

8/16/2023 0800 Arrived at [REDACTED] Leipsic, OH 45856,,,, Eric Ruhe (Ruhe Pilot/owner and Geoffrey Lance(Lance MAIN TURBINES([REDACTED] [REDACTED] were present. Lance was going to be performing the borescope.

N5048S AT-502B s/n 0495 Aircraft Hobbs:6753.3 Engine TT:8347.3 SMOH:563.3 Propeller TT:829.9

Aircraft was positioned (I was facing north) tailed into the northeast corner of the hanger resting on its own right-hand gear, additionally supported by 2ea well-constructed supports at two separate positions under the outboard section of the left-hand wing.

Performed a walk around aircraft. Upper engine cowlings had been removed by Ruhe as stated in ntsb debrief. Ruhe said main battery had been removed at accident site and could be reinstalled if needed.

No damage was observed to exterior surfaces of right-hand wing assembly, this includes the flap, aileron and spray boom. Center fuselage spray components and left-hand spray boom assembly damaged from ground impact. The two-step entry ladder used to enter the canopy on left hand side of fuselage was bent inboard. The 3-bladed propeller, one blade had bent tip, one had an s-bend and other appeared un-damaged. No damage was observed to exterior surfaces of nose cone assembly and upper engine cowlings (these were inspected as removed on the floor). Lower right-hand engine cowling ok, lower left-hand engine cowling and left side of inlet ram air scoop damaged. No grease fittings used for general servicing/lubrication were found to be dry/not serviced. Aux power start circuit breaker was not extended. No damage was observed to exterior surfaces of aft fuselage, horizontal stabilizer, left and right elevators, vertical stabilizer, and rudder assembly. Tail wheel assembly and support structure/tubing appeared to be in alignment, external visual inspection showed no cracking/tears. Tail wheel and pivot attach point were packed with dirt/debris. Left gear strut attach fittings had sheared causing gear strut to detach from aircraft. Right hand gear appeared ok. Left-hand outboard wing , left aileron and outboard portion of left flap damaged from ground impact.

Cockpit

Switches had positive positioning(up/down were not loose or wiggly). Warning/caution lights are dimmable/push to test type and appeared serviceable(did not power on aircraft to test). Engine Controls/Flight controls/rudder pedals had resistance, did not seem loose/detached. Cleanliness and general condition was ok, documents(AFM/AWC/registration) had all been removed by Ruhe and placed on table for review. Registration and airworthiness certificate were current, took photo of AFM cover but have not verified if current revision.

Engine: PT6A-34AG s/n:PC-E 56520 TCDS:E4EA TT:8347.3 SMOH:563.3

Prior to Lance performing the engine borescope or removing any components I performed a detailed visual inspection. Interconnects, power/condition/propeller control cables cambox, beta cambox, fuel control unit, propeller governor, push-pull locking/jam nuts at cable terminal rod ends, cable terminal clevis's, there were no missing cotter pins where required by hardware design(castellated nuts, bolt through holes). did not perform a rigging check to include interconnect rods/linkage length measurements. All of connections were coated with a light colored (white/tan) grease which appeared to be applied by brush method. There was a grease like substance on top of the right hand(looking from aft) inlet air transfer duct. Could not determine its origin, questioned Ruhe believes it may be the grease used for lubing the various components spline shafts (ie. Starter generator, a/c compressor). Wiring harnesses were not chaffing, appeared routed appropriately and secured. Fuel/oil lines/tubing were not chaffing, appeared routed appropriately and secured not leaking. There was oil residue on bottom of accessory gearbox, a drip was forming on a transfer tube.

Lance removed engine cowlings, lower air scoop panel, inlet shrouds to access engine. Air filters were secure(not loose/moveable). Upon gaining access(removed air transfer duct between air filters and firewall) and viewing from engine inlet side, it appears the filters were installed slightly off-center. Both filters had gaps which allowed unfiltered air to pass through to engine inlet. The inside of air transfer duct had black oily/dusty residue from the air that was bypassing the filters. Did not disassemble to inspect the installation.

Borescoping the compressor inlet side also had the blade rub on gravity/bottom side of engine. The leading edges of these blades also had no signs of foreign object damage.

Lance removed the both exhaust ducts and (viewed from front of airplane and counting clockwise) the 7, 8 and 11 fuel nozzles for borescope. The exhaust ducts did not appear damaged however, the engine exhaust outlet/plenum have bumps on outer surface, possibly caused by debris that was discharged from the power turbine section. The fuel nozzles had carbon powder on the sheath and spray nozzle. Borescope inspection through nozzles did not indicate anything abnormal. Overall the combustion chamber was ok, no cracks or indications of irregular spray pattern from nozzles. No marks were found to indicate compressor issues or foreign object damage. Debris and oil was found on the bottom of the chamber The accessory gearbox could not be rotated(by aft end of starter generator or air conditioner compressor pulley/belt but there was slight backlash from spline gear engagement) and lance tried his best to view the entire turbine and could find no defects on leading edge. He mentioned there was blade rub on the gravity side(lower/bottom of engine) of turbine shroud segments.

Moving forward, the power turbine stator aft side shows no debris ingestion, forward side damaged by power turbine. Portions of the stator had been broken off in the area the power turbine rubbed most heavily against the containment ring. The power turbine had worn through the shroud and into the containment ring. There were no whole blade assemblies on the power turbine. Many blades were fractured at the root. The power turbine did not appear centered in the housing assembly. Lance confirmed this by applying upward pressure, the turbine had free up/down movement.

Lance removed the reduction gearbox chip detector and drained the oil. The chip detector had collected large debris and some debris exited with the oil. We bagged the chip detector. He borescoped what he could and did not find any damage. asked if I could slowly rotate the propeller, when doing so he did not observe anything but after rotating approximately ninety degrees a clicking noise was heard and further rotation was not possible. Lance went back to the power turbine and I applied pressure to the blade, it appears that the gearbox had recoupled to the turbine shaft.

Lance removed the oil filter cover, oil was sparkling/metallic but had no large debris. Lance had an analysis kit but I made the decision to simply bag the filter, did not know who should be used for this analysis.

Having Lance (tooling) available I decided to separate the power section from the engine. Prior to Lance performing disassembly or removing any components I performed a detailed visual inspection to verify proper installation. All went well and no defects were noted. The prop was removed first, a spring compressor was attached to aid in removal. An engine support was attached and when removing the power section it would not separate. Inspecting through the fuel nozzle openings, It was decided that the turbine section was binding with the combustion chamber. Lance removed the remaining fuel nozzles and ignitors. All the nozzles looked same(carbon) as those initially removed. Ignitors appeared serviceable. The combustion chamber was extracted with the power section. With the power section separated at the flange, the compressor and accessory gearbox were no longer binding and rotated freely. The guide vanes and thermal couples were clearly visible. There was oil at bottom of vane assembly. All eight thermal couples were present and visibly serviceable. It was found that the containment ring had contorted/expanded into an oblong/oval shape and was binding outward against the chamber and inward against the turbine shroud. Lance used an angle grinder to make a slot so he could expand the chamber for removal. Once removed the thermal couple busbar/harness was inspected and visibly serviceable however housing assembly it was attached to out of round/damaged and caused some distortion. The housing assembly and its attach points were damaged. Lance used an angle grinder to make a slot to expand the containment ring for removal. The guide vane assembly and power turbine were removed. The power turbine attach bolt was secured and locked prior to removal. After removing the power turbine the number three bearing seal was visible. The number three bearing cover/seal/retaining rings were damaged. The number three bearing was damaged, I could not see any whole portions of the bearing. The shaft was not centered in the housing. When looking down the shaft toward gearbox, the bearing cage/separator was around the shaft but contorted and not serviceable. Lance borescoped into this area and was able to see pieces of the bearing. The number four bearing was in place and complete. I discussed with lance how the bearings are lubed, per ipc the oil flowing over bearings is scavenged through/but separate of the reduction gearbox. The debris on the chip detector would have been created forward of the number four bearing seal. The number three bearings pieces would be contained in the power turbine shroud.

At this point, further troubleshooting would need to be performed at the shop level.

Items were placed on a cart and covered with a tarp.

Notes.

Ruhe contacted me about removing left hand flap and sending for repair. I emailed Lyn with this request stating that this would be ok due to the flap not being a contributing factor to the engine shutdown. She replied ok and I informed Ruhe he could remove the flap.

With the power section separated at the flange, the compressor and accessory gearbox were no longer binding and rotated freely.

Picture 38 of borescope report shows an undamaged portion of bearing cage. I could not get a photo of this but I thought the cage was twisted/contorted and moveable about the shaft.

Ruhe does not use pwc bulletin to calculate engine life limits, all cycles are calculated as one to one, one hour of operation equals one cycle.

Ruhe stated that he has no problem arranging for the removal of the engine and sending for analysis so that he can move forward with repairing the aircraft. He would like to perform this repair over the winter season. He also has a spare engine ready for installation.

Per Ruhe during off season and long storage, every 2-3 months the aircraft are started up and ran for a bit. For the engine, a compressor/performance wash is performed at the beginning of the season,,, I could not confirm this during logbook review. The scheduled maintenance appeared to be performed in a timely manner (based on hours/cycles) however there are periods when the calendar time between such events is quite lengthy. (8/27/2019-5/5/2021). Noticed a period hours were accumulated while out of annual, but did not verify aircraft was flown, this could be the ground runs Ruhe mentioned. When speaking with Ruhe about storage, he mentioned nothing that would lead me to believe he was familiar with 72-00-00 Servicing PWC.

Reviewing logbooks,

engine/airframe had no annual 2020, prop inspected 8/01/2020

engine/airframe annual 2021, prop no inspection that year

records are not available for the overhaul work order 1031.

Per Ruhe the power turbine(17407 cycles) was probably installed because there may have been an issue with the existing.

Per Ruhe, AD 22-08-13 N/A by records search, he had contacted the repair shop and they told him that they had never ordered or used the pma blades so they could not be installed on his turbine.

The repair station, [REDACTED] which performed the overhaul had been owned by Ruhe at that time, the repair station has since been sold to his former employees. I have come to find out that this certificate is affiliated with Main Turbine LLC (Lance who performed the borescope)