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14 CFR Part 91: General Aviation

Accident occurred Friday, July 16, 1999 in VINEYARD HAVEN, MA

Probable Cause Approval Date: 7/6/2000

Aircraft: Piper PA-32R-301, registration: N9253N

Injuries: 3 Fatal.

The noninstrument-rated pilot obtained weather forecasts for a cross-country flight, which indicated visual flight rules (VFR) conditions with clear skies and visibilities that varied between 4 to 10 miles along his intended route. The pilot then departed on a dark night. According to a performance study of radar data, the airplane proceeded over land at 5,500 feet. About 34 miles west of Martha's Vineyard Airport, while crossing a 30-mile stretch of water to its destination, the airplane began a descent that varied between 400 to 800 feet per minute (fpm). About 7 miles from the approaching shore, the airplane began a right turn. The airplane stopped its descent at 2,200 feet, then climbed back to 2,600 feet and entered a left turn. While in the left turn, the airplane began another descent that reached about 900 fpm. While still in the descent, the airplane entered a right turn. During this turn, the airplane's rate of descent and airspeed increased. The airplane's rate of descent eventually exceeded 4,700 fpm, and the airplane struck the water in a nose-down attitude. Airports along the coast reported visibilities between 5 and 8 miles. Other pilots flying similar routes on the night of the accident reported no visual horizon while flying over the water because of haze. The pilot's estimated total flight experience was about 310 hours, of which 55 hours were at night. The pilot's estimated flight time in the accident airplane was about 36 hours, of which about 9.4 hours were at night. About 3 hours of that time was without a certified flight instructor (CFI) on board, and about 0.8 hour of that was flown at night and included a night landing. In the 15 months before the accident, the pilot had flown either to or from the destination area about 35 times. The pilot flew at least 17 of these flight legs without a CFI on board, of which 5 were at night. Within 100 days before the accident, the pilot had completed about 50 percent of a formal instrument training course. A Federal Aviation Administration Advisory Circular (AC) 61-27C, "Instrument Flying: Coping with Illusions in Flight," states that illusions or false impressions occur when information provided by sensory organs is misinterpreted or inadequate and that many illusions in flight could be caused by complex motions and certain visual scenes encountered under adverse weather conditions and at night. The AC also states that some illusions might lead to spatial disorientation or the inability to determine accurately the attitude or motion of the aircraft in relation to the earth's surface. The AC further states that spatial disorientation, as a result of continued VFR flight into adverse weather conditions, is regularly near the top of the cause/factor list in annual statistics on fatal aircraft accidents. According to AC 60-4A, "Pilot's Spatial Disorientation," tests conducted with qualified instrument pilots indicated that it can take as long as 35 seconds to establish full control by instruments after a loss of visual reference of the earth's surface. AC 60-4A further states that surface references and the natural horizon may become obscured even though visibility may be above VFR minimums and that an inability to perceive the natural horizon or surface references is common during flights over water, at night, in sparsely populated areas, and in low-visibility conditions. Examination of the airframe, systems, avionics, and engine did not reveal any evidence of a preimpact mechanical malfunction.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows:

The pilot's failure to maintain control of the airplane during a descent over water at night, which was a result of spatial disorientation. Factors in the accident were haze, and the dark night.

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## HISTORY OF FLIGHT

On July 16, 1999, about 2141 eastern daylight time, a Piper PA-32R-301, Saratoga II, N9253N, was destroyed when it crashed into the Atlantic Ocean approximately 7 1/2 miles southwest of Gay Head, Martha's Vineyard, Massachusetts. The certificated private pilot and two passengers received fatal injuries. Night visual meteorological conditions (VMC) prevailed, and no flight plan had been filed for the personal flight conducted under the provisions of 14 Code of Federal Regulations (CFR) Part 91. The flight originated from Essex County Airport (CDW), Caldwell, New Jersey, and was destined for Barnstable Municipal-Boardman/Polando Field (HYA), Hyannis, Massachusetts, with a scheduled stop at Martha's Vineyard Airport (MVY), Vineyard Haven, Massachusetts.

During interviews, witnesses stated that the purpose of the flight was to fly to Martha's Vineyard to drop off one passenger and then continue to HYA. An employee of a fixed-base operator (FBO) at CDW stated that he had called the pilot about 1300 on the day of the accident to verify that the pilot intended to fly the airplane, N9253N, over the weekend. The pilot informed the employee that he did plan to fly the airplane and that he would arrive at the airport between 1730 and 1800. The employee informed the pilot that he would have the airplane parked outside of the hangar.

Witnesses who were at CDW on the night of the accident stated that they saw the pilot and a female near the accident airplane. The witnesses also reported that they saw the pilot using crutches and loading luggage into the airplane. One witness stated that he watched the pilot perform an engine run-up and then take off about 2040. The witness further stated that "takeoff and right downwind departure seem[ed] normal."

According to air traffic control (ATC) transcripts from CDW's tower, about 2034, the pilot of N9253N contacted the ground controller and stated, "...saratoga niner two five three november ready to taxi with mike...right turnout northeast bound." The ground controller instructed the pilot to taxi to runway 22, which the pilot acknowledged. At 2038:32, the pilot of N9253N contacted the tower controller and advised that he was ready to take off from runway 22. At 2038:39, the tower controller cleared N9253N for takeoff; at 2038:43, the pilot acknowledged the clearance. A few seconds later, the tower controller asked the pilot if he was heading towards Teterboro, New Jersey. The pilot replied, "No sir, I'm uh actually I'm heading a little uh north of it, uh eastbound." The tower controller then instructed the pilot to "make it a right downwind departure then." At 2038:56, the pilot acknowledged the instruction stating, "right downwind departure two two." No records of any further communications between the pilot and ATC exist.

According to radar data, at 2040:59, a target transmitting a visual flight rules (VFR) code was observed about 1 mile southwest of CDW at an altitude of 1,300 feet. The target proceeded to the northeast, on a course of about 55 degrees, remaining below 2,000 feet. The target was at 1,400 feet when it reached the Hudson River. When the target was about 8 miles northwest of the Westchester County Airport (HPN), White Plains, New York, it turned north over the river and began to climb. After proceeding north about 6 miles, the target turned eastward to a course of about 100 degrees. The target continued to climb and reached 5,500 feet about 6 miles northeast of HPN. When the target's course was plotted on a New York VFR navigational map, the extended course line crossed the island of Martha's Vineyard.

The target continued eastward at 5,500 feet, passing just north of Bridgeport, Connecticut, and crossed the shoreline between Bridgeport and New Haven, Connecticut. The target ground track continued on the 100-degree course, just south and parallel to the Connecticut and Rhode Island coastlines. After passing Point Judith, Rhode Island, the target continued over the Rhode Island Sound.

A performance study of the radar data revealed that the target began a descent from 5,500 feet about 34 miles west of MVY. The speed during the descent was calculated to be about 160 knots indicated airspeed (KIAS), and the rate of descent was calculated to have varied between 400 and 800 feet per minute (fpm). About 2138, the target began a right turn in a southerly direction. About 30 seconds later, the target stopped its descent at 2,200 feet and began a climb that lasted another 30 seconds. During this period of time, the target

stopped the turn, and the airspeed decreased to about 153 KIAS. About 2139, the target leveled off at 2,500 feet and flew in a southeasterly direction. About 50 seconds later, the target entered a left turn and climbed to 2,600 feet. As the target continued in the left turn, it began a descent that reached a rate of about 900 fpm. When the target reached an easterly direction, it stopped turning; its rate of descent remained about 900 fpm. At 2140:15, while still in the descent, the target entered a right turn. As the target's turn rate increased, its descent rate and airspeed also increased. The target's descent rate eventually exceeded 4,700 fpm. The target's last radar position was recorded at 2140:34 at an altitude of 1,100 feet. (For a more detailed description of the target's [accident airplane's] performance, see Section, "Tests and Research," Subsection, "Aircraft Performance Study.")

On July 20, 1999, about 2240, the airplane's wreckage was located in 120 feet of water, about 1/4 mile north of the target's last recorded radar position.

The accident occurred during the hours of darkness. In the area of and on the night of the accident, sunset occurred about 2014. Civil twilight ended about 2047, and nautical twilight ended about 2128. About 2140, the moon was about 11.5 degrees above the horizon at a bearing of 270.5 degrees and provided about 19 percent illumination. The location of the accident wreckage was about 41 degrees, 17 minutes, 37.2 seconds north latitude; 70 degrees, 58 minutes, 39.2 seconds west longitude.

## PILOT INFORMATION

The pilot obtained his private pilot certificate for "airplane single-engine land" in April 1998. He did not possess an instrument rating. He received a "high performance airplane" sign-off in his Cessna 182 in June 1998 and a "complex airplane" sign-off in the accident airplane in May 1999. His most recent Federal Aviation Administration (FAA) second-class medical certificate was issued on December 27, 1997, with no limitations.

A copy of the pilot's logbook that covered from October 4, 1982, to November 11, 1998, was provided to the Safety Board. The pilot's most recent logbook was not located. The Board used the copied logbook, records from training facilities, copies of flight instructors' logbooks, and statements from instructors and pilots to estimate the pilot's total flight experience. The pilot's estimated total flight experience, excluding simulator training, was about 310 hours, of which 55 hours were at night. The pilot's estimated experience flying without a certified flight instructor (CFI) on board was about 72 hours. The pilot's estimated flight time in the accident airplane was about 36 hours, of which 9.4 hours were at night. Approximately 3 hours of that flight time was without a CFI on board, and about 0.8 hour of that time was flown at night, which included a night landing. In the 15 months before the accident, the pilot had flown about 35 flight legs either to or from the Essex County/Teterboro, New Jersey, area and the Martha's Vineyard/Hyannis, Massachusetts, area. The pilot flew over 17 of these legs without a CFI on board, including at least 5 at night. The pilot's last known flight in the accident airplane without a CFI on board was on May 28, 1999.

### Pilot Training

On October 4, 1982, the pilot started receiving flight instruction. Over the next 6 years, he flew with six different CFIs. During this period, the pilot logged 47 hours, consisting of 46 hours of dual instruction and 1 hour without a CFI on board. The pilot made no entries in his logbook from September 1988 to December 1997.

In December 1997, the pilot enrolled in a training program at Flight Safety International (FSI), Vero Beach, Florida, to obtain his private pilot certificate. Between December 1997 and April 1998, the pilot flew about 53 hours, of which 43 were flown with a CFI on board. The CFI who prepared the pilot for his private pilot checkride stated that the pilot had "very good" flying skills for his level of experience.

On April 22, 1998, the pilot passed his private pilot flight test. The designated pilot examiner who administered the checkride stated that as part of the flight test, the pilot conducted two unusual attitude recoveries. The pilot examiner stated that in both cases, the pilot recovered the airplane while wearing a hood

and referencing the airplane's flight instruments. After receiving his private pilot certificate, the pilot flew solo in his Cessna 182 and received instruction in it by CFIs local to New Jersey. He also received instruction at Million Air, a flight school in New Jersey, and flew their airplanes. During calendar year 1998, the pilot flew approximately 179 hours, including about 65 hours without a CFI on board. On March 12, 1999, the pilot completed the FAA's written airplane instrument examination and received a score of 78 percent.

On April 5, 1999, the pilot returned to FSI to begin an airplane instrument rating course. During the instrument training, the pilot satisfactorily completed the first 12 of 25 lesson plans. The pilot's primary CFI during the instrument training stated that the pilot's progression was normal and that he grasped all of the basic skills needed to complete the course; however, the CFI did recall the pilot having difficulty completing lesson 11, which was designed to develop a student's knowledge of very high frequency omnidirectional radio range (VOR) and nondirectional beacon operations while working with ATC. It took the pilot four attempts to complete lesson 11 satisfactorily. After two of the attempts, the pilot took a 1-week break. After this break, the pilot repeated lesson 11 two more times. The CFI stated that the pilot's basic instrument flying skills and simulator work were excellent. However, the CFI stated that the pilot had trouble managing multiple tasks while flying, which he felt was normal for the pilot's level of experience.

The pilot attended this training primarily on weekends. During this training, the pilot accumulated 13.3 hours of flight time with a CFI on board. In addition, the pilot logged 16.9 hours of simulator time. The pilot departed from FSI for the last time on April 24, 1999.

The pilot continued to receive flight instruction from CFIs in New Jersey in his newly purchased Piper Saratoga, the accident airplane. One CFI flew with the pilot on three occasions. One of the flights was on June 25, 1999, from CDW to MVY. The CFI stated that the departure, en route, and descent portions of the flight were executed in VMC, but an instrument approach was required into MVY because of a 300-foot overcast ceiling. The CFI requested an instrument flight rules (IFR) clearance and demonstrated a coupled instrument landing system (ILS) approach to runway 24. The CFI stated that the pilot performed the landing, but he had to assist with the rudders because of the pilot's injured ankle. (For additional information about the pilot's ankle injury, see Section, "Medical and Pathological Information.") The CFI stated that the pilot's aeronautical abilities and his ability to handle multiple tasks while flying were average for his level of experience.

A second CFI flew with the pilot between May 1998 and July 1999. This CFI accumulated 39 hours of flight time with the pilot, including 21 hours of night flight and 0.9 hour flown in instrument meteorological conditions (IMC). The pilot used this CFI for instruction on cross-country flights and as a safety pilot. On July 1, 1999, the CFI flew with the pilot in the accident airplane to MVY. The flight was conducted at night, and IMC prevailed at the airport. The CFI stated that, during the flight, the pilot used and seemed competent with the autopilot. The instructor added that during the flight the pilot was wearing a nonplaster cast on his leg, which required the CFI to taxi the airplane and assist the pilot with the landing.

The CFI stated that the pilot had the ability to fly the airplane without a visible horizon but may have had difficulty performing additional tasks under such conditions. He also stated that the pilot was not ready for an instrument evaluation as of July 1, 1999, and needed additional training. The CFI was not aware of the pilot conducting any flight in the accident airplane without an instructor on board. He also stated that he would not have felt comfortable with the accident pilot conducting night flight operations on a route similar to the one flown on, and in weather conditions similar to those that existed on, the night of the accident. The CFI further stated that he had talked to the pilot on the day of the accident and offered to fly with him on the accident flight. He stated that the accident pilot replied that "he wanted to do it alone."

A third CFI flew with the pilot between May 1998 and July 1999. This CFI accumulated 57 hours of flight time with the pilot, including 17 hours of night flight and 8 hours flown in IMC. The pilot also used this instructor for instruction on cross-country flights and as a safety pilot. This CFI had conducted a "complex airplane" evaluation on the pilot and signed him off in the accident airplane in May 1999. According to the CFI, on one or two occasions, the airplane's autopilot turned to a heading other than the one selected, which required the autopilot to be disengaged and then reengaged. He stated that it seemed as if the autopilot had

independently changed from one navigation mode to another. He also stated that he did not feel that the problem was significant because it only happened once or twice.

The CFI had made six or seven flights to MVY with the pilot in the accident airplane. The CFI stated that most of the flights were conducted at night and that, during the flights, the pilot did not have any trouble flying the airplane. The instructor stated that the pilot was methodical about his flight planning and that he was very cautious about his aviation decision-making. The CFI stated that the pilot had the capability to conduct a night flight to MVY as long as a visible horizon existed.

## AIRCRAFT INFORMATION

The accident airplane, N9253N, was a Piper PA-32R-301, Saratoga II, single-engine, low-wing airplane with retractable landing gear. The airplane was originally certificated by Piper Aircraft Corporation on June 9, 1995. The airplane was sold to Skytech, Inc., Baltimore, Maryland, on June 16, 1995, and then resold to Poinciana LLC, Wilmington, North Carolina, on January 5, 1996.

A review of records from an engine overhaul facility revealed that during a 100-hour and annual inspection of the airplane in May 1998, corrosion was observed on the interior surfaces of the engine cylinder walls. Additionally, pitting was observed on the surfaces of several valve tappets. At that time, the engine had a total time since new of 387.1 hours. The documents also revealed that the engine was shipped to the overhaul facility in June 1998, where the engine was disassembled, inspected, and reassembled (parts were replaced as necessary) in June and July 1998. The engine was also run in a test cell before it was shipped and was reinstalled in the airplane in July 1998.

On August 25, 1998, the airplane was purchased by Raytheon Aircraft Company, Wichita, Kansas, and then resold the same day to Air Bound Aviation, Inc., Fairfield, New Jersey. The airplane was sold on August 27, 1998, to a pilot in New Jersey. On April 28, 1999, the airplane was sold to Columbia Aircraft Sales, Inc., Groton, Connecticut. On the same day, the airplane was sold back to Air Bound Aviation and then to the accident pilot, operating as Random Ventures, Inc., New York, New York. According to maintenance personnel at CDW, the pilot kept the airplane's maintenance records inside of the airplane. The maintenance records were not recovered during the wreckage recovery operation.

According to FAA records, work orders, and a statement from an employee of a maintenance facility, a prepurchase inspection of N9253N was conducted on April 16, 1999. According to the maintenance facility employee, "the aircraft was found to be in very good condition, with only a few minor discrepancies." According to the records and the maintenance facility employee, an annual inspection was completed on June 18, 1999, at a total airframe time of 622.8 hours, and the airplane was returned to service on June 25, 1999. The records and maintenance facility employee also revealed that the airplane's return to service was delayed because of an error on the airplane's registration form about its exact make and model. A new registration form with the correct information had to be sent to the pilot for his signature.

A July 13, 1999, work order revealed that a "swing" of the compass and the horizontal situation indicator (HSI) were completed. No total airframe time was recorded on that work order. The tachometer recovered in the wreckage indicated 663.5 hours.

A review of other pilots' logbooks revealed that they had flown the airplane without the accident pilot on board. However, it could not be accurately determined how many other pilots might have flown the airplane without the pilot on board or how many flight hours they might have added on to the airplane.

## METEOROLOGICAL INFORMATION

The following airport designators (and those previously defined) are used in this section:

ACK - Nantucket Memorial Airport, Nantucket, Massachusetts.

BDR - Igor I. Sikorsky Memorial Airport, Bridgeport, Connecticut.

BID - Block Island State Airport, Block Island, Rhode Island.  
BLM - Allaire Airport, Belmar-Farmingdale, New Jersey.  
EWB - New Bedford Municipal Airport, New Bedford, Massachusetts.  
EWR - Newark International Airport, Newark, New Jersey.  
FMH - Otis ANGB, Falmouth, Massachusetts.  
FOK - Francis S. Gabreski Airport, Westhampton Beach, New York.  
FRG - Republic Airport, Farmingdale, New York.  
ISP - Long Island MacArthur Airport, Islip, New York.  
JFK - John F. Kennedy International Airport, New York, New York.  
PVD - Theodore Francis Green State Airport, Providence, Rhode Island.  
TAN - Taunton Municipal, Taunton, Massachusetts.  
TEB - Teterboro Airport, Teterboro, New Jersey.

ACK is located about 27 nautical miles (nm) east-southeast of MVY. HYA is located about 22 nm northeast of MVY.

### Pilot Preflight Weather Requests

According to Weather Service International (WSI) personnel, a search of their briefing logs indicated that the pilot, or someone using his user code, made two weather requests from WSI's PILOTbrief Web site on July 16, 1999. The first request, made at 1832:59, was for a radar image. The second request, made at 1834:18, was for a route briefing from TEB to HYA with MVY as an alternate.

The information provided to the requester included en route weather observations from BID, BLM, EWB, EWR, FMH, FOK, FRG, ISP, JFK, PVD, and TAN. These observations indicated that visibilities varied from 10 miles along the route to 4 miles in haze at CDW. The lowest cloud ceiling was reported at 20,000 feet overcast at PVD. These observations were made about 1800. Observations for ACK, CDW, HYA, and MVY were also included. Excerpts from these observations include the following:

ACK 1753...Clear skies; visibility 5 miles in mist; winds 240 degrees at 16 knots.  
CDW 1753...Clear skies; visibility 4 miles in haze; winds 230 degrees at 7 knots.  
HYA 1756...Few clouds at 7,000 feet; visibility 6 miles in haze; winds 230 degrees at 13 knots.  
MVY 1753...Clear skies; visibility 6 miles in haze; winds 210 degrees at 11 knots.

Also included were the following terminal forecasts for ACK and HYA:

ACK (July 16 at 1400 to July 17 at 1400)...July 16...1400 to 2000...Clear skies; visibility greater than 6 miles; winds 240 degrees at 15 knots. Becoming 2000 to 2100, winds 260 degrees at 13 knots.

HYA (July 16 at 1400 to July 17 at 1400)...July 16...1400 to 2200...Clear skies; visibility greater than 6 miles; winds 230 degrees at 10 knots.

According to WSI, the pilot, or someone using his user code, did not access the National Weather Service (NWS) Area Forecast.

### Aviation Forecasts and Surface Weather Observations

#### Area Forecasts (FA)

Excerpts from the Boston FA, issued July 16 about 2045 and valid until July 17 about 0200, included the following: Coastal Waters (includes area of MVY); Scattered clouds at 2,000 feet. Occasional visibility 3 to 5 miles in haze. Haze tops 7,000 feet.

Excerpts from the Boston FA, issued July 16 about 2045 and valid until July 17 about 0900, included the following: Coastal Waters (includes area of MVY); North of 40 degrees north latitude... Scattered cirrus.

Occasional visibility 4 to 5 miles in haze. Haze tops 8,000 feet.

#### Aviation Terminal Forecasts (TAF)

NWS does not prepare TAFs for MVY. Excerpts from TAFs pertinent to the accident include the following:

The TAF for ACK, issued July 16 about 1330 and valid from July 16 about 1400 to July 17 about 1400, was as follows: July 16 at 1400 to July 17 at 1100...Clear skies; visibility greater than 6 miles; winds 240 degrees at 15 knots. Becoming July 16 at 2000 to July 16 at 2100, winds 260 degrees at 13 knots.

The TAF for ACK, issued July 16 about 1930 and valid from July 16 about 2000 to July 17 about 2000, was as follows: July 16 at 2000 to July 17 at 0200...Winds 240 degrees at 15 knots; visibility 4 miles, mist; scattered clouds at 25,000 feet. Temporary changes from July 16 at 2100 to July 17 at 0100...clouds 500 feet scattered; visibility 2 miles, mist.

The TAF for HYA, issued July 16 about 1330 and valid from July 16 about 1400 to July 17 about 1400, was as follows: July 16 at 1400 to July 17 at 1100...Clear skies; visibility greater than 6 miles; winds 230 degrees at 10 knots. Winds becoming July 16 at 2200 to July 17 at 0000...250 degrees at 8 knots.

The TAF for HYA, issued July 16 about 1930 and valid from July 16 about 2000 to July 17 about 2000, was as follows: July 16 at 2000 to July 17 at 0200...Winds 230 degrees at 10 knots; visibility 6 miles, haze; scattered clouds at 9,000 feet. Temporary changes from July 16 at 2000 to July 17 at 0000...Visibility 4 miles, haze.

#### In-flight Weather Advisories

No airmen's meteorological information, significant meteorological information (SIGMET), or convective SIGMETs were issued by the NWS Aviation Weather Center in Kansas City, Missouri, for the time and area of the accident. No in-flight weather advisories were in effect along the route between CDW and MVY from 2000 to 2200.

#### Surface Weather Observations

MVY had an Automated Surface Observing System (ASOS), which was edited and augmented by ATC tower personnel if necessary. The tower manager at MVY was on duty on the night of the accident for an 8-hour shift, which ended when the tower closed, about 2200. During an interview, the tower manager stated that no actions were taken to augment or edit the ASOS during his shift. He also stated the following:

"The visibility, present weather, and sky condition at the approximate time of the accident was probably a little better than what was being reported. I say this because I remember aircraft on visual approaches saying they had the airport in sight between 10 and 12 miles out. I do recall being able to see those aircraft and I do remember seeing the stars out that night...To the best of my knowledge, the ASOS was working as advertised that day with no reported problems or systems log errors."

ASOS observations for the night of the accident include the following:

#### ACK

2053...Clear at or below 12,000 feet; visibility 4 miles, mist; winds 240 degrees at 11 knots; temperature 21 degrees [Celsius] C; dewpoint 20 degrees C; altimeter setting 30.10 inches of [mercury] Hg.

2153...Clear at or below 12,000 feet; visibility 4 miles, mist; winds 240 degrees at 12 knots; temperature 21 degrees C; dewpoint 20 degrees C; altimeter setting 30.11 inches of Hg.

#### BDR

2054...Clear at or below 12,000 feet; visibility 8 miles, haze; winds 230 degrees at 4 knots; temperature 27 degrees C; dewpoint 21 degrees C; altimeter setting 30.08 inches of Hg.

#### CDW

1953...Clear at or below 12,000 feet; visibility 4 miles, haze; winds 230 degrees at 4 knots; temperature 33 degrees C; dewpoint 18 degrees C; altimeter setting 30.07 inches of Hg.

2053...Clear at or below 12,000 feet; visibility 5 miles, haze; winds 220 degrees at 5 knots; temperature 31 degrees C; dewpoint 19 degrees C; altimeter setting 30.08 inches of Hg.

#### HPN

2045...7,500 feet broken, 15,000 feet overcast, visibility 5 miles haze; winds 140 degrees at 4 knots; temperature 28 degrees C; dewpoint 22 degrees C; altimeter setting 30.08 inches of Hg.

#### HYA

2056...Few clouds at 7,000 feet; visibility 6 miles, mist; winds 230 degrees at 7 knots; temperature 23 degrees C; dewpoint 21 degrees C; altimeter setting 30.07 inches of Hg.

2156...Few clouds at 7,500 feet; visibility 6 miles, mist; winds 230 degrees at 8 knots; temperature 23 degrees C; dewpoint 22 degrees C; altimeter setting 30.08 inches of Hg.

#### MVY

2053...Clear at or below 12,000 feet; visibility 8 miles; winds 250 degrees at 7 knots; temperature 23 degrees C; dewpoint 19 degrees C; altimeter 30.09 inches of Hg.

2153...Clear at or below 12,000 feet; visibility 10 miles; winds 240 degrees at 10 knots, gusts to 15 knots; temperature 24 degrees C; dewpoint 18 degrees C; altimeter 30.10 inches of Hg.

#### U.S. Coast Guard Station (USCG) Weather Observations

Safety Board staff reviewed weather observations from USCG stations. Excerpts pertinent to the accident include the following:

##### Point Judith, Rhode Island

1700...Cloudy, 3 miles visibility in haze, winds south-southwest at 10 knots.

2000...Cloudy, 3 miles visibility in haze, winds south-southwest at 10 knots.

2300...Cloudy, 2 miles visibility, winds southwest at 10 knots.

##### Brant Point, Massachusetts

1700...Clear, 8 miles visibility.

2000...Overcast, 6 miles visibility.

2300...Scattered clouds, 6 miles visibility.

The Brant Point report stated that two observations were reported by ships. About 2000, a ship 1 nm north of buoy 17, which was about 8 miles north of Martha's Vineyard, reported that the seas were 2 to 3 feet and that the visibility was 5 nm. About 2300, another ship reported that the winds were west-southwest at 10 to 15 knots, the seas were 2 to 3 feet, and the visibility was 6 nm in light haze.

#### Pilot Weather Observations

Three pilots who had flown over the Long Island Sound on the night of the accident were interviewed after the accident.

One pilot kept his twin turboprop airplane at TEB, and on the evening of the accident, he flew from TEB to



ACK. The pilot stated that he drove to TEB from New York City and that the traffic was the second heaviest he had seen in 15 years. The pilot stated that he had called the TEB FBO and estimated that his arrival time would be about 1850; however, he did not arrive until between about 1930 and 2000 because of traffic. The pilot also stated that this delay changed the flight from one that would have been conducted entirely during the day to one that would have to be conducted partially at night. The pilot further stated, "Our car took route 80 to Teterboro Airport. Caldwell Airport, where [the accident pilot] flew from is another 14 minute drive west on route 80 past TEB."

Before departing the city, the pilot had obtained current weather observations and forecasts for Nantucket and other points in Massachusetts, Connecticut, New York, and New Jersey. He stated that the visibility was well above VFR minimums. He also stated that he placed a telephone call to a flight service station (FSS) before leaving the city, while driving to TEB. Regarding the telephone call, he stated the following:

"I asked if there were any adverse conditions for the route TEB to ACK. I was told emphatically: 'No adverse conditions. Have a great weekend.' I queried the briefer about any expected fog and was told none was expected and the conditions would remain VFR with good visibility. Again, I was reassured that tonight was not a problem."

The pilot stated that he departed TEB "...in daylight and good flight conditions and reasonable visibility. The horizon was not obscured by haze. I could easily pick our land marks at least five [miles] away." The pilot also stated that he did not request or receive flight information after his departure from TEB. Once clear of the New York Class B airspace, he stated that he climbed his airplane to 17,500 feet and proceeded towards Nantucket. He reported that above 14,000 feet, the visibility was unrestricted; however, he also reported that during his descent to Nantucket, when his global positioning system (GPS) receiver indicated that he was over Martha's Vineyard, he looked down and "...there was nothing to see. There was no horizon and no light...I turned left toward Martha's Vineyard to see if it was visible but could see no lights of any kind nor any evidence of the island...I thought the island might [have] suffered a power failure."

He stated that he had his strobe lights on during the descent and that at no time did they illuminate clouds or fog. He also stated, "I had no visual reference of any kind yet was free of any clouds or fog." The pilot stated that when he contacted the ACK tower for landing, he was instructed to fly south of Nantucket about 5 miles to join the downwind for runway 24; however, he maintained a distance of 3 to 4 miles because he could not see the island at 5 miles. The pilot stated that, as he neared the airport, he had to make a 310-degree turn for spacing. He stated that, during the turn, "I found that I could not hold altitude by outside reference and had to use my [vertical speed indicator] VSI and HSI to hold altitude and properly coordinate the turn."

Another pilot had flown from Bar Harbor, Maine, to Long Island, New York, and crossed the Long Island Sound on the same evening, about 1930. This pilot stated that during his preflight weather briefing from an FSS, the specialist indicated VMC for his flight. The pilot filed an IFR flight plan and conducted the flight at 6,000 feet. He stated that he encountered visibilities of 2 to 3 miles throughout the flight because of haze. He also stated that the lowest visibility was over water, between Cape Cod, Massachusetts, and eastern Long Island. He stated that he did not encounter any clouds below 6,000 feet.

A third pilot departed TEB about 2030 destined for Groton, Connecticut, after a stopover at MVY. He stated that, after departure, he flew south of HPN and, remaining clear of the Class B airspace, he climbed to 7,500 feet. He also stated that, while en route, he monitored several ATC frequencies, but did not transmit on any of them until he neared MVY. His route of flight took him over the north shore of Long Island to Montauk, New York. He stated that he then crossed over Block Island, Rhode Island, and proceeded directly to MVY.

He stated that the entire flight was conducted under VFR, with a visibility of 3 to 5 miles in haze. He stated that, over land, he could see lights on the ground when he looked directly down or slightly forward; however, he stated that, over water, there was no horizon to reference. He stated that he was not sure if he was on top of the haze layer at 7,500 feet and that, during the flight, he did not encounter any cloud layers or ground fog during climb or descent. He further stated that, between Block Island and MVY, there was still no horizon to reference. He recalled that he began to observe lights on Martha's Vineyard when he was in the vicinity of

Gay Head. He stated that, before reaching MVY, he would have begun his descent from 7,500 feet and would have been between 3,000 and 5,000 feet over Gay Head (the pilot could not recall his exact altitudes). He did not recall seeing the Gay Head marine lighthouse. He was about 4 miles from MVY when he first observed the airport's rotating beacon. He stated that he had an uneventful landing at MVY about 2145.

About 2200, the pilot departed MVY as the controller announced that the tower was closing. After takeoff, he proceeded on a heading of 290 degrees, climbed to 6,500 feet, and proceeded directly to Groton. The pilot stated that, during the return flight, the visibility was the same as that which he had encountered during the flight to MVY, which was about 3 to 5 miles in haze.

Another pilot at CDW had stated to the news media that he cancelled his planned flight from CDW to MVY on the evening of the accident because of the "poor" weather. In a written statement he stated the following:

"From my own judgement visibility appeared to be approximately 4 miles-extremely hazy. Winds were fairly light. Based only on the current weather conditions at CDW, the fact that I could not get my friends to come with me, and the fact that I would not have to spend money on a hotel room in Martha's Vineyard, I made the decision to fly my airplane to Martha's Vineyard on Saturday."

## COMMUNICATIONS

No record exists of the pilot, or a pilot using the airplane's registration number, receiving a weather briefing or filing a flight plan with any FAA FSS for the accident flight. Further, no record exists of the pilot, or a pilot using the airplane's registration number, contacting any FSS or ATC tower or facility during the duration of the flight, except for those at CDW.

The MVY ATC tower tape revealed that, during the period of time from when the accident airplane departed CDW until the tower closed and the recorder was turned off (about 2200), no contact was attempted by the pilot, the call sign of N9253N, or any unknown station.

## TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS) ALERT NEAR HPN

According to the Aeronautical Information Manual (AIM), definitions for Class B and D airspace are as follows:

Class B Airspace: "Generally, that airspace from the surface to 10,000 feet MSL [mean sea level], surrounding the nation's busiest airports in terms of IFR operations or passenger enplanements...An ATC clearance is required for all aircraft to operate in the area, and all aircraft that are so cleared receive separation services within the airspace...Regardless of weather conditions, an ATC clearance is required prior to operating within Class B airspace..."

Class D Airspace: "Generally, that airspace from the surface to 2,500 feet above the airport elevation (charted in MSL) surrounding those airports that have an operational control tower...Two-way radio communication must be established with the ATC facility providing ATC services prior to entry and thereafter maintain those communications while in the Class D airspace...."

The following TCAS alert occurred during the approach of a commercial airplane to HPN, which was located within published Class D airspace and the New York Class B airspace. On July 16, 1999, about 2049, American Airlines flight 1484, a Fokker 100, was inbound for landing at HPN. According to the transcripts of communications between flight 1484 and the New York approach controller, at 2049:33, flight 1484 was level at 6,000 feet. At 2049:48, the controller instructed flight 1484 to descend and maintain 3,000 feet, which flight 1484 acknowledged. At 2050:32, the controller issued an approach clearance to flight 1484, which flight 1484 also acknowledged. The following is an excerpt of the communications transcript between flight 1484 and the controller regarding the TCAS:

2052:22, the controller, "American fourteen eighty four traffic one o'clock and five miles eastbound two

thousand four hundred, unverified, appears to be climbing."

2052:29, flight 1484, "American fourteen eighty four we're looking."

2052:56, the controller, "fourteen eighty four traffic one o'clock and uh three miles twenty eight hundred now, unverified."

2053:02, flight 1484, "um yes we have uh (unintelligible) I think we have him here american fourteen eighty four."

2053:10, flight 1484, "I understand he's not in contact with you or anybody else."

2053:14, the controller, "uh nope doesn't not talking to anybody."

2053:27, flight 1484, "seems to be climbing through uh thirty one hundred now we just got a traffic advisory here."

2053:35, the controller, "uh that's what it looks like."

2053:59, flight 1484, "uh we just had a."

2054:12, the controller, "American fourteen eighty four you can contact tower nineteen seven."

2054:15, flight 1484, "nineteen seven uh we had a resolution advisory seemed to be a single engine piper er commanche or something."

2054:21, the controller, "roger."

The event occurred outside of the New York Class B and the HPN Class D airspace, and no corrective action was reported to have been taken by the controller or flight 1484. A review of the radar data correlated the unknown target with the track of N9253N.

## AIRPORT INFORMATION

MVY had a field elevation of 68 feet. The hours of operation for the contract-operated tower were from 0600 to 2200. MVY had two runways. Runway 06/24 was asphalt-surfaced, 5,500 feet long, and 100 feet wide. Runway 15/33 was asphalt-surfaced, 3,297 feet long, and 75 feet wide. A VOR-distance measuring equipment (DME) navigation aid was located on the airport. The VOR was listed with a normal anticipated interference-free service of 40 nm, up to 18,000 feet with DME. ILS, VOR, and GPS instrument approaches were published for the airport.

MVY was located about 10 miles east of Gay Head. Gay Head had a lighthouse for marine navigation at 41 degrees, 20.9 minutes north latitude; 70 degrees, 50.1 minutes west longitude. According to USCG personnel, the top of the lighthouse was 170 feet above mean low water and operated 24 hours-a-day. The rotating beacon ran on a 15-second cycle, 7.3 seconds white and 7.3 seconds red. The expected range of the white light was 24 miles, and the expected range of the red light was 20 miles.

## FLIGHT RECORDERS

The airplane was equipped with a Flightcom Digital Voice Recorder Clock, DVR 300i. The unit contained a digital clock, was wired into the radio communications circuits, and could record conversations between the airplane and other radio sources, ground, or air. The unit was voice activated, and the continuous loop could record and retain a total of 5 minutes of data. The unit had a nonvolatile speech memory that required a 9-volt backup battery to preserve the speech data. When the unit was located in the wreckage, it was crushed, its backup battery was missing, and it had retained no data.

## WRECKAGE INFORMATION

On July 20, 1999, the airplane wreckage was located by U.S. Navy divers from the recovery ship, USS Grasp, at a depth of about 120 feet below the surface of the Atlantic Ocean. According to the divers, the recovered wreckage had been distributed in a debris field about 120 feet long and was oriented along a magnetic bearing of about 010/190 degrees. The main cabin area was found in the middle of the debris field.

A Safety Board investigator was present on the USS Grasp during the salvage operation. On July 21, 1999, the main cabin area was raised and placed aboard the USS Grasp. On July 22, 1999, the divers made five additional dives, and the wreckage retrieved from these dives was also placed aboard the USS Grasp. On July 23, 1999, about 2100, the wreckage was transferred from the USS Grasp to the Safety Board at a naval base in Newport, Rhode Island. The wreckage was then transported to the USCG Air Station at Otis Air Force Base, Cape Cod, Massachusetts, the evening of July 23, 1999. The wreckage was examined by Board investigators in a hangar at the USCG Air Station on July 24, 25, and 26, 1999. Follow-up examinations were conducted on August 1 and 2, 1999.

According to the Airworthiness Group Chairman's Report, the engine was found separated from the engine mount truss. The structural tubing on the right side of the engine mount truss was missing. The engine mount truss was deformed to the right and fractured in numerous locations. The upper left engine mount ear and both lower mount ears were fractured. The upper right engine mount ear was bent. The engine and propeller were retained for additional examination.

About 75 percent of the fuselage structure was recovered. A section of the aft cabin roof, about 5 feet long by 3 1/2 feet wide, had separated from the fuselage; this section included the airframe-mounted hinge of the left-side cargo door and a partial frame of the left-side cabin door. The left side of this section exhibited accordion crush damage in the aft direction and contained multiple folds about 5 inches deep. No fuselage structure from the left or right side of the cabin area was recovered, except for a piece of skin, about 2 feet by 2 feet, located beneath the left-side passenger window frame. The belly skin and floor structure of the fuselage were intact aft of the wing spar box carry-through section. The recovered floor structure forward of this section was fragmented. Portions of five of the six seats were found inside the fuselage. The sixth seat was not recovered. Most of the fuselage structure aft of the cabin area was recovered.

About 60 percent of the right wing structure was recovered, including the entire span of the main spar. The right wing had separated into multiple pieces and exhibited more damage than the left wing. The right wing main spar had separated into three pieces. The wing spar had fractured at its attachment to the main carry-through section. The upper spar cap fracture exhibited tension on its forward edge and compression on its aft edge. The spar web exhibited aft bending and tearing in this area.

The outboard portion of the wing leading edge exhibited rearward accordion crush damage and was separated from the remainder of the wing. No evidence of upward spar bending damage was found. No evidence of metal fatigue was found in any of the fracture surfaces.

The entire span of the right flap was recovered; it had separated into two sections (chordwise fracture), and both sections had separated from the right wing. Neither flap section exhibited bowing, bulging, or planar deformation. About 33 inches of the right aileron was recovered, and the leading edge of this section exhibited rearward crush deformation.

About 80 percent of the left wing structure was recovered, including the entire span of the main spar. The left wing main spar had separated into several pieces and exhibited less deformation than the right wing. The wing spar was fractured near the left edge of the main carry-through section. The upper and lower spar cap fractures in this area exhibited tension on the forward edges and compression on the aft edges. The spar web also exhibited aft bending and tearing in this area. No evidence of upward spar bending damage was found. No evidence of metal fatigue was found in any of the fracture surfaces.

About 90 percent of the upper and lower wing skin between the main and rear spars was recovered. The upper skin near the left wing tip was flattened out. The leading edge skin near the inboard portion of the left wing, near the stall warning port, exhibited damage consistent with uniform hydrodynamic deformation in the aft direction.

A 27-inch inboard section of the wing flap section was recovered, and the leading edge of this section exhibited aft accordion crush damage. The flap section did not exhibit any bowing, bulging, or planar deformation. The entire span of the left aileron was recovered; it had separated into two pieces. The outboard section of the aileron was curled downward.

The vertical stabilizer and rudder had separated from the aft fuselage. The stabilator had separated from the aft fuselage attach points and had fractured into five pieces. Two of the pieces consisted of left and right outboard sections, about 22 inches long, and exhibited symmetrical aft crush marks that were semicircular, with diameters of about 5 inches. The fracture surfaces of the left outboard section exhibited tearing in the aft direction. The fracture surfaces of the right outboard sections exhibited forward and upward tearing. The left inboard section of the stabilator was more intact than the right inboard section. The leading edge of the right stabilator section exhibited rearward uniform crush damage along its entire leading edge.

The lower portion of the rudder had separated from the vertical stabilizer fin structure and remained attached to the torque tube bellcrank assembly and fin aft spar. The rudder was folded over toward the right side of the airplane. The vertical stabilizer was also twisted, bent, and curled around toward the right. The structure surrounding the dorsal fin area was deformed symmetrically upward.

All three landing gear assemblies had separated from the airframe and were recovered. The retraction/extension actuating cylinders associated with the nose gear and the left main gear were found in the fully retracted position. The retraction/extension actuating cylinder for the right main gear was not recovered.

Examination of the aileron control cable circuit and associated hardware did not reveal any evidence of a preexisting jam or failure. Flight control cable continuity for the entire right aileron control circuit, including the entire balance cable that links the right aileron to the left aileron, was established. The control cable continuity for the left aileron could not be established because of impact damage and fragmentation. All of the ends of the separations of the aileron control cable circuits exhibited evidence of tensile overload. The stops for the ailerons were examined; no evidence of severe repetitive strike marks or deformations was noted.

Examination of the stabilator control cable circuit and associated hardware did not reveal any evidence of a preexisting jam or failure. Flight control cable continuity for the stabilator was established from the control surfaces to the cockpit controls. The stabilator balance weight had separated from the stabilator, and the fractures associated with the separation were consistent with tensile overload. The stops for the stabilator were examined; no evidence of severe repetitive strike marks or deformations was noted.

Examination of the stabilator trim control cable circuit and associated hardware did not reveal any evidence of a preexisting jam or failure. Control cable circuitry for the stabilator trim was established from the control surfaces to the cockpit area. An examination of the stabilator trim barrel jackscrew revealed that one full thread was protruding out of the upper portion of the trim barrel assembly housing. The barrel assembly was free to rotate and had the trim control cable wrapped around it. The two cable ends were separated about 41 inches and 37 inches, respectively, from the barrel assembly winding. Examination of the separations revealed evidence consistent with tensile overload.

Examination of the rudder control cable circuit and associated hardware did not reveal any evidence of a preexisting jam or failure. Flight control cable continuity for the rudder was established from the control surfaces to the cockpit controls. The stops for the rudder were examined; no evidence of severe repetitive strike marks or deformations was noted.

The electrically driven wing flap jackscrew actuator was not recovered. The flap switch in the cockpit was destroyed. The throttle and propeller controls were found in the FULL-FORWARD position. The mixture control was broken. The alternate air control was found in the CLOSED position. The key in the magneto switch was found in the BOTH position.

The tachometer needle was found intact, fixed in place, and pointed to 2,750 rpm. The red line on the tachometer began at 2,700 rpm. The hour register inside the tachometer read 0663.5 hours. The manifold pressure gauge needle was found fixed in place and indicated 27 inches Hg. The fuel flow gauge needle was found slightly loose and indicated 22 gallons per hour. The exhaust gas temperature gauge needle was found loose and indicated 1,000 degrees Fahrenheit (F). The oil temperature gauge was found fixed and indicated 150 degrees F. The oil pressure gauge was found fixed and indicated about 17 pounds per square inch (psi). The cylinder temperature gauge needle was not found. The fuel quantity gauges were destroyed. The altimeter needle was found fixed and indicated 270 feet. The altimeter setting was found fixed at 30.09 Hg. The top of the VOR indicator heading card was found at the 097-degree bearing.

Examination of all recovered electrical wiring and components did not reveal any evidence of arcing or fire. The circuit breaker panel was deformed and impact damaged. All of the breakers were found in the tripped position, except for the flap, transceiver, and DME. The circuit breaker that provided protection for the transponder, which provided the VFR code and altitude readout to radar facilities down to 1,100 feet, was also found tripped.

The fuel selector valve was recovered, and the bottom of the valve was missing. All three fuel line connections were broken off. The valve had separated from the fuselage attach points. The selector valve linkage was deformed, and the valve was found in the OFF position.

A liquid that had a similar color, odor, and texture as 100 low-lead aviation gasoline was found in the fuel selector valve sump. The electrically driven fuel boost pump was able to function when electrical power was applied to it.

The airplane had been equipped with six seats. The seats had been configured in a "club style" arrangement, with two forward-facing seats in row 1 (including the pilot's seat), two aft-facing seats in row 2, and two front-facing seats in row 3. The five recovered seats had separated from the floor structure. Examination of the aluminum backs of both aft-facing seats revealed that they were deformed (bulged) in the forward direction.

The left and right front seats were equipped with lap belts and shoulder harnesses. None of the belts for these seats could be identified in the wreckage. The four seats in rows 2 and 3 were also equipped with lap belts and shoulder harnesses. Both sections of the lap belt for the left-side aft-facing seat were found and exhibited evidence of stretching. The inboard section of the lap belt for the right-side aft-facing seat in row 2 had been cleanly cut about 3 inches from the male-end of the latch, and the outboard section of lap belt for this seat exhibited evidence of stretching. All of the lap belt sections for the seats in row 3 were identified and none exhibited evidence of stretching. The shoulder harnesses for the rear seats could not be identified in the wreckage.

## MEDICAL AND PATHOLOGICAL INFORMATION

On July 21, 1999, examinations were performed on the pilot and passengers by Dr. James Weiner, Office of the Chief Medical Examiner, Commonwealth of Massachusetts. The results indicated that the pilot and passengers died from multiple injuries as a result of an airplane accident.

Toxicological testing was conducted by the FAA Toxicology Accident Research Laboratory, Oklahoma City, Oklahoma. The toxicological tests were negative for alcohol and drugs of abuse.

### Medical Information

According to medical records, on June 1, 1999, the pilot fractured his left ankle in a "hang gliding" accident, and on June 2, 1999, he underwent surgical "open reduction internal fixation of left ankle fracture." On June 23, 1999, the pilot's leg was removed from a cast and placed in a "Cam-Walker." On July 15, 1999, the pilot's Cam-Walker was removed, and on July 16, 1999, he was given a "straight cane and instructed in cane usage." The medical records noted that the pilot was "full-weight bearing with mild antalgic gait."

During interviews, the pilot's physical therapist stated that the pilot did not have full dorsiflexion (bending upward of the foot) and that he could not determine whether the pilot's gait was caused by his slight limitation of motion or by mild pain. The pilot's orthopedic surgeon stated that he felt that, at the time of the accident, the pilot would have been able to apply the type of pressure with the left foot that would normally be required by emergency brake application with the right foot in an automobile.

According to 14 CFR Section 61.53, "Prohibition On Operations During Medical Deficiency," in operations that required a medical certificate, a person shall not act as a pilot-in-command while that person, "(1) Knows or has reason to know of any medical condition that would make the person unable to meet the requirements for the medical certificate necessary for the pilot operation."

According to an FAA medical doctor, a pilot with the type of ankle injury that the accident pilot had at the time of the accident would not normally be expected to visit and receive approval from an FAA Medical Examiner before resuming flying activities.

## TESTS AND RESEARCH

### Engine and Propeller Examinations

On July 26, 1999, the engine was examined at the Textron-Lycoming Facility, Williamsport, Pennsylvania, under the supervision of a Safety Board powerplants investigator. On July 28, 1999, the propeller hub and blades were examined at the Hartzell Propeller Facility, Piqua, Ohio, under the supervision of a Safety Board powerplants investigator. Parties to the investigation were present during both examinations.

According to the Powerplants Group Chairman's Factual Report, the examinations of the engine and propeller did not reveal evidence of any preexisting failures or conditions that would have prevented engine operation. The report further stated that "the investigation team found impact marks on one of the propeller blades and the top of the engine, witness marks inside the propeller, and the engine controls and instruments in the cockpit that indicated high engine power output."

### Autopilot Operation

The airplane was equipped with a Bendix/King 150 Series Automatic Flight Control System (AFCS), which was approved for use in Piper PA-32R-301 model airplanes by the FAA on November 1, 1982. The AFCS provided two-axis control for pitch and roll. It also had an electric pitch trim system, which provided autotrim during autopilot operation and manual electric trim for the pilot during manual operation.

The AFCS installed on the accident airplane had an altitude hold mode that, when selected, allowed the airplane to maintain the altitude that it had when the altitude hold was selected. The AFCS did not have the option of allowing the pilot to preselect an altitude so that the autopilot could fly to and maintain the preselected altitude as it climbed or descended from another altitude. The AFCS had a vertical trim rocker switch installed so that the pilot could change the airplane's pitch up or down without disconnecting the autopilot. The rocker switch allowed the pilot to make small corrections in the selected altitude while in the altitude hold mode or allowed the pitch attitude to be adjusted at a rate of about 0.9 degree per second when not in altitude hold mode.

The AFCS incorporated a flight director, which had to be activated before the autopilot would engage. Once activated, the flight director could provide commands to the flight command indicator to maintain wings level and the pitch attitude. To satisfy the command, the pilot could manually fly the airplane by referencing

the guidance received in the flight command indicator, or the pilot could engage the autopilot and let it satisfy the commands by maneuvering the aircraft in a similar manner via the autopilot servos.

The AFCS incorporated a navigation mode that could provide guidance to the pilot, or the autopilot, about intercepting and tracking VOR and GPS courses. While engaged in this mode, the AFCS could receive input signals from either the selected VOR frequency and course or from GPS course data selected for presentation on the pictorial navigation indicator. The flight command indicator could then command the bank required to maintain the selected VOR or GPS course with automatic crosswind compensation, and the autopilot, if engaged, would satisfy those commands.

The AFCS incorporated a heading select mode that allowed the pilot to select a heading by moving a "bug" on the outer ring of the pictorial navigation indicator. Once the bug was moved to the desired heading with the heading select button engaged, the autopilot could command the airplane to that heading at a bank angle of about 22 degrees.

The AFCS had a control wheel steering (CWS) button mounted on the control yoke that allowed the pilot to maneuver the aircraft in pitch and roll without disengaging the autopilot. According to AlliedSignal, when the CWS button was released, the autopilot would resume control of the aircraft at the heading and altitude that had been selected at the time the CWS button was released.

According to the FAA and Bendix/King, the trim system was designed to withstand any single in-flight malfunction. Trim faults were visually and aurally annunciated in the cockpit. Through the use of monitor circuits, aircraft control would automatically be returned to the pilot when a fault was detected.

After the AFCS had been preflight tested, it could be engaged and disengaged either manually or automatically. The following conditions would cause the autopilot to automatically disengage: power failure, internal flight control system failure, loss of a valid compass signal, roll rates greater than 14 degrees per second, and pitch rates greater than 8 degrees per second.

#### Avionics Examinations

On July 29 and 30, 1999, the avionics were examined at the AlliedSignal/King Radios Facility, Olathe, Kansas, under the supervision of a Safety Board investigator. On October 13 and 14, 1999, a follow-up examination of the navigation and communications transceivers and all three autopilot servos was also performed at the AlliedSignal/King Radios Facility under the supervision of a Safety Board investigator. Parties to the investigation were present during both examinations.

The accident airplane's AFCS was examined. Examination and functional testing of the AFCS pitch, pitch trim, and roll servos did not reveal any evidence of a preimpact malfunction or jam.

The accident airplane was equipped with a GPS receiver, Bendix/King model KLN-90B. The GPS was capable of presenting moving map displays; bearings and distances to programmable destinations, such as airports and waypoints; airport information; ground speed; and other information. The GPS was also capable of interfacing with the AFCS and the pictorial navigation indicator.

Examination of the GPS unit revealed that it was crushed vertically. The display in the front face of the unit was destroyed. The ON/OFF switch was found in the ON position. The navigation database indicated that it was effective on October 8, 1998, and that it expired on November 4, 1998. A wire that connected the circuitry of a 3.6-volt lithium battery was separated. According to AlliedSignal, the lithium battery provided electrical power to retain the nonvolatile memory of the GPS receiver and required a minimum of 2.5 volts to retain memory. The battery voltage was measured to be 0.2 volt, and it was determined that the memory had not been retained.

Examination of the Bendix/King model KR-87, automatic direction finder, revealed that the receiver's primary frequency was set at 400 kilohertz (kHz) and the secondary frequency was set at 200 kHz.



Both of the airplane's communication/navigation transceivers received severe impact damage and could not be powered up. The nonvolatile memory circuit chips were extracted from the transceivers, placed in a test unit, and powered up. The following information was noted about each of the transceivers:

#### Transceiver No. 1, KX-165

The in-use communication frequency was set at 132.02, which was the same frequency as the TEB automatic terminal information service (ATIS).

The standby communication frequency was set at 135.25; the CDW ATIS had a frequency of 135.5.

The in-use navigation frequency was set at 109.80, which was the same frequency as the New Haven, Connecticut, VOR.

The standby navigation frequency was set at 113.10, which was the same frequency as the LaGuardia Airport, New York, VOR.

#### Transceiver No. 2, KX-165

The in-use communication frequency was set at 121.40, which was the same frequency as the MVY tower.

The standby communication frequency was set at 127.25; the MVY ATIS had a frequency of 126.25.

The in-use navigation frequency was set at 108.80, which was the same frequency as the BDR VOR.

The standby navigation frequency was set at 110.00, which was the same frequency as the Norwich, Connecticut, VOR.

#### Safety Board Materials Laboratory Examinations

An examination of the accident airplane's components was conducted in the Safety Board Materials Laboratory in Washington, D.C.

The flight command indicator (Bendix/King model KI-256) was deformed, and its glass faceplate was missing. The center portion of the pictorial display was partially embedded in the side of the housing in a position that indicated a right turn with a bank angle of about 125 degrees and a nose-down pitch attitude of about 30 degrees. The air-driven gyro housing inside of the flight command indicator was corroded but not deformed. Disassembly and inspection of the gyro did not reveal any scoring marks on the spinning mass gyro and mating housing. The turn coordinator was deformed, and its glass was missing. The display was captured in a position indicating a steep right turn. The electrically driven gyro assembly inside of the instrument was removed and found free to rotate with no binding or case interference. No scoring marks were found on either the spinning mass gyro or mating housing.

The pictorial navigation indicator (Bendix/King model KI-525A) was deformed, and its glass faceplate was missing. The heading indicator was pointing to 339 degrees. The center navigational display needle was oriented along the 300/120-degree bearing. The heading flag was displayed. The heading bug was located at the 095-degree mark. The slaved gyro assembly was partially separated from its mounting, and its case exhibited minor deformation. The gyro housing and internal rotor were disassembled. The interior surface of the case and the exterior surface of the spinning mass rotor did not exhibit any deformation, impact marks, or rotational scoring.

The engine-driven vacuum pump drive shear shaft was intact. The drive end was removed to expose the internal rotor and vanes. The rotor showed several cracks between the bottom of the vane slots and the center of the rotor. All six vanes were removed intact. The rotor was removed in several pieces, and the housing was

examined. Examination revealed no evidence of scoring or rotational damage. A metal straight-edge was placed along the long ends of each vane, and no warping or wear was noted.

The electrically driven vacuum pump drive shear shaft was intact. The pump was opened from the motor drive end to expose the rotor and internal vanes. Several cracks were noted in the rotor between the vane slots and the center shaft area. Five of the six vanes were removed and found intact with no fractures or edge chipping. The sixth vane was found wedged and stuck in the rotor, which was stuck inside the housing. Approximately half of the rotor was removed, and examination of its housing revealed no evidence of scoring or rotational damage. A metal straight-edge was placed along the long ends of the removed vanes, and no warping or wear was noted. Disassembly and examination of the vacuum system filter did not reveal any evidence of contaminants or blockages.

The airspeed indicator was damaged, and its glass faceplate was missing. The needle position was found off-scale near the right edge of the density altitude adjustment window; it could be moved, however, when released, it spring-loaded to its as-found position. Magnified examination of marks on the instrument face revealed an outline similar to the size and shape of the needle. This mark was located about two needle widths above the 210-knot marking, which was the maximum marking on the indicator. The location of the needle mark on the airspeed indicator was consistent with the maximum mechanical needle travel position for the airspeed indicator design.

The VSI needle was missing. Magnified examination of marks on the instrument face revealed an outline similar to the size and shape of a needle. This needle mark was pointed at the down-limit position of 2,000 fpm descent.

Microscopic examination of the AFCS light bulbs on the front face of the unit was performed. None of the light bulbs exhibited evidence of filament stretch, including the autopilot engage, flight director, or trim failure light bulbs. An examination of all recovered light bulbs from the airplane's main and landing gear annunciator panels revealed no evidence of filament stretch.

### Aircraft Performance Study

An aircraft performance study was performed by a Safety Board specialist using the Board's computer simulation program. According to the specialist's report, airplane performance data for the final portion of the flight were calculated using radar, aircraft, and weather data. Performance parameters were then computed for the final 7 minutes of the flight.

The calculated parameters showed the airplane initially descending from 5,500 feet at descent rates varying between 400 and 800 fpm, at 2133:40. At 2137:20, the airplane attained a steady descent rate of close to 600 fpm as the airplane passed through 3,000 feet. During the entire descent from 5,500 feet, the calculated airspeed remained near 160 KIAS, and the flightpath angle remained close to -2 degrees. About 2138, the airplane started to bank in a right-wing-down (RWD) direction toward a southerly direction. Calculated parameters indicated an almost constant roll angle of 13 degrees RWD and a vertical acceleration of 1.09 Gs while executing the turn. About 30 seconds after the turn was initiated, at an altitude of 2,200 feet, the airplane stopped descending. The airplane then climbed for the next 30 seconds, attaining a maximum climb rate of 600 fpm. During the ascent, the airplane finished the turn to a southeasterly direction, reduced speed slightly to 153 KIAS, and returned to a wings-level attitude by 2138:50. By 2139, the airplane leveled at 2,500 feet and then flew in a southeasterly direction with wings level while increasing airspeed back to 160 KIAS.

At 2139:50, the airplane entered a left turn, while slightly increasing altitude to 2,600 feet. The airplane reached a maximum bank angle of 28 degrees left-wing-down (LWD) and a maximum vertical acceleration of 1.2 Gs in this turn. When the maximum LWD bank angle was obtained, the altitude started to decrease at a descent rate close to 900 fpm. The LWD attitude was maintained for approximately 15 seconds until the airplane was heading towards the east. At 2140:07, the airplane bank angle returned to wings level. At 2140:15, with the airplane continuing towards the east, it reestablished a descent close to 900 fpm and then

started to increase its bank angle in a RWD direction at nearly a constant rate. As the airplane bank angle increased, the rate of descent increased, and the airspeed started to increase. By 2140:25, the bank angle exceeded 45 degrees, the vertical acceleration was 1.2 Gs, the airspeed increased through 180 knots, and the flightpath angle was close to 5 degrees airplane nose down. After 2140:25, the airplane's airspeed, vertical acceleration, bank, and dive angle continued to increase, and the right turn tightened until water impact, about 2141.

## ADDITIONAL INFORMATION

### Cell Phones

The cell phone records for the three occupants of the airplane reflected one out-going call, about 2025. No calls were listed as being made from, or received by, the cell phones from the time of the takeoff through the estimated time of the accident.

### Preflight Briefing

The AIM, published by the FAA, is the official guide to basic flight information and ATC procedures. Under the Section, "Preflight Briefing," it states that FSSs are the primary source for obtaining preflight briefings and in-flight weather information. The AIM states that a standard briefing should be requested any time a pilot is planning a flight and has not received a previous briefing or has not received preliminary information through mass dissemination media. The standard briefing should include the following information:

**Adverse Conditions:** Significant meteorological and aeronautical information that might influence the pilot to alter the proposed flight.

**VFR Flight Not Recommended:** When VFR flight is proposed and sky conditions or visibilities are present or forecast, surface or aloft, that in the briefer's judgment would make flight under VFR doubtful, the briefer will describe the conditions, affected locations, and use the phrase "VFR flight not recommended."

**Current Conditions:** Reported weather conditions applicable to the flight will be summarized from all available sources.

**En Route Forecast:** Forecast en route conditions for the proposed route are summarized in logical order (for example, departure/climbout, en route, and descent).

**Destination Forecast:** The destination forecast for the planned estimated time of arrival. Any significant changes within 1 hour before and after the planned arrival are included.

**Winds Aloft:** Forecast winds aloft will be provided using degrees of the compass. The briefer will interpolate wind directions and speeds between levels and stations as necessary to provide expected conditions at planned altitudes.

The AIM also states that a standard briefing should include synopsis, notices to airmen, and ATC delays.

### Spatial Disorientation

A review of 14 CFR Part 61, "Certification: Pilots, Flight Instructors, and Ground Instructors," revealed that no specific training requirements exist regarding spatial disorientation. According to the FAA Practical Test Standards, an applicant for a private pilot rating must exhibit knowledge of spatial disorientation. In addition, the publication states that "the examiner shall also emphasize stall/spin awareness, spatial disorientation..."

A review of training records from FSI revealed that while the pilot was preparing for his private pilot certificate, he received instruction on the symptoms, causes, and effects of spatial disorientation and the correct action to take if it occurred. In addition, the pilot received unusual attitude training while attending

the private pilot and instrument training courses at FSI.

According to an FAA Instrument Flying Handbook, Advisory Circular 61-27C (AC) (Section II, "Instrument Flying: Coping with Illusions in Flight"), one purpose for instrument training and maintaining instrument proficiency is to prevent a pilot from being misled by several types of hazardous illusions that are peculiar to flight. The AC states that an illusion or false impression occurs when information provided by sensory organs is misinterpreted or inadequate and that many illusions in flight could be created by complex motions and certain visual scenes encountered under adverse weather conditions and at night. It also states that some illusions may lead to spatial disorientation or the inability to determine accurately the attitude or motion of the aircraft in relation to the earth's surface. The AC also states that spatial disorientation as a result of continued VFR flight into adverse weather conditions is regularly near the top of the cause/factor list in annual statistics on fatal aircraft accidents.

The AC further states that the most hazardous illusions that lead to spatial disorientation are created by information received from motion sensing systems, which are located in each inner ear. The AC also states that the sensory organs in these systems detect angular acceleration in the pitch, yaw, and roll axes, and a sensory organ detects gravity and linear acceleration and that, in flight, the motion sensing system may be stimulated by motion of the aircraft alone or in combination with head and body movement. The AC lists some of the major illusions leading to spatial disorientation as follows:

"The leans - A banked attitude, to the left for example, may be entered too slowly to set in motion the fluid in the 'roll' semicircular tubes. An abrupt correction of this attitude can now set the fluid in motion and so create the illusion of a banked attitude to the right. The disoriented pilot may make the error of rolling the aircraft back into the original left-banked attitude or, if level flight is maintained, will feel compelled to lean to the left until this illusion subsides.

Coriolis illusion - An abrupt head movement made during a prolonged constant-rate turn may set the fluid in more than one semicircular tube in motion, creating the strong illusion of turning or accelerating, in an entirely different axis. The disoriented pilot may maneuver the aircraft into a dangerous attitude in an attempt to correct this illusory movement....

Graveyard spiral - In a prolonged coordinated, constant-rate turn, the fluid in the semicircular tubes in the axis of the turn will cease its movement...An observed loss altitude in the aircraft instruments and the absence of any sensation of turning may create the illusion of being in a descent with the wings level. The disoriented pilot may pull back on the controls, tightening the spiral and increasing the loss of altitude....

Inversion illusion - An abrupt change from climb to straight-and-level flight can excessively stimulate the sensory organs for gravity and linear acceleration, creating the illusion of tumbling backwards. The disoriented pilot may push the aircraft abruptly into a nose-low attitude, possibly intensifying this illusion.

Elevator illusion - An abrupt upward vertical acceleration, as can occur in a helicopter or an updraft, can shift vision downwards (visual scene moves upwards) through excessive stimulation of the sensory organs for gravity and linear acceleration, creating the illusion of being in a climb. The disoriented pilot may push the aircraft into a nose low attitude. An abrupt downward vertical acceleration, usually in a downdraft, has the opposite effect, with the disoriented pilot pulling the aircraft into a nose-up attitude....

Autokinesis - In the dark, a stationary light will appear to move about when stared at for many seconds. The disoriented pilot could lose control of the aircraft in attempting to align it with the false movements of this light."

The AC also states that these undesirable sensations cannot be completely prevented but that they can be ignored or sufficiently suppressed by pilots' developing an "absolute" reliance upon what the flight instruments are reporting about the attitude of their aircraft. The AC further states that practice and experience in instrument flying are necessary to aid pilots in discounting or overcoming false sensations.

Further, the FAA Airplane Flying Handbook, FAA-H-8083-3, chapter 10, states the following about night flying and its affect on spatial orientation:

"Night flying requires that pilots be aware of, and operate within, their abilities and limitations. Although careful planning of any flight is essential, night flying demands more attention to the details of preflight preparation and planning. Preparation for a night flight should include a thorough review of the available weather reports and forecasts with particular attention given to temperature/dewpoint spread. A narrow temperature/dewpoint spread may indicate the possibility of ground fog. Emphasis should also be placed on wind direction and speed, since its effect on the airplane cannot be as easily detected at night as during the day...Night flying is very different from day flying and demands more attention of the pilot. The most noticeable difference is the limited availability of outside visual references. Therefore, flight instruments should be used to a greater degree in controlling the airplane...Under no circumstances should a VFR night-flight be made during poor or marginal weather conditions unless both the pilot and aircraft are certificated and equipped for flight under...IFR...Crossing large bodies of water at night in single-engine airplanes could be potentially hazardous, not only from the standpoint of landing (ditching) in the water, but also because with little or no lighting the horizon blends with the water, in which case, depth perception and orientation become difficult. During poor visibility conditions over water, the horizon will become obscure, and may result in a loss of orientation. Even on clear nights, the stars may be reflected on the water surface, which could appear as a continuous array of lights, thus making the horizon difficult to identify."

According to AC 60-4A, "Pilot's Spatial Disorientation," tests conducted with qualified instrument pilots indicated that it can take as long as 35 seconds to establish full control by instruments after a loss of visual reference of the earth's surface. AC 60-4A further states that surface references and the natural horizon may become obscured even though visibility may be above VFR minimums and that an inability to perceive the natural horizon or surface references is common during flights over water, at night, in sparsely populated areas, and in low-visibility conditions.

A book titled, Night Flying, by Richard Haines and Courtney Flatau, provides some additional information concerning vertigo and disorientation. It states the following:

"Vestibular disorientation refers to the general feeling that one's flight path isn't correct in some way. By calling this effect vestibular, it emphasizes the role played by the middle ear's balance organ. Flying an uncoordinated turn produces this effect as does excessive head turning during a turn in flight. Vestibular disorientation is often subtle in its onset, yet it is the most disabling and dangerous of all disorientation."

#### Pilot's Operating Handbook (POH)

According to the POH and a photo of the accident airplane's cockpit, the fuel selector control was located below the center of the instrument panel, on the sloping face of the control tunnel, on the cockpit floor. In the "Normal Procedures" section of the POH, under "Cruising," it states, "In order to keep the airplane in best lateral trim during cruise flight, the fuel should be used alternately from each tank at one hour intervals." Also, in the "Normal Procedures" section, under the "Approach and Landing" checklist, the first item listed is "Fuel selector - proper tank."

#### Wreckage Release

On August 5, 1999, the main airplane wreckage was released to a representative of the accident pilot's insurance company. On November 17, 1999, the remainder of the retained parts were released and shipped to the insurance company's storage facility.

#### Additional Persons Participating in the Investigation:

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