ENERGY MANAGEMENT CONCEPTS

BUILDING GOOD HABITS

BY MARK HENSHALL

THE AIRMAN CERTIFICATION STANDARDS (ACS) DEFINE WHAT PILOTS NEED TO KNOW, CONSIDER, AND DO IN ORDER TO GET A NEW CERTIFICATE OR RATING. The old Practical Test Standards (PTS) made no mention of energy management concepts, nor does the word "energy" appear anywhere in it. The ACS introduces us to this phrase in connection with approaches and landings. What energy management concepts does the FAA have in mind? Why is it important to you? And finally, how can you apply this information in order to increase your safety margins?

THE CONCEPT

Energy management concepts are nothing new. Airline training and standard operating procedures (SOP) have integrated these concepts for many years, and any good aerobatic pilot can tell you all about energy management. These concepts are only now beginning to trickle down to general aviation primary training. However, even now the FAA's *Pilots Handbook of Aeronautical Knowledge* (PHAK) makes only scant mention of energy management—here's how it's defined: "The energy state of an airplane is the balance between airspeed, altitude, drag, and thrust." In other words: It takes thrust to put an object in motion, so airspeed reflects energy at work; drag always exacts a penalty, so it is trying to drain energy away; and altitude can be thought of as stored energy that can be tapped into. Think of a car parked at the top of a hill with the parking brake set and the engine off.

If you release the parking brake, it will start rolling down the hill, even though the engine is not running. In the same way, if your airplane has excess altitude, you can trade that altitude for airspeed by pitching the nose down, effectively tapping into that stored energy. The reverse is also true. Excess airspeed can be traded for altitude by pitching the nose up. If you think of it in financial terms, thrust represents your income, drag represents your bills, airspeed represents your cash flow, and altitude represents assets such as money in savings accounts, etc.

Let's look at the example of flying aerobatics. If you begin a loop without sufficient energy, as you approach the top of the loop, you will run out of energy. You could fall out of the loop, or even slide backwards on your tail, known as a tailslide. With many aerobatic airplanes such as the Citabria—in level flight at full throttle—you will not have enough airspeed to begin a loop. You often have to dive and accelerate to a higher airspeed before beginning the maneuver. If you are performing a sequence of aerobatic maneuvers, you need to evaluate your energy state at the end of each maneuver before beginning the next. Airspeed and altitude are both part of that equation. If there isn't sufficient altitude and airspeed, you will have to break off the sequence and climb before resuming the sequence.

APPROACH AND LANDING

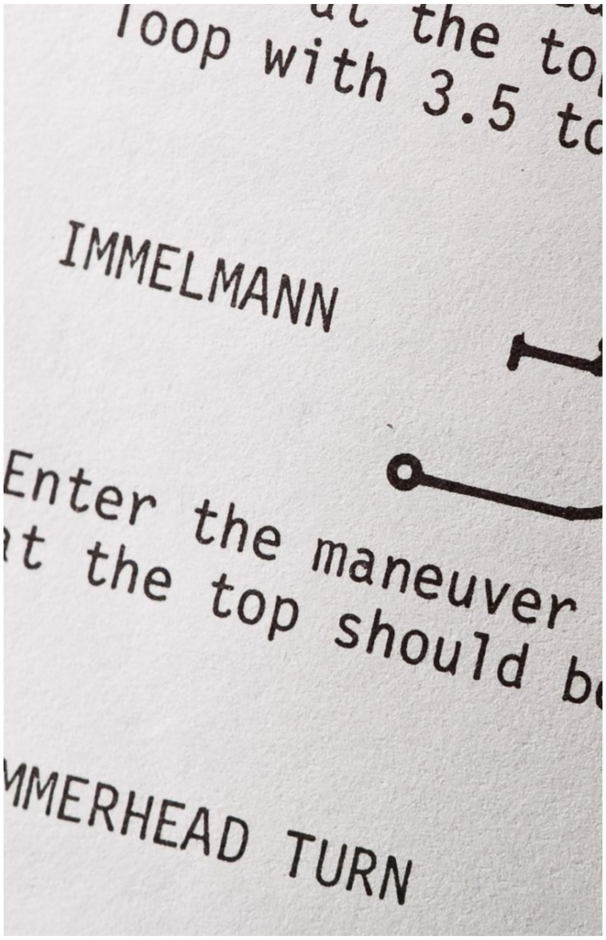
Now let's think about the application of these principles during approach and landing. Would you want to approach for landing at just a couple knots above stall speed? Probably not, since such a slow speed gives you no margin above stall speed to account for wind gusts or poor technique. Stalling the airplane at low altitude is hazardous to your health.

On the other hand, would you approach to land at a speed just a couple knots below redline? If you tried to flare to land at such an outrageously high speed, you would have so much excess energy that you would float into the next county before the airplane would be ready to land! Running off the end of the runway is likely to ruin your day, or worse.

Think of it this way. The stalling speed might be thought of as representing the point where you are out of energy, because the airplane no longer has enough airspeed to sustain level flight. When you compare the manufacturer's recommended approach speed versus the stall speed in the landing configuration, you will typically see a 20 to 30 percent margin above stall speed. This represents reserve energy to help protect against an unintentional stall. It also represents energy that must be bled off during the flare to land. Until that reserve energy is used up, the airplane will float down the runway. This manufacturer recommended approach speed is a good balance between too little reserve energy and too much. When flying the recommended approach speed, you will have some float during the flare, but it shouldn't be excessive.

Some pilots get into the habit of automatically adding 10 or 20 knots to the recommended approach speed, perhaps because of fear of stalling. Arbitrarily adding extra speed is not good energy management. When you calculate landing distance from the manufacturer's Pilot Operating Handbook (POH), it is based on using the recommended approach speed.

IF YOU TRIED TO FLARE TO LAND AT SUCH AN OUTRAGEOUSLY HIGH SPEED, YOU WOULD HAVE SO MUCH EXCESS ENERGY THAT YOU WOULD FLOAT INTO THE NEXT COUNTY BEFORE THE AIRPLANE WOULD BE READY TO LAND!



Approaching to land at a faster speed will significantly add to the landing distance required, and there usually is no provision in the handbook to predict landing distance at higher approach speeds. Congratulations, you just became an unpaid test pilot. You can easily end up needing more runway than you have available, especially if your aiming point isn't at the start of the runway, or the runway is wet or icy, or the airport sits at a higher elevation. Even if you have plenty of runway available, it is just considered poor form.

On the other hand, there are times when it is appropriate to add a measured amount to the usual approach speed for conditions such as gusty winds. For example, if reported surface winds at the airport are headwinds at 11 knots, gusting to 19 knots you have a gust factor of 8 knots, calculated by subtracting the steady wind speed of 11 knots from the peak gust speed of 19 knots. During gusty conditions, it's recommended to add half of the gust factor to your usual approach speed. In the above example, the gust factor is 8 knots, so you would add half of that, or 4 knots, to the usual approach speed. The extra 4 knots give you slightly more reserve energy to deal with the loss of indicated airspeed in case that 19 knot peak headwind changes to an 11 knot headwind just as you approach the runway threshold.

SHORT FIELD APPROACH

Some manufacturers recommend a slightly lower approach speed for short field landings than normal landings with full flaps. Such a recommended speed may reduce the margin to as little as 15 percent above stall speed. Why? Since the objective in that case is to touch down at the earliest point and stop the airplane in the shortest distance, having less reserve energy helps reduce float and you can bring the airplane to a stop in significantly less distance at the slower touchdown speed. On the other hand, flying this type of approach requires precise technique, and with less float don't expect a buttery smooth touchdown. Short field landings are often firm arrivals. Follow the recommended speeds and procedures found in your airplane's operating manual.

BUILDING GOOD HABITS

Good energy management is important when flying any airplane. Countless accidents have occurred in light single-engine airplanes because of poor energy management. The heavier the airplane, the more time and altitude it takes to recover from a low energy state. This is why building good energy management habits early on will form a good foundation for later. Because swept-wing aircraft have poor low-speed handling characteristics, and because jet engines experience a lag when going from low power to high power settings, good energy management becomes extremely critical. If you let the airplane get too slow, with a high sink rate, there simply may not be enough altitude to recover.

STABILIZED APPROACHES AND RECOMMENDED AIRCRAFT PROFILES

Energy management is accomplished by flying a stabilized approach, and by using a recommended profile for the aircraft you are flying. Let's take the profile first.

Flying a profile is defined as using predetermined power settings, and making incremental configuration changes—such as flap and landing gear settings—at specific points during the approach. Established on the final approach segment, you should be fully configured, meaning the power is set, you have your final flap selection, the landing gear is extended if it's retractable, and the airplane trimmed for the appropriate speed.

SOME PILOTS GET INTO THE HABIT OF AUTOMATICALLY ADDING 10 OR 20 KNOTS TO THE RECOMMENDED APPROACH SPEED, PERHAPS BECAUSE OF FEAR OF STALLING. ARBITRARILY ADDING EXTRA SPEED IS NOT GOOD ENERGY MANAGEMENT.

Each aircraft will have a separate profile for a visual approach, a precision instrument approach, and a non-precision approach.

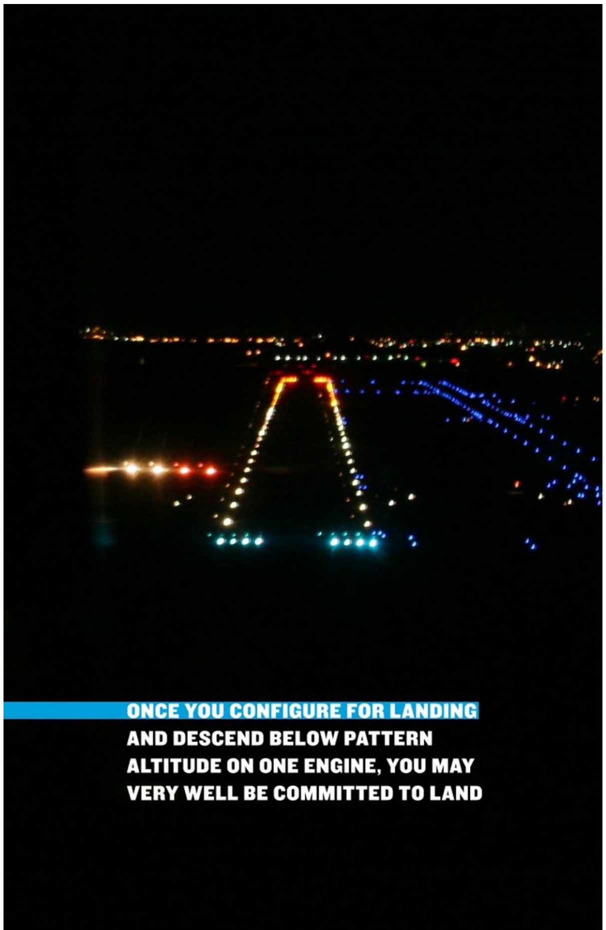
Flying a profile helps you manage energy because for a given power setting and configuration (landing gear and flap setting), the airplane will give you a predictable speed and rate of descent. This is true whether you are flying a Cessna 150, a Learjet, or a Boeing 777. The profile gives you a baseline to start with. Then you only need to make very minor corrections as needed.

A stabilized approach is defined as an approach where you maintain a constant angle glide path toward a predetermined aiming point on the landing runway, at a constant approach speed, descent rate, and configuration during the final stages of an approach. In visual conditions, if you are not stabilized by the time you are 500 feet above the touchdown point, go around. In low visibility conditions where you are flying on instruments, be stabilized no later than 500 feet above the published minimums for the approach you are flying. If not, immediately initiate a missed approach.

AIMING POINT AND GLIDE PATH

The aiming point is the point where the aircraft's flight path will intersect the runway if you were to fly into the ground without flaring. The true aiming point will appear stationary in the windshield as you approach. Points before the true aiming point will appear to move down in your field of view, and points beyond the true aiming point will appear to move up. If the point you are looking at appears to move, then this is not the true aiming point. For instance, if you are focused on a particular point on the runway and it appears to move up in your field of view, you will arrive short of that point. If it appears to move down, you will arrive beyond that point.

The runway itself appears to be in the shape of a trapezoid. If your glide path is at a constant angle, this shape will not change—it simply appears to grow larger. If you descend below the proper glide path, the shape of the runway will appear to shorten and become wider. If you move above the proper glide path, the shape of the runway will appear to get longer and narrower.



ONCE YOU CONFIGURE FOR LANDING AND DESCEND BELOW PATTERN ALTITUDE ON ONE ENGINE, YOU MAY VERY WELL BE COMMITTED TO LAND

Many runways also have lighting systems that indicate if you are on the proper glide path. When approaching to land during instrument meteorological conditions (poor or no visibility), you will use your instruments to determine if you are on the proper glide path.

If you are below the glide path, pitch up slightly and add a small amount of power. If you simply pitch up without adding power, your airspeed will decay, which is poor energy management. Of course, if you are too low and too fast at the same time, then pitching up without adding power may be appropriate. By trading airspeed for altitude, you fix two problems with one action.

On the other hand, if you are too high on the glide path, you need to pitch down slightly and reduce the power at the same time. If you pitch down without reducing power, your airspeed will increase, again not good energy management.

GO-AROUND

There is a practical limit to how much you can correct without gaining airspeed. If you find yourself unable to correct without gaining airspeed, the correct action is to go around. There is absolutely no shame in doing so. In fact, making the decision to go around is part of professionalism. You should also abandon the approach and go around anytime you are descending at a rate of more than 1,000 fpm. Such an approach is no longer stabilized. Failure to do so puts you at a much higher risk. Crashing into the runway is generally frowned on. Every airplane also has an appropriate profile for a go-around. The main idea is to promptly set power for the climb, reduce drag by retracting landing gear and flaps as appropriate, and so forth. Follow the recommendations of your aircraft's POH.

ONE-ENGINE OUT

If you are approaching to land in a twin with one engine inoperative, the same principles of flying a profile and keeping the approach stabilized apply—in fact, it is even more critical that you do so. You will need more power on the operative engine during the approach and you will probably want to configure the inoperative engine to reduce drag by feathering the propeller. You may also want to delay final flaps until you are sure that you can make it to the runway. Better yet, consider landing with approach flaps only. You also need to know if your airplane is capable of a single-engine go-around under the current conditions and at your current weight. Even if it is, once the gear is extended and final flaps are lowered, the vast majority of light twins cannot execute a go-around at that point. Once you configure for landing and descend below pattern altitude on one engine, you may very well be committed to land. Mentally prepare yourself for that inevitable fact.

IN SUMMARY

Managing energy during approach and landing means managing airspeed, altitude, drag, and thrust—keeping them properly balanced. This is accomplished by flying a profile and a stabilized approach, and by being willing to go around if the approach is not stabilized. Don't let anyone or anything make you feel less of a pilot for going around. Doing so when appropriate demonstrates your professionalism.

Mark Henshall *is an ATP, CFII, MEI and former airline pilot with 4385 hours, and 2115 dual given.*

FLYING A PROFILE HELPS YOU MANAGE ENERGY BECAUSE FOR A GIVEN POWER SETTING AND CONFIGURATION (LANDING GEAR AND FLAP SETTING), THE AIRPLANE WILL GIVE YOU A PREDICTABLE SPEED AND RATE OF DESCENT.

ENERGY MANAGEMENT CONCEPTS QUIZ *(answers on last page)*

1. GOOD ENERGY MANAGEMENT DURING THE APPROACH TO LAND INVOLVES

- **A.** Flying at the correct airspeed
- **B.** Flying the correct glide path
- **C.** Eating a candy bar right before landing
- **D.** a and b

2. GOOD ENERGY MANAGEMENT DURING THE APPROACH TO LAND IS IMPORTANT BECAUSE

- **A.** Having too little energy carries a risk of stalling
- **B.** Hyperactive pilots talk too much on the radio
- **C.** Having too much energy carries a risk of running off the end of the runway
- **D.** a and c

3. THE MANUFACTURER'S RECOMMENDED APPROACH SPEED IS

- **A.** A number that should be memorized and blindly flown at all times regardless of the circumstances
- **B.** An arbitrary number some chap in the marketing department made up
- **C.** A good balance between too little reserve energy and too much reserve energy
- **D.** Stupid because real pilots can approach at any speed they want

4. AUTOMATICALLY ADDING EXTRA AIRSPEED TO EVERY APPROACH WITHOUT GOOD REASON IS

- **A.** Good energy management
- **B.** Bad energy management
- **C.** A personal matter that is none of your instructor's business
- **D.** There is no such thing as bad energy

5. DURING GUSTY WIND CONDITIONS, IT IS RECOMMENDED THAT YOU

- **A.** Add half of the peak gust speed to your normal approach speed
- **B.** Add the gust factor to your approach speed
- **C.** Subtract the gust factor from your approach speed
- **D.** Add half the gust factor to your approach speed

6. SHORT FIELD APPROACHES ARE SOMETIMES FLOWN AT A SLIGHTLY SLOWER AIRSPEED

- **A.** To allow more room for error
- **B.** So that there is less reserve energy to dissipate during the flare and during braking
- **C.** Because that's how Wilbur Wright would have done it
- **D.** a and b

7. WHAT DOES IT MEAN TO FLY A PROFILE FOR THE APPROACH?

- **A.** It means flying an approach with predetermined power settings, and predetermined configuration changes at appropriate points during the approach
- **B.** It means flying the approach at a predetermined airspeed only
- **C.** It means flying the approach at an altitude that allows for recovery from a low energy state
- **D.** It's not PC because that is pilot profiling

8. WHAT DOES IT MEAN TO BE STABILIZED FOR AN APPROACH?

- **A.** It means remaining on proper speed, on proper glide path, with a constant descent rate, and with the airplane configured appropriately
- **B.** It means talking to an approach counselor to evaluate your mental fitness for the approach
- **C.** It means using a constant power setting for the approach
- **D.** It means using an autopilot to fly the approach

9. AN APPROACH PROFILE FOR YOUR AIRPLANE

- **A.** Can never be changed or altered
- **B.** Can be adjusted for current conditions, like gusty winds or a short runway
- **C.** Isn't available, so disregard
- **D.** Should be cobbled together from hangar talk and rumors about the airplane's flying qualities

10. ON FINAL APPROACH, YOUR DESCENT RATE IS GREATER THAN 1,000 FEET PER MINUTE.

- **A.** Add power only to correct
- **B.** Pitch up only to correct
- **C.** Add power and pitch up to correct
- **D.** Your approach is not stabilized, you should go around

11. GO-AROUNDS

- **A.** Are an indication that you screwed up
- **B.** Are an indication that you made a mature, good decision when the approach wasn't going well
- **C.** Real pilots don't go around
- **D.** a and c

WE WANT TO HEAR FROM YOU!

BE SURE TO EMAIL YOUR QUESTIONS, COMMENTS, AND GENERAL FEEDBACK TO: **CFINEWSLETTER@AOPA.ORG**

ENERGY MANAGEMENT QUIZ ANSWERS

(Questions on pg 11)

1. D	5. D	9. B
2. D	6. B	10. D
3. C	7. A	11. B
4. B	8. A	

WHY TALK TO ATC?

IN THIS EPISODE, AIR TRAFFIC CONTROLLERS EXPLAIN WHY WE SHOULD TALK TO THEM even when we don't have to (**airsafetyinstitute.org/askatc/talk**). Share this and other Ask ATC videos with your students.

Do you or your students have ATC questions you'd like answered? Send your question to ***CFInewsletter@aopa.org***.

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