National Transportation Safety Board
Washington, DC 20594

Brief of Accident

Adopted 01/13/2006

CHI04FA029

File No. 19297 | 11/12/2003 | Belleville, IL | Aircraft Reg No. N77JL | Time (Local): 06:45 CST

Make/Model: Learjet / 24D
Engine Make/Model: General Electric / CJ610-6
Aircraft Damage: Destroyed
Number of Engines: 2
Operating Certificate(s): On-demand Air Taxi
Name of Carrier: Multi-Aero Inc.
Type of Flight Operation: Non-scheduled; Domestic; Passenger/Cargo
Reg. Flight Conducted Under: Part 135: Air Taxi & Commuter

	Fatal	Serious	Minor/None
Crew	0	0	2
Pass	0	0	2

Last Depart. Point: St. Louis, MO
Destination: North Platte, NE
Airport Proximity: Off Airport/Airstrip

Condition of Light: Day
Weather Info Src: Weather Observation Facility
Basic Weather: Visual Conditions
Lowest Ceiling: None
Visibility: 10.00 SM
Wind Dir/Speed: Variable / 005 Kts
Temperature (°C): 18
Precip/Obscuration:

Pilot-in-Command Age: 40

Certificate(s)/Rating(s)
Airline Transport; Flight Instructor; Commercial; Multi-engine Land; Single-engine Land

Instrument Ratings
Airplane

Flight Time (Hours)

Total All Aircraft: 9054
Last 90 Days: 53
Total Make/Model: 760
Total Instrument Time: 1037

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!!THIS CASE WAS MODIFIED JANUARY 12, 2006!!

HISTORY OF FLIGHT

On November 12, 2003, at 0645 central standard time, a Learjet 24D, N77JL, operated by Multi-Aero Inc. and piloted by an airline transport pilot, was destroyed during a forced landing and post accident fire after a loss of power in both engines. The flight departed runway 12R (6,997 feet by 100 feet, asphalt) at St. Louis Downtown Airport (CPS), near Cahokia, Illinois, at 0641. The business flight was operating under the provisions of 14 CFR Part 135 flight and was on an instrument flight rules (IFR) flight plan with North Platte, Nebraska, as the destination airport. Visual meteorological conditions prevailed at the time of the accident. The pilot and co-pilot sustained minor injuries. The two passengers reported no injuries.

The pilot reported that the airplane was fueled with 300 gallons of jet A fuel with Prist, a fuel additive, from the local fixed base operator at CPS. The pilot reported that a ground power unit was used to start both engines and both engines started normally. The CPS tower was not open yet, so the flight received their departure weather from the CPS Automated Surface Observing System (ASOS), and received their takeoff clearance from St. Louis Approach Control.

The pilot reported that after all the takeoff checks were accomplished, the proper "V" speeds set, and the flaps set to 10 flaps, the flight departed from runway 12R. The pilot reported, "I lined up on 12R and we proceeded with our takeoff roll. Co-pilot made standard calls, we rotated positive rate gear up, V2 plus 30 flaps up, and at that point we struck birds taking No. 2 engine out. Upon losing No. 2 engine I advanced thrust levers forward and realized that the No. 1 engine was only producing approximately 70% RPM with EGT over red line. I then realized time nor altitude was going to be enough for a restart or a return to landing. With only seconds remaining, I looked and found the best suitable landing spot to crash land the aircraft. Upon crash-landing aircraft wingtips departed and we came to a stop. Co-pilot assisted passengers out the emergency window exit away from the wreckage, and I escaped out of the main emergency exit and got away from the wreckage that had broken out into fire in the tail first, and then traveled though out the cabin and cockpit, destroying 95% of the aircraft with fire."

The copilot reported, "The PIC was the 'Pilot Flying' and as the SIC, I was making the standard call outs. Everything was normal on the takeoff roll and I called out V1, rotate, V2, gear up, V2 plus 30, and flaps up. At approximately 500 to 1,000 ft. agl, I observed a large flock of birds straight ahead of us, and then passing just off our nose to the left side. I immediately heard an engine flameout. As I started to go to the checklist for single engine operations, I quickly realized that we were losing airspeed and unable to maintain altitude. The PIC said we were going down and heading for the best emergency-landing stop. I observed fire upon impact and as the aircraft slid to a stop. As I looked back to check on the passengers, I observed fire out both side fuselage windows. The passengers appeared to be uninjured. I attempted to open the top of the main cabin door but was unable. I then moved to the rear of the aircraft to open the emergency exit. I assisted the passengers out the emergency exit and got them away from the burning aircraft. I then observed the pilot coming from around the left side of the aircraft and we all moved away from the aircraft."

One of the passengers reported hearing a "pop" on the left side of the aircraft shortly after takeoff. He reported that he did not remember hearing an increase in engine noise after hearing the "pop." It became obvious to the passenger that the airplane was losing power and the airplane started to descend. He checked his seat belt prior to impact. Once the airplane came to a stop, he had trouble finding the emergency exit until the copilot came back and opened the emergency exit.

A witness on the ground reported seeing the airplane flying low and losing altitude. He reported that he could not tell by the sound if the engines were running. He reported that he did not see any smoke or flames coming from the airplane prior to impact. He reported that the tail of the airplane was on fire at first, but soon after the four people were out of the airplane, the whole airplane was on fire.

The airplane was emitting a discrete transponder beacon code that the St. Louis approach radar recorded. The radar track data recorded six valid radar "hits" which indicated the airplane's heading, altitude, time, and position. The radar track data indicated the airplane climbed to about 900 feet pressure altitude (about 834 feet above mean sea level) at 0642:44. The elevation at CPS is 414 feet msl. During the next 28 seconds, five more radar hits indicated the airplane was on about a 120 magnetic bearing from CPS at an altitude of about 900 feet pressure altitude. The last recorded radar hit was at 0643:13.

The airplane impacted the terrain on the down slope of a hill in a farm field that was recently planted. Local fire departments responded to the accident and used water and flame retardant to put out the fire.

PERSONNEL INFORMATION

The pilot held an airline transport pilot (ATP) certificate with single-engine and multi-engine land ratings. He also held a certified flight instructor certificate with single-engine airplane, multi-engine airplane, and instrument airplane ratings. He held a First Class medical certificate. The pilot had accumulated 9,054 total flight hours including 760 in the same make and model airplane as the accident airplane. Training records indicate that the pilot's most recent Airman Competency/Proficiency Check, as required by 14 CFR Part 135.299, was satisfactorily completed on January 8, 2003.

The copilot held a commercial certificate with single-engine and multi-engine land ratings. He also held a certified flight instructor certificate with a single-engine airplane rating. He held a First Class medical certificate. The copilot had accumulated about 3,400 total flight hours including 150 in the same make and model airplane as the accident airplane. Training records indicate that the pilot's most recent Airman Competency/Proficiency Check, as required by 14 CFR Part 135.297, was satisfactorily completed on July 29, 2003.

AIRCRAFT INFORMATION

The airplane was a twin-engine Learjet 24D, serial number 286, manufactured in 1974. The airplane seated 8 and had a maximum gross takeoff weight of 13,000 pounds. The engines were GE CJ610-6 engines that produced 2,950 pounds of thrust each. The airframe had a total time of 6,653.4 hours with a total of 6,504 cycles. The last aircraft inspection was conducted on November 7, 2003, in accordance with Multi-Aero Inc's., Approved Airworthiness Inspection Program (AAIP) maintenance inspection program. The airplane had flown 2.3 hours since the last inspection.

The left engine, serial number 251-518A, had accumulated 6,352.7 total hours. It underwent a 300-hour inspection on January 27, 2003, in accordance with Multi-Aero Inc's., AAIP. The right engine, serial number 251-517A, had accumulated 6,607.2 total hours. It was inspected on March 19, 2003, and an operational maintenance test flight was flown on April 18, 2003, to check that it operated within parameters.

METEOROLOGICAL CONDITIONS

At 0653, the observed surface weather at CPS was: Winds variable at 5 knots; visibility 10 statute miles; sky clear; temperature 18 degrees C; dew point 16 degrees C; altimeter 29.85 inches of mercury.

FLIGHT RECORDERS

A Fairchild model A-100, cockpit voice recorder (CVR), was installed on the airplane. The CVR was inspected by the National Transportation Safety Board's (NTSB) Vehicle Performance Division. The inspection revealed that the recording consisted of four channels of fair to good quality audio information. The CVR recorded the following information:

0640:54
HOT-2 (Copilot's microphone): uuh, one **... one seven six six, set ... set, speed. *, twenty seven, thirty, thirty-four. There's uh ...

0641:28
CAM (Area microphone): [sound similar to increase in engine RPM]

0641:31
RDO-1 (Pilot's radio transmission): Downtown traffic, Webber two eighty six rolling on one two right.

0641.47

HOT-2: Speed's alive.

0641:50
HOT-2: eighty knot cross checked.

0642:00
HOT-2: V one.

0642:01
HOT-2: rotate.

0642:02
HOT-2: V two

0642:09
HOT-2: positive rate.

0642:10
HOT-2: gear's up.

0642:11
CAM: [sound of thump]

0642:12
HOT-2: plus thirty.

0642:14
HOT-2: comin' up.

0642:19
CAM: [sound similar to decrease in engine RPM]

0642:19
CAM: [sound of thump]

0642:24
HOT-1 (Pilot's microphone): hit a bird.

0642:25
HOT-2: yep

0642:30

HOT-2: plus thirty.

0642:46
HOT-1: call approach.

0642:48
CAM: [sound similar to landing gear warning horn]

0642:54
HOT-1: call approach, tell 'em.

0643:00
HOT-2: gear's up, flaps up, air's on.

0643:05
CAM: [sound similar to yaw damper disconnect tone]

0643:05
CAM: what's wrong with ...

0643:11
CAM-?: [sound of heavy breathing]

0643:16
CAM [sound similar to stick shaker starts and continues to end of recording]

0643:19
HOT-2: over here.

0643:24
CAM-?: going down.

0643:30
CAM: [sound of impact]

0643:31
End of Transcript
End of Recording

The NTSB's CVR "Specialist's Factual Report of Investigation" is in the docket material associated with this case.

WRECKAGE AND IMPACT INFORMATION

The aircraft contacted the terrain on the downward side of a shallow sloping hill located about 3 statute miles from CPS on a 120 degree magnetic bearing. The wreckage path was about 750 feet in length from the initial point of impact to the main wreckage on a 175 degree magnetic bearing. The main wreckage was located at coordinates 38 degrees 31.876 minutes North latitude, 90 degrees 05.689 minutes West longitude. The airplane was destroyed by impact and post-impact fire with most of the cabin and tailcone being consumed by fire. The cabin area above the center section on the wing was consumed by fire. The center section of the fuel tank remained structurally intact, although damaged by impact forces. All three landing gear were attached to the airplane and found in the retracted position.

The nose of the airplane remained intact, but the cockpit received extensive fire and heat damage. Both windshields were melted and the upper skin was consumed. The instrument panel received impact damage and was covered with soot deposits. Both throttles were found in the cut off position. The thrust reverser levers were stowed. The fuel quantity indicator switch was in the right hand position. The fuel quantity gauge was fire damaged and the needle was in the 0 position. The left and right jet pump fuel switches were in the on position. The left and right boost pump switches were in the off position. The crossflow switch was in the closed position. The fuselage tank switch was in the off position. The fuel quantity indicator lights were destroyed.

The outboard section of the left wing had separated from the airplane about 4-5 feet (Wing Station 70) outboard from the fuselage. The detached outboard section of the wing received fire and soot damage and was found about 325 feet from the initial impact point. The left flap was found near the outboard section of the wing. The left flap actuator was found in the attached inboard section of the wing and it measured 5 1/4 inches of extension, which corresponded to about 16.3 degrees of deployment. The left spoiler actuator measured about 3/4 inches of extension, which corresponded to 0 degrees of extension. The left wing fuel tip tank separated from the wing and was found in numerous pieces beginning near the start of the debris trail. The inboard section of the wing that was still attached to the fuselage was partially consumed by fire.

The right wing remained attached to the forward fuselage section. The outboard section of the wing remained attached to the inboard wing section, but it was broken about mid-span and it was partially consumed by fire. The right flap and actuator remained attached to the wing. The right flap actuator was measured at 5 7/8 inches of extension, which corresponded to about 12.5 degrees of deployment. The right spoiler and actuator were still attached. The right spoiler actuator was measured at 8/10 inches of extension, which corresponded to 0 degrees of deployment. The right wing fuel tip tank separated from the wing and was found in numerous pieces along the wreckage path.

The tailcone aft of the rear pressure bulkhead was consumed by fire. Both engines were found in place and attached to the aft fuselage.

The vertical stabilizer, horizontal stabilizer, elevators, and rudder were found attached to the tailcone. The empennage section received fire damage and was covered with soot deposits. The horizontal stabilizer trim actuator nut screw assembly was measured at 16 11/16 inches total length, which equated to about -2.17 degrees nose down trim.

All flight controls were accounted for at the accident site. The elevators and rudder remained attached to the tail section, but control continuity could not be established. The right aileron remained attached to the right wing, and the left aileron remained attached to the outboard section of the left wing. Aileron control continuity could not be established.

The inspection of the inboard bays of the left and right wing center-section fuel tanks revealed that they received little or no fire damage. Internally, the inboard bays were clean and exhibited no effects from heat or mechanical damage. No contamination or corrosion was found in the inboard bays of the center-section fuel tanks, the jet pumps or boost pumps. The inboard fuel probes exhibited no anomalies. The left wing sump push-to-drain valve received impact damage. The left wing defuel valve was found undamaged and in the open position. The right wing sump push-to-drain valve received impact damage. The right wing defuel valve was found in the closed position.

The pneumatic system of the aircraft was inspected and no pre-impact anomalies were evident. The inspection of the bleed air flow control valve assembly revealed that it had received fire damage. No outward bulging was associated with the cracks found on the assembly.

A Federal Aviation Administration fire specialist inspector examined the airplane wreckage for evidence of an in-flight fire. He reported, "No evidence of an in-flight fire was observed on any area of the wreckage. The aft side of the vertical stabilizer had several production openings (small circular holes) adjacent to the leading edge of the rudder. An in-flight fire in the tail cone area would have likely produced soot trails from these openings and corresponding soot deposits on the leading edge of the rudder. These were not observed. The inside of the tail cone was sooted and much of the remaining aircraft structure was heavily damaged consistent with a post crash fuel fed fire."

The inspection of the engines revealed that both engine inlets and nacelles had been consumed by fire. The bleed air valves were open on both engines. There was no evidence of uncontainment on either engine. The oil tanks were melted and empty on both engines. All accessory drive shafts were intact. Both compressor inlets showed some dirt and vegetation was ingested. Both compressor sections had dirt and vegetation in the first compressor stages, but no clogging was evident at the compressor outlet guide vanes (OGV). The compressor blades did not exhibit soft-body damage.

There was no evidence of bird ingestion (feathers, tissue, bones) on the inlet guide vanes (IGV) or in the compressor, combustion, or turbine sections of the engines. Inspecting the compressor vanes under a black light showed traces of green colored luminescence (indicates organic material) on the 1st stage compressor rotor blades of the left engine, but not on the right engine. There was no significant luminescence from the black light on the high-pressure compressor (HPC) rotors and stators on either engine. Some burned residue was found in the right engine's high-pressure turbine (HPT) nozzle 1 shroud. The burned residue from the HPT nozzles and specimen swipes taken from the 1st stage compressor blades were sent to the Smithsonian Institution for examination.

Both combustor sections of the engines exhibited no defects. There was no evidence of over-temperature in the turbine sections of either engine. The accessory sections of both engines received fire damage. The fuel controls from both engines received fire damage, and were sent to Kansas Aviation of Independence (KAI), Kansas, for teardown inspections.

The GE Engine Disassembly report stated, "No evidence of internal component failure in either engine was observed." (The GE Engine Disassembly Report is in the docket material associated with this case.)

TESTS AND RESEARCH

Fuel samples were taken from the fuel truck that fueled N77JL prior to the accident and were sent to a laboratory for analysis. The chemical analysis of the fueled revealed that there were no "deviations of any consequence from published specifications for this type of aircraft fuel."

The two fuel controls and two fuel pumps were inspected at KAI in December 2003. The fuel controls and fuel pumps were disassembled as far as possible with the tools available. Due to the severely fire damaged assemblies, the units were further disassembled at GE Aircraft Engines, Lynn, Massachusetts, in February 2004.

The GE Aircraft Engines Report No. R2003AE494 stated the following information:

"No evidence of fuel control or pump malfunction was found and no signs of bird remains were seen on any of the components in this investigation. The control and pumps were not capable of performing bench testing, however, all of the pump hardware, control linkages, valves, servos, and filters were found

fully intact and normally positioned/connected as required. The pump and control fuel filters were found to be fully intact and mostly clear of contamination but with signs of white residue in the main flow path section of the filters. All of the control and pump damage appears to be the result of impact with the terrain, charred and burnt from post impact fire, and affected by the use of the extinguishing foam and outdoor weather environments."

The GE Report further stated:

"The RH [right hand] Control with the cam found at 60 percent position [engine speed] also was found with the stopcock off its seat (stop cock open). The LH [left hand] control unit with the cam at the 22 percent position [engine speed] was found with the stopcock in the closed position.

The GE Aircraft Engines Report No. R2003AE494 is in the docket material associated with this case.

The Vehicle Performance Division of the NTSB produced a Sound Spectrum plot from the CVR recording. The sound spectrum plot was based on 100 percent engine speed being equal to 16,500 rpm, which was equivalent to 275 Hz. A comparison of the CVR transcript events with the Sound Spectrum plot indicated the following:

At 0641:26, the CVR indicated a "sound similar to increase in engine RPM." The corresponding time on the sound spectrum plot indicates a steadily increasing rise in engine RPM until it stabilizes at 92 percent engine RPM.

At 0642:01, the CVR indicated that the copilot stated, "rotate." The corresponding time on the sound spectrum plot indicates engine RPM at 92 percent engine RPM.

At 0642:19, the CVR indicated a "sound similar to decrease in engine RPM" and a "sound of thump." The corresponding time on the sound spectrum plot indicates the engine RPM on both engines starts to decrease, but the engine RPM from the two engines split into two different operating ranges.

At 0642:24, the pilot stated, "hit a bird." The corresponding time on the sound spectrum plot indicates the engine RPM on one engine (labeled engine A) dropped to about 85 percent and then stabilized at about 83 percent, or at a corresponding harmonic frequency, until the CVR recording stopped.

The sound spectrum plot of the other engine (labeled engine B) indicated that about 2 seconds after the "thump," it decelerated to 88 percent engine speed for about 7 seconds. Then over the next 5 seconds it decelerated from 88 percent to about 73-76 percent engine speed. For about the next 11 seconds, the engine speed remained within the 73-76 percent range. Over the next 5 seconds the engine speed decelerated to about 49 percent speed, and it remained stabilized at this speed until the end of the CVR recording. Forty-nine percent engine speed corresponds to a flight idle engine speed.

At 0642:28, the CVR indicated a "sound similar to landing gear warning horn." The corresponding time on the sound spectrum indicated the engine speed on engine B was decelerating through about 70 percent engine speed. In the Learjet 24D, when the thrust lever on the power quadrant is pulled aft of the 70 percent N setting, the landing gear warning horn sounds.

At 0643:05, the CVR indicated a "sound similar to yaw damper disconnect tone." The sound spectrum indicated engine A was at about 83 percent engine speed, or at a corresponding harmonic frequency, and the engine B was at about 49 percent (flight idle).

At 0643:16, the CVR indicated a "sound similar to stick shaker starts and continues to end of recording" at 0643:30. The sound spectrum indicated the engine speeds remained stabilized at about 83 percent, or at its harmonic frequency, on engine A, and engine B stabilized at about 49 percent.

Learjet Inc. performed a Flight Profile Analysis for N77JL, which was reviewed and accepted by the NTSB National Resource Specialist for Aircraft Performance. The analysis was conducted in order to determine the probable operating status of both engines prior to the forced landing. The Flight Profile Analysis stated the following:

"The CVR data ... indicated that both engines were steady at 92 percent during the takeoff roll, rotation and initial climb. Approximately 17 seconds following rotation, the CVR recorded a "thump", after which time the activity of one engine appeared conclusive from the CVR, ultimately ending with that engine at flight idle, but the other engine activity was non-conclusive, with three possible scenarios:

Scenario #1: The "thump" was a violent stall which flames out the engine to about 14 percent wind-milling speed.

Scenario #2: The engine decelerated to about 83 percent speed, equaling 1000 lbs net thrust.

Scenario #3: The engine decelerated to about 55 percent speed, corresponding to just above flight idle thrust."

The conclusion derived from the Flight Profile Analysis was as follows:

"Based on the data shown, it appears extremely improbable that the unknown engine was rotating at 83 percent (Scenario #2) following the CVR "thump". It also appears that Scenario #3, with the unknown engine at just above idle thrust, is improbable. Scenario #1, with the unknown engine flaming out at the CVR "thump" and wind-milling through the remainder of the profile, is most likely, based on the flight profile derived from the known constraints."

The Learjet Inc. Flight Analysis Profile, L706-07-04-396, dated July 9, 2004, is in the docket material associated with this case.

The burned residue from the HPT nozzles and specimen swipes taken from the 1st stage compressor blades were sent to the Smithsonian Institution, Division of Birds, for examination. The Smithsonian report stated, "An examination of the material using light microscopy did not reveal any bird remains present in the samples." The Smithsonian Institution letter, dated December 9, 2003, is in the docket material associated with this case.

The Wildlife Services of the Unites States Department of Agriculture (USDA) had been conducting wildlife surveys at the St. Louis Downtown Airport (CPS) since May 2003. The survey revealed that 565 European starlings were counted on October 21; 35 European starlings were counted on October 23; and 163 European starlings were counted on November 4. A wildlife specialist was sent to CPS on November 14, 2003, in response to the Learjet 24D accident and a report of a possible bird strike. A letter from the USDA Wildlife Services to the NTSB stated the following:

"On 11/14/03, Wildlife Specialist [specialist's name] traveled to St. Louis Downtown Airport to look for bird carcasses that could have been the result of a strike incident on the overrun area of runway 12R and two agricultural fields on the departure pattern of runway 12R. No bird carcasses were found. Airport officials indicated they had already checked along the runway for evidence of a bird strike, finding none. On the day of the visit, [specialist's name] saw a large flock (approximately 800 birds) of European starlings." The letter from the USDA Wildlife Services, dated December 17, 2003, is in the docket material associated with this case.

GE Aircraft Engines conducted a CJ610 Bird Ingestion Test (No. - TM-61-657, November 15, 1961) as part of the original engine certification tests required by the Federal Aviation Administration. The report provided the results of sea level static bird ingestion test on the CJ610 Engine. The test procedures and results are summarized below:

1. CJ610 bird ingestion testing conducted in Lynn, MA, during October 1961 (sea level)

- A single 2-4 oz starling was fired into the engine six times.

- Throttle was set at maximum takeoff power each time.

2. Engine response in each case was typically as follows:

- Engine stalled to idle in 3-4 seconds.

- Recovered to 55-66 percent N and then stalled and recovered every 3-4 seconds.

- Stalls cleared when throttle chopped to idle after 20-25 seconds.

- Stalled again when throttle pushed to about 87 percent N (about 50 percent thrust).

3. Post shot inspection revealed engine damage to be as follows:

- No damage at 136 mph bird speed.

- Two stage 1 blades twisted at 80 mph bird speed (blades replaced).

- At about 200 mph bird speed, the damage from 4 birdshots was minor:

- One stage 1 blade had a small 1/8 inch long bend at leading edge tip.

- One more stage 1 blade slightly bent.

- No new physical damage; but excessive accumulation of 'dirt' from previous birdshots.

- One stage 1 blade with sight trailing edge tip curl.

4. GE report (TM-61-657) did not document amount of bird debris found in engine after each bird strike.

- MINOR OR NO DAMAGE TO RECOVERABLE ENGINE.

5. Conclusions and Recommendations from the 1961 GE report:

- Physical damage from bird and seagull ingestion was very slight due to the all steel construction and geometry of the CJ610 rotor, stator and front frame.

- Flameouts were not encountered and exhaust gas temperature remained within transient limits at all times.

- With proper throttle movement, 50 percent power can be obtained after a bird ingestion.

GE Aircraft Engines provided the NTSB a statement, dated 13 April 2004, that concerned the impact of "Simulated Bird Blockage" on CJ610 engines stall and recovery. The person who provided the information for the report was a recently retired GE engineer. He reported, "Unfortunately, the documents describing the results of this testing are not readily available. However, in my role as a GE Lynn engine operability engineer from 1973 until February 2004, I am familiar with the essential features of this testing and the lessons learned. Here are my recollections of test results that may be useful in the on-going analysis review of a recent CJ610 powered aircraft loss." The report stated:

"Relatively soon after the CJ610 engine was put into commercial service, bird ingestion incidents raised questions on the engine's thrust response or operability during take-off after bird ingestion. The impact of bird ingestion on CJ610 mechanical integrity was not an issue." He continued, "A unique test configuration was developed to simulate the airflow blockage created during a bird ingestion event and to evaluate the response of the CJ610 engine in a factory test environment. The objective of this testing was to identify the impact of simulated bird blockage and inlet distortion of CJ610 stall and stall recovery that played a dominant role in determining engines thrust response."

The engineer reported that, "a simple flat plate positioned near the engine face was used to simulate the flow blockage of a bird. The transient nature of bird ingestion flow blockage distortion could be investigated by varying the duration of this blockage with an actuation system that rotated the flat plate for specified time intervals." He further stated, "Two key test variables in this investigation were the size of the flat plate "flapper vane" used to simulate bird blockage and the time duration of the flow blockage." He reported the results of the tests as follows:

#1) High power surges can be expected for practically all flow blockage cases tested. The impact of the bird blockage distortion close to the engine face has a far greater adverse impact on the stall line that would be forecast from conventional testing with inlet distortion screens.

#2) The recovery from the simulated bird distortion is quite dependent on the duration of the blockage. The CJ610 will continue to surge as long as the blockage is present. Each surge drives the engine RPM to a lower value. After a sufficient number of surges the engine will not self-recover. This can be expected when engine corrected speeds are driven down into the compressor rotating stall region.

#3) For a normal engine at sea level, the stalls would not be expected to result in a combustor flameout. Surges above 20,000 ft altitude can be expected to result in a combustor flame-out. The presence of bird matter in the flow path can be expected to increase the likelihood of a flame-out but the extent of this effect is not well documented.

The GE Aircraft Engines statement, dated 13 April 2004, is in the docket material associated with this case.

ADDITIONAL INFORMATION

The parties to the investigation included the Federal Aviation Administration, Bombardier Aerospace, and GE Aircraft Engines.

The aircraft wreckage was released to Central Air Parts, Staunton, Illinois.

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

The total loss of power to the right engine and the partial loss of power to the left engine after the airplane encountered a flock of birds during initial climb out, resulting in impeded ram induction airflow.