CHAPTER 2

Multiengine Takeoff and Landings

The takeoff in a multiengine airplane poses a greater hazard than any other maneuver. Once the airplane has reached a safe altitude and speed, having a second engine is great, but the transition zone between slow and fast with two engines is twice as dangerous. Multiengine pilots must plan every takeoff with the expectation that one engine will fail. If an engine fails during takeoff, it will be a surprise to the pilot, but how the pilot reacts should not be a surprise.

As a normal takeoff progresses, the plane and pilot will pass definable points of decision that I call *speed milestones*. The proper action taken by the pilot when one engine quits on takeoff changes according to what milestones have been passed. To do the right thing, the pilot must understand that different speeds produce different reactions from the airplane. The pilot's proper response to a problem shifts as the takeoff continues (Fig. 2-1).

Speed Milestones

0 Knots

The first speed milestone is 0 knots. Before letting the airplane move down the runway, the pilot must ensure that the airplane has all its "ducks in a row." It is good practice to align the airplane with the runway centerline and then pause for a few seconds. While holding the brakes, run the engines up to takeoff power. Now check the engine instruments to ensure that all are in their respective green arcs. Verify that the manifold pressure and RPMs are acceptable. Be sensitive to any shudders or shakes that are unusual. Normal pretakeoff

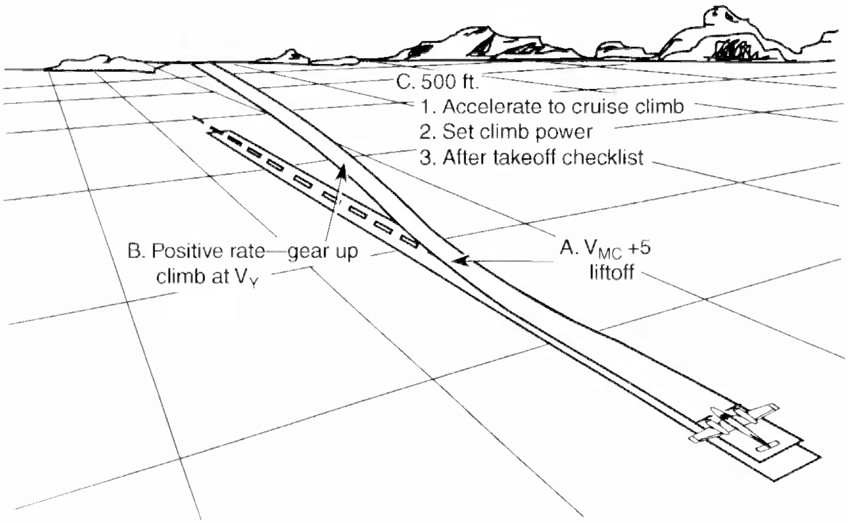

Fig. 2-1. Normal multiengine takeoff.

run-ups are done with less than takeoff power, so this is the first time you can witness the airplane at this higher power setting. If there is any indication of a problem, you would rather discover it while standing still. While holding the brakes, you can turn your full attention to engine observation. Once you let go of the brakes, you will be too busy with steering, crosswinds, and other excitement to carefully watch the engine instruments. Taking the runway but delaying takeoff for an engine test does have its hazards. The controllers in the tower do not like pilots to make unannounced delays on an active runway. Start observing the traffic load by listening to the tower or Unicom frequency before you call ready for takeoff. This will build your airport situation awareness. If the traffic is heavy, with one airplane after another landing, it will be best to advise the tower that you will need some time on the runway before you begin the roll. Just say, "N20131 is ready for takeoff, and we will need a 15-second delay on the runway." The controller will know exactly what you are doing and can space traffic accordingly. At uncontrolled airports, an unexpected delay could cause another pilot to go around. Protect yourself by checking that everything is working properly before letting the airplane move, but be courteous as well.

V_{MC}

When the speed of V_{MC} is reached and surpassed, another milestone is passed. The minimum control speed must be observed and the airplane held on the ground through this speed. It is a good idea to observe the airspeed indicator for these milestones to pass. At the very beginning of the takeoff roll, the airspeed indicator will not move because most indicators do not go as low as zero. Usually the plane must be into the takeoff roll for several seconds before the airspeed indicator starts to move. This is when I say out loud, "Airspeed's alive," even if I am alone. This verifies that the airspeed indicator really works and is in itself a milestone.

V_R

The next speed milestone is reached at the liftoff speed V_R. V_R stands for *rotation* and is the speed when the pilot pulls back on the wheel and rotates the nose up and off the ground. The V_R speed can never be safely slower than V_{MC}! If V_R were slower than V_{MC} and at this speed an engine failed, the pilot would merely become a spectator as the airplane went out of control. At such a low altitude, only a few feet above the ground, a safe recovery is unlikely. Allowing the airplane to become airborne at a speed slower than V_{MC} should never be acceptable to the pilot. Check your own airplane's recommended V_R speed. Ordinarily V_R is equal to V_{MC} plus 5 knots:

$$V_R = V_{MC} + 5$$

The first milestone speed of zero and now this milestone speed of V_R form the first takeoff *decision zone*. The question that must be answered is, If an engine fails now, do I stop or continue to takeoff? Between the speeds of 0 and V_R the decision is easy: *Stop!* While you are in this speed range, if anything should happen that makes you suspicious of the condition of the airplane, immediately reduce power on *both engines*. Pilot examiners predictably present engine problems to multiengine check ride applicants during this decision zone. They want to see not only that you will abort the takeoff while between 0 and V_R, but also that you will bring the power back on both engines. The examiner might say, "You have low oil pressure in the left engine." If the multiengine applicant pulls back the throttle on only the left engine, the check ride will be over. If only one engine is reduced, the other, full-power, engine will likely pull the airplane off the centerline and into the runway lights. You simply do not have time during this part of the takeoff roll to do much troubleshooting. Just pull everything back, steer with your feet, bring the airplane to a stop, and inform the control tower.

V_{YSE}

After liftoff the decisions become more complicated. V_{YSE} is the speed of the next milestone. This speed is the *best rate of climb* speed using only one engine. V_{YSE} is marked on the airspeed indicator with a blue radial line. Probably it should be called the *best one-engine performance*

CHAPTER 3

Engine-Out Procedures

You may know the story about the time an FAA inspector traveled to the North Pole to give Santa Claus his annual proficiency test. Santa was expecting the FAA man, so he had already hitched up all the reindeer to the sled. By the time Santa finished his preflight inspection and got in the sled, the inspector was already in the right seat, holding a large knapsack. After Santa gave the word to Rudolf to taxi into position and hold, the FAA inspector opened the knapsack and pulled out a long shotgun. He pumped the weapon and said, "Santa, I feel it's only fair to warn you that you may lose one on takeoff!"

When an engine does fail, the pilot must react correctly and without hesitation. Having two engines is an advantage, but the pilot must place the airplane in a position to utilize the advantage. The first reaction from the pilot depends on the airplane's speed when the engine fails. If the airplane's speed is slower than V_{MC}, the pilot must reduce power on both engines. If the speed is faster than V_{MC}, the pilot must increase power on both engines. Making the wrong choice here is fatal.

If one engine fails, the pilot will feel the sway yaw of the airplane. It can happen fast, and in that first second before you realize what is happening, it can surprise even the most veteran multiengine pilot. In that second it may be unclear which engine has failed because the airplane is reacting to the failure faster than the pilot can recognize it. Since the exact engine's failure has not yet been positively determined, the action taken by the pilot should include both throttles. By moving both throttles in unison, the pilot is sure to affect the operating engine, even if the pilot does not know which one is operating during this moment of confusion. It is better to move both throttles even though one is dead than to waste time figuring out which one works and which one does not.

Now we understand that both throttles should move together, but which way should they move? If the airplane is flying slower than V_{MC}, both throttles should be pulled back. If the pilot pushes the throttles to a higher power setting, the airplane's control will be lost. If both throttles are brought forward, the dead engine will continue to produce no power, but the operating engine at full power will produce the yaw that the rudder, while slower than V_{MC}, cannot overcome. This idea of *pull back when in trouble* goes against our earlier training. In single-engine airplanes, the remedy for a stall was to push forward on the wheel to break the stall and push forward on the throttle. We associate recovery with full power. Some of us have become "Pavlov's pilots" because we hear a horn and so add power without thinking. But below V_{MC}, power must be reduced on both throttles. By doing this the power output from each engine will be the same: zero. Having zero power is not good, but at least it is equal power and no yaw will result. With the power on both engines back, lower the nose and gain airspeed. When the airplane is traveling faster than V_{MC}, the pilot can afford to add power on the good engine while opposing yaw with rudder. This, of course, requires the airplane to have sufficient altitude to gain the speed. If there is no altitude, the pilot should land straight ahead on the flattest, softest thing available.

If the airplane's speed is greater than V_{MC} when an engine failure is felt by the pilot, both throttles should go forward. The greatest power will set up the best possible climb performance for the situation. But unfortunately the pilot cannot throw both throttles forward if the propeller controls are back. If the engine failure occurs during cruise flight, the props will be back. Asking the propeller in a high-pitch/low-RPM setting to take on full engine power is like putting the force of a cannon through the barrel of a rifle. It is not matched and can damage the propeller and engine. This is why it is the proper procedure to place the prop controls full forward for takeoff and for landing. In this position, should full power ever be required, the props are already prepared to handle the extra load. Most manufacturers also request that the engine mixtures be at full rich, because it could be a faulty mixture that caused one engine to fail in the first place. Consult your own airplane's manual, but usually the proper response to a faster-than-V_{MC} engine failure is

1. Both mixtures forward (rich)
2. Both propeller controls forward (high RPM)
3. Both throttles forward (high power)

These steps should be taken when the pilot feels the yaw of an engine failure. At the same time the pilot must fly the airplane. If the airplane's speed is faster than V_{MC} at the time of the failure, the pilot cannot allow the airspeed to deplete to V_{MC} while working inside to understand and fix the problem. When the yaw of engine failure is first felt, add rudder to keep the airplane straight, adjust the airplane's pitch as necessary to maintain a speed above V_{MC}, then go to work on the problem. Many pilots have panicked here, and while they were moving levers and throwing switches, their airplanes sank below control speed and crashed while the pilots were still running through the checklist. The safe multiengine pilot must be a little savvy. The safe multiengine pilot takes calculated time to fly the airplane and then goes to work on the problem. The mental checklist would actually read as follows:

1. Apply rudder as the unknown yaw sets in.
2. Control airspeed above V_{MC}.
3. Set both mixtures to full rich.
4. Control airspeed above V_{MC}.
5. Set both prop controls to high RPM.
6. Control airspeed above V_{MC}.
7. Set both throttles to full power.
8. Control airspeed above V_{MC}.
9. Use additional rudder as the power comes up on the good engine.
10. Maintain airspeed above V_{MC}.

This all needs to happen fast, but not in a mindless blur. Multiengine pilots must be alert, because their thought process can be challenged at any moment. Once the initial shock and reaction have passed and the airplane is under control, it will be time to think about performance. We know from Chap. 2 that single-engine climb performance is bad at best. To give the airplane the best chance of staying in the air, the pilot must now reduce drag so the remaining good engine can do its job.

The wing flaps are also drag producers, and they should be retracted to achieve the best possible climb unless the manufacturer has proscribed a *best-climb flap setting*. If the airplane is "stabilized" in level flight or in a climb, the pilot should also bring the landing gear up. It is vital that the decision to continue flight, as opposed to landing on the remaining runway (if any), be made before gear retraction. The thinking here is that if you are going