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Military Boeing 707 Strikes Birds After Liftoff; Damage to Engines No. 1 and No. 2 Results in Loss of Power and Impact with Terrain

U.S. Air Force personnel at Elmendorf Air Force Base in Alaska knew that geese posed a danger to aircraft and acted to disperse them. Nevertheless, their efforts to detect or deter roosting geese were inadequate, an official U.S. Air Force accident report says.

FSF Editorial Staff

The crew of the U.S. Air Force E-3B, a modified Boeing 707 equipped with sophisticated airborne warning and control systems (AWACS), was holding short of Runway 5 at Elmendorf Air Force Base (AFB), Alaska, U.S. As the crew waited for takeoff clearance, a Lockheed Martin C-130 that was departing Runway 5 disturbed a flock of Canada geese that were roosting in the infield adjacent to Runway 5. A controller in the Elmendorf air traffic control tower saw the geese become airborne but did not notify the E-3 crew or Elmendorf airfield management.

The E-3 (call sign "Yukla 27") was cleared into position on Runway 5. Approximately two minutes after the C-130 had departed, Yukla 27 was cleared for takeoff at 0745:30 hours local time, Sept. 22, 1995, and the crew began the takeoff roll. As the aircraft rotated for liftoff, the senior tower controller observed geese take flight and turn directly into the path of the E-3. Numerous birds were ingested into the aircraft's no. 1 (left outboard), and no. 2 (left inboard) engines, resulting in a catastrophic failure of the no. 2 engine and compressor stalls in the no. 1 engine, the report said.

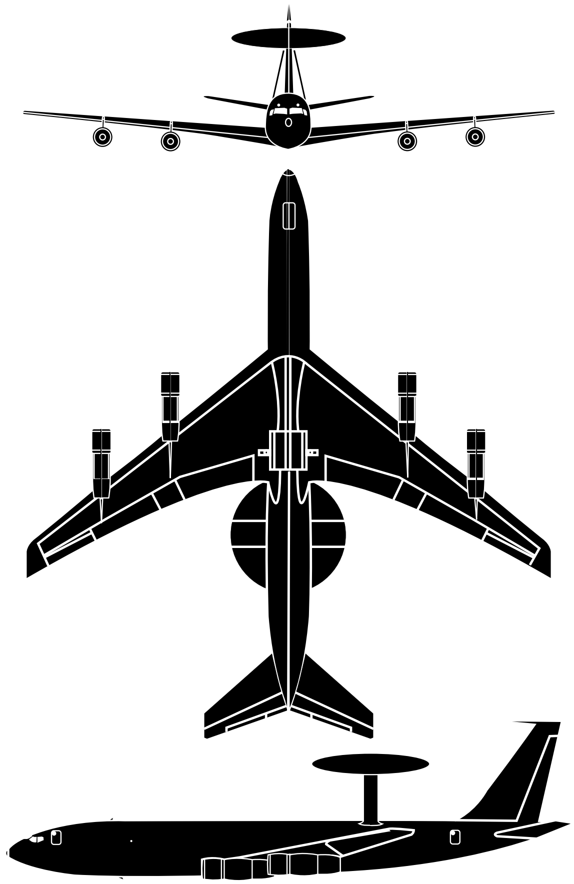
At 0746:43, the copilot radioed: "Elmendorf tower, Yukla two seven heavy has an emergency. Lost ah no. 2 engine, we've taken some birds," the report said.

Witnesses observed the aircraft enter a slow, climbing turn to the left. Six seconds later, the flight engineer said, "Starting dump fuel," the report said. The aircraft commander responded, "Start dumping." Four seconds later, the stick shaker activated and stayed on for the remainder of the flight.

At 0746:56, the copilot radioed: "Yukla zero two heavy's coming back around for an emergency return," the report said. Ten seconds later, the copilot radioed: "Two seven heavy, emergency," the report said. This was followed shortly by a transmission on the tower frequency: "Roll the crash, roll the crash."

At 0747:11, the aircraft commander said, "We're going down," the report said. The aircraft impacted a hilly, wooded area on the base, less than 1.6 kilometers (one mile) from the departure end of the runway (Figure 1, page 3). The aircraft broke up, exploded and burned. All 24 crew members were killed in the accident.

The official U.S. Air Force accident investigation report concluded that the accident "was directly caused by the ingestion of Canada geese into [engine no. 1 and engine no. 2]. Furthermore, two factors substantially contributed to the accident. First, the [3rd] Wing lacked an aggressive program to detect and deter geese; specifically, the bird hazard reduction working group [BHRWG] did not adequately prepare for the migration season, airfield management's efforts to detect and deter geese were inadequate and an earlier safety agency staff assistance visit [SAV] had [misled] the Wing to believe that [the Wing] was prepared.



Boeing E-3B Sentry

The E-3B Sentry airborne warning and control systems (AWACS) is a mobile, jamming-resistant high-capacity radar station and command, control and communications center installed on a Boeing 707 airframe.

The first development aircraft, known as the EC-137, first flew in 1972. The E-3B has a basic operational crew of 20, including four flight crew members and 16 AWACS specialists, although this number can vary depending on the mission.

The aircraft has a maximum takeoff weight of 147,417 kilograms (325,000 pounds), a service ceiling of 29,000 feet (8,850 meters) and a maximum level speed of 460 knots (853 kilometers per hour). It has an endurance on station of 870 nautical miles (1,610 kilometers), six hours from base, and a maximum unrefuelled endurance of 11 hours.

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

"Second, the tower controller failed to notify the [accident] aircraft or airfield management that geese were present in the infield."

The ingestion of the geese into the aircraft's engines caused a loss of thrust that "rendered this aircraft incapable of controlled flight," the report said.

The accident aircraft was assigned to the 962nd Airborne Air Control Squadron, 3rd Wing, at Elmendorf AFB, the report said. The accident flight was a scheduled 6.2-hour routine training mission. "This incident was the first loss of an E-3 so local and national media attention was high," the report said. The aircraft, valued at US$70.2 million, was destroyed.

The accident occurred during twilight and in visual meteorological conditions (VMC). Weather was not a factor in the accident, the report said. Sunrise on the day of the accident was 0742, the report said.

Witnesses on the ground described the accident sequence in subsequent interviews with Air Force accident investigators.

"He was off the ground, front tires [6.1 meters (20 feet)], back tires [three meters (10 feet)], and not very far, just broken ground," one witnesses said. "Loud popping noises. He wasn't gaining any altitude, the gear wasn't coming up, he wasn't trying to gain altitude, he was in trouble."

Another witness, who was driving along a road near the runway, told investigators: "I saw the no.1 and no. 2 engines on fire; I heard compressor, what sounded like compressor stalls — big loud booms coming out of the engines. Um, I knew, I knew something was wrong immediately. I sped up as fast as I could because ... they were flying ... [they just] passed over me. … It appeared to me that they didn't hardly have any speed, and eventually they were not climbing ... and all of a sudden I saw the tail start dropping and that's when they went into the woods."

The report said that Elmendorf AFB crash, fire and rescue vehicles were alerted before the aircraft impacted the ground. The accident aircraft crashed at 0747:12. "Base fire and rescue vehicles were alerted at 0746:44 when the tower controller activated the primary crash alarm system (PCAS)," the report said. "The wreckage was located and the first fire fighter was on [the] scene at 0758. The first crew member was located at 0832 and the last body was found at 1938."

Rescuers had difficulty reaching the accident site, because of the topography, the report said. "Although the [accident] site was on base, there were no access roads leading to the site," the report said. "[Accident]-response fire fighters initially proceeded to the scene on foot until a bulldozer created better access. The fire burned for several hours. The fire crew was able to get water hoses to the scene at 0901. Units from nearby Ft. Richardson [a U.S. Army base] also assisted in the crash response," the report said.

The report commented: "Overall, given the terrain and lack of access roads, [accident] response was very effective, and people were on [the] scene relatively soon after the [accident]. Due to the severity of the impact, however, [accident]-response and rescue efforts were not a factor in this [accident]."

The weather was not a factor in the accident or in rescue efforts, and "the sun was up and lighting conditions were good," the report said.

Postmortem examinations of the 24 crew members "revealed injuries that were consistent with damage to the aircraft and the crew members' duties on the [accident] flight," the report said. "Due to the nature of the accident and resultant injuries, the crew members died instantaneously and did not suffer."

Toxicological examinations of the 24 crew members were negative for alcohol and drugs, the report said.

Investigators reviewed the flight and wreckage path of the accident aircraft. "The [aircraft] lifted off and flew approximately [1.28 kilometers (0.8 mile)] before contacting trees," the report said. "The [aircraft] then flew approximately [0.72 kilometer (0.45 mile)] before making contact with the ground and crashing in a fireball."

When investigators reviewed the debris on the runway, their examination "did not reveal any parts of leading-edge slats, leading-edge flaps, wing leading-edge skins, horizontal leading-edge skins, etc.," the report said. "The parts found on the runway were limited to engine items such as fan blades and stators, one engine-nose dome and one engine-nose cowl." Numerous remains of Canada geese were also found on the runway, the report said.

The report noted: "Other than damage to the engine(s), there is no physical evidence to suggest that the [aircraft] fuselage, wing structure, empennage structure, flight controls or systems were degraded in any way prior to the first contact with the trees."

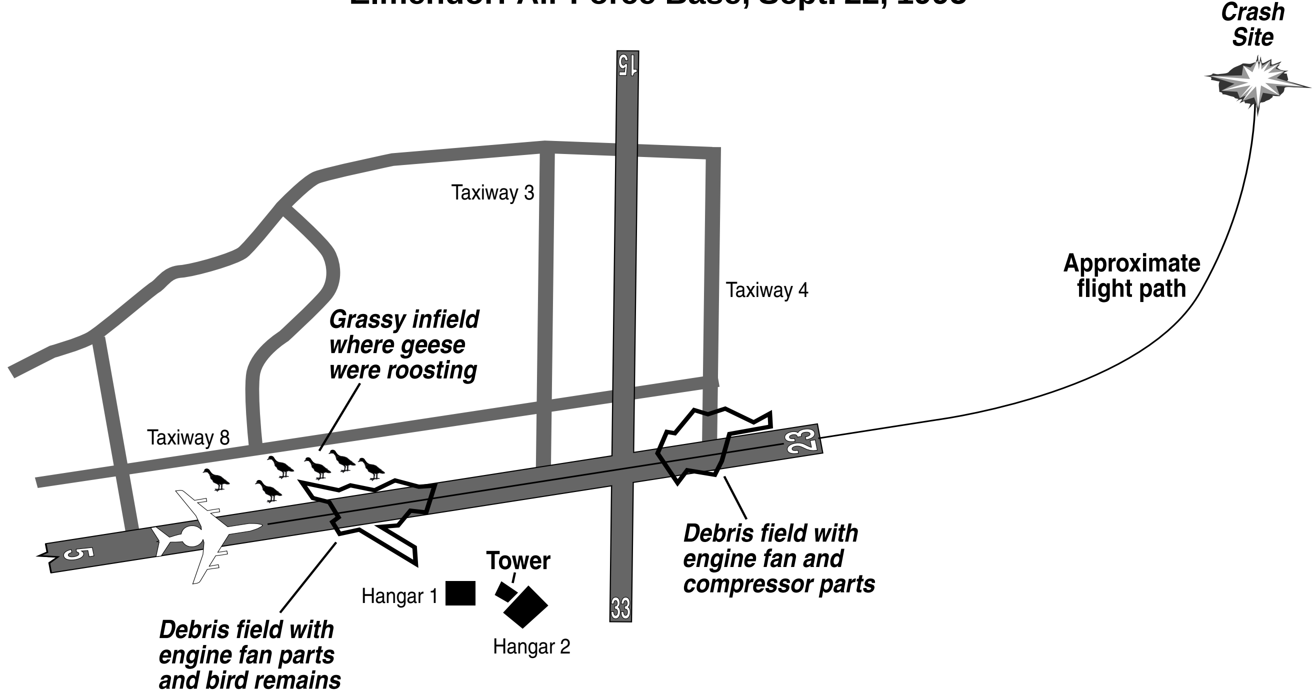
Investigators determined that the aircraft made initial ground contact with an antenna probe on the left wing tip, the report said. "The left-hand wing tip was found on the right-hand side of the crash path, suggesting that it had been thrown by wing-tip vortices," the report said. "A large section of the left-hand stabilizer was found on the right-hand side of the initial touchdown point with the elevator attached, indicating that the [aircraft] was yawed significantly to the left at time of impact. The no. 1 engine separated completely from the left wing upon or before initial ground contact."

The evidence also suggested that "the left-hand wing bent upward significantly between the no. 1 and no. 2 engines at the initial ground contact before the main ground-impact area," the report said.

The main ground-impact area began approximately 91.5 meters (300 feet) from the initial ground-impact point and extended approximately 45.7 meters (150 feet) to the peak of a hill, the report said.

The report described the wreckage path: "At approximately [96 meters (315 feet)] from the initial ground impact, there is a broken tree approximately [41 centimeters (16 inches)] in

Flight Path of Accident Aircraft, Boeing E-3B Sentry, Elmendorf Air Force Base, Sept. 22, 1995



Source: U.S. Air Force

Figure 1

diameter where the nacelle from the no. 2 engine impacted approximately [15 centimeters (six inches)] above ground level. Based on the patterns of fire damage, this tree caused significant structural breakup of the left wing."

The report continued: "Further to the right are trees left standing that should have been hit by the right-hand wing. This suggests that the [aircraft] was already extremely right-wing high, as would be expected with the left wing producing significantly less lift than the right. The direction of the no. 4 engine with the [aircraft] in a left yaw, right-wing high, at the point of main ground-impact points directly to the point where the no. 4 engine landed. This suggests that the no. 4 engine departed the [aircraft] at this point and that the engine was developing significant thrust."

Just before the crest of the hill, investigators found the "left-hand leading-edge flaps, slats, actuators (extended), trailing-edge flap drives and tracks (extended 17 degrees), left- and right-hand flaps, left-hand skin panels (curled under at the leading edge), nose-gear cylinder, and nose- and main-gear doors," the report said.

The wreckage continued over the peak of the hill and continued downslope toward a second hill. Beyond the peak of the first hill, approximately 137 meters to 201 meters (450 feet to 660 feet), investigators found "right-hand pieces such as landing-gear doors ... on the extreme right side of the path mixed in with upper and lower left-wing skins, left-hand wing roots and other left-wing parts, suggesting that the [aircraft] slid along the crash path on its left-hand wing and had not flipped over to this point," the report said.

The report also noted: "The [aircraft] had to be nose-first throughout this phase of the [accident, as] evidenced by a piece of the left-hand wing root found lying on top of the largest section of the nose radome."

Investigators determined from this portion of the wreckage path that the landing gear was down and locked during impact, the report said.

As the aircraft slid to the top of the second hill, located approximately 201 meters to 238 meters (660 feet to 780 feet) from the initial impact point, the empennage broke off, the report said. "As the [aircraft] cleared the second hill, it rolled over," the report said. "The fuselage broke up as the [aircraft] rolled. The outboard right wing impacted on the left side of the wreckage, the right-hand wing broke off and the rotodome section impacted on its back, breaking up the rest of the aircraft."

The report noted: "The lack of right-wing parts and the amount of fire damage at the bottom of the crash site is evidence that the right wing was full of fuel up to the time it broke from the [aircraft], probably just after the second hill. The fuel fire destroyed almost all evidence of how the fuselage broke up and how the right wing broke up. The fuel remaining in the right wing at the time it broke up probably resulted in the fireball that consumed most of the fuselage sections in its path."

Investigators calculated the forces encountered by the aircraft during the crash sequence. The forces encountered by the forward fuselage "probably did not exceed 16 Gs forward; however, it probably exceeded -5.5 Gs up and +/- 4 Gs side," the report said. The forces on the tail section "probably did not exceed 16 Gs forward; however, it probably exceeded -1.5 Gs aft and -5.5 Gs up and -1.5 Gs aft."

The report commented: "The [aircraft] was designed to sustain the specified limit loads in one direction, not all acting at once. The [aircraft] becoming inverted, and possibly its angle to the trees on the second hill, resulted in most of the fuselage breakup and most of the cabinets and seats breaking loose from the floor beams, with limit-exceeding or near limit-exceeding forces acting in several directions at once. Had [the] fuselage been straight and level throughout the crash, the crash probably would have been survivable by all crew members."

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All four engines on the accident aircraft were recovered and examined. Engine no. 1 was found to have experienced a bird strike (one major-size hit and two minor-size hits) seconds after rotation, the report said. "Within four seconds, [the] engine was operating at diminished power (approximately 50 percent TO [takeoff]), then [it] stalled four or five times and struck a tree upstream of the initial engine ground scar," the report said.

Engine no. 2 was found to have experienced a bird strike (three major-size hits) seconds after rotation. "Within eight seconds, this engine lost enough first-stage fan blades to severely damage and then fragment the IGV [inlet guide vanes] case," the report said. "[The] nose cowl was then free, [and] flipped up over the wing and departed the [aircraft]. Then the engine either fell to a 'hung' operating condition or flamed out and windmilled to ground impact," the report said.

There was no evidence to suggest that either engine no. 3 or engine no. 4 had experienced a bird strike, the report said. Both engines continued operating "at TO conditions until being pressed to a higher thrust condition by [the accident] crew within eight seconds after bird strikes on engine [no.] 1 and [no.] 2," the report said. "This operating condition continued until ground impact."

Many of the cockpit instruments were recovered and examined, although many of the instruments were unreadable because of heat damage. "All of the items had sustained impact damage and severe heat damage," the report said. "The heat damage was sufficient to have destroyed any pointer impact marks that may have existed."

After all the available instruments were examined, the report commented: "Nothing was noted during this analysis that indicated instrument or instrument system failure prior to impact or loss of signal input."

The accident aircraft was equipped with both a cockpit voice recorder (CVR) and a flight data recorder (FDR). Both recorders were recovered from the wreckage and delivered to the U.S. National Transportation Safety Board (NTSB) for analysis of the FDR data, the report said. When the recorders were disassembled, they showed substantial heat damage. "However, both tapes survived with minor warpage due to the extreme heat," the report said.

A transcript of the CVR data was obtained, the report said. But retrieval of the FDR data was limited because of technical problems. Documentation for the conversion equations, which were required to convert the raw data on the FDR tape into engineering units for analysis, was unavailable. Data tables from the Royal Saudi Air Force version of the installation, and equations from the British version, were substituted, the report said. But the resulting conversion equations were only approximations of those for the accident aircraft's FDR.

When technicians began reading the FDR data they encountered further problems. Many of the parameters were frozen [and] some were behaving erratically," the report said. Because of the documentation problems, investigators "could not determine which, if any, of the data [were] valid." Because the NTSB had several other accidents to investigate, its additional involvement in the Elmendorf accident would have been delayed. Air Force investigators contacted the Transportation Safety Board of Canada (TSB), which was able to assist in obtaining valid data for course altitude, throttle no. 1 position and engine pressure ratios (EPRs) for engines no. 1, no. 2 and no. 4. All other parameters were nonfunctional or could not be verified, the report said.

Because of the limited FDR data, investigators were able to determine only the following about the accident flight:

- "The aircraft lost power on engines no. 1 and no. 2 within six seconds after rotation;
- " … The aircraft was airborne for approximately 42 seconds after takeoff and 37 [seconds] to 39 seconds after losing power to the engines; [and,]
- "The maximum altitude the aircraft got above the runway elevation was approximately 250 feet [76.2 meters] +/-16 feet [4.8 meters] ... ."

The maintenance history of the accident aircraft was reviewed. "This aircraft had a good statistical record while assigned to the 962 AACS," the report said. "Over the past year, [the accident aircraft] had an 83 percent mission-capable rate and an 81.5 percent maintenance-fix rate. Additionally, this aircraft had only three ground aborts and six air aborts for FY [fiscal year] 1995."

A review of the maintenance documentation on the accident aircraft "revealed no discrepancies that contributed to the accident," the report said.

A review of the training records for the dedicated crew chief and the assistant dedicated crew chief on the accident aircraft found that both "were thoroughly trained and current on all assigned maintenance tasks," the report said. "No maintenance practice or procedures were related to this [accident]."

Investigators reviewed the Air Force regulations and the threat of bird/aircraft strikes at Elmendorf AFB. "Air Force Regulation [AFR] 127-15, *The Bird Aircraft Strike Hazard (BASH) Reduction Program*, gives policy and guidance for implementing an effective bird aircraft-strike hazard-reduction program," the report said. "It designates the Air Force agencies that are responsible for carrying out the program and evaluating its effectiveness. It outlines procedures for developing a Wing-level BASH program and establishes requirements for its operation," the report said.

Air Force personnel have counted the goose population at Elmendorf AFB since 1990, the report said. The population has increased from 1,000 geese in 1990 to 2,700 geese in 1995. On the day of the accident, there were approximately 900 geese on the base, the report said.

In reviewing safety data, investigators found that "the only recorded incident of geese striking an aircraft [at Elmendorf] occurred in September 1993, when a C-130 aircraft struck several geese on the runway after ... landing," the report said.

During a two-week period preceding the accident flight, Elmendorf base operations and wildlife personnel had dispersed geese from the infield areas of Runway 5 and Runway 33 on several occasions, the report said. "Clearly, 3rd Wing was on notice that geese were indeed locating in infields as well as on hard surfaces such as runways and taxiways," the report said. "On two occasions, [conservation personnel] had to kill geese with shotguns in order to disperse the flock. The geese were beginning to establish themselves and occasional dispersal was not deterring them from returning."

Investigators reviewed the efforts of the BHRWG at Elmendorf as required by Air Force regulations, the report said. "The BHRWG did not formulate a concrete plan to deal with changing bird activity levels or the presence of geese in the airfield," the report said. "3rd Wing had an effective OPLAN [operations plan], but the BHRWG was responsible for ensuring that the implementation of this plan resulted in effective geese detection and deterrence at all times of the year."

The efforts of Elmendorf airfield management personnel to detect and deter geese were reviewed. "Roosting infield geese went undetected because airfield management had no controlling plan to locate them," the report said. "It is evident that personnel knew geese posed a danger to aircraft, and they acted to disperse them on several occasions; but their efforts to detect or deter infield geese were inadequate. Few, if any, of the suggested patrol and deterrent methods suggested by AFR 127-15 were in place," the report said.

The report noted: "Airfield management did not sufficiently check these infield areas for the presence of geese. Base operations personnel and supervisors of flying [SOF] were engaged in little other than vehicle sweeps of runways and taxiways. A cursory glance at the infield would not result in the detection of geese. These patrols were effective, if at all, during daylight hours only. Prior to the accident, there was no illumination of infield areas before first light."

The report noted that the "last runway check ... occurred nearly 3.5 hours before the accident aircraft began takeoff roll."

Investigators found that "the worst possible combination [of circumstances] existed: there were infrequent patrols of the airfield, nearly no checking of infields and no placement of static deterrents," the report said. "Those aircraft that began takeoff roll at or before dawn were at risk that those geese would move into their flight path, as it happened in this accident," the report said.

An Air Force BASH Team conducted an SAV at Elmendorf AFB in July 1995, when the goose population was low, the report said. "This team emphasized habitat management but did not discuss the particulars of [the] 3rd Wing's plan for migration season," the report said. "The team did advise airfield management personnel to prevent geese from establishing themselves in the airfield."

The Air Force officer in charge of the accident investigation concluded: "I believe the BASH team's endorsement of the [3rd] Wing's OPLAN convinced the BHRWG that nothing else was required to prepare for migration season. … It is possible that airfield management personnel did not routinely check infields because, based on the SAV, they assumed there would be no geese there."

The Elmendorf AFB airfield manager was interviewed during the investigation. "She [the airfield manager] was well aware of the BASH plan and had been personally briefed by the BASH team during the July 1995 [visit]," the report said. "I [the investigating officer] attempted to establish her understanding of airfield management's specific responsibilities in the OPLAN, but she invoked her right to remain silent."

The investigating officer interviewed the senior tower controller and another controller who were on duty in Elmendorf tower at the time of the accident. Both controllers, who had "an excellent view of the runway area," invoked their rights to remain silent, the report said. Witnesses told investigators that after the accident,

CVR Transcript of Yukla 27
Boeing E-3B Sentry

0745:29	**RDO-TWR**:	Yukla two seven heavy, the wind three one zero at one one, cleared for takeoff Runway five. Traffic is a C-130 three miles north of Elmendorf northwest-bound, climbing out of two thousand.
	CAM:	[light switches]
0745:39	**AC?:**	In sight.
0745:41	**RDO-CP**:	And Yukla two seven heavy cleared for takeoff, traffic in sight.
0745:44	**CP**:	Cleared for takeoff, crew.
0745:45	**FE:**	*check complete.
0745:45	**CAM:**	[Engines spool up]
0745:47	**AC:**	Engineer, set takeoff power.
0745:49	**CAM:**	[Engines spool up]
0746:09	**CP**:	Eighty knots, copilot's aircraft.
0746:11	**AC**:	Your airplane.
0746:20	**AC**:	V_1.
0746:28	**AC**:	Rotate.
0746:28	**CP**:	All the birds.
0746:31	**FE**:	Lotta birds here.
0746:33	**AC**:	# we took one.
0746:36	**CP**:	What do I got?
0746:37	**FE?:**	We took two of 'em.
0746:37	**AC**:	We got two motors.
0746:37	**FE**:	Flight start.
0746:38	**CP**:	Roger that.
0746:40	**AC**:	Take me to override.
0746:41	**CP**:	Go to override on, on the …
0746:43	**RDO-CP**:	Elmendorf tower, Yukla two seven heavy has an emergency. Lost ah number two engine, we've taken some birds.
0746:44	**St5**:	You're in override.
	St5:	There's the rudder.
0746:46	**FE**:	Got it.
0746:47	**St5**:	You're in override.
0646:48	**AC**:	Thank you.
0746:49	**FE**:	Starting dump fuel.
0746:51	**AC**:	Start dumping.
0746:52	**RDO-TWR**:	Yukla two seven heavy, roger. Say intentions.
0746:55	**CAM**:	[Stick shaker activates, continues until impact]
0746:56	**RDO-CP**:	Yukla zero two heavy's coming back around for an emergency return.
0746:58	**CP**:	Lower the nose, lower the nose, lower the nose.
0747:00	**RDO-TWR**:	Two seven heavy, roger.
0747:00	**AC**:	Goin' down.
0747:02	**CP?:**	Oh my God.
0747:02	**AC**:	Oh #.
0747:04	**CP**:	OK, give it all you got, give it all you got.

0747:06	**RDO-CP**:	Two seven heavy, emergency.
0747:09	**RDO-W1**:	Roll the crash, roll the crash.
0747:10	**CAM**:	[PA tone]
0747:11	**CP**:	Crash (landing)
0747:11	**AC**:	We're goin' in.
0747:11	**AC**:	We're going down.

RDO = Radio transmission
TWR = Tower controller
CAM = Cockpit area microphone
AC = Aircraft commander
CVR = cockpit voice recorder
CP = Copilot
FE = Flight engineer
St5 = Instructor flight engineer
* = Unidentifiable word or words
# = Expletive
? = Unsure of origin
[ ] = Editorial insertion

Source: U.S. Air Force

the senior tower controller said he "observed geese lift off and turn right, directly into the path of the [accident] aircraft."

"Moments before the [accident] aircraft's departure, [the senior tower controller] witnessed a C-130 take off and flush a flock of geese from the infield adjacent to Runway 5," the report said. "Fortunately for that aircraft, this flock turned away from its flight path."

The report noted: "While [the senior tower controller] could have assumed that every infield goose joined the flock that the C-130 flushed and that this flock had left the area, sound judgment dictates that he should have contacted the E-3 and warned the crew. The aircraft could have held takeoff until the squadron SOF or base operations could ensure that these geese had not returned and that no more geese were in the area. I [the investigating officer] cannot imagine why [the controller] did nothing. He had more than two minutes to advise the [accident] aircraft that a flock of geese had taken wing and nearly struck the C-130."

The investigating officer commented in the report: "I believe [that the tower controller] had a duty to warn the [accident] aircraft and that his failure to do so was a contributing factor to this accident. While it would not have been standard operating procedure for a tower controller to raise the bird watch condition [BWC] to severe, he certainly could have warned the aircraft of the potential hazard."

The background and qualifications of the flight crew were reviewed. The aircraft commander, 28, had logged 1,922 total flying hours, excluding student pilot training, the report said. He had completed his initial E-3 copilot training in 1992 and upgraded to aircraft commander in 1994. The aircraft commander "had a solid flying background with no breaks in flying operational assignments since pilot training," the report said.

The aircraft commander had flown one 10-hour flight in the 30-day period preceding the accident, the report said. "He was current by all Air Force standards," the report said. "[He] had a strong flying record and was a very capable aircraft commander." There were no recurring problems in his training records, the report said.

The copilot, 27, had logged approximately 1,259 total flying hours, excluding student pilot training, the report said. He had completed his initial E-3 copilot training in 1992 and was certified as a mission-ready copilot in 1993. The copilot had flown three flights in the 30-day period preceding the accident and had logged 79.2 flying hours in the 90-day period preceding the accident, the report said.

There were no recurring problems noted in the copilot's training records. "He was a strong copilot who was being actively prepared for aircraft commander duties," the report said. "His training records were thorough and gave a very clear picture of a responsible and competent aviator."

The activities of the flight crew before the accident flight were reviewed. "The crew was scheduled to enter crew rest at 1800 [the day before the accident flight]," the report said. "This [schedule] provided 12 hours of nonduty time prior to a 0600 show time on [the day of the accident flight]. All evidence indicates [that] the flight crew received adequate nonduty time, and [that] crew rest was not a contributing factor in this accident," the report said.

In an aircraft simulator the investigating officer flew the profile of the accident flight, the report said. The investigator said: "I am convinced that a total power loss on no. 2 engine and a 50-[percent] to 70-percent power loss on the no. 1 engine immediately after rotation renders the E-3 incapable of controlled flight. I am convinced that the flight deck air crew accomplished their emergency procedures flawlessly in an attempt to fly this aircraft out of an unflyable scenario."

The following new procedures were ordered after the accident:

- "When workload permits, controllers will use binoculars to visually scan the runway and infield environments for concentrations of birds or bird activity prior to issuing a takeoff or landing clearance;
- "Airfield management will conduct an airfield inspection 30 minutes prior to civil twilight. This inspection should focus on the current bird activity and should help anticipate the increase in bird activity that is normally associated with the early morning period;
- "Airfield management will conduct an airfield inspection within 30 minutes of the first departure of each day;
- "The [SOF], airfield management, and ATC watch supervisor (WS) all have the authority to increase the declared BWC in the interest of flight safety. In the

absence of a Wing SOF, airfield management will have the authority to decrease the BWC;

- "In the absence of the SOF and when the tower watch supervisor and/or airfield management deems it necessary, he/she may increase the BWC. When the ATC WS upgrades the BWC, he/she will notify airfield management as to the location of the birds;

- "The SOF and the ATC WS may restrict and/or modify air traffic operations as deemed necessary for flight safety (e.g., cancellation of practice approaches, full stops only, etc.); [and,]

- "If bird dispersal is required on the airfield, the BWC will automatically be upgraded to severe during such activity."

The report noted that the new procedures required that the BWC be declared "if there are birds flying over or on the ground anywhere close to the runways (infield, edges, taxiways, ramps, etc.) ... because they need to be dispersed." Most severe bird conditions, which prohibit takeoffs and all but emergency and fuel-related diversionary landings, can be resolved within five minutes to 15 minutes.

As a result of the difficulties in reading the accident aircraft's FDR data, investigators made the following recommendations to the U.S. Air Force:

- "We recommend that the Air Force evaluate and correct the documentation pertaining to the recorded parameters on all its FDR aircraft. This is not the only case of the Air Force having [an FDR]-equipped aircraft [from which they could not] read out and evaluate the [FDR] data;

- "We recommend that all Air Force FDR-equipped aircraft have the FDR read out and the data evaluated by engineers at least once a year to locate failed sensors and other malfunctions/miscalibrations that cannot be found by the use of a built-in test;

- "The E-3 has a large amount of unused space in the data frames recorded on the FDR; however, many of the parameters are only recorded once every four seconds. We recommend that the software in the flight data acquisition unit (FDAU) be modified so that it stores the data from the four-second parameters at least once per second and the more active parameters more often than once per second. This can be done without having to add more sensors to the FDAU and would greatly improve the value of the data; [and,]

- "We also recommend that all four engine throttles be wired for recording by the FDR."♦

Editorial note: This article was adapted from *USAF [United States Air Force] Aircraft Accident Investigation Report, E-3B Aircraft #77-0354, Assigned to 3rd Wing, Elmendorf AFB, Alaska, 22 September 1995.* The report contains a 19-page summary and extensive supporting documentation, and includes diagrams and illustrations.

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