

Figure 1

THE FIRST FLIGHT OF YOUR AIRCRAFT

By Chris Heintz

With the mild spring weather upon us, it's time to get ready for that first flight of your homebuilt aircraft. The following information is not crash course on how to become a prototype test pilot; rather, it's simply instructions on how to perform that first flight of your aircraft built from plans or a kit.

For months you have been hard at work building your aircraft, spending all on your homebuilt aircraft. The following information is not a crash course on how to become a prototype test pilot; rather, current again - it's time to start getting ready for the first flight of *your aircraft*.

If you feel rusty, get some dual, then fly solo and regain your confidence in an aircraft that's similar to the one you've just completed. Even "hangar flying" can be useful, if you can separate the truth from all the bragging and "big stories."

Of course, your aircraft must be ready as well, and this includes:

Weight and balance within the designer's specifications.

See Figure 3

"Run up" of the engine as per manufacturer's recommendations. (This is especially important with the two-cycle engines that have become more and more popular recently.)

A check of the powerplant (i.e., engine, carburetor, intake and exhaust manifold, reduction unit if applicable and propeller) to verify that it meets the manufacturer's static RPM. An easy way of checking the THRUST is to inflate the tires "hard," rest them on a smooth and flat surface - plywood works well and attach a large fish scale at the aircraft's tail end. Start the engine, warm it up, go full throttle and have a friend, without glasses, read the scale. Thrust in pounds should be approximately four times the horsepower for a cruise prop, five times the horsepower for a climb prop. You may want to do it several times for better accuracy.

See Figure 1 and 2

Remember, though, the engine cooling system is not designed for indefinite full throttle on the ground. Do not exceed 30 seconds full open and allow three minutes cooling at 150 percent idle before the next test. Also note that the cowling must be installed as the baffling only ducts air past the cooling

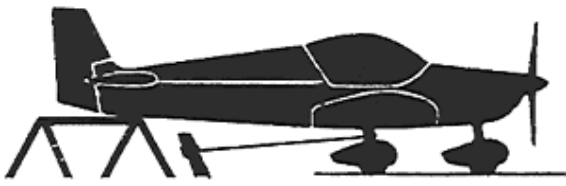


Figure 2

finns with the cowl properly installed. You can burn out the aircraft engine in less than 30 seconds full throttle without a cowl. The cowl is not only an aesthetic component but also an important part of the cooling system.

Of course, each time the engine is running either you or a knowledgeable pilot must be at the controls. Tie the aircraft down for extra precaution.

During ground run up of the engine, check that no part of the aircraft is shaking and/or vibrating heavily - check every 200 rpm from idle to full open and watch the tail and other control surfaces as well as the bottom of the fuselage.

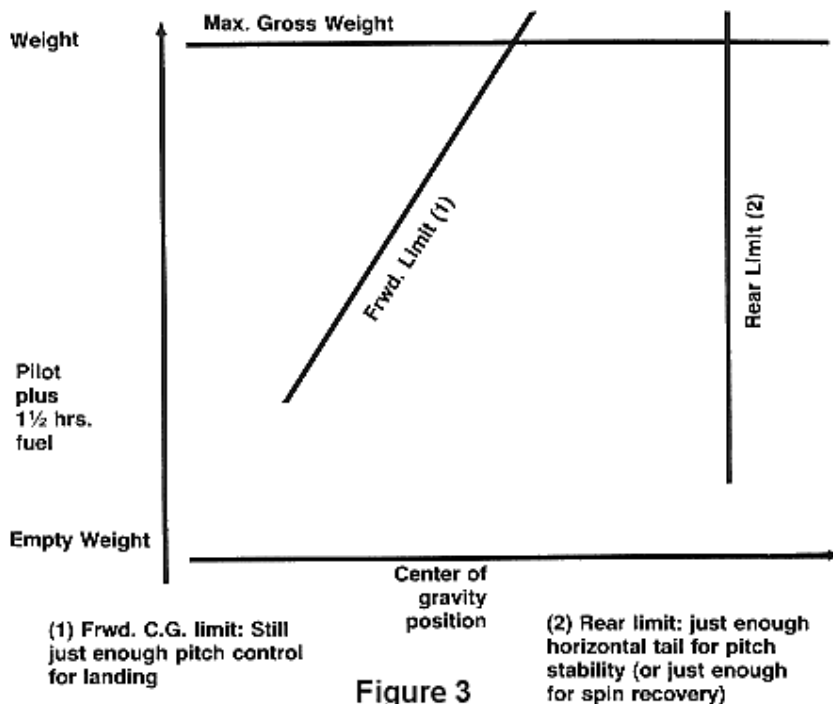
It is also vital to check that the fuel supply will be adequate in the most critical configuration - at full power usually in tail low attitude. The fuel "head", i.e. - height of fuel from carburetor to fuel tank must meet the minimum level for continued operation with little more than the unusable fuel in the tank.

At the same time it is important to check the fuel quantity gauge (empty equals when engine stops running in above critical attitude) at 1/4, 1/2, 3/4 and full. This is not only important for fuel consumption and range check but also to detect quickly if sudden unusually high fuel consumption develops (i.e. leak).

And, of course, by this time you either know that you can easily inspect your engine because the cowl comes off with six DZUS fasteners or you realize that you should look under the cowl, even if it requires unscrewing 20 fasteners for inspection!

Taxi Tests

Do not start taxi tests unless the aircraft has 1-1/2 hour fuel supply and is loaded (with ballast if required) in the mid-range of its center of gravity travel; if you don't follow these guidelines, you may find yourself in the air because you are not at gross (lower stall speed) and your error in the indicated air speed may be significant. Remember, you also are in ground effect.



During the taxi runs, check the brakes, the steering and get familiar with the noise level, seat belt fastening and release, control position (carburetor heat, fuel valve, trim, mixture, etc.) and the important instruments such as air speed and rpm, altimeter, engine temperatures and pressures. When you do taxi tests at speeds above 50 percent of the stall speed given by the designer, be prepared to (accidentally) lift off. If there is enough runway left, throttle back and put it down again. Do not push it down, though - it's always such a shame to have to repair a brand new aircraft!

Make some 10 taxi runs on the runway to get the feeling of when to abort take off with sufficient runway to stop with moderate use of the brakes. This helps familiarize you with initial acceleration, and a bit (only a bit) with how the controls feel (light, heavy, sensitive, sluggish). Always trim at the mid-range as you are only guessing where it should be set.

Okay, your engine runs well, brakes work, instruments seem okay, you handle the aircraft with confidence on the ground (if it's a taildragger and you have little conventional gear experience that will take some time getting used to. A taildragger is less stable on the ground than a tricycle gear plane). It is very important you feel comfortable and "at home" in the pilot's seat.

First Flight

So it is time to go

Check once more your center of gravity at mid-range position from the full travel given by the designer. Check your fuel quantity, check it physically

with your eyes or a dipstick, do not rely on the fuel gauge until proven reliable.

Okay, the aircraft is ready, but how about you?

First of all, you must want to do that first flight - do not let anyone push you into the air, even if he/she is a well-meaning relative or friend. Second, you must be relaxed - you may check your astrological sign or biorhythms if you want - but the important thing is you simply feel this is the day! And definitely not with the help of a couple of beers!

Now, check the weather: There should be little or no wind, good visibility (no haze) and at least a 3,000 foot ceiling. Avoid the time around sunset if your active runway is 22 to 33! And, have as few friends around as possible. (They have a tendency to make us show off; we can do that later. Now, we just want to get up, gather important information, and come down again as safely as possible, and get a good feel of that beauty sitting out there waiting.)

I have found that the best time for smooth weather is when those so-called friends are still in bed, when only the one reliable friend you really want around shows up. This best time is approximately one hour after sunrise.

Proceed with your pre-flight - fuel check, drain fuel system for condensation, water. Then, start the engine, warm it up and taxi to the take off end, check ignition and carburetor heat. Set the altimeter and trim at mid travel. If you wish, check full throttle rpm (I usually do this during the initial phase of take off).

Line up with the runway and push the throttle full open, not too slowly but not too quickly either. Keep one eye on the air speed, the other on the runway and one ear to the engine; if anything seems abnormal, just shut the craft down, check it and fix it. In our lives we get many warnings. We should listen to them and not have a "stubborn ego." And, I repeat, checking is not enough. If something is wrong, we have to fix it and then try again! But, today, everything is fine, so we keep the throttle open and very slowly lift the airplane off as soon as you think you are fast enough. Be prepared, it may be very nose heavy or light; we do not know the trim position yet.

Now that you are in the air, remember the danger is to hit mother earth again before you want to, so climb gently at some 10/20 mph faster than your lift-off speed. Adjust the trim for comfort, check the rpm, airspeed, engine, instruments (if it starts overheating, throttle back a little) . . . and relax! Not too much, though - keep one eye on the airport to which you want to return.

At two or three thousand feet AGL, still full throttle, level off. Push the nose slightly down until altitude no longer increases, note the rpm (this should be

less than 110 percent of the red line). Is there any unusual noise or vibration you should note?

Now, throttle back to about 90 percent of above full throttle rpm (this should be approximately 75 percent of cruise) and trim for level flight.

Finding the Stall Speed

Before you land you must know the indicated speed at which the aircraft will stop flying, so you better find out now when you are up high.

Relax! Carburetor heat on, throttle gently back (notice the tendency of the nose), now slowly raise the nose to reduce the speed. Do not use ailerons, keep the ball centered - or the wings level with your rudder. Do everything gently and stay relaxed. Keep one eye on the air speed and the other on the ball (or horizon and wing tips). Notice everything: buffeting, stick back pressure, control stops, "oil canning" or other noises....

Any well designed and correctly built light plane should have a gentle stall; its nose will gently (more or less!) drop. One wing may drop faster than the other (slight asymmetry in wing construction, or too little use of the rudder, or gusty weather). Notice the indicated stall speed then release the stick pressure slowly to increase the airspeed and reattach the air flow over the wing. Apply full power gently and climb at 130 percent of your stall speed. Trim (this trim setting will be your take off trim in this configuration, weight, C.G. and flaps up).

Check the airport (or are you lost by now?)

Make another two or three stalls to get a good average reading and feel comfortable.

Now come in for a landing: Use 130 percent of stall speed on base and final, aim a few feet above the runway entrance and reduce throttle, then speed only over the runway and just hold her back until the aircraft settles by itself on the ground at the stall speed you now know (do not "pump" her down!)

Without stopping the engine, taxi back for another take off. This time set the trim for climb, make the take off rotation at the indicated stall speed, accelerate to 130 percent of stall and let her climb, downwind at "cruise," base and final at 130 percent stall as for the first landing.

Perform one or two more circuits before you bring her back to her tie down. Correctly done, the above exercises will take 45 to 60 minutes. And now you are no longer afraid of your aircraft: You know it flies and you can handle it! Your aircraft was designed and built to fly and it does.

Call the designer of your aircraft and share with him the pleasure of your first flight - both you as the builder and he as the designer deserve it.

Next time you fly, start using flaps (if applicable).

Next month we will talk some more about the testing that should be completed during those first 15 hours of flying your new light plane.

PERFORMANCE TESTING YOUR AIRCRAFT

By Chris Heintz

After you have completed the first flight of your aircraft, your next challenge is to get acquainted with your airplane in its various usual (and unusual) flight attitudes and landing conditions so that you feel fully comfortable in your aircraft and have full control over it at all times. Only the very first flight should be an exciting adventure. After that, flying your aircraft must become just an enjoyable routine - that's one of the reasons for the FAA's initial flight restrictions on homebuilts. But, of course, you will also do much "hangar flying," and when talking about your beautiful new aircraft you should state facts, not guesses; only with hard, true figures can you compare various aircraft.

The airspeed is perhaps the most controversial figure talked about and we will see how you can obtain the CAS (Corrected Air Speed) from your IAS (indicated Air Speed). The IAS is just what it says, "indicated," by your instrument. You want to know the corrections to be applied to your reading so that you will know exactly (within one or two miles) at what speed you are flying at a given altitude on a given day.

The following procedure will help you establish those figures:

- Select a straight stretch of road (or railway track) with easy marks (crossover, bridge, police speed marks, etc.) approximately 3/4 to 1-1/2 miles apart. Check the exact distance (D) on an accurate chart (or with your car, etc.). The stretch must be flat, and you do not want any obstructions for at least 2 miles on either end.
- The aircraft must be operating well, and you have to know the following (i.e., you need adequate instrumentation to obtain these readings)
- aircraft weight (empty, plus fuel, plus occupants)
- aircraft center of gravity (in flight, not empty)

- outside temperature (T_e)
- pressure altitude (Pa) - set the altimeter at 29.9 in. hg.
- indicated air speed (IAS)
- engine rpm
- engine manifold pressure (PM) if available

For comparisons the aircraft weight and CG are important as the performance may vary with both (more lift, thus higher drag for heavier weight and the contributing lift and drag of the tail depends on the aircraft CG position).

The required instrumentation is basic, except that manifold pressure may not be available. In this case you can either install one or you may not have enough information to determine your power setting (RPM is *not* enough).

Note:

1. the altimeter must be set at the standard SL (sea level) for all these tests; and
2. the outside temperature sensor gauge must be protected from wind and sun!

Finally to complete your test equipment you need a stopwatch and "ideal" weather; no wind and no turbulence: a windless early morning - e.i., usually anytime within two hours after sunrise provides excellent conditions.

The Tests

If your IAS stall speed is 40 and usual cruise 105 mph (adapt the figures to your aircraft) you will do the runs at 50, 65, 80, 95, 110 and full open. Those six runs done three times each will take close to one hour. Two minutes before you reach your first mark, set your speed and then don't touch the throttle again during all three runs at that speed (it may be 48 or 52 mph instead of the intended 50!). Write down on a prepared paper the IAS, T_e , Pa, RPM, PM. Also note the date, weight, CG and weather conditions (slight wind, no wind, no clouds or structures, etc.)

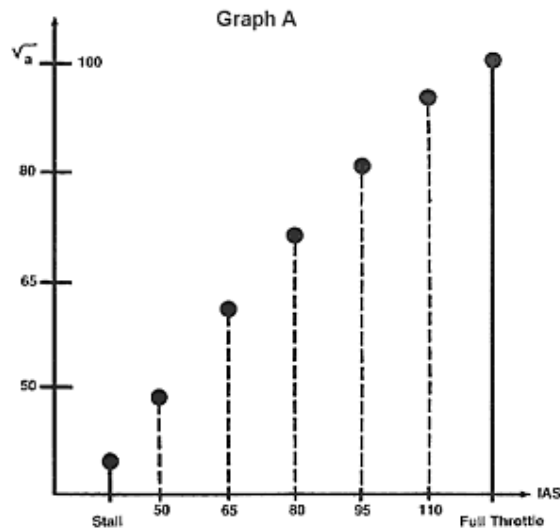
Do all the runs at the same altitude (some 300 ft. AGL - above ground level) and fly the aircraft straight along your chosen track, keeping the altitude as constant as possible and measuring the time (T) between the chosen landmarks (over the distance - D). Each run consists of a back (T^1) and forth (T^2) over D (this minimizes wind influence) and as mentioned you do three runs at each speed with large 180 degree turns (no throttle change) at each end. All this requires a good pilot, especially at the lower speeds.

The Calculations

1. **Speed:** For each run you will have a T^1 and T^2 . The average measured speed will be:
 $a(i) = 1/2 \times (d/T^1 + d/T^2)$ for each run. And the average run over the (say) 3 run is:
 $a = (a^{(1)} + a^{(3)})/3$.

Note: If the times T^1 and T^2 are more than five seconds different for consecutive runs, it is simply not accurate enough. Become a better pilot or wait for more favorable weather.

Now make a graph using the above calculated true speed over the IAS.



1. **Power:** With an aircraft engine, the manufacturer supplies a "sea level and altitude performance" chart in the operators manual: by using RPM, Pm and PA (you may neglect the temperature correction if you are not too far off standard atmosphere) you will find the power setting for each run. Without Pm you cannot know it!
2. **Altitude:** With Pa and Te you will find the density altitude, Pd, by using one of the modern flight computers or the FAA Density Altitude Compensation Chart reproduced below.

Now you can compare your aircraft with the figures given by others and especially the designer or manufacturer (or salesman):

For a given weight and balance and corrected to Sea Level for comparison with others, you use the speed chart.

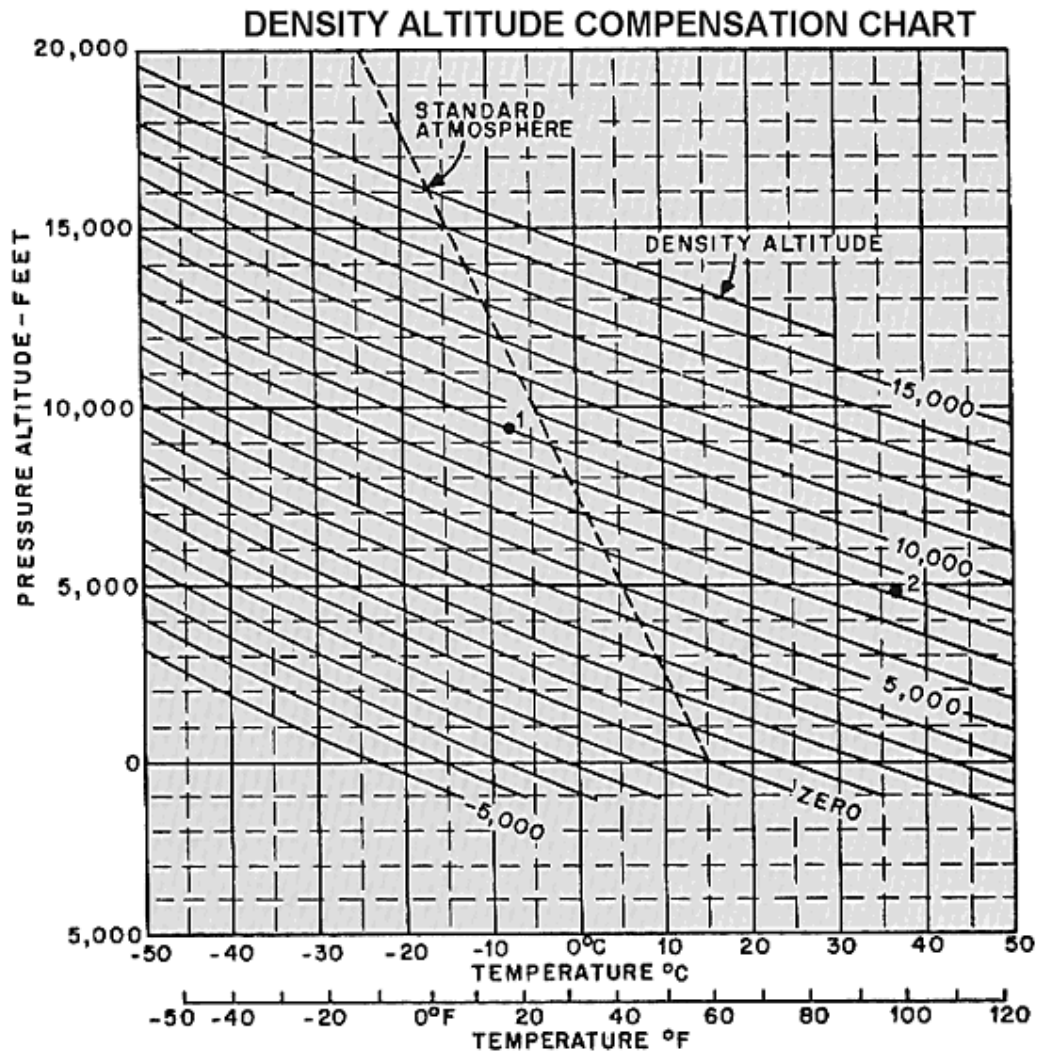
The stall speed is extrapolated and again corrected to sea level.

For cruise speed comparison you need the power setting (75% or 65%); if not available use the full throttle speed which is practical as measured below

3,000 ft.: The available power has about the same correction as the speed below this altitude.

Until you have done all the above testing, do not come to the designer and tell him you've got a much better (or worse) aircraft than his prototype. Remember, only hard, true figures allow comparisons, and to obtain those figures is "hard work."

Good luck and enjoy those early morning performance runs.



To find density altitude, either at field elevation or while in flight, enter the graph with pressure altitude at left and temperature at base of graph. Read density altitude from the sloping lines where the temperature and pressure altitude lines cross. Pressure altitude for an airport is usually available at any briefing office. If pressure altitude is desired while in flight or on the ground when not otherwise available, it may be found from a pressure altimeter. To determine pressure altitude from the altimeter, place the altimeter setting

indicator at standard sea level pressure (29.92 inches) and read the indicated altitude which will also be pressure altitude. (Corrections for instrumental error, if any, must be made.)

Example 1: With altimeter setting indicator at 29.92 inches, the altimeter reads 9,500 feet. Outside air temperature is -8 degrees C. Find 9,500 feet (pressure altitude) on the scale at the left side of the graph and follow it across the graph to where it crosses the -8 degree C. line. Density altitude is 9,000 feet (marked I on the graph).

Example 2: Density altitude is desired for take-off from an airfield at 5,300 feet with a runway temperature of 97 degrees F. (runway temperature is preferable to shelter temperature if available). The weather station furnishes a pressure altitude of 4,950 feet. Entering graph at 4,950 feet and moving across to 97 degrees F. indicates a density altitude of approximately 8,200 feet (marked 2 on graph). Note that in the warm air, although pressure altitude is lower than