

Investigation Report

Identification

Type of Occurrence:	Serious incident
Date:	1 March 2010
Location:	Near Stuttgart
Aircraft:	Airplane
Manufacturer / Model:	Cessna Aircraft Company Cessna 525A
Injuries to Persons:	No injuries
Damage:	Minor damage to aircraft
Other Damage:	None
Information Source:	Investigation by BFU
State File Number:	BFU 7X001-10

Factual Information

History of the Flight

On 1 March 2010 at 0803 hrs¹ the airplane took off from Stuttgart Airport for a ferry flight to Bremen. No other persons besides the pilots were on board. The pre-flight check, engine start-up, and take-off were uneventful. Simultaneously with the retraction of the flap from 15° to 0° the pilot noticed unusual vibrations and a strong

¹ All times local, unless otherwise stated.

left yawing moment. Immediately afterwards he heard the acoustic warning Left Engine Fire. He stated that at that moment the inter-turbine temperature (ITT) was far in the red area. Therefore, the thrust lever was pulled into Idle and immediately afterwards into shutoff position. Then the left Engine Fire Switched was pushed. After a few seconds the fire warning stopped so that the Engine Fire Bottles were not actuated. The pilot stated that at that time the vibrations were only slightly noticeable. The indication for N2 showed zero and for N1 approximately 20%. In the further course of the flight the vibrations increased again.

The airplane returned to Stuttgart Airport and landed at 0822 hrs without further incident.

Personnel Information

The 46-year-old Pilot in Command (PIC) held an Airline Transport Pilot Licence (ATPL(A)) initially issued in 1987 and valid until 20 December 2014. His class 1 medical certificate was valid until 20 June 2010. He had a type rating as PIC for Cessna 525 valid until 27 February 2011. He also had valid ratings for the aircraft type CLRJ 100 and for single and twin engined piston land aircraft.

His flying experience:

Total	Approx. 21,000 hours
On the type:	Approx. 300 hours
In the last 90 days:	128 hours
In the last 30 days:	52 hours

Aircraft Information

The aircraft Cessna 525A is a twin-engine low-wing airplane. It is called Citation Jet 2+ (CJ2+). The airplane has six seats. Both engines are installed at the tail section.

The last Airworthiness Review Certificate (ARC) was issued on 30 July 2009 and valid until 29 July 2010. The aircraft had a valid German Certificate of Registration and was operated by a German air operator.

At the time of the serious incident total operating times of airplane and engines were 1,223 flight hours and 1,161 cycles.

Manufacturer: Cessna Aircraft Company
Year of manufacture: 2007
Serial number: 525A-0358
MTOM: 5,613 kg
Engines: Williams International FJ44-3A-24
Serial number: 216118

The engine FJ44-3A-24 is a two-shaft turbofan engine. The two-stage Low Pressure Turbine (LPT) powers a single-stage fan and a three-stage axial Intermediate Pressure Compressor (IPC). The single-stage centrifugal High Pressure Compressor (HPC) is powered by the single-stage High Pressure Turbine (HPT). The engine has an annular combustor. An annular jet distributes the fuel in the area of the rotor shafts outward into the combustion chamber.

Meteorological Information

According to the Meteorological Aviation Report (METAR) of Stuttgart, time of issue 0820 hrs (0720 UTC), the following weather conditions prevailed:

Wind: 120° / 03 kt
Visibility: More than 10 km
Precipitation: None
Clouds: 1/8 – 2/8 in 2,000 ft.
Temperature: 5°C
Dewpoint: -1°C
Air Pressure: 1,009 hPa

Radio Communications

Radio communications with the air traffic control unit at Stuttgart Airport had been established.

Aerodrome Information

Stuttgart Airport is an international airport. The airport has one runway with the direction 074°/254° which has a length of 3,345 m and a width of 45 m.

Flight Recorders

The airplane was not equipped with a Flight Data Recorder (FDR) or a Cockpit Voice Recorder (CVR). These recording devices were not mandatory.

Wreckage and Impact Information

After the landing it was determined that the aft outer side of the left engine cowling had been destroyed. The engine had been damaged in this area. The engine cowling showed evenly spread puncture traces.

The engine examination was conducted at facilities of the engine manufacturer Williams International under supervision of the US National Transportation Safety Board (NTSB). The fan and the two compressors did not show any apparent damages. The diffuser case and skirt did not show any thermal distress. But the inner diameter of the skirt was sooted. The brazed forward end of the skirt was cracked between the 9:30 and 8:00 o'clock² position. The diffuser skirt had multiple axial cracks at the rear edge and several circumferential cracks radiating from the axial cracks.

The skirt was missing a section from the aft edge between the 2:00 and 3:00 o'clock position. The missing section had the size of 106 mm x 108 mm x 60 mm x 34 mm. It was found in the back of the combustor cover.

The hole in the diffuser skirt for the fuel manifold tube was ovalized and the clockwise side of the hole on the outer diameter had raised metal. The outer diameter of the fuel manifold tube showed abrasion signs.

The combustion cover showed holes and soot traces.

The fuel manifold tube fractured at the brazed outer edge to the diffuser housing.

² All locations on the engine, or directions, as referenced to the clock, will be as viewed from the aft looking forward, unless otherwise specified.

Damages were also determined on the high and low pressure turbines and the exhaust pipe. The low pressure turbine case was burned away between the 6 and 9 o'clock position.

The engine manufacturer also conducted a microscopic examination of the fuel pipe and the cracks on the diffuser. But this examination was limited to the fracture features which had not been obliterated. The forward and aft cracks on the diffuser showed clear signs of fatigue fractures. The investigated fracture surfaces on the fuel manifold tube also showed signs of fatigue fractures. They originated in the brazed joint fillet radius in the fuel manifold assembly and continued into the area of the tube.

Fire

The engine cowling and the pylon showed signs of fire.

Additional Information

During two previous flights the odour of smoke had been noticed in the cabin. It could be eliminated by selecting the Air Source switch to the right engine. During the previous six months it was observed that the turbine temperature of the left engine was about 20° - 30°C higher. On 11 November 2010 and on 7 December 2009 boroscope inspections of the left engine were conducted.

At the time of the engine examination the engine manufacturer stated that so far no fractures on the diffuser of the FJ44-3A-24 model had occurred. There were however 17 cases in the entire FJ44-3A program. The diffuser was reinforced in combination with the development of the FJ44-4 model. Gradually, the FJ44-3A and FJ44-3A-24 models should be re-fitted with this diffuser. Williams International issued the Service Bulletin (SB) FJ44-72-093 for that purpose.

On 5 April 2010 Williams International informed all operators of this engine about the serious incident and described three signs for diffuser damages:

- a persistent bleed odour
- a sudden increase in inter-turbine temperature (ITT) or in the ITT split between engines of 30°C
- difficulty removing the start fuel nozzle adapter or igniter.

The engine manufacturer stated that by January 2015 almost all FJ44-3A-24 engines had been refitted with the modified diffuser. So far the engine manufacturer has not received any information about fractures on the modified diffuser.

Analysis

The diffuser cracks were caused by naturally occurring airflow buffeting and vibratory modes of the inner flow path within the engine run range. The cracks at the forward end of the diffuser inner flow path allowed the inner flow path to separate and move aft until contacting the fuel manifold tube which subsequently failed due to vibration. The fracture of the fuel manifold tube allowed an uncontrolled amount of fuel to enter the combustion zone which resulted in the burn-out of the combustion cover. All other damages were secondary damages.

The firewall of the airplane prevented the fire from affecting the aircraft structure. The intensity of the fire was so low that the shut-off of the engine was sufficient to extinguish the fire. Therefore the use of fire extinguishers was not necessary.

The noticed smells of the bleed air and the increased inter-turbine temperature (ITT) of the left engine can be viewed as first signs of damage.

The pilot correctly carried out the actions necessary to cope with this situation.

The engine manufacturer's corrective action by refitting the engine model with the modified diffuser turned out to be effective because the fractures on the diffuser have not occurred again.

Conclusions

The serious incident was caused by fatigue fracture on the diffuser.

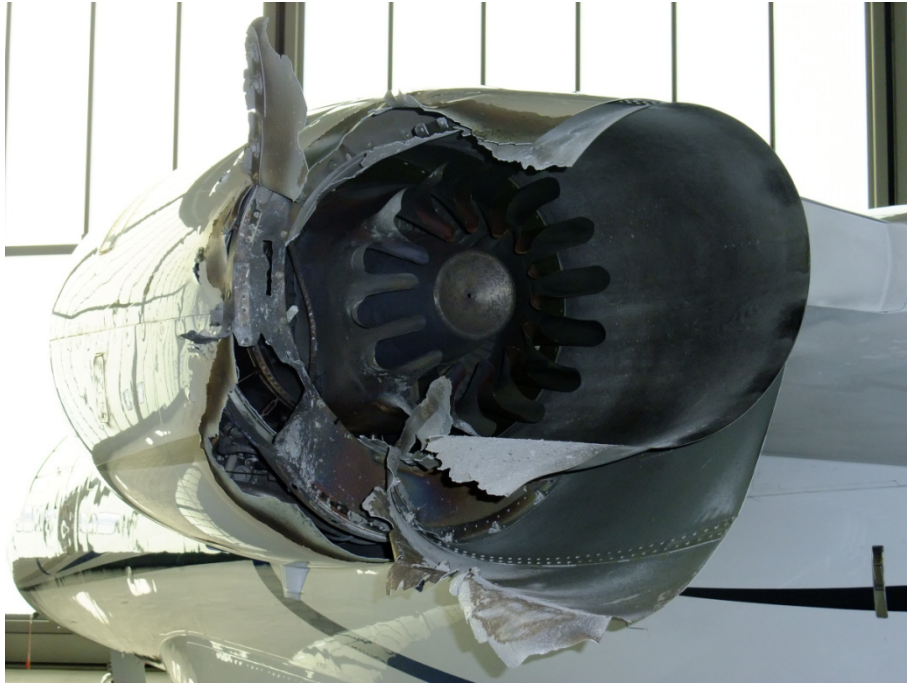
Safety Recommendations

Safety recommendations were not issued due to the manufacturer's corrective action.

Investigator in charge: Karge

Braunschweig: 11 November 2015

Appendices

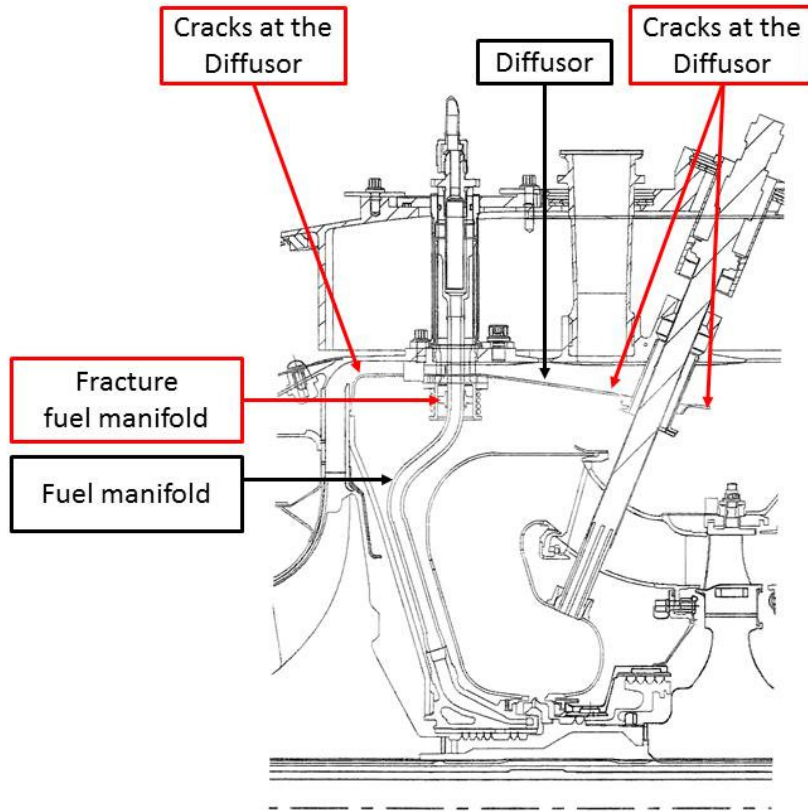


Destroyed engine



Damaged engine cowling and turbine

Photos (2): Operator



Location of the fracture and cracks in the engine

Source: Engine manufacturer/BFU

This investigation was conducted in accordance with the regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and the Federal German Law relating to the investigation of accidents and incidents associated with the operation of civil aircraft (*Flugunfall-Untersuchungs-Gesetz - FIUUG*) of 26 August 1998.

The sole objective of the investigation is to prevent future accidents and incidents. The investigation does not seek to ascertain blame or apportion legal liability for any claims that may arise.

This document is a translation of the German Investigation Report. Although every effort was made for the translation to be accurate, in the event of any discrepancies the original German document is the authentic version.

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