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

September 9, 2014

POWERPLANT GROUP CHAIRMAN'S FACTUAL REPORT

NTSB No: CEN14LA239

A. ACCIDENT

Location: Columbus, Ohio

Date: May 9, 2014

Time: 1537 eastern daylight time (EDT)

Aircraft: Cessna 525C, Registration Number N718MV

B. POWERPLANTS GROUP

Group Chairman: Robert Hunsberger
National Transportation Safety Board
Washington, DC

Member: Troy Lewis
Williams International
Commerce Township, Michigan

C. SUMMARY

On May 9, 2014, about 1537 EDT, a Cessna 525C, registration number N718MV, was substantially damaged during an engine start at Rickenbacker International Airport (LCK), Columbus, Ohio. The airplane was equipped with two Williams International FJ44-4A turbofan engines. The two crewmembers and two passengers were not injured. The airplane was registered to Foxy Air 2009 LLC; Columbus, Ohio, and was being operated by Capital City Jet Center, Inc.; Columbus, Ohio. Day visual meteorological conditions (VMC) prevailed at the time of the accident and an instrument flight rules (IFR) flight plan had been filed for the 14 Code of Federal Regulations Part 135 non-scheduled passenger flight. At the time of the accident, the airplane was preparing to depart LCK for a flight to Bolton Field Airport (TZR), Columbus, Ohio.

An on scene examination of the airplane was conducted at LCK by members from the Federal Aviation Administration (FAA) Columbus Flight Standards District Office (FSDO), Cessna Aircraft, and Williams International. The left side of the fuselage, empennage, and No. 1 engine cowling sustained extensive thermal damage during the event. The No. 1 engine was removed from the airplane and shipped to Williams International for examination and testing.

Members from Williams International and the National Transportation Safety Board (NTSB) convened at the Williams International facility in Commerce Township, Michigan to examine the engine. The engine was received in good condition without case breaches or thermal damage on external case surfaces. There was light sooting and dried fire retardant residue on the fan blades and the visible stator vanes. The stator vane assembly had melted polyurethane elastomer on vanes surfaces and along the outer diameter vane attachment points, most concentrated on the bottom half of the engine. The exhaust mixer lobes exhibited bluing and were sooted. The low pressure turbine (LPT) blades also had a layer of soot and dried fire retardant residue.

The engine was borescoped and all internal parts were intact and in good condition. The combustion liner did not exhibit signs of thermal distress and the fuel slinger system was free of obstructions. Prior to running the engine on the test cell, the stator vane assembly was removed and replaced due to thermal damage to the elastomer material that holds the vanes in place. The engine was water washed to clean soot and fire retardant from internal surfaces. A series of test cell runs were performed and the engine started normally on both Full Authority Digital Engine Control (FADEC) channels, verifying that both igniter plugs were functioning properly. Acceleration checks were performed from ground idle to take-off/go-around (TO/GA) power setting and no anomalies were noted.

The airplane was equipped with a monitoring device that recorded engine parameters for the event start and subsequent fire. Shortly after start initiation, the engine flamed out, the interstage turbine temperature (ITT) briefly climbed before rapidly decreasing to pre-start levels, and engine N2[1] speed did not accelerate above starter driven level.

D. DETAILS OF THE INVESTIGATION

1.0 ENGINE INFORMATION

1.1 ENGINE HISTORY/MAINTENANCE

According to maintenance records the engine had accumulated the following hours and cycles:

Engine Position	Serial Number	Time Since New (hours)	Cycles Since New	Time Since Overhaul (hours)	Cycles Since Overhaul
Left/ No. 1	211093	739.7	674	N/A	N/A

[1] N2 speed is the high pressure spool rotation speed. The high pressure spool includes the high pressure compressor and high pressure turbine.

The engine was installed on the accident aircraft on June 22, 2011 and had the following maintenance performed since installation:

Date	Engine Hours	Maintenance Item
3/28/2012	98.4	Oil filter replaced after false impending bypass indication
2/4/2013	327.2	Routine maintenance check #1
10/19/2013	520.9	Engine water rinse
2/1/2014	605.1	Routine maintenance check #2
3/7/2014	645.4	Replaced fuel delivery unit (FDU) and FADEC harness after faults indicating and FDU electrical issue. FADEC harness replaced in error.
5/8/2014	735.3	Engine water rinse

1.2 ENGINE DESCRIPTION

The Williams International FJ44-4A is a twin spool turbofan with a single-stage fan and three-stage axial intermediate pressure (IP) compressor, single-stage centrifugal compressor (HPC), annular combustor, a single stage high pressure turbine (HPT) and a two-stage LPT. The engine has a full length bypass duct and features a dual channel FADEC.

According to FAA Type Certificate Data Sheet E3GL, Revision 19, dated May 20, 2013, the Williams FJ44-4A turbofan engine has a maximum continuous sea level thrust rating of 3,443 pounds at 46^{o}F and a takeoff sea level thrust rating of 3,621 pounds at 76^{o}F.

All directional references to front and rear, right and left, top and bottom, and clockwise and counterclockwise are made aft looking forward (ALF). A schematic of the engine is shown in **Figure (1)**.

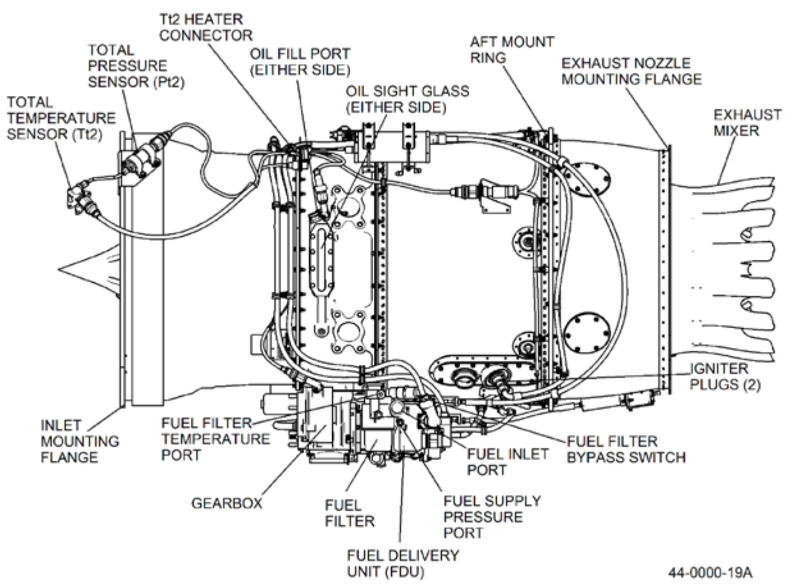

Figure 1- Williams International FJ44-4A (Left Side)

2.0 ENGINE INSPECTION

The engine was shipped to the Williams International facility in Commerce Township, MI for inspection and partial disassembly (**Photos 1 and 2**). A visual examination of the engine was conducted beginning at the inlet.

Photo 1- Engine (Left Side) and (Right Side), As Received

Photo 2- Engine Data Plate

The fan was intact and in good condition with sooting and fire retardant residue on all fan blade surfaces (**Photo 3**). The soot was easily removed with a cloth and light pressure. The case and insert assembly surrounding the fan was also sooted and dried white fire retardant residue/powder had accumulated at the 6 o'clock position. The fan stator, visible behind the fan, was sooted and had a green colored substance the consistency of foam running down the vanes along the bottom half the engine (**Photo 4**). The green substance was also seeping from the outer diameter vane attachment points to the outer shroud 360 degrees around the engine.

Photo 3- Fan Blade Sooting and Surface Deposits

Photo 4- Fan Stator as Viewed Through the Fan (6 o'clock)

All external case surfaces were in good condition with no indications of thermal exposure or sooting. One of the two igniter plugs was not shipped with the engine but was located and express shipped from Cessna Aircraft in Wichita, Kansas on the first day of the engine examination. The igniter plugs were both inspected and in good condition (**Photo 5**). The oil sight glass was cracked and a review of pictures taken on scene at LCK confirmed the damage happened during engine removal/packaging.

One of the ITT probes was found removed from the engine and hanging by the ITT harness. According to Williams, the igniter and ITT probes were both removed in order to borescope the engine at LCK prior to shipment. The three chip detectors were removed from the gearbox and were free of metal shavings and debris (**Photo 6**).

Photo 5- Igniter Plugs

Photo 6- Chip Detectors, Free of Debris

The exhaust mixer lobes exhibited bluing with discoloration and sooting consistent with exposure to fire (**Photo 7**). A significant amount of fire retardant residue had accumulated at the 6 o'clock position of the bypass duct. The visible LPT 2nd stage rotor blades were intact and in good condition but were sooted 360 degrees around (**Photo 8**).

Photo 7- Exhaust Mixer Lobes, Mild Discoloration and Sooting

Photo 8- LPT 2nd Stage Rotor Blades, Viewed Through the Exhaust

3.0 DISASSEMBLY

3.1 FAN/ FAN CASE AND STATOR ASSEMBLY

In order to better examine the thermal damage to the fan stator assembly, the fan and fan case and stator assembly were removed. As noted earlier, the fan stator had green residue seeping from vane connection points along the inner and outer shrouds (**Photo 9**). The stator vanes are secured in the case with a castable polyurethane elastomer. The elastomer is green and melts when exposed to temperatures above 140-150^{o}F. A representative stator assembly with focus on the elastomer is shown in (**Photo 10**). The outer diameter of the fan stator is manufactured out of aluminum and exhibited bulging in multiple locations consistent with thermal exposure.

Photo 9- Fan Stator Assembly Elastomer Damage

Photo 10- Castable Polyurethane Elastomer on Representative Fan Stator Assembly

4.0 BORESCOPE

The IP compressor, HPC, combustor and HPT were borescoped to ensure there was no internal damage to the engine. All rotor and stator assemblies exhibited the same sooting and fire retardant residue coating as was seen on the fan. The combustion section was intact without indications of burn through or fuel streaking. A dark shiny carbon like residue was built up around the fuel slinger that is considered normal for engines with similar hours/cycles according to Williams International (**Photo 11**). All visible slinger fuel holes and slots appeared to be free of obstructions and coking. The fuel supply and manifold lines were both intact and in good condition. The borescope findings at Williams International were consistent with what was oberved on scene at LCK.

Photo 11- Borescope Photo of Fuel Slinger

5.0 TEST CELL

After an evaluation by Williams International engineering it was determined that the engine was in an acceptable condition to run in the test cell to verify performance. Prior to placement in the test cell a new case and insert assembly was installed due to thermal damage to the stator vane elastomer material noted above[2]. The engine was water washed to remove sooting and fire retardant from internal components. To ensure that software was not a causal factor, the FADEC from the accident airplane was shipped and installed in place of the test cell slave FADEC. A series of starts and performance checks were completed in accordance with Williams International specifications. Two starts were conducted operating on separate FADEC channels which verified that both igniter plugs were in working condition. Both starts were normal, without excessive ITT temperature spikes. Acceleration checks from ground idle to TO/GA power were normal. A timed acceleration check from flight idle to TO/GA power was completed in 5 seconds, meeting the specification for a new engine. A copy of the test cell run sheets are available as **attachment (1)** to this report.

6.0 CESSNA AIRCRAFT RECORDING SYSTEM (AReS) DATA

The engine parameters during the event were captured by the Cessna Aircraft Recording System (AReS) (**Figure 2**). Based on the data, the N2 speed never exceeded 16% which corresponds to the starter assisted rotation speed. This means the rotation of the high pressure spool of the engine was driven by the starter without any additional energy from combustion. The ITT briefly peaked at 318.4^{o}C (605.1^{o}F) when the start sequence was initiated before rapidly decreasing over the next 10 seconds to a

[2] The case and insert assembly has a negligible effect on performance and will not alter engine start.

temperature below prestart levels. The N1[3] speed never exceeded 6% which further confirms that a sustained engine start was never achieved.

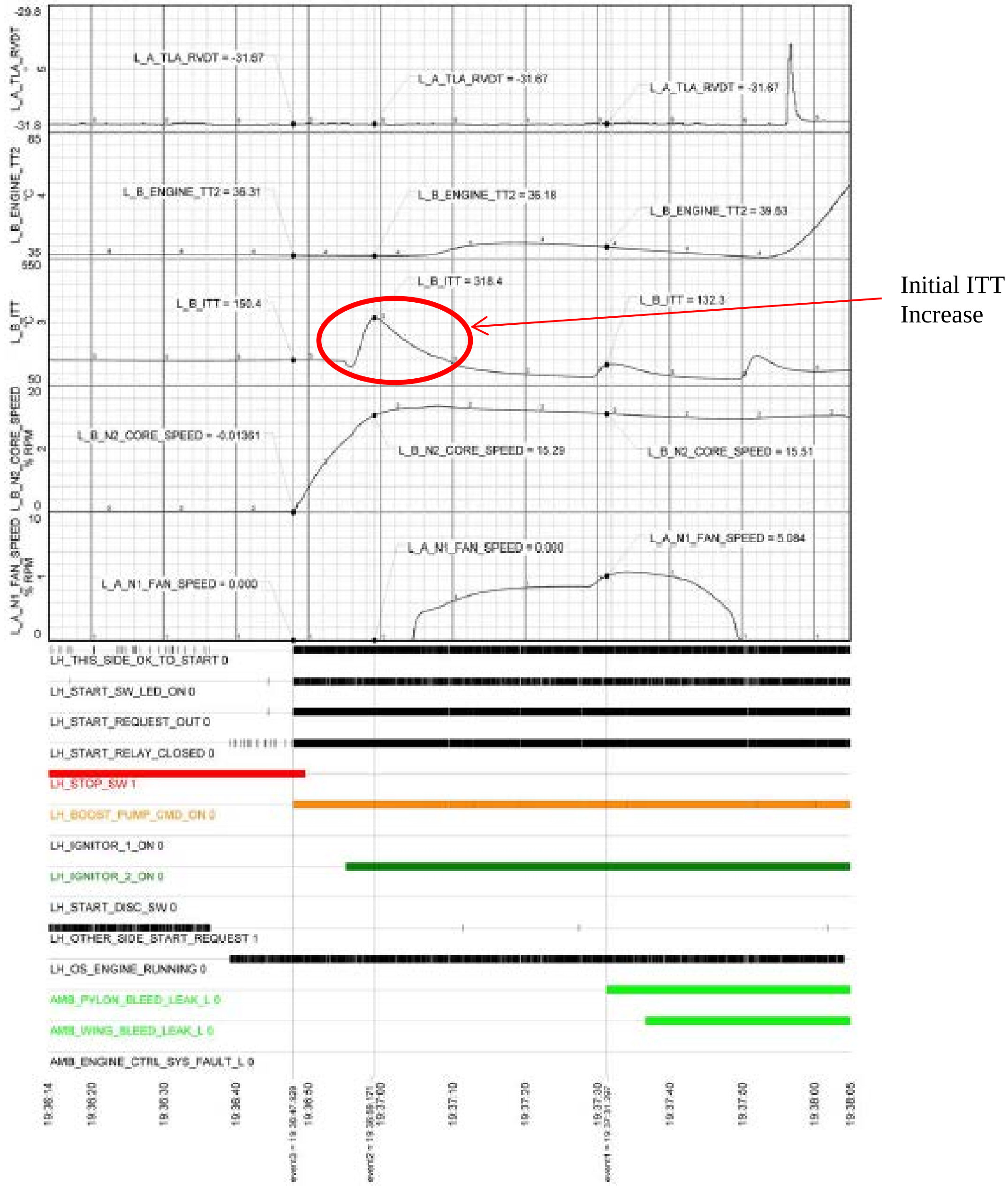

Figure 2- AReS Data, No. 1 Engine Parameters

[3] N1 speed refers to the low pressure spool rotation speed. The low pressure spool includes the fan, low pressure compressor, and low pressure turbine.

7.0 CESSNA 525C (CJ4) AIRCRAFT FLIGHT MANUAL START LIMITS

The Cessna 525C aircraft flight manual (AFM) lists the maximum allowable crosswind during an engine start as19kts. This limit is published due to the potential of a flameout condition when the wind direction opposes normal engine airflow.

Robert Hunsberger
Aerospace Engineer
Powerplants

ATTACHMENTS

1. Williams International FJ44-4A ESN 211093 Engine Test Cell Run Sheets