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

Powerplants Sub- Group Chairman's Factual Report of Investigation

February 27, 2015

A. ACCIDENT CEN13FA196

Location:	South Bend, Indiana
Date:	March 17, 2013
Time:	1623 Eastern Daylight Time
Aircraft:	Hawker Beechcraft Corporation Model 390 Premier 1A, N26DK

B. GROUP

Accident site documentation, March 19 – 22, 2013:

Chairman:	Tom Jacky National Transportation Safety Board Washington, D.C.
Member:	Bob Hendrickson Federal Aviation Administration Washington, D.C.
Member:	Kris Wetherel Hawker Beechcraft Corporation Wichita, Kansas
Member:	J. Chris Greene Williams International Walled Lake, Michigan

Engine Control Unit Examination at Walled Lake, MI, May 23, 2013:

Chairman:	Tom Jacky National Transportation Safety Board Washington, D.C.
Member:	Brian Weber Beechcraft Corporation Wichita, Kansas
Member:	J. Chris Greene

Williams International
Walled Lake, Michigan

C. SUMMARY

On March 17, 2013, at 1623 eastern daylight time, a Hawker Beechcraft model 390 (Premier IA), N26DK, serial number RB-226, collided with three residential structures and terrain following an aborted landing attempt on runway 9R located at the South Bend Regional Airport (KSBN), South Bend, Indiana. The private pilot and pilot-rated-passenger occupying the cockpit seats were fatally injured. An additional two passengers and one individual on the ground sustained serious injuries. The airplane was registered to 7700 Enterprises of Montana LLC and operated by Digicut Systems of Tulsa, Oklahoma, under the provisions of 14 Code of Federal Regulations Part 91 while on an instrument flight plan. Day visual meteorological conditions prevailed for the business flight that departed Richard Lloyd Jones Jr. Airport (KRVS), Tulsa, Oklahoma, at 1358 central daylight time.

The accident airplane was moved from the accident site to a maintenance hangar on the South Bend Airport on March 19, 2013. The group met at the hangar from March 19 – 22, 2013 to document the airplane for the relevant airworthiness aspects (structure, systems, and powerplants).

On May 23, 2013, the group met at the Williams International facility in Walled Lake, Michigan to examine the following components removed from the accident airplane:

1. Williams FJ44-2A Electronic Control Unit (Left)
   Part Number: 117162
   Serial Number: LH2A0603
   Software Version: CP317.03

2. Williams FJ44-2A Electronic Control Unit (Right)
   Part Number: 117162
   Serial Number: LH2A0608
   Software Version: CP317.03

The contents of the units' non-volatile memory (NVM) were downloaded and converted into engineering units. At the conclusion of the examination, the converted contents of the extracted information were provided to the group.

The on-scene examination of the powerplants determined evidence consistent with the left engine operating at the time of impact. For the right engine, the evidence gathered on-scene was consistent with the right engine not operating at the time of impact.

D. DETAILS OF INVESTIGATION

1. AIRPLANE POWERPLANT DESCRIPTION

The airplane's 2 powerplants were identified as follows:

Manufacturer:	Williams International
Model:	FJ44-2A Turbofan Engine
Part Number:	56000
Thrust Rating:	2300 lbs.

One engine is located on each side of the upper aft fuselage, connected to the fuselage via pylons. The engine is a two-spool co-rotating axial flow turbine engine with a medium bypass ratio, mixed exhaust, and high cycle pressure ratio. The engines provide mounting pads for electrical and hydraulic components, and bleed air for cabin pressurization, air conditioning, anti-icing, and hydraulic package pressurization. Engine driven accessories are mounted to the accessories gearbox which is secured to the bottom of the interstage housing.

The accessory gearbox's function is to turn the engine during starting and to drive the accessories for the engine and airplane systems. The following components are driven by the accessory box:

Generator
Hydraulic Pump
Lubrication and Scavenge Pump
Fuel Pump
Fuel Control

An engine can be started in the air by one of two methods: either a windmilling start or a starter-assisted airstart. Generally, the flight envelope to accomplish an airstart is between about 130 and 300 knots indicated airspeed (KIAS), displayed on the primary flight display and 20,000 to 25,000 Feet Pressure Altitude to the ground (depending on airspeed). At lower airspeeds, a starter-assisted start is recommended and utilizes the start switch. At higher airspeeds a windmilling start is recommended in which the engine start switch is not used.

The Starter Assisted Start Checklist, Windmilling Start Checklist, and Airstart Envelope Section of the Hawker Beechcraft Corporation Premier 1/1A Model 390 Pilot Checklist, Section 3A – Abnormal Procedures are included in Attachment 1.

The engine manufacturer indicated that the engine will windmill as long as the airplane has forward airspeed.

2. ENGINE CONTROL SYSTEM DESCRIPTION

2.1 General Description

The engine control system includes the flight deck thrust levers and throttle quadrant mechanism in the center pedestal, connected to power (throttle) control cables that extend aft through the airplane to the power control arm located on the bottom of the

hydromechanical fuel control unit (HMU). In addition, an electronic control unit (ECU) interacts with the HMU to provide automatic fuel control. See ECU description in Section 2.2.

The power control cables permit direct fuel control to the engines. When the thrust levers (throttles) are moved, the power control cables mechanically transfers that movement to the power control arm and into the HMU.

The mechanical Low Pressure (LP) Shaft Trip Sensor provides an emergency engine shutdown system by terminating fuel flow to the affected engine when tripped. The LP Shaft Trip Sensor is connected to a Fuel Shutoff Valve located in the fuel control unit (HMU). A cable linkage runs from the HMU to the Trip Lever assembly located on the Rear Bypass Duct. The LP Shaft Trip Sensor is activated whenever the LP Turbines are displaced .050" in the aft direction against the Trip Lever (e.g. an LP Shaft separation by internal failure, external force, or other event). When tripped, the mechanical trigger linkage will shut down the engine by activating the HMU Fuel Shutoff Valve. Activation of the sensor will terminate fuel flow within 300 milliseconds.

2.2 Electronic Control Unit (ECU) Description

The ECU (one per engine, for airplanes with multi-engine configurations) controls the Williams International FJ44-2A turbofan engine throughout the engine operating envelope. The ECU is a single channel electronic unit that provides engine fuel control by interacting with the HMU. Each ECU is mounted on the airframe.

The ECU provides limiting for such parameters as N1, N2, and ITT. The ECU also has non-volatile memory to record trend data and faults determined during engine operation.

The ECUs are on the Standby Bus 28 volt DC circuit. During normal operation the Standby Bus is powered by the Essential Bus. During engine pre-start and engine start, the ECUs are powered by the main battery until a generator is brought online after start. After a generator is brought online after engine start, the ECUs will be powered by the generators. The ECUs can also be powered by the standby battery if it is selected following the depletion of the main battery.

If an ECU fails, an amber caution flight deck annunciation alerts the pilots of the failure. Engine thrust is then controlled directly via the respective thrust levers.

3. POWERPLANT EXAMINATION

The accident site inspection of the engine was limited due to location of the airplane structure, debris and physical safety concerns. The airplane's engine mounting structures were fractured and the engines were noted as drooping from the normal pylon mounting position.

The detailed examination of the engines was conducted after the airplane wreckage was moved to the hangar. To facilitate the detailed examination, the South

Bend Fire Department assisted with engine cowling removal and the separation of the engines from the airplane pylon/tail structure.

Note: In this report, all directional references to front and rear; right and left; top and bottom; and clockwise and counterclockwise are made forward looking aft (FLA) as the convention. All numbering is in the circumferential direction starting with the No. 1 position at the 12:00 o'clock position or immediately clockwise from the 12:00 o'clock position, and progressing sequentially clockwise FLA.

3.1 Left Hand Engine, Serial Number 105363

The accident site inspection revealed that the inlet leading edge had been impacted and crushed from approximately the 7 to 10 o'-clock position FLA.

The detailed examination of the fan revealed evidence of leading edge foreign object damage (FOD), consistent with ingestion of debris during the accident sequence. However, the fan could still be rotated by hand. Circumferential scratches, but no FOD were noted on the spinner, consistent with engine rotation at impact. Please see Figures 1 and 2.

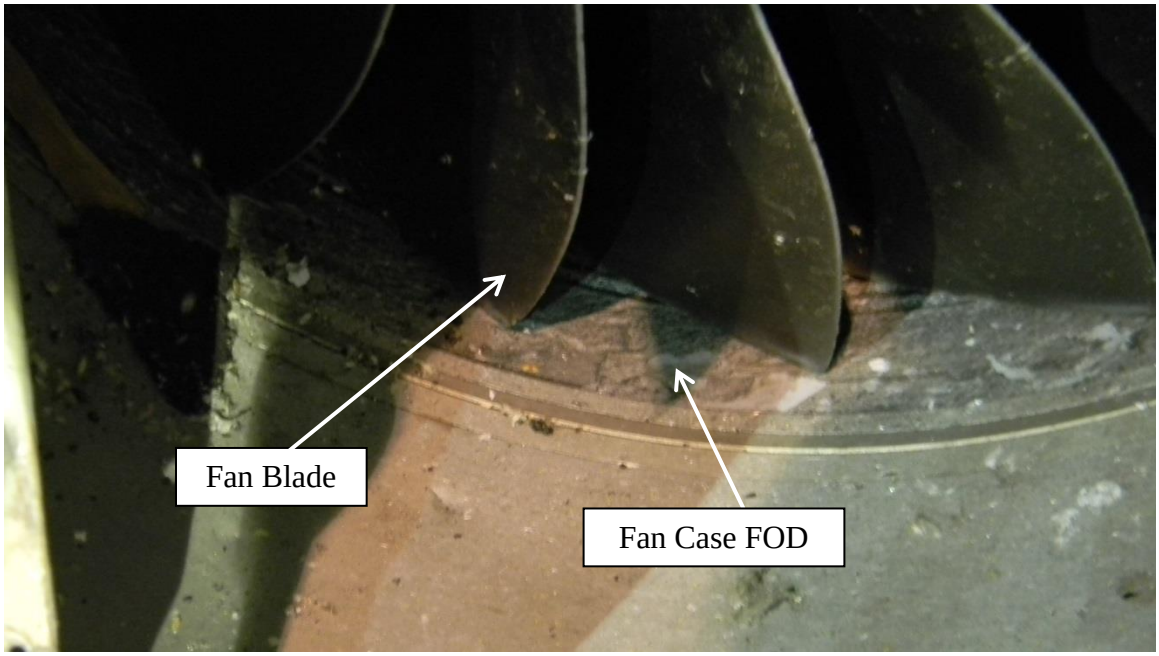

Figure 1 - FOD in the fan and fan case, for Left Engine.

Figure 2 - Left Engine spinner and inlet. Note circumferential scratches on the spinner and lack of FOD, evidence consistent with engine rotation at impact.

The exhaust nozzle and cowling were damaged. The rear bypass duct/exhaust nozzle mounting flange was separated from the attachment rivets for an approximately 270 degree arc at the bottom inboard FLA.

The continuity of the left engine power control (throttle) cable from the center pedestal to the engine could not be verified due to the severity of the airplane damage. However, on the engine, the power control cables were continuous from the engine pylon and the cable was still connected to the power control arm at the base of the HMU. The power control (throttle) cable bracket exhibited no visible damage. The HMU throttle lever was noted in the maximum power position. The HMU heat shield exhibited no visible damage.

The Low Pressure (LP) Trip Lever cables exhibited no visible damage, and the mechanism had not been activated.

All three engine magnetic chip collectors were inspected and were free of chips.

The engine's serial number was confirmed.

3.2 Right Hand Engine, Serial Number 105364

The accident site inspection of the engine revealed that the inlet leading edge had been impacted and crushed into the fan from approximately the 3 to 9 o'-clock position FLA. There was visible damage to the cowling and supporting structure but the extent could not be determined on site. See Figure 3.

Figure 3 - Right hand engine at the accident site.

A detailed examination of the engine was conducted after the airplane wreckage was moved to the hangar.

Damage to the inlet contacted the fan and prevented rotation of the fan. The exhaust duct was separated from the rear bypass duct.

The exhaust mixer was deformed and damaged. The rear housing center body cone was damaged. The rear bypass duct was dented and bent/distorted. The rear duct flange was separated at the front bypass duct mounting flange rivets.

The interior of the cowling contained attic insulation, pieces of home roofing shingles, pieces of wood, and other unidentified debris. However, the fan showed no visible evidence of leading edge foreign object damage that would be consistent with ingestion of debris during the accident sequence by a rotating fan. See Figures 4 and 5.

Figure 4 - Right hand engine fan blades and spinner. Note debris on fan blades and spinner, evidence consistent with no engine rotation during impact sequence.

Figure 5- Right hand engine inlet, fan blades and spinner. Note debris deposited on fan blades, spinner and inlet, evidence consistent with no engine rotation during impact sequence.

The continuity of the right engine power control cable from the center pedestal to the engine could not be verified due to the severity of the airplane damage. However, on the engine, the power control cables were continuous from the engine pylon and the cable was still connected to the power control arm at the base of the HMU. The power control cable bracket exhibited no visible damage. The HMU fuel control lever was noted in the

maximum power position. The HMU fuel control throttle lever cable was bent at the bottom, aft cable mounting bracket. The HMU fuel control heat shield was damaged.

The LP trip lever cable was found bent and damaged and the LP trip lever mechanism had been activated. Examination of the trip lever cable end at the HMU fuel control revealed that the "button" on the HMU fuel control that shuts off fuel to the engine when the LP trip lever has been activated had been pushed in. The "pushed in" found position of the "button" would shut off fuel to the engine. See Figure 6.

All three engine magnetic chip collectors were inspected and were free of chips.

The bypass duct contained foreign objects, what appeared to be home attic insulation materials.

The right hand engine serial number was confirmed.

4. EXAMINATION OF ELECTRONIC CONTROL UNITS

The Williams FJ44-2A Electronic Control Units (ECU) were hand-carried by the group chairman from the accident site to the Williams International facility in Walled Lake, Michigan. On May 23, 2013, the group met at the Williams International facility to examine the ECUs.

For the examination, each ECU was installed onto the Williams FJ44-2A engineering test cell and power applied to the unit. After a successful bit check at power-up, the engineering computer downloaded the contents of the ECU's non-volatile memory. The extracted values were converted into fault codes and trend data. Copies of the resultant converted information were provided in an electronic format to the group.

The examination of the recorded fault codes from each ECU related to the last flight leg in memory determined no faults were recorded.

For both units, the examination of the recorded trend information did not provide any information regarding the engine operation of the final flight leg.

Tom Jacky
Aerospace Engineer