Residual Deicing Fluid Freezes, Jams Elevator

The BAe 146 flight crew used the manual trim system to regain control and land the airplane.

BY MARK LACAGNINA

The following information provides an awareness of problems in the hope that they can be avoided in the future. The information is based on final reports on aircraft accidents and incidents by official investigative authorities.

JETS

Pitch Oscillations Occur on Departure

British Aerospace BAe146-300. No damage. No injuries.

After departing from Frankfurt, Germany, for a cargo flight to Stuttgart on March 12, 2005, the flight crew noticed a slow pitch oscillation that increased in amplitude as the airplane climbed on autopilot from Flight Level (FL) 80 (approximately 8,000 ft) to FL 100. "The oscillation resulted in a positive angle-of-attack of up to 18 degrees and in a rate of descent of up to 4,500 fpm," said the report by the German Federal Bureau of Aircraft Accidents Investigation (BFU).

The report said that the elevator had been jammed by ice that formed when residue from the deicing/anti-icing fluid applied to the airplane before departure rehydrated and froze during climb. The crew disengaged the autopilot and regained control of the airplane with the manual elevator trim system.

"A prolonged flight [at] FL 130 under visual meteorological conditions and free of icing conditions did not change the control problems they experienced with the airplane," the report said. The crew used the manual elevator trim system while conducting an instrument landing system (ILS) approach and landing at Stuttgart Airport.

"The airplane was examined immediately after the landing, and significant amounts of frozen and swollen-up deicing fluid residues were found in the gap between elevator and horizontal stabilizer, and in the area of ailerons and rudder," the report said.

A deicing/anti-icing fluid "thickened" with a polymer to increase adhesion time had been applied to the airplane before takeoff. The report noted that the polymer in Type II, Type III and Type IV deicing/anti-icing fluids can remain as a residue in areas of the airplane that are not exposed to airflow after the water and glycol in the fluid have dried. "The polymer residue is very hygroscopic — that is, it can absorb from the surrounding air a multiple of its own weight in water (rehydration) — and thus become a gel-like mass," the report said. "Depending on the ambient air temperature, this oversaturated gel freezes [and] can restrict control-surface movements." This is particularly hazardous for airplanes with nonpowered flight controls (see "Chilling Effects," *Aviation Safety World*, September 2006, page 26).

Among BFU recommendations generated by the incident investigation was that civil aviation authorities ensure that "nonthickened" Type I deicing/anti-icing fluid, which contains a relatively small amount of polymer, is available at European airports used by airplanes with nonpowered flight controls. The report said that only one-third of European airports had Type I fluid in stock.

Crew Surprised by Vehicles on Runway

Boeing 737-86N. No damage. No injuries.

While preparing to depart from Manchester (England) Airport with 190 passengers for a charter flight to Kos, Greece, on July 16, 2003, the flight crew selected a reduced-thrust setting for a planned takeoff using the full length of Runway 06L. The crew was not aware that because of work in progress to remove rubber deposits on the departure end of the runway, available takeoff length had decreased from 3,048 m (10,000 ft) to 1,927 m (6,322 ft), said the U.K. Air Accidents Investigation Branch (AAIB) report.

The crew's performance calculations were correct for a reduced-thrust takeoff using the full runway length, but the aircraft was 9,000 kg (19,841 lb) too heavy to meet reduced-thrust takeoff-performance requirements using the decreased runway length, the report said.

Although the crew was aware that work was being performed on the runway, they believed that the work was being performed at the far end of the runway and would not affect their takeoff calculations. Information on the work-in-progress and the decreased length of the runway had been disseminated by a notice to airmen (NOTAM) and the automatic terminal information service (ATIS). However, the report said that the crew did not read the NOTAM or copy the runway information included in the ATIS broadcast.

After being told by the tower controller to "line up and wait zero six left," the crew told the controller that they would begin the takeoff from an intersection. The controller said that 1,670 m (5,479 ft) of runway were available from the intersection. Although this information provided another opportunity to become aware of the decreased runway length, the crew either missed or misinterpreted the information, the report said.

Seven vehicles were on the runway, but the crew could not see them when the takeoff was begun because the runway is higher in the middle than at the ends. "As the aircraft passed the crest of the runway, the flight crew became aware of vehicles at its far end; but, as they were now close to their rotation speed, they continued and carried out a normal takeoff," the report said. "The aircraft passed within 56 ft [17 m] of a 14-ft [4-m] vehicle."

The crew told investigators that although they were surprised to see the vehicles, they believed that they had cleared them with a sufficient margin and that reporting the incident was not necessary. The incident was reported eight days later by the airport's air traffic control (ATC) manager and classified as a serious incident by the AAIB. The report said that among actions taken in response to the incident was a decision by the airport operator to prohibit takeoffs and landings from being conducted toward a closed section of runway with work in progress.

The crew was not aware that because of work in progress to remove rubber deposits on the departure end of the runway, available takeoff length had decreased.

Lightning Damages Hydraulic Lines

Fokker F28 100. Substantial damage. No injuries.

The aircraft was on a charter flight to Darwin, Northern Territory, Australia, from Kupang, Indonesia, with five crewmembers and 14 passengers on Dec. 17, 2005. ATC told the flight crew to hold about 50 nm (93 km) south of Darwin because of thunderstorms at the airport. "The crew reported that while holding in instrument meteorological conditions at approximately 16,000 ft above ground level and between 6 and 8 nm [11 and 15 km] from any storm cells, the aircraft was struck by lightning," said the Australian Transport Safety Bureau report.

About 20 minutes after the lightning strike, the no. 2 hydraulic system low-quantity warning light illuminated, and the crew observed that the hydraulic fluid level in the no. 1 system was

decreasing. The crew requested and received clearance to exit the holding pattern and fly directly to the airport.

The no. 1 hydraulic system low-quantity warning light illuminated when the crew extended the landing gear and flaps on final approach. "The landing was continued, and the aircraft was able to be taxied to the gate," the report said.

Investigators found that electrical arcing during the lightning strike had damaged two hydraulic fluid return lines to the elevator-boost unit. "The examination also found at least two strike holes to the forward- and mid-section of the aircraft fuselage," the report said. "There were approximately 90 other strike-related damage zones along the underside of the fuselage, landing gear doors and on the trailing edges of the wings and tailplane. During subsequent scheduled maintenance, further melting damage was found to the elevator flight control cables."

Crew Loses Situational Awareness

Boeing 737-800. No damage. No injuries.

During a flight from London to Ireland West Airport in Knock, Ireland, on March 23, 2006, the flight crew programmed the flight management computer (FMC) for the NDB (nondirectional beacon) approach to Runway 09. Surface winds at Knock were from 110 degrees at 15 kt, visibility was about 4,000 m (2.5 mi), and the ceiling was broken between 800 and 1,000 ft above ground level (AGL), said the Irish Air Accident Investigation Unit report.

Nearing the destination, the crew was told that the NDB approach was not available. They decided to conduct the ILS approach to Runway 27 and circle to land on Runway 09. The crew was cleared to fly directly to ELPEN, a newly established waypoint about 19 nm (35 km) east of the airport, on the extended centerline of Runway 27. The report said that ELPEN was not in the FMC database, and both pilots, who were relatively inexperienced in the 737-800, became "so engrossed in trying to reprogram the FMC that they both lost their critical situational awareness for a time."

The crew did not brief the ILS approach or conduct the "Descent" and "Approach" checklists. The report said that the approach was flown at high speed and with the aircraft improperly configured. The crew continued the approach to 400 ft AGL, which was 200 ft lower than the minimum height prescribed by the operator for a circling approach. The aircraft's groundspeed was 265 kt when the crew gained visual contact with the runway and decided to conduct a missed approach. About the same time, the terrain awareness and warning system (TAWS) generated a "TOO LOW, TERRAIN" warning. After climbing to 4,000 ft and holding at the NDB, the crew conducted another ILS approach and landed without further incident.

The report noted that according to International Civil Aviation Organization standards, this serious incident would be classified as "controlled flight into terrain (CFIT) only marginally avoided."

TURBOPROPS

Route Deviation Into a Box Canyon

CASA 212-CC. Destroyed. Six fatalities.

The civilian flight crew was conducting a contract charter flight in Afghanistan for the U.S. Department of Defense, carrying mortar rounds and three military passengers from Bagram Air Base to Shindand on Nov. 27, 2004. A company maintenance technician also was aboard the airplane.

Shindand is west of Bagram, but company pilots typically flew about 32 nm (59 km) south after departure, to avoid mountains, before proceeding directly to Shindand, said the U.S. National Transportation Safety Board (NTSB) report. The accident crew, however, departed to the northwest at about 0738 local time, climbed to 10,000 ft and turned west into an unfamiliar valley. "We'll just have to see where this leads," the captain said. "With this good visibility … it's as easy as pie. [If] you run into something big, you just parallel it until you find a way through."

The report noted that both pilots had substantial mountain-flying experience. At 0803,

the captain told the first officer, "It's about time we're going to start climbing. … We're coming up to a box up here." About 0819, a stall warning was recorded by the cockpit voice recorder (CVR). The captain said that he would make a 180-degree turn and told the first officer to "drop a quarter flaps." The first officer said, "Yeah, let's turn around." The CVR then recorded a stall warning that continued until the recording ended about 0820.

The report said that the operator's flight-locating procedures were inadequate. Search-and-rescue operations were begun at 1540 and initially focused on the standard route south of Bagram. The wreckage of the unpressurized airplane was found at 0815 the next day at 14,650 ft — about 350 ft below the top of a snow-covered ridge line. The report noted that the floor of the valley was about 11,000 ft in the area. The investigation determined that one of the military passengers had survived the impact but died at least eight hours later from his injuries, which were complicated by hypoxia and hypothermia.

NTSB said that the probable causes of the accident were "the captain's inappropriate decision to fly a nonstandard route and his failure to maintain adequate terrain clearance."

Loading, Ice Cited in Control Loss

Cessna 208B Caravan. Destroyed. One fatality.

The aircraft, which was equipped with an external cargo pod, was 488 lb (221 kg) over maximum weight for flight in icing conditions when it departed from Winnipeg (Manitoba, Canada) International Airport at 0537 local time Oct. 6, 2005, for a cargo flight to Thunder Bay, Ontario, said the Transportation Safety Board of Canada (TSB) report.

The aircraft entered icing conditions soon after takeoff. The aircraft flight manual recommends a minimum airspeed of 120 kt during climb in icing conditions, but ATC radar data indicated that the accident aircraft's airspeed decreased from 100 kt to about 90 kt and that its rate of climb steadily decreased. The aircraft reached a maximum altitude of 2,400 ft and began to descend at an average rate of 400 fpm. The pilot requested an immediate return to Winnipeg.

The report said that insufficient information was available to determine whether a wing stall or a tailplane stall led to the pilot's loss of control of the aircraft, which was in an inverted, steep nose-down and left-wing-low attitude when it crashed and burned on railway tracks in Winnipeg at 0543. The engine was developing significant power on impact, and investigators found no deicing system anomalies.

Among recommendations based on the findings of the investigation, TSB said that the Canadian Department of Transport and the U.S. Federal Aviation Administration should prohibit 208-series Cessnas from being flown "in forecast or in actual icing meteorological conditions exceeding 'light' until the airworthiness of the aircraft to operate in such conditions is demonstrated." The report noted that the aircraft currently are certified for flight in moderate icing conditions when properly equipped.

Insufficient information was available to determine whether a wing stall or a tailplane stall led to the pilot's loss of control of the aircraft.

'I Am a Bit Low Here'

Cessna 425 Conquest 1. Destroyed. Four fatalities.

Nighttime instrument meteorological conditions prevailed at Centennial Airport near Englewood, Colorado, U.S., on Aug. 13, 2005, when the pilot received vectors from ATC to the localizer course for the ILS approach to Runway 35R. The airplane was inbound on a private flight from Sandpoint, Idaho, the NTSB report said. The pilot, 62, had 5,000 flight hours, including more than 1,400 flight hours in type.

Visibility was 2 mi (3,200 m) in rain, and the ceiling was at 500 ft AGL. Decision altitude for the ILS approach is 6,083 ft, and touchdown zone elevation is 5,883 ft. The airplane was about 500 ft above the glideslope when it crossed the outer marker. Recorded radar data indicated that the airplane's flight path then deviated from the glideslope and localizer.

The tower controller observed a minimum safe altitude warning (MSAW) system warning when the airplane was at 6,800 ft, with a groundspeed of 170 kt, on final approach. The controller told the pilot, "I am getting a

low-altitude alert on you." The pilot replied, "Yeah, I am a bit low here." The airplane was at 7,200 ft with a groundspeed of 150 kt about 20 seconds later when the pilot said, "I'm back on glideslope."

The airplane was at 6,500 ft about 24 seconds later when the controller issued another low-altitude warning, but there was no response from the pilot. The airplane struck hilly terrain at 6,120 ft about 2.6 nm (4.8 km) from the runway.

"The pilot did not hold a valid medical certificate at the time of the accident, and a post-accident toxicological test revealed the presence of unreported prescription medications," the report said. "No anomalies were noted with the airframe and engines." NTSB said that the probable cause of the CFIT accident was "the pilot's failure to properly execute the published instrument approach procedure."

PISTON AIRPLANES

Wing Separates in Thunderstorm

Piper Aerostar 602P. Destroyed. Two fatalities.

The pilot telephoned an automated flight service station (AFSS) the morning of May 10, 2006, to obtain a weather briefing for a business flight from Cornelia, Georgia, U.S., to Mobile, Alabama. The AFSS specialist said that a significant meteorological advisory (SIGMET) was in effect for an embedded line of thunderstorms with tops between 41,000 ft and 50,000 ft along the route from Atlanta to Mobile.

"The specialist suggested that the pilot not depart immediately because of the weather but said that it might be possible to land at an intermediate stop ahead of the weather, possibility in the Pensacola[, Florida] area or further north in the Crestview[, Florida] area, wait for the storms to pass and then continue the flight to Mobile," the report said. The pilot filed an instrument flight rules (IFR) flight plan to Pensacola, requesting a cruise altitude of 16,000 ft.

The pilot telephoned the AFSS again a few minutes later to obtain an IFR clearance with a void time. The specialist placed the pilot's call on hold while he coordinated the clearance with ATC. "When he returned to the inbound telephone line to provide the pilot with the requested IFR clearance, the pilot was no longer on the line," the report said.

The pilot departed under visual flight rules and obtained an IFR clearance from the Atlanta Air Route Traffic Control Center. The center controllers broadcast a center weather advisory and SIGMET information about a line of thunderstorms 40 nm (74 km) wide with tops at 44,000 ft moving from 280 degrees at 35 kt. However, the report said that the controllers did not tell the Aerostar pilot about intense-to-extreme precipitation echoes displayed on their radar screens.

The airplane was at 16,000 ft when the pilot reported that he was reversing course. Radio and radar contact with the airplane were lost soon thereafter. The report said that the airplane was in a vertical nose-down attitude when it struck terrain near Camp Hill, Alabama. "Examination of the wreckage revealed that the right wing separated 9 ft 2 in [2.8 m] outboard of the wing root," the report said. "The separated outboard section of the right wing was not recovered."

Engine Fails During Go-Around

Cessna 402C. Destroyed. One serious injury.

Reported weather conditions included 1/4-mi (400-m) visibility and a 100-ft ceiling when the pilot began an ILS approach to Mather (California, U.S.) Airport during a cargo flight the night of Jan. 23, 2003. The pilot told investigators that he initiated a missed approach because of the weather conditions, but when he attempted to increase power, the left engine failed.

The pilot activated the fuel-boost pump for the left engine but did not retract the landing gear or flaps. "Without the airplane configured correctly for the single-engine missed approach, the net climb performance would be negative 400 fpm," the NTSB report said. The airplane struck a utility pole and trees, then descended to the ground, where it collided with a chain link fence before stopping on a road.

Investigators were unable to determine why the engine failed. NTSB said that the probable causes of the accident were the engine failure and the pilot's "failure to correctly configure the airplane for a single-engine missed approach" and that a factor was the pilot's "decision to initiate the approach when the weather conditions were below the published approach minimums."

HELICOPTERS

Corrosion Blamed for Engine Failure

Hughes 369D. Substantial damage. No injuries.

After completing a power-line-inspection flight on Oct. 4, 2005, the pilot landed the helicopter on a farm field near Lundsbrunn, Sweden, to visit an acquaintance. After a brief visit, the pilot departed for the return flight to the operator's temporary base at Skövde.

"After a climbing hover, which was completely normal, the pilot accelerated the helicopter forward while climbing," said the Swedish Accident Investigation Board (SHK) report. "When the helicopter reached approximately 30 kt of forward speed and at a height of 5–10 m [16–33 ft] above ground level, a loud bang was heard, and the engine suddenly stopped." The helicopter descended to the ground and rolled onto its left side. The cabin remained intact, and the pilot was not injured.

A tear-down examination of the Rolls-Royce — formerly Allison — 250-C20B engine revealed major damage to the compressor blades and guide vanes. "In addition, extensive resultant damage could be seen in the direction of flow," the report said. Metallurgical examination showed that the compressor failure began with a fatigue fracture at a third-stage blade root. "Closer examination under an electron microscope revealed a small corrosion mark there and at other locations close to the blade roots," the report said.

The engine manufacturer told investigators that fatigue cracks caused by corrosion damage in the second and third compressor stages have been found in 80 engines. "This would amount to a frequency of one event per million flying hours," the report said.

The operator had conducted compressor washes every 100 hours. However, the report noted that the engine manufacturer recommends daily compressor washes for engines operated in "corrosive environments." Based on the findings of the accident investigation, SHK recommended that the Swedish Civil Aviation Authority "inform operators using this type of engine of the risk of blade corrosion and the importance of regularly washing the compressor in accordance with the manufacturer's recommendations."

Fatigue Causes Stabilizer Failure

Bell 206B JetRanger. Destroyed. Two fatalities.

About 45 minutes after departing for a pipeline-inspection flight between Cumbernauld, Scotland, and Aberdeen on Dec. 21, 2005, the helicopter entered an uncontrolled descent to the ground, killing the pilot and observer. "The investigation found that the vertical stabilizer had detached from the tail boom and struck the tail rotor," said the AAIB report. "This subsequently caused the tail rotor and associated gearbox to become detached from the tail boom."

The report said that the fatigue fractures of the forward and aft vertical stabilizer supports likely had resulted from insufficient torque applied to the four bolts that attach the supports to a mounting platform on the tail rotor gearbox. The vertical stabilizer had been removed temporarily to facilitate repair of fuselage corrosion during the summer of 2005.

Visual inspections of the supports are required every 100 hours. A 100-hour inspection of the accident helicopter had been scheduled after the pipeline-inspection flight. If the supports had not failed during the flight, the inspection likely would have revealed that they were extensively cracked, the report said.

Based on the findings of the investigation, AAIB recommended that the European Aviation Safety Agency and the civil aviation authorities in Canada, the United Kingdom and the United States require that the vertical stabilizers on Bell and Agusta-Bell 206-series helicopters be removed for inspection of the stabilizer supports. ●

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Dec. 1, 2006	San Diego, California, U.S.	Learjet 36	substantial	3 none
The Learjet was on a public-use flight from North Island Naval Air Station and was being flown in formation with another airplane. While conducting a cross-under maneuver, the pilot lost sight of the other airplane due to sun glare. While being turned away from the other airplane, the Learjet banked 70 degrees right and pitched 50 degrees nose-down. The pilot recovered control and landed without further incident. The right elevator was missing, and the left elevator was deformed; the preliminary report did not say how the damage was incurred.				
Dec. 6, 2006	Deauville, France	Raytheon Premier	minor	none
The airplane overran the runway while landing. The number of occupants was not reported.				
Dec. 10, 2006	Hesperia, California, U.S.	Bell 412SP	destroyed	3 fatal
After completing an emergency medical services flight, the helicopter struck a mountain while being flown back to its base in nighttime visual meteorological conditions (VMC).				
Dec. 10, 2006	Waco, Texas, U.S.	Cessna 310Q	destroyed	3 fatal
The airplane struck terrain during an ILS approach on a dark night. Visibility was 2 mi (3,200 m) in fog, and the ceiling was overcast at 200 ft.				
Dec. 14, 2006	Port Heiden, Alaska, U.S.	Piper PA-32-301 Saratoga	destroyed	2 fatal
The single-engine airplane struck snow-covered terrain about 10 minutes after departing from Port Heiden for a commuter flight to King Salmon, Alaska. Nighttime VMC prevailed, but intermittent snow squalls had been reported.				
Dec. 14, 2006	Dagsboro, Delaware, U.S.	Bell 407	substantial	2 fatal
Dense fog was reported in the area when the helicopter struck terrain while departing on a charter flight.				
Dec. 15, 2006	Buenos Aires, Argentina	Swearingen Metro III	substantial	2 NA
A wing struck the runway during takeoff, and the airplane veered off the pavement. Both occupants survived the accident.				
Dec. 15, 2006	Cadiz, Spain	Piper PA-34-220T Seneca	destroyed	3 fatal, 1 serious
The airplane struck terrain after loss of control during approach to Jerez de la Frontera Airport.				
Dec. 16, 2006	Mbeya, Tanzania	Cessna 310Q	destroyed	2 fatal, 4 serious
Nighttime VMC prevailed when the airplane crashed in a residential area while departing on a charter flight. No one on the ground was injured.				
Dec. 24, 2006	Pandang, Indonesia	Boeing 737-400	substantial	162 NA
The airplane overran the runway while landing at Pandang-Hasanudin Airport. All 162 occupants reportedly survived the accident.				
Dec. 25, 2006	Lawrenceville, Georgia, U.S.	Cessna 414	destroyed	3 fatal
Visibility was 1/2 mi (800 m) in fog and vertical visibility was 100 ft when the airplane struck terrain during approach.				
Dec. 26, 2006	Johnstown, Pennsylvania, U.S.	Cessna 414	destroyed	2 fatal
The airplane was en route from Morgantown, West Virginia, to Teterboro, New Jersey, when the pilot reported airframe icing and diverted to Johnstown. The airplane struck terrain on approach.				
Dec. 28, 2006	Prague, Czech Republic	Airbus A321	none	168 none
The airplane was en route from Moscow to Geneva when a passenger began fighting with other passengers and demanded that the airplane be flown to Cairo, Egypt. The passenger was subdued by other occupants and arrested after the flight was diverted to Prague.				
Dec. 29, 2006	Rapid City, South Dakota, U.S.	Beech 99	substantial	1 none
The right wing tip struck the ground after the pilot initiated a missed approach at Rapid City Regional Airport. The airplane then crashed about 10 nm (19 km) south of the airport.				
Dec. 30, 2006	Nairobi, Kenya	de Havilland DHC-5 Buffalo	destroyed	3 minor
The airplane struck a house and burned after one engine failed during departure for a cargo flight to Somalia. The cargo included 4,000 liters (1,057 gallons) of jet fuel. No one on the ground was injured.				
Dec. 30, 2006	Culiacan Rosales, Mexico	Rockwell CT-39A	destroyed	2 fatal
The airplane, a military version of the Sabreliner, was on a cargo flight when it stalled and struck houses during approach. No one on the ground was injured.				

NA = not available

This information, gathered from various government and media sources, is subject to change as the investigations of the accidents and incidents are completed.