NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

July 17, 2001

POWERPLANTS GROUP CHAIRMAN'S FACTUAL REPORT

NTSB ID No: DCA01MA034

A. INCIDENT

Location: Aspen, Colorado

Date: March 29, 2001

Time: 1902 mountain standard time (MST)

Airplane: Grumman Gulfstream III, N303GA, Avjet

B. POWERPLANTS GROUP

Chairman: David Keenan
National Transportation Safety Board
Washington, D.C.

Member: Michael Weber
Rolls-Royce
Indianapolis, Indiana

Member: Timothy Centivany
Gulfstream
Batavia, Ohio

Member: Jeffery W. Fritz
Avjet Corporation
Burbank, California

C. SUMMARY

On March 29, 2001, at 1902 MST, a Grumman Gulfstream III, registration number N303GA, operated by Avjet Corporation, was destroyed when it collided with terrain about 0.4 miles northwest of the Aspen-Pitkin County Airport, Aspen, Colorado. The 2 flight crew, 1 flight attendant, and all 15 passengers were fatally injured. The accident site was about 100 feet above the airport elevation of 7,815 feet. The flight had arrived under Instrument Flight Rules (IFR) and had reported the airport in sight. The flight was operating as an IFR flight under 14 CFR Part 135 operations. The weather at 18:53 MST was: wind 250 degrees at 3 knots; visibility 10 miles; and light snow, few clouds at 1,500 feet, ceiling 2,500 feet broken, 5,000 feet broken. Approximately 10 minutes after the accident the visibility decreased to 1-¾miles in light snow.

The Powerplants Group's on-site examination of the engines revealed that the engines were broken off the empennage and were found side-by-side in the vicinity of the tail section. Both of the engines were intact and had not experienced any uncontainments or fires. The engines were not disassembled.

D. DETAILS OF INVESTIGATION

1.0 Engine information

1.1 Engine description

The engines were Rolls-Royce Spey Mk 511-8. The Spey is a two-shaft turbofan engine with a bypass ratio of 0.6:1 and an overall compression ratio of 19:1. It consists of a five-stage low-pressure compressor (LPC) and a twelve-stage high-pressure compressor (HPC) that are driven by a two-stage low-pressure (LPT) and two-stage high-pressure turbine (HPT), respectively. Combustion takes place in ten straight flow, interconnected combustion chambers. The engine is rated at 11,400 pounds of thrust (sea-level static, standard day) for takeoff.

1.2 Engine history

The engines were last overhauled by Dallas Airmotive (formerly Airwork Inc.) in December 1995. The engine times and cycles are indicated in the following table:

	Engine No. 1	Engine No. 2
Engine serial number	11005	11006
Time Since New	7,116.2 hours	7,562.7 hours
Cycles Since New	3,499 cycles	3,822 cycles
Time Since Overhaul	2,367.7 hours	2,367.7 hours
Cycles Since Overhaul	2,572 cycles	2,572 cycles
Time Since Midlife	2,367.7 hours	2,367.7 hours

2.0 On-site examination

2.1 Engine No.1

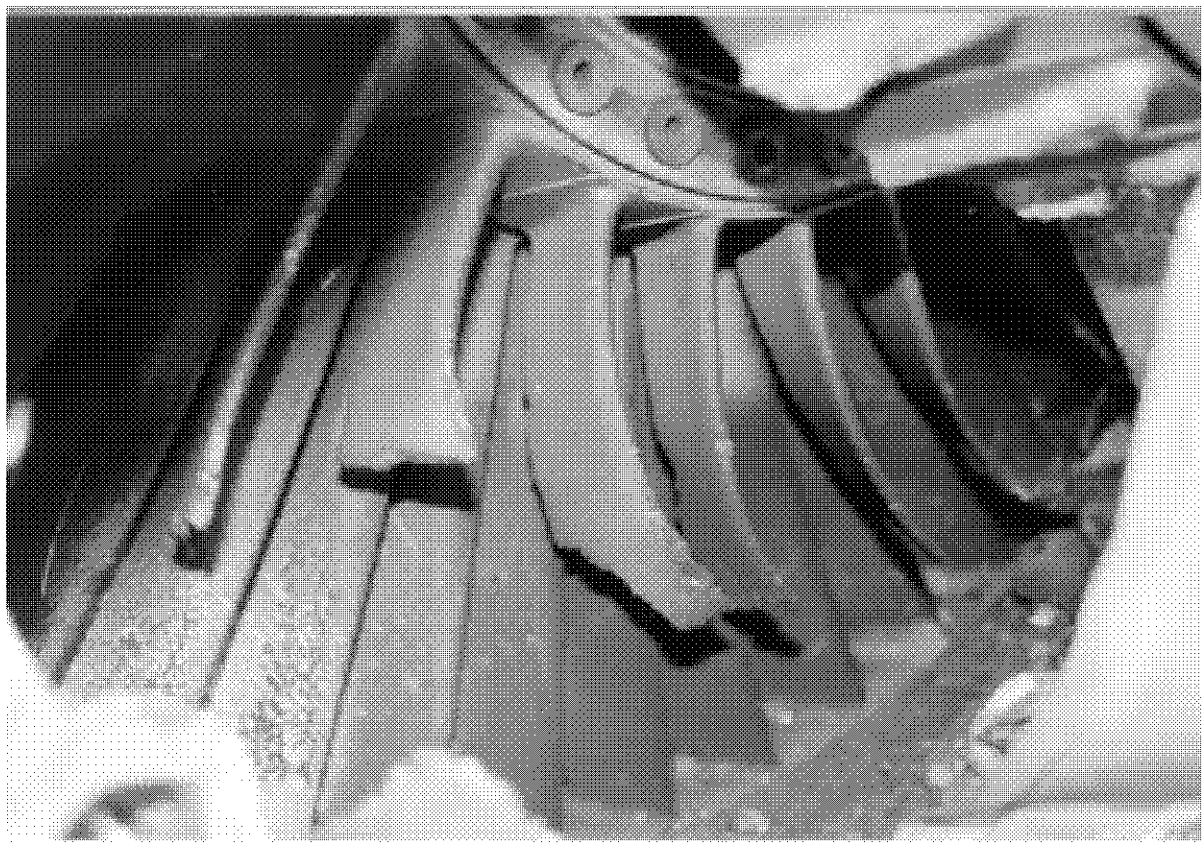
2.1.1 Compressor Section

There were no signs of any uncontainments or fires in the compressor section of the engine. The inlet and engine cowlings remained attached to the engine. The inlet was crushed from approximately 1 to 10 o'clock[1] and most of the inlet was folded closed and pushed back to the forward edge of the pylon attachment. The engine front face was crushed in between 3 and 8 o'clock. There were two inlet guide vanes (IGV) missing. Of the IGV's that remained, those in the lower half were bent and torn in the area of the mid-span. The

[1] All clock positions are as viewed from aft looking forward unless otherwise noted.

first-stage LPC blades were all broken off just above the platforms and the fracture surfaces had a rough, grainy appearance. The first-stage LPC vanes were missing between 2 and 7 o'clock and some of the remaining vanes were pulled in the direction of rotation, in the area of the mid-span. There was one second-stage LPC blade that was broken off just above the platform and the remaining second-stage LPC blades were all broken at various lengths in the outer half of their spans. All of the remaining second-stage blades had their tips curled and bent in the direction opposite of rotation. All of the second-stage LPC vanes were accounted for and were bent and torn slightly along their leading edges and heavily on their trailing edges. Some of the second-stage LPC vanes were bent in the direction of rotation in the mid-span area. All of the third-stage LPC blades were broken off in the outer third of their spans and had their tips curled and bent in the direction opposite of rotation.

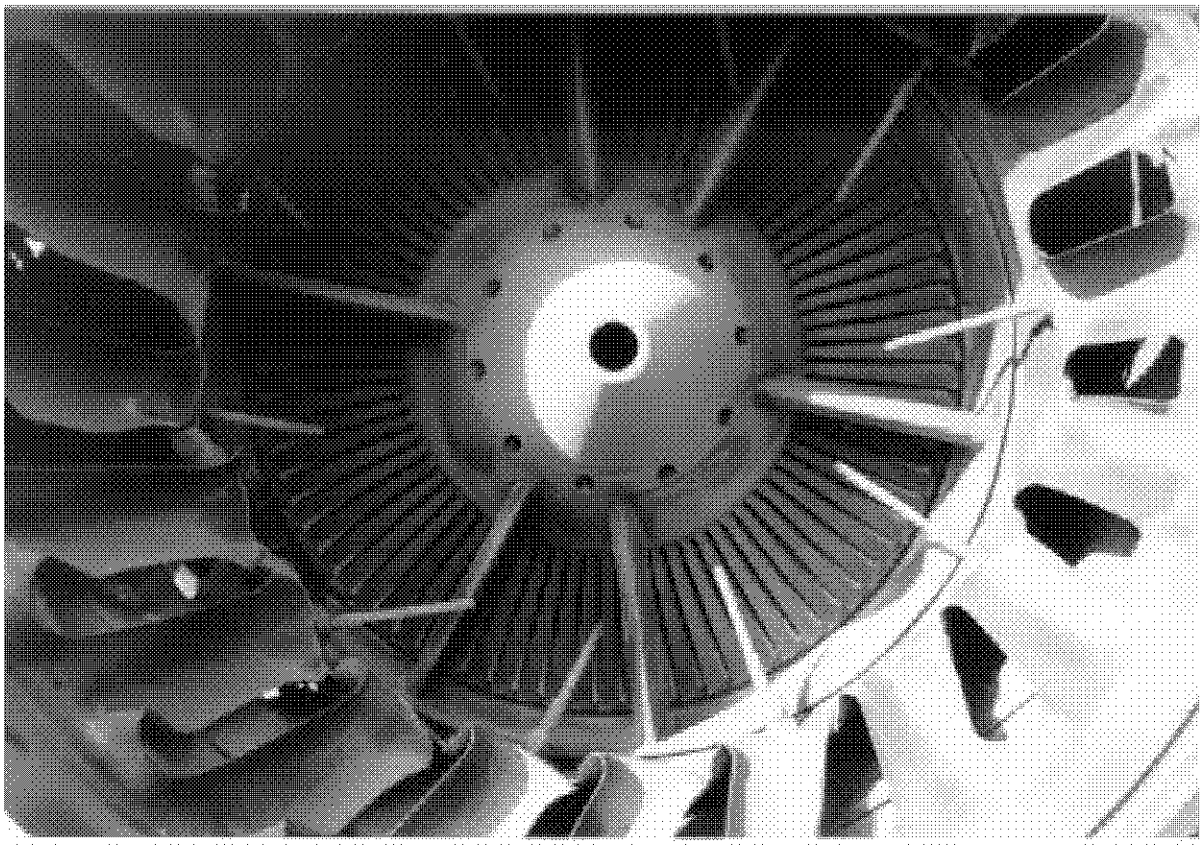
Photograph 1: No. 1 engine nose fairing and inlet guide vanes.



Photograph 2: No. 1 engine, second-stage LPC blades.

2.1.2 Turbine section

There were no signs of any uncontainments or fires in the turbine section of the engine. The second-stage LPT blades were all intact and undamaged. All of the leading edges of the blades were coated with metal spray on the outboard half of the convex side of the blade and extended out into the tip shrouds. This deposit was built-up heavier in the area of the blade fillet radius. There was metal spray on the second-stage LPT blades. All of the second-stage LPT nozzles were intact and undamaged. There was metal spray on the entire convex side of all the second-stage LPT nozzles that got progressively heavier as it progressed outward. There was metal debris in both the exhaust mixer and in the bypass duct.



Photograph 3: No. 1 engine, second-stage LPT blades

2.1.3 Exterior

The inlet, engine cowls, and thrust reverser were all still attached to the engine. The engine inlet was crushed closed and there was a ground fire underneath where the No. 1 engine came to rest. There was soot around the LPC case and back onto the forward half of the HPC case. The accessory gearbox was intact, showed no signs of any internal failure, and all accessories were accounted for with impact damage to many of the components. The thrust reverser was found in the stowed position.

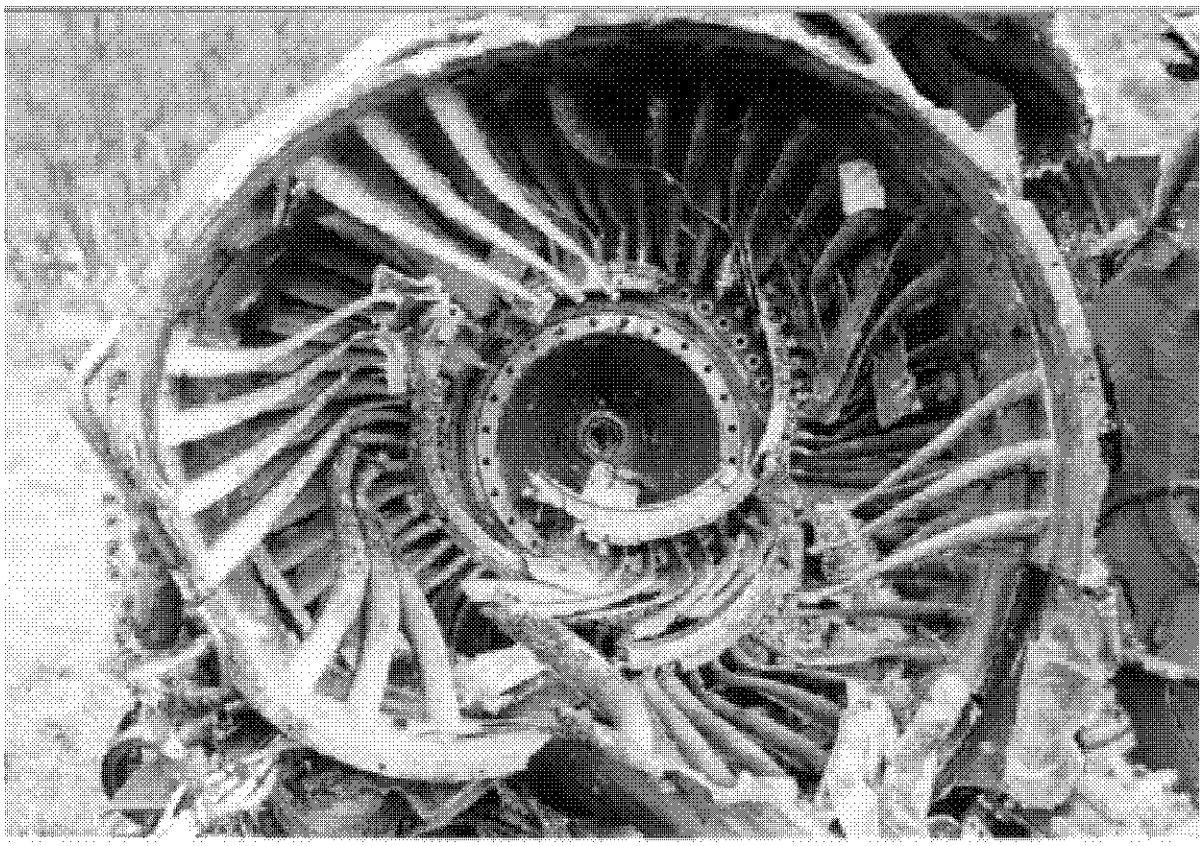
2.2 Engine No. 2

2.2.1 Compressor section

There were no signs of any uncontainments or fires in the compressor section of the engine. The inlet case and front bearing support, along with the first three stages of the LPC, were separated from the rest of the engine and came to rest approximately 15 feet from the remainder of the No. 2 engine. The IGV's were broken off between 4 and 8 o'clock and the remainder were torn on the leading edge at the spinner attachment. All of the first-stage LPC blades were broken off just above the platforms and the fracture surfaces had a rough, grainy appearance. The majority of the first-stage LPC vanes were broken off and the remaining vanes were bent, in the mid-span area, in the direction of rotation.

All of the second-stage LPC blades were broken off just above the platform and the fracture surfaces had a rough, grainy appearance. The majority of second-stage vanes were broken off and those that remained were bent in the direction of rotation. There were ten third-stage LPC blades that remained in their slots. Each of these ten blades was broken off at varying lengths from the mid-span outward and all were bent over in the direction opposite of rotation. All the other third-stage LPC blades were broken off just above the platform and their fracture surfaces had a rough, grainy appearance. The front bearing oil feed tube was still attached to the first three stages of the LPC. The mating flanges of the stage 1-3 LPC spool with the stage 4-5 spool were undamaged and the bolt holes were intact. The bolt heads remained in the stage 4 flange.

Photograph 4: No. 2 engine, LPC stages 1 – 3



Photograph 5: Engine No. 2, stage-two and stage-three stator vanes

2.2.2 Turbine section

All of the stage-two LPT blades were intact and undamaged. There was light metal spray on the outboard convex side of each of the blades. All of the second-stage LPT nozzles were intact and appeared undamaged. There was heavy metal spray on the entire length of the convex side of each of the second-stage LPT nozzles. The exhaust cone and exhaust support struts were all intact.

Photograph 6: No. 2 engine, second-stage LPT blades

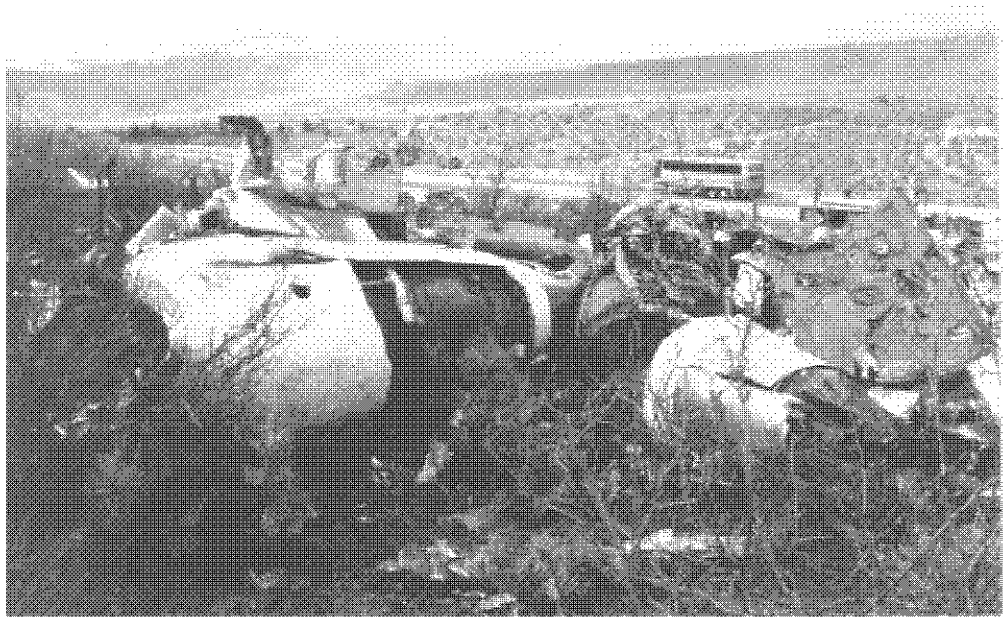
2.2.3 Exterior

The inlet was broken off of the engine forward face. The LPC case was intact with one, 5 inch by 5 inch, puncture at 2 o'clock, in the plane of the second-stage LPC blades. The compressor intermediate case was intact. The HPC and the diffuser cases were intact. The turbine case was intact and the thrust reverser was broken off the exhaust case. The thrust reverser was intact and in the stowed position. The accessory gearbox was intact, showed no signs of any internal failure, and all accessories were accounted for, with impact damage to many of the components.

3.0 Wreckage distribution

The wreckage was distributed over a southeast heading for approximately 325 feet. The engines came to rest side-by-side, just over the southern ridge of a 70-foot gully, 250 feet from the initial ground contact point.

For more information, refer to Federal Bureau of Investigation Crash Scene documentation, Appendix A.



Photograph 7: No. 1 engine on left, No. 2 engine on right. (View looking north)

4.0 Cockpit Voice Recorder Sound Spectrum Analysis

A sound spectrum analysis (SSA)[2] of the last six minutes of the cockpit voice recorder's cockpit area microphone (CAM) was conducted to record the engines rotor speeds. The SSA recorded a signature in the lower frequency range, which varied between 260 Hz and 510 Hz. A review of engine frequencies discovered that the engine-driven hydraulic pump, which operates between 1,673 and 3,276 revolutions per minute (RPM), is a nine element pump capable of producing frequencies 260 Hz to 510 Hz range. Each revolution of the hydraulic pump produces nine pressure pulses in the hydraulic system. Using a signature of 260 Hz[3], which, when correlated to the hydraulic pump, yielded an engine speed of approximately 52.9% N_2[4]. Using this correlation, the last six minutes of the CAM recording show engine speeds ranging from 53% to 102% N_2 (Appendix B).

For the landing at Aspen, the final six minutes of the CVR commenced at 1856:00 MST,[5] as the airplane was descending on final approach with the engines speeds decreasing through 84 percent N_2. The engine speeds continued to decrease until they stabilized at 71 percent[6] N_2 at 1857:40. At 1857:40, the engine speeds decreased to 53 percent[7] N_2 and then

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[2] A sound spectrum analysis is a procedure that can record audio frequencies, which may be inaudible to the human ear.

[3] The frequency of the hydraulic pump at idle is determined by taking the idle RPM of the hydraulic pump (1673), multiplied by it's nine elements, and divided by 60, to obtain the pressure pulse frequency of the pump in cycles per second (Hz).

[4] N_2 is the rotational speed of the high-pressure spool in a gas turbine engine.

[5] The DFDR data was correlated to local time through the cockpit voice recorder and air traffic control communication tapes.

[6] For the GIII airplane, seventy-one percent N_2 is flight idle.

increased to 54 percent N_2 at 1858:10. The engine speeds[8] increased to 79 and 80 percent N_2 at 1858:50, and decreased back to 53 and 54 percent N_2 at 1859:20. At 1900:30, the engine speeds began to increase reaching 82 percent N_2 at 1900:35, increased again to 84 percent N_2 at 1900:40, and then decrease at 1900:45, reaching 55 percent N_2 at 1901:00. At 1901:40, the engine speeds increased to 73 and 76 percent N_2, and further increased at 1901:50, reaching 102 percent N_2 at 1901:58, the end of the CVR tape.

Dave Keenan
Powerplants Group Chairman

Appendix A: Crash Scene, Aspen, Colorado prepared by the Federal Bureau of Investigation
Appendix B: Engine Speed Plots (% N_2)

[7] For the GIII airplane, fifty-three percent N_2 is ground idle.
[8] While the SSA can detect the presence of two distinct engine speeds, it cannot differentiate between them.