Multiengine Airplane Review

Excerpts from the Airplane Flying Handbook, Chapter 12

'Small" Multiengine is an airplane with max. certificated takeoff weight of 12,500 lbs. or less.

The term "light twin" is not formally defined, but means a small multiengine airplane with max. certificated takeoff weight of 6,000 lbs. or less.

"The penalties for loss of an engine are twofold: performance and control.
The most obvious problem is the loss of 50 percent of power, which reduces climb performance 80 to 90 percent, sometimes even more. The other is the control problem caused by the remaining thrust, which is now asymmetrical. Attention to both these factors is crucial to safe OEI flight."

"Under the small airplane certification regulations currently in effect, the flight test pilot must be able to

(1) stop the turn that results when the critical engine is suddenly made inoperative within 20° of the original heading, using maximum rudder deflection and a maximum of 5° bank, and

(2)
thereafter, maintain straight flight with not more than a 5° bank. There is no requirement in this determination that the airplane be capable of climbing at this airspeed. V_{MC} only addresses directional control."

"The current 14 CFR part 23 single-engine climb performance requirements for reciprocating engine powered multiengine airplanes are as follows.
• More than 6,000 pounds maximum weight and/or VSO more than 61 knots: the single engine rate of climb in feet per minute (f.p.m.) at 5,000 feet MSL must be equal to at least .027
VSO
2. For airplanes type certificated February 4, 1991, or thereafter, the climb requirement is expressed in terms of a climb gradient, 1.5 percent. The climb gradient is not a direct equivalent of the .027 VSO 2 formula. Do not confuse the date of type certification with the airplane's model year. The type certification basis of many multiengine airplanes dates back to CAR 3 (the Civil Aviation Regulations, forerunner of today's Code of Federal Regulations).
As an example: if an airplane had a Vso of 80 kias, then the climb rate would have to be 173 FPM.

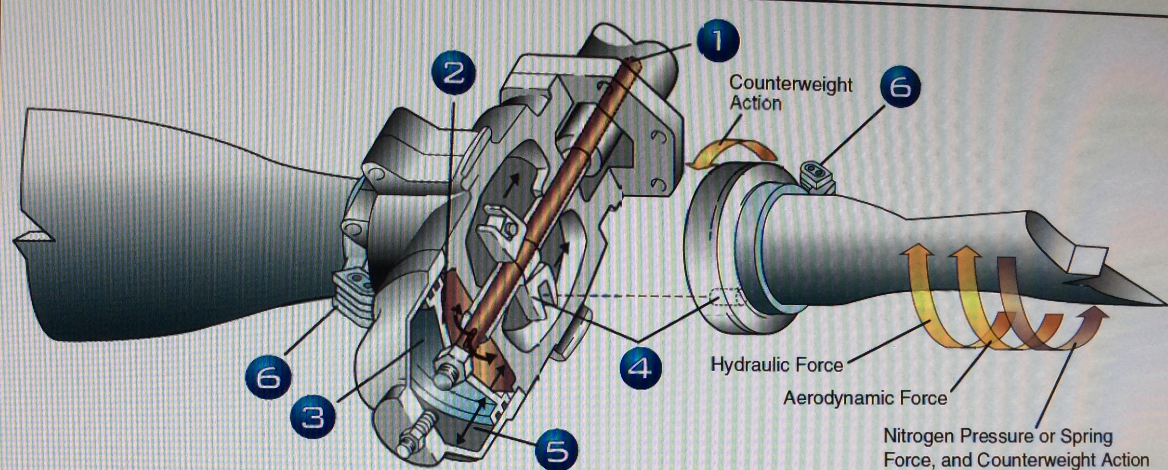
• 6,000 pounds or less maximum weight and VSO 61 knots or less: the single-engine rate of climb at 5,000 feet MSL must simply be determined. ***The rate of climb could be a negative number.***

There is no requirement for a single-engine positive rate of climb at 5,000 feet or any other altitude. For light-twins type certificatedFebruary 4, 1991, or thereafter, the single engine climb gradient (positive or negative) is simply determined."

There is a dramatic performance loss associated with the loss of an engine, particularly just after takeoff. Any airplane's climb performance is a function of thrust horsepower which is in excess of that required for level flight. In a hypothetical twin with each engine producing 200 thrust horsepower, assume that the total level-flight thrust horsepower required is 175. In this situation, the airplane would ordinarily have a reserve of 225 thrust horsepower available for climb. Loss of one engine would leave only 25 (200 minus 175) thrust horsepower available for climb, a drastic reduction. Sea level rate-of-climb performance losses of at least 80 to 90 percent, even under ideal circumstances, are typical for multiengine airplanes in OEI flight.

As a review, the constant-speed propellers on almost all single-engine airplanes are of the non-feathering, oil-pressure-to-increase-pitch design. In this design, increased oil pressure from the propeller governor drives the blade angle towards high pitch, low r.p.m.

In contrast, the constant-speed propellers installed on most multiengine airplanes are full feathering, counterweighted, oil-pressure-to-decrease-pitch designs. In this design, increased oil pressure from the propeller governor drives the blade angle towards low pitch, high r.p.m.—away from the feather blade angle. In effect, the only thing that keeps these propellers from feathering is a constant supply of high pressure engine oil. This is a necessity to enable propeller feathering in the event of a loss of oil pressure or a propeller governor failure.



1. High-pressure oil enters the cylinder through the center of the propeller shaft and piston rod. The propeller control regulates the flow of high-pressure oil from a governor.
2. A hydraulic piston in the hub of the propeller is connected to each blade by a piston rod. This rod is attached to forks that slide over the pitch-change pin mounted in the root of each blade.
3. The oil pressure moves the piston toward the front of the cylinder, moving the piston rod and forks forward.
4. The forks push the pitch-change pin of each blade toward the front of the hub, causing the blades to twist toward the low-pitch position.
5. A nitrogen pressure charge or mechanical spring in the front of the hub opposes the oil pressure, and causes the propeller to move toward high-pitch.
6. Counterweights also cause the blades to move toward the high-pitch and feather positions. The counterweights counteract the aerodynamic twisting force that tries to move the blades toward a low-pitch angle.

Figure 12-4. Pitch change forces.

12-4

To feather the propeller, the propeller control is brought fully aft. All oil pressure is dumped from the governor, and the counterweights drive the propeller blades towards feather. As centrifugal force acting on the counterweights decays from decreasing r.p.m., additional forces are needed to completely feather the blades. This additional force comes from either a spring or high pressure air stored in the propeller dome, which forces the blades into the feathered position.
The entire process may take up to 10 seconds.

Should the r.p.m. obtained with the starter be insufficient to unfeather the propeller, an increase in airspeed from a shallow dive will usually help.

The final approach should be made with power and at a speed recommended by the manufacturer; if a recommended speed is not furnished, the speed should be no slower than the single-engine best rate-of-climb speed (VYSE) until short final with the landing assured,but in no case less than critical engine-out minimum control speed (VMC).

Rudder and ailerons used together in the proper combination will result in a bank of approximately 2° towards the operative engine. The ball will be displaced approximately one-third to one-half towards the operative engine. The result is zero sideslip and maximum climb performance. [Figure 12-18] Any attitude other than zero sideslip increases drag, decreasing performance. VMC under these circumstances will be higher than published, as less than the 5° bank certification limit is employed.

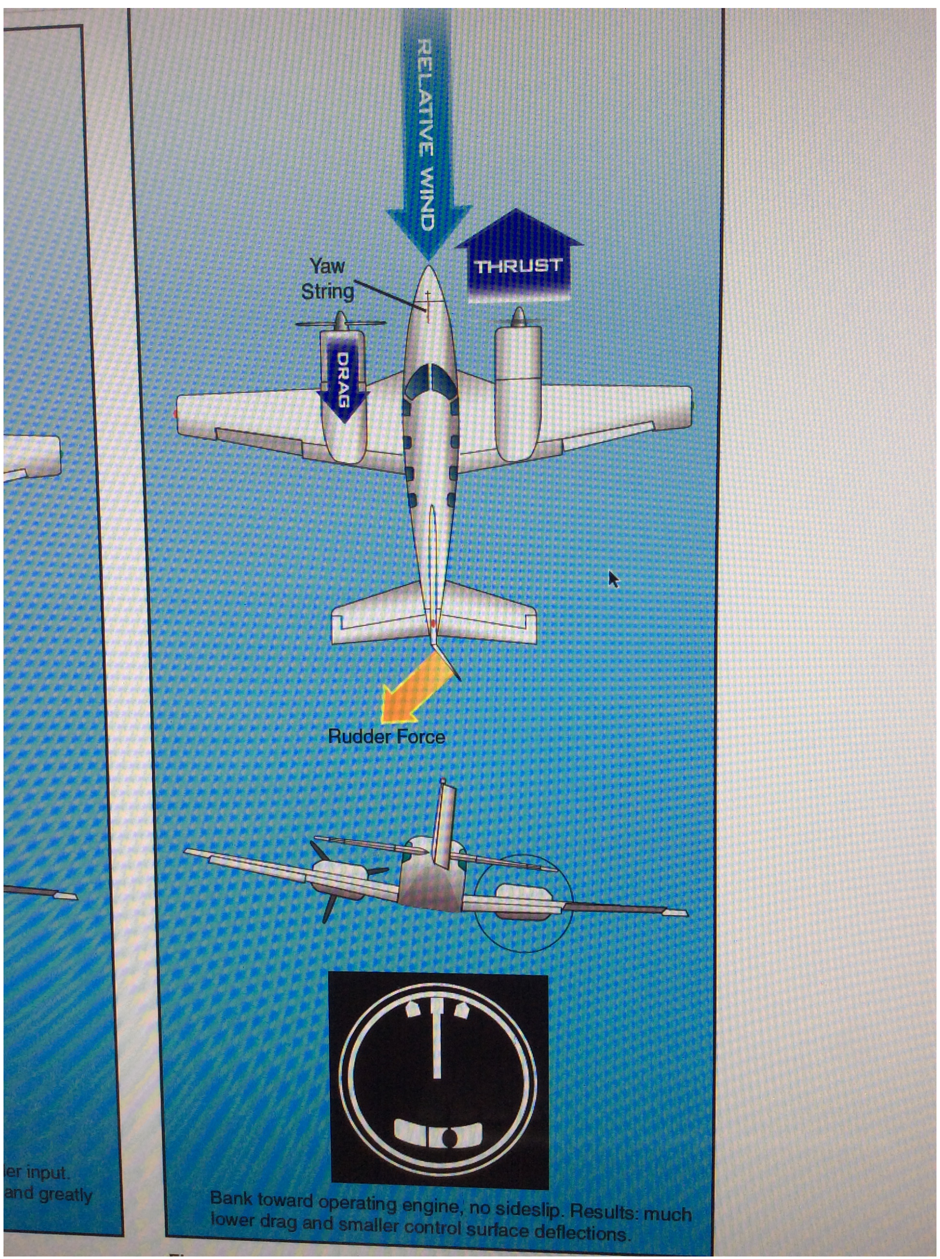


Figure 12-18. Zero sideslip engine-out flight.

It is usually not advisable to execute full stalls in multiengine airplanes because of their relatively high wing loading. **Stall training should be limited to approaches to stalls and when a stall condition occurs. Recoveries should be initiated at the onset, or decay of control effectiveness, or when the first physical indication of the stall occurs.**

SPIN AWARENESS

No multiengine airplane is approved for spins, and their spin recovery characteristics are generally very poor.

A situation that may inadvertently degrade into a spin entry is a simulated engine failure introduced at an inappropriately low speed. ***No engine failure should ever be introduced below safe, intentional one-engine inoperative speed (V_{SSE}).*** If no V_{SSE} is published, use V_{YSE}. The "necessity" of simulating engine failures at low airspeeds is erroneous. Other than training situations, the multiengine airplane is only operated below V_{SSE} for mere seconds just after lift-off or during the last few dozen feet of altitude in preparation for landing.

For a demonstration, the pilot should select an altitude that will allow completion of the maneuver at least 3,000 feet AGL.

The following description assumes a twin with non counter-rotating engines, where the left engine is critical.

With the landing gear retracted and the flaps set to the takeoff position, the airplane should be slowed to approximately 10 knots above VSSE or VYSE (whichever is higher) and trimmed for takeoff. For the remainder of the maneuver, the trim setting should not be altered. An entry heading should be selected and high r.p.m. set on both propeller controls. Power on the left engine should be throttled back to idle as the right engine power is advanced to the takeoff setting. The landing gear warning horn will sound as long as a throttle is retarded. The pilots should continue to carefully listen, however, for the stall warning horn, if so equipped, or watch for the stall warning light. The left yawing and rolling moment of the asymmetrical thrust is counteracted primarily with right rudder. A bank angle of 5° (a right bank, in this case) should also be established While maintaining entry heading, the pitch attitude is slowly increased to decelerate at a rate of 1 knot per second (no faster). As the airplane slows and control effectivity decays, the increasing yawing tendency should be counteracted with additional rudder pressure. Aileron displacement will also increase in order to maintain 5° of bank. An airspeed is soon reached where full right rudder travel and a 5° right bank can no longer counteract the asymmetrical thrust, and the airplane will begin to yaw uncontrollably to the left. The moment the pilot first recognizes the uncontrollable yaw, or experiences any symptom associated with a stall, the operating engine throttle should be sufficiently retarded to stop the yaw as the pitch attitude is decreased. Recovery is made with a minimum loss of altitude to straight flight on the entry heading at VSSE or VYSE, before setting symmetrical power. The recovery should not be attempted by increasing power on the windmilling engine alone. Maintaining altitude is not a criterion in accomplishing this maneuver. This is a demonstration of controllability, not performance. Many airplanes will lose (or gain) altitude during the demonstration. Begin the maneuver at an altitude sufficient to allow completion by 3,000 feet AGL.

Where VS is encountered at or before VMC, the departure from controlled flight may be quite sudden, with strong yawing and rolling tendencies to the inverted position, and a spin entry. Therefore, during a VMCdemonstration, if there are any symptoms of animpending stall such as a stall warning light or horn, airframe or elevator buffet, or rapid decay in control effectiveness, the maneuver should be terminated immediately, the angle of attack reduced as the throttle is retarded, and the airplane returned to the entry airspeed. Simulated engine failures during the takeoff ground roll should be accomplished with the mixture control. The simulated failure should be introduced at a speed no greater than 50 percent of VMC. If the student does not react promptly by retarding both throttles, the instructor can always pull the other mixture.

The FAA recommends that all in-flight simulated engine failures below 3,000 feet AGL be introduced with a smooth reduction of the throttle. Thus, the engine is kept running and is available for instant use, if necessary. Throttle reduction should be smooth rather than abrupt to avoid abusing the engine and possibly causing damage. All inflight engine failures must be conducted at VSSE or above. When an instructor simulates an engine failure, the student should respond with the appropriate memory items and retard the propeller control towards the FEATHER position. Assuming zero thrust will be set, the instructor should promptly move the propeller control forward and set the appropriate manifold pressure and r.p.m. It is vital that the student be kept informed of the instructor's intentions. At this point the instructor may state words to the effect, "I have the right engine; you have the left. I have set zero thrust and the right engine is simulated feathered."