

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



WPR23LA278

ENGINE EXAMINATION REPORT

October 25, 2023

A. ACCIDENT

Location: Farmington, Utah
Date: July 19, 2023
Time: 0830 mountain daylight time
Helicopter: N102UM, Aerospatiale, AS-355E

B. ENGINE EXAMINATION REPORT

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C. SUMMARY

The examination was conducted at the facilities of Keystone Turbine Services (KTS), in Coatesville, PA on October 24 and 25, 2023. No anomalies were observed that would have precluded normal operation to Engine 1. The most significant findings for Engine 2 were radial rubbing damage to blades and stators within the compressor section, and a small hole in the bleed valve diaphragm. The compressor section and bleed valve were retained for further examination.

Examination of the engine trim and control system indicated that they were functioning appropriately.

D. DETAILS OF THE EXAMINATION

1.0 Engine Examination

1.1 Engine 2

Model: 250 C20F
Engine SN: CAE-840052

The engine was removed from its crate and appeared undamaged by shipping (Figure 1). A pneumatic system leak check was performed, with no leaks detected. Both the N1 and N2 rotors appeared to be locked, and fuzz/light FOD was present on

the first stage compressor blades, some of which sustained leading edge nicks and tip abrasions. (Figure 2).

The compressor section was removed, and the rotating assembly could be spun smoothly by hand. The rear compressor assembly rear diffuser shims matched those documented in the shim record card.

The N1 gas producer turbine still appeared to be locked, and the N2 rotating group could now be rotated although it slightly resisted.

The gearbox was then separated from the turbine, and the turbine N1 was still observed locked, with N2 snug. The N1 and N2 gearbox drive trains could now be rotated smoothly by hand.

The power turbine, gas producer and exhaust collector assembly were then disassembled.

The combustion liner and outer case was removed, and brown fuzzy debris was found on the first stage nozzle shield and first stage blades. Wood chips and mud were found loose within the assembly.

The exhaust collector support assembly was then separated from the turbine, and now the third and fourth stage power turbine wheels could be spun. The number 6 & 7 bearing oil inlet screen was clear. The number 8 oil supply tube was removed and was free of obstructions.

Within the still locked gas producer turbine section, the number 6 bearing was intact and coated in black carbon-like deposits. The bearing did not show any evidence of rotational scoring indicative of a pre-accident failure. The 6 & 7 oil jet tube was removed and was free of obstructions when oil was lightly applied to its passage.

The number 8 bearing support was coated in oil, but the bearing appeared drier than the surrounding assembly. Oil flowed through the number 8 oil nozzle. The number 8 bearing was removed and found to spin. The previously locked gas producer wheels could now be moved, although with light resistance.

The gas producer bearing support was then removed. The number 7 bearing was coated in oil and carbon-like deposits but could be spun.

1.1.1 Compressor Section

The compressor case was opened. There was no evidence of catastrophic failure to any of the blades or stators. A prominent groove of the inner liner was observed in the area of the number 5 and 6 blade tips of one case half (figure 3, 4). The other case

half had similar rub signatures but to about ½ the depth. The neighboring stator vanes on one case half exhibited blade tip smearing opposite the direction of rotation (figure 4), with corresponding rub marks on the adjacent area of the blade hub (figure 5).

1.1.2 Fuel Control Unit

The fuel controller was installed in the fuel accessory test stand and tested in accordance with service limit testing procedures. It either met or came within an acceptable tolerance of the service limits, with no functional anomalies noted.

1.1.3 Fuel Nozzle

The fuel nozzle was configured in the fuel flow test bench. The unit met flow specifications. Light voids were observed in the spray pattern at higher pressure but according to KTS representatives, the unit's performance meant that it was still within serviceable limits.

1.1.4 Power Turbine Governor

The unit was installed in the power turbine governor test stand and met the service limit specifications.

1.1.5 Compressor Bleed Valve

ASSY: 23053176
SN: FF14052

The unit was installed and tested in the bleed valve test stand. The valve appeared to intermittently hang up when transitioning from the open to closed position. The unit did not meet the specifications for the interstage pressure reduction required to close the valve. The diaphragm leakage test yielded nominal results.

The unit was disassembled, and an approximately 1/16th inch hole was observed in the rolling diaphragm (figure 6, 7). Although the unit passed the leakage test, the group determined that because that test was performed with the valve in the closed position, the hole would have been flat against the chamber wall of the valve cavity, thereby limiting leakage.

The bleed valve had a service life of 1,500 hrs., and according to maintenance records, it had 76.6 hrs. remaining.

1.1.6 Fuel Pump

The fuel pump was tested in the fuel accessories test stand, in accordance with the evaluation test specifications for pump flow (no bypass). The pump met the flow rate specifications at all tested speeds.

1.2 Engine 1

Model: 250 C20F
SN: CAE832456

The engine was removed from the crate and appeared undamaged by shipping. Both the N1 and N2 stages could be spun by hand with appropriate drag. FOD damage was noted to the first stage compressor blades, all of which sustained leading edge nicks, and tip wear abrasions. The combustor case exhibited a dent on its upper aft side.

A pneumatic system leak check was performed, with no leaks detected.

1.2.1 Fuel Control Unit

The unit was installed in the fuel accessory test stand. It either met or came within an acceptable tolerance of the service limits, with no anomalies noted.

1.2.2 Fuel Nozzle

The fuel nozzle was configured in the fuel flow test bench. The unit met flow specifications. Light voids were observed in the spray pattern at higher pressure but according to KTS representatives, the unit's performance mean that it was still within serviceable limits.

1.2.3 Power Turbine Governor

The unit was installed in the power turbine governor test stand and met the service limit specifications.

1.2.4 Compressor Bleed Valve

The bleed valve was tested in the bleed valve test stand. The unit met serviceable limit specifications.

1.2.5 Fuel Pump

The fuel pump was tested in the fuel accessories test stand, in accordance with the evaluation test specifications for pump flow (no bypass). The pump met the flow rate specifications at all tested speeds.

2.0 Examination Figures

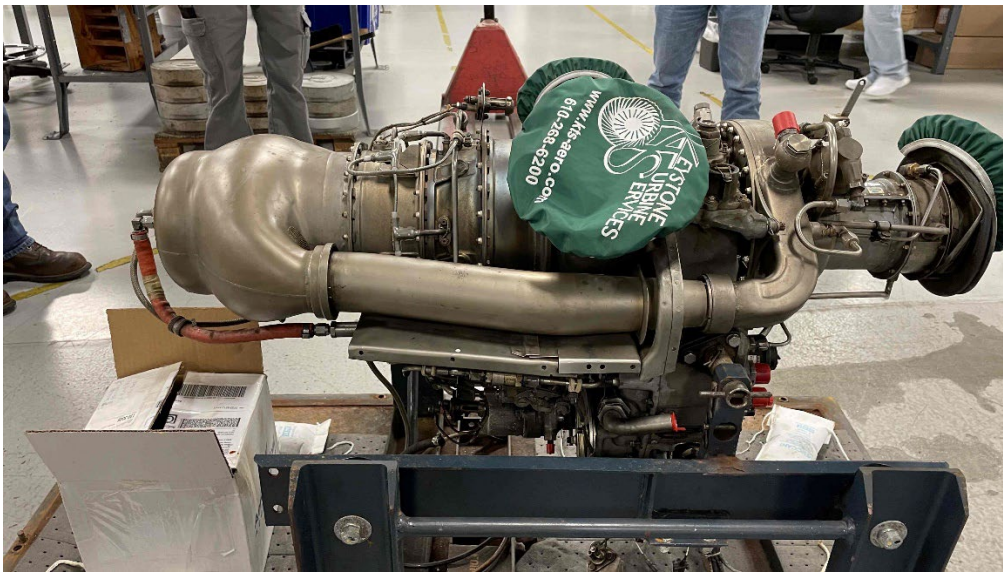


Figure 1 - Engine #2 after removal from the shipping crate



Figure 2 - First stage compressor blades - Engine #2.



Figure 3 - Rubbing indications from number 5 and 6 blade tips with groove in lining - Engine #2.

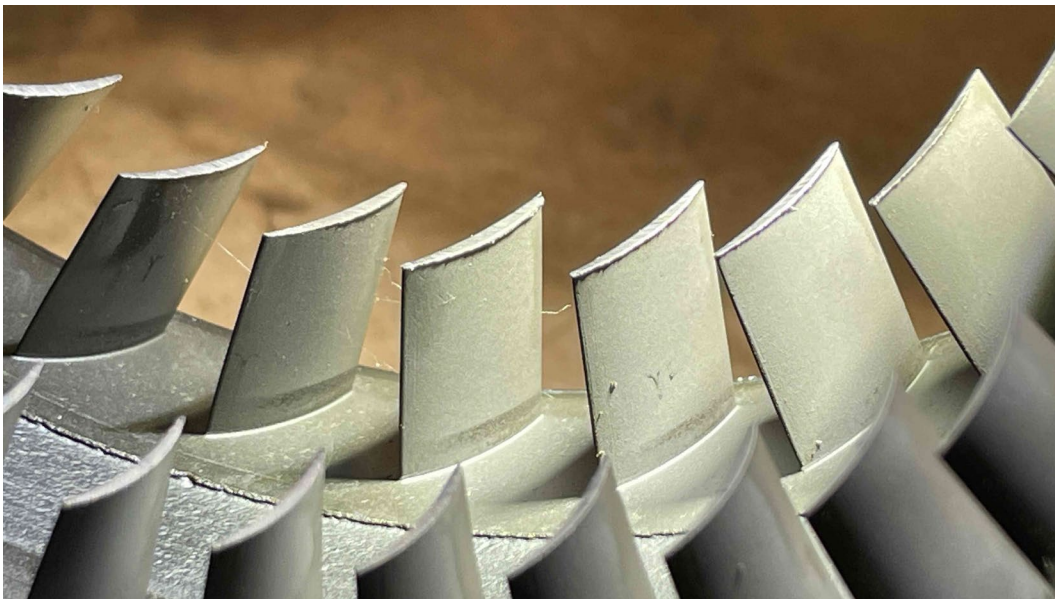


Figure 4 - Worn number 6 stator tips with groove in lining - Engine #2.



Figure 5 - Compressor blade hub with rub marks - Engine #2.



Figure 6 - Hole in diaphragm viewed from the inside - Engine #2.



Figure 7 - Hole in diaphragm viewed from the outside - Engine #2.

Submitted by:

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