



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Western Pacific Region

ENGINE EXAMINATION

WPR17LA097

This document contains 18 embedded photos.

A. ACCIDENT

Location: Santa Barbara, California
Date: May 5, 2017
Aircraft: Robinson R44, Registration Number: N981RR, Serial #: 0961
NTSB IIC: Elliott Simpson

B. EXAMINATION PARTICIPANTS:

Elliott Simpson
Aviation Accident Investigator
Los Angeles, California

Mark Platt
Air Safety Investigator
Lycoming Engines
Williamsport, Pennsylvania

Thom Webster
Aviation Safety Investigator
Robinson Helicopter Company
Torrance, California

Jerry Dees
Aviation Safety Inspector
FAA FSDO
Van Nuys, California

C. SUMMARY

Examination of the recovered engine was conducted on May 15, 2017 at the facilities of South West Aircraft Parts at Chino Airport.

Engine Model: O-540-F1B5
Serial Number: RL-9647-40E
Time Since Factory Overhaul: 1473.6 (At annual 4/5/17)
Rebuild Date: 9/5/2011

D. DETAILS OF THE INVESTIGATION

1.0 Engine Examination

The engine remained attached to the aft frame engine support assembly and the forward engine mounts. The frame was generally compressed in a downward direction, with the upper firewall resting against the magnetos (Photo 1). The engine sustained thermal damage, partially consuming most of its ancillary components. The lower sheave and fanwheel assembly remained attached to the crankshaft. The spring pin and safety wire for the nut connecting the fanwheel to the lower sheave shaft and bearing assembly, appeared offset about 20 ° clockwise (when viewed from the rear of the helicopter), relative to the torque seal reference lines (Photo 2).

The entire cylinder number 3 assembly had separated from the engine, and was located about ¼ mile from the accident site (Photo 3).

The upper portion of the crankcase deck, at the interface with the flange at the base of cylinder number 3 remained intact, and included the remnants of the top forward stud and the two center studs. (Photo 4) The top threaded portion of the aft carry-through bolt had detached; the remainder of the bolt was present, but had moved towards the center of the piston area, breaking away the flange of the deck (Photo 4). A square-shaped imprint on the inner radius of the upper deck was of a size that matched the approximate width of the connecting rod (Photo 4). The lower section of the deck, adjacent to the underside of the crankcase, along with the entire oil sump assembly was not present. The lower carry-through bolt had separated about flush with the deck, with the bolt remnants exhibiting downward bending and necking deformation (Photo 4).

The crankshaft could be viewed through the opening, and appeared intact. The number 3 connecting rod remained attached to the crankshaft, and protruded from the opening (Photo 4). The small end of the rod was not present, and the obliterated inner radius at the rod end was all that remained (Photo 5).

The cylinder head assemblies and pistons for numbers 1, 2, 5 and 6 were removed and examined. Cylinder 4 (opposite from cylinder 3) exhibited damage to the piston liner, and as such could not be removed. During disassembly, all carry-through bolts were removed, although thermal damage necessitated the use of heavy impact force to drive them through the crankcase.

Examination of the cylinder flanges for all removed cylinders revealed similar signatures in the area of deck contact including polishing of the machined surfaces, pitting, and brown corrosion deposits (Photos 6,7). The corresponding contact surfaces on the crankcase deck exhibited similar but signatures, along with gouges up to 1 mm deep in the deck surfaces at the edge of the cylinder flanges (Photos 8,9,10).

All removed pistons exhibited similar grey-brown deposits, with no obvious indication of valve contact. The valves, springs, and rocker arm assemblies for each cylinder were intact and undamaged. The valves were removed and examined, they slid easily out of their valve guides, and did not exhibit any indications of valve head “mushrooming” or burs to the areas in contact with the valve keys (keepers). The valve keys and exhaust valve caps were all undamaged. The pushrods appeared to be straight.

The piston remained within the detached cylinder number 3. The piston pin was in place, and sustained minimal damage. The raised flanges of the cylinder sleeve exhibited outward bending and material separation consistent with connecting rod contact (Photo 11). The spark plugs were removed, and the piston crown and head were examined with a borescope. The crown exhibited light grey deposits, and both valves were intact and undamaged. Both spark plugs exhibited bending damage to each center electrode, bringing them in contact with their respective case electrodes. Neither of the pushrods were recovered.

The upper mounting holes on the piston skirt flange did not contain any studs, and all holes were elongated in the upwards direction (Photo 11). A separated stud head remained within the mounting

hole at the left center position of the lower flange hole, all other flange holes were empty, and the entire lower flange was bent (Photo 11).

The accessory housing assembly was removed; the crankshaft, camshaft, and both crankshaft idler gears were intact and undamaged. The remaining two forward carry-through bolts at the rear end of the forward crankshaft bearing and their associated nuts were removed, and the crankcase was opened. The crankcase contact area for the two bolts exhibited significant galling damage, which had cut about 2 mm into the crankcase material (Photo 12,13).

The crankcase-to-crankcase contact areas exhibited light pitting and polishing throughout (Photo 14,15), with more exaggerated pitting, polishing signatures concentrated at the rear end of the forward crankcase bearing saddle area (localized primarily at the upper clamping area of the carry-through bolts that had created galling damage to the crankcase (Photo 16)), and all of the crankshaft bearing webs.

The oil filter had sustained thermal damage and was removed from the housing and disassembled. The filter element was black and charred, and contained bronze-like debris similar in appearance to connecting rod (piston-end) bearing material (Photo 17). The camshaft was intact, and all lobes and bearing surfaces were shiny in appearance and free of score marks.

The crankshaft could not be rotated through virtue of the seized number 4 piston. All counterweights were intact, and all main journals were either shiny and smooth in appearance or coated in burnt oil. The associated bearing surfaces were all shiny in appearance, and free of radial gouges, with the surface for bearing number 5 exhibiting globular molten features. The number 3 and 4 journal bearing webs exhibited indentations adjacent to the contact area of the outer keyway of each reciprocal bearing half (Photo 18). No such indentations were observed on any of the other journal bearings.

1.1 Engine Examination Photos

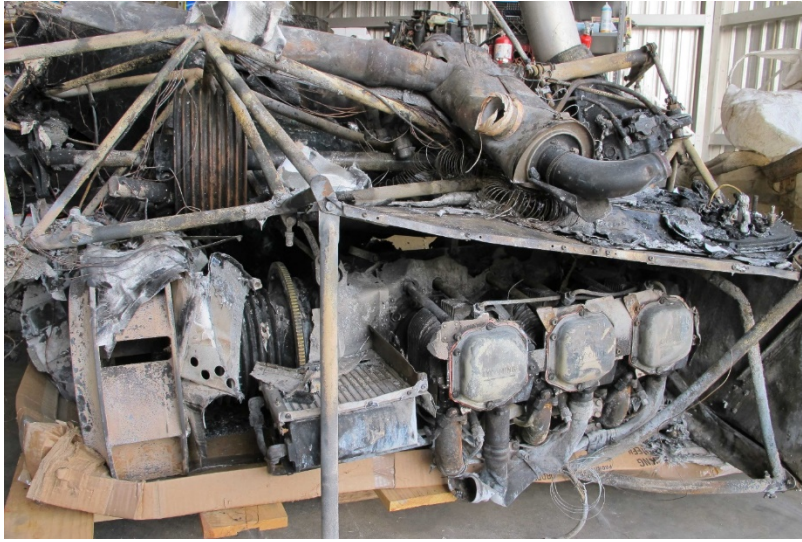


Photo 1 – Engine in Airframe



Photo 2 – Fanwheel to Lower Sheave Nut



Photo 3 – Cylinder Number 3



Photo 4 – Number 3 Connecting Rod



Photo 5 – Number 3 Connecting Rod



Photo 6 – Cylinder Flange



Photo 7 - Cylinder Flange



Photo 8 – Crankcase to Cylinder Flange Deck Surface

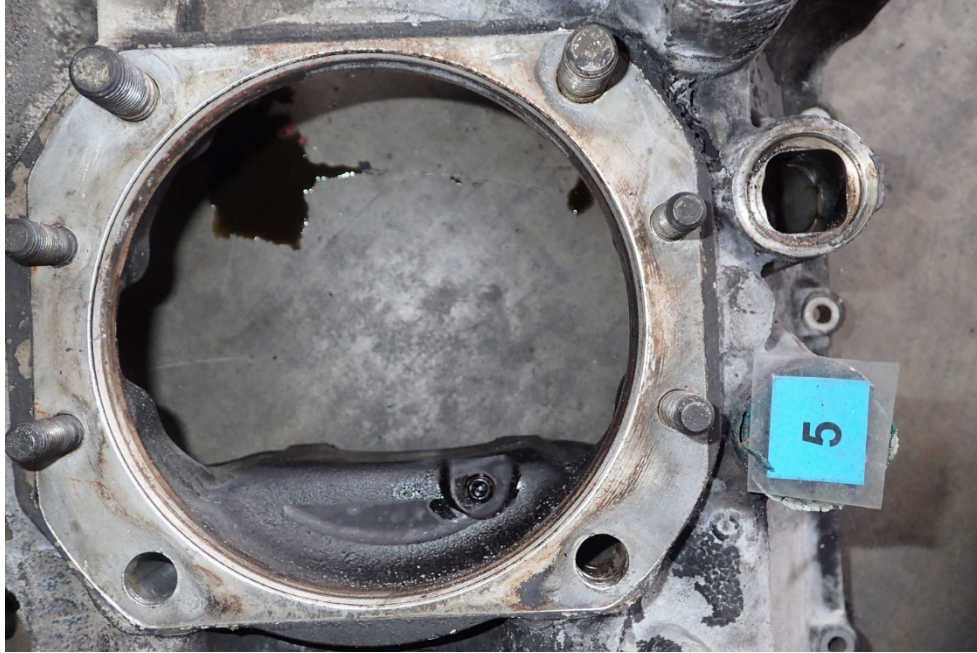


Photo 9 – Cylinder 5 Crankcase to Cylinder Flange Deck Surface



Photo 10 – Gouging on Crankcase to Cylinder Flange Deck Surface

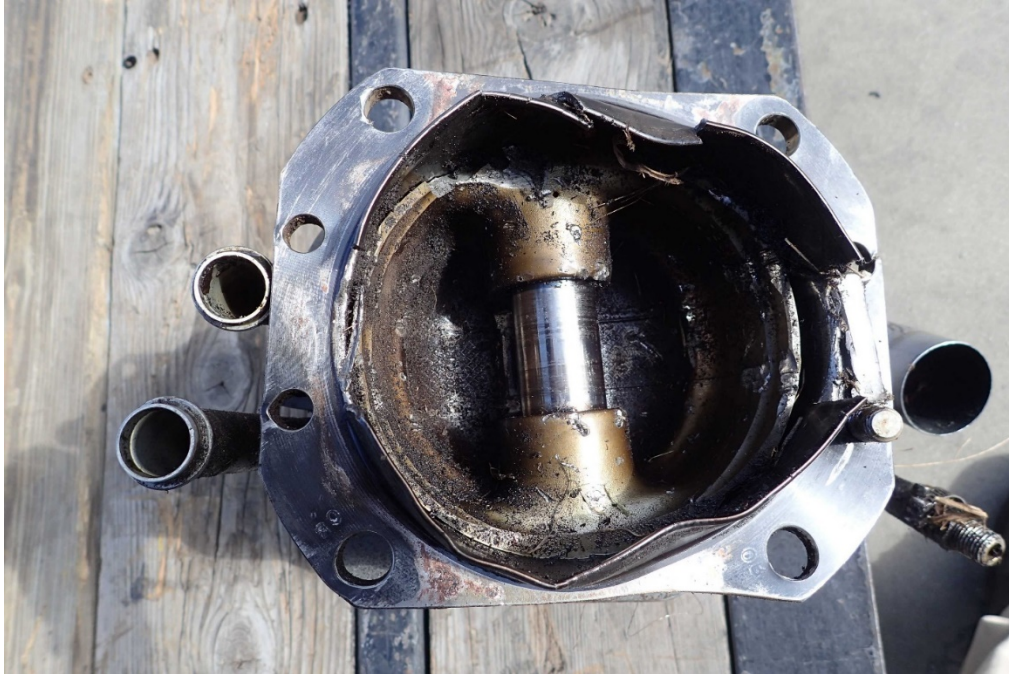


Photo 11 – Number 3 Cylinder

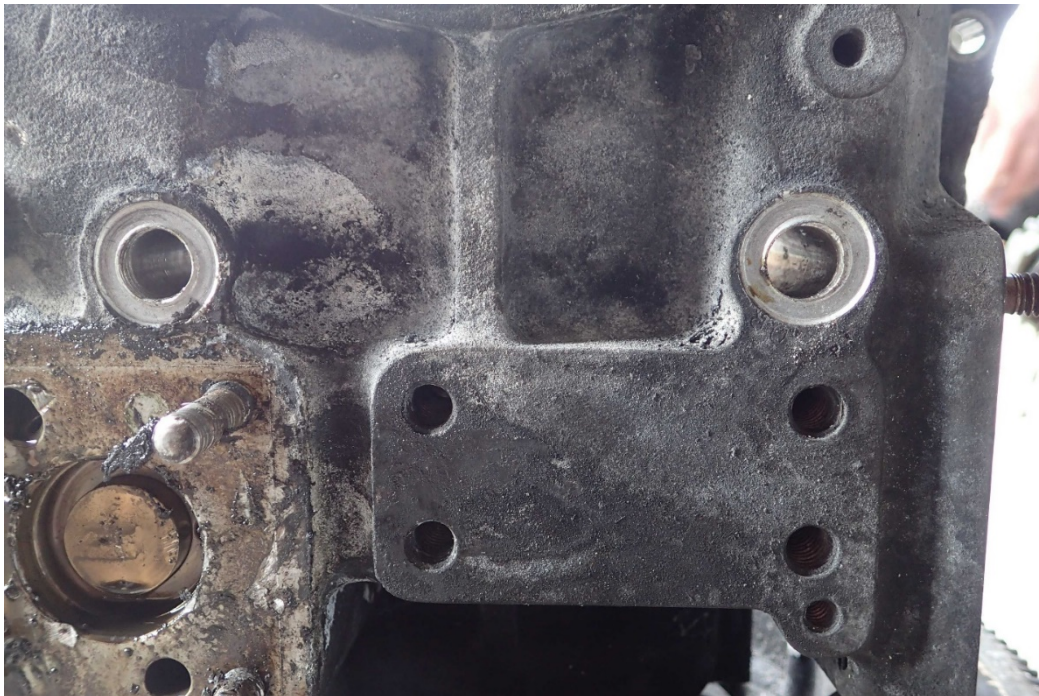


Photo 12 – Forward Carry-Through Bolt Holes



Photo 13 – Forward Carry-Through Bolt Hole



Photo 14 – Pitting at Crankcase Web



Photo 15 – Pitting at Crankcase Web



Photo 16 - Pitting at Forward Bearing Crankcase Saddle



Photo 17 – Oil Filter Remnants

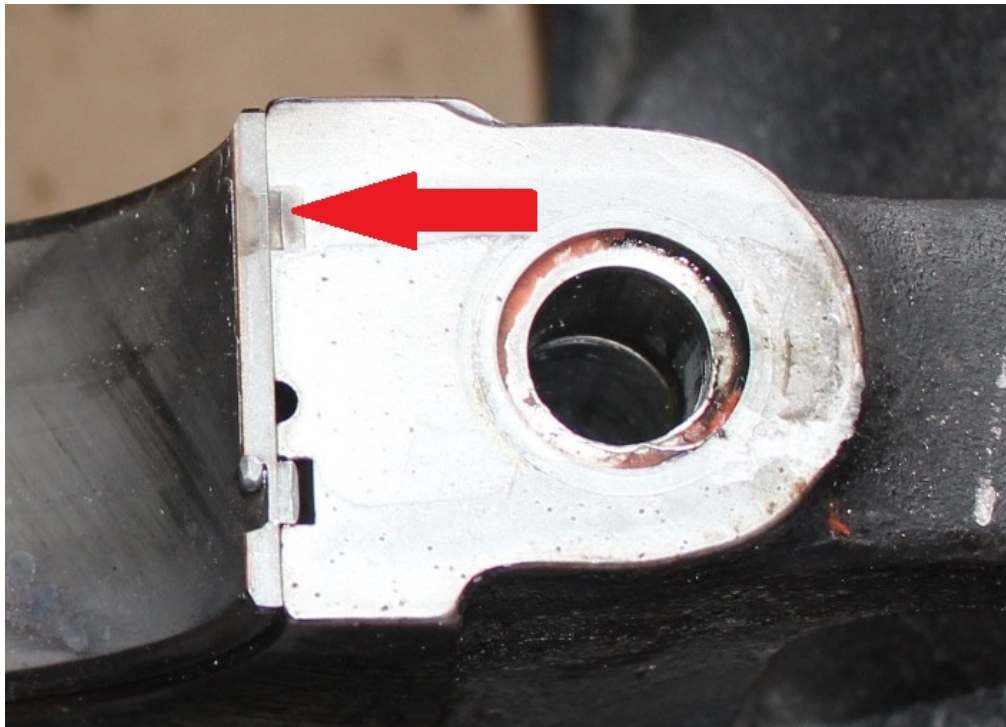


Photo 18 – Crankcase Plain Bearing Notch