

On the 22nd August 2003, the pilot of Yak-50 registration G-YAKK started his motor normally and allowed it to warm up. A few minutes later he released the brakes and had begun moving slowly forward when "there was a loud bang." The main-air bottle had burst, fracturing two pneumatic lines and a fuel system line. A two foot diameter hole was punched in the lower fuselage, three other holes were made in the upper fuselage by explosion fragments and one fuel tank was deformed. The aircraft was described as "damaged beyond economic repair." The UK report is a great read, with amazing photographs. It can be found on the internet here:

http://www.aaib.gov.uk/cms_resources.cfm?file=/dft_avsafety_pdf_027258.pdf

It's chilling to consider that not only could G-YAKK's air bottle have ruptured in flight, but also how close these same bottles are, in a Yak-52, to the passenger. Whether you like it or not, we are all, Yak, Nanchang, Sukhoi, and L29/39 alike, flying around with onboard bombs, pressurized to 750 psi.

So when is an air bottle NOT a bomb?

When an internal visual inspection and hydrostatic testing confirms that the bottle is still capable of performing the service expected of it. This test is recommended every five years. There are two air bottle failure modes (rupture, and slow leaks caused by pin-holing). The report, above, suggests a widespread belief that non-catastrophic pin-holing is "more likely,"—this has led to "inappropriate attitudes towards prevention, detection and rejection of corroded bottles."

Further, the report noted that even if the manufacturer's proposed maintenance schedule were followed—"bottles to be removed every 50 hours and drained"—it is unlikely that corrosion would be inhibited, because of the constant presence of moisture during operation. In light of this, the UK agency recommended one year, rather than five year, proof-pressure testing. In fact, annual visual inspections are common in the compressed gas industry. SCUBA cylinders, for example, are required to undergo an annual visual in-

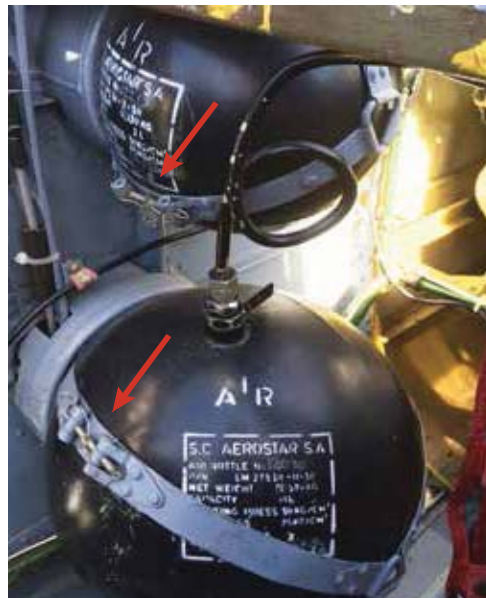
spection, and they are constructed of materials suited to resist corrosion.

Perhaps, in 2003, replacement bottles were more readily available. If you have tried to get your hands on one of these bottles lately, you'll know all about the "cost factors" that might be causing that "attitude." Finding new Yak main air bottles is an ongoing problem for current and prospective owners.

Getting them tested

If you want to remove the bottles from a Yak-52 yourself, it's not an enormous job. The rear seat comes out first.

Your aircraft may be fitted with one of the George Coy "wrap your passenger in fuel" style, reserve-fuel tanks. If so, plan an extra hour to remove that, because the safety-wired turnbuckles on both main and emergency Yak-52 air bottles face forward, and are obscured by this reserve fuel tank.



Do remember to vent both air bottles before releasing the connections! With the plane's gear down and locked, cracking either of the emergency air handles will soon vent that circuit, and it's up to you how you choose to vent the main circuit serving flaps, brakes, and starter. Also remember to chock your plane, since "no air" means "no brakes." The tee on the top of the emergency bottle has different size threads to ensure correct reassembly.



OK, there you are with bottles in hand. Now what?

As luck would have it, there is a tank-testing company in LA that has recently moved into a brand-new test facility. Brian Tyminski was kind enough to meet me at Fullerton airport. As we drove the short distance to his FAA repair station, he gave me the 411 on the past and the present of Compressed Gas Systems.

In 1948 Brian's grandfather started Tym's Inc., servicing fire extinguishers. In the 1950s, soda/acid fire-fighting technology was being replaced by pressurized CO₂, and similar, pressurized systems also began to appear in aircraft. In 1956, Grandfather hired an individual named John to focus on just the aviation-cylinder business—which by the seventies had become prodigious. Sadly, John died a few years ago, and Brian stepped up to take his place. In 2012, Brian bought the aircraft side of the business from Tym's, moving it to Cerritos. (Tym's Inc. is still in Inglewood and continues to provide commercial, non-aviation compressed gas and fire extinguishers services)

Brian has targeted both general aviation and the business jet markets, choosing to remain clear of big air carriers, and in 2013, his business has tripled.

That means the doors are open for everything from Gulfstream to Yak, Mig, and Nanchang!

CGS currently services:

- Halon-based fire extinguishing systems and portable fire extinguishers
- Aviation oxygen systems including

pressure regulators, valves, cylinders, lines, and fittings

- Pneumatic systems – such as our Russian and Chinese air bottles.

The 750 psi rating on our air bottles is considerable, but still meager when compared to pressurized oxygen in modern bizjets—typically 1850 psi. Gulfstream aircraft have other systems requiring 4500 psi—and for that reason, CGS can test up to 10,000 psi.

The internal surfaces of modern steel cylinders are “Parkerized,” or surface treated to prevent corrosion. The Russian bottles are not processed like that. Brian observes, by this stage in their life, the repeated introduction of moist, compressed air, has created small but acceptable amounts of pitting and corrosion in nearly all Russian/Chinese bottles he has inspected. The G-YAKK report contains a cross-section photo of the failed air bottle wall. The wall thickness when new is only sixty thousandths of an inch. As that picture shows, the thickness remaining after bad pitting had taken hold was alarmingly small.

Clean up time

At CGS, the refurbishment process starts in a dedicated cleanup room. All grease and oil contaminants are removed, prior to testing, and it is here (by visual detection of mechanical problems) that 99% of bottles fail. The staff at CGS has been trained to detect a multitude of problems, including damaged, or missing threads, internal corrosion, and pitting beyond acceptable limits.

Acceptable bottles are then de-greased internally and hot air-dried in preparation for hydrostatic testing.

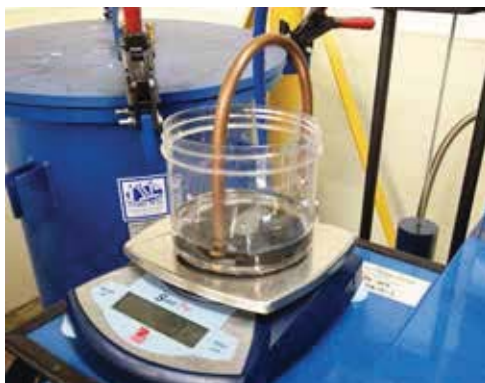
The water jacket test

My main air bottle was prepared with an adapter to add pressurizing water once submerged in the hydrostatic test chamber. Flowing water eliminates any air inside the bottle under test, then with the chamber sealed, the working pressure of 750 psi is applied. The system pressure is monitored, and stability will indicate that there are no leaks.

The basic idea of the hydro, or “water jacket” test, is to note the change in volume of the pressure vessel (as water pressure is increased inside it) by accurately measuring

the water displaced by its expanding outer surface. How well it returns to its original shape after relaxation is a health check of the vessel’s metallurgy.

The Department Of Transportation oversees cylinder manufacturing, testing and performance specs to ensure the safe transport of the pressurized cylinders. However once a pressure vessel is mounted inside the aircraft, it’s considered part of aircraft—and it becomes the FAA’s responsibility! The bottles installed in our aircraft were not manufactured to DOT specifications, so industry, OSHA, FAA, and DOT rules are implied by CGS to ensure a safe, and reliable inspection procedure. CGS uses 200% of duty pressure for 60 seconds. This is a standard for welded DOT spec cylinders, such as those found on fire extinguishers.



As my air bottle expanded under internally applied water pressure, water left the rigid test chamber, was lead to a beaker on an accurate scale. The expelled water’s weight was measured in grams. When the test pressure of 1425 psi was applied, my Yak main bottle expelled 157 grams, (and so 157 cubic centimeters) of water.

A stretched spring should return to its original length when the load is relaxed, and so is the case for pressure vessels. If it doesn’t, and remains stretched, this is an indication of under-performance, and possibly the approaching end of useful life.

The DOT criterion is that up to 10 percent residual stretch is acceptable. So when the internal pressure on the cylinder is relaxed, you would expect to see a zero on the scale if the bottle has returned to its original size. In my case up to 15.7 cc residual would be OK. If the bottle under test does exceed this residual limit, DOT test criteria allow for a retest, but it must withstand an additional 10% pressure. If

your bottle passes, (as most do, according to Brian), it will be metal-stamped on the neck or grounding lug with the month and two-digit year of the successful test. CGS also attaches a sticker with the date of the next retest.

Remember to adequately package your cylinders for shipment to the test lab. They are now too rare to allow them to be damaged in transit.

If your tank failed, what now?

With experimental-exhibition airworthiness certificates, we are at liberty to do what we must as replacements for original parts become scarce. But Brian has words of caution for owners considering adapting other tanks. The owner of the Yak-50 shown in this picture has adapted a Boeing 737 halon tank after the original Yak factory air bottle failed hydro. Some halon systems operate at lower pressures than our Yak pneumatic systems, but they are also an emergency system, designed to discharge by the pyrotechnic fracture of a critically designed rupture disc, (this can be seen facing the camera). Any modifications to an approved DOT pressure vessel are illegal according to transportation law, and may be viewed unkindly by the FAA. On top of that, the rupture disc is an intentional point of failure that did not exist in the original Yak bottle design.



On the upside, I understand there is a perfectly sized Carbon fiber bottle for Yaks that is used in the SH-60 helicopter, (used to inflate the emergency flotation device.)

The good news—you can pick one up for around \$15,000.

Good hunting for your next air bottle, and until you absolutely need one, get them tested on schedule. CGS is working with cylinder manufacturers in the aviation industry to design a direct replacement for the Yak air bottles. Development is currently ongoing. ★