



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Western Pacific Region

May 8-10, 2018

ENGINE EXAMINATION/RUN AND PROPELLER EXAMINATION

WPR18FA093

This document contains 14 embedded photos.

A. ACCIDENT

Location: San Diego, CA
Date: February 21, 2018
Aircraft: Cirrus SR22T, Registration N707DF, Serial #1621
NTSB IIC: Samantha Link

B. EXAMINATION PARTICIPANTS:

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C. SUMMARY

Examination of the engine, propeller, and an engine run was conducted on May 8-10, 2018 at the facilities of Continental Motors, Mobile, Alabama. No anomalies were noted with the engine, however, the engine exhibited operating signatures consistent with an extremely rich running engine. No discrepancies were noted with the propeller assembly that would have precluded normal operations.

D. DETAILS OF THE INVESTIGATION

1.0 Engine Examination

- Right side Turbocharger
 - o The turbocharger was removed from the engine and cleaned
 - o Turbine housing inlet was clear of oil and debris

- o Compressor outlet was clear of oil and debris
- o The compressor and turbine blades were intact and mostly undamaged
 - No evidence of debris related damage
- o The turbine housing outlet exhibited spiral streaking which appeared to be from a fluid
- o Both the turbine and compressor wheels were rotated by hand
 - They moved freely however there was scratching and slight binding along one edge of both the turbine housing and compressor housings
 - Damage was consistent with impact damage
- o Balance cuts were present on the turbine and compressor wheels
- o The oil outlet port of the center housing was removed, and the inside was well oiled
 - No evidence of coking, excessive heat, foreign object debris or lubrication blockage
- Left side Turbocharger
 - o Exhaust intake into the turbocharger housing was clean and clear of debris
 - o The turbine housing outlet exhibited spiral streaking which appeared to be from a fluid
 - o The turbine and compressor wheels were rotated by hand and rotated freely
 - o Balance cuts were present on both the turbine and compressor wheels
 - o Turbine housing inlet was clear of debris and oil
 - o Compressor outlet clear of debris and oil
 - o The compressor and turbine blades were intact and undamaged
 - No evidence of debris related damage
 - o The oil outlet port of the center housing was removed, and the inside was well oiled
 - No evidence of coking, excessive heat, foreign object debris, or lubrication blockage
- The slope controller sustained minimal damage and was removed from the engine
 - o The attachment points were fracture separated
 - o Some wetness at the deck pressure sense port was noted
- The pressure relief valve was removed from the engine and was mostly undamaged
 - o The pressure relief valve was installed onto a test table
 - It opened at 38.5 inches of mercury
 - Specifications indicate it should be 39.9 ± 0.25
- The waste gate sustained impact damage and was removed from the engine
 - o Sooting was noted on both sides of the waste gate body duct; however, it was mostly on the downstream side of the valve.
 - o The waste gate valve moved freely

- It was noted that the actuator mounting base was fractured and the control arm was bent consistent with impact damage
- The induction system was removed from the engine
 - It sustained heavy impact damaged and was fractured and separated throughout
- The baffling exhibited heavy crush damage and it was removed
- All of the spark plugs were removed from the engine and exhibited “RICH” operating signatures
 - All of the massive electrodes were circular
 - All of the spark plugs were very sooty and black in color
- The starter was removed
 - The starter adapter sustained impact damage.
- The alternator was removed from the engine
 - The alternator drive was oily and undamaged
 - It rotated freely when manipulated by hand
 - The rubber seal was intact and undamaged
- The magnetos were removed from the engine
 - The ignition harness was removed from the magnetos
 - A slave harness was attached to the magnetos and they were installed onto a test bench:
 - Both magnetos operated normally with a strong spark over a 7 mm gap
- The oil filter was removed from the engine and cut open
 - Oil was present and the filter was clear of debris
- The throttle body was removed from the engine. The throttle moved freely, but was “stiff”
 - During disassembly, fuel came out of the throttle body
 - The fuel smelled consistent with 100LL Avgas
- The valve covers were removed, and the rocker arms exhibited normal wear signatures
- Torque was tested on the cylinder bolts and all were normal
- The oil sump cover was removed and oil was present
 - The oil sump cover was crushed upward into the oil sump
 - The oil pick-up screen exhibited extensive crush damage, however, it was clear of debris.
- The engine was unable to be rotated by hand
- The cylinders were removed from the engine

- o The internal components of all six cylinders were extremely sooty consistent with an overly rich condition.
 - o The intake and exhaust valve heads in all six cylinders were extremely sooty
- The pistons:
 - o All six piston heads were extremely sooty and exhibited combustion deposits consistent with an overly rich operating condition
 - o The piston rings on all six pistons exhibited normal wear signatures and the ring gaps were spaced properly
 - o The piston pins on all six cylinders exhibited normal wear signatures and were easily removed from the piston head/connecting rods.
- The hydraulic lifters were removed from the engine and exhibited normal wear signatures
- The crankcase exhibited vertical cracks just aft of the propeller attachment point
 - o The crankshaft would not rotate by hand
 - o The crankcase was split in half along the spine and the internal components were well oiled
 - Both halves of the fourth main bearing support were cracked
 - The crankshaft was found pushed aft against the back of the crankcase
 - The bearings exhibited normal operating wear signatures
- The camshaft was removed from the crankcase
 - o The cam lobes exhibited normal wear signatures
- The crankshaft was removed from the crankcase
 - o The slinger/thrust washer was fracture separated from the crankshaft

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1.1 Engine photos



Figure 1: Spiral Streaking on the Right Turbine Housing



Figure 2: Spiral Streaking on the Left Turbine Housing



Figure 3: Waste Gate



Figure 4: Spark Plugs



Figure 5: Valves



Figure 6: Cylinders



Figure 7: Camshaft



Figure 8: Crankshaft and Connecting Rods

2.0 Propeller Assembly Examination

- The propeller assembly was removed from the engine
 - Spinner dome was torn and crushed aft into the propeller hub.
 - The spinner forward bulkhead was crushed against the propeller hub
 - The cylinder was crushed and fragmented
 - The pitch change rod was bent and jammed into the high pitch position
 - Pitch change rod was fractured aft of the piston
 - The propeller mounting flange was intact and undamaged (on the hub)
 - The forward hub half wall was compressed aft and fractured.
 - The inside of the aft hub half was compressed aft and fractured
 - Preload plates

- Preload plates showed pitch change fork damage
- 2 preload plate pockets showed impact damage
- Preload plate B retention lip was found sheared consistent with impact forces in the aft direction.
- Propeller Blades were removed and disassembled:
 - Blade C was fractured from the assembly
 - Blades A and B were cut to facilitate shipping
 - Blade A and C exhibited chordwise scoring on the face side
 - All blades exhibited gouging on the trailing edge consistent with contact with the airplane's cowl.
- The propeller governor
 - Oil was present
 - Gasket screen was clear of debris
 - The shaft rotated freely when rotated by hand
 - Oil was pumped out
- All damage was consistent with high impact forces.
- No discrepancies were noted that would precluded normal operations.

2.1 Propeller Assembly Photos



Figure 9: Spinner



Figure 10: Propeller Hub



Figure 11: Propeller Blades



Figure 12: Disassembled Propeller Hub



Figure 13: Face side of Propeller Blades

3.0 Engine Run

- The fuel pump, slope controller, and the manifold valve were installed onto a slave engine to be run in a test cell.
- The slave engine was installed into a test cell
 - The slave engine started uneventfully and idled for a warm up
 - The power was increased to full power; however, the RPM would not exceed 1800 RPM and the manifold pressure and turbo pressure were both about 30 inches of mercury.
 - The accident slope controller was disconnected from the engine and the waste gate was manually closed.
 - The slave engine was restarted; however, it was still not producing adequate RPM. The manifold and turbo pressure were noted to be adequately different
 - The slave fixed pitched propeller was examined and found to be at the improper angle. The propeller blades were adjusted properly, and the slope controller was reconnected.
 - The slave engine was restarted, and the manifold pressure and turbo pressure were, once again, the same.
 - The slave engine was stopped and the accident slope controller was removed from the engine and a new one was installed.
 - While removing the sense line, oil came spilling out of the line indicative of damage to the internal components of the slope controller.
 - The slave engine was restarted and it was noted that at about 2300 RPM the engine started to surge. It was unable to make it to full power.
 - The fuel pressure reading indicated 234 PSI, which is consistent with 39 gallons per hour.
 - Specifications indicated the fuel pressure should be between 210-220 PSI
 - Note: the slave engine was surging because the fuel flow became too high, therefore, the fuel pump would adjust to decrease the fuel, but the fuel flow would slowly increase again, etc.
 - The accident engine driven fuel pump adjustment screw was measured with a caliper and it was extended 0.4725 inches. The pump was adjusted one and a half turns in the lean direction.
 - The slave engine was restarted with the leaner accident engine driven fuel pump and it ran up to 2566 RPM (full power) with the fuel flow between 200-

213 PSI. We activated the test cell boost pump (unknown PSI) and the engine quit.

- The exhaust pipe was removed from the engine and no spiral streaking was noted on the turbocharger
- o The accident engine driven fuel pump adjustment screw was readjusted one and a half turns back to its approximate original position (caliper reading of 0.4740 inches).
- o The slave engine was restarted and was increased to full throttle. The engine started to surge, and the fuel pressure gauge varied from 220 PSI all the way up to 261 PSI (consistent with 44 gallons per hour). Towards the top of the engine surge, the fuel pressure gauge stayed between 250-260 PSI before spiking and returning to about 220 PSI.

3.1 Engine Run Photos

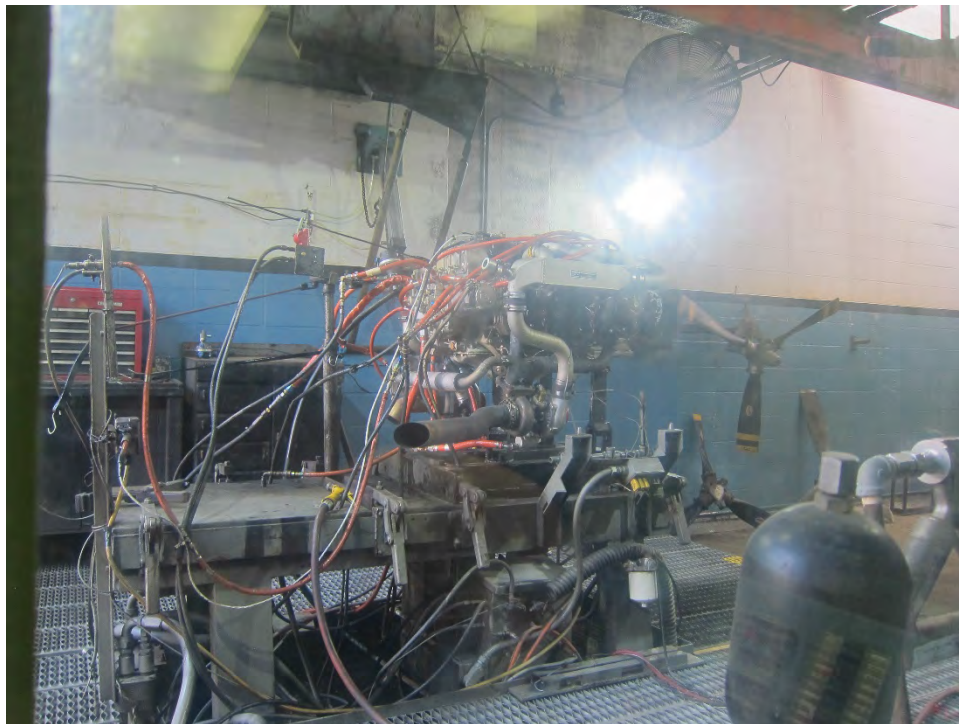


Figure 14: Slave Engine Running in Test Cell

END.

Submitted by: Samantha Link