FLIGHT SAFETY FOUNDATION

Accident Prevention

Vol. 61 No. 10 *For Everyone Concerned With the Safety of Flight* October 2004

Crew's Failure to Maintain Airspeed Cited in King Air Loss of Control

Investigation of the accident that killed a U.S. senator and seven others leads to calls for increased surveillance of on-demand aircraft operators, implementation of crew resource management training programs for two-pilot flight crews and development of low-airspeed-alert systems.

FSF Editorial Staff

About 1022 local time Oct. 25, 2002, the flight crew of a Raytheon Beechcraft King Air A100 were conducting a very-high-frequency omnidirectional radio (VOR) approach to Runway 27 at Eveleth–Virginia (Minnesota, U.S.) Municipal Airport in instrument meteorological conditions (IMC) when the airplane stalled and struck terrain about 1.8 nautical miles (3.3 kilometers) southeast of the runway. The two pilots and six passengers, including U.S. Sen. Paul Wellstone, were killed. The airplane was destroyed by the impact and a postaccident fire.

The U.S. National Transportation Safety Board (NTSB) said, in its final report, that the probable cause of the accident was "the flight crew's failure to maintain adequate airspeed, which led to an aerodynamic stall from which they did not recover."

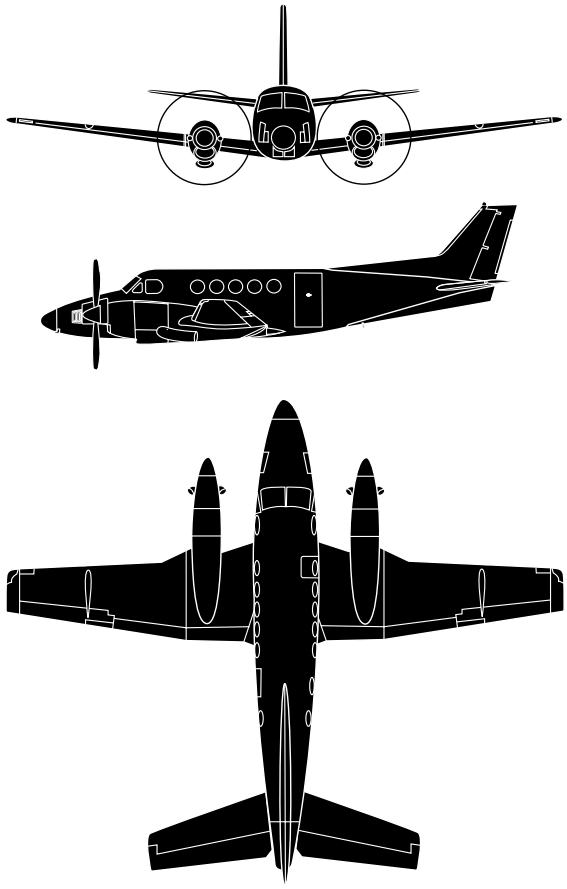
The airplane was operated by Aviation Charter, based in Eden Prairie, Minnesota, U.S. At the time of the accident, the company conducted on-demand flight operations with 24 airplanes, including four King Air A100s, and employed 25 pilots, eight copilots and three check airmen. The company conducted in-house training and contracted with SimuFlite for annual training of pilots-in-command in a flight-training device.

The A100 is certified for single-pilot operation, and the accident airplane was equipped for single-pilot on-demand operation. Nevertheless, after a fatal accident on Dec. 21, 1997, the company established a policy to have two pilots aboard all on-demand flights.

[The 1997 accident occurred during a missed approach following a nighttime instrument landing system (ILS) approach with a runway visual range (RVR) of 1,800 feet/550 meters in fog at Colorado Springs, Colorado, U.S. The pilot and one passenger were killed; another passenger received serious injuries. NTSB said that the probable causes of the accident were "failure of the pilot to follow IFR (instrument flight rules) procedures and maintain the minimum descent altitude."[1]]

Company records indicated that the Eveleth-accident pilot, 55, had an airline transport pilot (ATP) certificate, a Cessna Citation type rating and about 5,116 flight hours, including 200 flight hours as a King Air pilot-in-command.

The report said that the pilot failed a flight check for an ATP certificate in April 1989 because of unsatisfactory performance while conducting procedures including area arrivals and ILS approaches, unsatisfactory conduct of normal procedures and abnormal procedures, and unsatisfactory judgment. He received additional training and passed the flight check for an ATP certificate in August 1989.



Raytheon Beechcraft King Air A100

Beech Aircraft Corp., which was acquired by Raytheon Co. in 1980, introduced the King Air 100 in 1969. The airplane has a longer fuselage and more powerful engines than the 90-series King Air models, and two wheels on each main landing gear. Its successor, the King Air A100, was introduced in 1971 with a higher maximum takeoff weight, greater fuel capacity and four-blade propellers replacing three-blade propellers.

The airplane can accommodate two pilots and either eight passengers in executive-cabin configuration or 13 passengers in commuter-cabin configuration. The engine-bleed-air cabin-pressurization system has a maximum differential of 4.6 pounds per square inch (0.32 kilograms per square centimeter), providing a sea level cabin to 10,000 feet and an 8,000-foot cabin altitude at 21,000 feet.

Each of the two Pratt & Whitney PT6A-28 turboprop engines produces 680 equivalent horsepower (507 kilowatts). Fuel capacity is 470 gallons (1,779 liters).

Maximum takeoff weight is 11,500 pounds (5,216 kilograms). Maximum landing weight is 11,210 pounds (5,085 kilograms). Maximum rates of climb at sea level are 1,963 feet per minute with both engines operating and 452 feet per minute with one engine operating. Maximum cruising speed at 21,000 feet is 235 knots. Service ceiling is 24,850 feet. Stall speeds are 90 knots with landing gear and flaps retracted, and 75 knots with landing gear and flaps fully extended.♦

Source: *Jane's All the World's Aircraft*

Documents indicated that the pilot was employed by Simmons Airlines in November 1989 and that he conducted four revenue-service flights for the airline in late January 1990.

"From February 2 to 20, 1990, the pilot stood trial on criminal charges for mail [fraud] and wire fraud," the report said. "He was convicted and sentenced to two years in prison and five years probation. The pilot submitted a letter of resignation to Simmons dated April 27, 1990. He began his prison sentence on June 8, 1990, and remained in prison until November 8, 1991, at which time he started serving the probation sentence, which he completed on November 7, 1996."

The pilot was employed by Aviation Charter in April 2001. His employment application indicated that he had worked as a registered nurse for four different employers between March 1992 and March 2001. The application contained no information about previous aviation-related employment.

The pilot served as a King Air pilot and Citation copilot for Aviation Charter.

"Aviation Charter's lead ground instructor stated that the pilot was average on learning airplane systems and that several company pilots had indicated that the pilot's flying skills were below average," the report said.

A pilot who had flown with the accident pilot soon after he was hired by the company said that he was "too timid to be a pilot." Another company pilot said that the accident pilot had a tendency to become distracted.

"An Aviation Charter King Air pilot indicated that he had taken the airplane controls away from the accident pilot during an instrument approach because he could not maintain altitude," the report said. "A company King Air copilot indicated that during level flight in IMC, he had to take the controls away from the accident pilot because he allowed the airplane to enter a 45-degree bank and a 1,000-fpm [feet per minute] descent."

Another copilot said that during a flight about two months before the accident, he had to complete an instrument approach for the pilot because the pilot's navigation radio was tuned to an incorrect frequency for the approach and the pilot's course-deviation indicator (CDI) was providing erroneous indications for the approach.

Several copilots said that they liked the accident pilot because he allowed them to fly the airplane.

"A few copilots stated that because the pilot often let them handle the flight controls, they were not certain of his skill level," the report said. "Several Aviation Charter pilots indicated that the accident pilot often allowed them to conduct the flights they flew with him as if they were single-pilot operations (that is, he allowed them to handle the flight controls and communications, and perform all of the checklists without his assistance)."

Two days before the accident, the pilot received a six-month proficiency check administered by the company chief pilot. Maneuvers included a recovery from an impending stall, a recovery from an unusual attitude, an ILS approach and a VOR approach with a simulated engine failure.

"A vision-obscuring device was used to test the pilot's ability to conduct IFR approaches," the report said. "The chief pilot recalled that the check ride went smoothly and that the pilot's ILS and VOR approaches were precise."

The copilot, 30, had a commercial pilot certificate and about 701 flight hours, including 107 flight hours as a King Air copilot. He was employed by Aviation Charter in February 2001. Company records indicated no previous employment as a pilot. Nevertheless, logbook entries and other records indicated that he had worked as a pilot for a skydiving operator from October 1998 through March 1999.

"According to the [skydiving] operator, the copilot was let go [i.e., fired] when he did not meet the pilot qualification standards for flying the Cessna 182," the report said.

In February 1999, Northwest Airlines hired the copilot to provide instruction on Airbus A320 systems and procedures during pilot initial training and recurrent training. The report said that the copilot was not able to master all of the lessons he would be required to teach and resigned from the company in October 1999. He then worked as a customer service representative for another company.

The lead ground instructor for Aviation Charter said that the copilot's performance during initial training was below average and that he required extra instruction.

"He stated that the copilot had problems remembering memory items, calculating weights and balances, and applying formulas," the report said. "He added that the copilot's performance was acceptable at the conclusion of ground training."

Several pilots who had flown with the copilot described him as not assertive and unable to land the airplane without assistance.

"Two pilots stated that the copilot had difficulties with power management when flying an approach and had to be reminded to keep one hand on the throttles and to monitor his power gauges," the report said. "One of these two pilots, who had been mentoring the copilot and flew with him often, stated that this was a consistent problem for the copilot."

The pilot and copilot had flown together as a King Air crew on four previous flights. The pilot previously had landed four times at the Eveleth airport, twice in King Airs and twice in Citations.

"The pilot's logbook indicated that he had flown Senator Wellstone at least 12 times," the report said. "According to the pilot's wife, he got along well with the senator, who would often call her husband at home before scheduled trips."

The accident airplane had been chartered to fly the passengers from St. Paul, Minnesota, to Eveleth [about 127 nautical miles (235 kilometers) north], with a scheduled departure time of 0920. The flight crew then would fly the airplane to Duluth, Minnesota, where they would rendezvous with the passengers at 2115 for the return flight to St. Paul.

At 0716, the pilot received a weather briefing by an automated flight service station (AFSS) specialist. AIRMETs (airman's meteorological information[2]) were in effect for IMC and icing conditions over the route. Weather conditions at Eveleth included 4.0 statute miles (6.4 kilometers) visibility with light snow, scattered clouds at 1,000 feet and an overcast ceiling at 2,000 feet. Cloud ceilings from St. Paul to Eveleth were between 300 feet and 600 feet, and visibilities were 1.0 statute mile (1.6 kilometers) to 4.0 statute miles with light snow and mist.

The pilot told the AFSS specialist, "You know, I don't think I'm going to take this flight."

Weather conditions at Duluth included 2.0 statute miles (3.2 kilometers) visibility with light snow and mist, and a 500-foot overcast ceiling.

The pilot told the AFSS specialist, "You know, I don't think I'm going to take this flight."

At 0720, the pilot told Sen. Wellstone's election-campaign scheduler that icing conditions might be encountered during the flight, but he did not indicate that he was considering canceling the flight.

"The campaign scheduler stated that when she asked the pilot what he would do if icing became a problem, he told her that the airplane was equipped with deicing equipment and that, if necessary, he could turn the airplane back toward warmer air to melt the ice or divert to [Duluth]," the report said. "She stated that the pilot then reassured her that he was an experienced and conservative pilot."

At 0817, the pilot obtained from an AFSS specialist information about the current weather conditions at Eveleth, which included 3.0 statute miles (4.8 kilometers) visibility with light snow and a 900-foot overcast ceiling. He also was told that light mixed icing had been reported at 7,000 feet to 9,000 feet over Hibbing, Minnesota, which is about 16 nautical miles (30 kilometers) west of Eveleth.

After arriving at the St. Paul airport about 0900, the pilot spoke with another pilot who had just completed a flight from Duluth. The pilot asked the other pilot to share with Sen. Wellstone information about weather conditions along the route.

"The other King Air pilot indicated that he told the senator that the weather was at minimums, but he was sure the pilots could handle the flight," the report said.

The airplane was within weight-and-balance limits when it departed from St. Paul about 0937. The flight crew was cleared by air traffic control (ATC) to fly directly to Eveleth at 13,000 feet.

The airplane was not equipped with a cockpit voice recorder (CVR) and was not required to be equipped with a CVR. Investigators determined from recorded ATC radio communications that the copilot made almost all radio transmissions to ATC.

"Typically, dual-pilot operations are conducted with the flying pilot handling the flight controls and the nonflying pilot handling the communications," the report said. "Aviation Charter company practices were in accordance with this standard."

Nevertheless, because the pilot was known to allow copilots to conduct flights as if they were single-pilot operations, the investigation did not determine whether the pilot or the copilot was the pilot flying.

About 1001, the copilot established radio communication with Duluth Approach Control. The controller told the flight crew that the crew of a Saab reported moderate rime icing between 11,000 feet and 9,000 feet during descent about one hour earlier. The controller then told the crew to descend to 4,000 feet at the pilot's discretion. The automated weather-observing system at Eveleth was reporting 2.5 statute miles (4.0 kilometers) visibility in light snow, scattered clouds at 400 feet and a 700-foot overcast.

About 1004, the copilot told the controller that they had information about weather conditions at the airport and requested clearance to conduct the VOR approach to Runway 27. The controller told the crew to expect radar vectors for the VOR approach and asked them for their intentions if a missed approach was required.

The pilot responded to the controller's inquiry.

"Well, let's hope we don't have that," the pilot said. "If we do have a missed approach, we'll go up and circle and figure this out. I'll hold at the VOR."

The airplane was about 34 nautical miles (63 kilometers) south of the airport about 1009 when the copilot told the controller that they were beginning the descent to 4,000 feet. The controller told the crew to descend to 3,500 feet at the pilot's discretion.

At 1015, the controller told the crew to fly a heading of 050 degrees. At the time, the airplane was being flown through 6,200 feet at about 194 knots.

At 1017, the controller told the crew to turn left to a heading of 360 degrees; the crew had leveled the airplane at 3,500 feet, and airspeed was decreasing through 190 knots.

The airplane was less than 0.5 nautical mile (0.9 kilometer) south of the final approach course at 1018 when the controller told the crew that they were 10 nautical miles (19 kilometers) from the VOR and to turn left to a heading of 300 degrees and to maintain 3,500 feet until established on the final approach course (276 degrees).

"The airplane's speed and close proximity to the VOR final approach course when the controller issued the 300-degree interception heading precluded the flight crew from completing their left turn in time to initially intercept the final approach course," the report said.

Airspeed was decreasing through about 164 knots when the crew began the left turn. The controller told investigators that his observation of the radar display indicated that the airplane intercepted the final approach course about nine nautical miles (17 kilometers) from the runway threshold and then correctly tracked the final approach course at 3,500 feet. The controller's radar display was set at a 60-nautical-mile (111-kilometer) range.

The controller said that when he later observed the recorded radar data at a closer range, he was surprised to see that the airplane was off course.

The controller said that when he later observed the recorded radar data at a closer range, he was surprised to see that the airplane was off course.

"Almost immediately after the airplane began its left turn, it overshot the approach course and traveled for almost one [nautical] mile [two kilometers] north of the course as it continued the turn toward the course until establishing a ground track of about 262 degrees," the report said.

At 1019, the controller told the crew that they could change radio frequencies to the airport advisory frequency and that they should cancel their flight plan on the ground with a flight service station.

The copilot's acknowledgment of the instructions was the last radio transmission that ATC received from the crew. The crew had begun a descent from 3,500 feet and airspeed was 155 knots and increasing.

The company's chief pilot told investigators that King Air pilots were trained to conduct nonprecision approaches with airspeed stabilized at 130 knots until short-final approach and to touch

down at 100 knots. Maximum landing-gear-extension speed is 156 knots.

"The airplane's airspeed increased to about 170 [knots] and its vertical speed increased through 1,000 feet per minute (fpm) as it descended through 3,200 feet," the report said. "The airspeed stabilized briefly at about 170 [knots] and the vertical speed peaked at about 1,400 fpm."

The assistant manager of the airport heard one of the pilots report the airplane's position on the advisory (Unicom) frequency. He observed the pilot-controlled runway lights, which are activated by keying a microphone on the Unicom frequency, illuminate soon after the position report was transmitted.

The airplane was about five nautical miles (nine kilometers) east of the runway threshold and descending through 2,700 feet at 1020:06 when it was flown through the final approach course. The crew then conducted a slight right turn. Recorded ATC radar data showed that a ground track of 269 degrees then was maintained by the airplane.

"At this point, the airplane was south of the published approach course (of 276 degrees); therefore, this turn did not allow the airplane to intercept the course, and the flight crew never effectively maneuvered the airplane to remain near the approach course," the report said.

Airspeed and vertical speed began to decrease. Airspeed was 160 knots when the airplane was flown through 2,300 feet about 4.0 nautical miles (7.4 kilometers) from the runway threshold.

Subsequent altitude data and airspeed data recorded by ATC showed 2,200 feet and 156 knots at 1020:36; and 2,100 feet and 130 knots at 1020:54, when the airplane was 3.0 nautical miles (5.6 kilometers) from the runway threshold.

The airplane was about 2.6 nautical miles (4.8 kilometers) from the runway threshold when the pilots' CDIs likely were deflected fully. Airspeed at this time was about 110 knots.

"The inadequate airspeed or the full CDI needle deflection should have prompted the flight crew to execute a go-around; however, they failed to do so," the report said. "If the flight crew had been adhering to Aviation Charter's approach procedures and effectively applying CRM [crew resource management] techniques in the cockpit, at least one of the flight crewmembers should have been monitoring the instruments. The evidence clearly indicates that neither flight crewmember was monitoring the airspeed indicator or the CDI during the approach."

"The inadequate airspeed or the full CDI needle deflection should have prompted the flight crew to execute a go-around; however, they failed to do so."

The airplane was about 2.0 nautical miles (3.7 kilometers) southeast of the runway threshold at 1021:42, when a loss of ATC radar contact occurred. The last recorded radar data showed that the airplane was at 1,800 feet and airspeed had slowed to 76 knots.

The published minimum descent altitudes (MDAs) for the straight-in approach were 1,840 feet without distance-measuring equipment (DME) and 1,740 feet with DME.

The airplane flight manual indicates that the stall speed at the airplane's weight and configuration would have been about 77 knots with power at flight idle.

"Airplane simulations showed (and the stall-warning-system design indicates) that the flight crew should have received at least several seconds of aural stall warning in the cockpit if the airspeed decreased below 81 [knots] to 84 knots, if the stall-warning system was working properly and if the airplane was not affected by ice accumulation," the report said. "Further, the flight crew should have had other indications of low airspeed, such as increased pitch attitude and a quieter slipstream, and might have experienced buffeting and less-responsive flight controls, depending on the airspeed and whether there was any ice accumulation."

Investigators determined that icing was not a factor. During descent, the airplane was in moderate icing conditions (between about 11,000 feet and 8,000 feet) for about two minutes and 35 seconds, and in light-icing conditions and trace-icing conditions (between 8,000 feet and 5,000 feet) for about two minutes and 24 seconds. Other crews had reported that accumulated ice had begun shedding from their airplanes below 5,000 feet.

"The airplane was most likely not in the cloud layer in which moderate icing was present for enough time to accumulate any significant airframe icing," the report said. "Further, any icing that the airplane might have accumulated would have been shed by the deicing equipment, or it would have begun shedding off the airplane's surfaces as it was descending through 5,000 feet because of the warming temperatures.

"In addition, the airplane's performance was not consistent with the effects of icing, and flight simulations showed that the performance could be matched with and without simulated icing with enough reserve engine power available to increase the airspeed during the descent."

Absence of CVR data precluded a determination of whether the stall-warning system activated. Nevertheless, investigators concluded that "the flight crew failed to recognize that a stall

was imminent and allowed the airplane to enter a stall from which they did not recover."

The airplane struck trees and the ground at an elevation of 1,361 feet; airport elevation was 1,378 feet.

"The horizontal distance from the point at which the airplane entered the trees to the resting place of the aft section of the fuselage was about 130 feet [40 meters]," the report said. "Crash site damage included blunt force tree damage consistent with airframe impact and cleanly severed [tree] trunks and limbs consistent with cuts resulting from propeller blade strikes. … The airplane descended through the trees wings-level and upright on about a 26-degree downward flight-path angle on a ground track of about 180 degrees."

Autopsy reports said that the occupants died from multiple traumatic injuries sustained during impact. The results of toxicological analyses of tissue specimens and fluid specimens were negative for a wide range of legal drugs and illegal drugs, as well as for ethanol and carbon monoxide.

Several airplane systems, including the stall-warning system and the deicing systems, were damaged too severely for investigators to determine their preimpact configuration and operability.

Examination of the engines by the manufacturer, Pratt & Whitney Canada, indicated that they were operating normally on impact. Examination of the propellers by Hartzell Propeller indicated that the blade angles corresponded to power settings just above flight idle.

The report said that although surveillance of Aviation Charter by the U.S. Federal Aviation Administration (FAA) was conducted in compliance with FAA standard guidelines, the surveillance was not sufficient to detect discrepancies that existed at the company.

For example, postaccident interviews of the company's lead ground instructor and chief pilot indicated that CRM was not being taught during ground school in accordance with the company's training manual. The report said that although the company was not required by U.S. Federal Aviation Regulations (FARs) Part 135 to provide CRM training to its pilots, the inclusion of an FAA-approved CRM training module in the company's training manual required that the instruction be provided to pilots.

Moreover, the report said that the findings of the accident investigation indicate that Part 135 on-demand operators that conduct dual-pilot operations should be required to conduct CRM training, regardless of whether the airplanes they operate are certified for single-pilot operation.

The report said that some of the discrepancies that existed at Aviation Charter might have been detected by FAA during en route inspections.

"FAA requires en route inspections of Part 135 scheduled operations but not for Part 135 on-demand operations, despite its own acknowledgement that en route inspections are one of the best means for ensuring adequate surveillance," the report said.

The report said that numerous accidents and incidents in commercial operations have involved flight crews who inadvertently failed to maintain adequate airspeed.

"For example, [NTSB] has investigated at least 11 events since 1982 involving Part 135 flights and at least seven events involving Part 121 [air carrier] flights in which stall or failure to maintain airspeed during the approach or landing phases was cited as a causal [factor] or contributing factor and in which icing was not cited as a factor," the report said. "In addition, [NTSB] has investigated other events in which the drag associated with airframe ice and pilot inattention led to a critical loss of airspeed."

The report said that a low-airspeed alert system could help prevent these types of accidents and incidents.

"[NTSB] recognizes that the development and requirement of a low-airspeed alert system [would be] a departure from the previously accepted premise that adequate low-airspeed awareness is provided by flight crew vigilance and existing stall warnings," the report said. "However, the circumstances of this accident and the history of accidents involving flight crew lack of low-airspeed awareness suggest that flight crew vigilance and existing stall warnings are inadequate to reliably prevent hazardous low-airspeed situations."

Based on these findings, NTSB made the following recommendations to FAA:

- "Conduct en route inspections and observe ground training, flight training and proficiency checks at all [FARs] Part 135 on-demand charter operations as is done at Part 121 operations and Part 135 commuter operations to ensure the adequacy, quality and standardization of pilot training and flight operations. (A-03-51)."

  [In response to recommendation A-03-51, FAA told NTSB that conducting en route inspections would be problematic because on-demand operators do not have a fixed schedule and typically fly small aircraft with limited seating capacity and no jump seats. FAA said that its current safety oversight of on-demand operators is sufficient.[3]]

- "Require that [FARs] Part 135 on-demand charter operators that conduct dual-pilot operations establish and implement [an FAA-]approved [CRM] training program for their flight crews in accordance with [FARs] Part 121, subparts N [training programs] and O [crewmember qualifications]. (A-03-52)."

[In response to recommendation A-03-52, FAA said that revisions to Part 135, including a requirement for CRM training by "operators of airplanes with two pilots," will be included in a notice of proposed rulemaking that will be published in 2005.[4]]

- "Convene a panel of aircraft design, aviation operations and aviation human factors specialists, including representatives from the [U.S.] National Aeronautics and Space Administration, to determine whether a requirement for the installation of low-airspeed-alert systems in airplanes engaged in commercial operations under [FARs] Part 121 and [Part] 135 would be feasible, and submit a report of the panel's findings. (A-03-53)."

- "If the panel requested in Safety Recommendation A-03-53 determines that a requirement for the installation of low-airspeed-alert systems in airplanes engaged in commercial operations under [FARs] Part 121 and [Part] 135 is feasible, establish requirements for low-airspeed-alert systems, based on the findings of this panel. (A-03-54)."

  [In response to recommendation A-03-53 and to recommendation A-03-54, FAA said that it "shares [NTSB's] concern regarding flight crew awareness of low-airspeed situations" and will include a review of accident data "in determining what action needs to be taken to address the safety issue." FAA said, "Many current transport airplanes include additional cues on airspeed indicators (that are) intended to provide improved low-airspeed awareness. … Such displays are now becoming available for use in less-sophisticated general aviation airplanes."[5]]♦

[FSF editorial note: This article, except where specifically noted, is based on U.S. National Transportation Safety Board Aircraft Accident Report NTSB/AAR-03/03, *Loss of Control and Impact With Terrain; Aviation Charter, Inc.; Raytheon (Beechcraft) King Air A100, N41BE; Eveleth, Minnesota; October 25, 2002*. The 66-page report contains illustrations and an appendix.]

Notes

1. U.S. National Transportation Safety Board (NTSB). Accident report no. FTW98FA074. Dec. 21, 1997.

2. The U.S. Federal Aviation Administration (FAA), in the *Aeronautical Information Manual*, said that an AIRMET (airman's meteorological information) comprises in-flight weather advisories that are issued to amend the area forecast. The advisories are about "weather phenomena which are of operational interest to all aircraft and potentially hazardous to aircraft having limited capability because of lack of equipment, instrumentation or pilot qualifications."

3. FAA. *Brief Report for NTSB Recommendations*, A-03-051. <nasdac.faa.gov>.

4. FAA. *Brief Report for NTSB Recommendations*, A-03-052. <nasdac.faa.gov>.

5. FAA. *Brief Report for NTSB Recommendations*, A-03-053 and A-03-054. <nasdac.faa.gov>.

Further Reading From FSF Publications

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