

The last 100-hour inspection was performed on 01/07/2018 at a tachometer time of 1566.6; the inspection involved installing the engine after the engine was overhauled by Signature Engines Inc. The inspection also included installing new oil and fuel lines. According to the maintenance facility a fuel manifold valve fuel line had been replaced due to a significant fuel leak that was found on a previous flight; there were no logbook entries for the repair.

Prior to the engine run the spark plugs were noted to have different combustion signatures with the #1 and the #2 spark plugs displaying significant soot consistent with a rich mixture on those cylinders. The initial run of the engine was able to reach full rpm and produce rated horsepower; however, subsequent engine runs only reached 2,600 rpm. The fuel system was examined, and it was noted that 2 of the nozzles were partially clogged. The fuel nozzles were cleaned, and the engine was run again; the engine operated normally and displayed it could produce rated horsepower.

The engine displayed impact damage signatures; one of the crankshaft seal plates was partially displaced, the right rear engine mount was broken, and the #6 top spark plug ignition lead was partially severed. It was noted that the right side of the engine and the manifold valve displayed blue staining which is typical indications of a fuel leak.

The crankcase remained intact and there were no signs of a catastrophic internal engine failure. The propeller flange remained attached to the crankcase and there were no cracks noted in the crankshaft; there were several pits noted inside the crankshaft. All six cylinders remained attached to their cylinder bays and were undamaged.

The fuel pump remained attached to its installation point and was undamaged. All the fuel lines going to the fuel pump were secured to the pump. The throttle and metering assembly remained attached to its installation point and was undamaged. The fuel lines that were attached to the assembly remained secured the fuel T-fitting cap remained installed. The fuel manifold valve remained attached to its installation point and was undamaged. The fuel manifold valve displayed blue staining around the valve. All the fuel nozzles remained installed in their cylinders and were undamaged.

Both magnetos remained attached to their installation points and were undamaged. The ignition harness remained attached to the magnetos and the ignition leads had been removed from their spark plugs out in the field. The harness displayed impact damage signatures to the #6 top spark plug ignition lead; the lead was partially severed near the lead end. All the spark plugs remained in their cylinders. The top spark plugs were removed, and it was noted that the #1 and the #2 spark plugs had dark sooting signatures. All the top spark plugs displayed normal wear signatures.

There were several airframe related items removed in preparation for operation on the CMI test bed.

Items removed:

1. Propeller governor
2. Vacuum pump
3. Airframe baffling
4. Intake airbox and filter

The following substitute or repaired parts were required for engine operation:

1. Exhaust pipes
2. Right rear engine mount
3. #6 top ignition lead end

The cylinders were borescoped and the following was observed:

All of the cylinders were inspected using a lighted borescope. The pistons and valve heads displayed normal operating and combustion signatures. The cylinder bores displayed normal operating signatures. The bottom spark plug electrodes displayed normal operating and wear signatures.

A cylinder leakage test was performed prior to the test run in accordance with the latest revision of CMI Service Bulletin SB03-3 with the engine at room temperature with the following results (master orifice reading – 43 PSI):

Cylinder #1 - 70/80 PSI (exhaust valve/rings)
Cylinder #2 - 70/80 PSI (exhaust valve/rings)
Cylinder #3 - 10/80 PSI (exhaust valve)
Cylinder #4 - 70/80 PSI (exhaust valve/rings)
Cylinder #5 - 72/80 PSI (exhaust valve/rings)
Cylinder #6 - 0/80 PSI (exhaust valve/rings)

The engine was not disassembled prior to the engine run. The crankshaft endplay measured 0.014” and the run-out was 0.002”. The deflection was measured to be 0.025”. The engine was then prepared for operation by installing the appropriate thermocouples, pressure lines and test pads for monitoring purposes. The engine was then moved to CMI test cell number 43 and mounted for operation. The engine was fitted with a test club propeller for the IO-360-DB engine model.

The engine was started on the first attempt without any hesitation or stumbling. The engine RPM was advanced in stages for warm up the engine in preparation for full power operation; it was noted that the test cell throttle control actuator was not operating through its entire range and had to be adjusted multiple times during the engine run. The engine rpm was set to 1,200 rpm and held for five minutes to stabilize. The engine was then advanced to 1,600 rpm and held for five minutes to stabilize. The engine throttle was advanced to 2,450 rpm and held for five minutes to stabilize. The engine throttle was then advanced to full open and held for five minutes to stabilize. The engine could reach 2,835 rpm. It was noted that the unmetered fuel pressure was indicating the fuel system was

running lean. The fuel pump was adjusted to enrich the mixture; after the adjustment the engine would only reach an rpm of approximately 2,600. Due to safety concerns it could not be determined if the throttle actuator was actuating all the way to full throttle after the adjustments to the fuel pump. After the run the engine fuel components were removed to be tested and examined.

During the testing of the fuel components it was found that 2 of the nozzles were partially clogged. The engine driven fuel pump and the metering assembly were both tested and readjusted to factory specifications; refer to the fuel system test section of this report for additional details. All the fuel nozzles were cleaned using solvent. The fuel components were then reinstalled on the engine and another engine run was performed. The engine was again able to produce full power and reached approximately 2,830 rpm. The engine was brought back to a lower rpm and again advanced quickly to full throttle several times. The engine did not stumble or hesitate and could reach over 2,800 rpm each time the throttle was advanced.

A cylinder leakage test was performed after the test run in accordance with the latest revision of CMI Service Bulletin SB03-3 with the engine hot with the following results (master orifice reading – 43 PSI):

Cylinder #1 - 62/80 PSI (exhaust)

Cylinder #2 - 48/80 PSI (exhaust)

Cylinder #3 - 71/80 PSI (rings)

Cylinder #4 - 58/80 PSI (exhaust)

Cylinder #5 - 62/80 PSI (exhaust)

Cylinder #6 - 64/80 PSI (exhaust)

The fuel pump remained attached to its installation point and was undamaged. It was noted that the mixture control arm remained secured to the mixture control shaft and was capable of normal movement. After the initial engine run the fuel pump was removed and it was noted that the drive shaft remained intact and the drive was capable of normal rotation. The fuel pump was placed on a production test bench and it was noted to operate normally. The fuel pump adjustments were adjusted for production test bench specifications and it was noted the adjustments operated normally. After the second test run the fuel pump was placed on another test bench to ensure all adjustments would operate properly; all the adjustments operated normally. There were no anomalies noted with the fuel pump.

The throttle and metering assembly remained attached to its installation point and was undamaged. The throttle control arm was noted to be secured to the throttle valve shaft and was capable of normal movement. After the initial engine run the throttle and metering assembly was removed and placed on a production test bench; the throttle and metering assembly was capable

of normal operation. After testing the assembly was adjusted back to factory production test specifications and then reinstalled on the engine. There were no anomalies noted with the throttle and metering assembly that would have prevented normal operation.

The fuel manifold valve remained attached to its installation point and was undamaged. After the initial engine run the manifold valve was placed on a production test bench for evaluation. It was noted that two of the nozzles were partially clogged and that the manifold valve fuel pressure was significantly outside the production test values which is consistent with the clogged nozzles. The manifold valve was disassembled, and the internal components were visually inspected; there were no anomalies noted within the manifold valve. The valve was then reassembled and reinstalled on the engine.

All the nozzles remained installed in their cylinders and were undamaged. After the initial engine run the nozzles were removed and were installed onto the manifold valve for use during the manifold valve production test; it was noted that two of the nozzles were partially clogged. The nozzles were removed and cleaned using solvent. The nozzles were reinstalled on the engine and the engine operated normally. There were no anomalies noted after cleaning the fuel nozzles.

Propeller Governor Bench Test

The governor exterior was visually inspected and photographed and then installed on the McCauley engineering test bench for functional testing.

It was noted during the external examination that the governor serial number was inside a range of serials required to be inspected per McCauley Alert Service Bulletin ASB273C. The attending FAA representatives asked that the pump housing be opened to examine the pump gear idler bearing in accordance with McCauley ASB273C.

The Pump Housing Cover (P/N C-20943) was removed and the oil pump idler gear bearing was visually inspected for condition and part stamping. A suspected unapproved variant of the oil pump idler gear was found and photographed. The bearing was intact and functional. The bearing's needle cage was noted to have wear that would not have affected normal operation of the gear pump.

No other disassembly was requested or performed.

After the examination and bench testing, the following conclusions are drawn:

1. No indications of any type of governor failure or malfunction prior to impact were found.
2. The governor was found functional and met all the tested specifications found on McCauley Drawing D-20309.
3. The governor oil pump idler gear contained a suspected unapproved bearing marked "BA59". The bearing was intact, and the pump functioned normally.