Flying Light Twins Safely
Takeoff Planning Using Airborne V1

by
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I have often heard two seasoned pilots arguing the merits of single engine vs. light twin safety. It usually goes something like this.

"I like the added safety of two engines."

"The only thing the second engine does is take you to the scene of the crash."

There is some validity to both of these arguments. Certainly at a reasonable altitude a twin can continue over rugged terrain to an airport for a safe landing where a single engine airplane is committed to the angle of glide. On the other hand, most single engine aircraft have slower landing speeds and less inertia than twins.

The most dangerous time in a light twin, however, is the takeoff. Imagine your mind-set as you add power for takeoff. You are intent on climbing out as you have before, clearing obstacles by wide margins with the promise of an adventurous flight ahead of you. Just then the loss of an engine reduces your takeoff performance by 80-percent or more. This is true on all twin engine airplanes - even airliners. As we will see, in some cases performance may be reduced by over 100-percent.

Still if all the facts are known, and the pilot is proficient, two engines do offer additional options in this regime. In the best case it is possible to continue the climb-out and return to land. In some cases the working engine may indeed take you to the scene of the crash, but you may use it to find a slightly more acceptable "scene" than if you had lost your only engine.

In addition to loss of performance, loss of an engine creates a dramatically more difficult control dynamic. The pilot must use rudder in variable amounts - depending on changes in airspeed and power - to keep the airplane going straight. Airspeed must be controlled within a few knots by pitch to provide optimum performance and controllability.

Rusty procedures add more risk. If you fly a twin, you must practice "engine outs on takeoff" at least annually. Your initial training included seemingly hundreds of these. This over-training was done because your instructor knew that you may fly fifteen or twenty years before having to do it for real. Unfortunately, disuse causes even these over-learned procedures to die out.

The following is a proposal to take full advantage of the multiengine safety margin. This procedure calculates a realistic Accelerate-Go distance, and a procedure for takeoffs at fields shorter than this distance.

TAKEOFF PLANNING

Most manufacturers do not recommend continuing the takeoff in a light twin if you lose an engine while still on the ground. However, after liftoff, most manufacturers suggest something like “If airborne and inadequate runway remains, the pilot must decide whether to abort or continue the takeoff.”

OK, there you are 15 feet above the runway with gear down and a windmilling engine approaching the airport fence. At this point you are expected to determine how much distance is remaining, how much it really takes to stop, and how much damage will be sustained by either continuing or aborting. If you take a millisecond to consider any of these things, your decision will be made for you. You will waste the few critical seconds by not doing anything.

THE DECISION MUST BE MADE BEFORE YOU ADVANCE THE TROTTLES FOR TAKEOFF!

The technique shown below provides a way to calculate the approximate distance to accelerate to Vyse and then land back. Thus you will know if there is enough runway to abort the takeoff. The takeoff brief should include some words similar to: “If an engine fails with the gear still down we will abort. If the gear has been selected up we will continue.”

TURBINE TWIN TAKEOFF PERFORMANCE REQUIREMENTS

Modern jet aircraft are able to continue a takeoff above a given speed even if an engine fails while still on the ground. This speed is called V1 (See glossary at the end). Charts are provided to calculate "Accelerate-Stop" and "Accelerate-Go" distances with an engine failure at V1 for existing ambient conditions. The infamous “V1 Cut” is a training maneuver (best taught in the simulator) where the aircraft is accelerated to just below or just above V1, then an engine is “cut.” The pilot must decide to either stop or go. “Accelerate-Go” calculations are based on continuing to accelerate to Vr and climb out, clearing the departure end by 35-ft. If the engine is cut below V1 the pilot must close the throttles, deploy the speed brakes and stop in the remaining runway without using reverse thrust.

LIGHT TWIN TAKEOFF PERFORMANCE REQUIREMENTS

Certification requirements for light twins differ considerably. Most light twins will not accelerate to a flyable speed if still on the ground when an engine fails. Light twins are not required to climb out on one engine even at Vyse (See glossary at the end). Because of this, most light twins do not have a computed Accelerate-Go chart.

In the Piper Seminole, you can eek out a calculated 200 ft per minute climb at 88 knots if you are less than 2000 msl at standard temperature – and you weigh less than 3600 lbs. If you are no higher than Sea Level at 15C at that weight you will just barely be able to climb the 200 ft per nautical mile gradient for instrument departure obstacle clearance. Under higher, hotter or heavier conditions, full power on the good engine can only give you a slightly wider choice of forced landing sites. Keep this “slightly wider choice” in mind if taking off from a short field.

While some manufacturers provide an Accelerate-Stop chart, it is useless as a planning tool. The Accelerate-Stop chart is usually based on losing an engine at Vr. Most light twins do not have an Accelerate-Go chart because it is not possible at this point. None will climb – or accelerate with a windmilling propeller and the gear down. Most light twins won't achieve a usable climb until after reaching Vyse with the gear up. If you use this chart to determine the required runway length, you will have no preplanned response from that point until you have achieved a useable climb.

CALCULATING "ACCELERATE-GO" DISTANCE

We suggest calculating a usable Accelerate-Go distance by using Vyse as an “AIRBORNE V1.” This distance will always be longer than the Accelerate-Stop distance.

Assuming we have a usable climb rate on one engine at Vyse, we can conservatively calculate our Accelerate-Go distance. This can be done by adding the following distances from the performance charts:

- Normal Takeoff Distance to 50-ft
- Short Field Landing Distance Over 50-ft
- Approximately 500 ft to get from normal takeoff speed at 50-ft (Vyse) to Short Field Landing Speed with flaps deployed.

This simplifies takeoff planning. If the engine quits before V1/ Vyse:

- Close the throttles completely. (Pull them back and down.)
- Lower the nose quickly to the full flap landing attitude to avoid losing airspeed. (Hint - zero G = zero induced drag)
- Extend full flaps.
- Land.
- Apply adequate braking.

I have had the unfortunate opportunity to do this for real when an engine quit at 50-feet. I had planned ahead and briefed myself prior to takeoff. I didn’t hesitate. We stopped with room to spare. I didn't even know which engine quit. We had an uncommanded yaw and I reacted.

If the engine quits at or after V1:

- Increase to full power. (It should already be there - but check.)
- Reduce Drag - Gear and flaps up. (They should already be up - but check.)
- Identify the failed engine. (Stomp the lazy foot on the floorboard.)
- Verify. (Pull that throttle back approximately halfway.)
- Feather. (Pull that prop control to Feather.)

If you use this planning technique, you have determined the shortest runway that will give you the multiengine safety margin. That is the shortest runway you should accept today.

PRACTICING THE AIRBORNE V1 EXERCISE

The takeoff brief should be given aloud by the student before every takeoff: "If an engine fails with the gear still down we will abort. If the gear has been selected up we will continue." If the pilot has reached for the gear, he or she has decided to fly. This should happen at Vyse. If an uncommanded yaw occurs before reaching for the gear the pilot is cocked and primed to pull the throttles, lower the nose, extend the flaps, land and stop. If it happens after letting go of the throttles, they should be ready to continue with the shutdown procedure and fly.

Practicing the airborne abort should be done with an instructor at or above 3000 agl. With gear and flaps in the normal takeoff configuration, slow to Vr and add full power at the hard deck altitude. Accelerate toward Vyse. The instructor will pull the mixture before reaching Vyse (at or above Vsse). The proper technique, as listed above should be taught and practiced.

Once competent, the instructor might demonstrate a planned airborne abort by closing the throttles at Vyse and comparing the distance require to the planned Accelerate-Go distance as computed above. An exceptionally long runway is recommended for this demonstration.

WHAT ABOUT REAL SHORT FIELD TAKEOFFS?

What if the boss wants to use an airport shorter than that? He or she wants you to use the "Short Field Takeoff" procedure. After all, they bought the airplane (and hired you) to increase their flexibility. If you are committed to a shorter field you have the same problem as a single engine airplane if the engine quits. You are going to have to contend with the terrain.

This is perhaps the most dangerous training maneuver in aviation. In many light twins the recommended "speed at 50-feet" is below Vmc. In some cases it is below landing speed. In some aircraft, the gear is supposed to be on it's way up. If an engine failed at that point the pilot/instructor must react immediately by pulling the power to idle to avoid an immediate roll-over. The nose is at an extremely high attitude and must be abruptly lowered to avoid a stall. (Remember, zero G = zero induced drag. Push the nose over abruptly.) Unless you have conserved a speed above that required for landing, you will damage the airplane. With this in mind, it is advisable to practice Short Field Takeoffs - on longer runways with both pilots briefed on these procedures.

When you must take off from a field that is too short for the above "airborne V1" procedure you must make sure that all the stake-holders (airplane owner and passengers) know that you are giving up "Multiengine Safety." You still have the proven reliability of modern aircraft engines, but If an engine quits during this short field takeoff procedure you will have to pull the power and take your chances with the terrain. If you are above Vmc you may use the remaining engine to maneuver slightly to a more amenable forced landing site. If you are below Vmc you must not.

This "Airborne V_1" concept is not new. many pilots have come up with the some form of the same concept. An old rancher down in Arizona was getting ready to check me out in his Cessna 401. He was a rugged individual with some pretty solid opinions. I wasn't sure how we were going to get along. Pointing to the Accelerate-Go distance chart he said

"Yuh know, it says here in this chart that we can accelerate and go if we lose an engine at Vr, but just so you and me are on the same page, if we lose an engine and we haven't gotten to Vyse, we're gonna land, 'cause we sure as (expletive deleted) can't fly!"

Yes sir!

GLOSSARY OF V-SPEEDS FOR MULTIENGINE OPERATIONS

Vmc Minimum controllable speed with one engine windmilling and the other at full power

V_1 Maximum speed for abort and also the minimum speed for continuing the takeoff following loss of the critical engine.

Vr Rotation speed.

V_2 Takeoff safety speed. A speed that is passed through after rotation and after the decision to continue in jet aircraft.

Vsse Minimum speed for intentionally shutting down an engine in training.

Vxse Best angle of climb with one engine inoperative.

Vyse Best rate of climb with one engine inoperative.