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

November 1, 2013

POWERPLANT GROUP CHAIRMAN'S FACTUAL REPORT

NTSB No: ERA13MA139

A. ACCIDENT

Location:	Thomson, Georgia
Date:	February 20, 2013
Time:	2006 Eastern Standard Time (EST)
Aircraft:	Beechcraft 390 Premier 1A, Registration No. N777VG

B. POWERPLANTS GROUP

Group Leader:	Robert Hunsberger National Transportation Safety Board Washington, DC
Member:	J. Chris Greene Williams International Commerce Township, Michigan
Member:	Troy Lewis Williams International Commerce Township, MI
Member:	Ernest Hall Beechcraft Aircraft Corporation Wichita, Kansas

C. SUMMARY

On February 20, 2013, at 2006 Eastern Standard Time (EST), a Beechcraft 390 Premier 1A, N777VG, was destroyed following a collision with a utility pole, trees, and terrain following a go-around at Thomson-McDuffie Regional Airport (HQU), Thomson, Georgia. The airline transport-rated pilot and co-pilot were seriously injured, and five passengers were fatally injured. The airplane was registered to the Pavilion Group LLC and was operated by the pilot under the provisions of *14 Code of Federal Regulations Part 91* as a business flight. Night visual meteorological conditions prevailed, and an instrument flight rules flight plan was filed. The flight originated at John C. Tune Airport (JWN), Nashville, Tennessee, at about 1828 central standard time (1928 EST).

The engines were recovered and shipped to Williams International in Commerce Township, Michigan for inspection and disassembly. The No.1 (left) engine exhibited extensive impact deformation and was received in two sections, split at the interstage case flange, aft of the intermediate pressure (IP) compressor. The fan blades had tip bending opposite the direction of rotation and the low pressure turbine (LPT) shaft was twisted, consistent with a sudden stoppage due to impact.

The No. 2 (right) engine was received intact and components including the fan, IP compressor, high pressure compressor (HPC), high pressure turbine (HPT) and LPT all exhibited blade tip rubs with corresponding case rubs consistent with rotation at the time of impact. The accessory gearbox (AGB) tower shaft was sheared and impact damage was noted to the fuel pump and oil lube and scavenge pump.

D. DETAILS OF THE INVESTIGATION

1.0 ENGINE INFORMATION

1.1 ENGINE HISTORY

The most recent available history for engine serial numbers (ESN) 105327 and 105326 was collected on 31 January 2013 by Williams International. The engines were enrolled in a maintenance program where operators are required to report engine hours and cycles monthly. The engines had accumulated the following hours and cycles since new as of the last report.

Engine Serial Number (ESN)	105327 (No. 1)	105326 (No. 2)
Time Since New (TSN)	656.2 hours	615.4 hours
Cycles Since New (CSN)	759	714

Table 1 - Engine History

The No. 2 engine, ESN 105326, was removed from the airplane on 21 August 2012 and returned to a Williams International repair station to correct a high oil consumption issue. During the repair all engine main shaft bearings and carbon seals were replaced. A rental engine was installed and accumulated 40.8 flight hours and 45 cycles before the original engine was reinstalled following repairs.

1.2 ENGINE DESCRIPTION

The accident airplane was powered with two Williams International FJ44-2A turbofan engines. The FJ44-2A engine is a twin spool turbofan with a single-stage fan, a three-stage axial IP compressor, a single-stage centrifugal HPC, an annular combustor, a single-stage HPT, and a two-stage LPT.

According to the FAA Type Certificate Data Sheet, EG3L- Revision 18, dated March 13, 2013, the FJ44-2A engine has a maximum thrust rating of 2,300 pounds flat rated[1] at 59^{o}F and a maximum continuous thrust rating of 2,300 pounds flat rated at 72^{o}F.

All directional and clocking references are from pilot's view, aft looking forward (ALF). An engine diagram with flange location labels is provided in (**Figure 1**).

[1] Flat-rated to a specific temperature indicates that the engine will be capable of attaining the rated thrust level up to the specified inlet temperature.

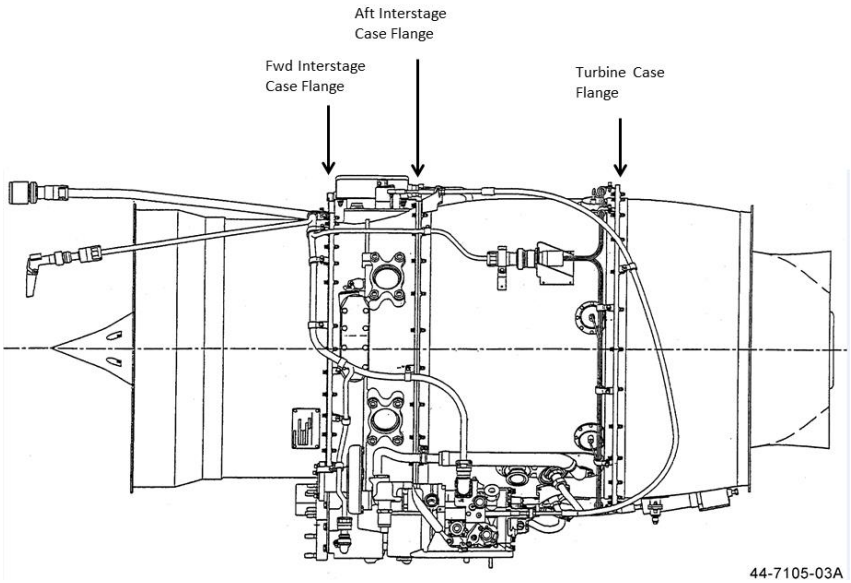

Figure 1- FJ44-2A Engine Flange Diagram

2.0 WILLIAMS INTERNATIONAL FJ44-2A ESN 105327 (NO. 1 ENGINE)

2.1 AS-RECEIVED

The engine was uncrated and exhibited extensive impact damage but there were no indications of under cowl fire or uncontainment. The engine core was received split in two separate sections at the forward interstage case flange and the LPT shaft was sheared (**Photos 1, 2 and 3**). The forward section consisted of the fan and IP compressor assemblies. The aft section included the HPC impeller assembly aft to the exhaust mixer lobes. The AGB and attached accessories including the starter, fuel-oil cooler and oil lube pump were separated from the AGB mount pad, but remained tethered to the engine by wiring harnesses. The hydromechanical unit (HMU) and fuel pump were separated from the engine but also remained tethered by wiring. The rear bypass duct was not shipped with the engine.

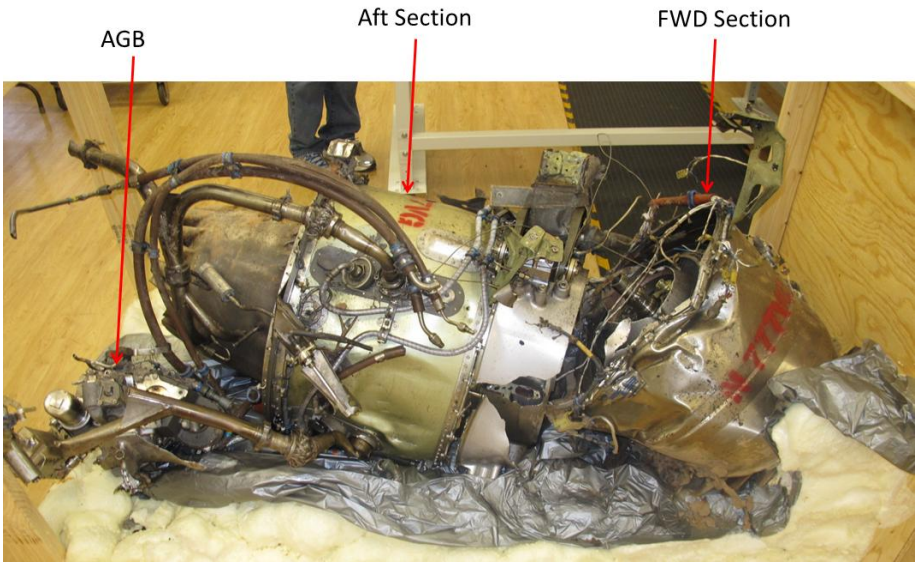

Photo 1- Right Side of Engine, as Received

Photo 2- Left Side of Engine, as Received

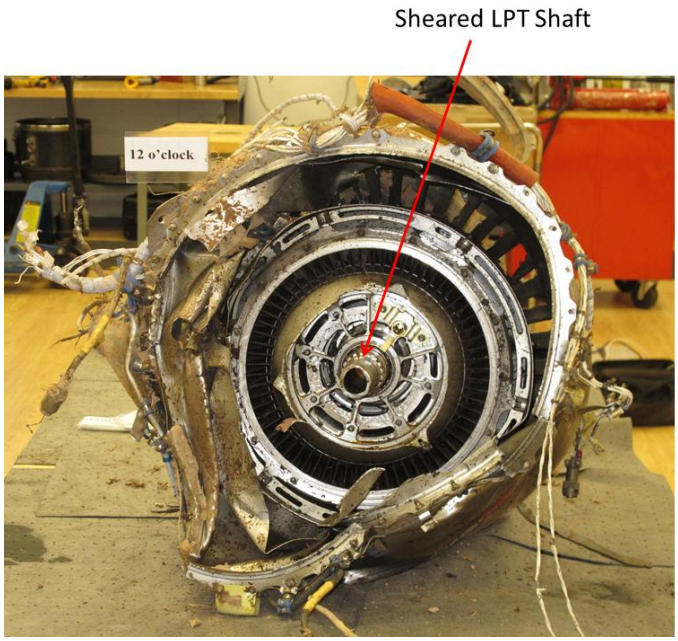

Photo 3- Rear IP Compressor Assembly, Sheared LPT Shaft

The fan exhibited blade tip bending opposite the direction of rotation with multiple blades fractured near the root.[2] The fan blades were coated with debris including dirt and airframe honeycomb material. The case and insert assembly that surrounds the fan was compacted and torn in the aft direction from 6 to 11 o'clock with shredded wood fibers wedged between the case and compressor (**Photo 4**).

Photo 4- Fan Damage, Organic Debris Lodged Between Fan and Compressor Case

The engine cases exhibited varying degrees of deformation and tearing around the engine. The interstage case was intact from 2 to 5 o'clock and at 7 o'clock with the remainder of the case separated and missing.

[2] The Williams International FJ44-2A engine features a blisk design fan where the disk and blades are a single piece machined from a titanium forging.

2.2 DISASSEMBLY

2.2.1 Compressor Assembly

The 1st stage compressor stator vanes exhibited leading and trailing edge tearing 360 degrees around, with vanes separated from 3 to 8 o'clock (**Photo 5**). The assembly was covered with a thick coating of dirt and debris. The stator center hub was ovalized consistent with a hard impact.

Photo 5- Compressor Fan Stator Assembly

The IP compressor rotor had impact damage and tearing on all 1st stage blades. The IP compressor rotor blade tips and compressor spool had rub marks with corresponding rub marks on the stator lands and vane tips. The IP compressor was covered in debris and wood fibers throughout all stages (**Photo 6**).

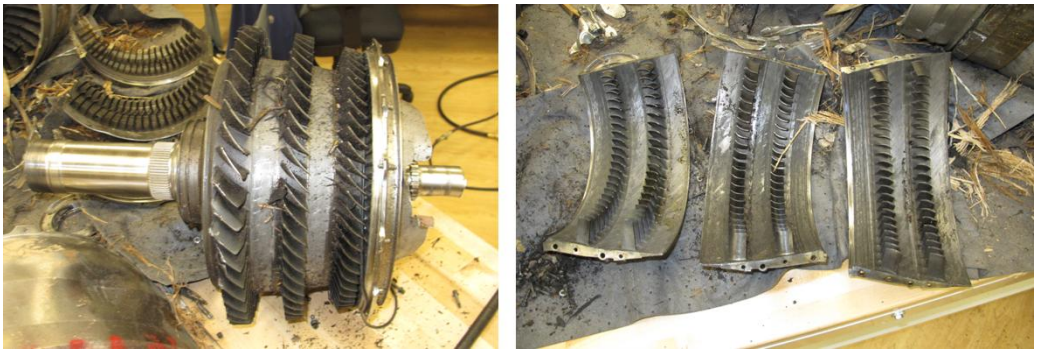

Photo 6- IP Compressor Rotor and Stators

The HPC impeller was not separated from the interstage case housing due to damage to the high pressure nut. The HPC impeller exhibited leading edge vane tearing 360 degrees around.

2.2.2 Accessory Gearbox and Components

The AGB tower shaft that provides drive power from the engine to the AGB was sheared just above the lower spline. The powerplants team decided not to further disassemble the AGB or accessories due to a lack of evidence that they were a causal factor in the accident.

2.2.3 Combustor Assembly

The combustion nozzle assembly and cover were intact but discolored consistent with debris ingestion and water submersion. The diffuser inner wall was buckled at 6 o'clock and water was pooled in low spots of the diffuser case (**Photo 7**). The fuel slinger system was intact and in good condition. The electrode depth was measured on the right and left igniter plugs in accordance with the Williams International FJ44-2A line maintenance manual and determined to be within serviceable limits. Due to impact damage, the igniter plugs had to be cut out of the engine so a spark check could not be performed.

Photo 7- Combustor Assembly

2.2.4 High Pressure Turbine Assembly

The HPT and nozzle assembly were both intact and covered in dirt and debris. The HPT 1st stage blade tips exhibited rub 360 degrees around consistent with turbine case contact.

2.2.5 Low Pressure Turbine

The LPT 1st and 2nd stage rotor and nozzle assemblies were intact. All components in the assembly were covered in dirt and debris. The aft section of the LPT shaft was removed from the engine (front half sheared) and exhibited twisting (**Photo 8**). The direction of shaft twist was consistent with a sudden stoppage of the fan.

Photo 8- LPT Shaft Twisting (Part Etching Should Be Straight)

3.0 WILLIAMS INTERNATIONAL FJ44-2A ESN 105326 (NO. 2 ENGINE)

3.1 AS-RECEIVED

The engine was uncrated and airframe components were removed to facilitate installation into a maintenance stand (**Photos 9 and 10**). The exterior of the engine exhibited no indications of under cowl fire or uncontainment.

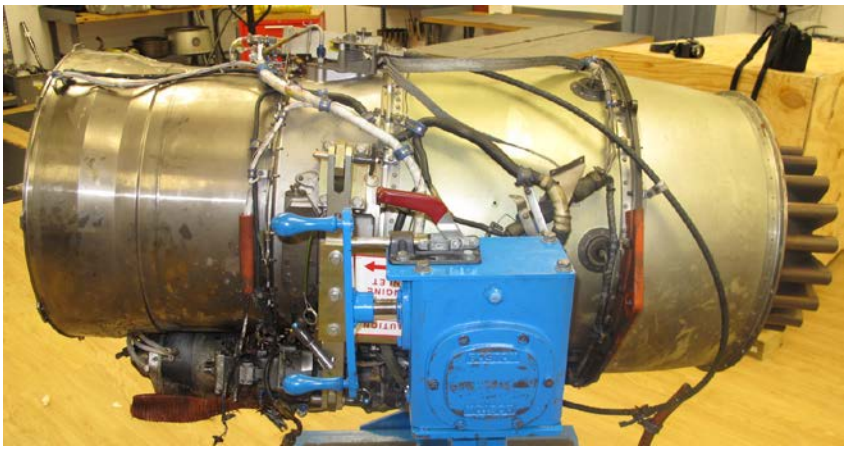

Photo 9- Left Hand Side of Engine with Airframe Components, Exhaust, and Inlet Cases Removed

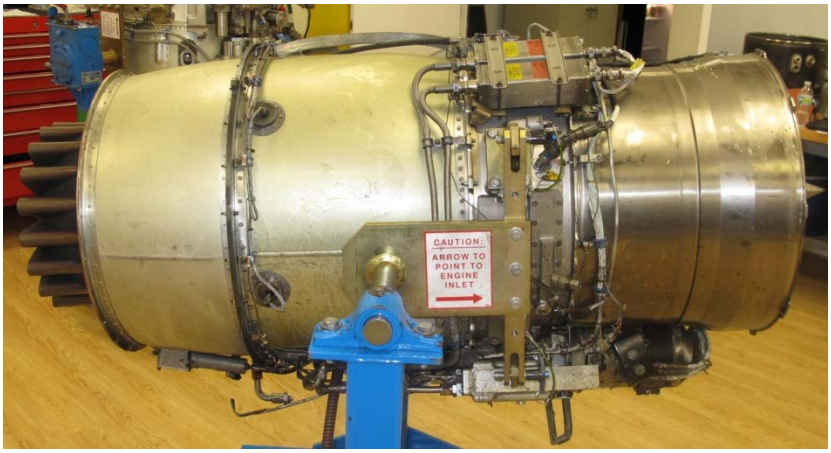

Photo 10- Right Hand Side of Engine with Airframe Components, Exhaust, and Inlet Cases Removed

During a visual inspection of the compressor inlet, organic debris and composite material remnants were seen behind the fan, into the rear stages of IP compressor. Multiple compressor fan blades had foreign object impact damage along the leading edge. The fan case abradable coating was rubbed and/or gouged around the case circumference, consistent with fan blade contact (**Photo 11**).

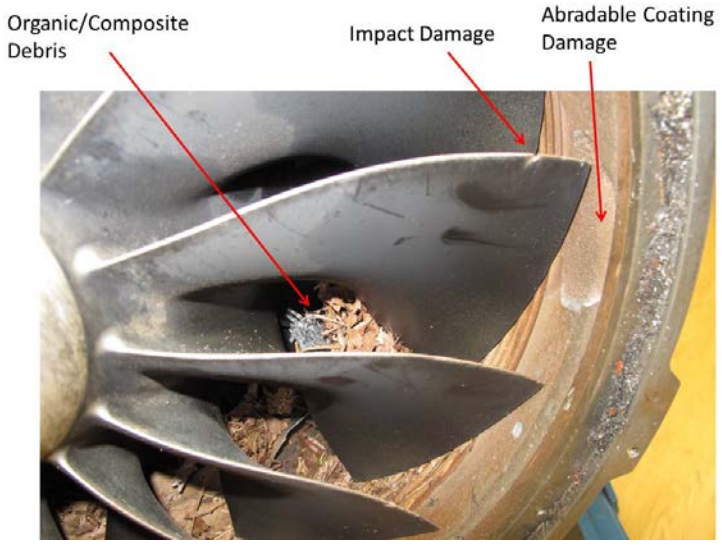

Photo 11- Compressor Inlet Fan Damage

The interstage case housing exhibited an open split fracture that transitioned into a series of cracks at approximately the 6 o'clock position. The fracture allowed the AGB to partially pull away from the engine (**Photo 12**). The forward bypass duct also exhibited impact damage at 6 o'clock causing inward buckling of the duct case.

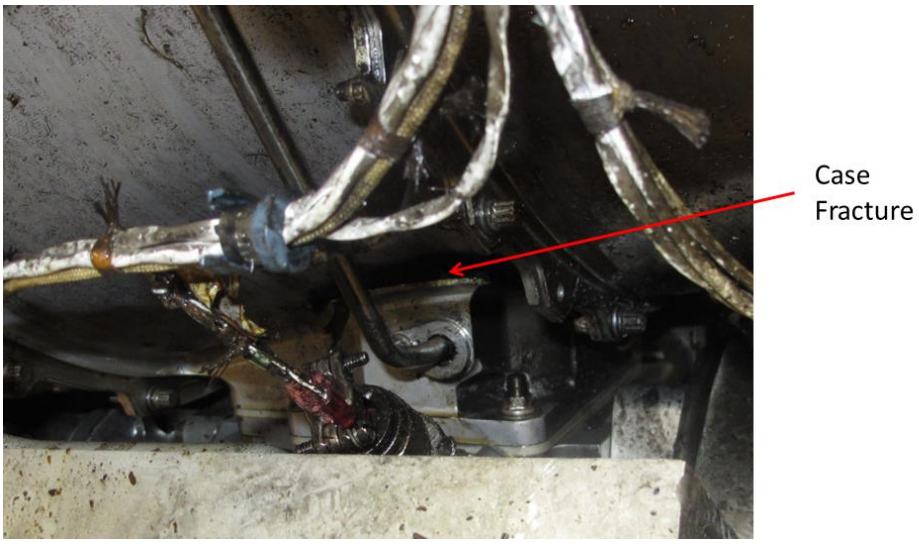

Photo 12- Interstage Case Split Fracture

The exhaust mixer lobes and rear housing (center body) were intact but heavily sooted. Loose organic debris was noted in the bottom of the aft bypass duct.

Continuity of the LPT shaft was confirmed by spinning the fan and observing rotation of the LPT. The fan spun smoothly without binding.

The magnetic chip detector plugs were removed and inspected for metal accumulation. The gearbox magnetic chip detector plug had accumulated a buildup of metal shavings. The scavenge and tank drain magnetic chip detector plugs were both clean. The oil filter element assembly did not contain debris or blockages.

3.2 DISASSEMBLY

3.2.1 Compressor Assembly

The fan was removed and exhibited blade tip rub 360 degrees around. The 1st stage compressor stator had discoloration on both the vane pressure and suction sides that was easily removed with a cloth and light pressure. The inner diameter of the fan stator hub was unevenly worn and air seal rubber material was shredded (**Photo 13**).

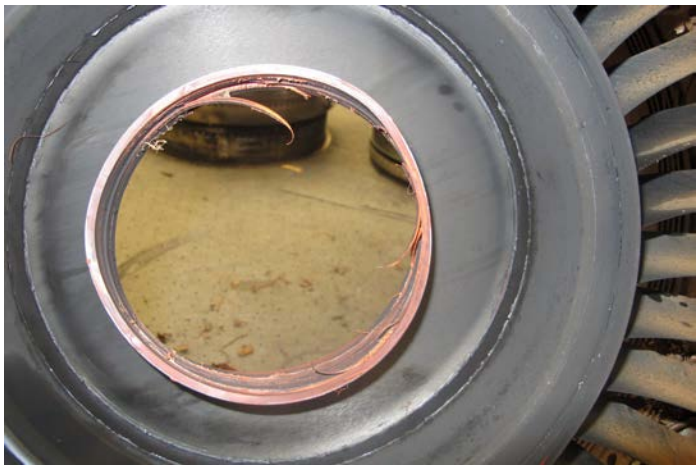

Photo 13- Compressor Fan Stator Inner Diameter

The IP compressor was intact but exhibited rubs on the compressor rotor blade tips and spool with corresponding rub marks on the compressor stator lands and vane tips (**Photo 14**). All stages of the IP compressor were coated with a layer of dirt and debris. The No. 1, 1 ½ and 2 bearings were all oil wetted and spun freely.

Photo 14- IP Compressor Rotor and Stator Rubs

The HPC impeller exhibited blade tip rubs 360 degrees around. The impeller cover had a rub from 5 to 8 o'clock consistent with impeller contact (**Photo 15**). The location of the damage on the impeller cover was coincident with the damage noted on the interstage case.

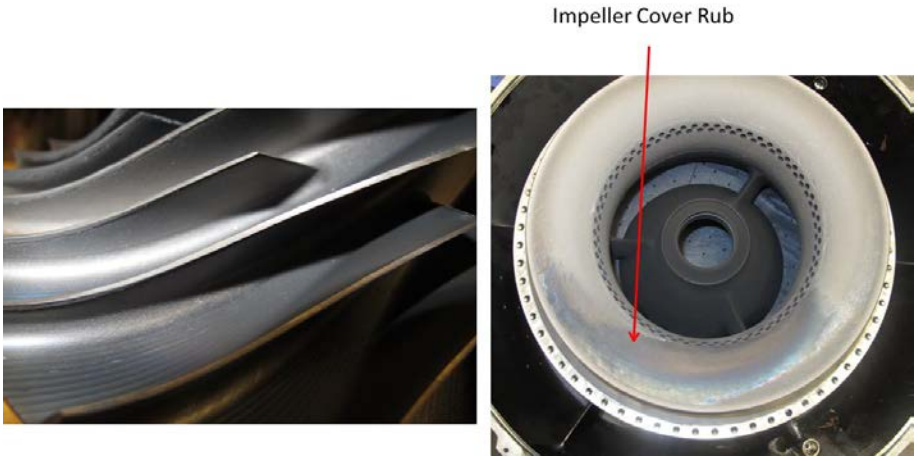

Photo 15- Centrifugal Compressor Impeller and Cover Rub

3.2.3 Accessory Gearbox and Components

The AGB tower shaft was sheared and the lower spline section remained engaged in the AGB (**Photo 16**). Impact damage and thermal discoloration was noted on the AGB second reduction bearing housing consistent with tower shaft contact during rotation (**Photo 17**). The fuel pump assembly was removed from the engine and it was noted that both the fuel inlet port and fuel filter had separated from the assembly during impact (**Photo 18**).


Photo 16- Sheared AGB Tower Shaft


Photo 17- AGB Second Reduction Bearing Housing Damage

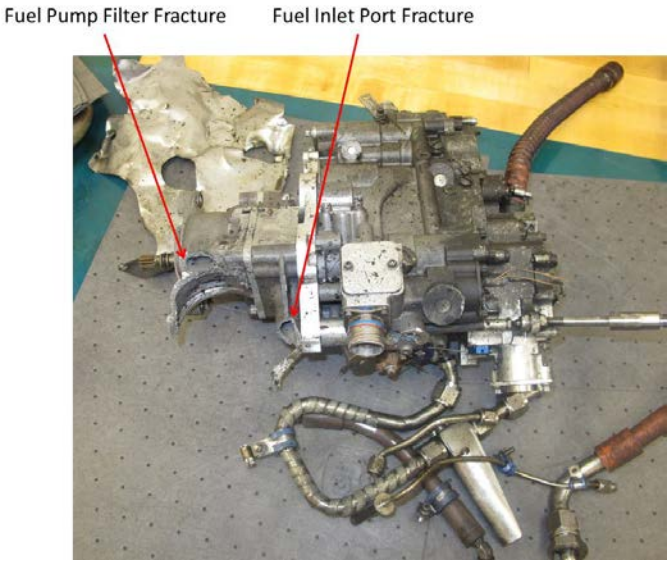

Photo 18- Damaged Fuel Pump

The oil lube and scavenge pump had three of the four mounting flange attachment points fractured and was held in place by a single mounting flange and nut. The oil lube pump input shaft from the gearbox was sheared (**Photo 19**).

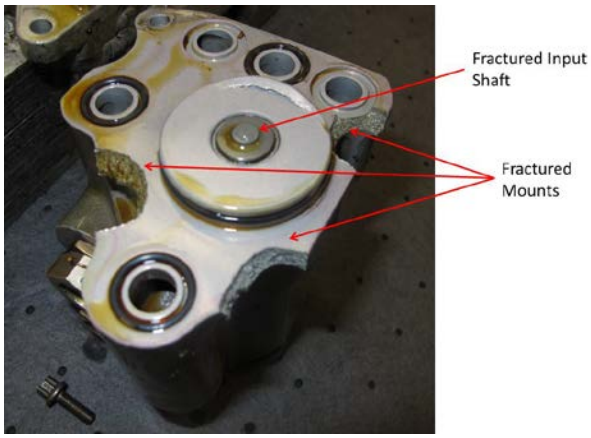

Photo 19- Damaged Lube and Scavenge Pump

3.2.4 Combustor Assembly

The combustion nozzle assembly and cover did not exhibit any thermal distress or burn through. Fine debris was noted throughout the combustion assembly. The fuel slinger system was intact and in good condition. The electrode depth was measured on the right and left igniter plugs and both were worn beyond serviceable limits in accordance with the Williams International FJ44-2A line maintenance manual. A spark check was performed using a power supply and both igniter plugs were verified to be operational.

3.2.5 High Pressure Turbine

The HPT rotor and nozzle assemblies were both intact and did not exhibit thermal distress or deformation.

3.2.6 Low Pressure Turbine

The LPT 1st and 2nd stage rotor and nozzle assemblies were intact. The forward side of the LPT 1st stage disk had a 360 degree rub along the blade fir tree platforms with a corresponding rub on the LPT 1st stage nozzle hub consistent with a forward axial shift (**Photo 20**). The LPT trip sensor was not engaged/tripped indicating the LPT did not shift in the aft direction.[3]

Photo 20- LPT 1st Stage Blade Fir Tree Platform Rub Marks

Robert Hunsberger
Aerospace Engineer
Powerplants

[3] The LPT trip sensor is a mechanical lever that shuts off fuel flow in the event of a turbine axial shift in the aft direction.