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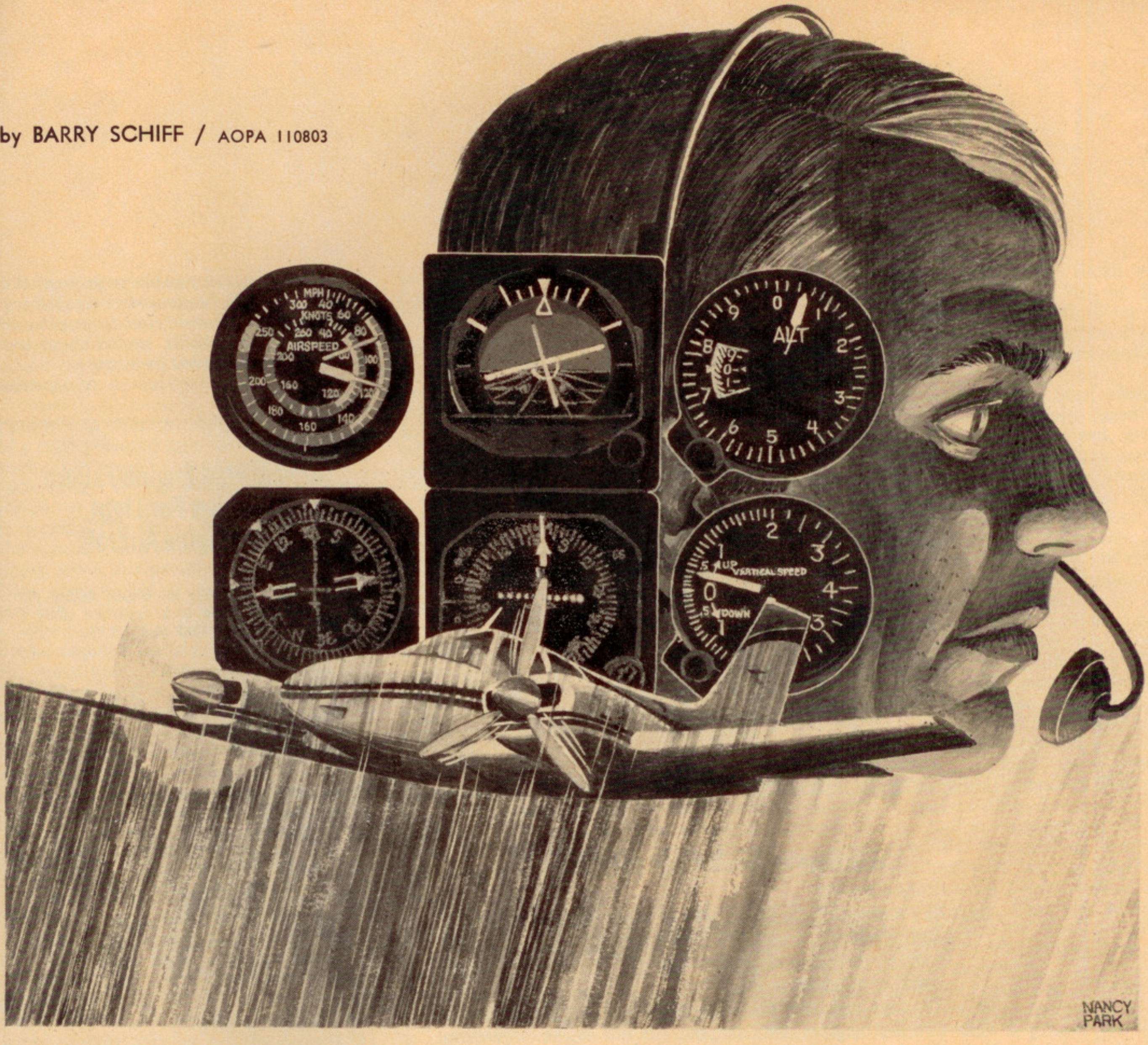

Multi-engine IFR

What to do when your twin becomes a single in the soup

■■ There is a dangerous deficiency in the federal aviation regulations.

Consider this. The average IFR pilot earns his instrument rating in a single-engine airplane. Generally, when he upgrades to a multi-engine rating he does so during a series of VFR flights. This pilot is then legally qualified to operate a light twin during actual instrument conditions.

This, according to numerous FAA inspectors and accident investigators, is blatantly dangerous because many (and perhaps most) nonprofessional, instrumented-rated, multi-engine pilots have never been required to demonstrate engine-out proficiency during simulated IFR conditions. (Briefly, during 1973 and 1974, such a demonstration was required of applicants for the multi-engine class rating who had instrument ratings, but for some unknown reason this requirement was deleted.)

continued

Those who are honest with themselves concede that the average "multi" pilot has difficulty managing an actual engine failure that occurs shortly after takeoff during *VFR* conditions. Proof of this is the fatal accident rate caused by engine failures. *The rate for twins is double that of single-engine aircraft.*

But should a power failure occur after penetrating a low overcast, the effect can be traumatizing. The average pilot becomes bewildered by a spectacular array of deflected needles, spinning instruments and confusing data. The result is often fatal.

During the previous 12 months, I administered eight Biennial Flight Reviews to multi-engine, instrument-rated pilots. Each was asked to don an IFR hood shortly after takeoff (about 300 feet agl). In each case, I simulated failure of the critical engine at between 700 and 900 feet agl. Instant disaster. Seven of the pilots lost control of the aircraft and admitted later that they had never before practiced the maneuver in other than CAVU conditions.

Curiosity compelled me to visit (and call) several FBOs where I inquired as to what maneuvers a pilot would be required to demonstrate prior to renting one of their light twins. Not one checkout was to include any simulated IFR flight. The industry-at-large (including the FAA) seems to assume that if a pilot has instrument and multi-engine ratings, he also has the ability to use them in combination. This illogical assumption has resulted in an unnecessary loss of lives.

Many pilots are unable to prevent this type of disaster for one very simple reason: *they have never had to acquire or demonstrate the skills necessary to perform such a complex procedure.*

Since no one requires a non-profes-

Glossary of Multi-Engine Terms

Vmc—The minimum airborne airspeed at which the aircraft is still controllable with a bank of not more than 5° when one engine suddenly becomes inoperative and the remaining engine is operating at takeoff power.

Vx —The best **angle-of-climb** airspeed with both engines operating.

Vxse—The best **angle-of-climb** airspeed with one engine inoperative.

Vy —The best **rate-of-climb** airspeed with both engines operating.

Vyse—The best **rate of climb** airspeed with one engine inoperative.

Generalized Engine-Failure Checklist For Light, Twin-Engine Aircraft

This checklist assumes an engine failure during the initial phase of a departure climb at an airspeed greater than V_{mc}.

1. CONTROL
- A. Arrest yaw.
- B. Power levers forward.
- C. Maintain V_{yse} (or V_{xse}).
- D. Activate turbocharger (if appropriate).

2. CONFIGURATION
- A. Check gear up.
- B. Check flaps up.
- C. Feather inoperative engine.
  1. Retard throttle.
  2. Mixture to idle cutoff.
  3. Feather propeller.
  4. Advance throttle to silence horn.
- D. Cowl flaps open (good engine).
- E. Cowl flaps closed (dead engine).
- F. Trim as necessary.

3. COMMUNICATIONS
- A. Advise ATC.
- B. Obtain appropriate clearance.

4. COCKPIT
- A. Fuel off to dead engine.
- B. Fuel pump off.
- C. Magnetos off (be careful!).
- D. Alternator (generator) off.
- E. Propeller synchronizer off.

5. CONSIDERATIONS
- A. Monitor cylinder head temperature of good engine.
- B. Reduce electrical load?
- C. Check pressurization?
- D. Eventual need to crossfeed?
- F. Single-engine service ceiling?

IMPORTANT NOTICE: This checklist is simply a guide and contains significant items of consideration. It is not intended to replace the procedures recommended for a given aircraft in the Pilot's Operating Handbook. Obviously, not all items apply to all aircraft nor is the order in which these items appear necessarily correct for all circumstances.

sional to develop engine-out, IFR proficiency, the conscientious pilot must take it upon himself to obtain the necessary instruction. In the meantime, it might be worthwhile to consider what follows.

Numerous sources of information recommend that the initial climb speed of a fully powered light twin be Vyse, the engine-out, best rate-of-climb airspeed (assuming all obstacles have been cleared and the gear and flaps have been retracted). The theory behind this is that the aircraft will be at the most efficient climb speed in case of an engine failure. Nice theory, but it doesn't work that way.

When an engine fails, it takes at least a few seconds for the pilot to react. In the meantime, airspeed erodes to less than Vyse (the blue radial marking on the airspeed gauge) and climb performance suffers.

Normally, it is wiser to climb at Vy, the best rate-of-climb airspeed when both engines are operating. Vy is better than Vyse for three reasons. First of all, when both engines are developing power, Vy results in the most rapid altitude gain—and altitude is one of a pilot's most precious commodities. With an ample supply, he has some room for error; without it, pilot performance must be flawless.

Secondly, Vy is usually faster than Vyse. Therefore, should an engine fail while climbing at Vy, some loss of airspeed cannot only be tolerated, it is desirable. This is because once the failure occurs, Vyse (a slower airspeed) becomes the new best rate-of-climb airspeed.

Thirdly, because Vy is faster than Vyse, it requires a slightly shallower pitch angle which represents a safer attitude in case of engine failure. The last thing a pilot wants concurrent with power loss is an unnecessarily high nose attitude. The larger the pitch angle, the more rapidly airspeed will decay.

When an engine fails during visual conditions, a pilot immediately recognizes the resultant yaw because of the eye-catching movement of the aircraft relative to the horizon. But when the natural horizon is obscured by cloud, the amount and direction of assymetrical yaw is not as easily determined (especially if the aircraft is in a turn when the failure occurs).

The pilot has only a pitifully few seconds to properly interpret the instruments and decide which engine has failed. This procedure is not as simple as it sounds, especially when the situation occurs unexpectedly during the initial phase of an IFR climb. Often, time is lost while simply trying to determine which instruments offer the most reliable, easiest-to-interpret information. Surprisingly, many pilots wastefully shift attention to the engine gauges to determine which engine has failed. Instead, they should stick to basics—the gyro instruments.

The yaw created by assymetrical thrust is most accurately indicated by the directional gyro. Firmly apply rudder pressure to whichever pedal will prevent further heading change. Also, keep a sharp eye on the artificial horizon. If the bank angle increases, the odds are you're stomping on the wrong pedal.

Much more can be written to describe the interpretation of various instruments under these conditions, but nothing is as descriptive as actual experience. Dual instruction in this procedure is mandatory. A low-altitude, IFR engine failure does not offer sufficient time for experimentation. A pilot must know precisely what to do without hesitation, or he and his craft may be scheduled for extermination. It's almost that simple.

Directional control cannot be maintained without sufficient airspeed, without a life-supporting flow of air rushing past the rudder. It would be ludicrous to suggest that there are very many pilots who don't know about the need to maintain airspeed healthily above Vmc (minimum controllable airspeed). But if this is the case, why do so many accidents result from attempted single-engine flight at airspeeds slower than Vmc?

The loss of an engine often results in an unavoidable descent. This is especially true if the failed engine has yet to have its propeller feathered. Very few light twins can climb on one engine while the opposite propeller is windmilling. A pilot's instinctive reaction to an unwinding altimeter—especially when IFR—is to apply back pressure to the control wheel in a futile attempt to arrest sink rate. This often results in an airspeed bleed to less than Vmc whereupon control of the airplane is impossible without reducing power on the "good" engine.

The pilot must be willing to accept an altitude loss during the time it takes to feather the propeller and determine that the gear and flaps are retracted. If insufficient altitude is available, it is far wiser to impact the earth with control than to spin in. All of this emphasizes the need to climb at Vy when both engines are operative. A safe altitude must be attained as quickly as possible.

Until the airplane has been cleaned up, sink rate can be minimized by maintaining Vyse. Any airspeed, either faster or slower, results only in an increased rate of descent. If the airplane has sufficient power, of course, flight at this identical airspeed produces the maximum possible rate of climb. But such positive results are not likely to occur until the prop of the inoperative engine has been feathered.

It seems so simple a chore. Just keep the airspeed needle on the blue radial mark. So simple in principle; so difficult in reality. The survival instinct somehow overrides logic and rejects the acceptance of a low-altitude, IFR sink rate, however temporary this condition may be. But cold logic must prevail and the pilot must concentrate almost totally on maintaining directional control and an optimum climb speed.

Once control of the airplane has been established, the prop of the malfunctioning engine must be feathered. This assumes, of course, that the problem cannot be remedied and that the ailing engine is not delivering sufficient power to overcome its own drag.

The feathering procedure must be executed as promptly as possible, but not so rapidly that a pilot risks shutting down the wrong engine. It happens.

The first step usually recommended is to retard the throttle of the inoperative engine (remember. "dead foot—dead engine"). This verifies that an excited pilot has the correct engine in mind. If throttle retardation results in sudden silence, advance the lever to its original, full-forward position and shift attention to the other engine. Then, depending on advice found in the Pilot's Operating Handbook, either retard the mixture to "idle cutoff" and feather, or vice-versa. (After the engine has been shut down, advance the throttle to eliminate distraction caused by the gear-warning horn.)

As the propeller feathers, the aircraft should accelerate to beyond Vyse (unless the nose is raised simultaneously) and this airspeed *carefully* maintained. Hopefully, the aircraft will climb, but don't count on it. Climb performance depends on density altitude and the pilot's ability to maintain the proper airspeed.

Unfortunately, Vyse is not a fixed airspeed as is implied by the blue radial marking on the indicator. The marking represents only the *maximum* Vyse and is valid only when the aircraft is at maximum allowable gross weight and at sea level. As altitude increases and gross weight decreases, Vyse decreases.

Take the case of a Cessna 310R. Maximum Vyse is 106 knots (blue radial marking), but Vyse is only 92 knots when the aircraft is lightly loaded at 5,000 feet msl. If this airplane, for example, is at 5,000 feet and the "blue-line" airspeed (106 knots) is maintained, it will not climb nearly as well as when the slower airspeed is used. Often, flight at the "blue line" instead of at a more suitable, slower Vyse can mean the difference between climb and descent.

Most "multi" pilots don't have the various Vyse speeds committed to memory and yet these performance numbers can be critical to survival. It is strongly recommended that a small placard of Vyse speeds be prepared and placed on the instrument panel (near the airspeed indicator) for ready reference.

Now the airplane is aerodynamically clean and being flown at that Vyse which is appropriate to altitude and weight. Is this pilot out of the woods yet? No way. He's got other, perhaps more ominous difficulties ahead.

First of all, is the single-engine climb performance sufficient to climb to a safe maneuvering altitude from which an IFR approach can be executed? And, where will the pilot go to execute that approach?

The most immediate problem may be climb performance. Many light twins simply can't climb to a very high altitude especially when loaded to gross on a warm day.

For the purpose of this discussion, consider a Cessna 310C, a relatively good single-engine performer in anybody's book. At a density altitude of only 2,500 feet, the 310C has a single-engine climb rate of only 310 fpm. This doesn't sound too bad until you realize that it equates to a 160-foot climb per statute mile of horizontal flight which is a climb angle of only 1.7 degrees. If the terrain ahead has an uphill slope of more than 1.7 degrees, an involuntary landing is likely.

At 5,000 feet, the same airplane climbs at a rate of only 93 feet per mile (a 1-degree climb angle). Consider that this is a twin with better-than-average single-engine performance; most other non-turbocharged twins can't do as well.

All of this simply validates the maxim, "Twin-engine airplanes are equipped with two engines for the best of all possible reasons: they (usually) don't fly worth a damn on one."

Therefore, if the climb is being made toward rising terrain, the pilot is in deep trouble unless he has the presence of mind to reverse course and head toward terrain that slopes downhill. And since he is IFR, it wouldn't be a bad idea for him to stay in touch with ATC.

Thus far nothing has been said about Vxse, that airspeed which provides the best *angle* of climb while operating on one engine. To overfly obstacles, Vxse is certainly more desirable than Vyse. But the use of this slower airspeed raises two cogent points. One, the already negligible single-engine climb angle usually is not increased significantly. At sea level, the increase in climb angle of a Cessna 310C is less than 15% and even this modest increase diminishes with altitude. But the pilot engulfed in cloud usually believes that the aircraft is climbing more steeply than it really is. A dangerous assumption.

Secondly, if the propeller has yet to be feathered, Vxse is not that much faster than Vmc. In the case of the Cessna 310C, Vxse is 83 knots and Vmc is 71 knots. This represents only a 12-knot margin of safety between the best climb angle and uncontrollability.

Once the propeller is feathered, however, Vmc reduces to a somewhat slower airspeed which increases the safety margin (and relieves that throbbing leg from having to apply almost full rudder).

Now let's assume that the departure airport is reporting less than landing minimums. The takeoff was legal, but an IFR approach would not be. At this point, however, perhaps legality isn't too important. After all, a pilot can exercise his emergency authority. But how safe would it be to shoot such an approach while maneuvering on one lung? Not very.

This, then, becomes a serious point to consider. When departing an airport with less than approach minimums, a prudent pilot should have a nearby alternate airport in mind, one to which an engine-out IFR approach would be both legal *and* safe.

Once the pilot is en route to a suitable approach fix, he must administer the necessary climb with the patience of Job. A climb from sea level to 5,000 feet in a 310R requires 19 minutes and 40 miles (an average altitude gain of only 125 feet per mile).

Consider that the 310R is relatively spunky on one engine. Several other non-turbocharged twins not only wouldn't do as well, but may be unable to climb to 5,000 feet at all. Here is where a pilot's knowledge of his aircraft's single-engine performance is mandatory. There's no point trying to climb to unreachable heights.

Generally, it is wise not to rely on being able to climb above the airplane's single-engine service ceiling (gross weight considered). This is the altitude above which a 50-fpm climb rate cannot be maintained (with one engine).

Once a safe altitude has been attained, the rest is all downhill, literally and figuratively.

But the engine-out, IFR approach also warrants special consideration. When on final approach, maintain an airspeed of at least Vyse until landing is assured. Should a missed approach become necessary (pray that it doesn't), it is convenient to already have the necessary airspeed. For the same reason, also delay gear and *total* flap extension until landing is assured.

On the other hand, avoid unnecessarily fast airspeeds that could result in an overshoot. Also, be aware that deceleration during the landing flare will be less than normal because the feathered propeller doesn't create nearly as much braking drag as when it is windmilling.

Also at this time, be alert for a yaw toward the "good" engine when its throttle is retarded. The severity of this yaw depends partially on how much contributory rudder trim had been applied earlier *in that direction* to prevent a yaw (during the approach) toward the "dead" engine.

Coping with an engine failure in a light twin during the initial phase of an IFR climb is one of general aviation's most complex procedures. But only a small percentage of non-professional, instrument-rated, multi-engine pilots have ever been exposed to the necessary, life-saving practice. And this is a deficiency that defies reason. ☐