Stan/Eval Newsletter
CIVIL AIR PATROL
UNITED STATES AIR FORCE AUXILIARY
105 S. Hansell Street
Maxwell AFB, AL 36112

May 2023

Table of Contents

Taking care of our engines (SM J. Ellis NVWG)

We rely on the engines in our airplanes to keep us safe by them operating reliably and dependably. Preventive maintenance like regular oil and filter changes; and periodic inspections like compression checks, examining the oil filter and looking at cylinders and valves with a fiber optic camera (borescope) to assess the condition of cylinders and valves are an important part of the picture. Proficiency and check flights put a lot of emphasis on how to deal with engine failures. This article focuses on actions air crews in general, and pilots and co-pilots in particular, can all take to help reduce the likelihood of having to deal with a full or partial engine failure to begin with by taking proper care of the powerplant when we fly.

Our role begins with engine starts. In cold climates, keep block heaters plugged in during the winter months to avoid cold starts that are hard on the starter and can cause excessive wear because it takes longer for cold oil to start circulating in the engine. If your aircraft doesn't come with a heater, something as simple as a blanket and a shop light is surprisingly effective. Know how to start the engine without excessive cranking to minimize metal-on-metal wear until oil is circulating.

Once the engine is running, keep it properly leaned for ground operations. A lean mixture at idle ensures lead in the fuel is scavenged so it doesn't build up on spark plugs and valve stems and guides, and it also prevents potentially more serious problem where soot from incomplete combustion keeps the exhaust valves from sealing tightly when closed. Ground leaning is generally accomplished by setting engine RPM to 1000-1200, leaning for maximum RPM and then retarding the throttle to 900-1000 RPM (see the POH). If the engine stumbles when you add power to start taxiing, enrich the mixture with half a turn of the red knob. The engine will stay cleaner, and it will signal its appreciation for the leaner mixture by purring like a kitten instead of sounding like it's coughing. You'll be able to taxi at lower RPM, which is safer and much easier on brakes. Aggressive ground leaning isn't just for specific engine types or at high altitude airports. It's as important for normally aspirated engines as for turbocharged engines, and carbureted engines benefit as much as their fuel injected counterparts. If you aren't sure how to lean on the ground, get an instructor to show you or read the POH for some of the newer 172, 182 and 206 models, or look at one of the references at the end of this article.

If you're departing an airport with a high-density altitude in an aircraft with a normally aspirated engine, set takeoff mixture for best power (maximum RPM) during the runup in accordance with the POH. If you aren't sure whether or how to lean for a high-altitude airport departure or if you haven't flown the aircraft in a while, review the POH before you get to the airport and talk with an instructor. For all aircraft with turbocharged engines, make sure the mixture control is full forward for takeoff no matter what the density altitude is to avoid detonation that can destroy an engine in minutes. The pilot or the MO should make sure fuel flow matches POH or checklist settings at full power. Be aware that applying full takeoff power in a turbocharged aircraft with the mixture leaned might damage the engine. While the damage may not be evident during your sortie, the engine could suffer a catastrophic failure on departure during the next one.

When applying takeoff power, advance the throttle smoothly but not too quickly. Don't jam it to the stops, especially on turbocharged engines. Applying power too quickly can damage the crankshaft counterweights. Pushing the throttle all the way forward too quickly on a turbocharged engine can lead to over boosting. Turbocharged engines will tolerate small over boosts for a few seconds but the controller that maintains constant manifold pressure can react slowly when the oil is cold, and it can also fall out of proper calibration so the pilot or co-pilot should monitor and call out any needed adjustments. If engine power doesn't come up to the expected takeoff value, abort the takeoff if there's enough runway or come around and land immediately. Do any troubleshooting on the ground. If the turbocharger fails and you continue, a damaged turbocharger could pump all the engine oil overboard in a few minutes.

Know where to find the cruise performance tables in the aircraft or POH and be familiar with any throttle and mixture settings that are not approved by the manufacturer or by CAP. In the T206 for example, manifold pressure is limited to 28 inches at an altitude of 10,000 feet when the outside air temperature is -13F, which is not uncommon during winter months in the mountainous areas where these aircraft typically fly. CAP also prohibits the T206 from operating lean-of-peak. Lycoming, which makes the engines for most CAP's newer airplanes, recommends limiting cruise power to 65% to maximize engine life.

An important but little-recognized enemy of engine health and longevity is heat, especially cylinder head temperatures (CHT) for all engines and turbine inlet temperature (TIT) for turbocharged engines. Most CAP aircraft are now equipped with digital engine monitors that present CHTs and TIT in real time on a cockpit display. Learn how to read and interpret them. Even more important, know the safe limits for CHT and TIT, which are lower than the redline values you'll find in the POH. DO NOT assume that temperatures anywhere in the green band are OK. CHTs should be kept below 400 F on all CAP aircraft and TITs should not exceed 1525 F for turbocharged aircraft, which are well below the red line values you will see on the instrument. Also see this reference (https://www.lycom ing.com/content/leaning-lycoming-engines). On aircraft equipped with digital engine monitors, know how to display numerical temperature values, and have the co-pilot keep an eye on them, especially during takeoff, climb and in search mode when the aircraft is at relatively high power and low airspeed. Know how to manage temperatures using a combination of fuel flow and in suitably equipped aircraft, cowl flaps. Remember that the strength of the aluminum cylinder heads on our engines decreases rapidly as temperatures rise above about 425F.

When operating any engine, it's important to move the engine controls in the proper order, especially when transitioning from the power levels used in searches or in cruise to full power. When increasing power, adjust engine controls from right to left (open cowl flaps for airplanes that have them, push in (enrich) the mixture, increase prop RPM for airplanes with constant speed propellers, and only then advance the throttle). When reducing power, adjust the controls from left to right (reduce throttle, then reduce engine RPM, then lean the mixture, then close cowl flaps). Adjusting the power controls in this order prevents the engine from being starved for fuel while transitioning from one power setting to another, brings in power faster, and avoids overheating cylinders.

It's good operating practice to ease back on the throttle when initiating a descent instead of simply closing the throttle, but there's also no need to reduce power in tiny steps. In the 182, 206 and GA8 aircraft, reducing manifold pressure in 5-inch increments will set up a 500-fpm descent and it won't cause cylinder head temperatures to fall too rapidly. For airplanes with constant speed propellers, minimize operation below the green arc for propeller speed to avoid damaging the engine counterweights. If the airplane has cowl flaps, close them during the descent and remember to open them again as necessary if you transition back to cruise. If you must execute a go-around, remember to reopen the cowl flaps after establishing a positive rate of climb and reaching a safe altitude, or ask your co-pilot to adjust the cowl flaps for you.

Airplanes with normally aspirated engines that are landing at high altitude airports should descend by reducing power, but the mixture should be left leaned for landing so that the engine can produce as much power as possible in the event of a go-around. Airplanes with turbocharged engines should always have the mixture control against the forward stop (full rich) prior to landing to provide maximum power and prevent engine damage in the event of a go-around. Airplanes with constant speed (controllable) propellers should always land with the prop control full forward (maximum RPM) so maximum engine power is available in the event of a go-around. Perform a GUMPS (Gas, Undercarriage, Mixture, Prop, Seat belts) check right before or upon entering downwind or before the final approach fix. If you're not sure what to do, consult the POH and aircraft checklist to familiarize yourself with the correct procedure on the ground prior to starting the sortie, or talk to an instructor.

After landing and taxiing clear of the runway, lean the engine again for ground operations and open the cowl flaps.

Turbochargers need some time to cool before shutting down. If you land after a go-around or it's a short taxi to parking, allow two or three minutes for the turbocharger to cool before shutting down. That's about as much time as it takes to call for the fuel truck and run the shutdown checklist. No need to make it a separate event. The turbocharger has already cooled about as much as it's going to during the descent.

For those interested in learning more, there is a list of references focusing on Lycoming engines at the end. Articles by Mike Busch, George Braly and publications found on the GAMI and AOPA web sites are excellent resources. Remember if you take care of the airplane's engine, the engine will be better able to take care of you.

Further reading:

Tips for Extending TBO: https://www.lycoming.com/content/tips-extending-tbo

Fuel Mixture Leaning
Procedures: https://www.lycoming.com/sites/default/files/attachments/Fuel%2520Mixture%2520Leaning%2520Procedures.pdf

More extensive article on engine management from the
UK: https://www.peter2000.co.uk/aviation/engine-management/index.html

Teaching to the ACS – Normal Takeoff (J. Lee LtCol, MAR)
As an active instructor, I get to experience a wide range of abilities in pilot proficiency. Whether I'm doing a stage check for a primary student on their first solo cross-country, a Flight Review for an airline pilot getting back in general aviation, or a CAP pilot on their seventh Form 5, the areas for improvement remain the same.

Let's look at the normal takeoff. I consistently find that during the Normal Takeoff, pilots veer off to one side. Not surprisingly, they do so to the left. This foundational skill is underestimated in its complexity and implications to safety. Executed properly, a good takeoff is the key to understanding the variables that affect a good landing. Let's apply the Airman Certification Standards for a Normal Takeoff and Climb and go over each skill element.

PA.IV.A.S1 Complete the appropriate checklist. The hardcopy checklist should be accomplished prior to entering the runway. (Incidentally, in reference to the checklist: SRM, positioning, challenge and response, and flows might be a topic for another day.)

PA.IV.A.S2 Make radio calls as appropriate. Review the AIM for proper phraseology. But certainly, readback the entire clearance, and never acknowledge by just saying something like "Roger, cleared for takeoff". At a towered field you must repeat that you are cleared for takeoff, the runway, and your call sign as a minimum. At a non-towered field, a CFI pet peeve is when pilots self-announce, "Jones Traffic, N12345 ***TAKING (or Taking Active)*** runway 20 for departure". Why are you "taking" the runway? Please give it back so others may use it as well. The expression "taking active" is more egregious since it gives no indication of which runway you're using – after all both runways are "active".

PA.IV.A.S3 Verify assigned/correct runway. This means verify that the runway designation, magnetic compass heading, PFD/Directional Gyroscope heading indication all agree. (For the purposes of a F5, I don't need to hear you verbalize - pointing alone at the respective items is acceptable. I prefer, when at the end of runway, that the pilot just points at the instrument.)

PA.IV.A.S4 Ascertain wind direction with or without visible wind direction indicators. As with the previous task, pointing at the windsock is acceptable. If lacking a windsock, verbalize the latest ASOS indication. At a towered airport, the controller will state the wind as part of the takeoff clearance (you don't need to repeat that back).

PA.IV.A.S5 Position the flight controls for the existing wind. Place the yoke to full aileron deflection into the wind. After adding power and gaining ground speed, the yoke will start to feel "alive", that is, it will attempt to get streamlined with the forward motion of the airplane and the yoke will pull against you – leave some input in.

PA.IV.A.S6 Clear the area; taxi into takeoff position and align the airplane on the runway centerline. Ensure the nosewheel is straight otherwise upon brake release the airplane will yaw. When I hear a pilot at a non-towered airfield announce, "lining up and wait", I cringe. There is no "line up and wait" at a non-towered airport. You are either holding short or taking off. I cannot imagine a time-critical situation where a pilot must line up and wait on the runway at a non-towered airfield. Sitting at the end of the runway with one's back to traffic introduces unnecessary risk. An exception might be after announcing takeoff and pulling on to the runway, you see wildlife on the runway. But don't just "line up and wait". Better to taxi slowly and exit the runway at the closest exit. On the other hand, at a towered field, when directed, that's a different scenario. At least the tower has considered other aircraft and the potential for conflict. However, you may still reject the clearance. In that case, if you're at the end of the runway the tower would then cancel your takeoff clearance (which you must acknowledge) and direct you to taxi off the runway.

PA.IV.A.S7 Confirm takeoff power and proper engine and flight instrument indications prior to rotation. The ACS calls for "takeoff power" as many airplanes do not use full power on takeoff. However, "takeoff power" for us in CAP usually means full power as stated in the POH. The key here is to verify you really are "full power". Anything less calls for an aborted takeoff. But beware as what is full power at sea level on a standard day won't be the same at a high-altitude airport on a hot day. Best Practice: align Heading Bug at this time. During the roll, glance at the MFD with pointing for full power and green indications. Any red X's will be hard to ignore – keep your eyes outside.

PA.IV.A.S8 Seaplanes

PA.IV.A.S9 Rotate and lift off at the recommended airspeed and accelerate to Vy. If you have takeoff trim with 10' flaps, with only a quarter inch of aft yoke, the airplane will takeoff. For me, it looks like "top of the cowl, end of the runway". Since this pitch attitude allowed you to takeoff without scraping the tail, it stands to reason that if you have this pitch attitude on landing, you won't scrape the tail. But you can also extend your arm to the top of the glareshield and pitch to one or even two finger-widths above the horizon. This should give you plenty of pitch for a normal climb. This should also place you in the ballpark for Vy with only minor pitch pressure. Maybe a quarter turn of the trim wheel – not keen on using electric trim. *(Ed note: On our G1000 aircraft the AI should indicate approximately 7.5 degrees both on landing and takeoff. 12 degrees is a tail strike and 5 degrees or less indicates a flat landing or a nose first landing.)*

PA.IV.A.S10 Seaplanes

PA.IV.A.S11 Establish a pitch attitude to maintain the manufacturer's recommended speed or Vy, +10/-5 knots. See S9.

PA.IV.A.S12 Configure the airplane in accordance with manufacturer's guidance. The POH for most of our aircraft states "Wing Flaps – RETRACT (at a safe altitude)". The term "safe altitude" is not defined. What does it mean? Suggest you define as either, "no more runway remaining" or, "1000' AGL". But in either case, confirm "positive rate (of climb) altitude increasing" – this may be particularly important during night flight where visual cues can be misleading.

PA.IV.A.S13 Maintain Vy +10/-5 knots to a safe maneuvering altitude. See S9.

PA.IV.A.S14 Maintain directional control and proper wind-drift correction throughout takeoff and climb. Unlike an instrument takeoff (where we do not include a wind-drift correction after takeoff), we fly a ground track that is over the extended centerline of the runway. Bias your right leg to compensate for torque. If conditions allow, look over your right shoulder and your position relative to the extended centerline should be evident.

PA.IV.A.S15 Comply with noise abatement procedures. Comply with what's in the Chart Supplement in relation to noise abatement. But we should all be aviation ambassadors of goodwill. To that end, fly night currency at a remote field, rather than at your home base if residential areas are adjacent to the airport. Avoid overflying populated areas at high power and low altitude if possible.

So, there it is – a normal takeoff. Yes, lots of things to consider and execute all in short order. Get with an instructor and develop a recurring training plan.

Back to Basics: The short field takeoff

In the previous edition of this newsletter, it observed that rotating to Vx on takeoff was not really a good idea in normal operations. Rotating to such a steep take off angle introduces unnecessary risks. However, that article also noted that it didn't mean that rotating to Vx is never a good idea. In fact, Vx is a very useful speed to fly when we are performing a short field takeoff. It is especially useful on a check ride as its part of the ACS standards. This article will briefly review the technique for a short field takeoff in a Cessna 182 and point out common errors that are made both in teaching and in executing this basic maneuver.

The purpose of a short field take off is twofold. The first purpose is to use a minimum of runway. That is to reduce ground roll as much as possible. The second purpose is to clear any obstacles which means to climb as steeply as possible in the least amount of space.

The definition of Vx is that air speed that gives us the best angle of climb or stated differently, the most climb in the least horizontal distance. One can easily see how this would be an important air speed when you're trying to avoid nearby obstacles after takeoff. The C182 POH tells us what Vx is:

> If an obstruction dictates the use of a steep climb angle, the best angle of climb speed should be used with flaps up and maximum power. This speed is 64 KIAS at sea level, increasing to 68 KIAS at 20,000 feet. This type of climb should be of the minimum duration and engine temperatures should be carefully monitored due to the low climb speed.

Here's where everything goes wrong. It starts with the short field takeoff checklist in the pilots operating handbook (Section 4). The checklist states that flaps should be set at the second notch or 20 degrees. That's good! It also specifies holding the brakes until full power is developed which is also good! But it does not have a rotation or liftoff speed, nor does it have us climbing out at the published Vx of 64-68 knots. It specifies a speed of 58 knots. Hmmm, what's going on?

SHORT FIELD TAKEOFF

1. Wing Flaps - 20°
2. Brakes - APPLY
3. Throttle Control - FULL (push full in)
4. Propeller Control - 2400 RPM
5. Mixture Control - RICH (above 5000 feet pressure altitude, lean for maximum RPM)
6. Brakes - RELEASE
7. Elevator Control - SLIGHTLY TAIL LOW
8. Climb Airspeed - 58 KIAS (until all obstacles are cleared)
9. Wing Flaps - RETRACT SLOWLY (when airspeed is more than 70 KIAS)

One of the mistakes I see in short field takeoffs is that the pilot rotates at or near the speed they would rotate normally. I guess the thought is the 20 degrees of flaps will get you off the ground faster. But that's not right. If you rotate at the normal rotation speed, your ground roll will not be reduced. So, you went to a lot of trouble for nothing. What the two notches of flaps does for you is to allow you to rotate much earlier than you would normally rotate. It's this early rotation that reduces the ground roll. The POH actually tells you what the speed is, but you have to look in the performance section (Section 5). This is what you'll see at a GW of 2700 lbs which is typically what we fly at:

CESSNA
MODEL 182T NAV III
GFC 700 AFCS

SECTION 5
PERFORMANCE

SHORT FIELD TAKEOFF DISTANCE
AT 2700 POUNDS

CONDITIONS:
Flaps 20°
2400 RPM, Full Throttle and mixture set prior to brake release.
Cowl Flaps OPEN
Paved, Level, Dry Runway — Lift Off: 45 KIAS
Zero Wind — Speed at 50 Feet: 54 KIAS

Here we see a "lift off" speed much lower than the normal rotation speed of 55. In fact, you must rotate about 40 knots to lift off at 45 knots. It's this early rotation which gives you the shorter ground roll. Rotate at 55 and you have defeated the purpose of a short field takeoff.

How about the climb out? This gives you 54 knots at 50' which is considerably less than the 64-68 published Vx. According to the checklist you would accelerate to hold 58 knots until clear of the obstacle. Vx does not appear at all in the checklist. This is speculation on my part, but I believe that the published Vx of 64 knots is with flaps up. Flaps at 20 gives a Vx of 58. Again, speculation, but makes sense.

Bottom line is that we need to emphasize early rotation and lower climb speed than the published Vx until flaps are retracted to achieve the book performance for short field takeoffs. Fly the POH!

Articles for the National Stan Eval Newsletter:

These articles have been written to present ideas, techniques, and concepts of interest to CAP aircrews rather than provide any direction. The articles in this newsletter should in no way be considered CAP policy. We are always looking for brief articles of interest to CAP aircrews to include in this newsletter. CAP has many very experienced pilots and aircrew who have useful techniques, experiences, and tips to share. Please send your contribution to stephen.hertz@vawg.cap.gov. You can view past issues here.