Bearhawk #164 “Three Sigma” Checkout Report

Date: 1 Mar 08

Objective: Fill brake system(s) with fluid. Test brake operation. Answer the burning question of whether the parking brake valve is a one-way or two-way valve.

Background: All texts I have found on this subject seem to assume a level of knowledge about how the bleeder valve works, which I didn’t happen to have.

The burning question is how does the parking brake valve respond to additional brake pedal applications after the valve is closed? That is, assume the aircraft is sitting with the parking brake applied. The brake pressure leaks down somehow and the aircraft starts to move. The pilot reacts by pressing on the toe brakes. Does the parking brake valve block the additional pressure from the brake cylinders or does it allow the additional pressure to pass through?

Procedure:

1. Remove forward floor to expose brake lines.
2. Open top of brake reservoir.
3. Open bleeder valve about one turn.
4. Fill brake system with Mobile 1 Synthetic Automatic Transmission Fluid. Use a pressure fed oil gun and plastic tube to feed fluid in from nipple on bottom of brake caliper.
5. Fill first side until fluid appears in reservoir (use dipstick to check).
6. Check for leaks.
7. Fill second side until more fluid appears in reservoir.
8. Check for leaks.
9. Apply brakes. Check for leaks, sponginess.
10. Finish filling reservoir.
11. Check parking brake feed through.

Results:

Bleeder Valve

The Cleveland brake bleeder valve is shown here.

The open end shown here is where the fluid comes out or goes in depending on which direction you're pushing it. The plastic tube will slide over this end. The hex area takes a 1/4" wrench to tighten or loosen the bleeder valve.

This is the side view of the bleeder valve. The end shown above is on the right.

The hole at the left end is connected to the hole at the right end. As done here, the fluid is forced in the right end, comes out the hole on the left, and continues on into the brake assembly.

The end shown here is the interior end. The conical portion presses against a seat in the brake assembly and forms the seal that keeps the brake fluid in the system when the bleeder valve is screwed all of the way in.

Brake Fluid

The typical choice of brake fluid for aircraft brake systems is MIL-H-5606G hydraulic fluid. Unfortunately, this stuff is very flammable. An F1 Rocket builder told me that several RVs have had brake fires that went wild because of the hydraulic fluid. According to his sources, there is another MIL SPEC fluid for brakes used in jets which is very expensive. However, without the MIL SPEC label, this fluid is identical to Mobil 1 Synthetic Automatic Transmission Fluid, also known under the "MERCON V" specification. MERCON V is an all synthetic hydraulic fluid. Do not confuse it with the similarly named MERCON ATF, which is a highly refined mineral oil.

The biggest concern with choosing a brake fluid is choosing one that is compatible with the rubber O-rings used in the brake system. According to the patron saint of homebuilding (Tony Bingelis) on page 260 of *The Sportplane Builder* (the blue book), "Do not use automotive brake fluid in the aircraft brake system as you may have a problem with the "O" rings."

Adding Brake Fluid

One possibility is to add the fluid to the reservoir and pump it down to the brake assemblies with the master cylinders. However, in general the fluid would be going down, while air bubbles tend to go up, and the idea is to fill the system with fluid and no air bubbles. Air bubbles are compressible, which can lead to spongy brakes.

I prefer the method of forcing the fluid in from the bottom, up to the reservoir. Since the fluid is mostly going up, it pushes the air ahead of it. To do this, some sort of pump is needed. A typical pump action oil can from the aviation supply section of your local hardware store is sufficient. Get a new one—you don't want to contaminate the hydraulic fluid with motor oil.

To connect the pump can to the bleeder valve, a one foot length of 1/4" OD x 0.170" ID vinyl tube was used. This fit nicely over the bleeder valve. The other end was not quite so easy. I should have bought an oil can with a more pointed end. This can had a fairly blunt end. I don't know if it helped, but I held the end of the tube under hot water to soften it, and pushed it over the end of the oil can.

The brake servicing apparatus is shown below. Note the use of the oil drip pan to protect the floor. The seal between the tube and the bleeder valve is not perfect, and you can see where a small puddle of fluid has dribbled down the outside of the tube.

I filled the right side system first, mostly because that was the side I was standing on when I was ready to start. The first few pumps were back into the ATF bottle until the plastic tube was filled with fluid with no air bubbles. It took 60 pumps to fill the system, as indicated by fluid appearing in the reservoir. A wooden mixing stick (sold as a tongue

depressor – in spite of Charlie Brown's admonition, I don't know who ate the ice cream off of it) was cut down to about 1/4 inch wide and placed in the reservoir as a dip stick. When fluid first started appearing on the dip stick, I stopped pumping and closed the bleeder valve. A strip of aluminum would have made a better dipstick because the fluid would seep up the wooden stick by capillary action, making it difficult to determine the level of the fluid.

I moved the system to the left side, opened the bleeder valve, attached the tube, and started pumping. After 50 pumps, air bubbles appeared in the tube, indicating that the can was running out of fluid. The bleeder valve was closed, the can refilled, and the fluid pumped until the air bubbles were gone. It was then reattached to the bleeder valve and fluid was pumped until the level in the reservoir increased. The bleeder valve was closed and the tube was removed.

The reservoir was filled the rest of the way from the top of the reservoir. Total fluid use was about 1/2 quart.

Brake Testing

The brakes were first tested by pressing the copilot's right brake pedal by hand and watching the right brake. This accomplished nothing, since the movement of the brake pads was so small that it could not be seen.

The next test was to rock the right wheel back and forth with my foot while pressing on the copilot's right brake pedal by hand. Pressing the brake pedal stopped the wheel immediately.

This test was repeated with the pilot's left brake pedal and left tire, then the copilot's left brake pedal and left tire, and then the pilot's right brake pedal and right tire. All combinations worked properly as designed.

No evidence of leaks in the brake system was found.

While doing these tests, the inner pedals (pilot's right, copilot's left) seemed to depress farther than the outer pedals. There seemed to be no reasonable reason for one side to be spongy when the other side was firm. Further observation revealed the problem to be flexing of the tube at the base of the rudder pedals, reacting to the force applied to the brake pedals. The outer pedals were closer to the mounts and were thus more rigid. The inner pedals were farther from the mounts, so the same force produced more flexing. This flexing was not excessive and did not noticeably affect operation of the rudder pedals.

Parking Brake Valve Operation

To test if the parking brake valve would pass pressure from the master cylinder to the brake assembly, the parking brake valve was closed while no brake pressure was applied.

Brake operation was then tested as described above. The wheel moved freely before the brake was applied. The wheel stopped moving as soon as the brake pedal was pressed, indicating that the parking brake valve had allowed the additional pressure to pass through. After releasing the brake pedal, the wheel still did not move, indicating that the parking brake valve was holding the previously applied pressure. Releasing (opening) the parking brake valve immediately released the brake pressure, allowing the wheel to move.

Thus, if the aircraft starts moving while the parking brake is applied, the natural reaction of the pilot to apply the brake pedals will stop the aircraft. The parking brake will then hold the newly applied pressure.

Conclusions: The brake systems were filled with fluid. The brakes operated properly as designed. The parking brake valve when closed will allow additional pressure to pass from the master cylinder to the brake assembly.

Recommendations: None.