Multi-Engine 'Drift Down'

Engine-out service ceilings are not as restrictive as you think

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Aviation progress generally is measured by improvements in power, payload, speed and range. But because of revised priorities, this trend has been somewhat altered; added emphasis is being placed on smaller, quieter, more efficient designs.

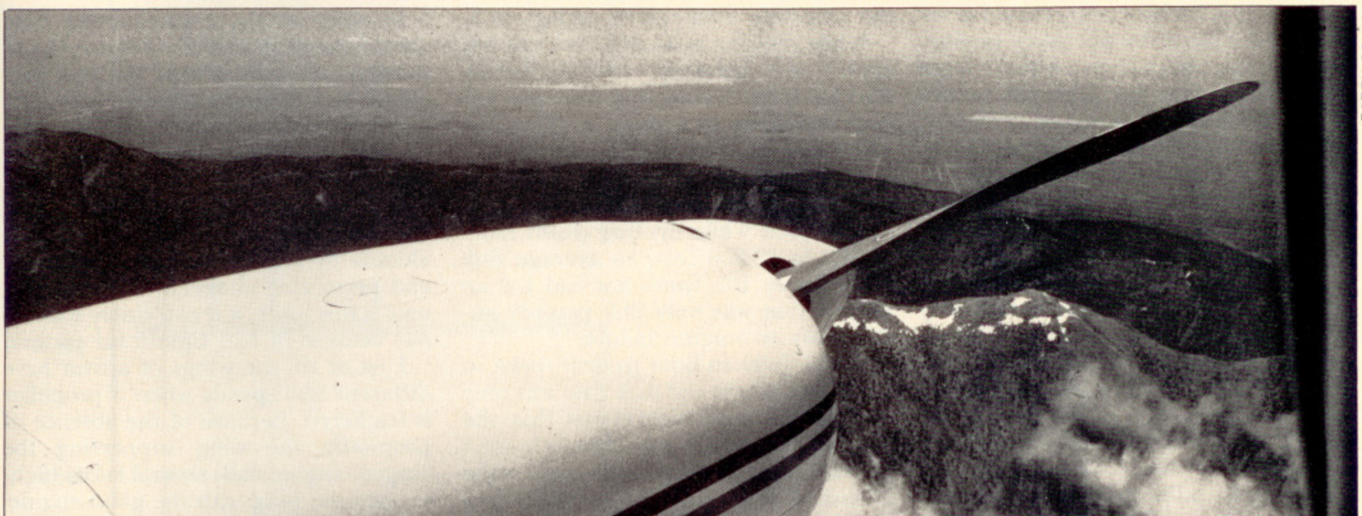
Airframe manufacturers, for example, already have produced a family of very light twins with 400 or less total horsepower to meet the fuel-conscious needs of the eighties. These include Cessna's Model 303, the Beechcraft Duchess, Gulfstream American's Cougar and Piper's Seminole. Although these newcomers are welcome relief to those without their own oil wells, others consider such aircraft a giant step *backwards*. This is because of the *apparent* lack of single-engine performance that is characteristic of these new generation aircraft. All have relatively low single-engine service ceilings, which vary from 4,100 feet (the Seminole) to 6,170 feet (the Duchess).

One conclusion drawn from these specifications is that an engine failure while cruising over mountainous terrain converts a perky twin into little more than a powered glider that is compelled to descend helplessly towards the high-rise granite. Such a conclusion, however, is fallacious. The situation is *not* that critical. By allowing a twin to "drift down" gradually, a pilot is afforded considerably more time and distance than he might imagine. In all but extreme cases, such a crippled twin *can* hobble to an airport and perform a safe landing even when that airport is above the aircraft's single-engine ceiling.

To begin with, the failure of an engine does not necessitate decending to the single-engine service ceiling. At this altitude, after all, the aircraft is capable of *climbing* 50 fpm. The aircraft will decend, however, to its single-engine *absolute* ceiling, which is substantially above the service ceiling. For example, an engine-out Beechcraft Duchess has a service ceiling of only 6,170 feet, but an absolute ceiling of 8,000 feet.

Secondly, these altitude limits apply only when the aircraft is at maximum allowable gross weight, an improbable condition considering fuel burnoff during climb and cruise. An aircraft weighing less enjoys dramatically higher service and absolute ceilings.

Consider, for example, a heavily loaded Beech Duchess cruising at 16,000 feet over the 14,000-foot peaks of Colorado. Figure 1 demonstrates that the aircraft does not "fall out of the



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This Piper Seminole is at 13,500 feet over the Rocky Mountains with an engine out—and a single-engine service ceiling of 4,100 feet. It can safely reach that lower ground in the distance if the pilot knows how to minimize altitude loss.

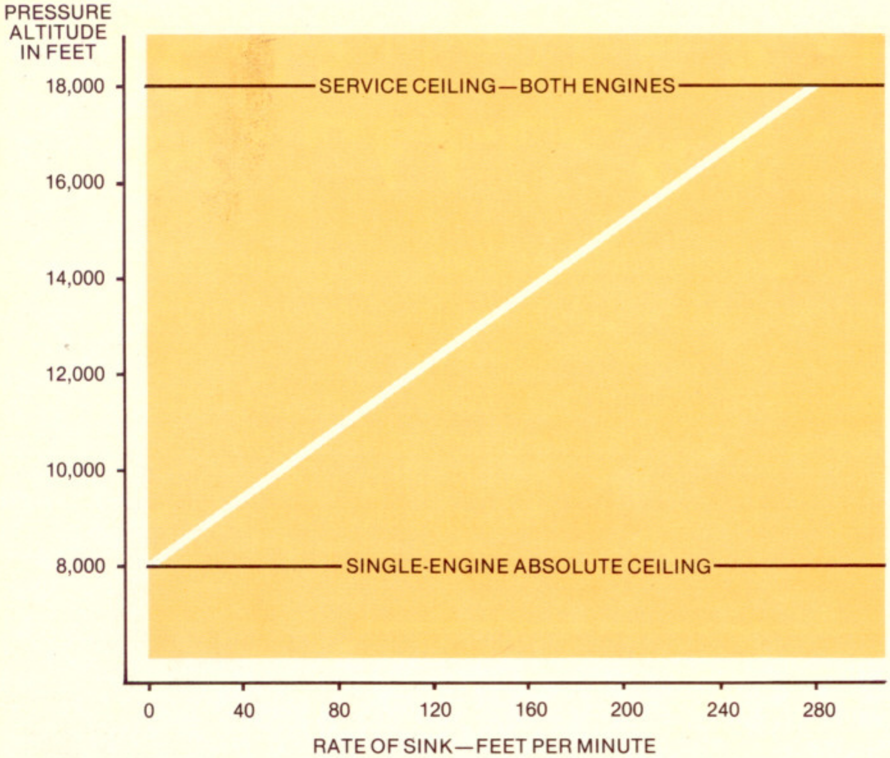

Figure 1: One Engine Inoperative Sink Rate, Beechcraft Duchess—*Conditions: max continuous power on operative engine, 85 kt CAS, Vyse (best single-engine rate of climb); gear up—flaps up—cowl flaps open; max allowable gross weight (3,900 lb).*

sky" following an engine failure. At 16,000 feet, the Duchess can be held to a sink rate as low as 228 fpm. When the aircraft reaches 14,000 feet, sink rate is only 180 fpm. This provides ample time to head for lower terrain.

At 10,000 feet, the rate of descent is a mere 60 fpm because of increased power available from the operative engine. Considerably more than an hour after engine failure, the aircraft finally settles at and maintains its absolute ceiling of 8,000 feet. Surely, however, the Duchess will have burned off considerable fuel and weigh much less than its maximum allowable weight, giving an absolute ceiling of 9,000 feet or higher.

Figure 2 shows drift-down range and reflects how far a Duchess can be flown during an engine-out descent (at gross weight). While descending from 14,600 to 10,200 feet, for example, the aircraft has a still-air range of 50 nm. From 14,000 to 9,000 feet, engine-out range is 80 nm.

Although published single-engine service ceilings do reflect practical climb limits, they obviously are well below the altitudes to which "single-engine" twins can descend and maintain. In this respect, airframe manufacturers are conservative. Often, a twin powered by only one engine can maintain an altitude twice as high as its engine-out service ceiling.

Since Figures 1 and 2 reflect *theoretical* drift-down data for the spunkiest of the very light twins, it is appropriate to examine the actual drift-down performance of the Piper Seminole because of its minimal single-engine altitude capability. Such a flight test was conducted recently by this writer and resulted in the revealing data shown in Figure 3.

While cruising at 14,000 feet, the left engine was throttled and feathered. Rudder trim was applied and the aircraft stabilized in a descent. The first 1,000 feet of altitude loss consumed 3 minutes and 36 seconds, an average sink rate of 254 fpm. Almost six minutes elapsed while drifting down from 13,000 to 12,000 feet, an average sink rate of only 168 fpm—not bad for an aircraft that was only 260 pounds under gross at "engine failure."

It took fully an hour to drift down to 8,000 feet where the sink rate was only 44 fpm. Extrapolation shows that the Seminole eventually would have leveled at 7,600 feet, almost twice as high as the published single-engine service ceiling of 4,100 feet.

It also is interesting to note that the still-air range during this descent was 104 nm; average rate of sink during the 5,000-foot loss was less than 100 fpm.

Using this data and aeronautical charts of the Rocky Mountain states, it can be shown that no matter where in the 48 contiguous states such an engine failure might occur, the Seminole would almost always be within drift-down range of a suitable airport.

Certainly this indicates that once any of these very light twins has climbed to some minimum safe altitude, an engine failure—even when above the published service ceiling—rarely dictates the need to make an off-airport, single-engine landing.

Unfortunately, manufacturers of very light twins have not developed specific recommendations for drifting down to a single-engine absolute ceiling following the failure of one engine. Thankfully, however, the procedure is relatively simple and applies to *any* multi-engine airplane being flown above its engine-out ceiling.

When the ailing engine rolls over and dies, the prescribed shutdown checklist should be completed. But don't be in too much of a hurry lest ye shall join the elite ranks of those who have feathered the wrong engine. Simultaneously, maintain altitude while the airspeed bleeds to that normally used for the best single-engine rate-of-climb, Vyse (the blue radial mark on the airspeed indicator). Then allow the aircraft to descend while maintaining this airspeed with the operative engine developing maximum power. It is important to recognize that Vyse results in the minimum sink rate (when above the absolute ceiling) or the maximum climb rate (when below the absolute ceiling). Under no circumstances, therefore, should the airspeed be allowed to vary either above or below Vyse. Otherwise drift-down performance suffers due to an increased rate of descent.

In other words, if maintaining Vyse doesn't result in a climb or the ability to maintain altitude, accept the sink rate (which will diminish steadily) and drift down to an altitude that can be maintained (the single-engine absolute ceiling).

It is very tempting when above the absolute ceiling to attempt maintaining altitude by raising the nose excessively and permitting airspeed to decay. Not only is this futile, it is extremely hazardous because of two significant factors.

First of all, the wings of a twin have different stall speeds when a propeller is feathered. Because of the absence of propwash, the wing supporting the "caged" engine stalls several knots higher than the wing with the good engine.

Secondly, because the naturally aspirated, operative engine develops considerably less than 100% power when at altitude, the minimum controllable airspeed (Vmc) is much lower than when the aircraft is at sea level. As a result, not as much rudder force is required to prevent yaw. But more significant is that Vmc may be considerably lower than the stall speed of the wing supporting the inoperative engine.

Therefore, if airspeed is allowed to drop much below Vyse, the "unpowered" wing probably will stall before directional control is lost. Such a stall conspires with the asymmetrical power condition to produce a most wicked spin. The maneuver is definitely counterproductive. Recovery necessitates throttling back the operative engine and involves a considerable altitude loss.

Although maintaining Vyse results in the minimum sink rate during drift-down, it does not necessarily maximize range. To fly the maximum horizontal distance during each thousand feet of altitude loss, it is necessary to maintain the "max-range" airspeed. Unfortunately, such a speed rarely is provided by general aviation airframe manufacturers. But in the case of very light twins, this speed is so close to Vyse that the difference in range is almost negligible. In the case of the Duchess, for example, max-range speed is 87 knots (CAS) while Vyse is 85 knots (CAS).

Once drift-down begins, use visual observations, sectional charts and an ATC radar facility (if available) to determine the safest direction in which to lose altitude. Usually it is best to head for down-slope valleys that lead to lower terrain and, hopefully, a suitable airport.

But don't be in a hurry to turn. Steep bank angles produce increased sink rates. A 15° bank angle should be considered a maximum. Although such a shallow bank angle may seem insufficient, the rate of turn this produces when flying at reduced airspeed (Vyse) is usually more than adequate.

And if a pilot is having difficulty maintaining his sanity during an engine-out drift-down, he might consider advancing the throttle of the dead engine to silence the gear-warning horn.

Also during the descent, try to hold a steady pitch attitude to maintain the desired airspeed; chasing the airspeed needle is inefficient and increases average sink rates. If an autopilot is available, by all means, use it to decrease cockpit workload (but only after the rudder has been trimmed properly).

While descending at so slow an airspeed, be sure to maintain a watchful eye on the cylinder-head temperature of the operative engine (which is developing maximum possible power). As altitude is lost, ambient temperature usually increases, as does the power output of the engine. This usually results in warmer cylinder-head temperatures, but these probably will not become excessive at intermediate altitudes. If the CHT needle does creep toward the red line, however, reduce rpm slightly. This reduces internal engine friction without significantly affecting power and sink rate.

Since drifting down to the airplane's single-engine absolute ceiling can take well over an hour, consider the possible need to crossfeed. Yes, accidents have been caused because the only operative engine suffered a fatal case of fuel starvation while the opposite tank remained untapped.

Once the absolute ceiling is reached and a specific altitude can be maintained, the airplane continues to become lighter. Unless power is reduced,

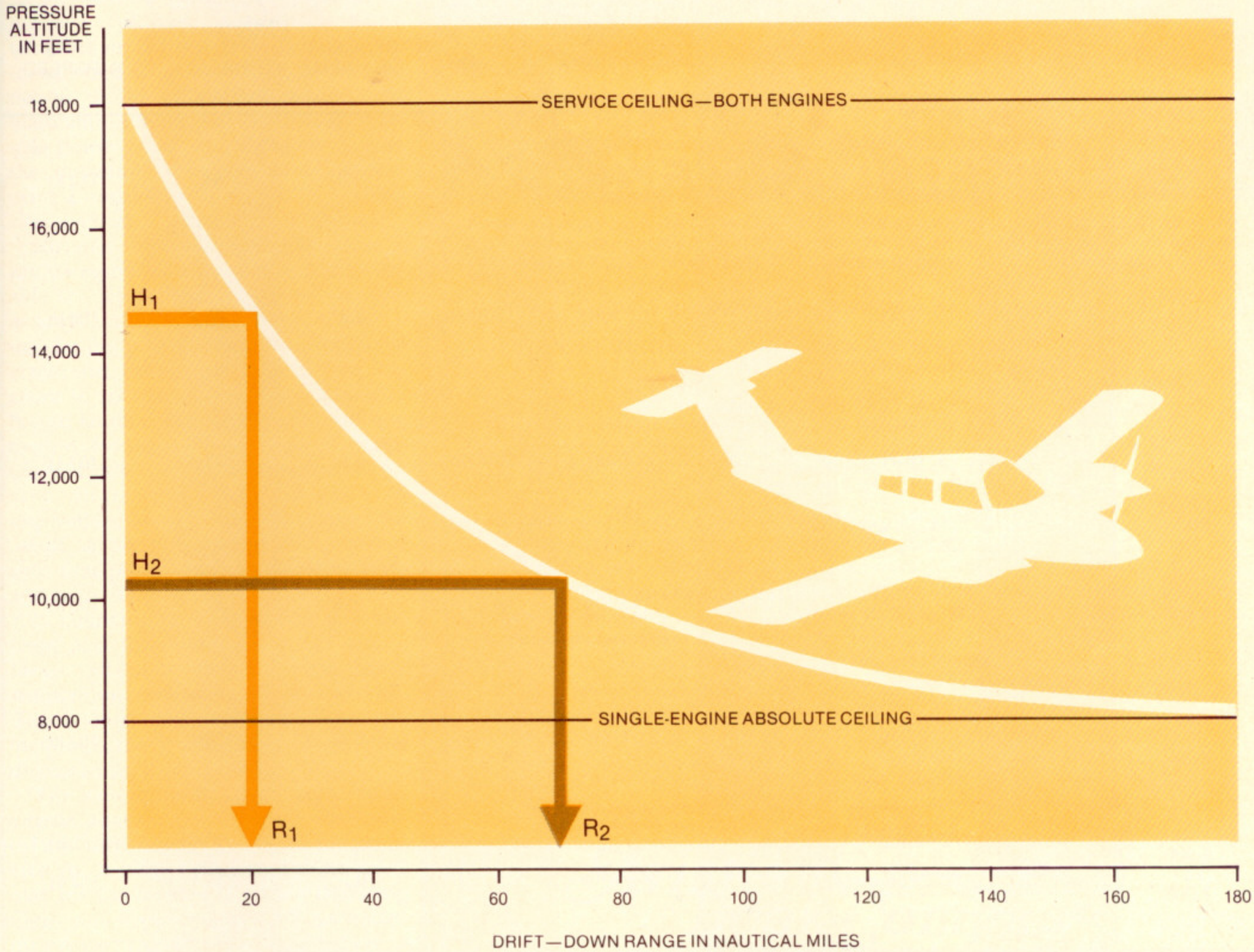

Figure 2: Drift-Down Range, Beechcraft Duchess—*Conditions: One engine inoperative, max continuous power on operative engine; 87 knots CAS (best range speed); gear up—flaps up—cowl flaps open; max allowable gross weight (3,900 lb).*

this results in a slight airspeed increase which can be used to "drift up" (at Vyse) to gain additional altitude.

There comes a time during such an emergency when a pilot's thoughts turn to landing . . . . . as soon as possible. In most cases, this requires little more than a single-engine approach to a low-lying airport. But if man and machine are over (or between!) the Rocky Mountains, for example, the nearest suitable airport may be near or *above* the airplane's single-engine ceiling. Such a problem requires considerable planning and cool heads-upmanship.

First of all, if an airport can be seen in the distance, it most likely is within range even if an initial appraisal indicates otherwise. Consider the data extracted during the Seminole flight test, for example (Figure 3). Notice that the descent from 12,000 to 11,000 feet resulted in an effective "glide ratio" of 71 to 1, which is considerably better than could be expected from the world's most efficient sailplane. The descent from 10,000 to 9,000 feet resulted in a "glide ratio" of 128 to 1, which is equivalent to a descent gradient of only four-tenths of one degree.

Properly interpreted, this means that, yes, if an airport can be seen, it probably is possible to get there safely and execute a landing no matter how far away it appears to be. But to be certain, watch the airport carefully from afar. If the landing area moves up with respect to a point on the windshield, you may not make it. Consider, however, that during drift-down, the descent angle becomes much shallower (and eventually becomes horizontal), which might confirm the ability to reach an airport previously rejected. If and when the landing area moves down with respect to a point on the windshield, you've got it made.

The approach to such a high-elevation airport must be executed carefully. Very carefully. Since a missed approach is virtually impossible because of the inability to climb (or even maintain altitude), the pilot is afforded only one opportunity. Fortunately, the maneuver doesn't require any fancy footwork.

To begin with, establish a long final approach. The aircraft should be lined up with the runway when at least three miles out. Use a normal, 3° approach slot. Although at least one airframe manufacturer recommends a higher-than-normal approach, this is not a particularly good idea because of the potential for an overshoot, which is at least as hazardous as an undershoot. If everything appears through the windshield as it normally does during a conventional approach, this helps to make the pilot feel more comfortable and enables him to more easily detect minor excursions from the visual "glide slope." And since the engine-out twin has such an outstanding "glide ratio" on one engine, there's no real problem if the aircraft dips somewhat below the slot. Simply maintain Vyse and sufficient power to recapture the "glide slope." A normal slot, after all, descends at three degrees while a single-engine twin can be made to descend at only a fraction of a degree.

ALTITUDE LOSS	ELAPSED TIME PER 1,000 FEET	CUMULATIVE TIME	AVERAGE SINK RATE	DRIFT-DOWN RANGE PER 1,000 = FT LOSS	CUMULATIVE DISTANCE	DESCENT GRADIENT	EQUIVALENT "GLIDE RATIO"	TRUE AIRSPEED
14,000 to 13,000	3:56	3:56	-254 fpm	7.2 nm	7.2 nm	1.3°	44:1	110 kt
13,000 to 12,000	5:58	9:54	-168 fpm	10.7 nm	17.9 nm	0.9°	65:1	108 kt
12,000 to 11,000	6:34	16:28	-152 fpm	11.7 nm	29.6 nm	0.8°	71:1	107 kt
11,000 to 10,000	8:32	25:00	-117 fpm	14.9 nm	44.5 nm	0.6°	91:1	105 kt
10,000 to 9,000	12:19	37:19	- 81 fpm	21.1 nm	65.6 nm	0.4°	128:1	103 kt
9,000 to 8,000	22:46	60:05	- 44 fpm	38.5 nm	104.1 nm	0.2°	234:1	102 kt

Figure 3. Drift-Down Flight Test Data, Piper Seminole*—Conditions: one engine inoperative, max continuous paper on operating engine; 85 knots; gear up—flaps up—cowl flaps open (operative engine); 260 lb under gross weight.*

A slight excess of airspeed (about 10 knots), however, is recommended until on short final approach.

Finally, when the landing is assured, extend the landing gear and flaps. During the flare and while reducing power, anticipate the need to apply rudder *toward* the dead engine to compensate for opposite rudder trim that had been applied earlier, as well as the drag created by the now-windmilling propeller of the good engine.

Occasionally a departure is made from an airport with a density altitude that is well above the single-engine ceiling of a light twin. An engine failure after takeoff, therefore, would result in a compulsory drift down to earth.

One way to avoid this is to load lightly because of the substantial effect this has on raising the single-engine ceiling. Instead of topping off the tanks before departure, for example, consider an en route landing for fuel at an airport with a lower elevation. Otherwise be mentally prepared to descend should an engine failure spoil the climbout. If the aircraft has reached at least 1,000 feet agl, a turnaround to the airport may be possible because of the minimal sink rate that can be maintained when below 10,000 feet msl. If a turnaround is not practical, accept the notion of an off-airport landing. By maintaining Vyse and maximum-available power from the operative engine, the outstanding "glide ratio" should offer a considerable choice of landing sites even at a relatively low altitude.

Statistics indicate, however, that a multi-engine pilot is psychologically unable to accept the reality of an off-airport landing as long as one engine is developing power. This stems from the erroneous belief that having two engines is an insurance policy against a forced landing due to the failure of one engine. He attempts to climb or maintain altitude even when conditions dictate that such performance is impossible. More often than not, the result is an asymmetrically powered spin that punctuates the flight quickly and with finality.

If maintaining Vyse results in a descent and lower terrain is not within range, accept a forced landing while maintaining control of the aircraft. This is much preferable to a spin and increases the probability of survival dramatically.

The new generation of light, twin-engine aircraft are relatively economical and safe, but only when flown properly by a pilot who appreciates their and his limitations. By understanding their performance potential and planning conservatively, an engine failure at altitude won't seem quite so traumatic. □