



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Western Pacific Region

AIRFRAME AND ENGINE EXAMINATION

WPR17LA172

Accident Date: July 31, 2017
Exam Dates: August 9-10, 2017

This document contains 41 embedded images

A. ACCIDENT

Location: Llano, California
Date: July 31, 2017
Aircraft: Cessna T-210F, N6109R, Serial # T210-0009
NTSB IIC: Michael Huhn

B. EXAMINATION PARTICIPANTS:

Michael Huhn
Air Safety Investigator
NTSB
Western Pacific Region

Michael Council
Air Safety Investigator
Continental Motors
Mobile, AL

C. SUMMARY

While on a cross-country flight, the pilot was unable to achieve the target/normal manifold pressure (MP) values. He made a precautionary landing, and had an aircraft mechanic examine the engine; no anomalies were noted. The pilot then departed on the continuation of his trip. While in cruise, the pilot noticed that the oil pressure had dropped to 0 psi. The pilot retarded the throttle, and diverted towards Crystal Airport. The airplane touched down in the desert terrain about 1 mile short of the diversion airport. The airplane was substantially damaged during the forced landing near Llano, California. Subsequent to the accident, the pilot reported that a "top overhaul" of the engine had been completed about 11 flight hours prior to the accident.

On-scene FAA examination of the airplane revealed that there was no measurable oil in the engine; there were no obvious indications of an oil leak or overboard venting, or any catastrophic internal mechanical failures of the engine. The airplane was recovered to Air Transport in Phoenix where it was examined in more detail. That examination by representatives of Continental Motors (CMI) and the NTSB was conducted on August 9-10, 2017. When the engine was manually rotated, the No. 1 piston was immobile in its cylinder, the No. 1 exhaust valve was stuck open, and the No. 1 intake valve remained closed. All other cylinders appeared to be normal.

This report documents the findings of the Phoenix exam. Based on these results, it was decided to remove the engine and ship it to CMI in Mobile AL for a full teardown and examination; those results will be documented separately.

The maintenance- and maintenance records-related information is documented separately from this report.

D. AIRFRAME INFORMATION

1.0 General

The wings, vertical stabilizer and elevator had been removed by the recovery crew. The engine, propeller and engine cowlings remained intact and in place. An examination of the external fuselage, including the belly, revealed the presence of oil and/or grease on some the surfaces, which had then resulted in an accumulation of dust. The oil/grease was generally consistent with normal in-service levels, particularly on the fuselage sides. The belly accumulation was slightly heavy, but could not on its own be considered as indication/confirmation of an oil leak or overboard venting that would account for the complete loss of engine oil. No oil was dripping from the fuselage. Recovery personnel stated that there was no oil staining on the ground at the accident site, and that no oil had leaked or dripped onto the trailer used to recover the airplane.

There was some evidence of possible oil on the exterior cowling near the cooling air inlets, and its source was not obvious, nor was it consistent with the complete loss of oil. No oil residue was observed on the wings, horizontal stabilizers, or elevators.

The pilot reported that he personally last cleaned the airplane underside ('belly') on July 30, 2017.



Figure 1 - Oil on Airplane Underside (view forward)



Figure 2 - Underside (view aft)



Figure 3 - Underside (view forward)

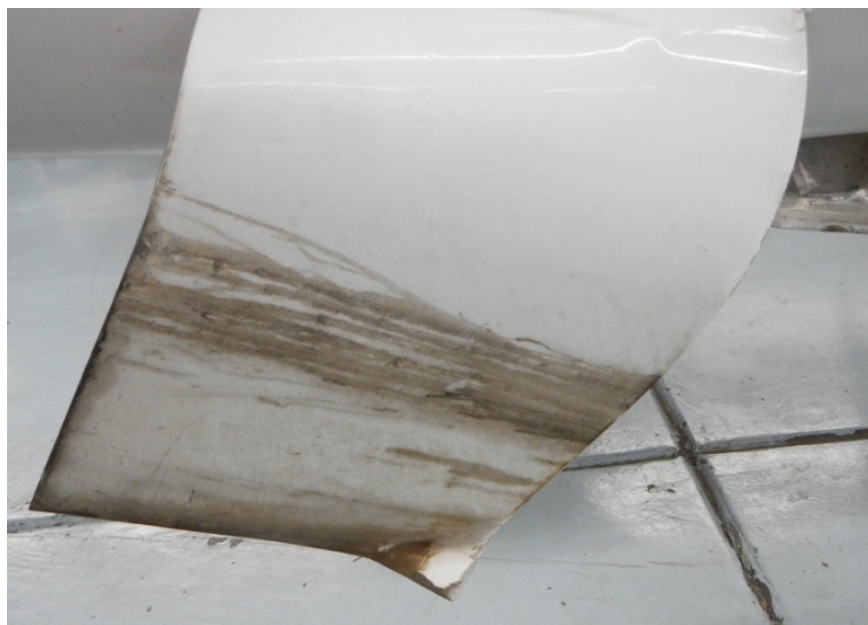


Figure 4 - Right MLG Door



Figure 5 - Left MLG Door



Figure 6 - Trace Oil Residue on Inlet



Figure 7 - Trace Oil Residue on Inlet



Figure 8 - Trace Oil Residue on Inlet



Figure 9 - Oil-Free Horizontal Stabilizers and Wings

2.0 Cockpit Instrumentation

The cockpit master switch was turned on to supply battery power to the cockpit instruments. The electronic "Horizon" brand tachometer indicated that the "Tachometer Time" was 3,534 hours (no decimal point).

An intact JPI EDM-700 engine monitor was removed from the airplane, and shipped to the NTSB Recorders Laboratory for possible data extraction. The device was serial number 15817, manufactured 2002, with software PN 302661 Rev 2.9

E. ENGINE INFORMATION

1.0 General

The top engine cowling panels were removed to facilitate an examination of the engine. There were no obvious indications of any catastrophic failure of the engine or any of its components, nor were any holes observed in the crankcase. There were no obvious indications of heavy/abnormal oil leakage or spray on the engine or interior surfaces of the engine compartment. There were no indications of any separation failure or disconnection of any electrical or fluid lines in the engine compartment.

The engine case halves were both stamped "WDC50270".

The engine dataplate indicated the following:

Model: TSIO-520-C (overstamped with a "C" and an "M")

Serial: 140012 – 5 – C

Continental Motors Records indicate that that engine serial number was shipped new to Cessna in May 1965.

The "C" overstamp denotes a "field conversion" (modified by other than CMI) of the engine, and the "M" denotes the resulting (new) engine model. The CMI-manufactured TSIO-520C engine is rated at 285 hp at 2700 rpm. The CMI-manufactured TSIO-520M engine is rated at 310 hp for takeoff (5 minutes maximum) at 2700 RPM, 285 hp continuous operation, and 230 hp recommended cruise. The accident airplane data plate was not modified to show these (or any) changes to the power rating.

The CMI representative noted that Ram Aircraft is a known converter of CMI engines and T210 airplanes. The accident airplane had a "RAM T210" decal on the engine cowl. However, to date, no maintenance records indicating a "Ram" conversion have been located.



Figure 10 - Left Nose Region



Figure 11 - Interior Surfaces of Engine Cowl Panels



Figure 12 - Left Upper Engine



Figure 13 - Upper Engine



Figure 14 - Right Upper Engine



Figure 15 - Engine Data Plate



Figure 16 - Engine Case Half ID Stampings

2.0 Spark Plugs

The top spark plugs were removed and inspected. All 6 were Champion RHB32S. When compared to a Champion Spark Plug “Check A Plug” chart, all top spark plugs appeared to have normal wear, with a slightly dark coloration. All spark plugs had an odor of fuel present. The porcelain insulator was found fracture-separated in the top spark plug from the No. 1 cylinder. The timing of the fracture was not determined.

The appearance of all 6 top spark plugs was consistent with significantly more than 11 hours in service. Subsequent discussion with the pilot revealed that 3 new spark plugs were purchased and installed for the top overhaul, while 9 were re-used.



Figure 17 - Top Spark Plugs

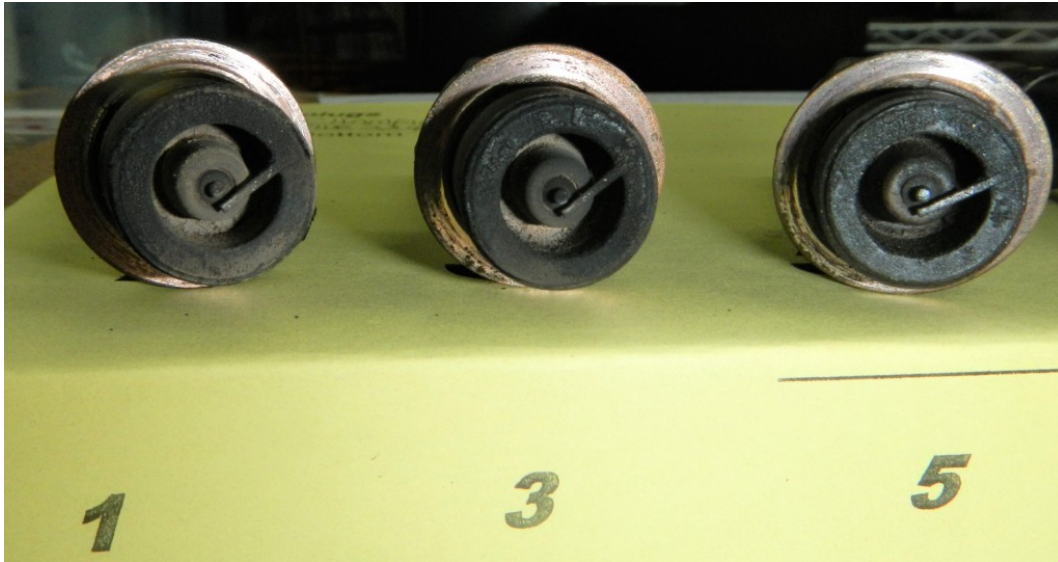


Figure 18 - Top Spark Plug Electrodes

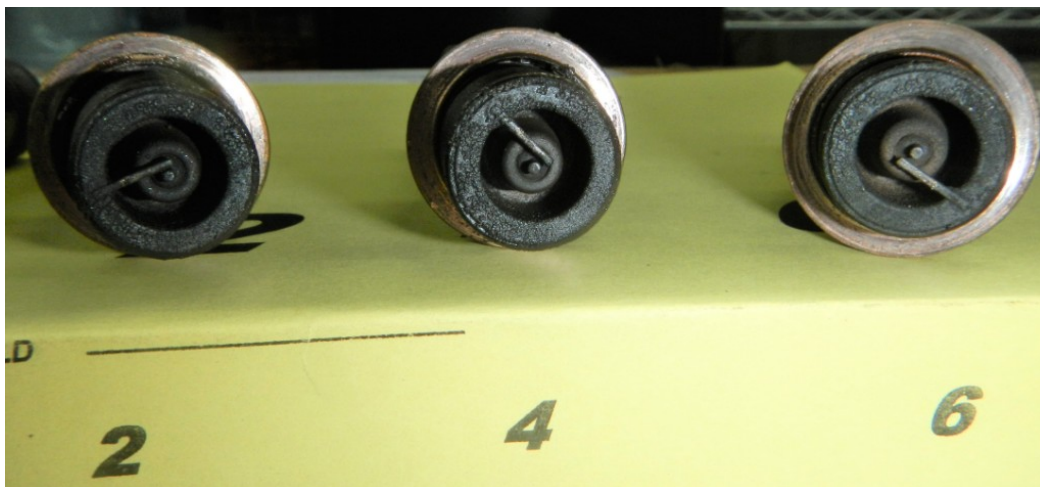


Figure 19 - Top Spark Plug Electrodes



Figure 20 - Fractured Insulator, Top No. 1 Cylinder

3.0 Propeller

The three-blade constant speed propeller remained attached to the engine crankshaft propeller flange. All three propeller blades exhibited smooth rearward bending at about their 2/3 span points, consistent with ground contact, and little or no engine power. No torsional twisting of the blades was observed. All three propeller blades were free to rotate within the propeller hub.

The propeller Model number was McCauley D3A34C402-C. The blades were arbitrarily labeled A, B & C. Access to the hub enabled correlation with the hub blade numbering scheme.

Letter	Number	Remarks
A	3	Least deformed. Least chordwise scoring. 1/3" LE nick/gouge
B	1	Significant chordwise scoring
C	2	Most deformed. Significant chordwise and spanwise scoring



Figure 21 -Blades in Hub



Figure 22 - Blade 'A' (uncambered side)



Figure 23 - Blade 'B' (uncambered side)



Figure 24 - Blade 'C' (uncambered side)



Figure 25 - Blade 'A' (cambered side)



Figure 26 - Blade 'B' (cambered side)



Figure 27 - Blades and Hub with Blade 'C' in Foreground (cambered sides)

4.0 Manual Engine Rotation

With all spark plugs still installed, the engine was free to rotate smoothly when the propeller was manually rotated in its normal rotation direction, and appeared to provide less resistance than expected/normal. Both magnetos remained intact and attached, and their impulse couplings snapped normally when the engine was manually rotated in its normal rotation direction.

With the six top spark plugs removed, when the engine was manually rotated, thumb compressions were achieved on all cylinders except No. 1. An electronic borescope inspection of that cylinder was performed. The borescope inspection showed that when the engine was manually rotated, the piston did not move up or down in the cylinder, the exhaust valve was fixed in the open position, and the intake valve was fixed in the closed position. No movement of the valves was exhibited when the engine was manually rotated.

Crankshaft continuity was confirmed by rotation of the starter adapter PTO drive on the rear of the engine. The No. 1 cylinder rocker box cover was removed. Both rocker arms were intact. The exhaust valve rocker arm was depressing the valve, and the spring tension was not relieved when the engine was rotated. The intake valve pushrod could be seen inside its pushrod tube, but the pushrod did not extend to the rocker arm; there was an approximate $\frac{3}{4}$ " gap between the two. The cause was not determined.

At this point in the examination, it was decided that no further disassembly of the engine would be conducted in Phoenix. The engine was removed intact from the airplane, in preparation for shipment to Continental Motors in Mobile, Alabama for detailed examination.

The remote-mounted oil filter was removed, drained, and bagged, and will be shipped to CMI for an examination along with the engine.

Once the engine was removed from the airplane, the engine compartment was able to be examined in greater detail. With the exception of the right cowl flap and lower cowling area, there were no indications of excessive oil presence in the compartment. The source of the oil stains was not positively determined, but it was directly below the No. 1 cylinder rocker assembly, which leaked oil when the rocker cover was removed. It was also only slightly displaced from being directly below the externally-mounted spin-on oil filter location.

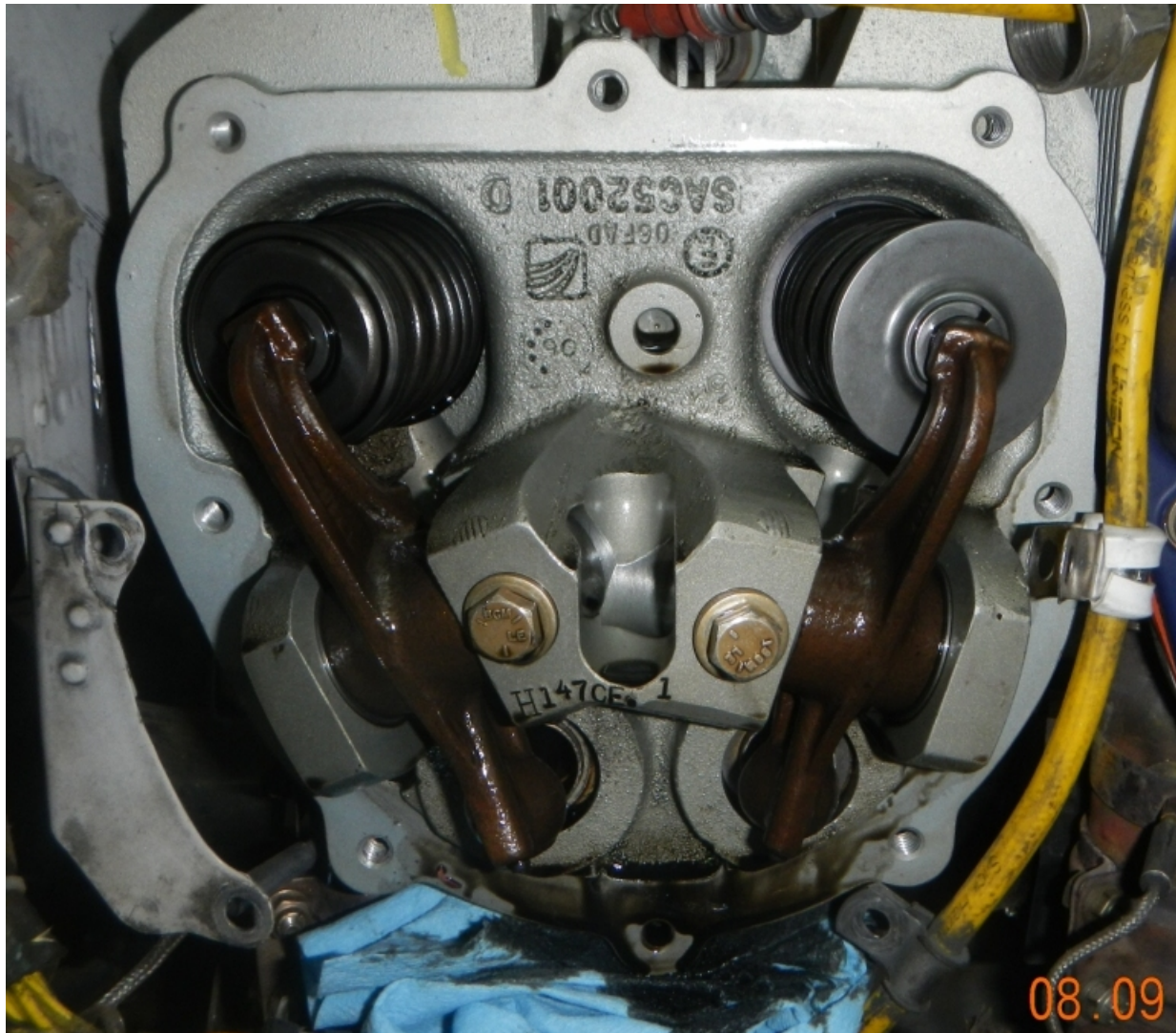


Figure 28 - Rocker Assembly Cylinder No. 1

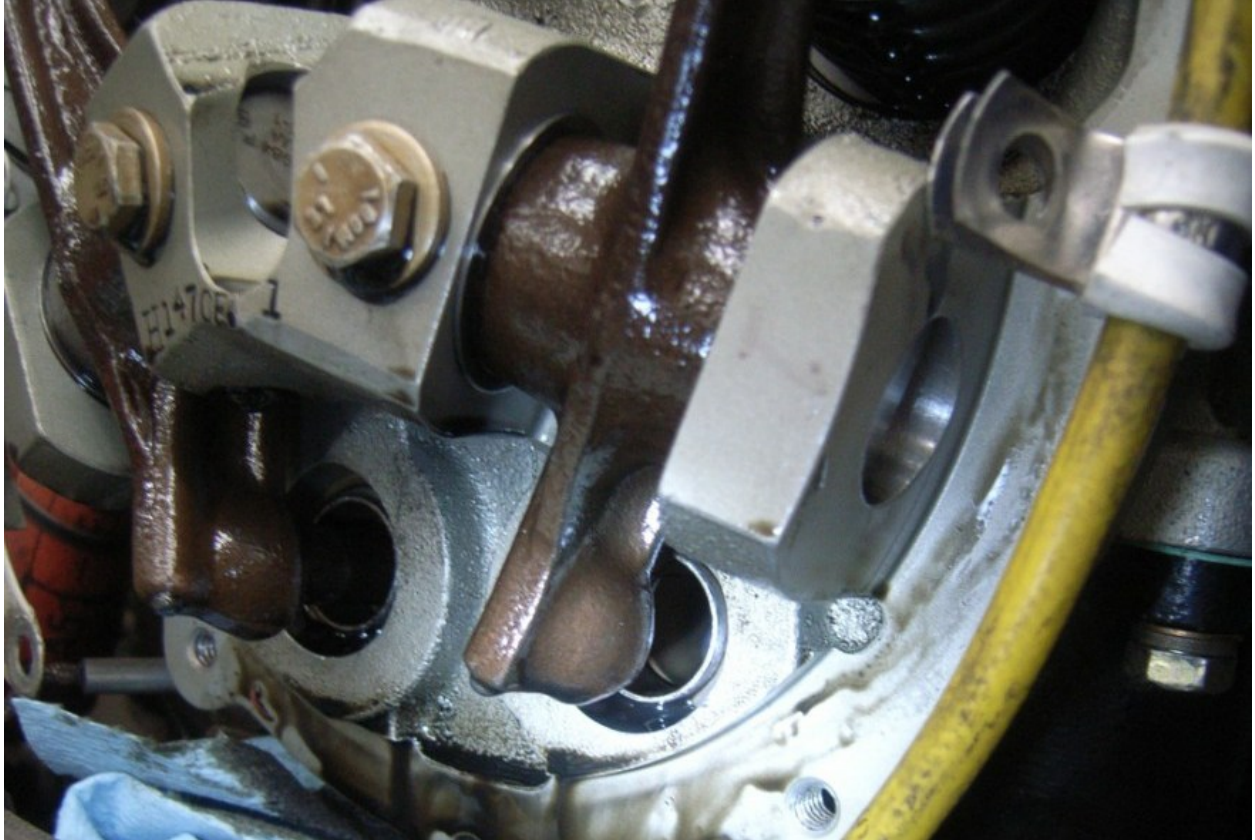


Figure 29 - Cylinder No. 1 Intake Rocker

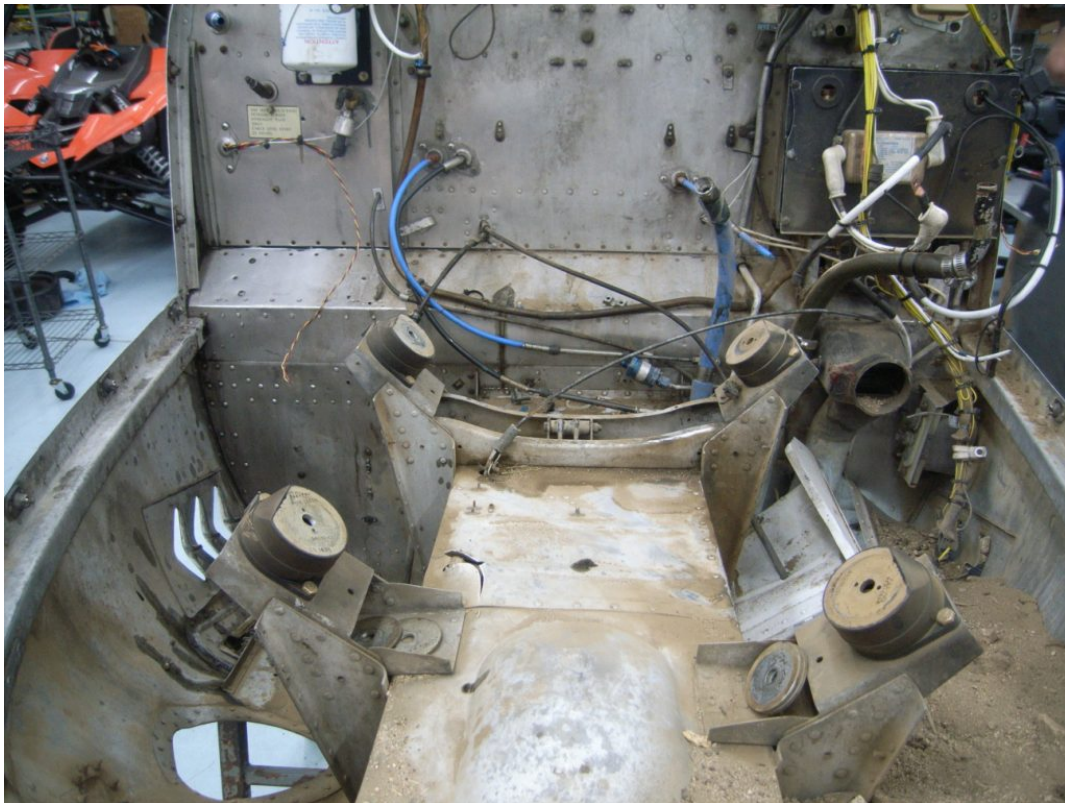


Figure 30 - Engine Compartment with Engine Removed

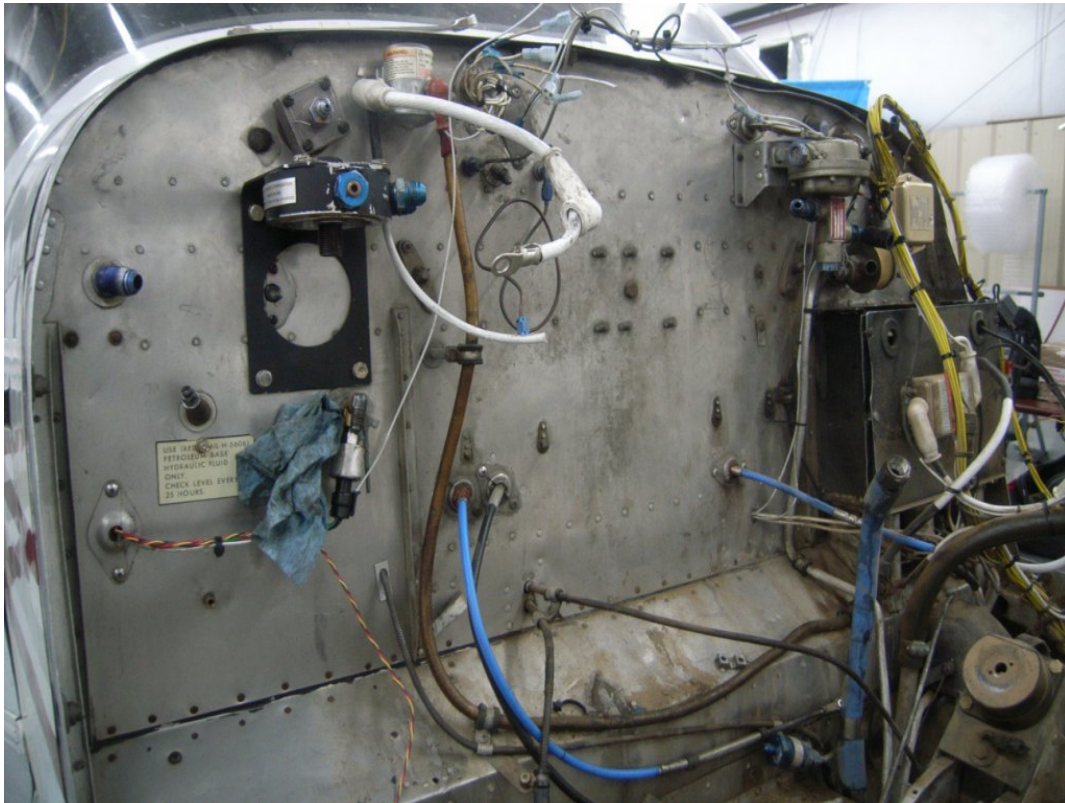


Figure 31 - Firewall with Engine Removed



Figure 32 -Right Aft Engine Compartment (engine removed)

5.0 Air-Oil Separator

The engine was equipped with two air-oil separators plumbed in series. One was located atop the engine, about 12 inches aft of the engine case breather. The second separator was located just aft of the aft transverse engine baffle; it was plumbed so that it drained the recovered oil into the oil dipstick tube, and vented the crankcase air to an opening near the left cowl flap.

6.0 Oil 'Dipstick' and Sump Information

The engine oil quantity rod ("dipstick") was removed, wiped clean, then reinserted in its tube. The oil level on the oil rod indicated that only a small amount (approximately one quart) of oil remained in the engine oil sump. The dipstick tube was undisturbed by the accident, and was oriented nearly horizontally, almost parallel to the airplane lateral axis. The overall tube extension from the side of the engine case measured $15 \frac{3}{4}$ inches. The dipstick had an overall length (including handle) of about 24 inches. The 'blade' portion of the dipstick measured about 22 inches. The blade was graduated on both sides to 12 quarts; one side contained machine-stamped numbers, while the other side bore hand-engraved numbers. The two scales were congruent. No part number was observed on the dipstick.

The oil sump had been fitted with a 'quick-drain' type valve to its drain plug location. That valve was found in its close position, and there were no indications that it had inadvertently been left open, or that it was leaking.

The engine oil sump was drained. Approximately one quart of dark oil was obtained from the sump. Full sump capacity is 12 quarts.



Figure 33 - Oil Rod with Trace Oil Quantity



Figure 34 - Oil Rod with Scale



Figure 35 - Oil Rod Tube (with scale)

7.0 Unopened Oil Container Information

Three quart-size unopened containers of AeroShell brand piston engine oil were found in the cabin. Two containers were identified as "W100 Plus," and the third was identified as "W15-50." Two of the containers had date stamps on them; one was dated "21JUL14" and one was dated "27MAR17." The NTSB IIC telephoned the AeroShell customer service line to determine the meaning of the dates stamped on the bottles, and to verify that these items were for ashless dispersant oil, and not the straight mineral oil that is to be used for engine/cylinder break-in. The AeroShell representative stated that the dates were the manufacture date of the oil, and that it was recommended to use the oil within 4 years of manufacture, or else have it tested prior to use. He also stated that the "W" prefix indicated Ashless Dispersant oil, which confirmed that none of the identified containers were for straight mineral oil that is to be used for aviation engine break-in.

According to the pilot, "Procraft [the facility that reassembled the engine after the cylinders were overhauled] put in 12 qts at top end overhaul. I bought 4 qts in Auburn, put 2 in the motor which brought the level back up to 12. This was about 8 hrs after overhaul. The other 2 qts should be in the baggage compartment of the airplane."

The pilot provided a receipt for the purchase of 4 quarts of AeroShell mineral oil from the FBO in Auburn. The evidence indicates that despite requesting it, he was not sold straight mineral oil, but rather Ashless Dispersant oil. According to Shell technical support, aside from slightly changing the engine break-in wear characteristics, there would not be any adverse effects of intermixing the two oil types.



Figure 36 - Oil Containers Recovered from Cabin

Full Throttle Aviation
 [REDACTED]
 Auburn, CA 95602
 [REDACTED]

PAID
 07/31/2017

Invoice

Date	Invoice #
7/31/2017	2017-264

Bill To

Terms	P.O. No.
Due on receipt	

Item	Quantity	Description	Rate	Amount
oil 100 m	4	Aeroshell 100w mineral oil	7.25%	

Figure 37 - Pilot's Oil Receipt

8.0 Safety Wire Observations

The engine oil pump assembly was installed at the bottom aft of the engine accessory face, a location which inhibits ready physical and visual access. After the engine was extracted from the airplane, two items on the oil pump were found to be partially safetied. These were the oil pressure relief valve (partially/incorrectly safetied) and a plug on the pump lower side (safety wire found cut, consistent with a removal/disassembly step). Based on their appearance, although neither was in accordance with accepted maintenance standards, both items were sufficiently constrained to prevent their unintentional rotation.

Two clamps (at least one of which was a "V-band" clamp) were secured with metal self-locking nuts, but were not safety-wired.



Figure 38 - As-Found Cut Safety Wire



Figure 39 - Non Safety-Wired Clamp



Figure 40 - Non Safety-Wired Clamp

9.0 Turbocharger Information

The turbocharger was mounted near the lower aft right side of the engine. Tactile and then visual examination of the turbocharger compressor inlet revealed that several blades were broken. Once the engine, with the turbocharger still attached, was removed, it was observed that three of the eight first stage rotor blades were fractured at about their one-half span

locations, and that the surrounding inlet case was heavily scored. The three fractured blades were adjacent to one another. The blade fragments were not observed in the wreckage. The compressor rotor rotated freely, and had about 1/8" axial and radial freeplay. Preliminary examination did not indicate the timing of the damage relative to the accident.

Review of the maintenance records indicated that the turbocharger and wastegate were overhauled in October 2004. A turbocharger "inlet hose" was replaced in June 2011, and the wastegate was lubricated in September 2013. No other turbocharger maintenance or inspection entries were noted.



Figure 41 - Fractured Turbocharger Compressor Blades