requires that aircraft be equipped with appropriate recording systems, offers a great opportunity for operators to improve the safety of their operations and avoid accidents.

A review of NTSB major aviation accident investigations involving Part 135 on-demand operators during the period of 2000 through 2015 found seven accident investigations with findings related to pilot performance. In these seven accidents, 53 people were fatally injured and another 4 were seriously injured. The NTSB believes that an effective FDM program can help an operator identify issues with pilot performance and, through an SMS, lead to mitigations that will prevent future accidents. As a result, the NTSB does not believe it is appropriate to indicate that there are no quantifiable benefits from a mandate for FDM equipment and programs.

In response to Safety Recommendation A-16-35, on January 9, 2017, the FAA replied that it previously considered mandating FDM programs as a part of the development of the February 21, 2014, helicopter air ambulance final rule and determined that its voluntary programs were successful for monitoring and evaluating operational practices and procedures. The FAA also said it believed that maintaining a voluntary nature was paramount to the success of FDM programs and that it planned to review the level of participation of Part 135 certificate holders in the FAA's voluntary FDM programs.

In the 4 years since we issued these recommendations, we have reiterated Safety Recommendation A-16-34 twice based on the findings from our investigations of other fatal accidents involving Part 135 operators that did not install flight data recording devices capable of supporting an FDM program (NTSB 2018 and 2019). Although the FAA administrator spoke favorably of FDM during his October 27, 2020, speech at the FAA's Rotorcraft Safety Conference and encouraged operators to adopt and use it (FAA 2020), we have not received any further information regarding the FAA's findings of its evaluations and reviews or any planned actions to address the recommendations. Currently, Safety Recommendation A-16-34 is classified "Open—Acceptable Response," and Safety Recommendation A-16-35 is classified "Open—Unacceptable Response."[70]

Thus, the NTSB concludes that an FDM program, which can enable an operator to identify and mitigate factors that may influence deviations from established norms and procedures, can be particularly beneficial for operators like Island Express that conduct single-pilot operations and have little opportunity to directly observe their pilots in the operational environment. Therefore, the NTSB reiterates Safety Recommendations A-16-34 and -35. Also, because of the lack of progress in the last 4 years in satisfying Safety Recommendation A-16-34, we are classifying it "Open—Unacceptable Response."

[70] See appendix C for more information.

Additionally, the NTSB believes that Island Express should not wait for the FAA to take action to require an FDM program. Therefore, the NTSB recommends that Island Express install flight data recording devices capable of supporting an FDM program on each helicopter in its fleet and establish an FDM program that reviews all available data sources to identify deviations from established norms and procedures as well as other potential safety issues.

2.7 Crash-Resistant Flight Recorder Systems

Certain circumstances of this accident could not be conclusively determined, including the visual cues associated with the adverse weather and the pilot's focus of attention in the cockpit following the flight's penetration of clouds and entry into IMC. A crash-resistant flight recorder system capable of capturing audio and images could have provided this valuable information, possibly enabling the identification of additional safety issues and the development of safety recommendations to prevent similar accidents in the future.

The NTSB has previously issued recommendations to require recorders on helicopters, such as on the Sikorsky S-76B helicopter involved in this accident. The first of these helicopter-specific recommendations resulted from our participation in the 2005 foreign-led investigation of a fatal accident involving a Sikorsky S-76C+ helicopter, registered in Finland, that experienced an upset and crashed into the Baltic Sea due to an airworthiness problem.[71] This was the first time that we participated in an accident investigation involving a helicopter that was equipped with a flight data recorder (FDR), which was required equipment per Finland's regulations. Importantly, without the FDR data, the investigation would not have been able to identify and address the airworthiness issue that caused the accident.

As a result, we not only issued three urgent NTSB safety recommendations to address the airworthiness issue, but we also issued Safety Recommendations A-06-17 and -18 to the FAA to address recorders for helicopters in the United States. These recommendations asked the FAA to require all rotorcraft operating under Parts 91 and 135 with a transport-category certification (such as the Sikorsky S-76-series helicopter) to be equipped with a cockpit voice recorder (CVR) and an FDR, and to not permit exemptions or exceptions to the flight recorder regulations that allow such rotorcraft to operate without recorders (NTSB 2006). As a result of the FAA's decision not to take these actions, we classified both A-06-17 and -18 "Closed—Unacceptable Action" on September 11, 2014.

On May 6, 2013, the NTSB issued Safety Recommendation A-13-13 to recommend that the FAA require a crash-resistant flight recorder system compliant with Technical Standard Order (TSO) C197, "Information Collection and Monitoring Systems," as a retrofit on existing turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with an FDR or CVR and are operating under Parts 91, 121, or 135.[72] The crash-resistant flight recorder

[71] The accident, which killed both pilots and all 12 passengers, occurred on August 10, 2005, and involved a Sikorsky S-76C+ helicopter that departed Tallinn, Estonia, en route to Helsinki, Finland.

[72] The types of CVRs and FDRs that are required by regulation to be installed on certain aircraft are designed to stringent crash-survivability standards. Crash-resistant flight recorders, which are designed to a less stringent survivability standard, are generally less expensive, lighter weight, and able to record much of the same information as CVRs and FDRs, as well as cockpit images.

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 (NTSB 2013).[73]

In the 7 years since we issued Safety Recommendation A-13-13, we have reiterated it five times based on our findings from investigations of other fatal accidents (NTSB 2014, 2017a, 2017b, 2018, and 2020a). We have been issuing similar recommendations since 2000 (NTSB 2000).[74] During this 20-year period, the FAA has replied that it does not disagree with these recommendations but that it is unable to create a cost-benefit analysis for such a mandate that would satisfy the requirements of the Office of Management and Budget for new federal regulations. The FAA has not been able to identify quantifiable benefits associated with a mandate for recorders. During 2017, staff from the FAA and the NTSB met to discuss what information from the NTSB would help the FAA develop the needed cost-benefit analysis to justify the recommended mandate.

On July 19, 2017, NTSB staff provided the FAA a list of all accidents in our database from 2005 through 2017 that involved turbine powered, nonexperimental, nonrestricted-category aircraft and in which flight crew were killed. There were 185 such accidents. For 159 of these, the accident aircraft had no form of recording equipment and involved advanced aircraft with complex systems that are more difficult to investigate due to the lack of information. Of the 159 accidents, the probable cause for 18 contained "unknown" (for example, if the aircraft crashed after takeoff for unknown reasons). On October 2, 2017, we noted that, although doing the cost-benefit analysis needed to issue the recommended mandate would be challenging, the FAA now appeared to be examining how to accomplish it. Pending the FAA taking the recommended action, Safety Recommendation A-13-13 was classified "Open—Acceptable Response."

In addition, on June 2, 2020, the NTSB issued Safety Recommendation A-20-29 to six helicopter manufacturers (including Sikorsky) to recommend that they provide, on existing turbine-powered helicopters that are not equipped with an FDR or CVR, a means to install a crash-resistant flight recorder system that records 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 TSO C197. The recorder system installation should be considered essential equipment that remains installed for the life of the helicopter and have provisions to ensure it remains operational during each flight (NTSB 2020b).[75]

Thus, the NTSB concludes that a crash-resistant flight recorder system that records parametric data and cockpit audio and images with a view of the cockpit environment to include

[73] We also issued Safety Recommendation A-13-12, which applied to newly manufactured helicopters; see appendix C for more information. The accident helicopter, as operated by Island Express (per its OpsSpecs) for VFR flights, was not required to be equipped with a CVR because only one pilot was required. (Per 14 *CFR* 135.151[a], a CVR was required for multiengine, turbine-powered airplanes and rotorcraft having a seating configuration of six or more and for which two pilots were required by certification or operating rules.)

[74] See appendix C for more information.

[75] Safety Recommendation A-20-29 is classified "Open—Acceptable Response" overall (with the recipient classification for Sikorsky "Open—Await Response"); see appendix C for more information. On October 5, 2020, the General Aviation Manufacturers Association sent us a letter stating that, although it (on behalf of the rotorcraft community) supported the objective of our safety recommendation, it found it to be prohibitively prescriptive.

as much of the outside view as possible could have provided valuable information about the visual cues associated with the adverse weather and the pilot's focus of attention in the cockpit following the flight's entry into IMC. Therefore, the NTSB reiterates Safety Recommendations A-13-13 and A-20-29.

Also, on September 29, 2020, the FAA provided us with an update stating that it submitted a rulemaking project for fiscal year 2020 to review various standards and methodologies to determine the feasibility of requiring aircraft operated under Parts 91, 121, and 135 to be equipped with a crash-resistant flight recorder system. However, we note that fiscal year 2020 has ended, and the action has not been taken. Therefore, we are classifying Safety Recommendation A-13-13 "Open—Unacceptable Response."

3. Conclusions

3.1 Findings

1. None of the following safety issues were identified for the accident flight: (1) pilot qualification deficiencies or impairment due to medical condition, alcohol, other drugs, or fatigue; (2) helicopter malfunction or failure; or (3) pressure on the pilot from Island Express Helicopters Inc., the air charter broker, or the client to complete the flight.

2. Although the air traffic controller's failure to report the loss of radar contact and radio communication with the accident flight was inconsistent with air traffic control procedures, this deficiency did not contribute to the accident or affect its survivability.

3. Had the pilot completed an updated flight risk analysis form for the accident flight that considered the weather information available at the time the flight departed, the flight would have remained within the company's low-risk category but would have required the pilot to seek input from the director of operations and to provide an alternative plan.

4. At the time that the pilot took action to initiate a climb, the helicopter had already begun penetrating clouds, and the pilot lost visual reference to the horizon and the ground. The loss of outside visual reference was possibly intermittent at first but likely complete by the time the flight began to enter the left turn that diverged from its route over US Route 101.

5. The pilot's poor decision to fly at an excessive airspeed for the weather conditions was inconsistent with his adverse-weather-avoidance training and reduced the time available for him to choose an alternative course of action to avoid entering instrument meteorological conditions.

6. The pilot experienced spatial disorientation while climbing the helicopter in instrument meteorological conditions, which led to his loss of helicopter control and the resulting collision with terrain.

7. The pilot's decision to continue the flight into deteriorating weather conditions was likely influenced by his self-induced pressure to fulfill the client's travel needs, his lack of an alternative plan, and his plan continuation bias, which strengthened as the flight neared the destination.

8. Island Express Helicopters Inc.'s lack of a documented policy and safety assurance evaluations to ensure that its pilots were consistently and correctly completing the flight risk analysis forms hindered the effectiveness of the form as a risk management tool.

9. A fully implemented, mandatory safety management system could enhance Island Express Helicopters Inc.'s ability to manage risks.

10. The use of appropriate simulation devices in scenario-based helicopter pilot training has the potential to improve pilots' abilities to accurately assess weather and make appropriate weather-related decisions.

11. Objective research to evaluate spatial disorientation simulation technologies may help determine which applications are most effective for training pilots to recognize the onset of spatial disorientation and successfully mitigate it.

12. A flight data monitoring program, which can enable an operator to identify and mitigate factors that may influence deviations from established norms and procedures, can be particularly beneficial for operators like Island Express Helicopters Inc. that conduct single-pilot operations and have little opportunity to directly observe their pilots in the operational environment.

13. A crash-resistant flight recorder system that records parametric data and cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible could have provided valuable information about the visual cues associated with the adverse weather and the pilot's focus of attention in the cockpit following the flight's entry into instrument meteorological conditions.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the pilot's decision to continue flight under visual flight rules into instrument meteorological conditions, which resulted in the pilot's spatial disorientation and loss of control. Contributing to the accident was the pilot's likely self-induced pressure and the pilot's plan continuation bias, which adversely affected his decision-making, and Island Express Helicopters Inc.'s inadequate review and oversight of its safety management processes.

4. Safety Recommendations

4.1 New Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following new safety recommendations.

To the Federal Aviation Administration:

Require the use of appropriate simulation devices during initial and recurrent pilot training for Title 14 *Code of Federal Regulations* Part 135 helicopter operations to provide scenario-based training that addresses the decision-making, skills, and procedures needed to recognize and respond to changing weather conditions in flight, identify and apply mitigation strategies for avoiding adverse weather, practice the transition to the use of flight instruments to reduce the risk of spatial disorientation, and maintain awareness of a variety of influences that can adversely affect pilot decision-making. (A-21-5)

Convene a multidisciplinary panel of aircraft performance, human factors, and aircraft operations specialists to evaluate spatial disorientation simulation technologies to determine which applications are most effective for training pilots to recognize the onset of spatial disorientation and successfully mitigate it, and make public a report on the committee's findings. (A-21-6)

To Island Express Helicopters Inc.:

Participate in the Federal Aviation Administration's Safety Management System Voluntary Program. (A-21-7)

Install flight data recording devices capable of supporting a flight data monitoring (FDM) program on each helicopter in your fleet and establish an FDM program that reviews all available data sources to identify deviations from established norms and procedures as well as other potential safety issues. (A-21-8)

4.2 Previously Issued Recommendations Reiterated in This Report

The National Transportation Safety Board reiterates the following safety recommendations.

To the Federal Aviation Administration:

After the action in Safety Recommendation A-16-34 is completed, require all 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)

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

To Airbus Helicopters, Bell, Leonardo Helicopter Division, MD Helicopters, Robinson Helicopter Company, and Sikorsky, a Lockheed Martin Company:

Provide, on your existing turbine-powered helicopters that are not equipped with a flight data recorder or a cockpit voice recorder, a means to install a crash-resistant flight recorder system that records 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." The recorder system installation should be considered essential equipment that remains installed for the life of the helicopter and have provisions to ensure it remains operational during each flight. (A-20-29)

4.3 Previously Issued Recommendations Classified and Reiterated in This Report

The National Transportation Safety Board classifies and reiterates the following safety recommendations.

To the Federal Aviation Administration:

Require all 14 *Code of Federal Regulations* Part 135 operators to install flight data recording devices capable of supporting a flight data monitoring program. (A-16-34)

Safety Recommendation A-16-34 is classified "Open—Unacceptable Response" in section 2.6 of this report.

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 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)

Safety Recommendation A-13-13 is classified "Open—Unacceptable Response" in section 2.7 of this report.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III
Chairman

JENNIFER HOMENDY
Member

BRUCE LANDSBERG
Vice Chairman

MICHAEL GRAHAM
Member

THOMAS CHAPMAN
Member

Report Date: February 9, 2021

Board Member Statement

Chairman Sumwalt filed the following concurring statement on February 16, 2021; Vice Chairman Landsberg and Member Graham joined in this statement.

I fully support the findings, recommendations, and probable cause contained in this report, as well as the entire report. I appreciate the tremendous work done by NTSB's staff to complete this investigation in such a timely manner, without any compromise to the integrity of the product.

Through this concurring statement, I'd like to expand upon some of the items that were discussed in the board meeting, but not necessarily contained in this report.

Autopilots and Two Pilots

Part of the pilot's training when encountering inadvertent instrument meteorological conditions (IIMC) was, once a climb was established, transition to using the autopilot. The S-76B has a capable 4-axis autopilot that can climb to, and level off at, a preset altitude. Autopilots can usually fly an aircraft more precisely than a human pilot and, as it could have helped in this situation, autopilots are not susceptible to spatial disorientation. If the accident pilot had engaged the autopilot, as called for by his training, the encounter with instrument conditions likely would have enabled him to climb safely through the clouds without losing control.

Moving now to the topic of two pilots versus one: I realize this helicopter was certified to be operated by a single pilot. I do believe that a helicopter such as this can be operated safely by a single pilot – until that sole pilot becomes spatially disoriented, distracted, or has a medical event. For this reason, each of the several S-76 operators that I spoke with only operate with two pilots. In fact, this same helicopter – N72EX—was always flown with two pilots when owned by its previous owner. Furthermore, once this helicopter was owned by Island Express, one client -- oil and gas giant Chevron -- insisted that it be operated with two pilots. This client requirement isn't surprising, as the oil and gas industry at-large requires two pilot operations for offshore operations. In this case, Chevron required two pilots for both overland and offshore operations.

A second pilot could have served as a valuable back-up to the accident pilot's planned actions and decision-making. Once the helicopter entered IMC, the second pilot could have helped with monitoring and correcting the flying pilot's control inputs to prevent loss of control. More to the point, however, a second pilot might have provided an important check on the accident pilot's fateful decision to enter IMC in the first place.

After analyzing 60 helicopter air ambulance flights where pilot acts or omissions led to a crash, NTSB stated that most of these accidents might have been prevented had a second pilot and/or an autopilot been present.[1] In our safety recommendation report to FAA, NTSB stated:

[1] *Public Hearing: Safety of Helicopter Emergency Medical Services (HEMS) Operations,* February 3-6, 2009. For more information, visit the hearing page at https://www.ntsb.gov/news/events/Pages/2009_HEMS_Hearing.aspx.

"Conducting flights with two pilots allows one pilot to fly the airplane while the other communicates on the radio, programs aircraft avionics, and runs checklists."[2]

Given the safety benefits of two pilot operations, I'm left wondering why Island Express did not insist on operating this helicopter with two pilots. I believe it's important that those seeking to charter flights also consider the potential safety advantages of using two pilots, rather than one.

Low-Altitude Instrument Flight Rules (IFR) Infrastructure

There are safety advantages associated with flying on an instrument flight plan for a properly trained pilot, flying IFR-equipped and certified aircraft, with an operator that is approved for IFR operations. Island Express was not approved for IFR flights, so the pilot was forced to attempt to stay beneath the clouds to conduct the flight. Unfortunately, it appears that the accident pilot was faced with becoming trapped below clouds with decreasing visibility, eventually and inadvertently encountering IMC.

In the Board's 2009 hearing on the safety of helicopter air ambulances, we received testimony that the current airspace infrastructure is not conducive to efficient, low-altitude helicopter operations, and that the absence of navigational routing and the strict regulatory IFR structure make local, low-altitude helicopter flights in metropolitan areas impractical and, in some cases, unsafe. Our analysis of helicopter air ambulance crashes revealed that several of those accidents might have been prevented if the pilots had been able to fly in a structured low-altitude IFR environment.

As a result of that analysis, NTSB issued two recommendations to FAA to "conduct a systematic evaluation and issue a report on the requirements necessary for a viable low-altitude airspace infrastructure that can accommodate safe helicopter emergency medical services (HEMS) operations," and once the study was completed, initiate actions to implement it.[3] Although those recommendations were issued for helicopter air ambulances, they could apply equally to passenger-carrying helicopter flights. Unfortunately, FAA chose not to implement either of these recommendations.

Self-Induced Pressure

The evidence of record indicates that the accident pilot was considered, by all measures, to be a "good pilot." NTSB files are filled with accident reports of "good pilots" getting into bad situations. I imagine there are a number of reasons for such, but one reason that has been often cited over the years is "get-home-itis" or "get-there-itis." There was good discussion in the board meeting regarding self-induced pressure. As a former pilot myself – 24 years as an airline pilot, and four years in business aviation – I have felt self-inducted pressure firsthand. Fortunately, no one ever pressured me to complete a flight, but I can attest that there was certainly self-induced

[2] Safety Recommendation letter to Honorable J. Randolph Babbitt, Administrator, Federal Aviation Administration, from Honorable Deborah A.P. Hersman, Chairman, National Transportation Safety Board, September 24, 2009, at 16.

[3] *Id.* at 18 (referencing Safety Recommendations A-09-093 and A-09-094).

pressure. Pilots are, by nature, “can-do” oriented. We want to get the job done, and it is possibly perceived that if we can’t carry out the mission, we have somehow failed.

Perhaps a better way to look at it is that professional pilots aren’t paid to fly - they are paid to say no when conditions warrant. If paid pilots and those who aren’t paid to fly look at it that way, perhaps we will have fewer crashes attributed to “get-home-itis.”

5. Appendixes

Appendix A: Investigation

The National Transportation Safety Board (NTSB) was notified of this accident on January 26, 2020, and members of the investigative team arrived on scene later that day. Member Jennifer Homendy accompanied the team.

Investigative groups were formed for operational factors and human performance, air traffic control, airworthiness, engines, and maintenance records. Also, specialists were assigned for meteorology and personal electronic devices and to develop a helicopter performance study and visibility study.

The Federal Aviation Administration; Sikorsky, a Lockheed Martin Company; Rotorcraft Support Inc.; Honeywell Aerospace; Island Express Helicopters Inc.; and the National Air Traffic Controllers Association were parties to the investigation. The Transportation Safety Board of Canada (TSB), representing the state of design of the engines (Canada), designated an accredited representative to the investigation. Pratt & Whitney Canada participated in the investigation as the technical advisor to the TSB’s accredited representative.

Appendix B: Consolidated Recommendation Information

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

For each recommendation—

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

(2) a description of the Board'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-21-5

> Require the use of appropriate simulation devices during initial and recurrent pilot training for Title 14 *Code of Federal Regulations* Part 135 helicopter operations to provide scenario-based training that addresses the decision-making, skills, and procedures needed to recognize and respond to changing weather conditions in flight, identify and apply mitigation strategies for avoiding adverse weather, practice the transition to the use of flight instruments to reduce the risk of spatial disorientation, and maintain awareness of a variety of influences that can adversely affect pilot decision-making.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.5, Benefits of Simulation Devices for Pilot Training. Information supporting (b)(1) can be found on page 44; (b)(2) can be found on page 44; and (b)(3) is not applicable.

A-21-6

> Convene a multidisciplinary panel of aircraft performance, human factors, and aircraft operations specialists to evaluate spatial disorientation simulation technologies to determine which applications are most effective for training pilots to recognize the onset of spatial disorientation and successfully mitigate it, and make public a report on the committee's findings.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.5, Benefits of Simulation Devices for Pilot Training. Information supporting (b)(1) can be found on page 44; (b)(2) can be found on page 45; and (b)(3) is not applicable.

To Island Express Helicopters Inc.

A-21-7

> Participate in the Federal Aviation Administration's Safety Management System Voluntary Program.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.4.2, Benefits of a Mandatory Safety Management System. Information supporting (b)(1) can be found on pages 41-43; (b)(2) is not applicable; and (b)(3) can be found on pages 42-43.

A-21-8

> Install flight data recording devices capable of supporting a flight data monitoring (FDM) program on each helicopter in your fleet and establish an FDM program that reviews all available data sources to identify deviations from established norms and procedures as well as other potential safety issues.

Information that addresses the requirements of 49 *USC* 1117(b), as applicable, can be found in section 2.6, Benefits of Flight Data Monitoring. Information supporting (b)(1) can be found on page 46; and (b)(2) and (b)(3) are not applicable.

Appendix C: Previously Issued Safety Recommendations

Safety Management System for Part 135 Operators

Number	Classification	Date Closed	Recommendation
		Closed Recommendations	
A-09-89	Closed—Unacceptable Action	9/11/2014	**To the Federal Aviation Administration:** Require helicopter emergency medical services operators to implement a safety management system program that includes sound risk management practices.
		Open Recommendations	
A-16-36	Open—Unacceptable Response	N/A	**To the Federal Aviation Administration:** Require all 14 *Code of Federal Regulations* Part 135 operators to establish safety management system programs.

Adverse-Weather-Avoidance and Simulation Training for Pilots

Number	Classification	Date Closed	Recommendation
		Closed Recommendations	
A-08-61	Closed—Acceptable Action	3/28/2012	**To the Federal Aviation Administration:** Develop, in cooperation with Southeast Alaska commercial air tour operators, aviation psychologists, and meteorologists, among others, a cue-based training program for commercial air tour pilots in Southeast Alaska that specifically addresses hazardous aspects of local weather phenomena and in-flight decision-making.
A-08-62	Closed—Acceptable Alternate Action	6/14/2012	**To the Federal Aviation Administration:** Once a cue-based training program that specifically addresses hazardous aspects of local weather phenomena and weather-related, decision-making issues is developed as requested in Safety Recommendation A-08-61, require all commercial air tour operators in Southeast Alaska to provide initial and recurrent training in these subjects to their pilots.
A-09-87	Closed—Unacceptable Action	9/11/2014	**To the Federal Aviation Administration:** Develop criteria for scenario-based helicopter emergency medical services (HEMS) pilot training that includes inadvertent flight into instrument meteorological conditions and hazards unique to HEMS operations, and determine how frequently this training is required to ensure proficiency.

Number	Classification	Date Closed	Recommendation
A-09-88	Closed— Unacceptable Action	9/11/2014	**To the Federal Aviation Administration:** Once the actions recommended in Safety Recommendation A-09-87 are completed, require helicopter emergency medical services pilots to undergo periodic FAA-approved scenario-based simulator training, including training that makes use of simulators or flight training devices.
A-11-57	Closed—Acceptable Action	1/11/13	**To the Airborne Law Enforcement Association:** Revise your accreditation standards to require that all pilots receive training in methods for safely exiting inadvertently encountered instrument meteorological conditions for all aircraft categories in which they operate.
A-14-107	Closed—Unacceptable Action	9/18/18	**To the Federal Aviation Administration:** Work with operators, training providers, and industry groups to evaluate the effectiveness of current training programs for helicopter pilots in inadvertent instrument meteorological conditions, and develop and publish best practices for such training.
		Open Recommendations	
A-07-18	Open—Acceptable Response	N/A	**To the Federal Aviation Administration:** In cooperation with Hawaii commercial air tour operators, aviation psychologists, and meteorologists, among others, develop a cue-based training program for commercial air tour pilots in Hawaii that specifically addresses hazardous aspects of local weather phenomena and in-flight decision-making.
A-07-19	Open—Acceptable Response	N/A	**To the Federal Aviation Administration:** Once a cue-based training program that specifically addresses hazardous aspects of local weather phenomena and weather-related, decision-making issues is developed (as requested in Safety Recommendation A-07-18), require all commercial air tour operators in Hawaii to provide this training to newly hired pilots.
A-09-97	Open—Acceptable Response	N/A	**To 40 Public Helicopter Emergency Medical Services Operators:** Conduct scenario-based training, including the use of simulators and flight training devices, for helicopter emergency medical services (HEMS) pilots, to include inadvertent flight into instrument meteorological conditions and hazards unique to HEMS operations, and conduct this training frequently enough to ensure proficiency.
A-14-103	Open—Acceptable Response	N/A	**To 44 States, the Commonwealth of Puerto Rico, and the District of Columbia:** Require all pilots who perform state law enforcement search and rescue missions to receive, on an annual basis, scenario-based simulator training in inadvertent instrument meteorological conditions that includes strategies for recognizing, avoiding, and safely escaping the conditions.

Number	Classification	Date Closed	Recommendation
A-17-37	Open—Unacceptable Response	N/A	**To the Federal Aviation Administration:** Work with members of the Ketchikan air tour industry to improve existing training programs aimed at reducing the risk of weather-related accidents involving continuation of flight under visual flight rules into instrument meteorological conditions, with special attention paid to the human factors issues identified in this investigation, including (1) the need to help pilots better calibrate what constitutes safe weather conditions to conduct flights based on objective standards and requirements, such as set criteria for what landmarks must be clearly visible from which locations in order to proceed on a particular route; (2) the need to help pilots who are new to the area recognize dynamic local weather patterns that can place them in a dangerous situation; and (3) operational influences on pilot decision-making
A-18-13	Open—Acceptable Response	N/A	**To the Federal Aviation Administration:** Although controlled flight into terrain (CFIT)-avoidance training programs are not required by federal regulation for Title 14 *Code of Federal Regulations* Part 135 fixed-wing operations, work with Part 135 operators in Alaska to improve any voluntarily implemented training programs aimed at reducing the risk of CFIT accidents involving continuation of flight under visual flight rules (VFR) into instrument meteorological conditions, with special attention paid to the human factors issues identified in recent Alaska accident investigations, including, but not limited to, (1) the challenges of flying in mountainous terrain in Alaska and low-altitude VFR flight in an area subject to rapid changes in weather; and (2) limitations of the Alaska infrastructure, particularly weather observations, communications, and navigation aids.

Flight Data Monitoring

Number	Classification	Date Closed	Recommendation
		Closed Recommendations	
A-09-90	Closed—Unacceptable Action	1/25/2018	**To the Federal Aviation Administration:** 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.
		Open Recommendations	
A-16-34	Open—Acceptable Response	N/A	**To the Federal Aviation Administration:** Require all 14 *Code of Federal Regulations* Part 135 operators to install flight data recording devices capable of supporting a flight data monitoring program.

Number	Classification	Date Closed	Recommendation
A-16-35	Open— Unacceptable Response	N/A	**To the Federal Aviation Administration:** After the action in Safety Recommendation A-16-34 is completed, require all 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.

Crash-Resistant Flight Recorder Systems

Number	Classification	Date Closed	Recommendation
	Closed Recommendations		
A-99-59	Closed—Acceptable Action	11/9/2006	**To the Federal Aviation Administration:** Incorporate the European Organization for Civil Aviation equipment's proposed standards for a crash-protective video recording system into a technical standard order.
A-99-60	Closed—Superseded	12/23/2003	**To the Federal Aviation Administration:** Require, within 5 years of a technical standards order's issuance, the installation of a crash-protective video recording system on all turbine-powered nonexperimental, nonrestricted-category aircraft in 14 Code of Federal Regulations Part 135 operations that are not currently required to be equipped with a crashworthy flight recorder device. (Superseded by A-03-64)
A-03-62	Closed—Unacceptable Action/Superseded	2/9/2009	**To the Federal Aviation Administration:** Require the installation of a crash-protected image recording system on all turbine-powered, nonexperimental, nonrestricted-category aircraft that are manufactured after January 1, 2007, that are not equipped with a flight data recorder, and that are operating under 14 *Code of Federal Regulations* Parts 135 and 121 or that are being operated full-time or part-time for commercial or corporate purposes under Part 91. (Superseded by A-09-9)
A-03-64	Closed—Unacceptable Action/Superseded	2/9/2009	**To the Federal Aviation Administration:** Require all turbine-powered, nonexperimental, nonrestricted-category aircraft that are manufactured prior to January 1, 2007, that are not equipped with a cockpit voice recorder, and that are operating under 14 *Code of Federal Regulations* Parts 91, 135, and 121 to be retrofitted with a crash-protected image recording system by January 1, 2007. (Supersedes A-99-60) (Superseded by A-09-10)
A-03-65	Closed—Unacceptable Action/Superseded	2/9/2009	**To the Federal Aviation Administration:** Require all turbine-powered, nonexperimental, nonrestricted-category aircraft, that are manufactured prior to January 1, 2007, that are not equipped with a flight data recorder, and that are operating under 14 *Code of Federal Regulations* Parts 135 and 121 or that are being used full-time or part-time for commercial or corporate purposes under Part 91 to be retrofitted with a crash-protected image recording system by January 1, 2010. (Superseded by A-09-11)

Number	Classification	Date Closed	Recommendation
A-06-17	Closed—Unacceptable Action	9/11/2014	**To the Federal Aviation Administration:** Require all rotorcraft operating under 14 *Code of Federal Regulations* Parts 91 and 135 with a transport-category certification to be equipped with a cockpit voice recorder (CVR) and a flight data recorder (FDR). For those transport-category rotorcraft manufactured before October 11, 1991, require a CVR and an FDR or an onboard cockpit image recorder with the capability of recording cockpit audio, crew communications, and aircraft parametric data.
A-06-18	Closed—Unacceptable Action	9/11/2014	**To the Federal Aviation Administration:** Do not permit exemptions or exceptions to the flight recorder regulations that allow transport-category rotorcraft to operate without flight recorders, and withdraw the current exemptions and exceptions that allow transport-category rotorcraft to operate without flight recorders.
A-09-9	Closed—Unacceptable Action	6/11/2012	**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 are operating under 14 *Code of Federal Regulations* Parts 91, 121, or 135. The crash-resistant flight recorder system should record cockpit audio (if a cockpit voice recorder is not installed), 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 to be specified in European Organization for Civil Aviation Equipment document ED-155, Minimum Operational Performance Specification for Lightweight Flight Recorder Systems, when the document is finalized and issued. (Supersedes Safety Recommendation A-03-062)
A-09-10	Closed—Unacceptable Action	6/11/2012	**To the Federal Aviation Administration:** Require all existing turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a cockpit voice recorder and are operating under 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, 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 to be specified in European Organization for Civil Aviation Equipment document ED-155, Minimum Operational Performance Specification for Lightweight Flight Recorder Systems, when the document is finalized and issued.

Number	Classification	Date Closed	Recommendation
A-09-11	Closed—Unacceptable Action	6/11/2012	**To the Federal Aviation Administration:** Require all existing turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder and are operating under 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 (if a cockpit voice recorder is not installed), 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 to be specified in European Organization for Civil Aviation Equipment document ED-155, Minimum Operational Performance Specification for Lightweight Flight Recorder Systems, when the document is finalized and issued. (Supersedes Safety Recommendation A-03-065)
		Open Recommendations	
A-13-12	Open—Acceptable Response	N/A	**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 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-13-13	Open—Acceptable Response	N/A	**To the Federal Aviation Administration:** 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 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."

Number	Classification	Date Closed	Recommendation
A-20-29	Open—Acceptable Response (overall)	N/A	**To Six Helicopter Manufacturers (Including Sikorsky):** Provide, on your existing turbine-powered helicopters that are not equipped with a flight data recorder or a cockpit voice recorder, a means to install a crash-resistant flight recorder system that records 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." The recorder system installation should be considered essential equipment that remains installed for the life of the helicopter and have provisions to ensure it remains operational during each flight.

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