Collision with Terrain
Promech Air, Inc.
de Havilland DHC-3, N270PA
Ketchikan, Alaska
June 25, 2015

Accident Report

NTSB/AAR-17/02
PB2017-102178

National Transportation Safety Board

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Notation 56539
Adopted April 25, 2017

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National
Transportation
Safety Board

490 L'Enfant Plaza, S.W.
Washington, DC 20594

National Transportation Safety Board. 2017. ***Collision with Terrain, Promech Air, Inc., de Havilland DHC-3, N270PA, Ketchikan, Alaska, June 25, 2015*****. Aircraft Accident Report NTSB/AAR-17/02. Washington, DC.**

Abstract: This report discusses the June 25, 2015, accident in which a turbine-powered, float-equipped de Havilland DHC-3 airplane, N270PA, operated by Promech Air, Inc., collided with mountainous, tree-covered terrain about 24 miles east-northeast of Ketchikan, Alaska. The commercial pilot and eight passengers sustained fatal injuries, and the airplane was destroyed. Safety issues discussed in this report relate to the need for training program improvements for Ketchikan air tour operators that address pilot human factors issues, such as assessment of safe weather conditions, recognition of potentially hazardous local weather patterns, and operational influences on decision-making; the need for collaboration among Ketchikan air tour operators to identify and mitigate operational hazards through analysis of automatic dependent surveillance-broadcast data; the lack of conservative weather minimums for Ketchikan air tour operators; the lack of defined curriculum segments for controlled flight into terrain-avoidance training for all 14 *Code of Federal Regulations* Part 135 operators; nuisance alerts from the Class B terrain awareness and warning system during tour operations; the limitations of older software and terrain database versions for the legacy Chelton Flight Systems FlightLogic electronic flight instrument system; the lack of minimum training requirements for operational control personnel and the lack of guidance for Federal Aviation Administration inspectors for performing oversight of operational control training programs; the need for cruise industry awareness of schedule pressures associated with air tours sold as shore excursions; the lack of a requirement for a safety management system for Part 135 operators; and the lack of a crash-resistant flight recorder system.

For background information, visit https://www.ntsb.gov/investigations/SitePages/dms.aspx and search for NTSB accident number ANC15MA041. Recent publications are available in their entirety on the Internet at www.ntsb.gov. Other information about available publications also may be obtained from the website or by contacting:

National Transportation Safety Board
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Abbreviations

AAIP	approved airplane inspection program
AC	advisory circular
ADS-B	automatic dependent surveillance-broadcast
agl	above ground level
AIRMET	airmen's meteorological information
ATD	aircraft training device
BATD	basic aircraft training device
CEO	chief executive officer
CFIT	controlled flight into terrain
CFR	*Code of Federal Regulations*
CLIA	Cruise Lines International Association
CRM	crew resource management
CWA	caution/warning/advisory
DO	director of operations
EFIS	electronic flight instrument system
EMS	emergency medical services
FAA	Federal Aviation Administration
FAASTeam	FAA Safety Team
FDM	flight data monitoring
FSDO	flight standards district office
GMM	general maintenance manual
GOM	general operations manual
GPWS	ground proximity warning system
IDU	integrated display unit
IFR	instrument flight rules
IMC	instrument meteorological conditions
KTN	Ketchikan International Airport
KVB	Ketchikan Visitors Bureau
KVRS	Ketchikan Volunteer Rescue Squad

MFD	multifunction display
msl	mean sea level
MVFR	marginal visual flight rules
nm	nautical miles
NPRM	notice of proposed rulemaking
NTSB	National Transportation Safety Board
NWS	National Weather Service
PED	portable electronic device
PFD	primary flight display
POI	principal operations inspector
PTRS	program tracking and reporting system
SMS	safety management system
SNPRM	supplemental notice of proposed rulemaking
SOP	standard operating procedure
STC	supplemental type certificate
TAWS	terrain awareness and warning system
TSO	technical standard order
VFR	visual flight rules

Executive Summary

On June 25, 2015, about 1215 Alaska daylight time, a single-engine, turbine-powered, float-equipped de Havilland DHC-3 (Otter) airplane, N270PA, collided with mountainous, tree-covered terrain about 24 miles east-northeast of Ketchikan, Alaska. The commercial pilot and eight passengers sustained fatal injuries, and the airplane was destroyed. The airplane was owned by Pantechnicon Aviation, of Minden, Nevada, and operated by Promech Air, Inc., of Ketchikan. The flight was conducted under the provisions of 14 *Code of Federal Regulations* (*CFR*) Part 135 as an on-demand sightseeing flight; a company visual flight rules flight plan (by which the company performed its own flight-following) was in effect. Marginal visual flight rules conditions were reported in the area at the time of the accident. The flight departed about 1207 from Rudyerd Bay about 44 miles east-northeast of Ketchikan and was en route to the operator's base at the Ketchikan Harbor Seaplane Base, Ketchikan.

The accident airplane was the third of four Promech-operated float-equipped airplanes that departed at approximate 5-minute intervals from a floating dock in Rudyerd Bay. The accident flight and the two Promech flights that departed before it were carrying cruise-ship passengers who had a 1230 "all aboard" time for their cruise ship that was scheduled to depart at 1300. (The fourth flight had no passengers but was repositioning to Ketchikan for a tour scheduled at 1230; the accident pilot also had his next tour scheduled for 1230.) The sightseeing tour flight, which the cruise ship passengers had purchased from the cruise line as a shore excursion, overflew remote inland fjords; coastal waterways; and mountainous, tree-covered terrain in the Misty Fjords National Monument Wilderness.

Promech pilots could choose between two standard tour routes between Rudyerd Bay and Ketchikan, referred to as the "short route" (which is about 52 nautical miles [nm], takes about 25 minutes to complete, and is primarily over land) and the "long route" (which is about 63 nm, takes about 30 minutes to complete, and is primarily over seawater channels). Although the long route was less scenic, it was generally preferred in poor weather conditions because it was primarily over water, which enabled the pilots to fly at lower altitudes (beneath cloud layers) and perform an emergency or precautionary landing, if needed. Route choice was at each pilot's discretion based on the pilot's assessment of the weather. The accident pilot and two other Promech pilots (one of whom was repositioning an empty airplane) chose the short route for the return leg, while the pilot of the second Promech flight to depart chose the long route.

Information obtained from weather observation sources, weather cameras, and photographs and videos recovered from the portable electronic devices (PEDs) of passengers on board the accident flight and other tour flights in the area provided evidence that the accident flight encountered deteriorating weather conditions. Further, at the time of the accident, the terrain at the accident site was likely obscured by overcast clouds with visibility restricted in rain and mist. Although the accident pilot had climbed the airplane

to an altitude that would have provided safe terrain clearance had he followed the typical short route (which required the flight to pass two nearly identical mountains before turning west), the pilot instead deviated from that route and turned the airplane west early (after it passed only the first of the two mountains). The pilot's route deviation placed the airplane on a collision course with a 1,900-ft mountain, which it struck at an elevation of about 1,600 ft mean sea level. In the final 2 seconds of the flight, the airplane pitched up rapidly before colliding with terrain. The timing of this aggressive pitch-up maneuver strongly supports the scenario that the pilot continued the flight into near-zero visibility conditions, and, as soon as he realized that the flight was on a collision course with the terrain, he pulled aggressively on the elevator flight controls in an ineffective attempt to avoid the terrain.

Although Promech's *General Operations Manual* specified that both the pilot and the flight scheduler must jointly agree that a flight can be conducted safely before it is launched, no such explicit concurrence occurred between the accident pilot and the flight scheduler (or any member of company management) before the accident flight. As a result, the decision to initiate the accident tour rested solely with the accident pilot, who had less than 2 months' experience flying air tours in Southeast Alaska and had demonstrated difficulty calibrating his own risk tolerance for conducting tour flights in weather that was marginal or below Federal Aviation Administration (FAA) minimums. Further, evidence from the accident tour flight and the pilot's previous tour flights support that the pilot's decisions regarding his tour flights were influenced by schedule pressure; his attempt to emulate the behavior of other, more experienced pilots whose flights he was following; and Promech's organizational culture, which tacitly endorsed flying in hazardous weather conditions, as evidenced (in part) by the company president/chief executive officer's own tour flight below FAA minimums on the day of the accident.

The National Transportation Safety Board (NTSB) identified the following safety issues as a result of this accident investigation:

- **Need for training program improvements for Ketchikan air tour operators that address pilot human factors issues such as pilot assessment of safe weather conditions, pilot recognition of potentially hazardous local weather patterns, and operational influences on pilot decision-making.** Ketchikan's air tour industry, which involves the operation of float-equipped airplanes at low altitudes through fjords and mountain valleys, is subject to a dynamic local weather environment. The accident pilot had received cue-based and controlled flight into terrain (CFIT)-avoidance training (specific to operations in Ketchikan) in a basic aircraft training device (BATD). However, the BATD (which is designed to serve as a platform for procedural and operational performance tasks) did not provide a realistic decision-making scenario, and the training was insufficient to counteract the cultural and peer influences that encouraged the pilot to continue flight into deteriorating weather.

- **Need for collaboration among Ketchikan air tour operators to identify and mitigate operational hazards through analysis of automatic dependent surveillance-broadcast (ADS-B) data.** During the investigation, NTSB investigators reviewed ADS-B data from Ketchikan-area tour flights to gain valuable insight into where and at what altitudes tour flights were conducted. However, there is no mechanism for Ketchikan-area air tour operators to review and discuss such objective data to identify any operational hazards reflected in the data and collaborate on mitigation strategies.

- **Lack of conservative weather minimums for Ketchikan air tour operators.** The Ketchikan air tour industry is competitive, and, on the day of the accident, Promech and other operators that were willing to take the most weather risks were able to fly more revenue passengers. It is likely that, unless corrective action is taken, some operators will continue to disregard weather minimums, thus putting pressure on other operators to follow suit to stay competitive. More conservative minimums, particularly when combined with open discussions of how actual behavior compares with the established requirements (for example, through a review and discussion of ADS-B data as described above), can help establish a safety-oriented culture that will encourage pilots to fly more conservatively.

- **Lack of defined curriculum segments for CFIT-avoidance training for all 14 *CFR* Part 135 operators.** Although the accident pilot received some CFIT-avoidance training, such training is not required for pilots of fixed-wing aircraft operated under Part 135; FAA-approved training programs and the guidance for principal operations inspectors for evaluating CFIT-avoidance training programs (as specified in FAA Order 8900.1) applies only to helicopter operations.

- **Nuisance alerts from the Class B terrain awareness and warning system (TAWS) during tour operations.** The accident airplane's Chelton Flight Systems FlightLogic electronic flight instrument system (EFIS) included an integrated caution/warning/advisory (CWA) system that could provide an auditory voice annunciation (such as "pull up") accompanied by a red flag with text (such as "PULL UP") on the display. Based on its turbine-power and passenger-seating configuration, the accident airplane was required to be equipped with Class B TAWS, which specifies an alerting threshold of 700 ft above ground level (agl) during cruise flight and 500 ft agl during descent. However, the float-equipped accident airplane was authorized, per 14 *CFR* 135.203(a)(1), to cruise over the surface as low as 500 ft agl, which is below the Class B TAWS design alerting threshold. Several tour pilots reported that frequent nuisance alerts during tour operations prompted them to inhibit the alerts. (Technical Standard Order C151c defines a nuisance alert as "an inappropriate alert, occurring during normal safe operations, which is the result of the design performance limitation of TAWS.") The switch controlling the accident airplane's TAWS CWA auditory and flag alerting functions was set to the "inhibit" position. Nuisance alerts and the associated increase in the use of the inhibit mode prevent TAWS from effectively providing the intended protection.

- **Limitations of older software and terrain database versions for the legacy Chelton Flight Systems FlightLogic EFIS.** The accident airplane was equipped with a Chelton EFIS, which is a legacy system still in use in many airplanes operated in Alaska. The system's original 2003 terrain database, which was installed in the accident airplane, does not distinguish small, inland bodies of water from the surrounding terrain. The more-detailed 2007 terrain database update depicts bodies of water in blue. The Chelton system is also capable of depicting terrain hazards on the multifunction display as a red (warning) or yellow (caution) overlay on the terrain map. According to the system's manufacturer, EFIS software version 6.0B (which was installed in the accident airplane) displays these red and yellow overlays with some degree of transparency so that the underlying terrain outlines can be distinguished. However, for operators using older versions of the EFIS software, these overlays may not be as transparent and may obscure the terrain depiction on the map. Thus, the limitations of the older software and terrain database versions can negatively affect the usefulness of these systems for reference.

- **Lack of minimum training requirements for operational control personnel and lack of guidance for FAA inspectors for performing oversight of operational control training programs.** Promech's training and supervision of the flight scheduler who was on duty on the day of the accident was insufficient to ensure that she fully understood and was performing her responsibilities to work jointly with the pilots to make safe and appropriate operational control decisions. Although 14 *CFR* 119.69 requires that a person exercising operational control be qualified through training, experience, and expertise, the FAA has no minimum training requirements for personnel authorized to exercise operational control and provides no guidance for inspector oversight of operational control training programs.

- **Need for cruise industry awareness of schedule pressures associated with air tours sold as shore excursions.** The cruise industry may not be aware that air tour operators that fly air tours as cruise line shore excursions may face schedule pressures to return passengers to the ship on time.

- **Lack of a requirement for a safety management system (SMS) for Part 135 operators.** Promech lacked an SMS, which has been recognized in the industry as an effective way to establish and reinforce a positive safety culture. This accident is one of many Part 135 accidents and incidents in which the NTSB has determined that operational issues played a role. An

SMS would have helped Promech learn from previous safety-related incidents, including those in which pilots had difficulty avoiding adverse weather during tour flights, and establish policies to reduce the risks of recurrence.

- **Lack of a crash-resistant flight recorder system.** The airplane was not equipped, and was not required to be equipped, with any crash-resistant flight recording system. However, data retrieved from other devices, including the Chelton system and passenger PEDs, as well as recorded ADS-B data, provided information about the accident flight. Had these devices been destroyed by the accident sequence or ADS-B not been installed, the accident airplane's flightpath and altitude, the localized weather conditions, and the pilot's actions at the end of the flight would have been in doubt. Although the recovered data were invaluable to this investigation, the nonregulated nature of the devices challenged the investigation because their data lacked the types of critical details provided by the devices that meet the criteria specified in FAA Technical Standard Order C197, "Information Collection and Monitoring Systems."

The National Transportation Safety Board determines that the probable cause of this accident was (1) the pilot's decision to continue visual flight into an area of instrument meteorological conditions, which resulted in his geographic disorientation and controlled flight into terrain; and (2) Promech's company culture, which tacitly endorsed flying in hazardous weather and failed to manage the risks associated with the competitive pressures affecting Ketchikan-area air tour operators; its lack of a formal safety program; and its inadequate operational control of flight releases.

As a result of this investigation, the NTSB makes nine new safety recommendations to the FAA and one to the Cruise Lines International Association. The NTSB also reiterates three previously issued recommendations to the FAA.

1. Factual Information

1.1 History of the Flight

On June 25, 2015, about 1215 Alaska daylight time, a single-engine, turbine-powered, float-equipped de Havilland DHC-3 (Otter) airplane, N270PA, collided with mountainous, tree-covered terrain about 24 miles east-northeast of Ketchikan, Alaska.[1] The commercial pilot and eight passengers sustained fatal injuries, and the airplane was destroyed. The airplane was owned by Pantechnicon Aviation, of Minden, Nevada, and operated by Promech Air, Inc., of Ketchikan.[2] The flight was conducted under the provisions of 14 *Code of Federal Regulations* (*CFR*) Part 135 as an on-demand sightseeing flight; a company visual flight rules (VFR) flight plan (by which the company performed its own flight-following) was in effect. Marginal visual flight rules (MVFR) conditions were reported in the area at the time of the accident.[3] The flight departed about 1207 from Rudyerd Bay about 44 miles east-northeast of Ketchikan and was en route to the operator's base at the Ketchikan Harbor Seaplane Base, Ketchikan.

The flight was a sightseeing tour, sold as a "Cruise/Fly" shore excursion for cruise ship passengers whose ship was docked in Ketchikan. The Cruise/Fly tour package was a two-part excursion that included both a boat tour of the bay and a flight tour. The cruise ship passengers on board the accident flight had departed Ketchikan earlier that day for the tour-boat portion of the excursion through Misty Fjords National Monument Wilderness. Upon arrival at a floating dock in Rudyerd Bay, the tour-boat passengers disembarked from the boat. Once at the dock, the passengers were met by the tour airplanes for the return trip to Ketchikan. The intended departure time from the floating dock in Rudyerd Bay was 1145.

The accident airplane departed from Rudyerd Bay at 1207 (having pushed back from the floating dock a few minutes earlier) as the third of four Promech-operated, float-equipped airplanes that departed about 5 minutes apart. The accident flight and the two Promech flights that departed before it were carrying cruise ship passengers who had a 1230 "all-aboard" time for their cruise ship, which was scheduled to depart at 1300. (Cruise ship passengers, after their tour flights land in Ketchikan, disembark from the airplanes at a dock and board an awaiting bus for a 5- to 7-minute ride to the cruise ship dock.) The fourth flight had no returning passengers but was repositioning for a tour scheduled to depart from Ketchikan at 1230; the accident pilot also had his next tour scheduled for 1230 from Ketchikan.[4]

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[1] All times in this report are referenced in Alaska daylight time.

[2] In April 2016, Promech ceased its Ketchikan operations, and a local competitor purchased Promech's Alaska-based assets.

[3] MVFR conditions are defined as a ceiling from 1,000 ft to 3,000 ft above ground level (agl) and/or visibility 3 to 5 miles.

[4] The accident pilot and other Promech pilots had flown multiple tours both to and from Ketchikan on the morning of the accident. Tours departing from the operator's base in Ketchikan were referred to as outbound tours, while tours returning to the base from elsewhere (such as the floating dock in Rudyerd Bay) were referred to as inbound or return tours.

Tour flights overflew remote inland fjords; coastal waterways; and mountainous, tree-covered terrain. Promech pilots could choose between two standard tour routes between Rudyerd Bay and Ketchikan, referred to as the "short route" (which is about 52 nautical miles [nm], takes about 25 minutes to complete, and is primarily over land) and the "long route" (which is about 63 nm, takes about 30 minutes to complete, and is primarily over the seawater channels).[5] Pilots flying the short route normally exit Rudyerd Bay, cross Behm Canal, then proceed overland through Ella Narrows and southwest across Ella Lake before crossing Thorne Arm and proceeding to Ketchikan. The long route turns more to the south after crossing Behm Canal to remain primarily over water (see figure 1).

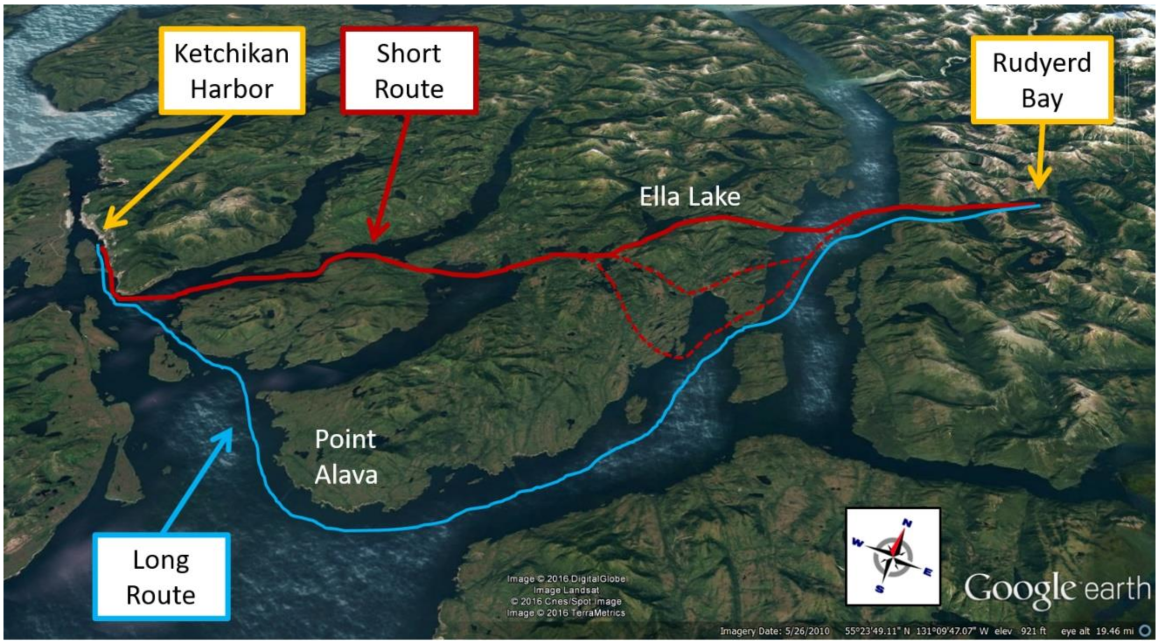

Figure 1. Map showing Promech's two major routes between Ketchikan and Rudyerd Bay.

Note: The long route over water is in blue, and the short route over land is in red. The red dashed lines depict possible variations for the short route.

The accident pilot and two other pilots chose the short route for the return leg, while the pilot of the second Promech flight to depart chose the long route. (Section 1.8.4 provides more information about pilots' tour route selections.)

When the accident airplane did not return to Ketchikan, the operator initiated a search along the anticipated flight route and detected an emergency locator transmitter signal. A pilot of a helicopter from Temsco Helicopters, Inc., of Ketchikan, who was dispatched to the area to locate the missing airplane said that he was unable to search the upper levels of the mountainous areas due to low ceilings and poor visibility. The helicopter pilot said that, after waiting for the weather conditions to improve, he was able to search the upper elevations of the search area and located

[5] Tour route distances and times were estimated from averaging the information obtained from the automatic dependent surveillance-broadcast (ADS-B) data for several tour flights.

the wreckage about 1429 (see figure 2). Ketchikan Volunteer Rescue Squad (KVRS) team members reached the accident site later that afternoon and confirmed that there were no survivors.

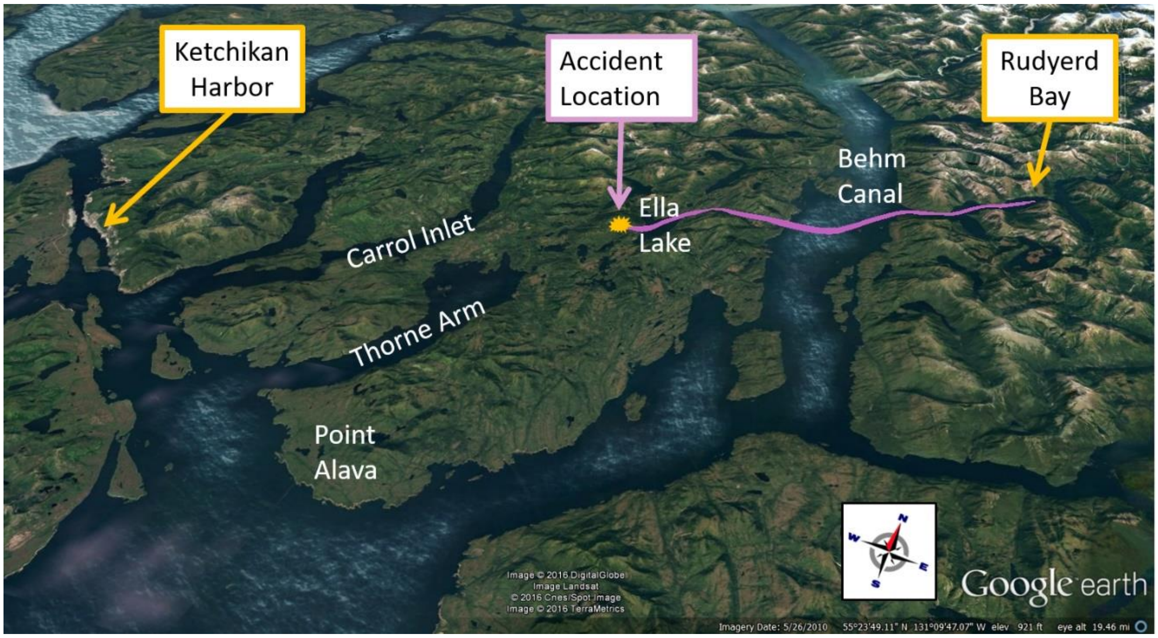

Figure 2. Map showing the accident flightpath and wreckage location.

Data recovered from the accident airplane's Chelton Flight Systems FlightLogic electronic flight instrument system (EFIS) provided information about the airplane's flight route and altitude.[6] Also, digital photographs and videos captured by passengers' portable electronic devices (PEDs) and cameras provided information about the weather conditions that the flight encountered. (Section 1.3.3 contains more information about the Chelton EFIS, and section 1.4.2 describes photographs provided by passengers on board the first Promech flight in the tour group, which transited the area within minutes of the accident flight.) The corrected data showed that the accident airplane entered Ella Narrows (a low-lying valley about 100 to 300 ft in elevation flanked by 2,000- to 2,500-ft mean sea level [msl] mountains) at an altitude of about 1,300 ft msl. (The flights from Rudyerd Bay transit Ella Narrows before overflying Ella Lake.)

A video recovered from the PED of a passenger on the accident flight showed that, when the airplane was passing over Ella Narrows, the airplane passed one or two thin scud clouds.[7] The

[6] The Chelton EFIS recorded the airplane's indicated altitude based on an altimeter setting of 29.56 inches of mercury. The actual altimeter setting for the area of the flight was 29.91 inches of mercury; consequently, the recorded altitudes are about 330 ft lower than what they would be had they been based on the actual altimeter setting. All altitude references for the accident flight in this report have been corrected using the current, local altimeter setting. (The airplane's panel-mounted altimeter [separate from the one internal to the Chelton EFIS] was found set between 29.88 and 29.90 inches of mercury.)

[7] As used in this report, scud cloud means small, ragged cloud fragments. Federal Aviation Administration (FAA) Advisory Circular (AC) 00-6A defines scud as "small, detached masses of stratus fractus clouds below a layer of higher clouds, usually nimbostratus" and "low, ragged clouds."

corrected Chelton EFIS data showed that, as the accident airplane transited Ella Narrows, it descended rapidly from about 1,300 ft to about 1,000 ft msl before gradually climbing again.

Data showed that, after reaching the northeast end of Ella Lake, the flight was about 1,200 ft msl and turned southwest and overflew the lake while climbing to about 1,300 ft msl (about 1,050 agl). Upon reaching the center of the lake, while still about 1.25 nm from the south shore, the airplane turned west about half-standard rate and climbed to about 1,500 ft msl while crossing over a 900-ft msl ridge on the lake's west shore.[8] A downward-looking photograph (recovered from the camera of a passenger on the accident flight) captured near this location and about 28 seconds before the collision showed some treetops partially obstructed by cloud cover (figure 3) and a forward-looking photograph (recovered from the same camera) captured about 7 seconds later showed that the terrain was mostly obscured (figure 4).

[8] The FAA *Aeronautical Information Manual* defines a standard rate turn as 3° per second. The accident airplane turned about 1.5° per second.

Figure 3. Downward-looking photograph showing evergreen trees and visibility that is partially obstructed by thin cloud cover.

Figure 4. Forward-looking photograph through part of right cockpit windscreen. Rain on the windscreen and the propeller arc are visible. The lower right portion of windscreen shows a darker area, similar to mostly obscured terrain.

After crossing the ridge, the airplane continued on a relatively constant heading between 1,400 ft and 1,500 ft msl for about 30 seconds. Data from the Chelton EFIS showed that, about 2 seconds before the collision, the airplane began to pitch up rapidly, experiencing about +2 Gs of vertical acceleration and climbing before it collided with terrain.[9] The airplane struck the terrain at an elevation of about 1,600 ft msl. The accident flight's west turn over the lake differed from the standard route, which would have continued past the high terrain before turning west (see figure 5).

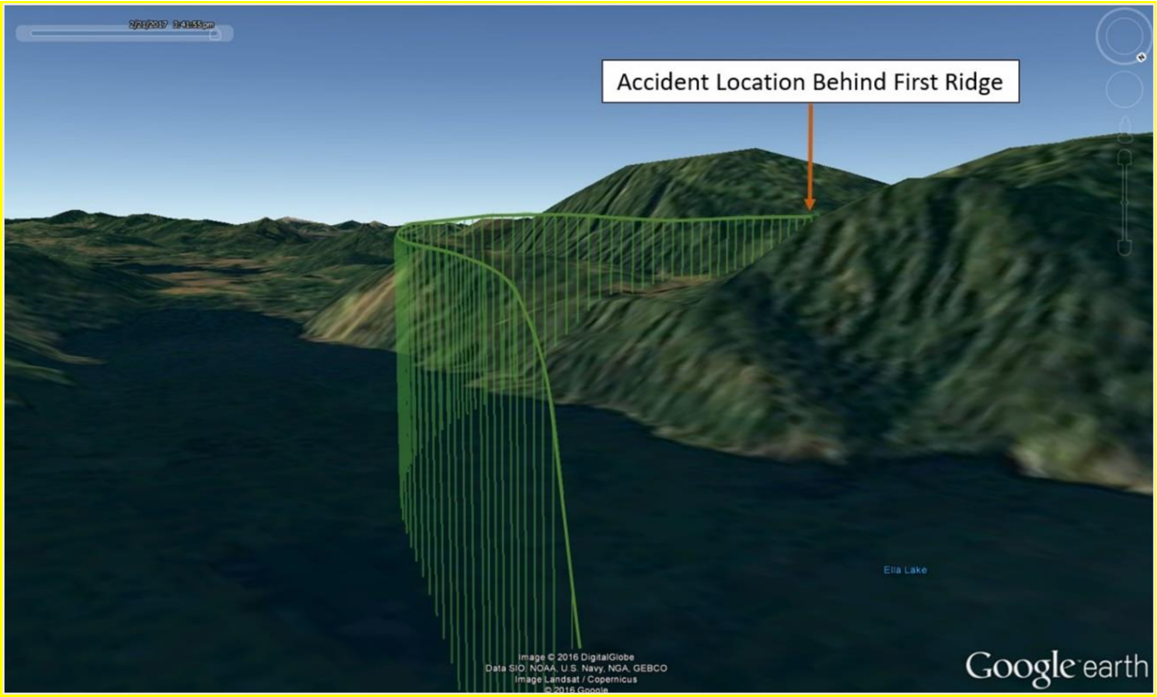

Figure 5. The path flown by the accident airplane (green), viewed from the approximate altitude of the accident airplane, is shown turning to the west (right) toward high terrain.

Note: The vantage point of the image distorts the flight route depiction in the foreground (where the segment of the route originates in the bottom center of the image); there is no steep vertical climb in the flight route at the location shown in the foreground.

1.2 Pilot Information

1.2.1 Certificate and Qualifications

The pilot, age 64, held a commercial pilot certificate issued on April 3, 2013, for airplane single-engine land and sea with a rating for instrument airplane. The pilot held an FAA second-class airman medical certificate dated March 23, 2015, with the limitation "[m]ust wear corrective lenses." FAA medical records indicated that the pilot's corrected distant, intermediate, and near vision was 20/20. The pilot reported no medications, significant medical conditions, or recent medical procedures

[9] G is a unit of measurement of deceleration and acceleration. One G is equivalent to the acceleration caused by the earth's gravity (about 32.2 ft/sec^2).

to the FAA. The National Driver Registry revealed no record of driver's license suspension or revocation.

The pilot's estimated flight experience, based on logbook data, interview information, and company records, was about 4,070 hours total flying time, which included about 500 hours in de Havilland DHC-2 airplanes and about 40 hours in the de Havilland DHC-3. He accumulated about 1,200 of his flying hours in Alaska, but his job with Promech was his first job flying in Southeast Alaska.

Promech hired the pilot on April 27, 2015, and he completed company training for the DHC-2, including a pilot-in-command checkride as required by 14 *CFR* 135.293 on May 1, 2015. Promech's records for the pilot's training in avoiding controlled flight into terrain (CFIT) included a completed written examination dated May 1, 2015. The examination, which was not graded, was part of Promech's participation in the voluntary Medallion Foundation program. Also, the Medallion Foundation sign-in/training log showed that the pilot received 1.3 hours of training on its aircraft training device (ATD), which was classified as an approved basic ATD (BATD), on May 4, 2015, instructed by the Promech assistant chief pilot. (The CFIT-avoidance training is discussed in section 1.8.5, and the Medallion Foundation is discussed in section 1.8.7.)

The pilot flew his first tour for Promech on May 3, 2015, in a DHC-2 airplane. He soon began company training for the DHC-3 airplane, which included training flights with the director of operations (DO) that included emergency procedures for engine malfunctions and simulated encounters with instrument meteorological conditions (IMC) that required use of the Chelton system for reference. According to company records, the pilot's DHC-3 training included a knowledge examination in accordance with 14 *CFR* 135.293(a). The pilot completed company training for the DHC-3 on June 6, 2015, and flew his first air tour in the DHC-3 on June 10, 2015. At the time of the accident, the pilot had accumulated about 152 hours of flying time with Promech.

According to the pilot's resume, his primary occupation was a restaurant business owner; however, he had also been a pilot for more than 20 years and had flown for various operators in Alaska, including summer tour seasons in Bettles (2011-2013) and Talkeetna (2014-2015).

1.2.2 Past Performance and Decision-Making

Most of the Promech pilots interviewed about the accident pilot described him as very competent. Promech's DO and other Promech pilots described the accident pilot as a conservative decision-maker who was willing to turn back when weather conditions were poor. The DO provided an example of the accident pilot having turned around during a tour with a group of other Promech pilots, returning to Ketchikan while the rest of the group continued. After returning to the office, the pilot told the DO that it was raining and he had felt uncomfortable with the visibility. The DO said that the pilot had apologized for not completing the trip but that the managers told the pilot he had done a good job and had made the correct decision. One of the other pilots who had flown in this group said that the other pilots also reacted positively to the accident pilot's decision. Another pilot described the accident pilot as a humble mentor who was conscientious and looked out for others.

However, two Promech pilots raised questions about the pilot’s judgment regarding weather-related decisions. One pilot, who had been with the accident pilot in a company airplane during the accident pilot’s training flights, stated that the accident pilot had trouble correctly completing the inadvertent IMC/CFIT-escape maneuver and had to make multiple attempts to complete the maneuver successfully. The same pilot said he was following the accident pilot during a tour flight on one occasion when the accident pilot’s airplane disappeared into what seemed to be an area of IMC in the Ella Lake area. The pilot said that he radioed the accident pilot and asked him about the conditions, and the accident pilot stated that it was fine. This pilot described that he thought that the accident pilot seemed to think he was invincible or more skilled than he actually was. Another Promech pilot described that, early in the 2015 season, he was flying a company airplane out of the Ella Lake area when he encountered the accident pilot flying the other direction. The pilot said that he warned the accident pilot that the area was closed due to weather, but the accident pilot disregarded this pilot’s report. The pilot said that the accident pilot continued the flight in Ella Lake but was unsuccessful and had to backtrack out of the area, eventually running low on fuel.

Both of these pilots who expressed concerns also described an occasion in which they warned the accident pilot via the radio about an area of severe downdrafts that they had encountered in Rudyerd Bay. They said that the accident pilot disregarded their warning and instead heeded the advice of his friend (another Promech pilot) who said that the conditions were fine. These pilots said that, when the accident pilot attempted to fly through the area, he encountered a downdraft, and the floats of his airplane struck trees.

An entry in the accident pilot’s logbook, dated June 14, 2015, included a note, “Misty Trip, Thought I was dead.” (National Transportation Safety Board [NTSB] investigators determined that this logbook entry was referring to the flight during which he reportedly flew the airplane in a downdraft and struck trees.) Company records showed that the pilot flew two trips to the Misty Fjords Wilderness that day. NTSB investigators contacted the passengers on both flights, and none of the passengers stated that they noticed anything out of the ordinary, except that the flight was turbulent. Both the president/chief executive officer (CEO) and the DO stated that they were not aware of any issues regarding the specified flight and noted that no safety report was filed through the company’s anonymous reporting system (described in section 1.8.2).

1.2.3 Recent Activities

The pilot’s most recent day off was Saturday, June 20, 2015, 5 days before the accident. Records provided by the company and activity information retrieved from the pilot’s PED (which included voice, text, and internet browser activity) revealed information about the pilot’s activities in the 4 days before the accident. The PED activity gap from night to morning was used to determine each night’s sleep opportunity; in each instance, the pilot’s first PED use of the day and his last PED use of the evening involved internet browsing activity.

On Monday, June 22, the pilot’s first PED use occurred at 0426. Company flight and duty time records indicated that the pilot worked from 0700 to 1600 and operated five flights for a total of 5.5 flight hours. The pilot’s last PED use occurred at 2038.

On Tuesday, June 23, the pilot's first PED use occurred at 0348; thus, his previous night's sleep opportunity was 7 hours 10 minutes. Company flight and duty time records indicated that the pilot worked from 0730 to 1630 and operated five flights for a total of 5.5 flight hours. His colleagues reported routine interactions with him between flights that day. The pilot's last PED use occurred at 2112.

On Wednesday, June 24, the pilot's first PED use occurred at 0449; thus, his previous night's sleep opportunity was 7 hours 37 minutes. Company flight and duty time records indicated that the pilot worked from 0700 to 1700 and operated three flights for a total of 3.5 flight hours. His colleagues reported routine interactions with him between flights that day. The pilot sent a text message at 1617 indicating that he was back from his last flight. Two other Promech pilots and the flight scheduler ate dinner at a restaurant with the pilot about 1900 or 2000. They recalled that he was in a good mood. The pilot's last PED use was at 2229.

On the day of the accident, the pilot's first PED use occurred at 0700; thus, his previous night's sleep opportunity was 8 hours 31 minutes. He was scheduled to begin work at 0700; however, none of his coworkers could recall seeing him arrive. The flight scheduler recalled seeing the pilot preflight his airplane sometime before his first flight of the day. The pilot's last PED use occurred at 0743. The pilot's first tour was scheduled to depart from Ketchikan at 0800, and he was scheduled to operate additional tours departing from Ketchikan at 0930, 1100, and 1230 (each tour consisted of an outbound and a return flight). Interviews indicate that he flew the 0800, 0930, and 1100 tours; the accident occurred during his return flight from the 1100 tour.

1.2.4 Other Information

The pilot was a resident of Sagle, Idaho, but, while working for Promech for the summer, he had been renting a room in a house in Ketchikan with two other Promech pilots and the wife of one pilot. The accident pilot's wife said that he had been in a good mood recently and that he was generally a positive person. She said that he was very excited to be working as a floatplane pilot in Alaska.

The pilot's wife said that the pilot planned to move into his own apartment when he got off work the day of the accident. She said that his living arrangements had been somewhat crowded and that he had experienced some personality conflicts with one of his roommates and that roommate's wife. The pilot's wife and another of the pilot's roommates said that the pilot was feeling relaxed about the situation because he had found his own apartment and preferred to live alone.

The pilot's wife stated that the pilot was a morning person who typically went to sleep at 2200 and woke at 0500 when off duty for an extended period. She said that he experienced no difficulty falling asleep at night or remaining awake during the day. She said that the pilot snored but had never been diagnosed with any sleep disorders. She said that he preferred to get at least 8 hours of sleep per night. Another Promech DHC-3 pilot who became the pilot's close friend in Ketchikan said that the pilot typically went to bed early, woke early, and did not report difficulty sleeping.

1.3 Airplane Information

1.3.1 General

The de Havilland DHC-3 Otter is a single-engine, propeller-driven, single-pilot, high-wing, short takeoff and landing airplane originally designed in the early 1950s. The original DHC-3 was powered by a single reciprocating radial engine; however, the accident airplane was modified and powered by a Pratt & Whitney PT6A-135A turboprop engine in accordance with Vazar, Inc., supplemental type certificate (STC) SA3777NM. The accident airplane was equipped with Edo 7490 floats in accordance with A.M. Luton STC SA4375NM. The type certificate for the airplane is currently owned and maintained by Viking Air Limited, Sidney, British Columbia, Canada.

1.3.2 Maintenance

A review of maintenance records revealed, as of June 24, 2015, the total time accumulated for the airplane was 24,439.5 airframe hours, 14,575.9 engine hours, and 3,700.4 propeller hours. Promech maintained the airplane under an approved airplane inspection program (AAIP) that was published as Annex A to the Promech *General Maintenance Manual* (GMM). According to the GMM and the AAIP, the AAIP is an FAA-approved document that contains the detailed timing and tasks associated with the maintenance of the accident airplane. Revision 5 of the AAIP, dated February 1, 2013, was current at the time of the accident. The FAA had approved an on-condition maintenance program for the turbine engine on the accident airplane with no hard time between overhauls. According to Promech's director of maintenance, Promech had always maintained the engine on condition since acquiring the airplane and engine.

The most recent AAIP inspection of the airplane was an AAIP-MM (mini monthly) inspection that was performed on June 10, 2015, at 24,395.8 airframe hours, 14,532.2 engine hours, and 3,656.7 propeller hours. The only discrepancy reported during the inspection was an inoperative strobe light, which was replaced. The most recent AAIP-A, -B, or -C inspection of the airplane documented in the airframe, engine, and propeller logbooks was an unidentified inspection completed on May 11, 2015, at 24,334.3 airframe hours, 14,470.7 engine hours, and 3,595.2 propeller hours.[10] The records package for the most recent AAIP-B inspection indicated that the airplane was down for maintenance between February 25, 2015, and May 11, 2015, when the AAIP-B inspection was signed off. (In addition, the numerous AAIP-Limitations items were completed and documented during this maintenance visit.) The most recent AAIP-M125 (mini 125-hour) inspection was signed off on August 21, 2014, at 24,242.8 airframe hours. The most recent AAIP-A inspection was signed off on July 23, 2014, at 24,130.9 airframe hours, 14,267.3 engine hours, and 3,391.8 propeller hours. The most recent AAIP-C inspection was signed off on March 28, 2014, at 23,891.5 airframe hours, 14,027.9 engine hours, and 3,152.4 propeller hours.

[10] The A, B, and C inspections are scheduled every 250 hours, 500 hours, and 1,000 hours, respectively. Each inspection is progressively more detailed than the previous one. The inspection checklist is signed off and retained until the inspection is repeated and is entered in the aircraft logbooks.

The propeller was overhauled on December 5, 2012, and installed on the airplane on July 8, 2013, at an airframe time of 23,602.2 hours. The propeller had 2,863.1 hours total time when it was installed. The engine was overhauled on January 4, 1999, and installed on the airplane on May 20, 1999, at an airframe time of 14,034.0 hours. The engine had accrued 4,170.4 hours since new at the time of installation after the overhaul.

1.3.3 Chelton Flight Systems EFIS

The airplane was equipped with a Chelton Flight Systems FlightLogic EFIS, the hardware for which included two integrated display units (IDUs). The IDUs, which are identical part numbers, can be configured to operate as either a primary flight display (PFD) or a multifunction display (MFD). Using sensors, including solid-state air data and an attitude heading reference system, the PFD displays aircraft parameter data, including altitude, airspeed, attitude, vertical speed, and heading. Among the MFD's display options is a moving map that provides position and navigation information. The Chelton EFIS system is a first-generation technology and was used in the Capstone Project.[11] According to the FAA principal avionics inspector for Promech, almost all of the area operators of turbine-powered aircraft used the Chelton devices because they had been provided them free as part of the Capstone Project.

The accident airplane's IDUs were recovered from the wreckage and showed minor impact damage. Data recovered from these units provided information about the airplane's route, altitude, and other recorded parameters for the accident flight and the four flights that preceded it.

The Chelton EFIS in the accident airplane included a terrain awareness and warning system (TAWS), software version 6.0B, that provided color-coded cautions and warnings of terrain on the moving map on the MFD and a forward-looking "virtual" model of the outside world (a replica of a day VFR view out the front window in proper scale and perspective according to the aircraft's position, altitude, and heading) on the PFD. The system's integrated caution/warning/advisory system (CWA) also provided auditory and flag alerting functions. The CWA alerts for the TAWS features included an auditory annunciation (such as "pull up") accompanied by a red flag and text (such as "PULL UP") on the display. (See figure 6.)

[11] The Capstone Project was a joint industry and FAA research and development effort to improve aviation safety and efficiency in Alaska. Under Capstone, the FAA provided avionics equipment for aircraft and the supporting ground infrastructure. The Capstone Project operated from 1999 to 2006, and its success in Alaska laid the groundwork for the nationwide deployment of ADS-B.

Figure 6. An example of how the Chelton EFIS software version 6.0B depicts TAWS cautions (yellow) and warnings (red) on the MFD.

Promech pilots said they used the Chelton displays to help them judge distances to visually identifiable landmarks, and the company president/CEO said the Chelton system was a primary tool for terrain avoidance.

The Chelton EFIS provides TAWS functionality as defined in FAA Technical Standard Order (TSO) TSO-C151c, “Terrain Awareness and Warning System (TAWS).” Depending upon aircraft configuration settings and external sensors/switches, the system is configurable as a Class A, B, or C TAWS or a Class A or B HTAWS (helicopter TAWS).[12] The accident airplane’s TAWS functionality was set to Class B in accordance with 14 *CFR* 135.154(b)(2), which states that, for airplanes manufactured on or before March 29, 2002, “[n]o person may operate a turbine-powered airplane configured with 6 to 9 passenger seats, excluding any pilot seat…unless that airplane is equipped with an approved [TAWS] that meets as a minimum the requirements for Class B equipment in...[TSO]-C151.”

Functions provided by the Class B TAWS include the following:

- Terrain display: Display of terrain and obstacles on the PFD and MFD.

[12] Per TSO-C151c, Class A or B TAWS equipment is required for certain Part 91, 135, and 121 operators, based on specific operating rules and other details. Class C TAWS equipment is intended for voluntary installations on airplanes not covered by TAWS requirements. All classes of TAWS share certain basic functions, and the TSO specifies different criteria for certain functions, features, and alerting for each class.

- Forward-looking terrain awareness: A warning function that uses a terrain database and an obstruction database to alert the pilot to hazardous terrain or obstructions in front of the aircraft.
- Premature descent alert: A warning function that alerts the pilot when descending well below a normal approach glidepath on the final approach segment of an instrument approach procedure.
- Excessive rate of descent (ground proximity warning system [GPWS] Mode 1): A warning function that alerts the pilot when the rate of descent is hazardously high as compared to height above terrain (that is, descending into terrain).
- Sink rate after takeoff or missed approach (GPWS Mode 3): A warning function that alerts the pilot when a sink rate is detected immediately after takeoff or initiation of a missed approach.

The MFD depicts potentially hazardous proximity to terrain (based on the TAWS requirements) as a red (warning) or yellow (caution) overlay on the terrain map. EFIS software version 6.0B, which was installed in the accident airplane, depicts these overlays with some degree of transparency to allow the underlying contours to be distinguished to aid in a terrain avoidance maneuver. Several pilots interviewed reported that, in their airplanes, the red and yellow overlays could, at times, obscure the terrain depiction. One Promech pilot described that the red and yellow warning and cautions can cover the moving map's terrain depiction, creating an issue if a pilot needed to use the map for situational awareness in a CFIT-avoidance situation. Other pilots interviewed provided similar descriptions of the cautions and warnings covering the map display. According to a representative from Genesys Aerosystems (owner of the former Chelton Systems) the transparency of the red and yellow TAWS overlays depends on the software version, and version 6.0B was identical to what was carried forward to the current version of the software. (For the pilots interviewed, it is not known what version of the software was installed in their airplanes.)

The Chelton system also included a TAWS inhibit switch that could be used to manually inhibit the CWA auditory and flag alerts. The switch was of the latching type and gave an obvious indication of actuation (that is, a toggle switch). Data recovered from the accident airplane's EFIS recorded that the TAWS CWA alerting function was set to the inhibit position at the time of impact. The toggle switch was found in the inhibit position in the wreckage, and a digital image from the camera of a passenger on the accident flight showed that the switch was in the inhibit position during the flight.

Promech pilots revealed in interviews that water landings and tour operations near terrain resulted in frequent nuisance alerts, which sometimes prompted them to inhibit the alerts. TSO-C151c defines a nuisance alert as "an inappropriate alert, occurring during normal safe operations, which is the result of the design performance limitation of TAWS" (FAA 2012).

NTSB investigators reviewed a simulation of the MFD terrain moving map using data from the accident flight and noted that the moving map depiction of terrain did not use color-coding to differentiate between terrain and inland bodies of water. The database card recovered from the accident airplane's IDU was the original 2003 terrain database (a 2007 terrain database is the most current database update available for Chelton units). One pilot interviewed explained that one database did not show bodies of water on the display, whereas another does. The original 2003 database does not distinguish inland bodies of water, but the 2007 database update displays them in blue. (See figure 7.)

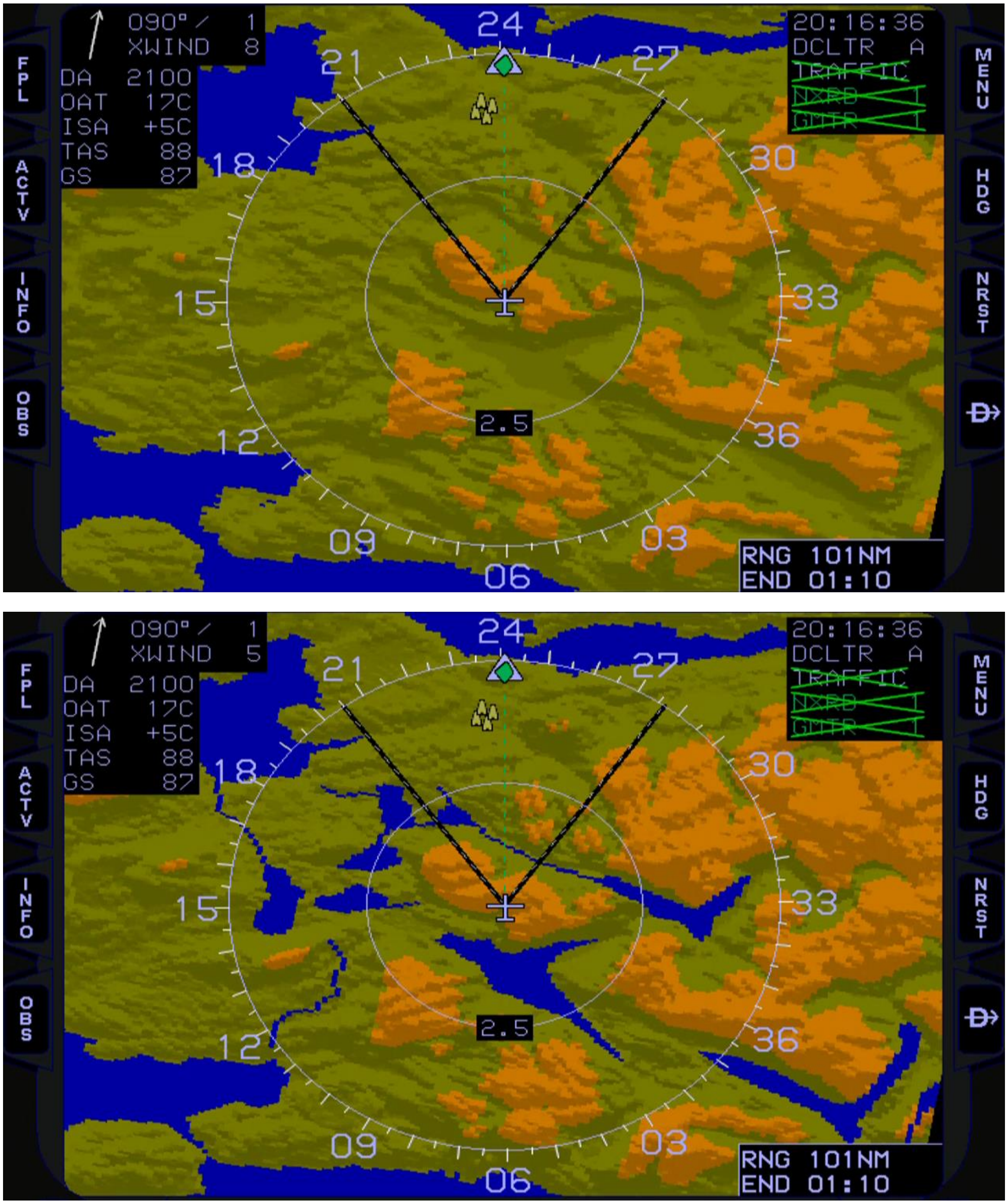

Figure 7. The top image shows how the Chelton EFIS's original 2003 database depicts the Ella Lake area, and the bottom image shows how the 2007 database update depicts the same area. Note that, in the most current database, the inland bodies of water are shown in blue.

Another Promech pilot described that, when flying over a body of water in the Misty Fjords, his display depicted the water as terrain. However, this pilot (and others) also described the system as very capable, and he said that the synthetic vision on the PFD, combined with the map on the MFD, were very useful tools for avoiding terrain.

The Chelton EFIS user manual includes procedures for using the system when escaping inadvertent VFR flight encounters with IMC. These procedures include reversing course; looking at the moving map to determine the direction to turn away from terrain; and, in the event of a terrain alert, identifying the threatening terrain on the moving map and maneuvering to avoid it.

1.4 Meteorological Information

1.4.1 Weather Forecasts and Observations

The National Weather Service (NWS) surface analysis chart and surface forecast charts depicted a low-pressure system off the Alaska coast associated with a dissipating occluded front, which was expected to produce MVFR weather conditions with rain and fog over the region. The area forecast valid for the period expected scattered clouds at 2,500 ft with broken to overcast clouds at 5,000 ft layered to 25,000 ft with visibility 3 to 5 miles in light rain and mist and isolated ceilings below 1,000 ft. In addition, an airmen's meteorological information (AIRMET) for mountain obscuration was current for the area. The outlook expected continued MVFR conditions due to low ceilings and visibility in rain to prevail across the region.

The nearest weather reporting facility was at Ketchikan International Airport (KTN) in Ketchikan, which was near the planned destination and about 24 nm west-southwest of the accident site. The KTN aviation routine weather report at 1153 reported wind 130° at 15 knots with gusts to 23 knots; visibility 6 miles in moderate rain and mist, runway 11 visual range 4,000 ft variable to greater than 6,000 ft; few clouds at 800 ft, broken clouds at 1,200 ft, overcast clouds at 2,700 ft; temperature 61° F; dew point 57° F; and altimeter setting 29.91 inches of mercury.

The terminal aerodrome forecast for KTN current during the period expected, from 1000 to 1300 wind from 160° at 9 knots, visibility of 6 miles in light rain and mist; scattered clouds at 1,000 ft, ceiling broken at 1,500 ft, overcast at 5,000 ft; with low-level wind shear at 2,000 ft with wind from 160° at 30 knots. A temporary period of visibility of 2 miles in moderate rain and mist with ceiling broken at 1,000 ft, overcast at 2,000 ft, was expected. The forecast was amended at 1204 for wind from 140° at 16 knots gusting to 26 knots with continued expected MVFR-to-instrument flight rules (IFR) conditions.[13]

Misty Fjords' four FAA weather cameras were located 10 miles east of the accident site and provided the closest official camera observations of the conditions in the area of the accident.

[13] IFR conditions are defined as a ceiling below 1,000 ft agl and/or visibility 1 to less than 3 miles.

The west-facing camera captured the accident area. Figure 8 depicts the camera range of views over a sectional chart with the accident flightpath marked in purple.

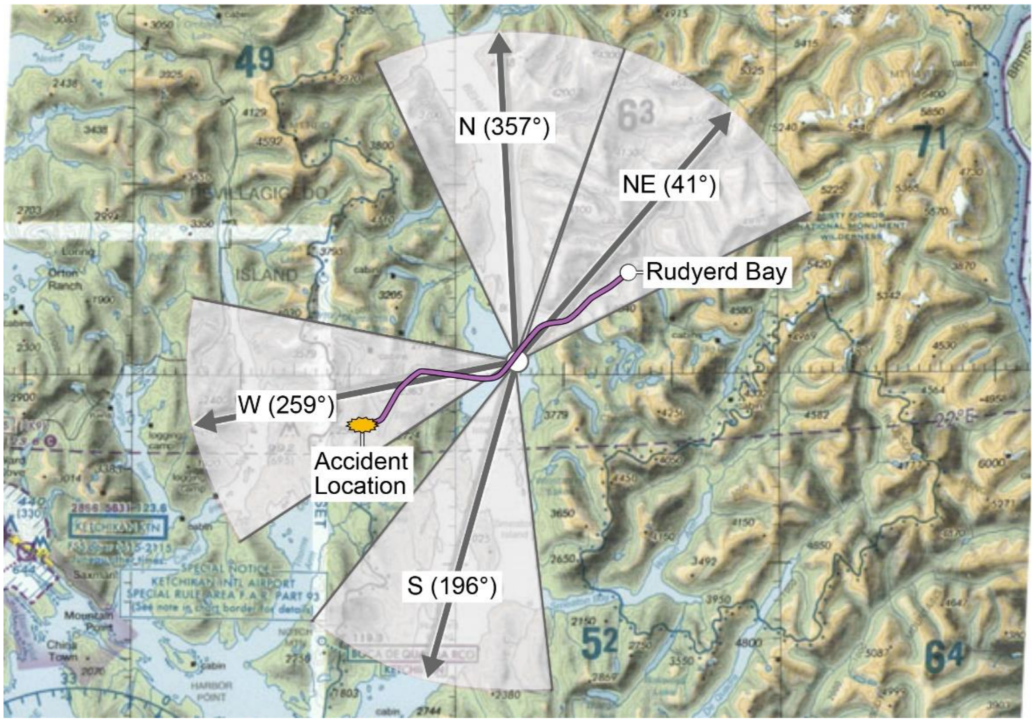

Figure 8. Map showing Misty Fjords camera range of views with the accident flightpath shown in purple.

Note: The direction and bearing labels are approximate and presented in reference to true north.

The following three figures show annotated images from the west-facing Misty Fjords camera. Figure 9 is an exemplar image from a clear day with measured distances to identifiable landmarks labeled for reference. The other two images were captured on the day of the accident; figure 10 was captured at 1158 (a few minutes before the airplane departed), and figure 11 was captured about 3 minutes before the accident. The images show that the higher ridge elevations were obscured by clouds with a layer of stratiform clouds below the peaks. Visibility also decreased during the period with rain.

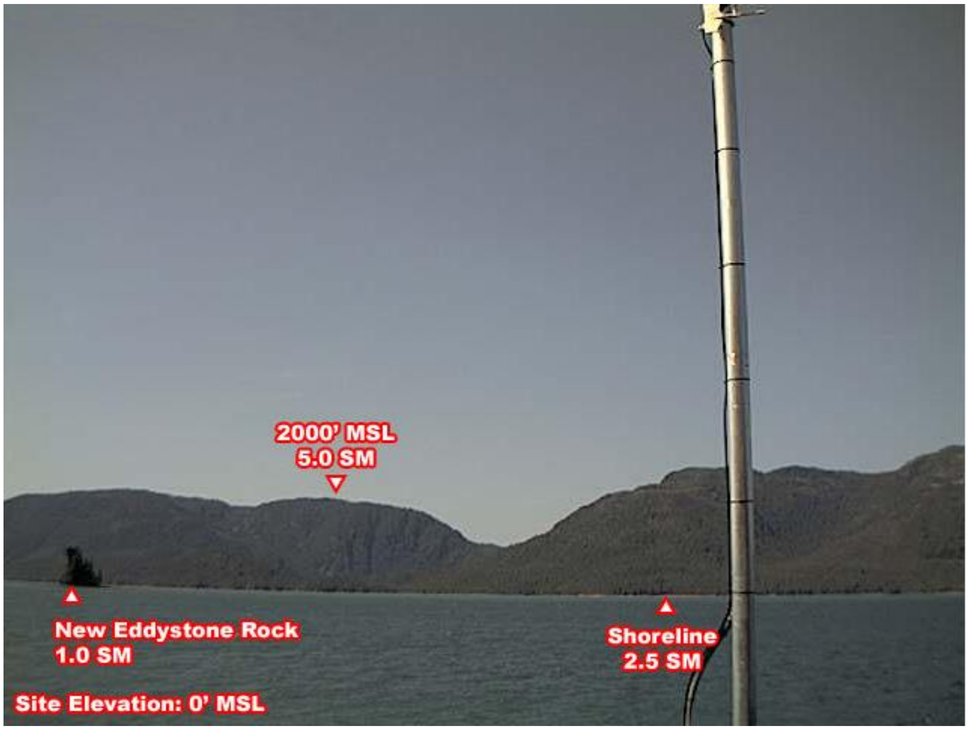

Figure 9. Image from west-facing (259°) Misty Fjords camera on a clear day.

Note: Distances to select landmarks are provided for reference, and the accident site is about 5 miles beyond the labeled 2,000-ft ridge. This image, as labeled, appears on the FAA web page for this camera, available from http://avcams.faa.gov/sitelist.php.

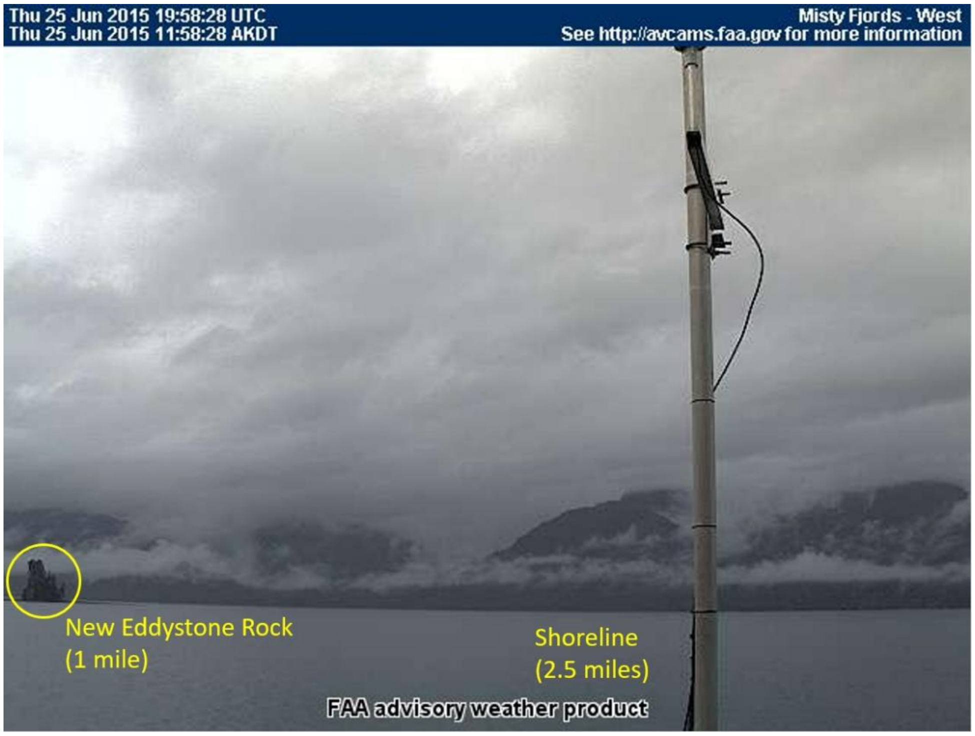

Figure 10. Image from west-facing (259°) Misty Fjords camera at 1158, a few minutes before the airplane's departure from Rudyerd Bay.

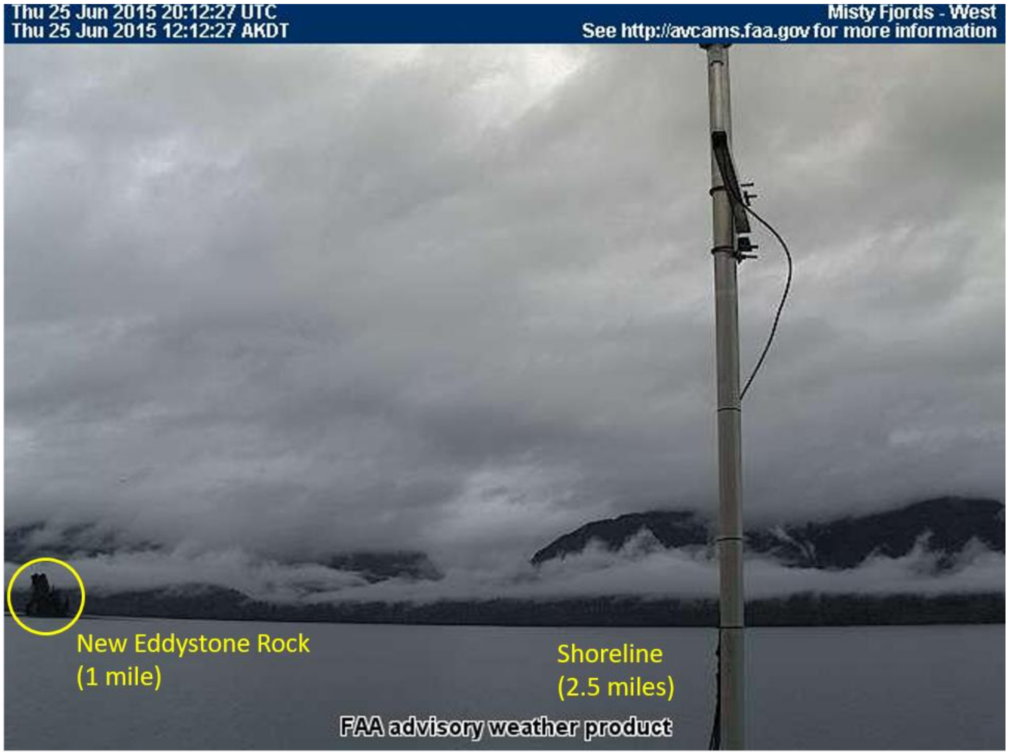

Figure 11. Image from west-facing (196°) Misty Fjords camera at 1212, about 3 minutes before the accident.

An FAA weather camera in Ketchikan facing toward the accident location also depicted the higher terrain obscured by clouds with visibility restricted less than 1 mile during the period. Figure 12 is an image captured by the south-facing Misty Fjords camera at 1208. This camera view showed that conditions in Behm Canal, which is part of the long route over the water, included good visibility.

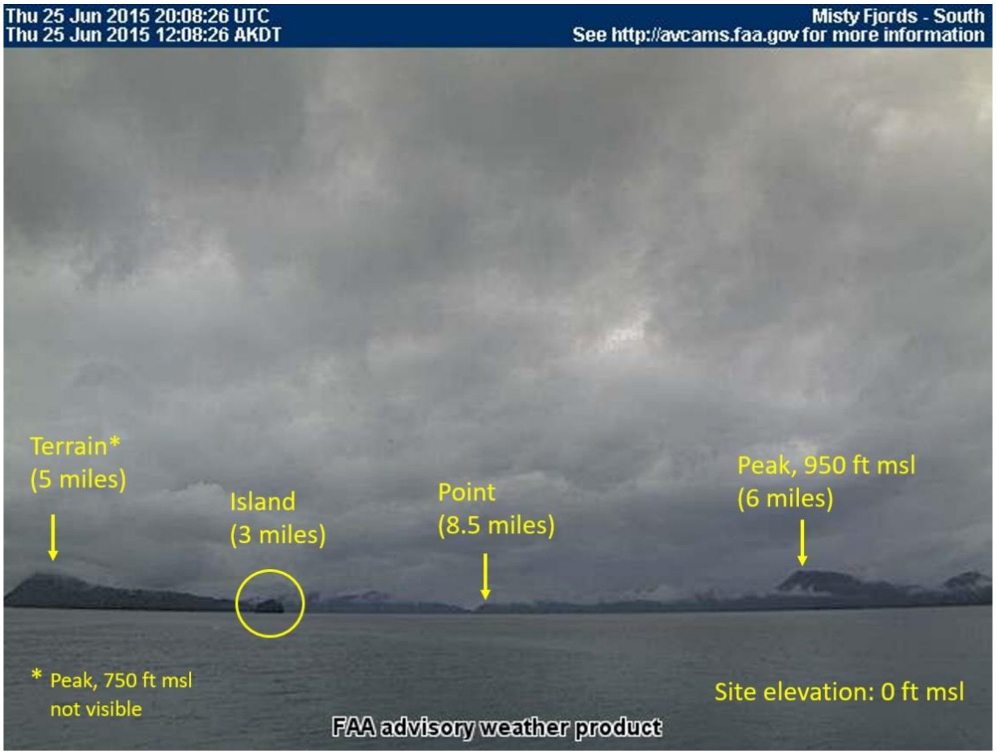

Figure 12. Image from south-facing (196°) Misty Fjords camera at 1208, showing conditions on the long route over the water.

1.4.2 Tour Pilots' Descriptions and Passengers' Photographs

The pilot of the first Promech flight to depart from Rudyerd Bay in the accident flight's tour group followed the short route, and his flight transited Ella Lake about 5 to 10 minutes before the accident flight. He described the weather conditions in Ella Narrows (which the flights transit as they enter Ella Lake en route to Ketchikan) as good. Digital photographs taken by two passengers on board this flight provided information about the weather conditions in Ella Narrows at that time. Figure 13 shows one of the photographs.

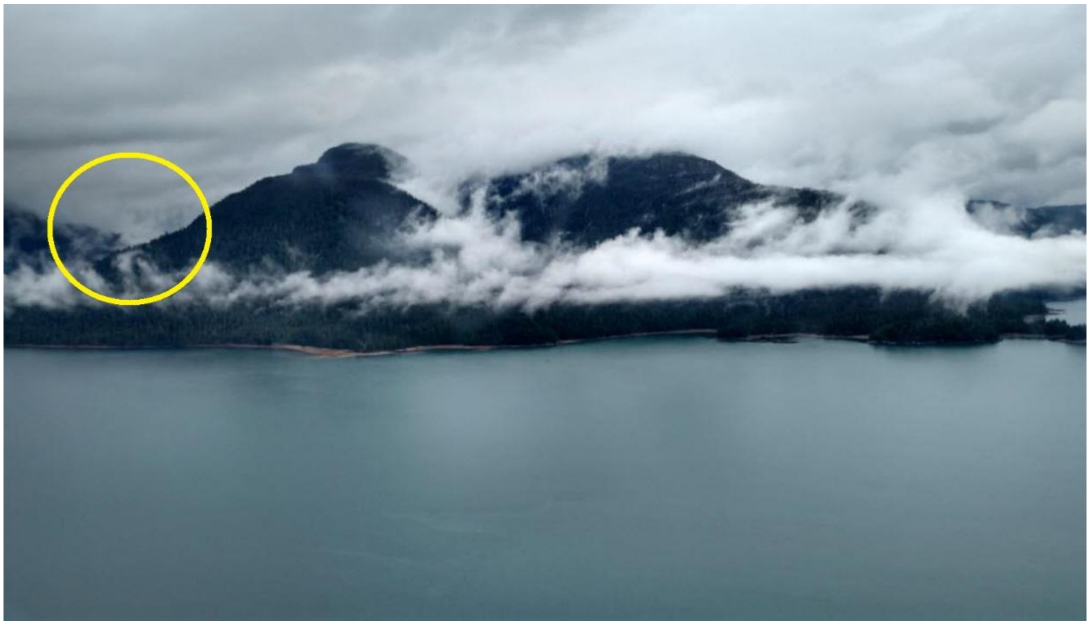

Figure 13. Photograph of entrance to Ella Narrows (circled) taken by a passenger on board the first Promech flight in the accident tour group to depart Rudyerd Bay.

The pilot of this first Promech flight stated that, when his flight reached Ella Lake, a cloud ceiling was above the lake about 1,600 to 1,700 ft msl, with a slightly lower ceiling (about 1,400 to 1,600 ft msl) over the south end of the lake. He reported that there were no "jagged edges" or "hanger" clouds below the ceiling. He recalled encountering misty rain and flying near the clouds but said his visibility was never obscured and recalled that he could see Thorne Arm (located about 5 nm from the south end of Ella Lake) while the flight was over the lake.

Digital photographs taken by a passenger on board this first Promech flight provided information about the weather conditions encountered when the airplane was about 0.5 nm south of Ella Lake. The most distant landmarks visible in the photographs are estimated to be about 1.5 nm away. Landmarks in the photographs provide a basis to estimate that the first Promech airplane transited this area about 300 to 400 ft agl. The southeast face of a large mountain is visible in the photographs and is completely obscured by clouds above about 1,000 ft msl, with some scattered clouds hanging down the mountainsides to lower elevations. This is the same mountain that the accident airplane subsequently struck about 1 nm to the north. A DHC-2 airplane operated by another tour company is visible in the upper right corner of the photograph. (See figure 14.)

Figure 14. Southwest-looking photograph taken about 0.3 nm south of Ella Lake and 1.3 nm south of the accident location by a passenger on board the first Promech airplane.

The pilot of the fourth Promech flight to depart, whose flight reached Ella Lake a few minutes after the accident flight, described a scattered cloud layer about 1,200 to 1,300 ft msl over Ella Lake. He said that the layer did not constitute a ceiling, but there were multiple cloud layers above it. He said that some rain restricted visibility over the lake but that visibility was at least 2 miles. When shown the accident location on a map, he recalled that it had been raining in the accident location, and the visibility in that area looked to be less than 2 miles. He also stated that mountaintops were obscured in that area. He reported encountering rain and moderate turbulence over the southern half of the lake and said visibility deteriorated to 1 or 2 miles as he transited terrain south of the lake. He recalled seeing low-hanging "wisps" of cloud near the surface in that area. He told investigators that he did not feel comfortable turning west after crossing the south shore of Ella Lake until he had continued south for 2 or 3 miles over lower terrain. He recalled that when he reached Thorne Arm, the conditions improved dramatically.

1.5 Flight Recorders

The accident airplane was not equipped, and was not required to be equipped, with a cockpit voice recorder, flight data recorder, or image recorder. Various devices on board the airplane recorded parametric, audio, image, and video information that survived the accident. None of the electronic devices recovered from the accident were designed for crash resistance or crash survivability.

As described in section 1.3.3, the airplane was equipped with a Chelton EFIS that recorded parametric data once per second, including GPS lateral position information, aircraft attitude, speed, and barometric altitude information. Also, passengers on board the accident airplane (and other tour flights) used PEDs and digital cameras to record photographs and videos during most of the accident flight. This content did not include any cockpit conversations or radio communications. The data that the NTSB retrieved collectively from these devices are described throughout this report. Section 1.9.2.3 describes the NTSB's previously issued safety recommendations regarding the need for crash-resistant flight recorder systems.

1.6 Wreckage and Impact Information

The NTSB investigator-in-charge, along with another NTSB investigator, reached the accident site with help from KVRS on the morning of June 27. The airplane had collided with a near-vertical rock face in a nose-high, wings-level attitude at an elevation of about 1,600 ft msl. The main wreckage came to rest upright on top of its separated floats in an area of heavily forested, steep terrain.

The entire airplane and all control surfaces were located at the main wreckage site. Examination of the wreckage at the accident site revealed that the terrain impact point was on a vertical rock face about 35 ft above the final resting point of the fuselage. The propeller was separated from the engine and found between the fuselage and the initial impact point. The propeller blades exhibited curling of the tips, chunking and gouging of the leading edges, and chordwise scratching on the forward faces of the blades. The tips of two propeller blades were separated and found adjacent to the propeller.

The fuselage was mostly intact with significant crushing damage at the forward end. The passenger cabin was mostly intact. Four of the passenger seats on the right side and one seat on the left side were partially attached at either the floor or wall; the remaining passenger seats were separated from their mounting points. The empennage remained partially attached to the fuselage but was deformed to the left. The fuselage forward of the empennage was fractured along the right side and buckled along the left side; the rudder was attached. The right elevator was partially attached to the empennage at the torque tube on the inboard end; the left elevator was attached. The right wing was separated from the fuselage at the wing root, and the right forward wing attach point was fractured on the wing side of the fitting. The outboard portion of the right wing was separated and was located about 100 ft below the main wreckage. The left wing remained attached to the fuselage at the left aft wing attach point, and the forward attach point was fractured on the wing side of the fitting.

The wreckage was recovered to a hangar facility for extensive follow-up examination and documentation of the airframe, flight controls, engine, propeller, systems, and components. Control continuity was established to all of the flight controls, taking into account the impact damage, the cables that were cut to facilitate wreckage recovery, and the tension overload signatures on the control cables that were found separated. The power lever, propeller lever, and condition lever were positioned aft of their normal in-flight positions with the instrument panel deformed down into them.

The engine was mostly intact. The propeller shaft was fractured from the engine immediately aft of the propeller's mounting flange. The forward end of the engine was deformed downward about 30° relative to the engine centerline in the exhaust duct area. Loose soil was found in the 1st, 2nd, and 3rd compressor stages and through the centrifugal impeller. Rotational scoring was noted throughout the compressor assembly. All of the compressor rotor and stator blades were intact with rubbing damage to the tips. The centrifugal impeller vanes and shroud exhibited rotational scoring, heat discoloration, and material smearing. The No. 1 bearing and air seals were intact with no indications of distress. The No. 2 bearing was intact with no indications of distress, and the air seals exhibited rotational scoring. The combustion chamber liner, large exit duct, and small exit duct were intact with no indications of operational distress. Evidence of rotational scoring, heat discoloration, and material smearing was noted on the compressor turbine guide vane ring, shroud, disc, and blades. The compressor turbine blades were intact with no signs of operational distress to the airfoils. The power turbine housing and components exhibited significant damage, rotational scoring, heat discoloration, and material smearing consistent with the deformation of the exhaust duct and power turbine shaft. All of the power turbine blades were fractured, and blade debris was found in the deformed exhaust duct.

Disassembly of the propeller enabled a detailed examination, including blade butt contact marks. Each of the blade butt contact marks were matched with the corresponding blade arm contact marks on the hub arm flange and indicated all three blades were in the low-pitch range (internal contact marks in the piston-cylinder assembly were consistent with a blade angle of about 26º).

The pilot seats in the cockpit each had a two-point lap-belt restraint and inertia reel shoulder harness. The seats in the cabin were each made of a welded steel tube frame with a hinge at the bottom of the seatback that allowed an operator to fold down the seatbacks or remove the seats. The cabin seats had two-point lap-belt restraints and no shoulder harnesses. Examination of the wreckage revealed that every seat showed some degree of deformation, crush damage, fragmentation, and/or detachment from anchoring aircraft structures.

1.7 Medical and Pathological Information

The State of Alaska State Medical Examiner's Office, Anchorage, Alaska, performed a postmortem examination of the pilot on June 27, 2015. The cause of death for the pilot was reported as "multiple blunt force injuries." The autopsy report also documented "focal myocardial fibrosis" and "mild, 10-20% atherosclerotic narrowing, focally present in the three main coronary arteries."

The FAA's Bioaeronautical Sciences Research Laboratory performed toxicological testing on specimens from the pilot. The specimens tested negative for carbon monoxide, ethanol, and a range of other legal and illegal drugs.[14]

[14] Immunoassay and chromatography screened for the following drugs: amphetamine, opiates, marijuana, cocaine, phencyclidine, benzodiazepines, barbiturates, antidepressants, and antihistamines.

The State of Alaska State Medical Examiner's Office performed autopsies for the eight passengers. The cause of death findings for all individuals were listed as either "multiple blunt force injuries" or "blunt impacts of…[multiple areas]."

1.8 Organizational and Management Information

1.8.1 General

Promech held operations specifications for both on-demand and commuter Part 135 operations. From 2005 until October 2014, the company provided air taxi service and scheduled passenger flights and mail contract services and, at the time, was the biggest air freight operator serving some communities in Southeast Alaska. However, the company began losing money each winter due to less demand for scheduled passenger service and the loss of the mail service contract to another operator. As a result, the company decided to cease providing scheduled service and focused instead on air tours and lodge transportation. At the time of the accident, about 90% of Promech's business consisted of air tours, including cruise line contracts.

At the time of the accident, Promech employed about 30 to 40 people, which included 3 full-time and 9 seasonal pilots. The company operated nine airplanes (four DHC-3 and five DHC-2 airplanes) in Ketchikan and two DHC-3 airplanes in Key West, Florida, where it had a satellite tour operation. The company president/CEO, the DO, assistant chief pilot, and director of maintenance were located in Ketchikan, and the chief pilot was located in Key West. In addition to their management roles, the company president/CEO, the DO, and the assistant chief pilot also had flying duties; the president/CEO operated an airplane during the second tour on the day of the accident. The company had no specific safety officer position; the DO was responsible for safety management. (Section 1.8.2 describes the company safety program.)

The company president/CEO had been in his position with Promech since 2005. He had also served as the DO until 2013 (when the current DO was hired). He described that his duties entailed mainly "big picture" activities rather than the day-to-day movement of airplanes and said that his role in Ketchikan mainly focused on accounting, buying parts, working on cruise line agreements, and maintaining relationships.

The DO had lived in Ketchikan his entire life and was hired directly into the position in May 2013. He said that he was listed in the Promech operations specifications for operational control. The DO said that he helped maintain pilot records, helped with pilot training, served as the interface between the pilots and the mechanics, and assisted with general maintenance of the mooring docks and fuel systems. He described his role as a "jack of all trades." He also had flying duties and estimated that he flew the line 3 to 4 days per week.

The assistant chief pilot, who had also lived in Ketchikan his entire life, was hired by Promech in November 2013 as a line pilot but assumed the role of assistant chief pilot in January 2015. His normal duties and responsibilities included flying the line, maintaining pilot records, assisting with training, and mentoring and providing moral support to employees. He said he was still learning his management position and described that he tried to mimic what he had seen other managers do over the last year of his employment. Recently, he had also become a company check airman. In addition, he worked with accounting personnel to oversee how the pilots were paid and also served as one of the company's primary pilots in the winter for both the DHC-2 and DHC-3 airplanes.

1.8.2 Safety Program

Section 3.4 of the Promech *General Operations Manual* (GOM) sets forth the policy and procedures for safety management and states, in part, the following:

> The [DO] promotes and encourages safety in all areas and ensures instructions pertinent to safety are properly observed. She/he monitors the education and training of all flight and ground support personnel that are involved in flight operations.

The DO stated that the size and centralized nature of the company's Ketchikan operations enabled the company to maintain a safety culture through the presence of the DO and the use of multiple communication methods. For example, he said that the bulletin board in the dispatch area contained a great deal of useful information. He said that company personnel continually posted bulletins there about hazards and provided information that could help the operation and the pilots. Regarding a flight risk assessment process, the DO said that, although he had worked with formal risk assessment forms in other jobs, he believed that Promech was able to accomplish the same objective informally. He said that the company had an anonymous hazard-reporting system that could be used to report operational hazards and general unsafe conditions.

Section 3.6 of the GOM, which covers safety reporting, states, in part, the following:

> Any employee who witnesses an unsafe condition or procedure is responsible to report the unsafe condition/procedure to his/her immediate supervisor, or if his/her supervisor is unavailable, then report to the [DO]. …The goal of this reporting is to eliminate any hazardous or unsafe condition before it causes an accident. Safety concerns brought to the attention of…management will, upon request, be kept in strict confidence.[15]

The GOM contains a "Safety Report Form" by which employees could report observed safety hazards or safety concerns, including suggested corrective action, and a section in which the receiving supervisor could note the investigation of the issues and the corrective action taken. The DO stated that all company pilots were told where they could find the safety reporting forms and that they needed to use them to report hazards, including any slips or falls, bumped heads, or dropped cameras. He gave an example of missing bumper tires on the dock that could damage the airplanes. When asked specifically about nonpunitive safety reporting for the pilots, the DO said that pilots could submit a form anonymously using the collection box, which he would check from

[15] The same section of the GOM also describes procedures for employees' mandatory use of the company's "Incident/Accident Report Form" in the event of an incident, accident, or mechanical malfunction.

time to time, but there was never anything in it. The DO said that he believed that everyone knew that they could bring up anything they wanted and that he liked to think that Promech's culture was one in which pilots felt free to bring up issues that were bothering them.

The company president/CEO said that employees could submit safety reports anonymously in a box in the lunchroom but that, typically, pilots just walked in and told the managers if they had a concern. Asked whether managers received written reports or mostly verbal reports, he said that verbal reports were more likely. According to the company president/CEO, the company did not have a documented risk assessment process; they just performed general risk assessment. They had general managers' meetings, brought the pilots in, and spent a large amount of time watching the operation.

When asked if they were aware of an earlier incident in which the accident pilot apparently struck trees with the floats of an airplane and told some of his colleagues that he nearly died, both the company president/CEO and the DO stated that they had no knowledge of it and received no reporting form. In addition, both appeared unaware that the accident pilot had turned around due to poor weather conditions during his first tour on the day of the accident. They also appeared unaware that two other Promech pilots were forced to alter their courses to find their way out of Ella Lake during an earlier tour on the morning of the accident. (Previous tours are discussed in section 1.8.4.2.)

The company did not employ a safety management system (SMS).[16] The DO said it would be possible to scale an SMS to their operation; however, he believed that the company accomplished the same objective through its safety culture. He said that he felt the company did not have enough employees to manage an SMS and ensure that it was appropriate, useful, and effective.

During interviews with multiple Promech pilots, NTSB investigators received varied responses when pilots were asked who in the company was responsible for managing the company safety programs. One pilot thought that there was a safety officer and that it was either the DO or the assistant chief pilot. Another pilot said he was not aware of a specific safety manager but thought that it might be the office manager, and another said that the DO managed safety programs.

Interviews with multiple Promech pilots revealed that some described the company as safety conscious and stated that they felt at ease bringing up any safety concerns. Some of the company's more experienced pilots said that they did not feel pressured to fly in unsafe conditions; however, one of these pilots was part of the group that encountered the 200-ft ceiling during the second tour of the day, and this pilot told investigators that he had never needed to turn down a flight for safety-related reasons.

One less-experienced pilot (who had about 500 hours flying float-equipped airplanes and had worked for Promech for about 6 weeks at the time of the accident) described that, when he

[16] SMS is recognized in aviation and other industries as an effective way to establish and reinforce a positive safety culture and identify and correct deviations from standard operating procedures (SOPs).

arrived for work on the morning of the accident, he expressed concern to Promech's president/CEO that the weather conditions were not good enough to fly. He stated that the response he received was, "That's just Alaska weather," so he flew the tour. (See section 1.8.4.2 for more information.)

This pilot also reported that he overheard the company president/CEO expressing frustration in the company office when he saw (using the company's ADS-B display) that one of the pilots was returning from the accident tour via the long route. He also stated that, during initial training, the assistant chief pilot, when talking about weather minimums, told him and a group of other Promech pilots that they had to bend the rules because they were operating in Alaska. He said that the assistant chief pilot also said that, if one pilot turned around while the others made it through, he and that pilot were going to "have a conversation." This pilot, who had not previously flown commercially in Alaska before working for Promech, said he just assumed "that's the culture [in Alaska]… it's like, 'we push through, we push through.'"

One experienced pilot (who had about 26,000 flight hours with 5,000 hours in float-equipped airplanes) described that, on one occasion, when he was flying a trip and saw the accident pilot's airplane disappear into the clouds (as described in section 1.2.2), he made a radio call to the accident pilot asking, "how's the weather up there because it looks IFR here?" He said that company management had heard the radio exchange and ridiculed him for mentioning IFR on the radio. He said that he was told to never say "IFR" on the radio, or he would be fired.

1.8.3 Operational Control

Section 1.4 of the GOM defines operational control as "the exercise of authority over initiating, conducting, or terminating a flight." According to the GOM, the company president, chief pilot, DO, director of maintenance, and assistant chief pilot have operational control authority in accordance with Part 135. The GOM also states that operational control responsibilities may be delegated to other trained and qualified personnel and that the following personnel have "limited operational control":

- Flight Schedulers—Flight Schedulers are authorized to initiate flights and terminate flights. Flight Schedulers shall be trained and qualified and a current list of Flight Schedulers shall be kept on a white board in the Dispatch Office.
- Pilots—Pilots are authorized to conduct and terminate flights. A current list of Pilots (with certificate numbers) shall be kept on a white board in the Dispatch Office.

Section 1.4 of the GOM also states, in part, the following:

> Flights are conducted in joint agreement and coordination between the Pilot and Flight Scheduler. **Both** the Pilot and Flight Scheduler must agree that the flight can be conducted safely before a flight may be launched. During the flight both the Pilot and Flight Scheduler will monitor and reassess the conditions to ensure that the flight can continue safely. **Either** the Pilot or Flight Scheduler can terminate a flight when they are not confident that the flight can continue safely. The Pilot and Flight

> Scheduler will work together to decide whether the flight should divert to a new location, or return to where it took-off from, but ultimately the pilot has the final decision in this matter. It is worth repeating that it takes the concurrence of both the Pilot and Flight Scheduler to launch and continue a flight, but either may decide to terminate the flight.

According to the DO, the role of the flight schedulers relating to operational control was to provide weather information to the pilots, which included obtaining information from other operators; the DO would ask the flight scheduler if the other operators were out flying, and, if not, it was a “red flag.” If they had already done a weather check, they could see it on the flight tracking display and would wait to hear. In the past, when the weather had been questionable, the DO had told the flight coordinator to have someone go check. According to the DO, flight schedulers had very limited operational control (almost none).

When asked about the provision of Promech’s GOM that stated that responsibility for operational control could be delegated to the flight scheduler and/or pilots for initiating and canceling the flights, the DO said that, if no managers were at the office, the pilot and flight scheduler could work together to decide whether to release a flight.

When asked about the provision of the GOM that stated that both the pilot and flight scheduler had to agree to a flight before it departed and about how that factored into the decision-making process, the DO said that it would be a joint effort between the scheduler and pilots looking at all of the available weather information (including the Misty Fjords and other area weather cameras). He said he thought there could be a time when the pilots might want to go and the flight scheduler might say, “I’m not sending you,” but normally it was discussed and decided between the pilots and flight scheduler. He said he did not think that a flight coordinator would say not to go and the pilots would overrule that decision.

When the DO was asked if he sampled the operational control delegates’ performance of the operational control function, he said that he did and gave the following example: Occasionally pilots would cancel a 0930 tour because they had gone out, turned around, and come back, and the managers would say, “good call,” because the pilots had exercised that decision-making authority, and those decisions had been appropriate.

The flight scheduler who was on duty on the day of the accident said that she did not have any conversations with the accident pilot on the day of the accident beyond normal greetings and receipt of a weather report from him when he was outbound on his first tour. The only member of management on duty that morning was the company president/CEO. He stated that he did not have any conversations with the accident pilot before the first tour and that their subsequent communications consisted only of routine greetings. When asked to summarize who had overall responsibility for operational control of flights, the flight scheduler stated that the company president/CEO, the DO, and the director of maintenance had full operational control. When asked whether they delegated operational control to the flight scheduler and the pilot jointly for each specific flight, she said yes.

According to Part 135 regulations, personnel authorized to exercise operational control must be qualified through training, experience, and expertise. Specifically, 14 *CFR* 119.69, "Management Personnel Required for Operations Conducted Under Part 135 of this Chapter," states, in part, the following:

> …[a]nyone in a position to exercise control over operations conducted under the operating certificate must—(1) Be qualified through training, experience, and expertise; (2) to the extent of their responsibilities, have a full understanding of the following material with respect to the certificate holder's operation—(i) Aviation safety standards and safe operating practices; (ii) 14 CFR Chapter I (Federal Aviation Regulations); (iii) the certificate holder's operations specifications; (iv) all appropriate maintenance and airworthiness requirements of this chapter …; and (v) the manual required by section 135.21 of this chapter; and (3) Discharge their duties to meet applicable legal requirements and to maintain safe operations.

The flight scheduler who was on duty at the time of the accident held a private pilot certificate and had worked at Promech for 5 years. She stated that this was her third summer working as flight scheduler and that her training for her duties consisted of studying the GOM and operations specifications and receiving on-the-job training. She could not recall how long her initial training lasted, and she had not received any recurrent training.

1.8.4 Tour Routes and Weather Minimums

As previously described, Promech's pilots could choose to take either the short route or the long route between Ketchikan and Rudyerd Bay. Although the long route was less scenic, it was generally preferred in poor weather because it was primarily over water, which enabled the pilots to fly at lower altitudes (beneath cloud layers) and perform an emergency or precautionary landing, if needed. Route choice was at each pilot's discretion based on the pilot's assessment of the weather.

Per the VFR minimum altitudes specified in 14 *CFR* 135.203, Promech's flights were authorized to operate as low as 500 ft above the surface.[17] The basic weather minimums specified in 14 *CFR* 135.205(a) state that no person may operate an airplane under VFR in uncontrolled airspace when the ceiling is less than 1,000 ft unless the flight visibility is at least 2 miles. Title 14 *CFR* 91.155 states that, for day VFR flight in uncontrolled airspace, when flying 1,200 feet or less above the surface, flight visibility must be 1 mile and clear of clouds.[18] Promech's GOM, section 4.12, specified that the company would release no flight under VFR unless the en route ceiling and visibility (as indicated by available weather forecasts or reports, or a

[17] The regulation states that, except when necessary for takeoff and landing, no person may operate an airplane under VFR during the day below 500 ft above the surface or less than 500 ft vertically from any obstacle.

[18] Pilots operating under Part 135 must adhere to the more conservative of any applicable Part 135 or Part 91 regulation. Considering the two regulations, a pilot operating under Part 135 is permitted to operate in uncontrolled airspace with 1 mile visibility provided that the ceiling is above 1,000 ft.

combination thereof) are and will remain at or above applicable weather minimums for VFR operation at the landing areas.

Promech pilots could communicate with each other while en route by using local advisory frequencies and could locate each other's flights on a traffic information display inside the cockpit of each airplane. New Eddystone Rock (which is an island in the center of Behm Canal) was the location where pilots normally changed from one advisory frequency to another. This was also the location where pilots on the return leg of the tour decided which route they were going to take back to Ketchikan. Because the airplanes flew over New Eddystone Rock a few minutes apart, all pilots were not always listening to or communicating on the same frequency at the same time.

1.8.4.1 Tour Pilots' Route Decisions during the Accident Tour

The four Promech airplanes (the three DHC-3s and one DHC-2) scheduled for the 1100 tour group (which included the accident flight) departed Ketchikan on the outbound leg between 1118 and 1120, with the accident pilot taking off at 1120; all four airplanes took the long route. As the airplanes were departing, the company president/CEO made a radio transmission to them; he told investigators that the content of this transmission was, "Hey guys, don't forget about your 1230 all-aboard." According to the company president/CEO, as the group of airplanes was headed for Point Alava (see figure 1), one of the DHC-3 pilots (the accident pilot's close friend) transmitted that the weather was looking "wide open" and that the short route would be preferred on the way back. ADS-B data showed that one other tour operator also departed on the outbound leg of a tour on the short route, taking off from Ketchikan about 1052.

On the return leg of the tour, the pilot of the first Promech flight to depart Rudyerd Bay said that he decided to take the short route based on his personal observations that the weather was generally improving, his own visual assessment of the weather conditions in Ella Narrows, and a response (via radio) from another operator's pilot (the one that had departed Ketchikan on the outbound leg around 1052 and was on a return leg in the Ella Lake area about the same time as the Promech flights) describing the weather conditions over Ella Lake as good. This first Promech flight reached Ella Lake several minutes before the accident flight. NTSB investigators interviewed the pilot from the other tour company who had been flying a tour near Ella Lake and who had communicated via radio with the first Promech flight to depart. (This other tour company pilot was flying the DHC-2 airplane that is visible in figure 14, the image taken by a passenger on board the first Promech flight.) This pilot, who had more than 12,000 hours of Alaska flying experience, said that he told the first Promech pilot that the weather looked good around Ella Bay and that there were a couple of clouds but no ragged bottoms. He said that he felt that the short route was more scenic, so he decided to fly it.

The pilot of the second Promech flight to depart Rudyerd Bay said that he chose the long route because he saw low clouds hanging in Ella Narrows and was not happy with what he heard other pilots saying on the radio about the conditions. He said he recalled hearing fragments of radio conversations between pilots ahead of him, specifically the words "scattered layers" and "ragged." He told investigators that he had been forced to turn around in Ella Lake earlier in the day because of poor weather conditions and that he wanted to avoid having to do it again. He decided to fly the long route but did not broadcast his intentions on the radio.

Data recovered from the Chelton EFIS showed that the accident flight (the third Promech flight to depart) changed course upon reaching New Eddystone Rock and proceeded into Ella Narrows. The data showed that one Promech airplane and an airplane from another operator transited the area on the short route about 5 to 10 minutes before the accident flight.

The pilot of the fourth Promech flight to depart Rudyerd Bay said that he initially intended to fly the long route. He said that he subsequently overheard fragments of communication between the accident pilot and the other pilots ahead of him and radioed the accident pilot to ask about the conditions in Ella Lake. He recalled that the accident pilot was unable to provide any detailed information because he was not yet far enough into Ella Narrows to see Ella Lake. However, this pilot said that he thought that the conditions in Ella Narrows looked good, so he decided to return to Ketchikan via that route. He followed the accident pilot's flight, which he could see depicted on his traffic display about 3 miles ahead of his flight.

1.8.4.2 Tour Pilots' Route Selections during Previous Tours on the Day of the Accident

First Tour Group (0800)

Promech's first tour group of the day, which was scheduled to depart at 0800, involved three airplanes, one DHC-2 and two DHC-3s, including the one flown by the accident pilot. ADS-B data revealed that the group departed Ketchikan between 0756 and 0800. The accident pilot was the first to depart and flew the short route outbound to Rudyerd Bay. The data showed that his flight rounded Mountain Point about 600 ft msl and climbed to 2,900 ft by the time it reached Gokachin Lakes. The flight transited Gokachin Lakes about 2 miles south of Ella Lake and proceeded northeast over Behm Canal to Rudyerd Bay at 3,000 ft msl. According to the flight scheduler, the accident pilot radioed that the weather on the short route was good with isolated rain showers.

The other two Promech pilots on the 0800 tour flew the long route outbound. ADS-B data showed that they climbed to 600 to 700 ft msl by Mountain Point but then descended as low as 200 ft msl near Bold Island. Next, they rounded Point Alava about 500 to 600 ft msl and then climbed to 2,000 ft msl while flying north up Behm Canal. The flight scheduler stated that the pilots who flew the long route said the conditions were "not great" but above minimums. For the return leg to Ketchikan, all three pilots attempted the short route but each eventually altered course to join the long route instead. The accident pilot, who departed alone about 15 minutes ahead of the other two flights, executed a course deviation that consisted of a circuitous route that included course reversals and substantial changes in altitude; he returned to Ketchikan on schedule.

Second Tour Group (0930)

The second tour was scheduled to depart at 0930. The accident pilot departed about 0940 and was the fourth of six Promech airplanes (three DHC-2s and three DHC-3s) that departed between 0934 and 0947. All of the Promech airplanes flew the long route outbound to Rudyerd Bay. Five of the six airplanes descended below 500 ft msl over the water between Bold Island and Point Alava (the accident pilot descended to 325 ft, and the other pilots to altitudes as low as 250 ft). The company president/CEO, who was flying a DHC-2, maintained a minimum altitude of 625 ft msl while transiting that area. On the way to Point Alava, some of the Promech airplanes passed a DHC-2 operated by Taquan Air's DO who was performing a weather check. The Taquan DO said that, as a result of this flight, he determined that the weather conditions between Ketchikan and Point Alava were not adequate for Taquan to operate tours because the flights could not maintain the required minimums in that area.

All six Promech airplanes flew the return leg via the long route, and all descended below 500 ft msl over the water between Point Alava and Bold Island, with the accident pilot flying as low as 375 ft and the company president/CEO flying as low as 250 ft. One pilot of a Promech DHC-2 flew as low as 225 ft above the water. He told investigators that it was his first flight of the day and that, when he arrived for work that morning, he expressed concern to Promech's president/CEO about the weather conditions but (as described in section 1.8.2) his concerns were dismissed. This pilot stated that, during the tour, the weather conditions encountered were so bad that he felt lucky to return from this flight and was surprised that the company continued operating that day. He recalled feeling relieved when he learned while inbound that he would not have to fly his next tour because there were not enough paying passengers. The six Promech airplanes landed in Ketchikan between 1053 and 1103, with the accident pilot landing last.

According to ADS-B data, at least four other operators were flying tours during this period. The owner and operator of one company told investigators that, after flying this tour, she decided to cancel her next tour.

1.8.5 CFIT-Avoidance Training

The CFIT-avoidance training program that Promech used (and on which the accident pilot was trained) was a voluntary training program that included materials and concepts designed specifically for commercial air tour operators in Southeast Alaska. Some training content was developed as part of a cue-based training project by a collaboration between the FAA's Juneau flight standards district office (FSDO), local operators in Southeast Alaska, the Medallion Foundation, and the National Institute for Occupational Safety and Health/Centers for Disease Control and Prevention, in response to NTSB Safety Recommendation A-08-61 (see section 1.9.2.1 for more information). As of the 2011 Alaska summer air tour season, all air tour operators in Southeast Alaska included, as part of their training programs, materials and concepts developed as part of the cue-based training project.[19]

Promech's *CFIT Avoidance Manual,* which was created in conjunction with the Medallion Foundation, described the policies and procedures for company pilots to use for CFIT avoidance during all phases of flight. The manual specified that initial new-hire pilots, all pilots receiving recurrent training, and any pilot needing requalification (due to not having received recurrent

[19] The Alaska summer air tour season runs from May to September.

training and/or a required flight or competency check within the appropriate period) were eligible for CFIT-avoidance training. Per Promech's *CFIT Avoidance Manual*, the training used a combination of ground training and instruction in an FAA-approved ATD. Both the ground training and ATD curriculum outlined in the manual included segments on recognition of loss of visual reference, situational awareness, and aeronautical decision-making topics.

Medallion's BATD, in which the accident pilot trained, consists of three 27-inch monitors for the out-the-window view, one smaller monitor for cockpit instrumentation, and physical flight and aircraft system controls (see figure 15). The BATD does not have (and is not required to have) a navigation information display (like the moving map capability of the Chelton EFIS installed in the accident airplane). The BATD uses X-Plane® software and has a separate monitor for the instructor's station.

The cue-based training module that the accident pilot completed in the BATD included a scenario that required him to escape an inadvertent encounter with IMC by reversing course. NTSB investigators observed a demonstration of the training module, which involved an overwater flight with progressively decreasing cloud ceiling and visibility. Investigators noted that both the ceiling height and forward visibility were uniform and transitioned abruptly when adjusted by the instructor. Also, the terrain features and ground texture were not photorealistic.

Figure 15. Medallion Foundation BATD and CFIT-avoidance training scenario.

When asked about the usefulness of the training, the DO said he thought it might be helpful but had a "hard time believing that a person would blindly keep flying along without turning around if they did not have the training." The owner of (and pilot for) another local air tour operator expressed the opinion that the simulation can only do so much and that the real world is different. This owner/pilot said that a simulator cannot duplicate the real-world conditions of getting bounced around by turbulence while talking on the radio and trying to see through a pass.

Company records showed that the accident pilot also had practiced a 180° (course reversal) inadvertent-IMC escape maneuver in a Promech DHC-3 airplane while using a view-limiting device. However, the DO (who provided the CFIT-avoidance training) and a Promech pilot who completed the training with the accident pilot differed in their assessments of the accident pilot's performance. The DO stated that the accident pilot performed well in training, including performing the escape maneuver to reverse course perfectly in both the DHC-2 and DHC-3 airplanes. The DO said that the accident pilot also spent a great deal of his own time using the company's Chelton simulator to learn the system and that he used it well in the airplane. The other Promech pilot said that the accident pilot experienced difficulty performing the CFIT-avoidance maneuver and, instead of making a level 180° turn as expected, the accident pilot made a descending 270° turn and flew the airplane toward another ridge. The Promech pilot also said that he expressed concern to the DO about the accident pilot's readiness to transition to the DHC-3, but the DO expressed confidence in the accident pilot's flying abilities.

1.8.6 FAA Oversight

The Juneau FSDO was responsible for the oversight of Promech's certificate. The principal operations inspector (POI), who had been assigned to Promech since about 2008 or 2009, was also responsible for about 20 other certificates. A review of FAA program tracking and reporting system (PTRS) records showed that the POI had completed three required inspections of Promech between July 17, 2013, and the date of the accident, including an operational control inspection on April 6, 2015, which was closed with a "satisfactory" outcome. No comments were noted in the PTRS record.

The POI described the relationship between Promech and the FAA as cooperative and responsive. He stated that he believed that Promech was operating safely and was not a higher risk operator. Regarding flight risk assessment, the POI said that he thought Promech had a program in development, but nothing had been completed before the accident.

FAA Order 8900.1, volume 3, chapter 25, section 5, 3-2029, J, "Summary of Operational Control," states, in part, that only approved persons may exercise operational control on the certificate holder's behalf and that the certificate holder must have adequate controls in place to ensure that officials in a position of authority over flights conducted under the certificate do so safely, and in compliance with the regulations, operations specifications, the GOM, and accepted or approved procedures.

FAA Order 8900.1, volume 3, chapter 25, section 5, 3-2029, E, "Operational Control Failures," states, in part, that "failure in operational control requires action by both the certificate holder and the FAA." The order identified operational control failure modes, including at least the following basic conditions:

1) Loss of operational control within the air carrier—hands-off management results in inadequate controls over its own operations.
2) Loss of operational control within the air carrier—exercise of operational control by an unapproved person.

3) Loss or surrender of operational control externally (e.g., an air carrier's illegal renting/franchising-out the use of its air carrier certificate to one or more uncertificated entities).

The POI described that, for operational control, Promech had white boards that listed pilots and airplanes in the dispatch office. He said that the chief pilot and the DO ensured that everyone was current and qualified, and the company also used company flight plans. The POI said that the chief pilot, DO, and anyone to whom they delegate the authority could exercise Tier 1 operational control.[20] The POI said that 14 *CFR* Part 119 management personnel are authorized to exercise operational control and thought that the flight schedulers were also authorized but first needed approval from management.

The POI had never observed flight scheduler training at Promech. The flight scheduler training was not part of the crewmember training program, and the POI was unsure if Promech had a written program for it. He had never looked at flight scheduler training records and was not aware of any requirements to be a flight scheduler at Promech. When asked how flight schedulers were qualified as required by 14 *CFR* 119.69, he said that he was not sure how the qualification was accomplished but that the flight schedulers would have to be watched and trained until they could perform the job adequately.

1.8.7 Medallion Foundation Participation

The Medallion Foundation, Inc., is a nonprofit organization with an Internal Revenue Service 501(c)(3) tax exemption status and receives federal, state, and private funds. It was created in 2001 by the Alaska Air Carrier's Association with the goal of improving aviation safety in Alaska and reducing commercial air carriers' insurance rates. In 2002, the Medallion Foundation signed a grant agreement with the FAA "to launch a major statewide aviation safety program to establish safety standards that exceed regulatory requirements through the detection of safety trends or needs before actual accidents occur."[21]

The Medallion Foundation has a Shield Program for operators, which, according to its website, focuses on creating and maintaining a higher level of safety using system safety and SMS principles. In order to obtain a shield, an applicant would first need to earn a "star" in each of the following categories: CFIT avoidance, operational control, maintenance and ground service, safety, and internal evaluation. To earn a "star," an applicant organization must complete specific training classes, produce a required manual, and undergo an external audit to determine if the

[20] FAA Order 8900.1, volume 3, chapter 25, section 5, 3-2029, H, states, in part, that the first-tier operational control, which is described as the assignment of flight crewmembers and aircraft for revenue service, must be exercised by company management or management delegates. The order states that any management delegates must be trained, found competent, designated by the certificate holder, listed in the GOM, and be under management supervision, which includes tracking the actions of the delegate and reviewing samples of decisions made.

[21] For more information about the Medallion Foundation's history and programs, see the Medallion Foundation's website (http://medallionfoundation.org/, accessed February 21, 2017).

company has incorporated the information into its corporate culture. Annual independent audits would follow the initial audit.

Promech's president/CEO stated that the company had achieved the Shield Program's CFIT-avoidance star and that the safety star was in progress. When asked if the safety star was like an SMS, he said that it was. He noted that SMS was not a requirement, but Medallion was working with Promech to start an SMS.

1.9 Additional Information

1.9.1 Cruise Line Sales of Air Tours

Ketchikan and other Southeast Alaska cities (including Juneau, Sitka, and Skagway) are a popular stopover for many cruise ship operators during the summer tour season. In 2015, an estimated 945,000 cruise ship passengers visited Ketchikan alone.[22] Area attractions served by air tours include Misty Fjords National Monument, bear-viewing destinations, and harbor tours. A review of NTSB accident data revealed that, including this crash, in the 8-year period between 2007-2015, there have been four fatal crashes involving cruise ship passengers on air tour flights in Alaska.[23]

The passengers on board the accident flight were from the Holland America Line cruise ship *Westerdam* and had purchased the tour through the cruise line as a shore excursion.[24] Consistent with cruise industry practice, the cruise line marketed and sold the air tours to its passengers either online or on board the ship and earned a percentage of the sales price for tours flown. According to the product manager for the cruise line's shore excursion department, one benefit of purchasing a shore excursion through the cruise line (rather than from the air tour operators directly) is that cruise ship guests incur no expenses if a late-returning excursion delays the ship's departure (or causes the guests to miss its departure). According to the cruise line's senior director for shore excursions, if a ship sailed without guests who were delayed due to a late arriving tour, the tour operator would be responsible for the accommodations and travel expenses associated with delivering those passengers to the ship's next port of call. She said that it was very rare for a tour to be late and cause guests to miss the "all aboard."

[22] Passenger data are published by the Ketchikan Visitors Bureau (KVB). According to the KVB, cruise ship operators that stop in Ketchikan include Carnival Cruise Lines, Celebrity Cruises, Disney Cruise Lines, Holland America Line, Norwegian Cruise Line, Princess Cruises, Regent Seven Seas Cruises, Royal Caribbean International, and Silversea Cruises. For more information, see the 2016 Cruise Ship Calendar on KVB's website (www.visit-Ketchikan.com, accessed February 24, 2017).

[23] The brief report for each event summarized in this accident report can be searched by case number from the NTSB's Aviation Accident Database web page, and each investigation's public docket can be accessed from the NTSB's Accident Dockets web page. NTSB documents, including safety recommendations, referenced in this report are accessible from the NTSB's Aviation Information Resources web page (www.ntsb.gov/air). For more information, see NTSB case numbers ANC13FA054, ANC07MA083, and ANC07FA068.

[24] Holland America Line is one of 10 brands under Carnival Corporation and PLC, the world's largest leisure travel company.

The shore excursion manager for the ship stated the decision to fly or cancel a tour remains exclusively with the air tour operator. For the day of the accident, the cruise line sold tours operated by both Promech and Taquan. After Taquan decided to cancel its tours due to concerns about the weather, the cruise line rebooked the Taquan passengers onto Promech flights.

The shore excursion manager stated that, about 1200 on the day of the accident, she was on the dock working to receive the returning tours, which involved communicating with the ship's navigation bridge and the security officer regarding tour arrival times back to the ship; she said that, in Ketchikan, there is a "big push" to get everyone on board because the ship has to be at its next port on time. She said that, at 1220, a representative of the bus company responsible for bringing guests from the Promech base back to the ship informed her that an airplane was late.

1.9.2 Previously Issued Safety Recommendations

1.9.2.1 Safety of Air Tours in Southeast Alaska

On July 24, 2007, a float-equipped DHC-2 airplane operated by Venture Travel LLC dba Taquan Air Service as a Ketchikan-area Part 135 air tour flight collided with terrain in IMC, fatally injuring the pilot and all four passengers.[25] As a result of our investigation, on July 31, 2008, the NTSB issued Safety Recommendations A-08-59 through -62 to the FAA to improve the safety of Southeast Alaska air tour operations.

Safety Recommendation A-08-59

> Install and maintain weather cameras at critical areas of air tour routes within the Misty Fjords National Monument and other scenic areas in Southeast Alaska that are frequently traveled by air tour operators.

In a February 25, 2011, response, the FAA stated that it installed 10 weather camera facilities (which included weather cameras referenced in this investigation) along critical tour routes in Southeast Alaska. As a result, on June 7, 2011, the NTSB classified Safety Recommendation A-08-59 "Closed—Acceptable Action."[26]

Safety Recommendation A-08-60

> Develop a permanent mechanism to provide en route and ground-based observations of air tour flights in Southeast Alaska at least once a month during the tour season to ensure operators are adhering to safe flying practices.

On December 13, 2013, the FAA responded that, in fiscal year 2010, it permanently added en route inspections of air tour operators to FAA Order 1800.56, "National Flight Standards Work

[25] For more information about this accident, see NTSB case number ANC07FA068.

[26] See the correspondence history for Safety Recommendation A-08-59.

Program," which was followed by a special emphasis program for Southeast Alaska using its surveillance priority index tool to ensure that inspectors conduct at least 10 unannounced en route inspections and 15 ramp surveillances of area operators. As part of the program, inspectors conduct two ground-based surveillance activities per year of air tour operators in and around the Misty Fjords and Traitor Cove areas, among other activities. Although the FAA's program allowed for fewer inspections than recommended, the NTSB believed that the FAA's implementation of unique surveillance activities appropriate to the Alaska tour environment would let all air tour operators know that the FAA is observing their operations. As a result, on March 21, 2014, the NTSB classified Safety Recommendation A-08-60 "Closed—Acceptable Alternate Action."[27]

Safety Recommendation A-08-61

> 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.

In 2008 and 2009, the FAA indicated that it was collaborating with various organizations to develop a voluntary cue-based training program, and on January 4, 2012, the FAA informed the NTSB that all commercial air tour operators in Southeast Alaska were providing this training to their pilots. As a result, on March 28, 2012, the NTSB classified Safety Recommendation A-08-61 "Closed—Acceptable Action."[28]

Safety Recommendation A-08-62

> 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.

On April 3, 2012, the FAA responded that, as of the 2011 Alaska (summer) air tour season, all air tour operators in Southeast Alaska had incorporated the training into their programs. As a result of the FAA's action and assurances of continued monitoring of tour operator compliance with the training through regular surveillance, on June 14, 2012, the NTSB classified Safety Recommendation A-08-62 "Closed—Acceptable Alternate Action."[29]

[27] See the correspondence history for Safety Recommendation A-08-60.

[28] See the correspondence history for Safety Recommendation A-08-61.

[29] See the correspondence history for Safety Recommendation A-08-62.

1.9.2.2 SMS for Part 135 Operators

As a result of our investigation of the November 10, 2015, fatal accident involving a British Aerospace HS 125-700A airplane that departed controlled flight while on approach to an airport in Akron, Ohio, on November 3, 2016, the NTSB issued Safety Recommendation A-16-36 to the FAA recommending SMS for all Part 135 operators (NTSB 2016).

Safety Recommendation A-16-36

Require all 14 [*CFR*] Part 135 operators to establish [SMS] programs.

On January 9, 2017, the FAA responded that, while SMS is not currently required of Part 135 operators, the FAA has a formal SMS voluntary program in which Part 135 operators may participate. The FAA indicated that it would conduct a review to determine the feasibility of recommending SMS for Part 135 certificate holders and determine if further action is needed. Based on this response and pending the FAA's completion of planned responsive action, the NTSB classified Safety Recommendation A-16-36 "Open—Acceptable Response" on April 6, 2017.[30]

1.9.2.3 Crash-Resistant Flight Recorder Systems

On August 26, 2011, a Eurocopter AS350 B2 helicopter crashed following a loss of engine power as a result of fuel exhaustion in Mosby, Missouri, fatally injuring the pilot, flight nurse, flight paramedic, and patient. The emergency medical services (EMS) helicopter was operated by Air Methods Corporation, doing business as LifeNet in the Heartland, as a Part 135 medical flight. The helicopter was not equipped, and was not required to be equipped, with any onboard recording devices.

The investigation revealed that the pilot did not comply with several company SOPs that, if followed, would have led him to detect the helicopter's low fuel state before beginning the first leg of the mission. However, because the helicopter was not equipped with any type of recording device, the pilot's control inputs in response to the loss of engine power, the helicopter's altitude and airspeed in the final 30 to 50 seconds of the flight, the area where the pilot's attention was directed, and the brightness setting on the caution/warning annunciator panel were unknown (NTSB 2013). As a result, on May 6, 2013, the NTSB issued Safety Recommendations A-13-12 and -13 to the FAA regarding crash-resistant recorders.

Safety Recommendation A-13-12

Require the installation of a crash-resistant flight recorder system on all newly manufactured turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder and a cockpit voice recorder and are operating under 14 [*CFR*] Parts 91, 121, or 135. The crash-resistant flight recorder system should record cockpit audio and images with a view of the cockpit

[30] See the correspondence history for Safety Recommendation A-16-36.

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, "Information Collection and Monitoring Systems."

Safety Recommendation A-13-13

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 [*CFR*] 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 [TSO] C197, "Information Collection and Monitoring Systems."

These safety recommendations are the latest in a series of recommendations that the NTSB has issued since 1999 regarding the need for crash-resistant flight recorder systems on new and existing aircraft that are not already required to have such recorders, as shown in the following table.

Table. Safety recommendations preceding A-13-12 and -13.

Recommendation number	Outcome
A-99-60	Classified "Closed—Superseded." Superseded by A-03-64 on December 22, 2003.
A-03-62	Classified "Closed—Unacceptable Action/Superseded." Superseded by A-09-9 on February 9, 2009.
A-03-63	Classified "Closed—Unacceptable Action" on October 27, 2009.
A-03-64	Classified "Closed—Unacceptable Action/Superseded." Superseded by A-09-10 on February 9, 2009.
A-03-65	Classified "Closed—Unacceptable Action/Superseded." Superseded by A-09-11 on February 9, 2009.
A-09-9	Classified "Closed—Unacceptable Action" on June 11, 2012.
A-09-10	Reiterated on June 9, 2011. Classified "Closed—Unacceptable Action" on June 11, 2012.
A-09-11	Reiterated on June 9, 2011. Classified "Closed—Unacceptable Action" on June 11, 2012.

Note: A-99-60 was issued as part of the investigation of DCA98MA002. A-03-62 through -65 were issued as part of several investigations, including DCA03MA008. A-09-09 through -11 were issued as part of the investigation of LAX07MA231A and LAX07MA231B. A-09-10 and -11 were reiterated as part of the investigation of ANC10MA068.

Regarding Safety Recommendations A-13-12 and -13, on August 1, 2013, the FAA stated that it had responded to similar safety recommendations, including A-09-9 through -11, and that the position stated in its last two letters to the NTSB regarding those recommendations (dated February 15, 2011, and January 27, 2012) had not changed. The FAA repeated that it did not intend to mandate crash-resistant flight recording systems on all turbine-powered, nonexperimental, nonrestricted-category aircraft because (1) the rulemaking environment required new regulations to have "a positive economic cost-benefit to society"; (2) the FAA could not "place a quantitative benefit" for mandating crash-resistant flight recording system equipage; and (3) data from crash-resistant flight recording systems were primarily used for risk identification, evidence-based decision-making, enhanced training scenarios, risk mitigation, and remedial action effectiveness.

On December 10, 2013, the NTSB stated that it continues to investigate accidents in which crash-resistant flight recorder systems would have provided vital, detailed information regarding the circumstances of the accidents, but the FAA has not yet required the installation of such systems. The NTSB further stated that the lack of crash-resistant flight recorder systems in aircraft remains an important safety issue and, as a result, classified Safety Recommendations A-13-12 and -13 "Open—Unacceptable Response."

On May 23, 2016, the FAA responded that crash-resistant flight recorder systems would provide a visual account of crew actions and parametric data to use for accident investigation but indicated that it still did not intend to mandate such systems on all turbine-powered, nonexperimental, nonrestricted-category aircraft because of significant costs and the limited ability to assess benefits.[31] The FAA stated that, because rulemaking to mandate such recorders on these aircraft was not a viable option, the agency adopted a position of "promoting and incentivizing" the voluntary equipage of image recorders through the use of the following three documents:

- TSO-C197, which provides the minimum operational performance standards for recording systems, including audio and image recorders, and standardizes the design and production certification requirements for equipment manufacturers to streamline aircraft installation and integration;

- "Helicopter Air Ambulance, Commercial Helicopter, and Part 91 Helicopter Operations, Final Rule" (79 *Federal Register* 9931), which requires (in section 135.607) that helicopters conducting air ambulance operations be equipped with flight data monitoring (FDM) systems by April 23, 2018 (NARA 2014); and

- "Helicopter Flight Data Monitoring – Industry Best Practices," which, according to the FAA, is an "excellent" resource for the rotorcraft community and has information that can be applied generally to airplane operations, including incentives for the voluntary equipage of FDM systems.

On August 11, 2016, the NTSB stated it considered the FAA's framework for "promoting and incentivizing" the voluntary equipage of image recorders and determined that the issuance of TSO-C197 was a positive action but did not satisfy the intent of the recommendations. The NTSB also determined that the final rule did not address all turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with flight data recorders or cockpit voice recorders and that the requirement addressed in the final rule would not promote the voluntary equipage of image recorders on those aircraft.

[31] The FAA had previously responded to these recommendations in an August 14, 2014, letter, and the NTSB response to this FAA letter was dated November 17, 2014.

In addition, the NTSB determined that, although the "Helicopter Flight Data Monitoring – Industry Best Practices" publication provided beneficial guidance for establishing and operating an FDM program, the publication did not promote such a program. The NTSB further noted that it would be unlikely that those not involved with helicopter operations would refer to this document.

The NTSB stated that the FAA, as part of its evaluation of these recommendations, should review the safety improvements that have been implemented because of the information learned from recorder data. Specifically, for some improvements, safety risks would not have been identified, or would not have been sufficiently understood to develop a mitigation, without the recorder data. The NTSB also stated that such a review should acknowledge the number of accidents that the NTSB investigated in which the probable cause could not be determined because of the lack of recorder data. The NTSB believed that such information would be important for developing the needed cost-benefit analyses that the FAA stated was necessary to justify rulemaking for crash-resistant flight recorder systems. On March 28, 2017, when the NTSB met to determine the probable cause of a July 3, 2015, fatal accident involving an Airbus Helicopters AS350 B3e that crashed following a loss of control at takeoff in Frisco, Colorado, the NTSB voted to reiterate Safety Recommendations A-13-12 and -13, which remain classified "Open—Unacceptable Response" (NTSB 2017).[32]

1.9.2.4 CFIT-Avoidance Training for Part 121 Pilots

As a result of our investigation of the December 20, 1995, accident involving American Airlines flight 965, which crashed into a mountain near Buga, Colombia, fatally injuring all but 4 of the 163 passengers and crew on board, we issued Safety Recommendation A-96-95 to the FAA regarding CFIT-avoidance training for Part 121 pilots.

Safety Recommendation A-96-95

> Develop a controlled-flight-into-terrain training program that includes realistic simulator exercises comparable to the successful wind shear and rejected takeoff training programs and make training in such a program mandatory for all pilots operating under 14 *CFR* Part 121.

In response to Safety Recommendation A-96-95, in January 1997, the FAA and Boeing developed and published the "Controlled Flight into Terrain Education and Training Aid," which was distributed to all Part 121 and 135 operators for inclusion in their training programs. On February 25, 1997, the FAA issued Change 2 to AC 120-51B, "Crew Resource Management [CRM]," which recommended CRM training for cockpit crewmembers that contains a CFIT scenario.

[32] See the correspondence history for Safety Recommendation A-13-12 and the correspondence history for A-13-13.

On November 13, 1997, the NTSB informed the FAA that, although we appreciated the progress these actions represented, the newly developed training had not been mandated for all pilots operating under Part 121, as requested in the second part of this recommendation. On August 11, 1999, the FAA replied that it was preparing a notice of proposed rulemaking (NPRM) to revise Part 121, subparts N and O, proposing to require the recommended training. The revisions to Part 121, subparts N and O, were addressed in the January 12, 2009, NPRM, and a May 20, 2011, supplemental notice of proposed rulemaking (SNPRM) regarding pilot training for Part 121 operations. Each document contained the proposed requirement, and, in the NTSB's comments on each document, we stated that, if implemented as proposed, the final rule would satisfy this recommendation. Unfortunately, the November 12, 2013, final rule based on the SNPRM did not contain the relevant provisions.

Subsequently, the NTSB discussed with FAA staff other actions taken that might have addressed the need for this requirement in an alternate manner. FAA staff stated that, on March 29, 2000, the FAA had published the final rule, which required in 14 *CFR* 121.354 the installation and use of a TAWS in aircraft operated under Part 121. Title 14 *CFR* 121.354(c) requires that the airplane flight manual contain appropriate procedures for (1) the use of the TAWS and (2) proper flight crew reaction in response to a TAWS warning. Further, under 14 *CFR* 121.415 and 135.293, certificate holders are required to ensure that each crewmember is qualified in the procedures and techniques used with all of the equipment on the aircraft operated by the certificate holder, including TAWS. Although the FAA did not mandate the training described in the CFIT Education and Training Aid, the requirements of 14 *CFR* 121.354, 121.415, and 121.354 satisfied the recommendation in an alternative manner. Consequently, on March 18, 2014, Safety Recommendation A-96-95 was classified "Closed—Acceptable Alternate Action."[33]

[33] See the correspondence history for Safety Recommendation A-96-95.

2. Analysis

2.1 General

The pilot was properly certificated and qualified in accordance with federal regulations and company requirements.

Information about the pilot's activities before the accident (derived from his work schedules, interviews, and PED records) showed that the pilot had sleep opportunities greater than 7 hours per night during the 3 nights before the accident. He was not subjected to any circadian disruptions, and the time of the accident did not coincide with a window of circadian low. At the time of the accident, the pilot had not been awake for a lengthy period of time and had not completed a high number of flight legs or flown a substantial number of flight hours. In addition, the pilot had no significant known medical conditions or toxicological findings.[34] Thus, no evidence was found indicating that the pilot's performance was affected by fatigue, medical conditions, toxins, alcohol, or other drugs.

Promech maintained the airplane in compliance with all required AAIP inspections and on-condition engine maintenance and propeller overhaul requirements per the company's operations specifications. The airplane had no outstanding maintenance items that would have precluded its normal operation.

Examination of the wreckage at the accident site revealed that damage to the airplane and the surrounding trees was consistent with a wings-level, nose-up attitude at the time of the collision with the near-vertical, tree-covered terrain. The entire airplane and all control surfaces were located at the main wreckage site. Control continuity was established to all of the flight controls, taking into account the impact damage, the cables that were cut to facilitate wreckage recovery, and the tension overload signatures on the control cables that were found separated. The power lever, propeller lever, and condition lever were positioned aft of their normal in-flight positions with the instrument panel deformed down into them; thus, the engine controls were likely in the cruise settings during flight but moved during the impact sequence. Engine damage signatures were consistent with operation at the normal high power range at the time of impact, and damage to the propeller indicated that it was rotating and in the normal blade angle range at the time of impact. The NTSB concludes that the airplane had no preimpact anomalies that would have precluded its normal operation.

The crew and passenger seat structures were severely damaged and fragmented due to the high loads sustained during the terrain collision, and the floor and sidewall structures of the

[34] The pilot's autopsy identified mild focal narrowing in the pilot's three main coronary arteries, which was not significant and was unlikely to cause symptoms. Although the autopsy also identified focal intraventricular septal fibrosis (scar tissue), a condition that may increase the risk of irregular heart rhythm and possible incapacitation (Morita et al. 2014), the circumstances of the accident, including evidence that the pilot suddenly and aggressively pulled on the elevator flight controls in the final seconds of the flight (described in section 2.2.3), are inconsistent with incapacitation.

airplane were damaged to the extent that they could no longer anchor the seats. Thus, the NTSB concludes that, based on the damage and high loads sustained during the impact sequence, the accident was not survivable.

2.2 Accident Sequence

The accident flight departed at 1207 and was the third of four Promech-operated float-equipped airplanes that departed within minutes of each other from Rudyerd Bay. The accident flight and the two flights that preceded it were returning cruise ship passengers to Ketchikan for a 1230 "all aboard" time; the fourth flight had no passengers but was repositioning to Ketchikan for a tour scheduled at 1230. All of the flights were running behind schedule from the intended 1145 departure time. The accident pilot and two others chose the short route between Rudyerd Bay and Ketchikan (which takes about 25 minutes), while one pilot (the second Promech flight to depart) chose the long route (which takes about 30 minutes). (Section 2.3 provides more information about pilot decision-making regarding route choice.) After landing, the airplane must be taxied to and secured at a dock for the passengers to disembark and board a bus for a 5- to 7-minute ride to the cruise ship.

2.2.1 Weather Conditions

About the time of the accident, multiple weather observation stations in the area (each located about 20 to 30 miles from the accident site) were reporting MVFR conditions (and one was reporting IFR conditions) with visibility restricted in rain and mist. Satellite imagery showed an extensive area of low clouds over the region, including a broken-to-overcast layer with some vertical development consistent with some clouds supporting rain showers. Images from FAA weather cameras located in Misty Fjords (10 miles east of the accident site) and Ketchikan (23 miles southwest of the accident site) showed that the higher ridges were obscured by clouds and that, at times, poor visibility and/or low cloud layers existed in some areas.

The NWS area forecast valid for the accident area for the period before and during the accident flight included an AIRMET advisory for mountain obscuration with MVFR and temporary IFR conditions due to light rain, mist, and low ceilings. There was no record of the accident pilot obtaining any official preflight weather briefing and or reviewing any FAA weather camera images or other weather information sources before the flight. Although Promech pilots used local traffic advisory frequencies to communicate with each other (and other operators' pilots) via radio, the airplane was not equipped with any recording device; thus, any information the accident pilot may have heard over the radio frequencies while en route is not known. The flight scheduler who was on duty the day of the accident did not recall having any preflight conversations with the accident pilot about weather. (Section 2.4.1 provides more information about the flight scheduler's duties.)

Other pilots' descriptions of the weather they encountered, as well as digital photographs and videos taken by passengers (including those on board the accident flight), provided information about weather conditions on the short route. The Promech pilot whose flight transited Ella Lake on the short route about 5 to 10 minutes before the accident flight indicated that the cloud ceiling over the south end of Ella Lake was between 1,400 and 1,600 ft msl (which is about 1,150 to 1,350 ft above the surface of the lake and 800 to 1,000 ft over terrain located south of the lake) and the visibility was slightly restricted by rain but was otherwise good. The Promech pilot whose flight followed the short route about 3 to 4 nm behind the accident flight described that conditions deteriorated as his flight approached the southern portion of the lake, with visibility less than 2 miles in rain and low clouds obscuring mountainous terrain.

Based on all the available weather information, the NTSB concludes that the accident flight encountered deteriorating weather conditions over the southern half of Ella Lake, and, at the time of the accident, the terrain at the accident site was likely obscured by overcast clouds with visibility restricted in rain and mist.

2.2.2 Pilot's Flight Route Deviation

Despite the deteriorating weather conditions in the Ella Lake area, the two other Promech pilots on the short route (one who departed before the accident flight and one who departed after) successfully completed their trips. In reduced visibility weather conditions, Promech pilots typically fly southwest over Ella Lake and proceed beyond the south end of the lake before turning west. This route allows the flights to avoid the high terrain located west of the lake, which includes two similarly shaped mountains. (See figure 16.)

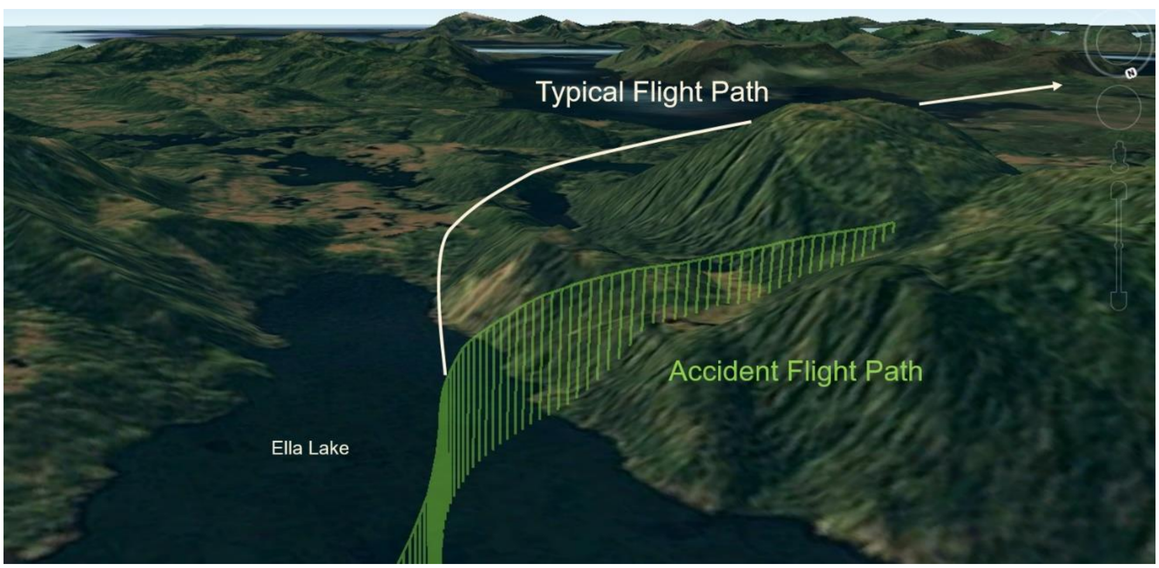

Figure 16. The typical flight route (white) passes two similarly shaped mountains before turning west. For comparison, the path flown by the accident pilot is shown in green.

Although the accident pilot climbed the airplane to an altitude that would have provided safe terrain clearance along the typical route, he deviated from that route and turned the airplane west after it passed only the first of the two mountains. The pilot's route deviation placed the airplane on a collision course with the 1,900-ft second mountain, which it struck at an elevation of about 1,600 ft msl. (See figure 17.)

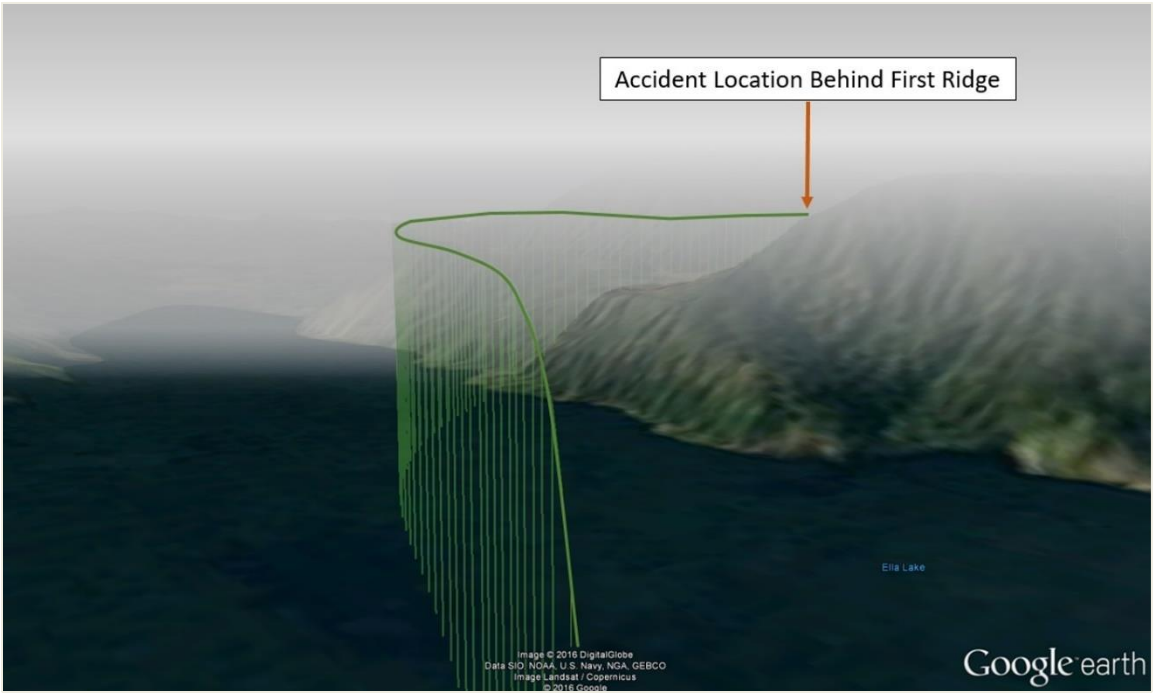

Figure 17. The path flown by the accident pilot (green), viewed from the approximate altitude of the accident airplane, is shown turning to the west (right) after passing the first mountain.

Note: A translucent mask is imposed on the image to provide a notional representation of reduced visibility weather conditions. The vantage point of the image distorts the flight route depiction in the foreground (where the segment of the route originates in the bottom center of the image); there is no steep vertical climb in the flight route at the location shown in the foreground.

Research suggests that, when navigating, people find their way through large-scale environments by learning to identify key landmarks (route knowledge) and developing map-like internal representations (cognitive maps) of the area. When traveling, people use the landmarks to update their position on their internal cognitive map and decide when and where to turn (Golledge 2010). However, a number of factors can increase the likelihood of navigational errors. Navigational errors are more likely if landmarks are difficult to discern or if cognitive maps are inaccurate (Golledge 2010). Landmarks are more difficult to discern when visibility of fine detail is degraded or when landmarks are viewed from an unfamiliar vantage point (Cuqlock-Knopp and Whitaker 1993; Schreiber et al. 1998).

Several factors were present during the accident flight that increased the likelihood that the pilot would make a navigational error.[35] Visibility was degraded over the south end of Ella Lake; thus, the pilot may not have been able to clearly distinguish some of the landmarks by which he typically navigated. In addition, the accident pilot was flying the route at a relatively low altitude because of the poor weather conditions, which resulted in his viewing terrain from a lower-than-normal vantage point. (The accident pilot had transited the area earlier that day about 2,000 ft msl, and other Promech pilots had flown about 2,500 to 3,000 ft msl.) Further, the accident

[35] In addition, some pilots reported that it could be difficult to see directly ahead in the DHC-3 because the turbine engine conversion resulted in less efficient clearance of rain from the windscreen. However, investigators were unable to independently evaluate these claims.

pilot's relatively short time flying in the local area suggests that his cognitive map of the terrain between Rudyerd Bay and Ketchikan may not have been as detailed or accurate compared to those of other pilots who had more local flying experience. Considering all these factors, it is possible that the accident pilot mistook the first mountain for the second one and turned the airplane west too early; such a mistake, in which a pilot does not recognize or maintain the desired position relative to the external ground and airspace environment is an example of geographic disorientation (Antuñano, Mohler, and Gosbee 1989). The fact that the pilot subsequently continued the flight straight and level at an altitude that would have been sufficient to clear terrain on the typical route (but was insufficient to clear the high terrain he was flying toward) further supports the possibility that the pilot was geographically disoriented. Thus, the NTSB concludes that the pilot's continued flight in low-visibility conditions at a lower-than-normal vantage point in an area in which he lacked extensive flying experience reduced his ability to visually identify landmarks and resulted in a navigational error due to geographic disorientation.

2.2.3 CFIT

According to recorded flight data, the airplane's final turn to the west occurred about half-standard rate; then the airplane continued on a nearly straight and level flightpath toward the higher terrain for about 30 seconds. In the final 2 seconds of the flight, the airplane pitched up rapidly, experiencing a vertical acceleration of about +2 Gs before colliding with terrain. The timing of the pilot's aggressive pitch-up maneuver strongly supports the scenario that the pilot continued the flight into near-zero visibility conditions and, as soon as he realized that the flight was on a collision course with the terrain, he pulled aggressively on the elevator flight controls in an ineffective attempt to avoid the collision.

Effective CFIT avoidance requires assessment of weather conditions and appropriate aeronautical decision-making in response to cues associated with deteriorating weather. The pilot missed opportunities to prevent the accident both in his decision to take the short route despite the presence of low clouds and obscured terrain, to turn toward an area of the lake where visibility was further reduced, and to continue the flight into deteriorating conditions rather than escape them. Research on weather-related accidents suggests that expert and novice pilots assess weather differently and that some weather-related accidents may result, in part, from an inaccurate assessment of weather conditions (Wiggins and O'Hare 2003a).

The FAA defines (in 14 *CFR* Part 1) daytime flight visibility as the average forward horizontal distance from the cockpit at which prominent unlighted objects may be seen and identified; additional FAA guidance (in FAA Order JO 7900.5D) states that, if a reference marker "can barely be seen and identified, the visibility is about the same as the distance to the marker." However, several factors can affect the extent to which landmarks are identifiable or barely visible to a pilot flying in poor visibility conditions, including the pilot's contrast sensitivity, familiarity with the landmarks involved, and accuracy of distance estimates to those landmarks.

Contrast sensitivity declines with age, beginning about age 40 (the pilot's age was 64); therefore, the accident pilot may have had less ability to identify features in reduced contrast visual scenes like those obscured by rain or mist. Although the accident pilot was experienced, he had relatively little experience flying tours around Ketchikan; thus, he likely had less finely detailed knowledge of the local geography. This same lack of knowledge of the fine details of the local geography could also have made it more difficult for him to estimate distance. Therefore, the pilot's relative unfamiliarity with the landmarks on the tour route and the area weather dynamics may have affected his ability to accurately assess and respond to the deteriorating weather conditions he encountered.

2.2.3.1 Pilot's CFIT-Avoidance Training and Experience

The FAA does not require CFIT-avoidance training for pilots of fixed-wing aircraft. However, since 2012, all commercial air tour operators in Southeast Alaska have been providing cue-based training to their pilots that was developed specifically for their operations as a result of NTSB Safety Recommendation A-08-61, which recommended a cue-based training program that "specifically addresses hazardous aspects of local weather phenomena and in-flight decision-making." Such training programs are based on the premise that exposing pilots to realistic depictions of deteriorating in-flight weather will help calibrate their weather assessment and foster an ability to accurately assess and respond appropriately to cues associated with deteriorating weather (Wiggins and O'Hare 2003b).

Promech's *CFIT Avoidance Manual*, which was created in conjunction with the Medallion Foundation, outlined its training program and described the policies and procedures for company pilots to use for CFIT avoidance during all phases of flight. Per the manual, CFIT-avoidance training included ground training and cue-based training in an FAA-approved ATD. Both the ground training and the ATD curriculum outlined in the manual included segments on recognition of loss of visual reference, situational awareness, and aeronautical decision-making.

Promech's CFIT-avoidance training records for the accident pilot included a completed written examination. A Medallion Foundation sign-in/training log showed that, about 2 months before the accident, the pilot received 1.3 hours of training on its BATD, instructed by the Promech assistant chief pilot. The cue-based training module that the accident pilot completed in the BATD included a scenario that required him to escape an inadvertent encounter with IMC by reversing course. BATDs, which are designed to serve as a platform for procedural and operational performance tasks, have limited capabilities for realistically replicating weather, terrain, and aircraft equipment (FAA 2014).

NTSB investigators observed a demonstration of the CFIT-avoidance training module that the accident pilot completed, which involved an overwater flight with progressively decreasing cloud ceiling and visibility. The BATD's depiction of both the ceiling height and forward visibility were uniform and transitioned abruptly when adjusted by the instructor. The simulation did not portray the dynamic, variable, and localized patterns that often characterize real-world weather. This limitation, which is inherent to many types of approved ATDs, decreases the usefulness of such tools for training pilots to assess real-world weather conditions (Johnson and Wiegmann 2015).

Further, the BATD's depiction of terrain features and ground texture had only a moderate degree of fidelity and, thus, had limited usefulness in training a pilot to judge ceiling height and visibility. The BATD also did not have (and was not required to have) a navigation information display like the Chelton EFIS; Promech pilots said that, in the actual airplane, they used the Chelton EFIS to assist them in judging distances to identifiable landmarks. One local air tour operator's owner stated that the simulation was not very realistic and did not impose the same workload as an actual tour flight, making the decision-making scenario less realistic.

Promech also provided the accident pilot with CFIT-avoidance training in a company DHC-3 airplane. The training included practicing a 180° (course reversal) inadvertent-IMC escape maneuver. However, the DO (who provided the CFIT-avoidance training) and a Promech pilot who completed the training with the accident pilot differed in their assessments of the accident pilot's performance. Although the DO believed that the accident pilot performed well during training, the other Promech pilot said that the accident pilot experienced difficulty performing the CFIT-avoidance maneuver. Based on this conflicting information, the investigation cannot draw a conclusion about the pilot's level of proficiency and confidence in performing the CFIT-avoidance maneuver.

During tour flights, the accident pilot's responses to actual encounters with adverse weather varied under different circumstances. Although the DO and other Promech pilots described the accident pilot as a conservative decision-maker who was willing to turn back when weather conditions were poor, the accident pilot's flights on the day of the accident demonstrated examples of both conservative and risk-taking decisions.

The accident flight occurred during the third round of Promech tours that day. ADS-B data and passenger interviews showed that, when the accident pilot was returning from his first tour on the day of the accident, he responded to an IMC encounter by executing a climbing, 180° turn and then following a different route. During the accident pilot's second tour of the day, however, he continued his flight into deteriorating conditions, and his airplane descended as low as 375 ft agl (which was below the FAA minimum altitude for that area). In addition, during the accident flight (the pilot's third tour of the day), he chose to fly the short route despite the presence of low clouds and obscured terrain and then continued the flight into deteriorating weather rather than escape it.

One major difference between the scenarios is that, during the tour in which he reversed course, the accident pilot was flying alone, whereas, during the two tours in which he continued flight into deteriorating weather (his second tour and the accident tour), he was following 5 to 10 minutes behind other tour airplanes. This suggests that operational factors may have influenced the pilot's decision-making. (Operational factors are discussed in section 2.3.)

2.2.3.2 Nuisance Alerts from Class B TAWS during Tour Flights

The accident airplane's Chelton FlightLogic EFIS provided the Class B TAWS capabilities required by 14 *CFR* 135.154(b)(2) for the airplane (based on its engine and seating configuration). Class B TAWS alerting parameters, which are specified in FAA TSO-C151c, are based on terrain clearance of 700 ft agl in cruise flight and 500 ft agl during descent. When these clearances are not maintained, the Chelton system's Class B TAWS provides color-coded cautions and warnings of terrain on the moving map on the MFD, a forward-looking view of terrain ahead of the aircraft (a replica of a day VFR view out the front window) on the PFD, and CWA auditory and flag alerts.

However, in the accident airplane, data recovered from the Chelton EFIS showed that the switch controlling the CWA functions was in the "inhibit" position, which suggests that the accident pilot either chose to disable the auditory and flag alerts or did not check to ensure that they were enabled.

Although Class B TAWS specifies 700 ft agl during cruise flight and 500 ft during descent (as specified in TSO C-151c), the float-equipped accident airplane was authorized, per 14 *CFR* 135.203(a)(1), to cruise over the water as low as 500 ft agl, which is below the Class B TAWS design alerting threshold. As a result, Class B TAWS auditory and flag alerts would be triggered during normal tour operations. Several Promech pilots described that frequent nuisance alerts during tour operations and water landings sometimes prompted them to inhibit the alerts.

The NTSB has found other examples in which pilots involved in fatal CFIT accidents were also flying with their respective Class B or C TAWS alerts inhibited. Data recovered from the general aviation enhanced GPWS of a Cessna 208B airplane (operated by Hageland Aviation Services, Inc., dba Era Alaska as a Part 135 scheduled commuter flight) that was involved in a November 2013 CFIT accident in Saint Mary's, Alaska, revealed that the system's Class B terrain-alerting feature had been operated in "inhibit" mode 76% of the time (9,277 hours in inhibit mode out of 12,206 hours operating time).[36] In the July 2015, fatal CFIT accident involving a Cessna 207A airplane operated as a Part 135 scheduled commuter flight by SeaPort Airlines, Inc. (dba Wings of Alaska), the switch for that airplane's Class C TAWS was found in the inhibit position.[37] Similarly, the TAWS auditory annunciation and display text alerts were inhibited on board the de Havilland DHC-3T airplane involved in the August 2010 fatal accident in Aleknagik, Alaska; that flight was operated under Part 91 (NTSB 2011).

Research has shown that frequent nuisance alerts decrease user confidence in the alerts due to the "cry wolf" effect, motivating users to disable or otherwise disregard them (Sorkin 1988). The fact that nuisance alerts have resulted in users disabling or disregarding the terrain-alerting feature is disappointing, especially considering that, according to a Capstone Project survey, terrain awareness was the most important safety benefit that Southeast Alaska operators expected to achieve by installing these systems (Berman et al. 2003).

The NTSB concludes that, for single-engine airplanes operated under Part 135 that frequently operate at altitudes below their respective TAWS class design alerting threshold, the nuisance alerts and associated increase in the use of the inhibit mode prevents the system from effectively providing the intended protection. Therefore, the NTSB recommends that the FAA implement ways to provide effective TAWS protections while mitigating nuisance alerts for

[36] For more information, see NTSB case number ANC14MA008.

[37] For more information, see NTSB case number ANC15FA049.

single-engine airplanes operated under Part 135 that frequently operate at altitudes below their respective TAWS class design alerting threshold.

2.2.3.3 Terrain Depiction: Chelton EFIS Software and Database Considerations

The Chelton EFIS user manual includes procedures for using the system when escaping inadvertent VFR flight encounters with IMC. These procedures include reversing course, looking at the moving map to determine the direction to turn away from terrain, and (in the event of a terrain alert) identifying the threatening terrain on the moving map and maneuvering to avoid it. However, the original 2003 terrain database used in the accident airplane and older versions of the EFIS software (such as that installed in other airplanes) can limit the fidelity of the terrain information available to system users.

The legacy Chelton system's original 2003 database (which was installed in the accident airplane) does not distinguish small, inland bodies of water in blue on the terrain moving map but rather shows the area in the same color as the surrounding terrain; the 2007 terrain database, which is more detailed, depicts small, inland bodies of water (such as Ella Lake) in blue. The more-detailed updated database would have provided the accident pilot with better information for situational awareness near Ella Lake. More detailed information would also be useful to any pilot when performing the prescribed procedures for using the system when escaping inadvertent VFR flight encounters with IMC.

As described above, the Chelton MFD depicts potentially hazardous proximity to terrain (based on the TAWS requirements) as a red (warning) or yellow (caution) overlay on the terrain map. Although these overlays have some degree of transparency in version 6.0B of the EFIS software (which was installed in the accident airplane) to allow the underlying contours to be distinguished to aid in a terrain avoidance maneuver, some pilots reported that the overlays in their airplanes could, at times, obscure the terrain depiction. This issue, which, according to the manufacturer, is inherent to an older version of the EFIS software, could affect several airplanes because the legacy Chelton systems that were installed in the majority of the original Alaska Capstone Project airplanes are still in use today.[38]

Thus, the NTSB concludes that, for legacy Chelton systems in use by many Alaska operators, the more-detailed 2007 terrain database update and the current EFIS software version provide pilots with more useful terrain information for position reference and for use in escaping an inadvertent encounter with IMC during visual flight. Other Ketchikan-area air tour operators who use these systems could benefit from awareness of these limitations and how to resolve them; one means by which safety information is exchanged among operators is through regular Ketchikan Air Safety meetings, which are hosted by the FAA's Safety Team (FAASTeam). The FAASTeam hosts both pre- and post-season meetings, typically in March and September (respectively). Therefore, the NTSB recommends that the FAA discuss at the next Ketchikan Air

[38] A similar legacy Chelton system was installed in the Cessna 207A airplane that was involved in a fatal CFIT accident in Juneau, Alaska, on July 17, 2015 (discussed in section 2.2.3.2). For more information, see NTSB case number ANC15FA049.

Safety meeting the database and software considerations for legacy Chelton systems and encourage operators to use the most current terrain database and EFIS software.

2.3 Operational Influences on Pilot Decision-Making

During tour flights, Promech's pilots could choose to take either the short route or the long route at their discretion, based on each pilot's assessment of the weather. The short route was described by some pilots as more scenic for the passengers. The long route, which took about 5 more minutes to complete, was generally preferred in poor weather conditions because it was primarily over the water and enabled the pilots to fly at lower altitudes (beneath cloud layers) and to perform an emergency or precautionary landing on the water, if needed.

During the accident tour, the accident pilot chose to follow another Promech pilot on the short route, even though the route presented an increased risk of an inadvertent encounter with IMC and increased the risk of CFIT. The pilot's decisions to fly the short route and to continue flying once he encountered deteriorating weather were likely influenced by several operational factors.

2.3.1 Company Tour Schedules and Practices of Other Pilots

About 90% of Promech's business consisted of air tours, and the company competed with other area operators for cruise line contracts; thus, the company was likely motivated to provide service that would be highly rated by the cruise line passengers, including returning the passengers to the ship on time. In addition, tour operators that failed to return passengers in time for a ship's departure were responsible for the accommodations and travel expenses associated with delivering those passengers to the ship's next port of call, providing further motivation for punctual returns.

The accident tour departed late, and Promech's president/CEO had reminded the pilots to be mindful of the cruise ship boarding time. Three of the four Promech flights that departed together on the return leg for Ketchikan followed the short route; the only exception was one pilot (the second pilot) whose personal risk tolerance led him to conclude that the weather was too hazardous. (This pilot wanted to avoid reversing course as he had done earlier in the day [during the return leg on the first tour] because of weather over Ella Lake.) Thus, schedule pressures likely motivated the pilots in the accident tour group to return to Ketchikan using the most direct route, if possible.

In addition, the two pilots flying their airplanes (one from Promech and one from another operator) a few miles ahead of the accident pilot chose to fly the short route over Ella Lake and broadcast their intentions by radio to other pilots on the frequency. (The pilot who chose to take the long route did not announce his decision.) The Promech pilot who took the short route ahead of the accident pilot was highly experienced and a close friend of the accident pilot; colleagues said the accident pilot admired and tried to emulate him. The other operator's pilot was also highly experienced with flying in Alaska.

Social psychological research indicates that people may look to others for cues on how to behave in uncertain situations, a phenomenon called "social proof"; social proof has been documented in a variety of contexts, including aviation, where it has been shown that the decisions of other pilots flying directly ahead significantly influences the behavior of those who follow (Facci, Bell, and Nayeem 2005; Rhoda and Pawlak 1999).[39] Thus, the NTSB concludes that the pilot's decision to fly a riskier, overland route despite marginal weather conditions and the availability of a safer, overwater route was influenced by schedule pressure and his attempt to emulate the behavior of other, more experienced pilots whose flights he was following.

2.3.2 Organizational Culture

Promech policy required its pilots to maintain the applicable FAA-specified VFR weather minimums for uncontrolled airspace of 2 miles visibility at a minimum operating altitude of 500 ft agl, with 1-mile visibility allowed if the ceiling is above 1,000 ft. Although this weather policy was consistent with regulations, some Promech pilots, including the company president/CEO, did not comply with the policy on tour flights.

Pilot interviews and ADS-B data indicate that, earlier in the day (during the second tour group), Promech's president/CEO was the pilot of the first flight in a group of Promech flights that flew through an area of reduced visibility, and the pilots operated at altitudes below 500 ft agl. One Promech pilot told investigators that the weather conditions encountered by the group as they returned via the long route were so bad that he felt lucky to return from this flight and was surprised that the company continued operating that day. (The accident flight occurred during the next tour.)

At least one Promech pilot described pressure to fly in weather that was at or below FAA minimums. This Promech pilot also reported that he overheard the company president/CEO expressing frustration in the company office when he saw (using the company's ADS-B display) that one of the pilots was returning from the accident tour via the long route. He also stated that, during initial training, the assistant chief pilot told him and a group of other Promech pilots that they had to bend the rules because they were operating in Alaska, and that, if one pilot turned around while the others made it through, they were going to "have a conversation." He said that, because he was new to flying commercially in Alaska, he assumed that this was the culture and that they were to push through the weather.

Some of the company's more experienced pilots said that they did not feel pressured to fly in unsafe conditions; however, one of these pilots was part of the group that encountered the 200-ft ceiling during the second tour of the day, and this pilot told investigators that he had never needed to turn down a flight for safety-related reasons. Another experienced Promech pilot said that he was ridiculed and threatened with termination for asking on the radio if another pilot (the accident pilot) was operating in IMC.

[39] A National Aeronautics and Space Administration-sponsored study of terminal area thunderstorm penetrations by commercial airline flights found, for example, that pilots were more likely to penetrate convective weather if they were following another aircraft, they were behind schedule by more than 15 minutes, or they were flying after dark. Thus, the weather-related decision-making of pilots is influenced by other pilots (Rhoda and Pawlak 1999).

Considered together, these multiple accounts of pilots, including company managers, suggest the normalization of flying in weather conditions below FAA minimums. The NTSB concludes that, as evidenced by the company president/CEO's own tour flights on the day of the accident, Promech management fostered a company culture that tacitly endorsed operating in weather conditions that were below FAA minimums.

The DO provided an example of having praised the accident pilot on one occasion when he was the only pilot in one particular group of flights to abort a tour and return to base because he felt the weather conditions were unsafe; one of the other pilots who had flown in that group said that the other pilots also reacted positively to the accident pilot's decision. Although this superficially suggests a safety-oriented organizational culture, there is no indication that Promech questioned the appropriateness of the other pilots' decisions to continue their tours in the same weather conditions. As a result, it is likely the pilot's decision to return to base in adverse weather conditions was actually negatively reinforced because the actions of the other pilots indicated that it was acceptable to continue.

The risky behavior exhibited by other Promech pilots and management may have increased the difficulty that the accident pilot had in evaluating the risks associated with adverse weather, particularly considering that he had relatively little experience flying in the Ketchikan area. Research has identified that difficulty evaluating risks is an important factor in weather-related accidents (Johnson and Wiegmann 2015). The accident pilot's more conservative decision-making when flying alone versus his continued flights into adverse weather when following other Promech flights (including those piloted by company managers and another experienced pilot he admired) provides evidence that the accident pilot struggled with calibrating his own perceptions of risk in Promech's risk-tolerant organizational culture before the accident.

As described in section 2.2.3.1, Promech provided the accident pilot with cue-based CFIT-avoidance training that included segments on aeronautical decision-making. Although the voluntary training program, components of which were developed by the Medallion Foundation, was intended to specifically address in-flight decision-making in the context of the hazardous aspects of local weather phenomena, it did not address the types of organizational and social factors that influenced the accident pilot's decision-making. The NTSB concludes that the cue-based and CFIT-avoidance training modules that Promech provided the accident pilot were insufficient to counteract cultural and peer influences that encouraged the pilot to continue the flight into deteriorating weather conditions.

Therefore, the NTSB recommends that the FAA 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 VFR into IMC, 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.

Although the Southeast Alaska CFIT-avoidance training program was a voluntary program developed for operators of tour airplanes, CFIT-avoidance training is required for all pilots who conduct helicopter operations under Part 135. FAA Order 8900.1, volume 3, chapter 19, section 6, "Safety Assurance System: Flight Training Curriculum Segments," outlines in paragraph 3-1251(B) the requirements for FAA-approved training programs and provides guidance for POIs for evaluating the required CFIT-avoidance training program for helicopter operations and for providing competency checks to the pilots. According to the order, all helicopter pilots operating under Part 135 must receive initial and recurrent training and procedure checks for the avoidance of and recovery from inadvertent IMC encounters. Also, as discussed in section 1.9.2.4, the required training for Part 121 pilots on the use of TAWS addresses CFIT-avoidance for Part 121 pilots. Such FAA-approved training programs for Part 135 and 121 operators include FAA oversight and qualification modules, unlike the voluntary CFIT-avoidance training program in which the accident pilot participated and for which he took an examination that was not graded.

The NTSB believes that all pilots who conduct low-altitude VFR operations in airplanes could benefit from CFIT-avoidance training. For example, a Cessna 207A airplane operated by SeaPort as a Part 135 scheduled commuter flight was involved in a fatal CFIT accident in July 2015 in Juneau. That pilot had not completed, and was not required to complete, CFIT-avoidance training. The SeaPort and other accidents demonstrate that CFIT accidents in Part 135 operations are not limited to helicopter operations and air tours in Southeast Alaska. The NTSB concludes that CFIT-avoidance training for Part 135 airplane pilots, similar to that which is specified for helicopter pilots in FAA Order 8900.1, could reduce the risk of CFIT accidents for all Part 135 airplane operations. Therefore, the NTSB recommends that the FAA expand the application of FAA Order 8900.1, volume 3, chapter 19, section 6, "Safety Assurance System: Flight Training Curriculum Segments," paragraphs 3-1251(B) and 3-1252, which address CFIT-avoidance training programs for Part 135 helicopter operations, to all Part 135 operations.

2.4 FAA Requirements and Oversight

2.4.1 Promech's Operational Control Policies

FAA Order 8900.1, chapter 25, section 1 (which provides guidance to POIs), 3-1921, "Background and Definitions," defines operational control with respect to a flight as the "exercise of authority over initiating, conducting, or terminating a flight." Promech's operations specifications and policies delegated operational control jointly to the flight schedulers and pilots. Per Promech's GOM, "**[b]oth** the pilot and flight scheduler must agree that the flight can be conducted safely before a flight may be launched." However, no such explicit concurrence occurred between the accident pilot and the flight scheduler, or between the accident pilot and the company president/CEO (who was the only member of management on duty the morning of the accident), before his tour flights that day. The flight scheduler described her role as mainly collecting preflight weather data and giving it to the pilots; however, she had no preflight weather-related launch-planning discussion with the accident pilot on the day of the accident.

As a result, the decision to initiate the accident tour rested solely with the accident pilot, who (as described in section 2.3.2) was subject to cultural and peer influences and had difficulty calibrating his own risk tolerance for conducting tour flights in weather that was marginal or below minimums. Thus, the NTSB concludes that Promech did not exercise an adequate level of operational control of the accident pilot's flights on the morning of the accident.

Title 14 *CFR* 119.69 states that anyone in a position to exercise operational control must be qualified through training, experience, and expertise and, to the extent of their responsibilities, have a full understanding of aviation safety standards and safe operating practices with respect to the company's operation. Pilots are required to complete an FAA-approved training program; however, Promech did not have a formal training program for flight schedulers, and the POI assigned to Promech was unsure how the company trained and qualified its flight schedulers. An in-depth understanding of operational control theory, guidelines, and procedures is essential for all personnel exercising operational control authority for an operator; however, there is no formal FAA training or checking requirement to assess an individual's training, experience, and expertise as required by 14 *CFR* 119.69.

The flight scheduler on duty at the time of the accident held a private pilot certificate, and her training for her flight scheduling duties consisted of studying the GOM and operations specifications and receiving on-the-job training. She could not recall how long her initial training lasted and had not received any recurrent training. She said that the flight schedulers and the pilots had partial control over launch decisions, but that, ultimately, a manager decided whether a flight should go out. Based on the gathered information, the NTSB concludes that Promech's training and supervision of the flight scheduler were insufficient to ensure that she was qualified under 14 *CFR* 119.69 and fully understood and could perform her responsibilities to work jointly with the pilots to make safe and appropriate operational control decisions. The NTSB further concludes that a flight scheduler with more in-depth operational control training might have played a more influential role in ensuring that flights conducted on the morning of the accident were safe for pilots to initiate and complete.

During the investigations of three other Part 135 accidents between November 2013 and July 2015, the NTSB discovered similar operational control issues that contributed to the cause of each accident. Collectively, these four accidents (including the Promech accident) claimed the lives of 16 people and seriously injured 10 others. In one example, the dispatcher on duty at the time of the July 2015 CFIT accident involving SeaPort's Cessna 207A airplane had received no formal classroom training; his initial training had no structured syllabus and consisted of shadowing a dispatcher and then performing the duties himself under the supervision of a dispatcher.[40]

In another example, the flight coordinators who were performing risk assessment tasks for the flight of the Cessna 208B that was involved in the CFIT accident in Saint Mary's, Alaska, (discussed in section 2.2.3.2) had not received training on the company's risk assessment program.[41] In the third example, the operator's (Southern Seaplane, Inc.) dispatch procedures did not prevent the pilot from flying beyond his duty day and at night (for which he was not current)

[40] For more information, see NTSB case number ANC15FA049.

[41] For more information, see NTSB case number ANC14MA008.

and in IMC (for which he was not company-qualified); the pilot lost control of the Cessna 210L airplane while being vectored for an approach in night IMC in Clay, Alabama, in February 2014.[42]

Although 14 *CFR* 119.69 requires that a person exercising operational control be qualified through training, experience, and expertise, the FAA provides no published guidance for operators on how to ensure such qualification. The NTSB concludes that guidance for establishing an FAA-approved structured training program and qualification module would help operators ensure that persons authorized to exercise operational control are appropriately trained and possess the knowledge and experience required to make safe and appropriate operational control decisions. Therefore, the NTSB recommends that the FAA establish minimum initial and recurrent training requirements for personnel authorized to exercise operational control, including, but not limited to, approved subject knowledge areas, training hours, subject hours, and qualification modules.

Further, the NTSB concludes that all Part 135 operators could benefit from best practices guidance on operational control, similar to that which is provided in AC 120-96A, "Operations Control Center for Helicopter Air Ambulance Operators." Therefore, the NTSB recommends that the FAA publish an AC that provides guidance on operational control best practices, including, but not limited to, such areas as risk mitigation strategies, joint flight safety responsibilities, prior experience of operational control personnel, and operational control personnel duty time limitations.

The POI who performed Promech's most recent operational control inspection before the accident stated that the outcome was "satisfactory" but did not recall any specific findings. He stated that the DO, chief pilot, and anyone to whom they delegate authority could exercise operational control of flights; he said that this included management personnel (authorized per 14 *CFR* Part 119) and any flight schedulers they authorize. Currently, FAA Order 8900.1, volume 1, "General Inspector Guidance and Information," provides no guidance for FAA inspectors on how to assess the adequacy of an operator's training program or the qualifications of its operational control personnel.

The NTSB concludes that a quantitative and qualitative standard would enable the FAA to evaluate the training methods and content of operational control training programs. Therefore, the NTSB recommends that the FAA revise FAA Order 8900.1 to include guidance for inspector oversight of operational control training program subject areas, including, but not limited to, the criteria for a qualification module.

2.4.2 Promech's Safety Program

The Promech GOM specified that the DO was responsible for promoting and encouraging safety in all areas and for ensuring compliance with safety-pertinent instructions. According to the DO, company personnel used the bulletin board in the dispatch area to post bulletins about hazards and to share other useful information for the pilots and the operation. The DO said that company personnel looked to him for information on safety-related matters based on his previous role in

[42] For more information, see NTSB case number ERA14FA120.

Promech's safety programs when the company had provided service under Part 121. However, interviews with Promech pilots revealed that they did not know who in the company was responsible for managing safety; several provided different names when asked about the subject. The DO stated that Promech performed flight-risk assessment informally but that he believed the informal process accomplished the same objective as the use of formal risk assessment forms (which he had used at other jobs).

Promech had an anonymous safety-reporting system for use in submitting written reports of operational hazards and general unsafe conditions; however, neither the company president/CEO nor the DO could recall any safety report forms having been submitted. The company president/CEO said that, typically, pilots verbally told the managers if they had a concern. Although company managers seemed confident that pilots would use either verbal or anonymous reporting if they had concerns, company management was unaware of serious incidents that had occurred, including a flight in which the accident pilot struck trees with an airplane during takeoff and later told some of his colleagues (and noted in his pilot logbook) that he "nearly died." In addition, company managers stated that they were unaware that the accident pilot had turned around due to poor weather conditions during his first tour on the day of the accident and that two other Promech pilots reversed course multiple times to find their way out of Ella Lake on the morning of the accident.[43]

As a Part 135 operator, Promech was not required by the FAA to have a formal SMS; however, SMS has been recognized in all aspects of aviation operations as an effective way to establish and reinforce a positive safety culture and identify and correct deviations from SOPs. The DO indicated that the company did not have enough staff to manage a formal SMS program and that the company's safety culture accomplished the same objective as a formal SMS program. The NTSB concludes that, although Promech had a hazard reporting system, the system was underused by the pilots, and the company's informal safety processes were not effective for identifying major risks in the company's flight operations and did not facilitate organizational learning about major areas of risk.

A more proactive safety program, like an SMS, could identify safety risks, seek to mitigate them, and foster a culture in which safety-related incidents are reported without embarrassment or fear of reprisal and in which the company focuses its efforts on the risks that pose the greatest potential threat to life and equipment. SMS could help Promech learn from incidents (like the accident pilot's tree collision and pilots' turnarounds because of weather) and establish policies to reduce the risks of recurrence.

The FAA issued its final rule in January 2015 requiring SMS for Part 121 air carriers and included the key requirements for an SMS in newly created 14 *CFR* Part 5, "Safety Management Systems." In its final rule, the FAA stated that its intent in developing Part 5 was to establish a uniform standard that could be extended to apply to other operating parts, including Part 135

[43] NTSB investigators discovered this through an interview with one of the pilots and by reviewing ADS-B data from the morning of the accident.

(80 *Federal Register* 1308) (NARA 2015). However, in the 2 years since Part 5 was established, the FAA has not initiated rulemaking to address SMS for Part 135 operators.

The NTSB also discovered operational safety issues during its investigation of the November 10, 2015, fatal accident involving a British Aerospace HS 125-700A airplane that departed controlled flight while on approach to an airport in Akron, Ohio (NTSB 2016). The airplane was operated under Part 135 by Execuflight, which did not have an SMS. Although not required, an SMS likely could have helped Execuflight and the FAA identify and correct the operational safety issues that contributed to the accident. (The Execuflight accident report also referenced three other accidents involving Part 135 operators that could have benefitted from an SMS program.)[44] As a result, on November 7, 2016, the NTSB issued Safety Recommendation A-16-36, which asked the FAA to "[r]equire all 14 [*CFR*] Part 135 operators to establish [SMS] programs." As of the date of this report, Safety Recommendation A-16-36 is classified "Open—Initial Response Received."

The safety benefits of SMS have been demonstrated by Part 121 carriers and Part 135 helicopter EMS operators who have voluntarily implemented SMS (Bergin 2013; Buckner 2013). The FAA has a formal voluntary program that Part 135 operators can use to establish an SMS and has produced a video presentation, *SMS for Small Operators*, that shows how an SMS can be effectively scaled for a smaller operator, such as Promech.[45] Because Part 135 operations often involve carrying passengers for hire, the FAA is responsible for ensuring that Part 135 operators have adequate safety protections in place for the flying public. The NTSB concludes that an SMS can benefit all Part 135 operators because they require the operators to incorporate formal system safety methods into their internal oversight programs. Therefore, because of the relevance of Safety Recommendation A-16-36 to Promech's accident, the NTSB reiterates the recommendation in this report.

2.4.3 Ketchikan-Area Air Tour Operations

The air tour industry in Ketchikan is highly competitive, with multiple operators seeking to maximize revenue in a relatively short summer tour season. On the day of the accident, multiple operators' pilots were flying tours in the Misty Fjords Wilderness at low altitudes in mountainous, confined areas, even though sufficient weather observation and forecast information was available that suggested a high likelihood of encountering low ceilings and low visibility. Some of these pilots may have continued flight into IMC rather than turning around.

The NTSB discovered similar issues during its investigation of the July 2007 fatal air tour accident in Ketchikan involving Taquan Air.[46] As a result of that investigation, on July 31, 2008, the NTSB issued four safety recommendations (discussed in section 1.9.2.1) to the FAA to

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[44] These accidents are NTSB case numbers ERA14FA120, ANC14MA008, and ANC14LA007.

[45] The video presentation, which was developed by the FAA SMS program office and originally released in 2013, can be viewed from the FAASTeam Central Florida's YouTube web page (https://www.youtube.com/watch?v=bxrbwBhuNbU, accessed February 21, 2017).

[46] For more information, see NTSB case number ANC07FA068.

improve the safety of Southeast Alaska air tour operations. Among these was Safety Recommendation A-08-60, which asked the FAA to "develop a permanent mechanism to provide en route and ground-based observations of air tour flights in Southeast Alaska at least once a month during the tour season to ensure operators are adhering to safe flying practices." As a result of the FAA's implementation of unique surveillance activities appropriate to the Alaska tour environment, the NTSB classified Safety Recommendation A-08-60 "Closed—Acceptable Alternate Action" on March 21, 2014. The NTSB believed that the FAA's action would let all air tour operators know that the FAA is observing their operations.

However, the review of ADS-B data from the day of the accident corroborated reports from pilots and managers from various operators who described that occurrences of flights below FAA minimum altitudes were common and widespread. Despite incomplete coverage of the ADS-B network because of antenna placement, rugged terrain, and line-of-sight limitations on the transmission of ADS-B data, NTSB investigators also identified several instances in which pilots (including the accident pilot) reversed course at low altitude to avoid areas of poor weather (evidenced by photographs and videos taken by passengers). Thus, although the NTSB was pleased with the FAA's past action in response to Safety Recommendation A-08-60, these more recent instances of tour operators' continued noncompliance indicate that more work toward a solution is needed.

2.4.3.1 Safety Review of ADS-B Data

Information from the review of ADS-B data and available weather information (including weather camera images and photographs and videos taken by passengers) provided NTSB investigators with useful information on the presence of weather-related hazards and operators' strategies for managing them. When ADS-B technology was introduced in Southeast Alaska, the FAA assured operators that the data would not be used for enforcement purposes (Berman et al. 2003). This assurance increased operators' acceptance of the technology, the use of which has yielded safety benefits for the region.

In this investigation, ADS-B data identified multiple instances of operational hazards, such as pilots flying below minimum en route flight altitudes and making course reversals in geographically confined areas, likely to avoid or escape adverse weather conditions. Because of the operational insight that collective regional ADS-B data provide, Ketchikan-area air tour operators would likely benefit from an annual review of these data to identify patterns indicating possible operational hazards and to collaborate on developing industry solutions for mitigating those hazards. The FAA could facilitate such a data review and discussion at the annual beginning-of-season or end-of-season Ketchikan Air Safety meeting it conducts with Ketchikan air tour operators. To ensure open discussion and sharing of information about hazards experienced by meeting participants, this discussion should be nonpunitive for the individual participants and aimed at examining the effectiveness of existing risk controls and identifying ways in which safety could be improved.

This type of collaboration could be analogous to the FAA's ongoing efforts to collaborate with Part 121 operators on the analysis of safety data as part of the Aviation Safety Analysis and

Information Sharing program. Such a collaboration could lead to changes in the organizational culture of local operators and encourage incident reporting and timely adoption of voluntary increased safety margins. Thus, the NTSB concludes that ADS-B information from a focused operational area could serve as a basis for the FAA to promote open, nonpunitive discussions of safety issues reflected in objective data to increase awareness of operational hazards. Therefore, the NTSB recommends that the FAA analyze ADS-B data from Ketchikan air tour operations on an ongoing basis and meet annually with Ketchikan air tour operators to engage in a nonpunitive discussion of any operational hazards reflected in the data and collaborate on mitigation strategies for any hazards identified.

2.4.3.2 Safety Benefits of Conservative Weather Minimums

Following its fatal tour accident in 2007 in the Misty Fjords Wilderness, Taquan Air voluntarily imposed higher weather minimums for its overland routes. It chose to require 4 miles visibility (as defined by the visibility of specific landmarks from specific vantage points) to proceed via certain overland routes, including the Ella Lake area. Taquan also provided higher minimums for new pilots and required groups of pilots to adhere to the highest minimums of any individual pilot in the group.

On the day of Promech's accident, both Taquan and at least one other tour operator decided not to fly scheduled tours, whereas Promech and at least one other operator continued to operate in conditions that were at or below FAA minimums. Promech received some of its passengers after Taquan canceled tours due to poor weather, and the cruise line rebooked those passengers onto Promech flights. Thus, more conservative operators paid an economic penalty in lost revenue for their safety decisions while operators that were willing to operate in unsafe or potentially unsafe weather conditions reaped economic benefits. Given the competitiveness of the Ketchikan tour industry for local air tour operators, those willing to take the most weather risks were able to fly more revenue passengers. It is likely that, unless corrective action is taken, some operators will continue to disregard weather minimums, thus putting pressure on other operators to follow suit in order to stay competitive.

Ketchikan's air tour industry, which involves the operation of float-equipped airplanes at low altitudes through fjords and mountain valleys, is different from other major air tour hubs in Alaska, such as Denali National Park (which involves mostly mountain flying) and the Juneau Ice Field (which involves primarily helicopter operations). More conservative minimums for overland routes and higher minimums for pilots with less time in aircraft type and less time in the local area could address some of the safety issues identified in this accident.

The NTSB believes that more conservative minimums, particularly when combined with open discussions of how actual behavior compares with the established requirements (for example, through a review and discussion of ADS-B data as described in section 2.4.3.1), can help establish a safety-oriented culture that will encourage pilots to fly more conservatively. Thus, the NTSB concludes that the establishment of a more conservative set of weather minimums that are tailored to the types of air tour operations that occur in Ketchikan and are applied to all area air tour operators would help balance competing goals of production and safety and remove the incentive of individual operators to adopt the lowest possible weather minimums to stay competitive. Therefore, the NTSB recommends that the FAA develop and implement special operating rules for the Ketchikan air tour industry that include en route VFR weather minimums that are tailored to the industry's unique requirements and are more conservative than those specified in Part 135.

2.5 Cruise Line Sales of Air Tour Shore Excursions

The passengers on board the accident flight had purchased the tour through the cruise line as a shore excursion; the cruise line marketed and sold the tours, which is a common practice in the cruise industry. One benefit for cruise ship guests who purchase air tour shore excursions through the cruise line (rather than from the tour operators directly) is that the cruise line guarantees that guests are not responsible for any expenses related to a late returning excursion. However, the cruise line passed the risk of these expenses on to the air tour operators, such as Promech, as the cruise line specified that any tour operator that failed to return guests in time for a ship's departure was responsible for covering the expenses associated with accommodations and travel to deliver those passengers to the ship's next port.

On the day of the accident, the cruise passengers on board the accident flight had a 1230 "all aboard." However, the accident flight departed Rudyerd Bay at 1207, which was later than planned. The accident pilot had two return routes to Ketchikan available: the shorter, overland route (which takes about 25 minutes to complete) and longer, overwater route (which takes about 30 minutes to complete). As discussed in section 2.3.1 of this report, the pilot's decision to fly the riskier, overland route despite marginal weather conditions and the availability of a safer, overwater route was influenced, in part, by schedule pressure. The circumstances of this accident show that some air tour operators (like Promech, for which cruise-line contracted air tours made up a large percentage of its business) may set tour schedules that leave little time margin for weather and/or other delays.

All of the cruise lines servicing Ketchikan (including Holland America) are members of Cruise Lines International Association (CLIA), which is the largest cruise industry trade association worldwide. CLIA is dedicated to "providing a unified voice and leading authority of the global cruise community. CLIA supports policies and practices that foster a safe, secure, healthy, and sustainable cruise ship environment and is dedicated to promoting the cruise travel experience."[47] CLIA also has a safety committee that meets regularly to share among its members shipboard safety information and lessons learned. The cruise industry has extensive experience with risk assessment practices and SMS in its shipboard operations; however, the NTSB is concerned that the industry may not be aware that the cruise line's schedule may contribute to the schedule pressures air tour operators face associated with returning shore excursion passengers to their ship on time. Therefore, the NTSB concludes that a robust discussion by CLIA's safety committee with its members about the scheduling pressures associated with air tour shore excursions identified in this investigation would benefit the entire cruise industry. Therefore, the

[47] For more information about CLIA, see CLIA's website (www.cruising.org, accessed on February 24, 2017).

NTSB recommends that CLIA encourage its members that sell air tours as shore excursions to review the circumstances of this accident and to consider ways to mitigate associated risks.

2.6 Crash-Resistant Flight Recorder Systems

The airplane was not equipped, and was not required to be equipped, with any crash-resistant flight recorder system. However, data were retrieved from other devices recovered from the wreckage, including the Chelton EFIS and passenger PEDs and cameras. These devices were not designed for crash-resistance; however, investigators were able to extract data from them. Collectively, data recovered from these items (as well as recorded ADS-B data) provided information about the airplane's position, attitude, airspeed, altitude, and cockpit switch positions, as well as photographic and video evidence of weather conditions. Had these devices been destroyed by the accident sequence or ADS-B not been installed, none of the noted information would have been available to the investigation. Without this information, the accident airplane's flightpath and altitude, the localized weather conditions, and the pilot's actions at the end of the flight would have been in doubt.

Although the recovered data were invaluable to this investigation, the nonregulated nature of the devices challenged the investigation because their data lacked the types of critical details provided by devices that record the parameters specified in TSO-C197. For example, the Chelton data contained only indicated altitude (not pressure altitude) and a one-time snapshot of the altimeter setting; passenger photographs and videos did not include a view of the cockpit, pilot, or direct imagery out the front of the aircraft. Further, the recorded data did not include any cockpit conversations or radio communications.

Because the accident airplane was not equipped with a flight recorder system that captured cockpit images, investigators lacked detailed information about the visual scene the pilot faced as the events leading up to the accident progressed. Having more information about dynamic aspects of the weather the pilot faced when he turned toward high terrain and how the visual scene evolved thereafter would have allowed investigators to highlight specific characteristics of the weather situation faced by the pilot. This could have provided invaluable information about the types of scenarios that Ketchikan air tour pilots should be trained to recognize and avoid, which could be used to enhance operator training programs aimed at preventing VFR into IMC accidents. Thus, the NTSB concludes that a flight recorder system that captured images of the pilot's forward view would have benefitted this accident investigation and provided potentially valuable information for air tour operator training programs.

As discussed in section 1.9.2.3, the FAA has indicated repeatedly and as recently as May 23, 2016, that it does not intend to mandate the equipage of additional recorder systems on all turbine-powered, nonexperimental, nonrestricted-category aircraft. On March 28, 2017, when the NTSB met to determine the probable cause of a July 3, 2015, fatal accident involving an Airbus Helicopters AS350 B3e that crashed following a loss of control at takeoff in Frisco, Colorado, the Board voted to reiterate Safety Recommendations A-13-12 and -13, which remain classified "Open—Unacceptable Response."

Although investigators had some sources of data when investigating this accident, a crash-resistant flight recorder system would provide a more appropriate dataset for the discovery of hazards that may otherwise remain undetected in the aviation system. Because of the relevance of crash-resistant flight recorder systems to this accident and their importance for all turbine-powered, nonexperimental, nonrestricted-category aircraft not presently equipped with a flight data recorder or cockpit voice recorder, the NTSB reiterates Safety Recommendations A-13-12 and A-13-13.

3. Conclusions

3.1 Findings

1. The pilot was properly certificated and qualified in accordance with federal regulations and company requirements. No evidence was found indicating that the pilot's performance was affected by fatigue, medical conditions, toxins, alcohol, or other drugs.

2. The airplane had no preimpact anomalies that would have precluded its normal operation.

3. Based on the damage and high loads sustained during the impact sequence, the accident was not survivable.

4. The accident flight encountered deteriorating weather conditions over the southern half of Ella Lake, and, at the time of the accident, the terrain at the accident site was likely obscured by overcast clouds with visibility restricted in rain and mist.

5. The pilot's continued flight in low-visibility conditions at a lower-than-normal vantage point in an area in which he lacked extensive flying experience reduced his ability to visually identify landmarks and resulted in a navigational error due to geographic disorientation.

6. For single-engine airplanes operated under 14 *Code of Federal Regulations* Part 135 that frequently operate at altitudes below their respective terrain awareness and warning system class design alerting threshold, the nuisance alerts and associated increase in the use of the inhibit mode prevents the system from effectively providing the intended protection.

7. For legacy Chelton systems in use by many Alaska operators, the more-detailed 2007 terrain database update and the current electronic flight instrument system software version provide pilots with more useful terrain information for position reference and for use in escaping an inadvertent encounter with instrument meteorological conditions during visual flight.

8. The pilot's decision to fly a riskier, overland route despite marginal weather conditions and the availability of a safer, overwater route was influenced by schedule pressure and his attempt to emulate the behavior of other, more experienced pilots whose flights he was following.

9. As evidenced by the company president/chief executive officer's own tour flights on the day of the accident, Promech management fostered a company culture that tacitly endorsed operating in weather conditions that were below Federal Aviation Administration minimums.

10. The cue-based and controlled flight into terrain-avoidance training modules that Promech provided the accident pilot were insufficient to counteract cultural and peer influences that encouraged the pilot to continue the flight into deteriorating weather conditions.

11. Controlled flight into terrain (CFIT)-avoidance training for 14 *Code of Federal Regulations* (*CFR*) Part 135 airplane pilots, similar to that which is specified for helicopter pilots in Federal Aviation Administration Order 8900.1, could reduce the risk of CFIT accidents for all 14 *CFR* Part 135 airplane operations.

12. Promech did not exercise an adequate level of operational control of the accident pilot's flights on the morning of the accident.

13. Promech's training and supervision of the flight scheduler were insufficient to ensure that she was qualified under 14 *Code of Federal Regulations* 119.69 and fully understood and could perform her responsibilities to work jointly with the pilots to make safe and appropriate operational control decisions.

14. A flight scheduler with more in-depth operational control training might have played a more influential role in ensuring that flights conducted on the morning of the accident were safe for pilots to initiate and complete.

15. Guidance for establishing a Federal Aviation Administration-approved structured training program and qualification module would help operators ensure that persons authorized to exercise operational control are appropriately trained and possess the knowledge and experience required to make safe and appropriate operational control decisions.

16. All 14 *Code of Federal Regulations* Part 135 operators could benefit from best practices guidance on operational control, similar to that which is provided in Advisory Circular 120-96A, "Operations Control Center for Helicopter Air Ambulance Operators."

17. A quantitative and qualitative standard would enable the Federal Aviation Administration to evaluate the training methods and content of operational control training programs.

18. Although Promech had a hazard reporting system, the system was underused by the pilots, and the company's informal safety processes were not effective for identifying major risks in the company's flight operations and did not facilitate organizational learning about major areas of risk.

19. A safety management system can benefit all 14 *Code of Federal Regulations* Part 135 operators because they require the operators to incorporate formal system safety methods into their internal oversight programs.

20. The establishment of a more conservative set of weather minimums that are tailored to the types of air tour operations that occur in Ketchikan and are applied to all area air tour operators would help balance competing goals of production and safety and remove the incentive of individual operators to adopt the lowest possible weather minimums to stay competitive.

21. Automatic dependent surveillance-broadcast information from a focused operational area could serve as a basis for the Federal Aviation Administration to promote open, nonpunitive discussions of safety issues reflected in objective data to increase awareness of operational hazards.

22. A robust discussion by the Cruise Lines International Association's safety committee with its members about the scheduling pressures associated with air tour shore excursions identified in this investigation would benefit the entire cruise industry.

23. A flight recorder system that captured images of the pilot's forward view would have benefitted this accident investigation and provided potentially valuable information for air tour operator training programs.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was (1) the pilot's decision to continue visual flight into an area of instrument meteorological conditions, which resulted in his geographic disorientation and controlled flight into terrain; and (2) Promech's company culture, which tacitly endorsed flying in hazardous weather and failed to manage the risks associated with the competitive pressures affecting Ketchikan-area air tour operators; its lack of a formal safety program; and its inadequate operational control of flight releases.

4. Safety Recommendations

4.1 New Safety Recommendations

To the Federal Aviation Administration:

Implement ways to provide effective terrain awareness and warning system (TAWS) protections while mitigating nuisance alerts for single-engine airplanes operated under 14 *Code of Federal Regulations* Part 135 that frequently operate at altitudes below their respective TAWS class design alerting threshold. (A-17-35)

Discuss at the next Ketchikan Air Safety meeting the database and software considerations for legacy Chelton systems and encourage operators to use the most current terrain database and electronic flight instrument system software. (A-17-36)

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-17-37)

Expand the application of Federal Aviation Administration Order 8900.1, volume 3, chapter 19, section 6, "Safety Assurance System: Flight Training Curriculum Segments," paragraphs 3-1251(B) and 3-1252, which address controlled flight into terrain-avoidance training programs for 14 *Code of Federal Regulations* (*CFR*) Part 135 helicopter operations, to all 14 *CFR* Part 135 operations. (A-17-38)

Establish minimum initial and recurrent training requirements for personnel authorized to exercise operational control, including, but not limited to, approved subject knowledge areas, training hours, subject hours, and qualification modules. (A-17-39)

Publish an advisory circular that provides guidance on operational control best practices, including, but not limited to, such areas as risk mitigation strategies, joint flight safety responsibilities, prior experience of operational control personnel, and operational control personnel duty time limitations. (A-17-40)

Revise Federal Aviation Administration Order 8900.1 to include guidance for inspector oversight of operational control training program subject areas, including, but not limited to, the criteria for a qualification module. (A-17-41)

Analyze automatic dependent surveillance-broadcast data from Ketchikan air tour operations on an ongoing basis and meet annually with Ketchikan air tour operators to engage in a nonpunitive discussion of any operational hazards reflected in the data and collaborate on mitigation strategies for any hazards identified. (A-17-42)

Develop and implement special operating rules for the Ketchikan air tour industry that include en route visual flight rules weather minimums that are tailored to the industry's unique requirements and are more conservative than those specified in 14 *Code of Federal Regulations* Part 135. (A-17-43)

To Cruise Lines International Association:

Encourage your members that sell air tours as shore excursions to review the circumstances of this accident and to consider ways to mitigate associated risks. (A-17-44)

4.2 Safety Recommendations Reiterated in this Report

To the Federal Aviation Administration:

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

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-13-12)

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

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III
Acting Chairman

CHRISTOPHER A. HART
Member

EARL F. WEENER
Member

T. BELLA DINH-ZARR
Member

Adopted: April 25, 2017

Board Member Statement

Member Christopher A. Hart filed the following concurring statement on May 1, 2017:

Despite the absence of a flight data recorder or cockpit voice recorder on the airplane, this report analyzes the accident comprehensively through our investigators' very ingenious use of a variety of electronic and other sources. I concur with the report, findings, and recommendations, but I would like to address two key issues further.

Adverse Safety Incentives. First, some of the key elements of this accident resemble circumstances we have seen in helicopter emergency medical services (HEMS) accidents, namely, competitive pressures to provide a service, with prospective customers sometimes continuing to call potential carriers until one agrees to the carriage; and compensation that creates adverse safety incentives such that the carrier that takes the risk, even after others declined, gets the revenue. In our safety study several years ago of a series of HEMS accidents, we looked at the bigger picture and attempted to focus on this issue by recommending to the insurers that their compensation scheme should incentivize improved safety by taking the carrier's level of safety into account to determine the level of compensation (Recommendations A-09-104, 105). Unfortunately we were unable to encourage any movement in this regard and those recommendations were closed unacceptable.

Nonetheless, by analogy here, the big picture would suggest that two other participants that are involved in this situation – the cruise ship operators and the Medallion Foundation – should work with the carriers in an effort to create a sightseeing program that eliminates financial incentives to carriers to take more risk. The cruise ship operators make the flight services available to the passengers, and the Medallion Foundation was created to help improve the safety of the carriers in Alaska, so they, in addition to the carriers, have a vested interest improving the safety of the sightseeing carriers by eliminating these adverse incentives.

Time Pressure. Another issue in this accident was the time pressure that was created by the agreement between the cruise ship operator and the sightseeing carrier that if the carrier returned passengers too late to catch the ship, the carrier would be responsible, at its expense, for timely delivery of the passengers to the cruise ship's next port of call, which might be several hundred miles away. In this accident the pressure to return the passengers to the ship in time clearly played a key role in the pilot's decision to take a shorter but obviously more dangerous route back to the ship.

As with the adverse safety incentives, the cruise ship operators and the Medallion Foundation should work with the carriers to develop agreements that eliminate this time pressure because they all have a vested interest in improving safety. The program would need to be more comprehensive than simply enlarging the time window because the problem, although it might be less frequent, could still occur.

Acting Chairman Sumwalt and Members Weener and Dinh-Zarr joined in this statement.

5. Appendix

Investigation

The National Transportation Safety Board (NTSB) was notified of this accident by the Federal Aviation Administration (FAA) regional operations center in Renton, Washington, on June 25, 2015, about mid-afternoon. The NTSB investigator-in-charge and another air safety investigator, both from the NTSB's regional office in Anchorage, Alaska, arrived at the accident site on the morning of June 27, 2015, with the assistance of the Ketchikan Volunteer Rescue Squad. The following investigative groups were formed: airworthiness, meteorology, operations and human performance, and survival factors. Also, specialists were assigned to examine recovered portable electronic devices and cameras, recover data from avionics, and evaluate pilot medical issues.

Parties to the investigation were the FAA, Promech, Hartzell Propeller, Genesys Aerosystems (owner of the former Chelton Systems), and Holland America Group.

In accordance with the provisions of Annex 13 to the Convention on International Civil Aviation, the Transportation Safety Board of Canada participated in the investigation as the representative of the State of Design and Manufacture (airframe and powerplants), with Viking Air Ltd (the current holder of the airframe type certificate) and Pratt & Whitney Canada (powerplants manufacturer) serving as technical advisors.

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