STANDARDIZATING MULTIENGINE TRAINING

by
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In the early 1960’s when practical light twins started becoming popular, there was no such thing as a Multiengine Flight Instructor rating. If you were a CFI for airplanes you could teach in single or multiengine, land or sea based on your pilot ratings. Many people were killed during training accidents as instructors developed their own methods of teaching in dramatic fashion what they had just so recently learned themselves. I gave my first multiengine instruction the day after I became a multiengine pilot. The person who taught me had several thousand hours of multiengine flying and I had less than ten. I did not sleep very well the night before, trying to figure out how to do it safely. How many different reactions could I anticipate from the student? When should I take over?

During those years we did some things that made sense at the time, but we were close to some dangerous edges. We would actually pull the mixture at any time from engine power-up to taxiing in. The student was expected to pull the knobs to the full feathered, shutdown condition. We would perform this carefully practiced hand ballet to restore a zero-thrust condition before the propeller actually stopped. The value to this procedure was that students learned the response that they will need to perform when they actually lose an engine. The down side was that we were creating an actual emergency situation very close to the ground.

I remember pulling a mixture just after liftoff when the student had raised the gear at about five-feet. The student pulled both throttles and made a stuttering reach for the gear handle. I had to restore power and continue the takeoff at that altitude. At that time I attributed the fact that we didn’t scrape paint to my expert handling of the situation. This is just one of the close calls that I recall. Some students would "flat hand" the six power levers full forward at once, then slap a propeller control into feather- not always on the correct engine. One student went straight to feather without even identifying. Often students will raise the nose, reducing speed to near Vmc *(minimum controllable airspeed with one engine windmilling and the other developing full power*)

Those of us who survived learned to teach in a self-standardized manner - making sure that all of our students did things in a predictable sequence. If the student got out of order or hurried we would stop and takeover. We would then review the cues and reactions and start over.

Since that time there has been a concerted effort to make multiengine training safer. The Multiengine Flight Instructor rating was instated, and several publications suggested safer procedures for handling malfunctions . The procedures contained in the FAA Airplane Flying Handbook FAA-H-8083-3A have been carefully thought through by many different groups of highly experienced pilots. The rationale for each procedure has been thoroughly discussed. There is no time during a simulated engine failure for the student to get creative and try to improve on what we do. We would like each new group of pilots to think creatively about ways to improve these procedures, but we should all *do* them the same. If someone comes up with a procedure that seems super, we should let it stand the test of time and review before accepting it.

TEACHING ENGINE FAILURE REACTION

The reaction to an engine failure is an area where standardization has been refined, but I believe we need to go one step further. When an engine fails, pilots usually do all the right things, but not necessarily in the same order. They should be done deliberately but it is not necessary to rush through the procedure. I remember the words of one 747 captain when asked his reaction to a malfunction he said "First I wind the clock." - emphasizing the need to be deliberate and avoid rushing through a critical operation. The accepted order of reaction is:

1. **Maintain Heading and Blue Line**
2. **Increase power**
3. **Clean up the airplane**
4. **Identify the dead engine**
5. **Verify the dead engine**
6. **Troubleshoot if altitude and time allows**
7. **Feather the dead engine**
8. **Follow the checklist to secure the engine**
9. **Decide where to take the airplane**

Taken one at a time, I would like to suggest taking standardization one step farther. As a pilot examiner, I would like to see the following procedures on rating rides. Unfortunately, until they are cast in stone I have to accept anything that conforms to the Practical Test Standard (PTS). I cannot fail someone just because they don't agree with me.

If you experience an uncommanded yaw - react as follows:

1. Maintain Heading and Blue Line

Your eyes should go directly to Airspeed and Heading indicators using the Attitude indicator to make necessary corrections. If you have achieved Vyse on two engines, you will have to lower your nose to the single engine Vyse attitude. Use one-half of the pitch required for both engines as a starting point. Believe it or not, the airplane will turn after you lose an engine. Nail the heading with the rudder and bank slightly toward your working foot.

2. Increase Power

Do this two at a time in the proper order, while maintaining Heading and Blue Line:
Mixtures - Enrich, Props - Increase RPM and Throttles - Increase Power. Don't try to sort out the dead engine at this stage. Move both engine's controls at the same time.

Some instructors teach to push all six knobs forward at once. While this gets the job done it doesn’t save a significant amount of time and leads to hurrying the whole procedure. In the name of "Standardization" let's push them forward one set at a time.

3. Clean Up The Airplane

While maintaining Heading and Blue Line, reduce drag in the order stated in the Emergency Procedures section of the airplane handbook. Some require flaps first, some gear first. Some require consideration of the cowl flaps. At some point the cowl flaps should be adjusted to keep one engine cool and the other warm – but not necessarily here.

4. Identify The Dead Engine
The foot that isn't working is the engine that isn't working. While maintaining Heading and Blue Line, lift that foot off the rudder pedal and stamp it on the floor. The knobby knee that is moving is the knobby throttle that I want to retard in the next step.

Some instructors teach to tap the lazy knee with your hand. This is undesirable because it takes one hand out of the control equation. Also if both feet are still physically on the pedals it is possible to put 150 pounds of pressure on both, and be unable to determine which foot isn't working. There is a lot of adrenalin running through your leg muscles.

5. Verify The Dead Engine
This means reduce power on the one that you think is dead while looking at Heading and Blue Line. If no change occurs, you got the right one. Retard the throttle to the low power position – ***not to idle***. There are two reasons for this. First it will keep the gear horn quiet, and second, if the engine starts during the next step you will ***know*** it.

Someone suggested "Just prove it with the prop control. If the sound doesn't change just continue to feather." This sounds like a super idea, but you might overboost a turbocharged engine and kill your good one. Let's all do it the same.

6. Troubleshoot If Time And Altitude Allows
If you are still in the takeoff environment, or in a critical phase of an instrument approach, the distractions of the troubleshooting process may be more hazardous than continuing with a feathered engine. There is some leeway on this, but it usually should not be done below 1000 agl on takeoff, or after turning base. Think ahead to the next "stop sign." How much time do you have before you have to do something. Trouble shooting should consist of the steps listed in the Emergency Procedures section of the handbook while maintaining Heading and Blue Line.

7. Shut Down The Dead Engine
At this point (while watching Heading and Blue Line) move the verified Throttle to Idle, then move the same Propeller control to Feather, then move the same Mixture control to Idle Cutoff.

8. Secure The Dead Engine
When time allows refer to the emergency checklist and shut off everything you don't need. Some airplanes have two very good generators/alternators and can continue with only one operating. Check the electrical load to see if it needs reduced.

9. Decide Where To Take The Airplane
Each time you practice engine failure procedures imagine a scenario involving a real flight to a desirable destination. If an engine actually fails on takeoff continue around and land. If it happens in flight you need to reorder your priorities and get to a safe landing. It may be possible to continue to your original destination, but the additional power required by the remaining engine – combined with the reduced performance might compromise your fuel range.
If you decide to continue to a distant destination, consider that the additional stress might cause the other engine to fail. Consider the additional stress that might affect pilots and passengers as

well. In any case, verbalize what you would do so that you and everyone else knows what's happening.

TEACHING THE GO-NO GO DECISION

There is an FAA Advisory Circular that prohibits shutting off fuel to an operating engine below 3000 agl. Below that altitude we simulate power failures by pulling the throttle back. In the traffic pattern the multiengine student is expected only to touch the engine controls rather than move them. Over-learning of this "practice procedure" creates a false reaction to this critical situation. The actual procedure of moving the knobs should be taught thoroughly at a safe altitude or in a simulator.

Using a "hard deck" altitude, use scenarios for practicing engine-failure-on-takeoff either above or below the decision speed moving the knobs as they are intended. The instructor can pull the mixture or turn off the fuel above 3000 agl and let the student pull the knobs the Idle, Feather and Cutoff without damaging anything. The only critical instructional task is to move the Prop control out of feather before rotation stops. The mixture/fuel can then be restored and the throttle advanced to simulate Zero Thrust. Practice cruise scenarios starting several knots above Vyse, maintaining heading and altitude while slowing. At some point you should try it at an altitude well above the single engine service ceiling to experience a drift-down.

If only "traffic pattern procedures" are taught, it is very possible that your student will just touch the knobs when he has his first actual engine failure on takeoff fifteen years from now. We must take advantage of the Laws of Primacy and of Exercise by teaching the full procedure until it is internalized, then teach the traffic pattern training procedure of touching rather than moving. Recurrent training in light twins should include going up to altitude and actually moving the knobs in reaction to simulated takeoff emergencies.

SINGLE ENGINE GO-AROUND / MISSED APPROACH

The practical test used to require a single engine go-around from the full flap landing configuration. We practiced this until we could Identify Verify and Feather, raise the flaps and gear within 200 feet of altitude. Today, if I have practiced, and I know it's coming, I can still manage to do it within 200 feet. However we should not set ourselves up for this. Given the natural tendency to "swim in glue" when something happens, several respected aviation writers have decided to double that, and not perform a single engine go-around below 400 agl. The traffic pattern should be flown at or above Vyse until reaching 400 agl. At that point the pilot may add landing flaps and slow to Short Field Landing speed.

If the tower says "GO AROUND" at any altitude below 400 agl with one engine inoperative, just say "unable" and land on any usable part of the airport. Full power on the good engine in this configuration will reduce your descent rate a mere 800 fpm down. You may need all available power to make it to the runway. If both are operating, and you get an uncommanded yaw as you start the go-around, land. (See Switch #3 below.)

Well, OK, how about missed approach from a single engine ILS when you are going down to 200 feet ? The secret here is to delay adding landing flaps until after landing is assured. Even in medium twins with approach speeds of 120 kts, you can add full flaps at 200 feet and slow to Short Field Landing speed before reaching the Runway Aiming Point (1000-foot markers).

Vmc DEMONSTRATION

Pilots are required to demonstrate the correct reaction to reaching Vmc during their certification ride. In the early days instructors often introduced this dramatically by cutting the mixture at the published speed - with or without previous instruction. As you can imagine, the number of stall/spin accidents increased in the 1960's and 70's resulting in an FAA staff study ("Flying Light Twins Safely" FAA-P-8740-66). This study formed the basis for present standardized "slow deceleration" procedures contained in the Airplane Flying Handbook.

Although Vmc demonstrations are usually performed at higher altitudes where full power is not available to the operating engine, there are several factors which could cause loss of control at a speed well above the published speed.

Vmc was determined by using "no more than five-degrees bank toward the operating engine." This provides a slip toward the operating engine enough to streamline the airflow around the fuselage and across the rudder. If the wings are held level, loss of control may occur 10-20 knots above the published number. We experimented in the 260 hp Baron BE-95-55 and found that we lost control 19-knots above the published speed at 3000 msl.

Vmc on older twins was calculated at maximum weight. Actually Vmc will be higher at lighter weights. The airplane is easier to yaw when light because there is less inertia with the same turning force. Newer twins are certified at the most adverse weight - usually as light as possible. In one popular light twin trainer with two aboard and light fuel, we reach maximum rudder deflection at 10-12 kts above Vmc at 4500 msl. This is just a few knots below rotation speed. I wonder what it is at sea level on a standard day.

We used to teach engine failure during power-on stall practice - pulling the mixture below Vmc. Although we don't do that anymore, the possibility should be discussed and anticipated by instructors. (See switch #2 below.) The proper reaction is to reduce power in the event of an uncommanded yaw.

Back when stall-spin accidents were common in training, about half of the twins spun away from the windmilling engine. This occurs when the student still holds full opposite rudder just as power is abruptly reduced.

MULTIENGINE SWITCHES

There are three switches that should go off in a pilot's head when flying a multiengine airplane.

1. **When accelerating past Decision Speed.** At Decision Speed, you can unlatch your grip from the throttles, raise the gear and commit to fly.

2. **When airborne and flying less than or near Vmc** (or when full rudder isn't enough). In this case you must be aware of loss of rudder authority. Anticipate the need to reduce the throttles if yaw control is lost.

3. **When on final below 400 ft agl with full flaps extended.** In this case you should commit to not attempting a single engine go-around. If you start a two engine go-around and only one engine responds, you should land. You might have to avoid whatever required you to go around, but you should be able to land safely on some part of the airport.

SUMMARY

Multiengine instruction has several dangerous edges. We can practice critical things at altitude or in a simulator. Instructors need to review two things before they simulate a malfunction. First, what are the two most critical mistakes the student can make in this situation? And Second, how will I react when they do. Above all, don't let the student continue a critical procedure if he or she gets out of order. Remember the safety-valve phrase when they do something unexpected. "Stop - I have the controls."

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