Gear up to Go up? Making the decision for continued flight after an engine failure in a multi-engine piston.

Many decades of traditional multi-engine training has re-enforced a common rubric "Wheels up to go up" for determining if the pilot should continue flight after sustaining a low altitude engine failure soon after aircraft rotation. This concept is required mantra for training and passing the Multi check ride along with running "The Drill". This article explores the risk factors for continued flight in a light piston twin sustaining an engine failure shortly after rotation.

Risk Analysis of engine failure after rotation.

Startle response: This is 10 or 15 seconds in well trained pilots, with recent emergency training and high proficiency.

Time from engine failure to feathered prop, zero side slip and climb. On check rides with pilots just completing training is 45 to 60 seconds (my personal observation). It is rare to see this accomplished in 30 seconds or less.

Gear position to determinate to feather and continue vs land straight ahead.

"Gear down to go down" is widely accepted as an indication to reduce power and land roughly straight ahead regardless of landing surface available. This is because the drag penalty and time to clean up and then have an effective climb in a light twin is unlikely. This makes intuitive sense as the gear is generally down in low proximity to the surface. The problem is pilots then assume that if the "gear is down to go down", then clearly the opposite must also be true "gear up" should be "go up". This is faulty and potentially deadly logic.

"Gear up to Go up" is commonly used as an indication for feathering and continuing flight. The difficulty is determining when to bring the gear up. Some use "no remaining usable runway" others use "Blueline and positive rate of climb". The problem is there is no objective way to determine if there is usable runway. Usable runway changes with runway length, aircraft climb performance and the pilot's best guess. "Blue Line and Positive rate of climb" happen very quickly in most light twins. In either case, gear is typically retracted anywhere from 50 to 200 ft. Higher if we get distracted or forget. What if we forget to retract gear and we are 1000 ft AGL, should we pull power and land straight ahead? In most cases not.

Additionally, using "gear up to go up" does not consider the startle response, recency of training, proficiency of the pilot, obstacles, terrain, density altitude and other aircraft performance factors. In fact, this type of training creates false confidence such that the pilot is less likely to consider other risk factors. For example, most light twins taking off at a mountain airport where density altitude is near or above the single engine service ceiling, a low altitude engine failure is more likely to lead to CFIT and mortal outcome if the pilot opts for continued flight.

Risk of landing gear up or gear down. I think everyone would agree landing gear down on the runway is the preferred option. However, aircraft frequently land gear up more often than they have engine failures. The fatality and injury rate for a gear up landing is not much different than landing gear down. Then we have to consider off airport landings. It is difficult to determine for any given terrain or topography if it is better to have gear up or down for impact. For wet or muddy, we tend to think gear up. For rough terrain we think gear down to absorb impact. Water is probably better gear up. Given the urgency and limited time in a crisis, we have to ask how important this is in making the decision to land straight ahead or continue flight. The real risk factor is not the gear position but rather if we impact terrain at minimum airspeed,

in a Vmc roll, or at blue line. In this case, landing at minimum control airspeed has my vote with gear position a much less important risk factor. At this point, the risk analysis favors “Gear down to go gown” but we still have to assess other risks to see if “gear up to go up works”.

In the moments immediately after an engine failure, we must consider the pilots’ initial actions and effects.

> Immediately after engine failure is the startle response, average of 10 seconds
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> The initial pilot response is to push the yoke forward and bank toward the good engine with bank angles in excess of 10^0 and far from zero side slip with over aggressive rudder use. Combined with a propellor that has not yet been feathered, aircraft climb rate is severely reduced. Pilots tend to focus on the airspeed indicator and ignore other duties till they recover from the startle effect. The net result is likely a descent rate of 200 to 400 fpm depending on the aircraft.
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> Then the process of running an engine failure drill can be protracted when facing a real emergency. During multiengine check rides pilots often repeat steps to be sure or go too fast and do the wrong thing despite intensive recency of training. The average time to complete these tasks is about 40 seconds.
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> Then the pilot has to concentrate on obtaining zero side slip and blue line to get maximum climb performance. In the best case we have 30 seconds struggling to maintain altitude and worse case 60 seconds of descending at 200 to 400 ft per minute. If we use “Wheels up to go up” and an engine failure happens shortly after, we are somewhere between 100 and 200 ft AGL descending at 200 to 400 fpm. It is highly likely we will impact terrain even at low density altitudes and with a recently trained and proficient pilot. How many GA pilots of light twins practice low altitude engine failures more than once a year or every two years?
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> The question becomes how much altitude is required give the pilot sufficient time to “run the drill”, get the prop feathered, cleaned up, zero side slip and get a positive rate of climb. This also depends on many factors.

Then we should consider obstacles, terrain, density altitude, aircraft performance, and pilot proficiency.

Obstacles and Terrain can pose a hazard if in a low altitude flight path with marginal maneuvering capability. This especially dangerous before the prop is feathered. Any turn into an un-feathered prop to avoid an obstacle will likely result in a Vmc roll and fatal accident. Turns in any direction will likely cause a decrease in climb performance or even a descent.

Departing a high density altitude airport, the aircraft may have marginal climb or unable to maintain any altitude. Then the pilot has a choice to accept a landing at minimal airspeed or strike terrain or obstacle at Blue line. If touch down speed is at 60 to 70 kts and blue line is near 100 kts, the energy difference is at least double and the mortality rate higher striking terrain or an obstacle at blue line.

Aircraft Performance. There is a broad range of light piston twin performance. My experience is the POH values are very optimistic to what I see in practice. I often see light twin POH single engine service ceilings to be reported between 5000 and 8000 ft density altitude. During Check rides and training events, the average multi-engine trainers struggle to maintain density altitudes of 3000 AGL with many lower than this. Simulating low altitude engine failures during training is done with throttle reductions where the failure is expected and observed. Then the propellor is placed in “neutral thrust” or “simulated” feather. Applicants and instructors are then overconfident in their ability and aircraft performance with low altitude engine failures. This is a potentially deadly confidence.

Pilot Proficiency and recency of training. Pilots overestimate their proficiency. A lot. The internet is replete with videos of Vmc roll overs with engine failures shortly after liftoff. Most of these are professional pilots in high performance turboprops and piston twins that have demonstrated accelerate go performance. So what is happening? The pilots believe they can continue flight with limited altitude (time). Task overloaded in the few moments after liftoff, the pilot gets slow avoiding impact or trying to climb and results in a Vmc roll into a fire ball. These events even happen with turboprops that have auto feather. Consider the young aspiring pilot with a new multi-engine rating. How often do they fly twins and get recurrent training? How much time and altitude do they need to get the prop feathered, zero side slip and climb away? Is it wheels to go up or does the pilot need time and altitude to make it work?

Summary of risk analysis. Clearly, “gear down to go down” seems reasonable as we are likely low with few options and high coefficient of drag. However, “Gear up to Go up” does not consider the many other risk factors that should be considered such as pilot training, recency, proficiency, aircraft performance, density altitude, obstacles and terrain. Also, pilots need altitude (time) consistent with the previous risk factors outlined to allow them to continue flight if aircraft performance allows. Having “Gear Up” by itself does not mitigate the various other factors. I generally recommend pilots make the decision if continued flight is possible with engine failure under prevailing conditions before climbing into the aircraft. In low density altitude, no obstacles, to consider adding 500 ft (AGL) to the field elevation if the pilot has recency and proficiency. This becomes the decision point easily determined on the altimeter for continued flight regardless of gear position. Consider 1000 ft AGL added to the field elevation for pilots who do not have recency of engine out training as a decision point for continued flight vs landing relatively straight ahead. In mountainous terrain or high density altitude, the decision to return to the airport may require a few thousand feet and careful pre-flight planning.

Comments on Maneuvering on engine In-operative. Many multi instructors tell pilots, “never turn into a dead engine”. This is fear driven bad advice as pilots are afraid of maneuvering the aircraft and may elect to only make turns away from the dead engine despite traffic or rising terrain. Once the propellor is feathered, Vmc is usually far below stall speed. You are now flying a relatively normal single engine aircraft with a stall speed. We make turns in both directions in single engine trainers.

Emphasis should be placed on getting the propellor feathered, maintain altitude and at least blue line airspeed before making any turns. Once these three things are accomplished, the pilot should be confident in making turns any direction. Altitude is required because banks of more than about 20 degrees either direction may result in altitude loss. The internet is filled with videos of multi-engine aircraft near pattern altitude with an engine failure. In a panic, the pilot makes a turn into an un-feathered prop with the expected Vmc roll and spin into the ground. As long as the pilot has altitude, airspeed and a feathered prop, they can turn either direction with as much bank as required to achieve the objective.

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