# General Condition Inspection and Maintenance

## Part 2 by Craig Payne

Previously in Part 1, I reviewed the preparations necessary to conduct the General Condition Inspection. Since the aircraft must be opened up for inspection, “annual” time is an opportunity to perform essential maintenance and upgrades as well. While the workflow need not follow any pattern, the effort should be recorded first on a worksheet/checklist and then pertinent items will be transferred to the logbooks: Airframe, Engine and Propeller. Aircraft certified under the U.S. Experimental-Exhibition category are issued Operating Limitations that specify a 12 calendar month interval for a condition inspection that follows the “scope and detail” of appendix D to Part 43. A more focused and detailed checklist is available on the Red Star website under store/manuals.

## Airframe: Pneumatics

Most Red Star aircraft utilize pneumatic systems to start the engine, operate the retractable landing gear, the flap/flaps and braking system. No air, no fly. Conducting the inspection of the pneumatics basically comprises a large piece of the airframe work load. Depending on the hours flown and the operating environment (Arizona vs Florida); the depth of the inspection is determined.

Virtually all pneumatic issues are the result of moisture causing corrosion or deterioration in rubber and metal parts. Aluminum turns to aluminum oxide when water and oxygen meet, steel springs and valve faces rust, and rubber seals either turn to dust or to “goo”, depending on the environment. Where dissimilar metals meet, the effect is accelerated. Unlike hydraulic systems, pneumatic leaks do not leave behind telltale signs like fluid stains. Some sort of detection equipment must be employed when looking for a leak. A spray bottle of soapy water can handle most leaks but specialized electronic stethoscopes do a great job of ‘hearing” ultrasonic leak noise.

Check valves are one-direction of flow only, an arrow on the valve body indicates the flow direction. “If” the air-water separator is maintained regularly, the check valves need not be opened and checked every annual, “If” the system is functioning normally. I check mine every other year unless a problem is noted. Mr. Doug Sapp stocks check valve rebuild kits, have one or two handy.

Tip: Since my valves are opened every two years, I use 16mm x 2mm Buna-N O-rings rather than a lead seal.

Certainty, the gear must be “swung” from both front and rear cockpits using the Main and Emergency system. Sometimes that emergency system gets overlooked, the wrong time to test it is when you really need it! Twice, over 1200 hours, emergency gear down saved my skinny little butt. As part of this check, some light lubricating of the actuators, per the maintenance manual, must be performed. Mechanical clearances of the uplocks must also be measured and adjusted due to wear.

Tip: Go easy on the air pressure for the gear swing, many airframes had their flow restrictors removed during military service. Now would be a good time to add them to the main system. Often, it is the check valves and hand operated valves that need the most attention. Many in-flight failures have been traced to these components. A little lube goes a long way, too much causes “goop”. Goop is the result of excess lubrication and moisture combined. Check valve rebuild kits are inexpensive. Many air leaks are the result of cracks in or near the flared fitting due to normal vibration or over tightening of the “B” nut. The straight nipple threads wear out over the years as well as get nicked on the flare face; buy some spares.

Tip: SAE ¼” 5052-0 tubing can be used with metric “B” nuts by drilling the nut to a size “M” drill bit or a 5/16” bit for a nominal 5/16” shank ferrule used with ¼” diameter tubing in place of 6mm (.236”) stock tube.

Do not forget to follow the recommended air bottle service intervals, especially in high humidity areas. Speaking of, even Arizona has a “monsoon” season where accumulations of moisture can gather and be trapped in the system.

Tip: Every pneumatic system should have an air-water separator; it is the final barrier to keeping moisture out of the system. Mr. Doug Sapp sells an excellent stainless steel filter that all Yaks/CJs could benefit from. Don’t leave home without one. I service mine every 15 to 25 hours, depending on the season.

Brakes are important too; many times they wear out early due to excessive use, especially the left brake. I use the control surfaces to steer while taxiing in the wind as much as possible. I also discourage tight nose-to-tail taxi at airshows. How snappy will lead look when his flight piles up behind him due to overheated brakes? Check the condition of the bladders and hoses as well, they do rot. Most of the brake components are interchangeable between Yak/CJ but I think the Yak brake drums might be a bit thicker.

# Airframe: Controls

Every airframe inspection targets the control system for attention. Cables, pulleys, rod end bearings, hinges and bell cranks are the biggest inspection items. These parts all wear. The Yak/CJs have a way of fraying their cables, perhaps due to their length and aerobatic use. Light lube is important but too much will attract dirt and wear out sooner. Foreign objects damage or “FOD” has been a serious issue with the Yak-52 and I once suffered a rudder jam in my CJ. Lucky it happened on the runway during landing when my less-than-graceful technique broke loose a metal relay housing that dropped in front of the rudder bar. What caused that to happen? Well maybe it was some missing screws and some that loosened after 45 minutes of clumsy acro and “dished out” barrel rolls that subjected both me and the airframe to G-forces not normally seen.

Rod or wire hinges wear out, both the rod and the hinge halves. Wash with mineral spirits and then lightly lube. A telltale sign of wear is metal dust, or metal streaks on the hinge.

Check tightness of rivets that hold the hinges and controls, stresses in these areas can cause rivets to rotate and “smoke” with telltale metal dust around them. These rivets must be replaced. The same goes for structural parts and skins.

### Tip: Rivets in the slipstream may get oil and dirt rings that look like “smoking” rivets. Use mineral spirits to wipe clean; loose rivets will still look loose but just dirty ones clean up.

I prefer the fabric covered control surfaces over “metalized” ones since the condition of the structure can be easier determined and repaired. A good Dacron cover should last the lifetime of the airframe if hangered out of the sun. Removal of the Chinese fabric on my airplane revealed newspaper was used was used for a gluing surface! No doubt about the source as the print was in Chinese. Paper can retain moisture and corrode the metal ribs so I’m sure someone in the field cut some corners.

# Engine:

Technically, accessories such as the solenoid start valve are part of the airframe. Only “accessories” attached to the engine are considered part of the engine. Components like the start/boost coil, air solenoid, air-pressure “pop-off” valve, fuel “bubbler” and oil tank system need to inspected as well. The mounting of the air start solenoid traps moisture in the bottom of the unit and must be cleaned regularly.

Tip: A brownish-looking stain on the firewall near the start valve indicates a build-up of rust in the lower part of the unit. The remedy is to disassemble the lower air portion of the unit and clean it.

A detailed visual inspection of the engine bay initiates the process. Much can be uncovered by simply looking in the right places. Places like mount bushings where cracking of the rubber and looseness can be seen; exhaust stains on the inside of the cowling indicates leakage. The lack of clearance between hoses and other parts leads to chafing and wear-thru. This is especially critical for fuel and oil hoses.

Tip: Nylon zip-ties “age” quickly and become brittle. I use clamps when possible and change out zip ties during the annual inspection, avoiding the cheap kind that leaves sharp edges. Rather, find the type that lies flat and can be trimmed without protruding edges.

On both Yaks and CJ’s, some routine tasks are certain to be required:

* Checking tightness of both intake and exhaust collars at the cylinders
* Check for loose exhaust clamps. Yak-52 clamps rust.
* Check intake collars at the plenum
* Clean or change the air compressor intake filter
* Clean or change the carb air filter if there is one installed

Tip: Brackett makes the BA-197 filter to fit over the Nanchang intake screen. Order one directly from the manufacturer at 928-757-4009.

Compression Testing: The differential compression test is regarded as the gold standard in the certified world. Low compression in a certified shop can mean the difference between hundreds of dollars and thousands of dollars. It’s a liability thing, covering their behind and all. Volumes have been written on the subject so I’ll confine my remarks to my experiences.

Neither the Huosai nor M-14P maintenance manuals specify a *differential compression* test. What they do specify is an automotive style compression test where a gauge is attached to the front spark plug and the cylinder pulled through to obtain 51 PSI. The M-14 manual also shows a value of 74 PSI (5 kgf/cm2) as an upper value. Likewise, appendix D of Part 43 does not spell out the specific procedures to use either.

So, the application of a “Western” shop procedure to an “Eastern” shop procedure is subject to interpretation. Following U.S. convention the differential compression tester is set up to supply 80 PSI and check leakage from there. Some cylinders may not show any difference, in other words, 80/80, while others may register a lower value. In the certified world, “high” 60’s is considered the bottom end if so stated by Manufacturer’s Service Bulletin. I have seen older Continental Service Bulletins that placed a value of 58/80 PSI as their minimum.

If an engine is running well and all cylinders show in the 60’s; my opinion would be that the engine is wearing normally but nearing a “top end” rebuild. If most cylinders read in the mid 70’s and one or two are in the low 60’s or below, I would placing those cylinders on a watch list.

Use the test as a diagnostic tool, air blowing out the exhaust could be caused by nothing more than lead-carbon build-up on the valve seats. In this case I would “Spike” the valves by bouncing the valve off its seat with a hammer blow while under air pressure. If an immediate increase in pressure is not seen then I would suspect worn valve guides or pitting on the valve seats. Air blowing out the breather could indicate worn rings or perhaps just ring gaps lined up and not staggered. Listen for hissing air leaks.

Tip: Do not start removing a cylinder for low compression before running the engine again and then re-checking. I check compression with the engine cold; if a low reading is found, then I run it and check it warmed up. Be sure and check valve clearance first if low compression is indicated.

Ignition System: I believe I have seen more engine problems resulting from the ignition system than all other issues combined. What some pilots may call a magneto problem is usually an ignition wiring problem. The stock harness was built from 5mm stranded wire with rubber insulation. The numerous fittings and elbows can trap moisture, and rubber insulation breaks down.

For these reasons, the automotive wiring conversion became a popular modification. However, even auto wire setups can develop issues due to the design of the distributor cap and the non-metallic center conductors used. Isolating a rough running “magneto” problem can be accomplished by running the engine on the “bad” side for several minutes and then checking each cylinder at the spark plug boss with a digital laser thermometer. Significantly colder cylinders indicate weak or no spark. While that could still be caused by different items, the problem has been isolated.

Tip: No not gap automotive spark plugs wider than .020” or the magneto coil will heat up at cruise altitude due to excessive resistance and prematurely fail at some point.

### Lubrication System: Oil, and lots of it, is required to keep that fan up front turning. The engine system is considered “dry sump” since all lubrication is by positive pressure created by the accessory shaft oil pump. While the engine section has no sump, the propeller reduction gear case does. Lubrication is provided by blizzard of oil droplets, thrown about inside the case. Scavenge oil is cooled by the remote oil cooler before being returned to the oil tank.

In military service, the aircraft were flown almost every day and the oil was changed frequently. It’s not like that in our world. Abrasives (dirt) in the air are combusted and ends up in the oil along with combustion byproducts which break down into acids. That’s what oil does; lubricate and protect the engine. However, our engines do not run as often and oil sits for a relatively long time before being changed. The result is fine abrasives and contaminated oil. Now the oil molecules act as transporters for attacking the engine metals with acid when sitting and helping abrade metal when moving.

Tip: Install both an air filter to reduce silca (dirt) ingestion and a 10 micron oil filter to remove abrasives from the oil.

Greasing the lubrication fittings is also part of routine maintenance but often gets overlooked. I use 10mm “zerk” fittings for most lube points but still retain the original flat style where clearance with the zerks is too tight. I Lube with Aeroshell #5 grease. Sometimes old grease has caked and hardened, losing lubricant properties and must be removed before fresh grease can replace it.

Misc. Systems: I define a system as a feature or function of the aircraft. The pitot-static is a system consisting of a combination probe, lines and hoses, moisture traps and gauges. Another “system” is Carb Heat. Not normally used in Florida but I have seen the need for carb heat when operating during Northern Illinois winters which are notorious for very humid air when temps hover around freezing. This system consists of an airbox, warming “ears”, actuator flap and push-pull controls. All Carb Heat systems, regardless of aircraft type, I have encountered suffer from cracks in sheet metal and control functioning. Often overlooked, don’t forget this “system” during inspection.

Other systems include cabin heat, smoke oil setups, aux fuel tanks, engine pre-oilers, intake drains and other aftermarket mods like the remote snot valve control. All need to be inspected for operation.

# Propeller:

Often overlooked in an inspection, the propellers on Yaks and Huosai’s require period lubrication and inspection. I have seen props allowed to tighten up from lack of lube so that range was limited to higher RPM settings only. When grease hardens inside the hub, voids in grease are created and moisture gets in.

The large diameter hub bearings should first be cleaned of all grease, using solvent and an air hose to blow the old stuff out. Discoloration indicates the start of corrosion which must be further inspected with a 10X lens on the bearings. Worn or corroded bearings are not allowed and the assembly must be replaced. More commonly, the brass “sliders” that drive pitch change get scored from dirt and worn from lack of lube. These can be readily replaced. When screwing the blades back in (on stock propellers), go all the way to the stop and then back off to the correct angle.

The dome seals, inner and outer, often get a lot of blame for oil in the hub when the real reason is a leaking standpipe which transfers oil from the engine/governor to the pitch control dome. There are seals under the standpipe: I use an O-ring as well, replacing it each time the pipe is removed.

Tip: Use a digital level on the face (back) of the blade to set the angle. A good spot is behind where the tip stripes are painted or the 36” from center. Tape into place or make a simple fixture to hold the level. Be certain to subtract (or push “Calibrate”) to compensate for inclination of the centerline; usually about 2-1/2 degrees nose up when setting the blade angle; about 14.5 to 15 degrees.

Overall: The checklist looks overwhelming at first but many of the items are quickly checked off as the inspection progresses. The purpose of the list is to cover all of the points which must be looked at. Most of my time during the “annual” is spent on maintenance and fixing known squawks; the checklist can be cleared in a day. Save the checklist in a binder for reference from year to year.

2nd Look: Having someone else familiar with your type of aircraft check-over your work is a bonus. Many mechanics insist that someone who’s opinion they respect check over the work done. It doesn’t take long and often the simplest items can be found, here are some of my “bads”:

* #4 spark plug not installed or re-connected, done both.
* Firewall fuel valve in the “Off” position, happened more than once.
* Tighten down the magneto base nuts after setting the timing.
* Re-connect the P-leads after magneto timing, forgot twice.
* Panels not re-installed.
* Valve cover hold-down wires not seated in groves, many times.

After Inspection Run-up: Repeating the pre-inspection run-up and operational checks serves to verify that the airplane is at least as good as when the annual started. This is not a guarantee! Document the same instrument gauge readings as part of the record. Never go and fly until shutting down, checking for leaks, open panels, etc. after the post inspection run-up.

Part 3: In the final article of this series I will cover the post-inspection run up and flight test as well as doing the required paperwork.