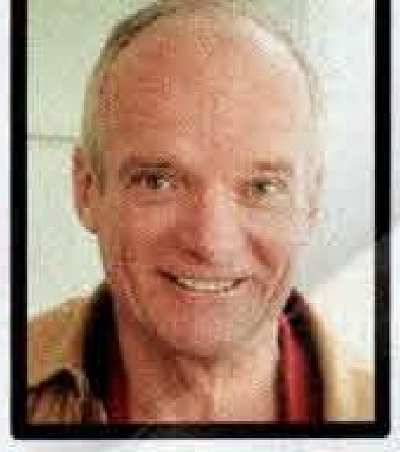

Engine Out by the Numbers

Practice leads to preparedness

BY CHARLIE PRECOURT AND CHRIS GLAESER

LAST MONTH, I DISCUSSED some good techniques for "when the engine goes quiet," and I want to continue the discussion regarding some additional tests that you can accomplish with your own aircraft. Chris Glaeser, a test pilot colleague and volunteer on our safety committee, provided some thoughts from his experience flying U.S. Air Force F-16s. Over to you, Chris.

FROM CHRIS GLAESER

According to industry safety expert Ron Wanttaja, EAA 275698, a study of nearly 450 experimental amateur-built (E-AB) engine failure accidents between 2008 and 2018 showed that 42 percent occurred during takeoff or initial climb, 43 percent were en route, and 12 percent happened in the traffic pattern.

Before takeoff, I like to review four things:

- Abort criteria.
- Where I'll land following an engine failure below 500 feet.
- Planned actions for engine issues above 500 feet.
- Immediate actions for a thrust loss.

I always compute my takeoff distance at maximum gross weight, then add about 30 percent more distance to determine an abort point and make sure I have plenty of runway remaining for the abort. If I haven't lifted off before that point, the takeoff is aborted. The *EAA Flight Test Manual* flight test card 10 discusses how to test for takeoff performance. Many of the E-AB accidents in Ron's database are partial power failures, and a failure to be airborne when expected is all you need to know to abort.

Once power is set, I target specific parameters to verify if the engine and propeller combination are performing properly. These parameters can be rpm, manifold pressure, and both fuel flow and fuel pressure. All it takes is a targeted look at those parameters in the initial part of the takeoff roll. If your avionics are programmable, the airplane will provide a caution or warning if you set the limits of these key parameters and will alert you if a parameter is out of limits subsequent to your targeted look.

Once airborne, I maintain runway heading, which results in the aircraft drifting with the crosswind. This will reduce the turn radius necessary for an emergency 180 back to the runway, and any turn

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following engine failure should be made into the wind. Maintain V_Y (best rate of climb speed) to maximize your climb rate, while reducing your distance from the runway. Below 300 feet AGL, an emergency landing should be made with only 15-30 degrees of heading change maximum. This heading change can be increased at altitudes above 300 feet AGL. I always turn crosswind at 400 feet in the traffic pattern to minimize my distance from the runway. By 500 feet on crosswind, I am pretty much assured of being able to accomplish a downwind landing, having already achieved a 90-degree heading change. Don't forget to preplan for the use of crosswind runways, if one is available.

If your engine fails during initial climb, your "first responsibility is to maintain flying speed. The pilot must immediately lower the nose to achieve the proper pitch attitude necessary to maintain the appropriate approach airspeed. Make the initial turn into the wind." That quote is directly stated in the FAA's *Glider Flying Handbook* to help pilots in the event the towrope breaks during the initial part of the climb. It stresses an immediate nose-down move to maintain adequate airspeed.

Here is a test you should do to understand how your particular airplane performs in a similar event. For safety, do this test at or above 3,000 feet AGL:

- Stabilize at V_Y at takeoff power and takeoff configuration.
- Note the pitch attitude (it will be a few degrees higher during actual takeoffs).
- Retard the power over 3-4 seconds, simulating an engine failure.
- Immediately lower the nose to achieve V_G (best glide speed) and record the necessary pitch attitude.

A typical takeoff attitude is around 6-9 degrees nose up for a C-172, and a typical glide attitude is approximately 2 degrees nose down. Note that V_Y in a C-172 is approximately 72 knots, while V_G is approximately 68 knots. Any delay in lowering the nose following a loss of power on takeoff will result in a very slow airspeed. Note the difference between the climb pitch attitude and the required pitch attitude for best glide is at least 8 degrees nose down. This critical maneuver is rarely practiced.

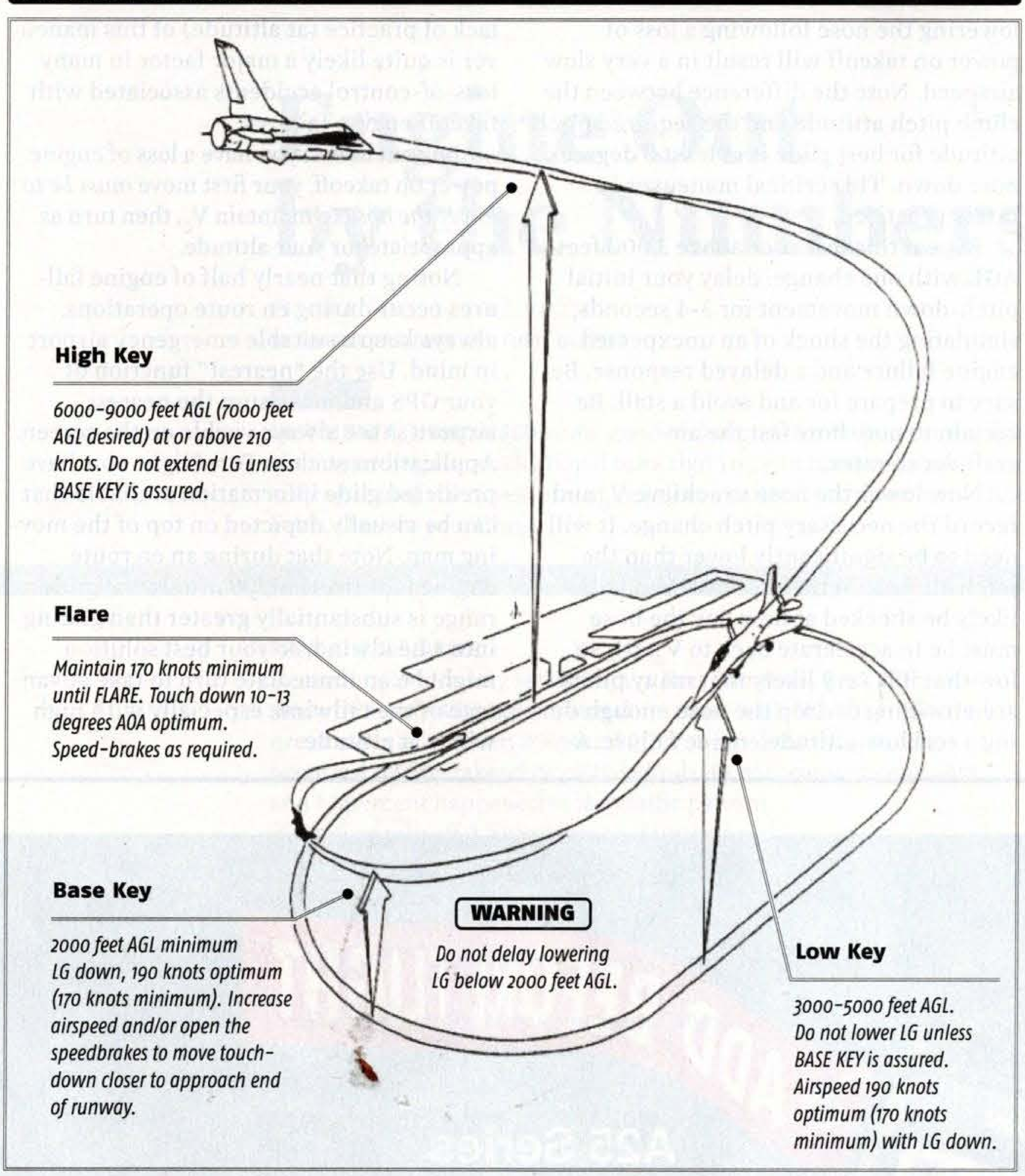
Repeat this test at or above 3,000 feet AGL with one change: delay your initial pitch-down movement for 3-4 seconds, simulating the shock of an unexpected engine failure and a delayed response. Be sure to prepare for and avoid a stall. Be certain to note how fast the aircraft decelerates.

Now lower the nose to achieve V_G and record the necessary pitch change. It will need to be significantly lower than the pitch attitude in the first test. You will likely be shocked at how low the nose must be to accelerate back to V_G. It's so low that it is very likely that many pilots are unwilling to drop the nose enough during a real low-altitude engine failure. A lack of practice (at altitude) of this maneuver is quite likely a major factor in many loss-of-control accidents associated with takeoff engine failures.

Bottom line: If you have a loss of engine power on takeoff, your first move *must be to lower the nose* to maintain V_G, then turn as appropriate for your altitude.

Noting that nearly half of engine failures occur during en route operations, always keep a suitable emergency airport in mind. Use the "nearest" function of your GPS and make sure the nearest airport(s) are always visible on the screen. Applications such as ForeFlight now have predicted glide information available that can be visually depicted on top of the moving map. Note that during an en route engine failure event, your tailwind glide range is substantially greater than gliding into a headwind, so your best solution might be an immediate turn to take advantage of the tailwind, especially with high winds at altitude.

FLAMEOUT LANDING PATTERN



When I was a U.S. Air Force F-16 test pilot, we were required to routinely demonstrate proficiency in flameout landings. In addition, we always practiced simulated flameout landings at the beginning of test flights that were engine test flights or loss of control (high AOA) test flights because risk of an engine flameout was more likely. Many engine test flights involved an intentional engine shutdown for relight tests. On one occasion, I needed to perform an actual flameout approach after multiple unsuccessful restart attempts.

Note that there are three notes in this F-16 diagram regarding a minimum speed of 170 knots (slightly above V_G). V_G was considered an absolute minimum speed at all times.

I personally fly V_G *plus 10 knots* during all engine-out approaches in my RV-7A to keep a little bit of energy "in the bank." Going below V_G at any time is a really, really bad idea because regaining V_G will require you to lower the nose significantly. If you are short of the runway on final and below V_G, you have zero options for stretching your glide, while V_G plus 10 knots allows you to extend your glide slightly. In strong winds, it's difficult to judge the winds accurately going from a tailwind at "low key" to a headwind on final, and I therefore like to aim a little long and fly a little fast until I can accurately judge the final glide angle.

You should perform glide tests at altitude to determine your altitude loss in a 360-degree turn ("high key"), and a 180-degree turn "low key" using the *EAA FTM* flight test card eight. Knowing your own aircraft's performance is essential in intercepting this flameout landing pattern. Charlie's aircraft lost 925 feet in a power-off 360 in a 30-degree bank turn and 825 feet in a 45-degree turn. You should be comfortable in this maneuver in any case as the Airman Certification Standards requires an emergency descent between 30-45 degrees of bank. To achieve a final approach rollout altitude of 300 feet, Charlie could use a high key of 1,200 feet, low key of 800 feet, and "base key" of 500 feet (all based on a 30-degree bank). You might need an extra 360 turn if you arrive at high key with too much altitude, or you may need to otherwise modify the pattern to lose energy. In any case, it's better to widen the downwind, S-turn, or sideslip than to extend final beyond your normal pattern. Practicing a flameout pattern from pattern altitude (1,000 feet AGL) works well if abeam the numbers and using this point as your low key. Charlie also suggested aiming one-third down the runway to provide a pad for stronger-than-expected headwinds or errors in your approach. Perform S-turns or slips on final to bleed excess energy, but don't extend flaps until you are certain you have the runway made.

Also note that F-16 pilots do not extend the landing gear until they have intercepted the flameout pattern (unless they are below 2,000 feet). If you have an aircraft with retractable gear, it's good to know how the gear affects your descent rate and how long it takes to fully extend and then take both into consideration. Redo *FTM* flight test card eight with the gear up and the gear down (honoring maximum gear speeds) to see how this affects your descent rate.

After you've completed these tests, put an engine failure overhead diagram in your pilot's operating handbook, and make a habit of practicing these approaches from different setups such as high key, low key, or longer range during cruise flight.

Fly safe! *EAA*

Charlie Precourt, EAA 150237, is a former NASA chief astronaut, space shuttle commander, and Air Force test pilot. He built a VariEze, owns a Piper JetPROP, and is a member of the EAA board of directors.

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