

AOPA BARON FUEL CELLS

LEAKING DURING AIRVENTURE 2024



KURT HARTWIG | EAGLE FUEL CELLS | AUGUST 22, 2024

CONTENTS

This report is being generated to document the background and the post AirVenture 2024 findings regarding the Baron fuel cells. The following areas cover what occurred or was found.

- Background
- AirVenture 2024
- Post event
- Receiving inspection
- Cleaning Pre-Test
- Pressure Test
- Post test inspection
- Determinations
- Final Observations
- Summary

BACKGROUND

Early in 2023, Eagle Fuel Cells was approached by AOPA to work with them on the fuel cells for the Baron used to demonstrate the GAMI G100UL. The back log on new cells was over four months so it was decided to overhaul the existing cells, if possible, in order to get the plane ready for showing at events in 2023. The plane was initially being made ready in Minnesota at Twin Cities Aviation Inc. The lefthand aux was found to be a newer FFC cell that wasn't leaking so the three older Uniroyal cells from the 1970's were sent for repair. The lefthand main was a Uniroyal built in December of 1974. The righthand main was a Uniroyal built in August of 1978 and the righthand auxiliary was built in July of 1970. The right-hand cells had been repaired previously with numerous external patches. All cells were a bit stiff (less flexible than normal) and exhibited mild weather checking from ozone on the outboard ends. Each main had one leaking area and the nipples needed to be reinforced with coated fabric due to the wear of hose clamps. All repairs were performed externally, and the weather checking was sealed with a coating to prevent further degradation. The cells were returned mid-March.

The plane had additional maintenance and avionics work done with lots of delays. It did not start flying until near the end of October, when it was brought to GAMI on October 31, 2023, with a total of about 15 hours of time in service. At that time, it was first flown for the cover photo with the left wing tanks with G100UL Avgas. The plane then stayed at Ada and was flown as much as possible. From November on G100UI was used almost exclusively in the lefthand cells and 100LL in the right.

In mid-November small blue stains were noticed under the right wing and on the hangar floor. In early February a slight leak was noticed on the right main. As far as I know no other leaks were detected in any of the cells until after its arrival at AirVenture in Oshkosh, Wisconsin.

AIRVENTURE 2024

On the way to AirVenture, it is my understanding the aircraft made it's final fuel stop in Illinois where G100UL was available. It was then flown into AirVenture on Saturday and parked at the AOPA pavilion. About 10-15 gallons of fuel per side was used during the flight. On Monday, dark stains had formed along the left forward spar down to the low point on the wing and then leaving a brown stain in the grass. The following are photos taken Thursday July 25, 2024.



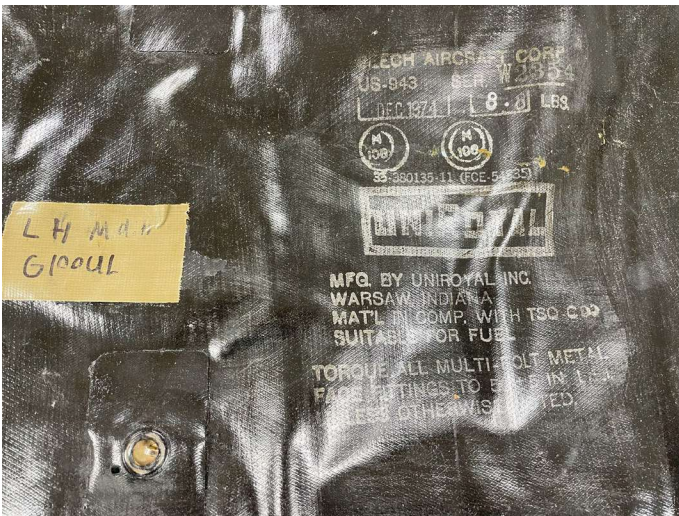
The amount of staining and residue found is normally seen when there is a significant leak that floods the fuel cell cavity floor and removes the tape adhesive leaving a gooey mess. Small leaks will first give a fuel smell and possibly a small stain. A significant leak would cause a significant stain and a drip. If there was a serious leak the bottom of the wing would be covered in stain and goo with fuel dripping. By Tuesday there was no visible dripping only residue. Initially I felt gaskets could be the cause. I supplied AOPA's mechanic Carlo with a fuel set of gaskets and the torque values. Upon inspection he did not find any staining or loose bolts. Given the now stable condition the aircraft was left on display.

POST EVENT

Following AirVenture the aircraft was moved to a local FBO until it could be flown to a facility that could remove the old cells and install the new ones that had been waiting to be installed at a convenient time. The FSDO was contacted by AOPA to determine if a ferry permit was required. The MKE FSDO did not require one but one was requested. The cells were topped with 100LL and flown to Luray, VA. Dale Kraus removed the old cells and installed the new cells. Requests for specific findings and details of other associated parts should be directed to Dale.

RECEIVING INSPECTION

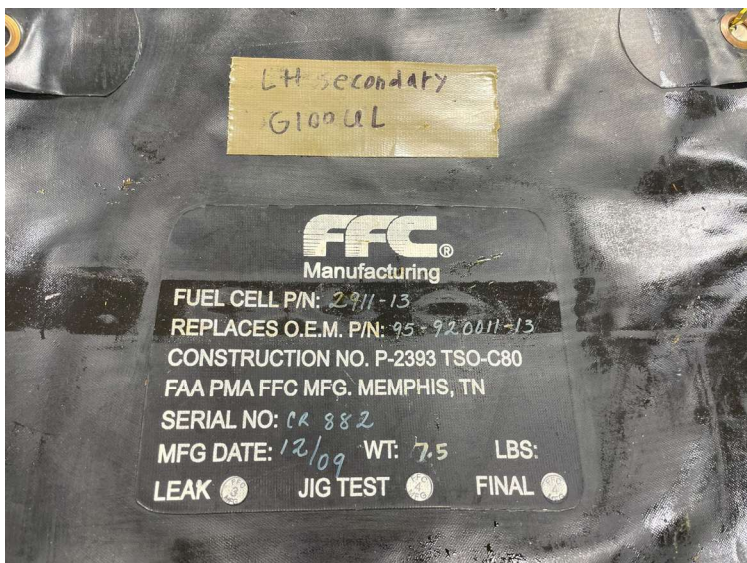
We received all four fuel cells via FedEx on Friday afternoon on August 16, 2024, and began the work of documenting the cells starting with the left main then aux and then right side main and aux.



We noted the brownish color.

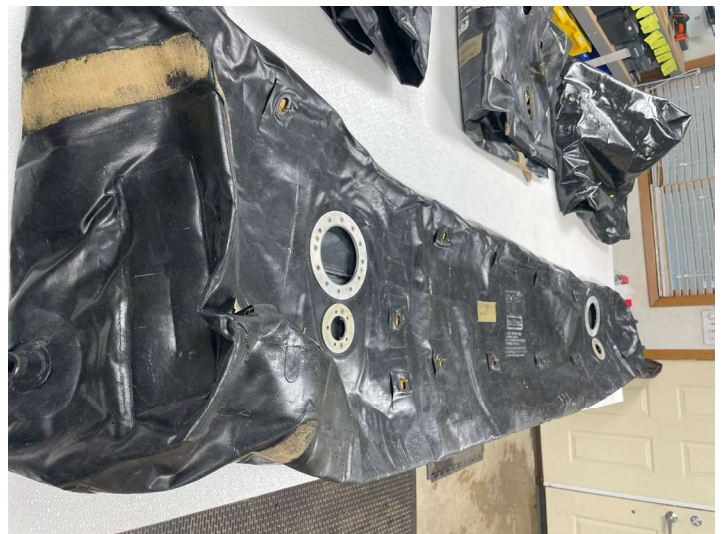
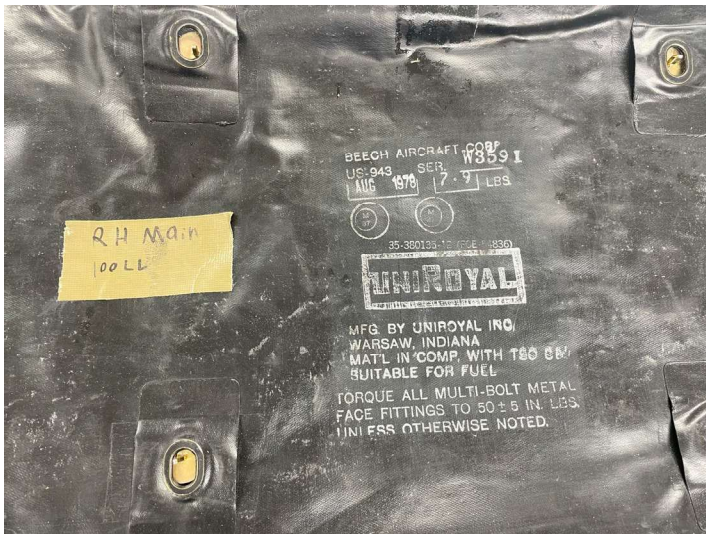


The top and bottom of the left main had the normal amount of sticky residue for a leaking cell but also seemed oily.

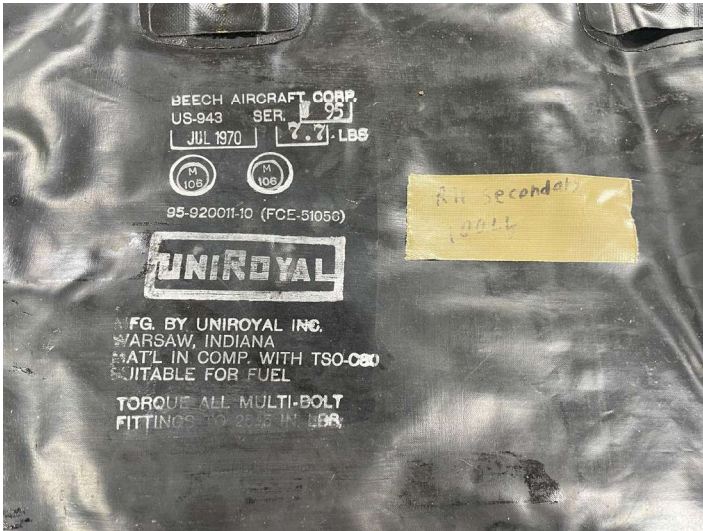


Curiously the top and bottom of the left aux was just as sticky as the left main which would normally indicate a significant leak in the aux cell. Note the detached cavity tape stuck to both top and bottom.





The bottom of the right main had moderate tape residue indicating a small leak.



No tape residue on the right aux would indicate a non-leaking cell.

CLEANING PRE-TEST

The cells were then cleaned and prepared for testing.



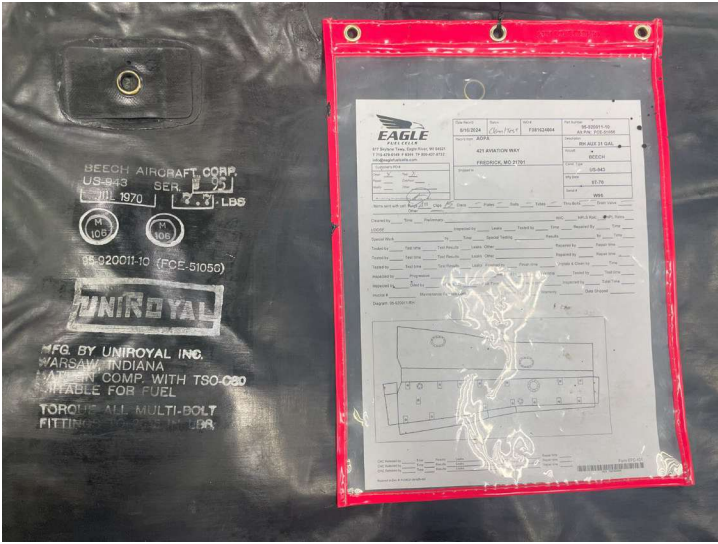
Photos of the previously repaired area forward of the filler neck wrapping around the leading edge on the left main.



Cleaned lefthand aux.



Cleaned right main



Cleaned right aux.

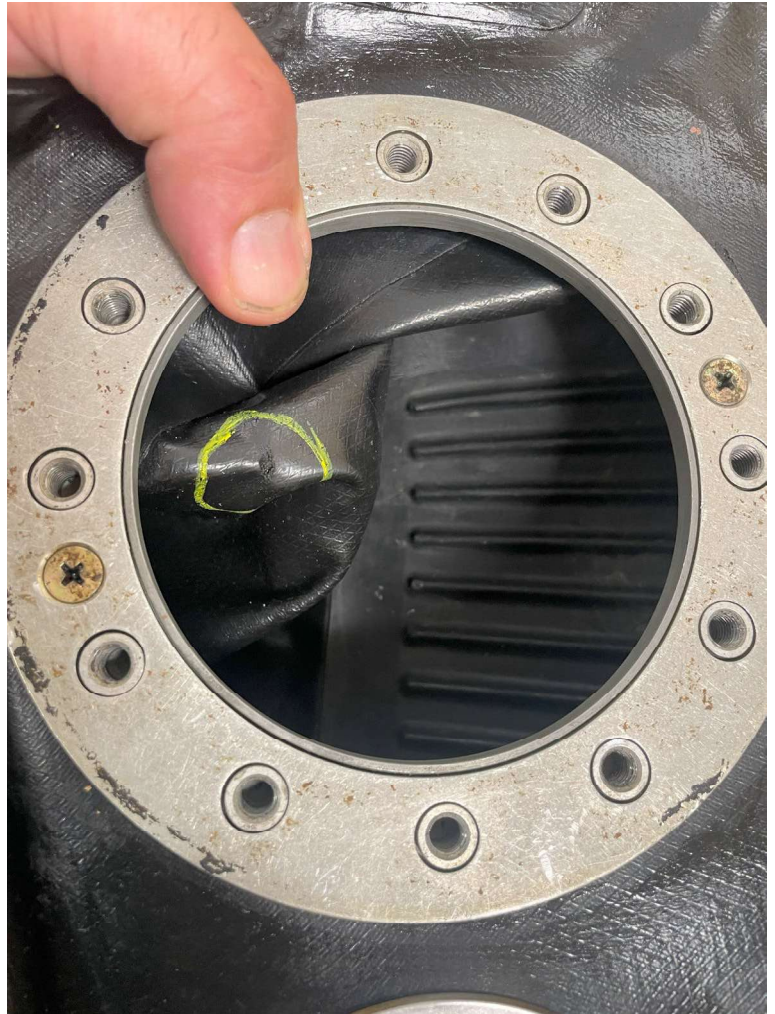
PRESSURE TEST

The pressure test indicated that the two main cells were leaking, and the auxiliaries were not. The right main in I00LL had nine very small leaks. The left main in G100UL had fifteen small leaks and a loose repair. The majority of all leaks were on the upper surfaces. None of the leaks were significant; most of which would evaporate in summer temperatures.



POST TEST INSPECTION

There were no cuts found on any of the cells. However, there was a small bit of missing rubber internally just outboard and forward of the striker pad below the filler neck in the left main. Directly on the outside of this area was a repair that was loose. Also the weather checking, that was documented and coated sixteen months prior, was pronounced again and this time it was leaking both on the left main as well as the right. This is the main reason for all the small leaks on both.



DETERMINATIONS

Given the areas of stain and stickiness observed during the receiving inspection, we expected the lefthand auxiliary cell to leak as well. However, the stickiness could have been caused by seepage into that cavity. The stickiness of the leaking main cells was in keeping with the number of leaks found. There is no doubt the patch may have been partially loose given its location however, the extent of the detachment in situ is in question. The removal and subsequent handling would have further separated the repair. The important question is why the repair began to detach. It may be possible that the missing internal rubber may have allowed the solvents in the fuel to penetrate the fabric and the exterior rubber coating and then getting beneath the external repair. This is most likely the reason given how the repairs are bonded. The installation and removal process is very stressful on the rubber since the cells must be rolled up tight in order to insert them through the small access panels. Generally, the older the rubber the stiffer the cell, so the actual number and size of the leaks in situ is almost impossible to determine as the removal process usually does create more leaks and work. Keep in mind the two leaking main cells are forty six and fifty years old.

FINAL OBSERVATIONS

What we know.

- A significant leak occurred in the left wing sometime between fueling in Illinois on Saturday July 20, 2024, and first notice of leak on Monday morning July 22, 2024, while parked in front of the AOPA pavilion.
- Approximately ten gallons were used during the flight into Oshkosh. (Check engine monitor data for exact qty)
- The leak subsided after about three to five gallons. (Check the top off qty before departure for exact qty)
- The gaskets and bolt torque on the left main cell was checked and found secure.
- The cavity tape in both left main and aux cell cavities was removed by fuel on both the top and bottom surfaces and mostly toward inboard end.
- On the left aux, several bolts on the lower access plates and screws on a transmitter were under torque.
- The left and right main cells both had a number of minor leaks, and the left and right aux cells did not.
- The left main cell had a loose exterior patch and a scuff like divot directly inside the cell below the filler.



What we don't know.

- Why several gallons of fuel was loosed inside the wing in a short period of time
- How much the left main cell was actually leaking prior to removal
- Was the left aux leaking at a connection or gasket
- Why there is a divot inside the left main cell below the filler
- Why the external patch directly opposite the scuff came loose
- Were there any other abnormalities discovered at the time of removal

SUMMARY

Though the left main cell was leaking, I believe that the amount and size of the leaks would not have caused enough fuel to pass into the main cavity, down the spar to the low point drain in such a quick and dramatic way. Given all the evidence above, especially the amount of tape residue on top and bottom of the left aux cell, I believe a significant amount of fuel saturated this cavity. According to Dale Kraus, his team found that the left aux cavity was extremely sticky but not wet at the time of the fuel cell removal. They also found that several bolts on the bottom access plates were loose though safety wired. Additionally, one of the transmitter plates on the top was also loose. Since I am not familiar with GI00UL's evaporation rate, I am not sure how long it would take for the cavity to dry up.

These types of leaks are common when mechanics get in a hurry and do not allow the gasket and cell to adjust to the torque applied to the bolts or screws. The correct procedure is to torque the bolts/screws to the specified torque and allow the materials to adjust. Usually, one to two hours is enough, then retorque again to the specified value before safety wiring. If the retorque is not done before safety wiring, after ten or more hours the torque will drop enough that a quarter turn will be seen after the safety wire is removed. This would appear to be what was experienced in both wings to some extent but more specifically the right aux as Dale indicated.

Unfortunately, we were all focused on the left main fuel cell. I did not check the left aux fuel level while it was parking at AirVenture, and I do not know if anyone else checked to see if it was lower than full. I do not know how long the aircraft sat before the cells were removed. Also, when the cells were removed, intentional diagnosis and investigation was not the focus, rather the removal, thorough prep and installation of new cells. Therefore, a definitive explanation remains allusive.

It would appear that old cells, under torqued bolts and unbelievably bad timing led to the leaks and drama at AirVenture.

