Bearhawk #164 “Three Sigma” Checkout Report

Date: 6 May 08

Objective: Reinstall split nose bowl. Characterize the induction pressure losses through the carburetor airbox and air filter. Governor RPM check. Validate full throttle fuel flow. Characterize the induction pressure losses through the carburetor heat system. Verify front crankshaft oil seal function. Idle mixture check. Compression check.

Hobbs Time: 1.2 to 1.7

Reinstall Split Nose Bowl

Background: With the unsplit nose bowl arthroscopic surgery techniques were required to safety wire the propeller bolts. This was a huge dent in maintainability and considered unacceptable.

The initial reticence to split the nose bowl was primarily driven by the perceived inaccessibility of the inner webs. The spinner that came with the prop was several inches in diameter larger than the spinner on Proto I. This problem did not exist on Proto I, from which this nose bowl was recommended. This nose bowl had already been procured when a different nose bowl more appropriate to the Hartzell spinner was recommended.

Procedure: The solution to the inner webs was to place the screw to enter from the side instead of the front. To do this, additional fiberglass had to be added to maintain sufficient edge distance. The inner portion of the outer web was modified in the same fashion. The outer edge was secured by a flat head screw under the cowl doors.

A fiberglass flange was built up on the lower half of the nose bowl to hold the nutplates.

Results:

The finished modification. Later the finish will be removed and the surfaces re-contoured with glazing putty, followed by priming and painting.


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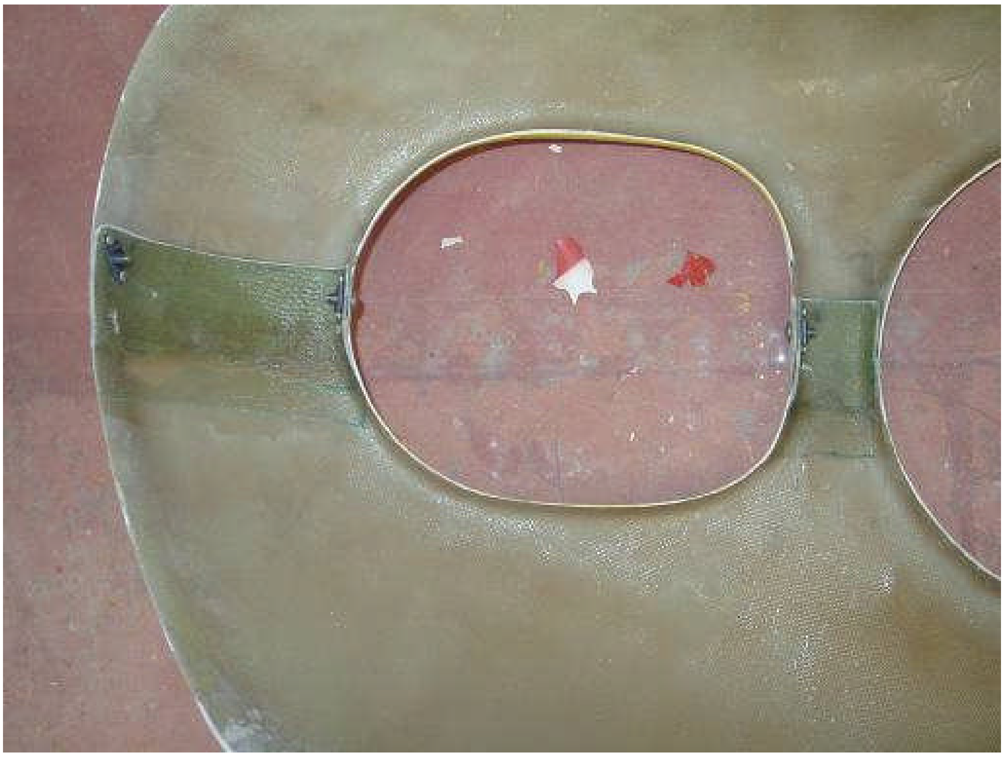
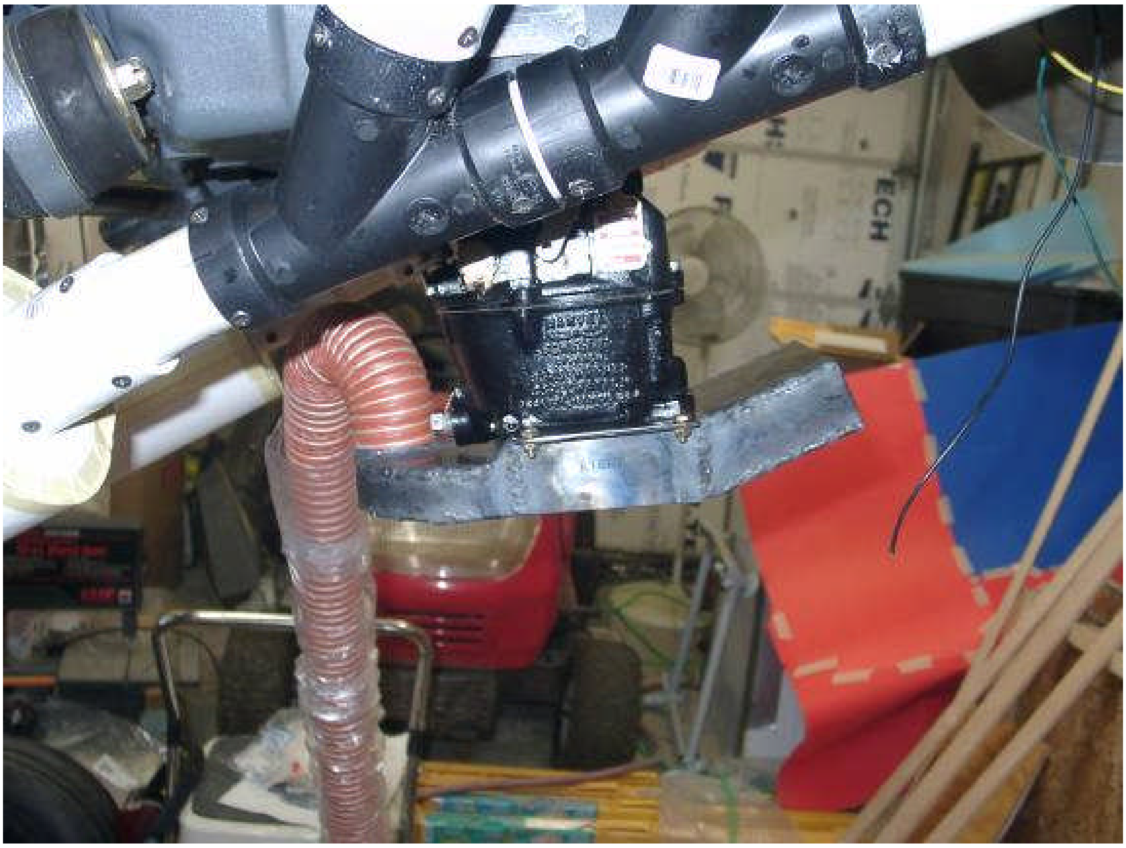


The nose bowl was successfully re-installed on the aircraft. Even with just six screws the result was surprisingly stiff.

Induction Pressure Loss: Airbox and Filter

Background:

Several other EAAers had expressed concern that my low-profile carburetor airbox (of my own design) had too small of a cross-sectional area to properly supply air to the O-540. The airbox design had been designed to have a similar cross-sectional area as the 3 inch SCAT tube used on another design with a similar engine. The question that needed answered was how much pressure loss would happen through the airbox at maximum power.



Procedure:

To measure the pressure drop through the induction system, three full throttle ground engine runs were accomplished in the following configurations.

1. Carburetor only (no airbox or air filter)
2. Carburetor with airbox (no air filter)
3. Carburetor with airbox and air filter (normal flight configuration)

For each run, measure the ambient air pressure (pressure altitude), manifold pressure, RPM, and fuel flow.

Results:

These data were collected for each of the engine runs.

Configuration	Pressure Altitude	Atmos Pressure (in Hg)	RPM	MAP (in Hg)	Fuel Flow (gal/hour)	MAP Loss (in Hg)	Incremental MAP Loss (in Hg)
Carb only	2520	27.3	2550	26.0	17.8	1.3	0
Carb + Airbox	2520	27.3	2590	25.9	18.9	1.4	0.1
Carb + Airbox + Filter	2520	27.3	2540	25.7	19.9	1.6	0.2

The pressure drop through the carburetor and intake manifold was 1.3 inches of mercury. This would be the minimum possible pressure loss in the induction system.

Adding the air box resulted in an additional pressure loss of 0.1 inches of mercury. The air filter added another 0.2 inches of mercury pressure loss.

The pressure loss through the airbox is minimal and almost unmeasureable. The benefits to be gained by redesigning the airbox to a larger cross section are not significant enough to justify the effort required. **Leave the airbox as designed.**

Governor RPM Check

Background: Previous testing had shown a maximum ground RPM of 2510. The governor high RPM stop screw had been readjusted to increase the RPM. According to the governor manual, this should increase the maximum ground RPM to about 2600.

Procedure: Maximum RPM was measured as part of the Induction Pressure Loss test.

Results: While the maximum RPM was increased, it only went up by half of what was expected. It is suspected that the engine was not powerful enough to get the propeller into the governing range on the ground. Thus, the propeller blades are still sitting on the low pitch stop, acting as a fixed pitch prop. The variations in maximum RPM are suspected to have been caused by varying wind speeds during the tests. Winds were blowing between about 10 and 20 knots during the tests. Varying wind speed would affect a fixed pitch prop, but not a prop in the governing range. **Make no further adjustments to the prop governor until after flight test. Exercise caution on the first flight for a possible overspeed caused by an improper governor adjustment.**

Verify Full Throttle Fuel Flow

Background: The fuel flow tests were made based on a maximum expected fuel flow of 25.3 gallons per hour, as read from the chart in the Lycoming Engine Operator's Manual.

Procedure: Maximum fuel flow was measured as part of the Induction Pressure Loss test.

Results:

The fuel flow results are shown below with the corresponding predicted fuel flows from the Lycoming Engine Operator's Manual.

Configuration	RPM	MAP (in Hg)	Fuel Flow (gal/hour)	Predicted Fuel Flow (gal/hour)
Carb only	2550	26.0	17.8	23.0
Carb + Airbox	2590	25.9	18.9	23.4
Carb + Airbox + Filter	2540	25.7	19.9	22.9

One conclusion that can be drawn from these data is that the Operator's Manual overpredicts the fuel flow. Therefore, it can be assumed that the previous results of the fuel flow tests are still valid, as they were based on a higher expected fuel flow than would actually be required.

These conclusions assume that the fuel flow instrumentation is accurate. While expected to be close, the fuel flow calibration has not been accomplished yet.

During these tests while running the Engine Run-Up checklist, the spark plug for cylinder #2 on the right ignition system was not firing, as evidenced by the loss of EGT on cylinder #2 when the left ignition system was turned off. Since the #1 spark plug, which is fired simultaneously by the same coil as the #2 spark plug, was still firing, the ignition box and coil are assumed to be functional. **Replace the #2 spark plug.**

Induction Pressure Loss: Carb Heat

Background:

Determine if the carburetor heat air path creates an unacceptable manifold pressure loss.

Procedure:

Record manifold pressure with carburetor heat OFF and ON at the same engine conditions.

Results:

During an engine run-up, these data were collected immediately before and after applying the carburetor heat.

Carburetor Heat	OFF	ON
RPM	1710	1650
MAP	14.3	14.6
Carb Air Temperature	61	74

Applying the carburetor heat caused a drop of 60 RPM, as expected in any Private Pilot Ground School textbook. The carburetor air temperature went up by 13 degrees F (less than I would have expected, but sufficient to cause the expected RPM drop).

The manifold pressure actually increased. One explanation would be the reduced RPM reduced the airflow, causing less of a pressure drop across the throttle plate. Another explanation would be that the carburetor heat air path is not filtered, and thus does not have the pressure drop across the filter.

Verify Crankshaft Oil Seal

Background: After the previous ground engine run, a large amount of oil was found in the cowling coming from the front of the engine. The source of this leak was traced to a missing front crankshaft oil seal. A crankshaft oil seal was subsequently installed.

Procedure: Check for oil in the cowling after engine runs.

Results: No oil was found in the engine coming from the front of the engine.

However, a larger than expected amount of oil was found coming out of the crankcase breather, sufficient to overwhelm the air-oil separator. Some of this may be caused by a large amount of blow-by gasses from unseated piston rings pressurizing the crankcase. Additionally, the oil quantity at the beginning of the test was about 9.5 quarts. Discussions with other EAAers suggest that the oil sump may be overfilled, allowing the crankshaft and other internal parts to sling the oil around. This is exacerbated by the nose up attitude causing more of the oil to pool in the rear of the crankcase. **At the next oil change, do not fill oil sump to 12 quarts.**

Idle Mixture Check

Background: Previous testing indicated that the idle mixture is too lean, as shown by a lack of RPM increase while moving the mixture to IDLE CUT-OFF.

Procedure: Turn the Idle Mixture Screw 1/2 turn richer (counterclockwise). Test by pulling the mixture slowly to IDLE CUT-OFF and observe RPM.

Results:

The procedure above was tried twice. Test results show that the mixture is still too lean. **Continue adjusting idle mixture.**

Compression Check

Background: Several sources, including AC 90-89A, recommend performing a compression check to establish a baseline for future compression checks. It is suspected that the readings may be low because of unseated piston rings.

Results:

Cylinder	Reading
1	32
2	42
3	71
4	76
5	47
6	36

Conclusions:

The nose bowl was successfully split.

The pressure drop through the carburetor air box and air filter were minimal.

The propeller is not reaching the governing range in static ground run-ups.

The Lycoming Engine Operator's Manual over-predicts the full throttle fuel flow, so that the results of the previous fuel flow tests based on the maximum predicted fuel flow are still valid.

The right ignition #2 spark plug was no longer firing.

The carburetor heat air routing does not cause an airflow restriction.

The front crankshaft oil seal is working properly.

A large amount of oil is being expelled through the crankcase breather, overwhelming the air-oil separator.

After two adjustments, the idle mixture is still too lean.

A compression check was accomplished.

Recommendations:

Leave the airbox as designed.

Make no further adjustments to the prop governor until after flight test. Exercise caution on the first flight for a possible overspeed caused by an improper governor adjustment.

Replace the #2 spark plug.

At the next oil change, do not fill oil sump to 12 quarts.

Continue adjusting idle mixture.