

Rolls-Royce Engine Investigation Report



Aircraft Type: Hiller UH-12F (Soloy)
Aircraft Reg: N7173S
Engine Model: M250-C20B
Engine S/N: 823398
Engine Rating: 420 shp (takeoff)

9 February 2021

Executive Summary: The engine power loss was due to the fracture and liberation of multiple blades from the fourth stage compressor wheel and subsequent secondary damage. The initial blade loss resulted in significant damage to the third, fourth, fifth and sixth stage compressor stages rendering the compressor inoperative. The fractures on the fourth stage compressor blades were initiated from corrosion damage and progressed in fatigue until the blades were overloaded and ultimately liberated from the wheel.

Wreckage Exam Date: 27 May 2020
Wreckage Exam Location: Vernal, UT

The engine was examined in-situ on 27 May 2020 under the supervision of the FAA FSDO inspector (Salt Lake City UT Office).

The aircraft was recovered to a rented hangar at the Vernal airport and was positioned on makeshift skids. The main rotor blades were removed for transport and not observed. Impact damage was noted to the tail boom and the tail rotor assembly was not present.

The engine was secure and in place with no damage to the mounts. External engine damage consisted of small dents on the left compressor discharge tube consistent with internal debris travelling outward. The engine N1 system was locked while the engine N2 system turned and was connected to the aircraft power train. No Foreign Object Damage (FOD) was noted on the first stage compressor blades or compressor inlet and the inlet barrier filter system was intact and free of debris. The fourth stage turbine wheel was normal in appearance when viewed from the exhaust collector.

The compressor case was not penetrated but downstream internal damage could be seen when viewed from the inlet. The compressor bleed valve was removed and normal in appearance. The plunger extended with the appropriate resistance and retracted under spring force. Metallic debris, consistent with liberated compressor material, was log-jammed in the compressor bleed valve manifold which is located adjacent to the fifth stage compressor wheel.

The outer combustion case, combustion liner, and compressor discharge tubes were removed for inspection. The left compressor discharge tube exhibited impact damage on

the interior of the tubes. No noticeable damage was noted to the right discharge tube. Loose metallic debris was noted within the outer combustion case, which was otherwise undamaged. The combustion liner was normal in appearance. The first stage nozzle shield and first stage nozzle airfoils were coated with a gray powder-like substance. The gas producer turbine rotated freely once the compressor was removed and all of the first stage turbine wheel blades were intact.

Linkages from the collective to the Power Turbine Governor (PTG) and from the throttle twist grip to the Fuel Control Unit (FCU) were secure. The FCU throttle input lever was rigged appropriately and contacted the min and max stop when the throttle was rotated to the cut off and fly position respectively. The PTG rotated through ~20deg when the collective was moved from full down to full up.

All external air, fuel, and oil line connections were at least finger tight. A pneumatic air leak check was performed with no leaks detected. The aircraft mounted fuel filter bowl was full of fuel which was normal in smell. The fuel filter element presented no obvious contamination or blockage. A fuel sample was retained from the bowl. The aircraft mounted scavenge oil filter was clean and full of oil which was normal in appearance and smell. The pending bypass button was not extended. Both the upper and lower magnetic chip detectors were free of ferrous debris and an oil sample was retained from the engine gearbox.

The compressor module (P/N 6890550, S/N CAC 36300) was removed from the engine and installed in a shipping container for future examination and analysis. Please see Appendix A for relevant photos of the wreckage examination.

Engine Information:

Engine Model	250-C20B
Rating	450 Shaft Horsepower
Serial Number	CAE 823398
Total Time	unk hrs

Component	Serial Number	Part Number
Engine 250-C20B	CAE 823398	6893660
Gearbox	CAG 36192	6894171
Compressor*	CAC 36300	6890550
Turbine	CAT 35839	23038241
PTG	27785	23065121
FCU	325868	23070606
Fuel Nozzle	n/a	n/a
Bleed Valve	FF30108	23053176
Fuel Pump	T102246	6899253

*Records indicate the compressor was installed 505 operating hours prior with 0 hrs Time Since Overhaul (TSO) on 12 June 2012.

Compressor Disassembly Date: 16 July 2020

Compressor Disassembly Location: Rolls-Royce Regional Customer Training Center,
Indianapolis, Indiana

The author did not attend the compressor disassembly. Please see Appendix B for disassembly notes.

The compressor rotor, case halves, front support, and impeller shroud were submitted to the Rolls-Royce materials laboratory for further examination. The findings of the materials examination are as follows:

- 2.1 At least three stage 4 compressor blades exhibited fracture features consistent with fatigue. Two of the blades exhibited fracture features consistent with fatigue progression from the suction side crown and one blade exhibited fracture features near the suction side crown location that were consistent with fatigue progression aft from the leading edge area.
- 2.2 The stage 4 compressor rotor exhibited corrosion damage on the airfoil and rim surfaces. Both of the blades that fractured in fatigue from the suction side crown had corrosion damage near the middle of the fatigue fractures.
- 2.3 The stage 4 compressor blades did not have a diffused aluminide coating on the gas path surfaces.
- 2.4 The remaining stage 4 compressor blades exhibited a combination of overload fracture features and smearing damage.
- 2.5 One of the stage 5 compressor blades exhibited partially smeared fracture features that were consistent with fatigue progression from the suction side crown location.
- 2.6 Several stage 5 blades exhibited shiny thumbnail-shaped areas within fields of overload fracture and smearing damage.
- 2.7 There was no evidence of any foreign object impact damage upstream of the liberated stage 4 compressor blades.


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Appendix A Wreckage Examination Photos



Figure 1. Aircraft after recovery to hangar on makeshift skids.



Figure 2. Engine in-situ prior to field examination



Figure 3. Compressor in-situ prior to field examination

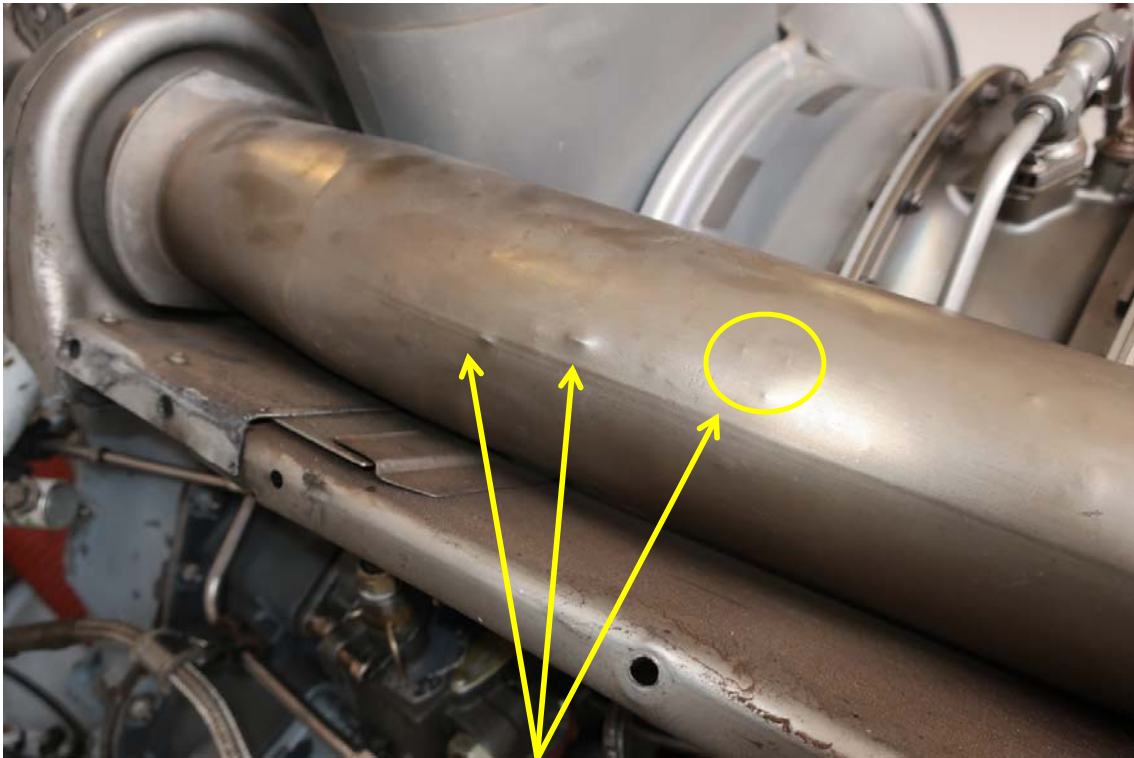


Figure 4. Left side compressor discharge tube peening damage

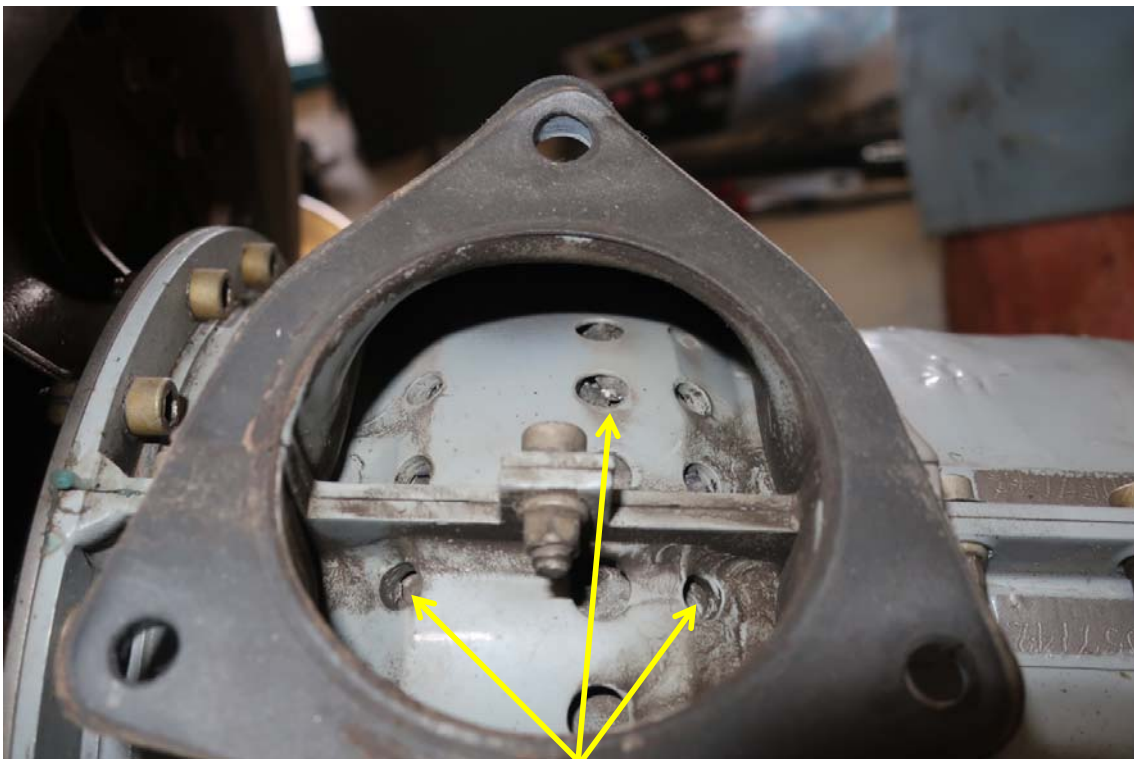


Figure 5. Liberated debris log-jammed in bleed valve manifold

Appendix B Compressor Disassembly Notes