Synopsis of an Engine Failure

Generation 1 Jabiru 3300A, S/N 299

Sonex #271, N157SX

Robert E. Barber

May 5, 2019

On April 27th, 2019, a Jabiru 3300A299 in service in Sonex S/N #271, N157SX, suffered a catastrophic engine failure. This is a report of what was found in the subsequent teardown and inspection.

Background

The engine had been rebuilt completely per Jabiru Engine Overhaul Manual JEM001-11 at 880 hours. The rebuild was necessitated by an oil analysis report showing significant increase in metals in the oil. The crankshaft was magnafluxed and yellow tagged, and all mandatory parts were replaced. All parts were inspected, and all critical dimensions measured and recorded. At the time of failure, the engine had broken in at 929.5 hours (49.5 hours TTSO)

The engine has suffered several failures in its lifetime. At 640 Hours, the #5 head (Generation 1), an intake valve cracked and came loose in the head. Only rough running indicated the found failure. At ~650 hours, a full top end was done on the engine. 2 generation 1 heads were replaced with generation 2 heads. At 750 hours, a borescope inspection revealed the remaining generation 1 heads were failing. Water cooled heads from Rotec were installed, and remained until the engine overhaul. At 845 hours, the propeller flange separated from the crankshaft in flight. No overspeed occurred in this incident, but the lack of the propeller could have precipitated the subsequent high metal found in the oil.

Event Description

On the 27th of April, as departing the Dillard Ranch Spring “Critters Lodge” Fly-in, N157SX took off normally, circled and made a low pass down the runway. As N157SX neared the end of the low pass, a loud bang was heard and a clear loss of one cylinder was felt. There was enough momentum to climb to pattern altitude, and the engine did not stop. The throttle was lowered immediately to about 2500 RPM after the initial “bang”, and continued to run. The engine continued to run but was losing power the longer it ran. After assuring the runway was made, the throttle was reduced to idle, and the engine locked immediately. Landing was uneventful and normal afterwards. The aircraft was transported home the following day by trailer.

The MGL Enigma recorded the event, and the relevant data is plotted below.

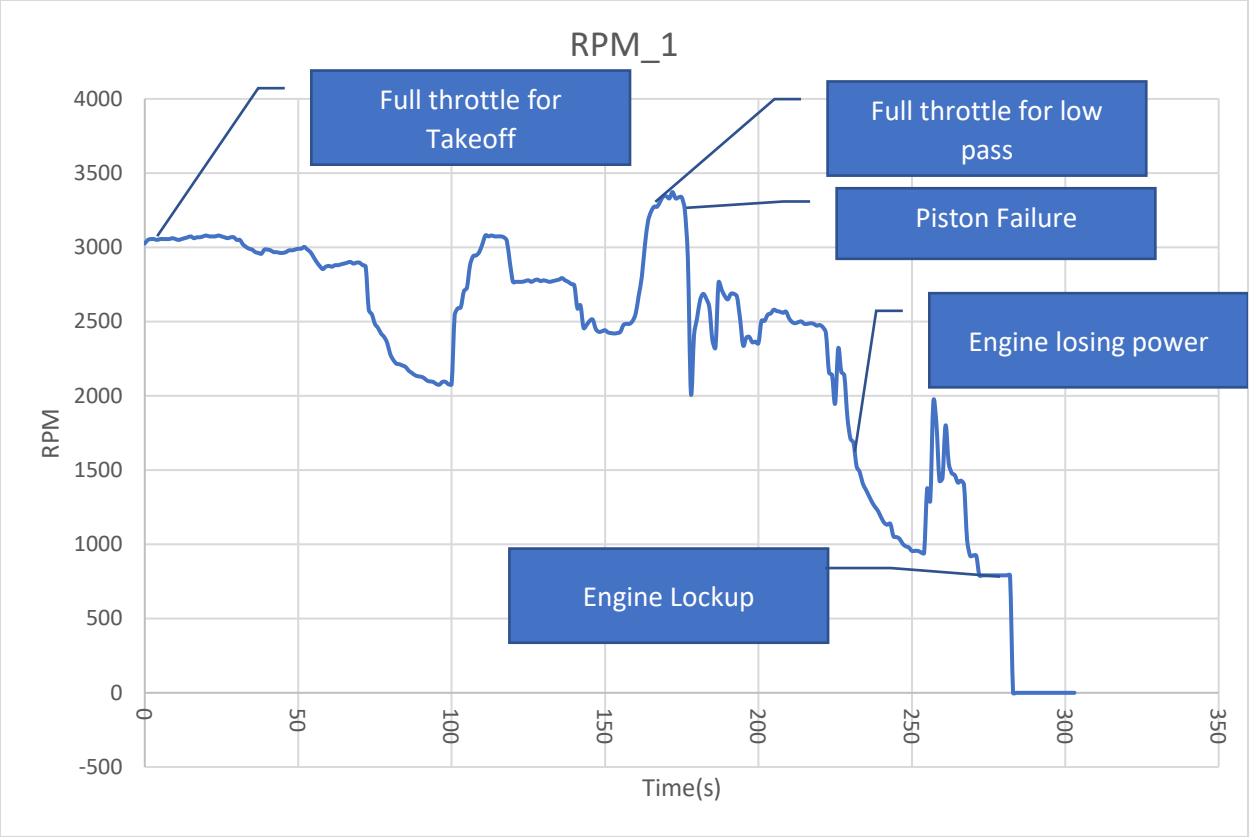

Figure 1. RPM history, from takeoff to landing. Max RPM 3330.

As can be seen in Figure 1, the entire flight lasted only about 5 minutes. The drop in RPM associated with the failure can be clearly seen.

In Figure 2, the reduction in speed corresponds to climb out to pattern altitude.

Figure 3 shows the CHT for all cylinders. Note the CHT for #2 dropping after the failure, despite the rod flailing around in the cylinder.

Figure 4 shows an immediate rise in oil temperature post failure, but the temperature is not excessive.

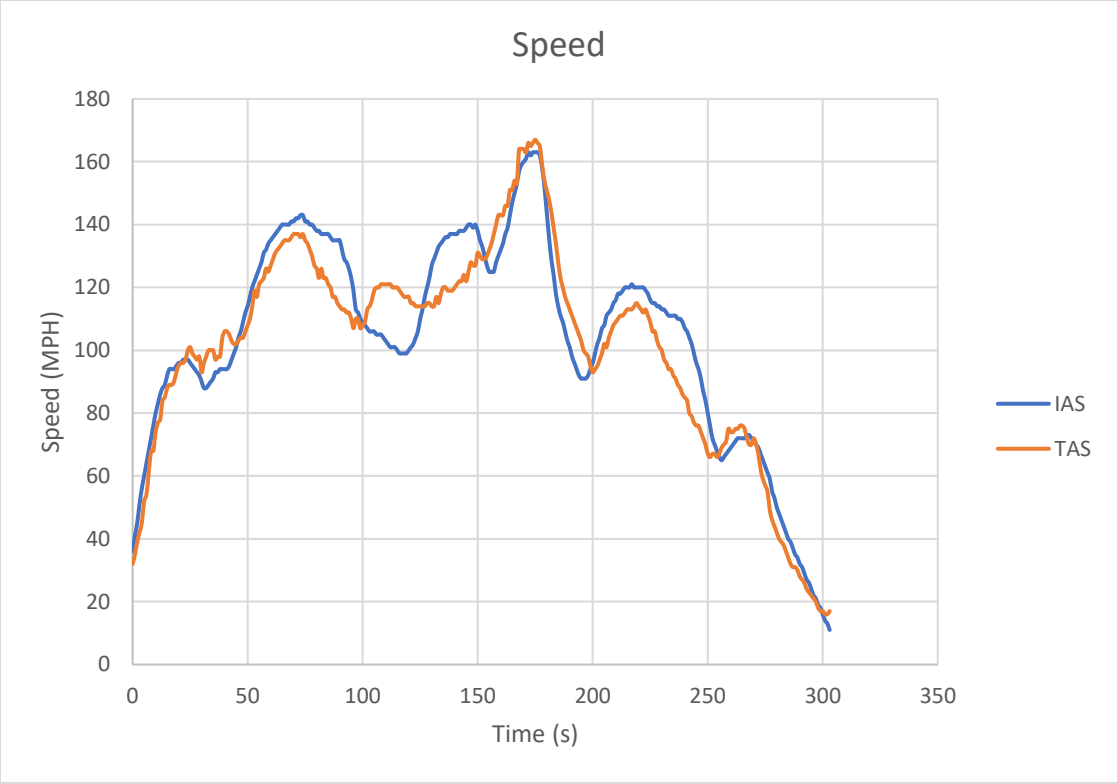

Figure 2. Speed vs time.

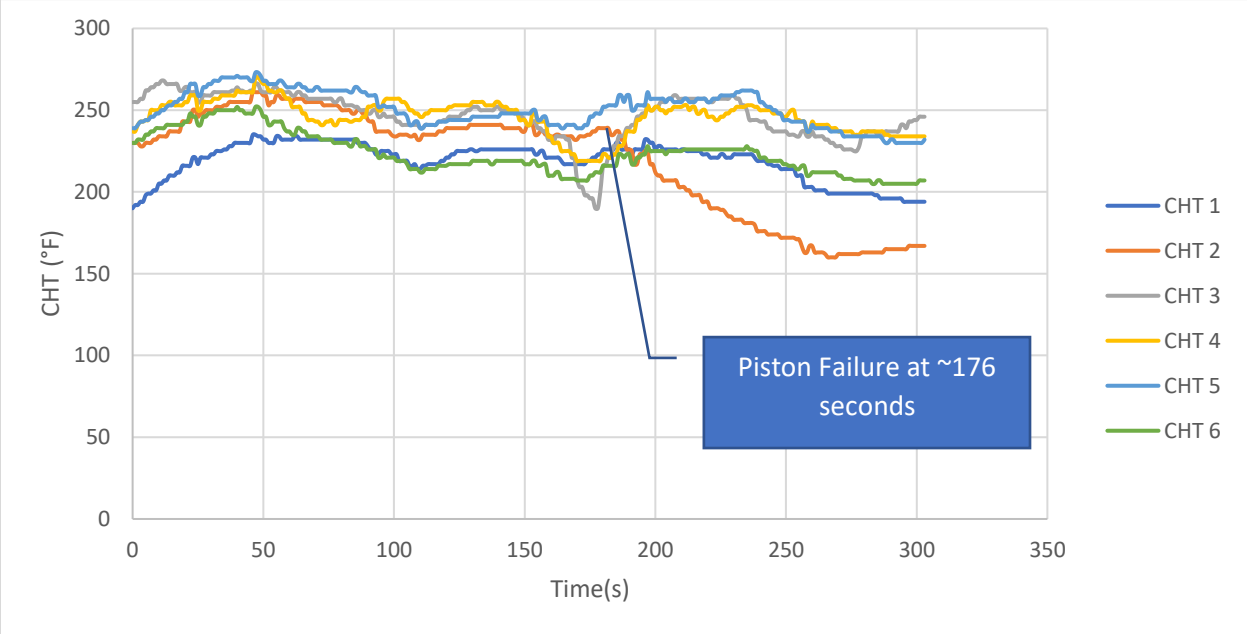

Figure 3. CHT vs Time

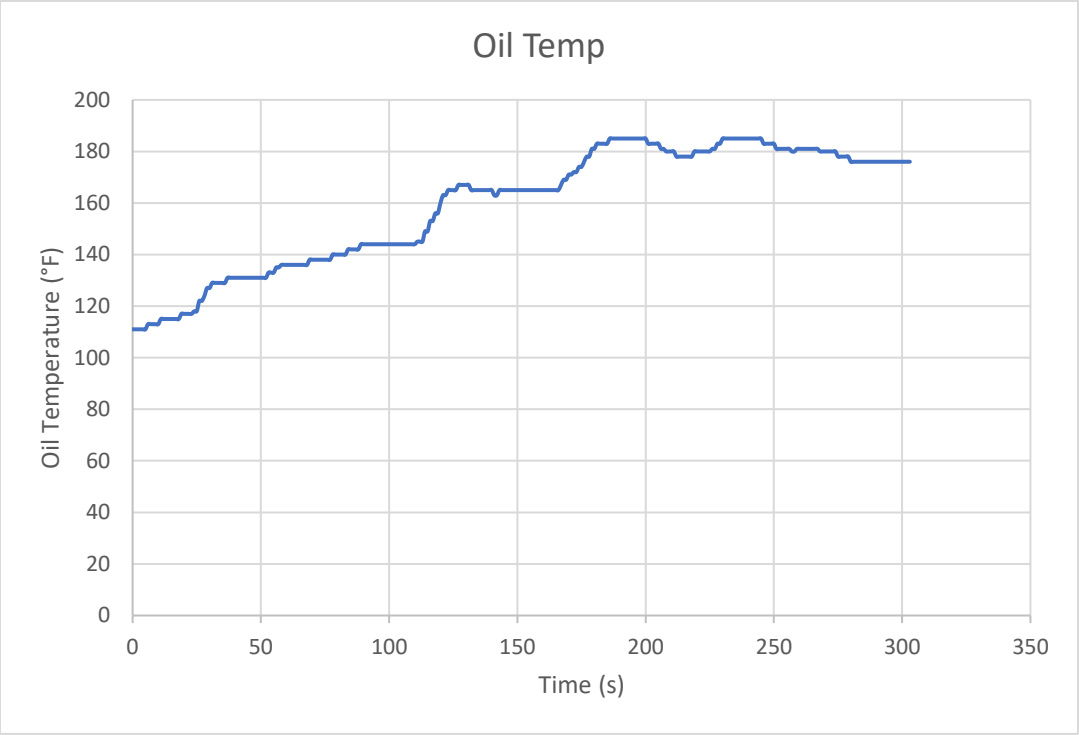

Figure 4. Oil Temperature vs Time. Max Oil temperature was 185°F.

Post Mortum

Post failure disassembly and examination was done in hopes to find the root cause of the failure. Pictures were taken during disassembly, and are presented below.

Figure 5. #2 Head removed. The piston is mostly missing, but the rod, wrist pin, and everything else is still there.

Figure 6. Head (cylinder face). Both valves remain. Exhaust valve has slight bend.

Figure 7. Spark plugs examined looking for signs of detonation. Cylinders were also borescoped for evidence, but none was found. Note that all plugs are black, indicating a rich mixture.

Figure 8. Inside the cylinder. Not including the damage caused by the rod/wrist pin beating against the cylinder walls, the cylinder looks actually quite good.

Figure 9. The rest of the piston, rings, and circlips were found in the sump.

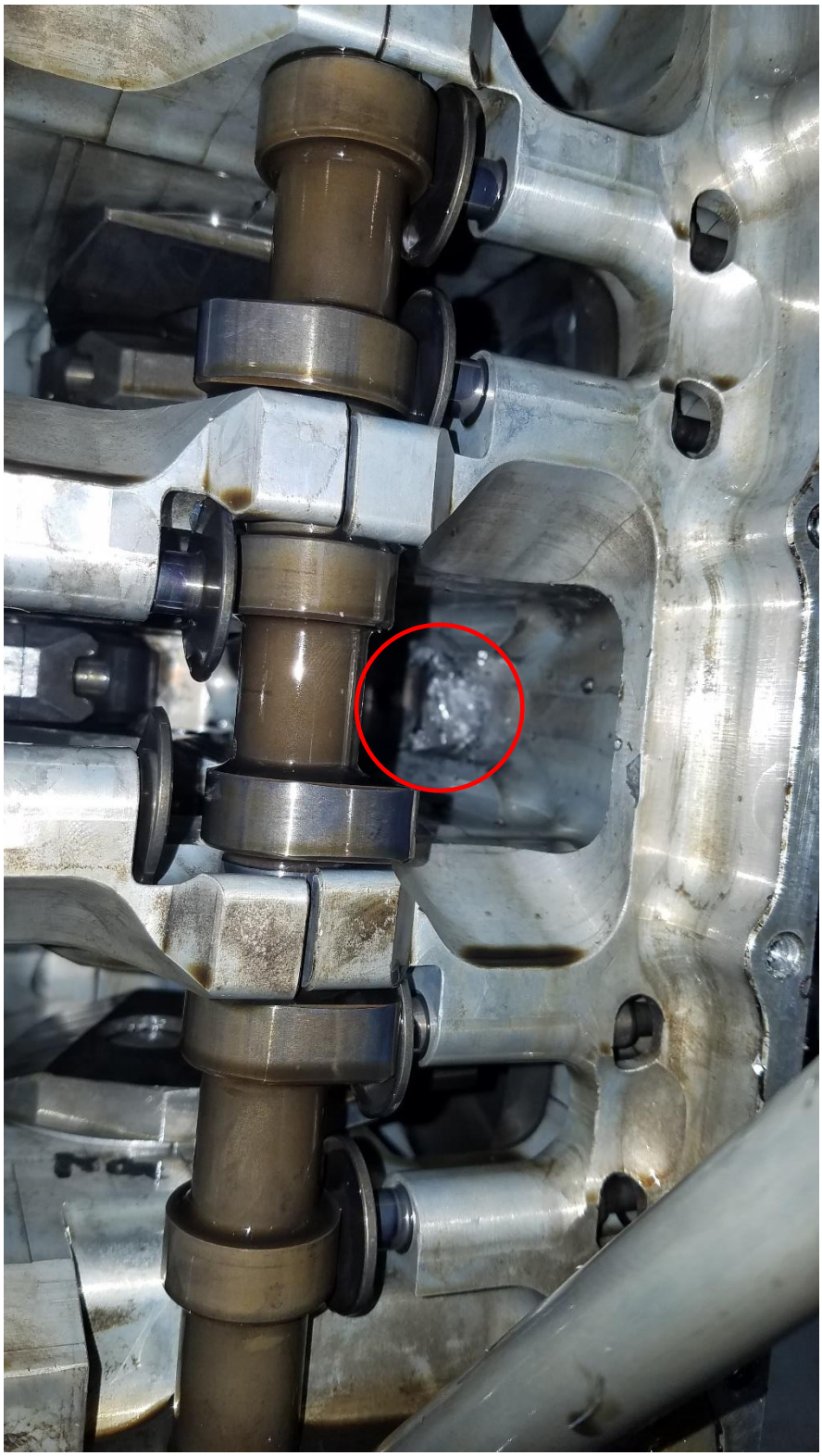

Figure 10. Bottom of the crank case. Notice the deformation evident by the separation of the case halve beneath the cam. Also note the chunk of piston shoved through the wall of the case between cylinders 1 and 3.

Figure 11. Picture of cylinder wall. Aside from the damage caused by the rod crushing the piston, the cylinder has no scratches, scoring or other damage.

Possible causes

The speculation about what could cause this failure can get quite unwieldy. I will try to stay with the most likely scenarios:

1) A valve stuck, and struck the piston, but did not break (or bend much)
2) The piston had a casting flaw in it from the factory
3) There was inadequate oil to the rings, and the piston stuck breaking the bottom off the piston.

In scenario 1, the valve stuck open and impacted the piston. The valve does not have any evidence that this occurred, other than being slightly bent, which could have happened as the rod reduced the piston to aluminum granola. Evidence of this would be usually a broke valve of at least severely bent.

In scenario 2, the new piston could have had a casting flaw in it. It was relatively new (less than 50 hours). Though rare, it does happen. A small precipitate, grain of sand, etc. at the correct place with enough cycles would cause this. There would likely be no evidence unless the origination point could be found among the battered aluminum in the crank case.

In Scenarios 3, if the piston/rings were deprived of oil and stuck, the wrist pin would simply pull the bottom off of the piston. Evidence of aluminum sticking to the cylinder or scratches on the cylinder from the rings would be evident. There is no obvious signs of either, but they could be buried 1n the region pummeled by the rod/wrist pin.

Conclusions

Since the valves appear intact (I believe the head is salvageable), I don't believe scenario 1 is likely. Scenario 3 is also unlikely, since there is no evidence to support it. No scratches or galling in the cylinder. Scenario 2 I feel is most likely, but there is no evidence to support it, as the piston has been reduced to granola size bits.

The damage includes the engine case, the crankshaft, the rod, wrist pin, at least two lifters, the camshaft, and possibly the head. I am currently working toward buying a new Gen 4, since the parts for a rebuild are getting scarce. The case, lifters, and camshaft are no longer made. I hate this, as the time and money spent rebuilding the engine is now for a meager 50 hours. And it ran so sweet.

I hope someone finds this useful.