Lesson 2: Shortfield Takeoffs and Landings

Fly This Lesson Now

by Rod Machado

Years ago, there was a story circulating about a pilot who certainly wasn't the sharpest knife in the drawer. Supposedly, in the heat of confusion while approaching an airport, this guy landed across (or perpendicular) to the runway centerline. After a massive application of brakes, the bewildered pilot came to a stop, looked around and said, "Wow! Look at how short this runway is." Apparently his passenger glanced right then left and replied, "Yeah, and look how wide the thing is, too."

Not all pilots are created equal, nor are all airports created equal. Some have runways more than 10,000 feet in length, while others are stunted at just a little more than 1,000 feet long. Some are hard surfaced, some are made of grass, some are narrow, and some are even wide (but not that wide, thank you). As a pilot, you'll need to know how to take off and land on the short ones, since the longer ones will seldom pose any kind of problem.

That's what this lesson is about. I plan on showing you how to perform something known as a *short field takeoff* and a *short field landing*. This will be done at a little airport in the state of Washington known as Cashmere. Cashmere has a short runway that's approximately 1,800 feet long. I don't know why it's so short...probably because there's just not enough room to make it longer.

Just so you'll have a big picture idea of how this lesson will work, here's a quick overview. You'll start with the Beechcraft Baron 58 holding in position on the very beginning of Runway 7 at Cashmere. Off the end of the runway, you'll see many tall trees and some mountains (Figure 2-1).

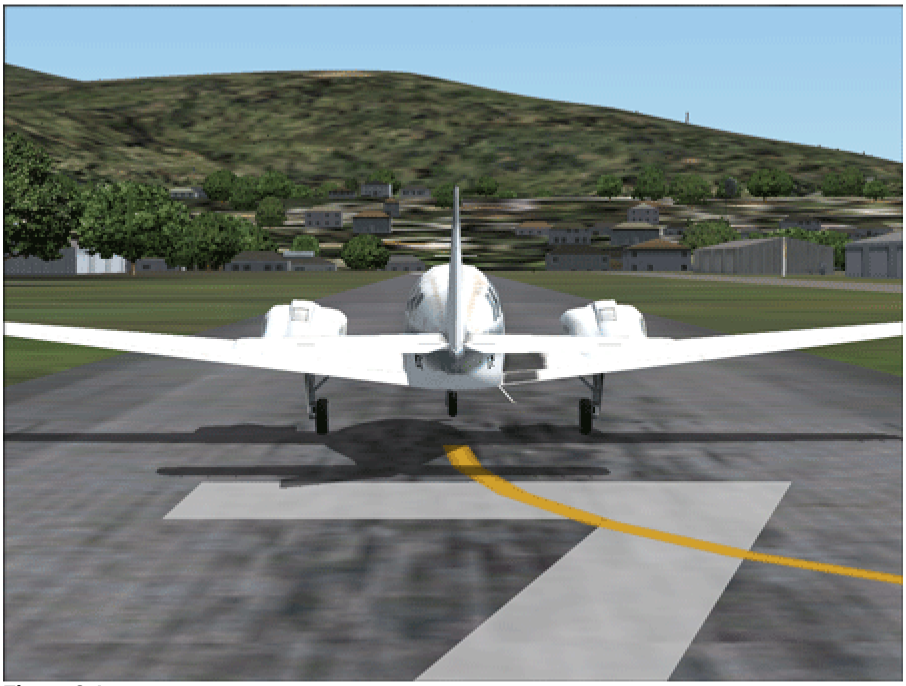


Figure 2-1

You may want to put your hands over your eyes just to keep from seeing these things, but I'll gently remind you that it's difficult to take off without using your hands. You'll depart, using short field takeoff techniques, fly a left hand traffic pattern then return for a short field landing on Runway 7. You'll understand why we use short field landing techniques when you have a chance to view the precipitous terrain along the final approach area (Figure 2-2).

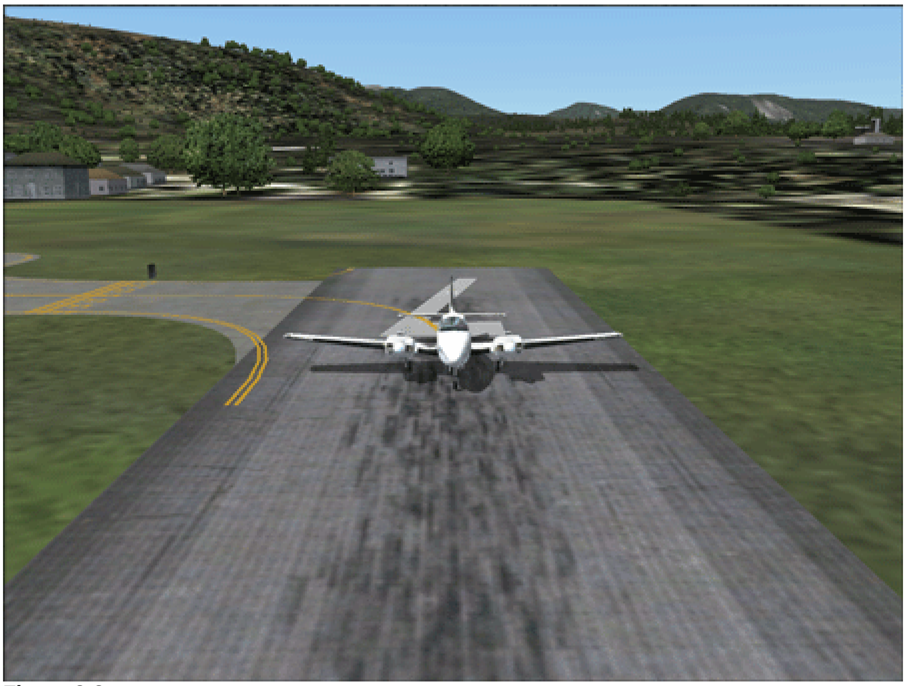


Figure 2-2

That's the basic idea, so let's get started.

Short Field Takeoffs and Climbs

Short field takeoffs are normally associated with an obstacle or obstacles located off the departure end of the runway. This certainly is the situation in Cashmere. The runway there is only 1,800 feet long and it looks like someone planted quite a few big trees along Runway 7's departure path, too. Therefore, you'll want to use all of the available runway for departure, meaning that we'll start at the very beginning of the runway. I've already made this possible by placing you right near the threshold for this departure.

Of course, before any departure, you'd check the performance charts for your airplane to ensure that a takeoff is actually possible on the chosen runway. I've already done this for you. Since you're departing into a 15-knot wind, my calculations indicate that the Baron needs approximately 1,600 feet of horizontal distance to accelerate, lift off, and climb to 50 feet. This is enough performance for a departure out of Cashmere, given that the temperature is pretty much standard today. Since it's not too cold today, you needn't worry about wearing your special sweater for departure, otherwise known as the *Cashmere sweater*.

Once you've completed the takeoff checklist and are ready to depart, you'll begin the takeoff by holding the brakes and applying full power. No, you don't actually try and take off this way. You do this because it allows you to develop maximum static rpm before beginning the takeoff roll. The net result is that you obtain greater acceleration and use less runway during the ground roll. Once your rpm is at a maximum, release the brakes and keep the airplane along the runway centerline.

The Best Angle-of-Climb Speed

Speed is your next concern. The Baron's operating reference notes indicate that you should climb at a speed known as Vx, or best *angle-of-climb* speed, when making a short field takeoff. Vx is the speed that allows the airplane to gain the most altitude for a given distance over the ground. If it doesn't cause traumatic flashbacks for you, then think back to geometry class. The greatest vertical gain in altitude for a given horizontal distance means the greatest angle of climb as shown in Figure 2-3. The best angle-of-climb speed in the Baron is 92 knots.

Figure 2-3

If you wait until reaching 92 knots before you rotate, you'll waste valuable runway space during takeoff roll. This means you might run a tire through a bird's nest located in one of those distant trees. Of course, no one (not even the birds) would like to see to see a giant tire crashing through their house and turning their kids into scrambled eggs. That's why you want to rotate about 5 knots below Vx. As the airplane rotates, it is still accelerating, therefore, rotating a few knots below Vx allows the airplane to be at Vx when the rotation is complete. This maximized the short field takeoff efficiency. So plan on rotating at 87 knots (Figure 2-4) and raise the airplane to a pitch attitude that produces a 92 knot climb (Figure 2-5). Because of my psychic ability (not *psychotic debility*), I predict that this attitude will be 18 degrees pitch up. The fact that I've done this a billion times really helps with the psychic ability, too.

Figure 2-4

Figure 2-5

(As an aside, since this is a multiengine airplane, you want to avoid rotating below the single-engine minimum controllable speed—84 knots, the low speed red line—whenever possible. As I mentioned in Lesson 1, an engine failure below this speed could result in losing control of the airplane.)

Once you're established in a climb at 92 knots I want you to raise the gear (a positive rate of climb is assumed here). This will help maximize your climb performance.

OK, there are actually two schools of thought on raising the gear during a short field takeoff. One school has it that pilots should leave the gear down until clearing the obstacle. The concern here is that fiddling with the gear handle is difficult for pilots who have difficulty handling multiple tasks—like climbing and raising the gear—on takeoff. The other school says that it's best to get the gear up to maximize climb performance, despite the fact that it places a task burden on the pilot. Because this is commercial training, I'm just assuming that you already have the skill to avoid being distracted by raising the gear handle soon after liftoff. Either way, it's best to do what your Pilot Operating Handbook (POH) suggests that you should do.

The Best Rate-of-Climb Speed

Once you're off the runway and clear of obstacles in your immediate departure path, there's no reason to continue climbing at Vx. After all, this attitude doesn't allow you to see much over the airplane's nose (Figure 2-6).

Figure 2-6

Considering how formidable those trees looked off the end of the runway, not seeing any other trees might seem like a good thing. It's not. That's why I want you to lower the nose and climb at a new speed called Vy or the *best rate-of-climb* speed.

Vy is a speed that gives you the most altitude gain for a given amount of time. In other words, it's the speed that results in the greatest upward deflection in the needle of your vertical speed indicator as shown in Figure 2-7.

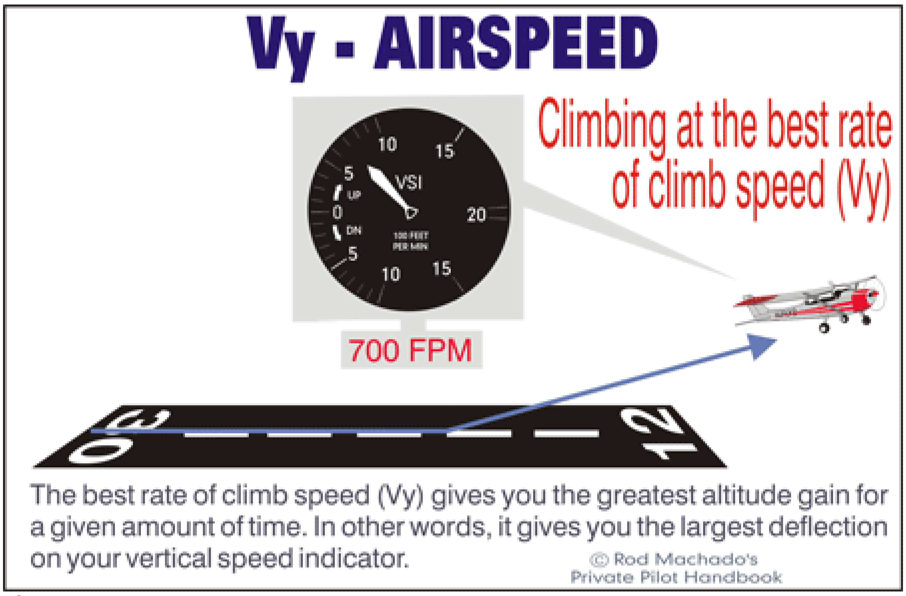


Figure 2-7

Vy in the Baron is 105 knots (Figure 2-8).

Figure 2-8

This speed will get you to traffic pattern altitude in the shortest period of time. Figure 2-9 shows the difference between Vx and Vy.

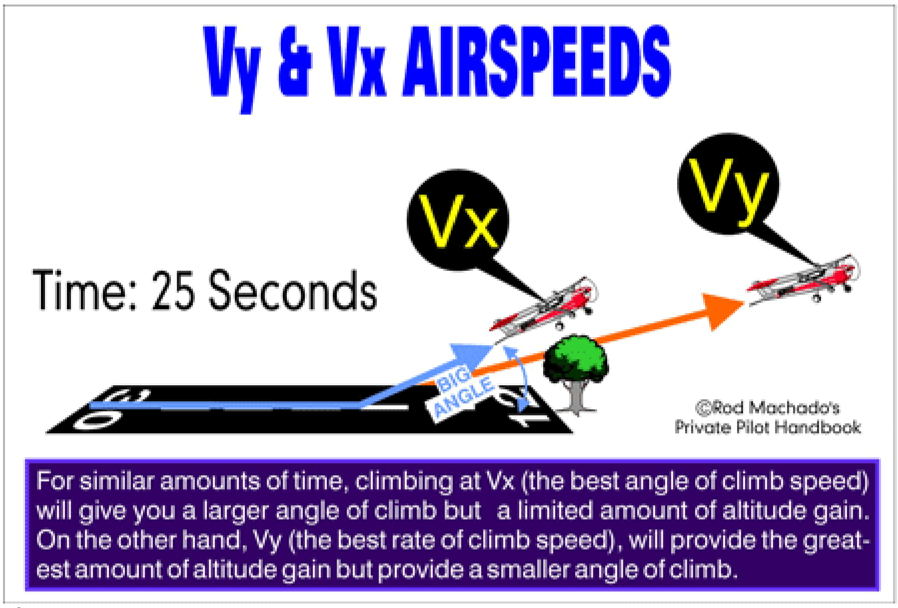


Figure 2-9

As a memory aid to help you remember the difference between the best *angle-of-climb* and the *best rate-of-climb* speeds, just ask yourself which speed, Vx or Vy, has the most angles associated with the letters that make it up. Obviously the "x" has more angles than the "y".

Maneuvering to the Downwind Leg

Once established at 105 knots climb speed, you'll continue your climb to a safe maneuvering altitude of 2,000 feet MSL, which puts you a little more than 1,000 feet above ground level at Cashmere (although we used 500 feet AGL as a safe maneuvering altitude in Commercial Lesson 1, we're in mountainous area now. Therefore, I prefer using twice that—1,000 feet AGL—as our safe maneuvering altitude). At 2,000 feet MSL, you should reduce your manifold pressure and rpm to the climb setting of 25 inches and 2,500 rpm. I know you won't forget to reduce the manifold pressure first before making an rpm reduction (Remember, I'm psychic, and I just had a premonition that you won't forget this).

During the first portion of this lesson, if you didn't quite clear the trees off the end of the runway, I'll gently mention it to you. After all, you're busy flying and may not have noticed that you've uprooted a Douglas fir and are now dragging around the traffic pattern with you. This could prove to be very embarrassing for you. The other pilots at the airport are sure to think that you prefer a more life-like air freshener rather than the little, green, paper-tree type that normally hangs from the compass. If you knocked over a few trees on takeoff, consider this the subtle clue that an improvement in your short field technique is in order on a subsequent lesson.

The traffic pattern altitude (TPA) at Cashmere actually is 1,650 feet MSL. Unfortunately, we can't use this altitude for training purposes. Because it's difficult to divide your attention between the panel and your outside view, I need you to use a higher traffic pattern altitude of 3,500 feet. There's nothing wrong with this, either. Pilots often use higher pattern altitudes when flying bigger and faster airplanes. So plan on turning your crosswind leg at an altitude of 2,500 feet and leveling off at 3,500 feet.

Turning crosswind requires turning left to a heading of 340 degrees (Figure 2-10). During the turn, I want you to limit your bank angle to no more than 20 degrees. I know I can bank on you to do this. And you can take that to the bank.

Figure 2-10

It's likely that you'll reach TPA on the crosswind leg. If you do, I want you to lower the nose and reduce power to 19 inches of manifold pressure (Figure 2-11). This will keep your airspeed from increasing and intimidating all the slower airplanes that may be in the pattern. (This is especially important if you're dragging that tree around the pattern.)

Because you're operating in a hilly environment, I want you to turn onto the downwind leg before flying too far away from the airport. That's why I'll provide you with a verbal cue when to turn downwind during this lesson. When I do, you'll turn left to a heading of 250 degrees. Additionally, you want to fly the downwind close enough to prevent the hills from obstructing your view of the runway.

As I've previously mentioned, it's always best to have the gear extended by the time you're flying downwind. This helps prevent the overtaking of slower airplanes in the pattern as well as helping ensure that you'll land with the gear down. So, as soon as you're established on the downwind leg, lower the gear.

At any time during this lesson you can press 1, 4, or 7 on your numeric keypad to look for, or at, the runway. (Make sure the **Num Lock** light is off.)

Figure 2-11

Feel free to use your GPS to help keep you oriented to the runway. I want you know where that runway is at all times.

Up to this point, you've experienced what it's like to make a short field takeoff over an obstacle. Now it's time to prepare for the short field landing over an obstacle as I have you maneuver to landing on Runway 7 at Cashmere.

Short Field Landings

Short field approaches and landings are used at airports equipped with relatively short landing areas or obstacles that may litter the final approach path. Given that you are flying a twin-engine airplane that requires more runway than most single-engine airplanes, you can certainly consider Cashmere airport to be worthy of short field landing procedures. The rather steep terrain found along the final approach path also suggests the use of obstacle clearance procedures on final approach.

As with all landings, you'll want to make sure that the landing performance charts indicate that a safe landing is possible at any airport before you even contemplate doing it yourself. Although this lesson doesn't include a discussion of performance charts, I've done the calculations for you. Given the 15-knot headwind and 1,800 foot runway length, Cashmere, you should have no difficulty making a safe landing on Runway 7, according to my figures.

The question is: how do you go about landing on a short field and what, if anything, makes these types of landings more critical than say landing on a runway of normal length? Good question. I'm glad you asked it. Perhaps you are psychic, too. If not, then we always have an opening for a good sidekick. Let's take the last question first.

Short field landings are accomplished at the slowest reasonable approach speed for the particular airplane being flown. This assumes, of course, that the airplane being flown at this slow speed can actually land safely at this airport. Not all airplanes qualify. That's why you shouldn't be landing a jet at Cashmere. No matter how slow you fly a jet, it's probably still too fast to get it safely into airports like this. And even if you did mange to get it into Cashmere, it's unlikely you'll get it out. You won't have this problem in the Baron because you can make an approach at a relatively slow airspeed. In your case, the Baron's POH recommends that you use a speed of 97 knots with 30 degrees of flaps for a short field approach.

Flying at 97 knots keeps you above the Baron's single-engine minimum control speed (just in case one of your engines decides to go on vacation). And 97 knots also allows you to come to a complete stop, with the judicious application of brakes, before running out of asphalt (which keeps you from being "at-fault" for bending an airplane). The only concern is that 97 knots also places you at only 30 percent above the airplane's stalling speed. That's why you want to use the proper landing technique on final. You certainly don't want *this* final to be *your* "final" final, right? What technique should you use to maintain your speed and control your glide path? I know you won't say, "Ahhh, the technique of letting the instructor fly." Here's a recommendation:

How Navy Pilots Avoid Walking on Water

U.S. Navy pilots are required to be good at making short field landings. That's because the field they land on is less than 1,000 feet in length. That field is called an *aircraft carrier*. What makes these pilots so competent is that the runway they're trying to land on is often moving. No, the captain of the ship isn't trying to get away from the pilots, either (practical jokers though those captains often are). The ship moves to generate a headwind for landing, resulting in a shorter landing distance for the pilot. This is a good thing since a running off the end of that particular runway means being run over by the airport. That has got to hurt.

Navy pilots use their elevator to maintain precise control of the pitch attitude, and thus their airspeed. They use their throttle to control their rate of descent. Although you can certainly switch the way you use those controls (just as we do when flying an ILS), let's use the Navy's technique here. After all, if this technique can get a pilot on a boat, it ought to be able to get you down at Cashmere without bending any part of the airplane.

Here's how you should fly a short field approach beginning from the downwind leg.

Flying the Approach

While on the downwind leg, you should have the gear lowered and power reduced to 19 inches of manifold pressure. At this point, you should further slow the airplane down to 110 knots by initially reducing the manifold pressure to 15 inches. Make sure you hold the desired TPA of 3,500 feet as you're slowing down. This means you may need some nose up trim, so be generous with the movement of that trim switch.

As long as your speed is below 152 knots, you can apply the first 15 degrees of flaps, otherwise know as the APR or the *approach flap* setting. You should have approach flaps set with an airspeed reading of 110 knots by the time the runway threshold is 45 degrees to the left of the wing. This is the standard runway position reference that cues you into when to begin your turn to base leg (traffic permitting, of course). Feel free to use your numeric keypad, your joystick hat switch, or your GPS to identify when the runway threshold is 45 degrees to the left of the wing. When you're at this reference point, turn left to a heading of 160 degrees and fly the base leg (Figures 2-12a and 2-12b).

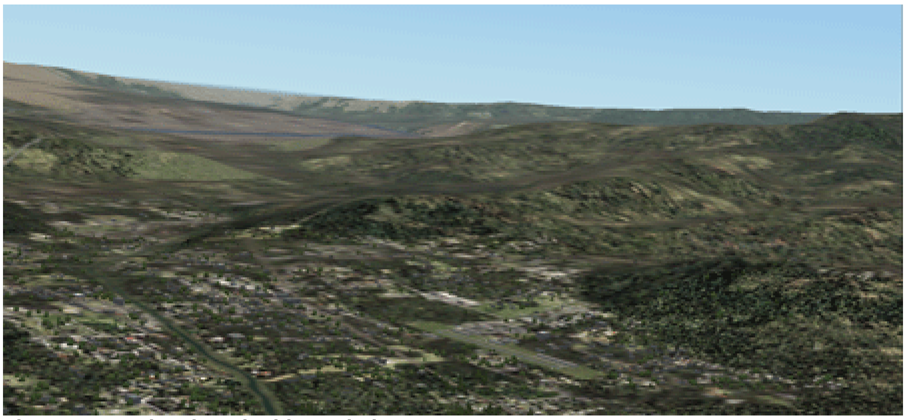


Figure 2-12a View from inside cockpit.

Figure 2-12b Exterior view.

Once you're established on base leg, you should be in a position to begin your descent. Start by reducing your manifold pressure and configuring the airplane for landing by adding full flaps. There are two reasons for adding full flaps here. First, this allows you to make a relatively steep descent over any obstacles. Second, it allows the airplane to safely fly at a slower speed, which results in touching down at a slower speed. That means you'll be able to stop sooner on the runway, which is what this lesson is all about (no, putting the right foot in and putting the right foot out isn't what it's all about, either).

When you're in position to do so, you'll turn final onto Runway 7. (Feel free to use your keypad, hat switch, or GPS to help you determine when to make this turn as shown in Figure 2-13).

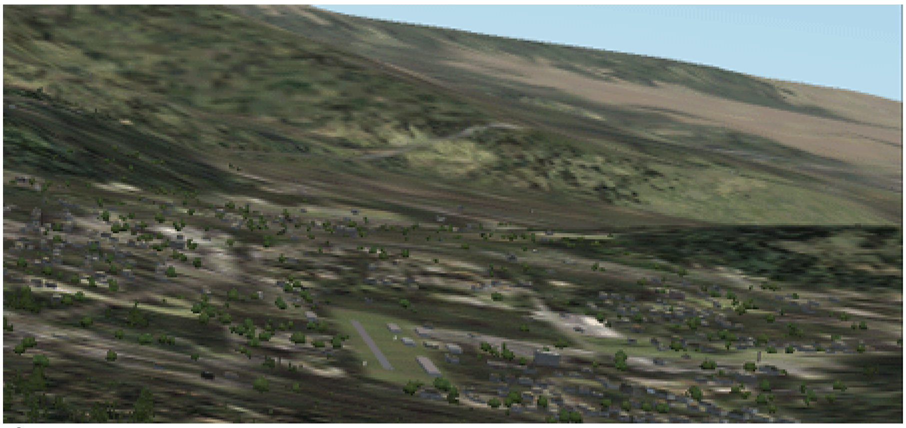


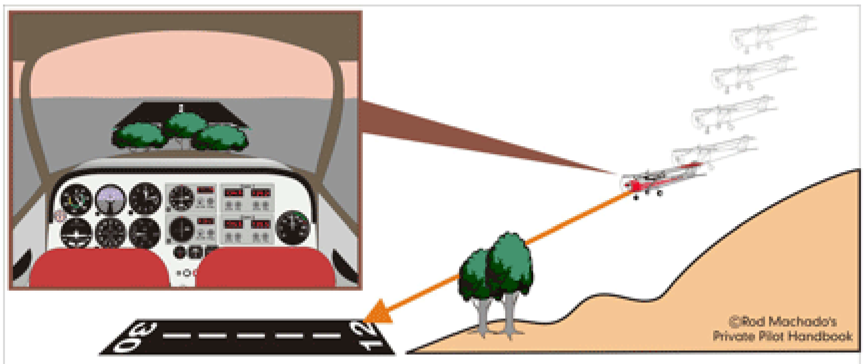
Figure 2-13

Once you're established on final approach, you should slow the airplane down to 97 knots and trim for a stabilized descent. Now you're ready to begin the most important part of the short field landing. This is the part where you modify your approach path to ensure that you clear obstacles (if any) and the airplane lands as close to the runway threshold as possible.

Finally, the Final

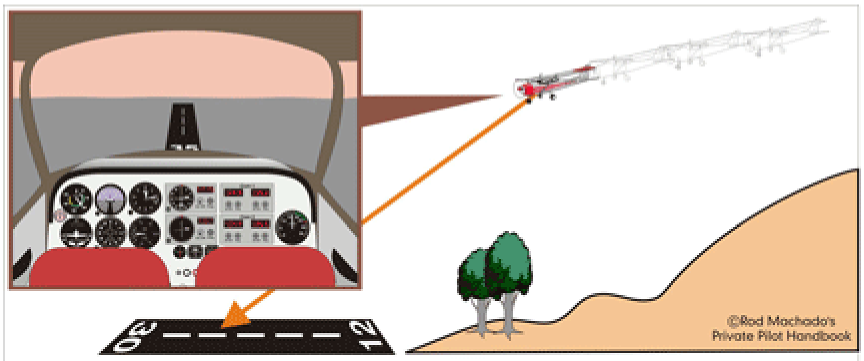
When you turn final with the airplane configured for landing, you should be at least 500 feet above the touchdown area (airport elevation is a satisfactory reference here). You'll need at least 500 feet to determine the airplane's current glide path, make corrections, and estimate whether or not the short field landing will be a success. After this determination, if your approach didn't look good for the home team (this means you), you should go around and try it again.

The objective is to avoid descending too quickly as shown in Figure 2-14 or not descending quickly enough, as shown in Figure 2-15.



Descending too quickly on a short field approach might prevent clearing obstacles in the final approach path.

Figure 2-14



Not descending quickly enough on a short field approach could result in a long landing, possibly running off the end of the runway.

Figure 2-15

If you descend too quickly, you'll never clear the obstacles on final, much less land on the runway. Not descending quickly enough results in landing long. This is why you turn onto final with at least 500 feet of altitude above the touchdown area. Since the short field final approach is usually flown with a little bit of power, you are now in a perfect position to make adjustments to your glide path as necessary to land as close to the runway threshold as possible.

Here's how to estimate if you're descending properly: While on final approach, with the pitch stabilized to give you 97 knots (meaning you've got the airplane trimmed properly), adjust the power to give you the desired glide path. If it appears that you'll cross any obstacles on final at an excessive altitude, resulting in a long landing without sufficient room to stop, then reduce power and lower the nose slightly. This control movement combination results in an increased descent rate while allowing you to maintain 97 knots. If it appears that you're descending too quickly and won't clear the obstacles on final, then increase your power and raise the nose slightly. This combination should decrease your rate of descent and help you maintain 97 knots. It's important to keep in mind here that being too low can result in your raising the nose and adding power while letting the airspeed decay dangerously close to stall speed. You can't let this happen. It's actually possible to end up low and sufficiently slow that it becomes difficult (if not impossible) to power yourself out of such a condition to make a safe go-around. Getting too slow means ending up on the back side of the power curve. Trust me when I say that you don't want to let your airspeed ever decrease below 97 knots until you're ready to do the roundout and landing flare.

How do you know if you're on a proper descent path? The same principles you learned in earlier landing lessons still apply here. Remember, you're using runway geometry, peripheral cues (which are hard to identify in a simulator) as well as the VASI lights available on the runway. Oh, I didn't mention the VASI? Well, it's there so use it to help keep you on the proper glide path. The particular type of VASI available to you is known as a PAPI or Precision Approach Path Indicator (Figure 2-16).

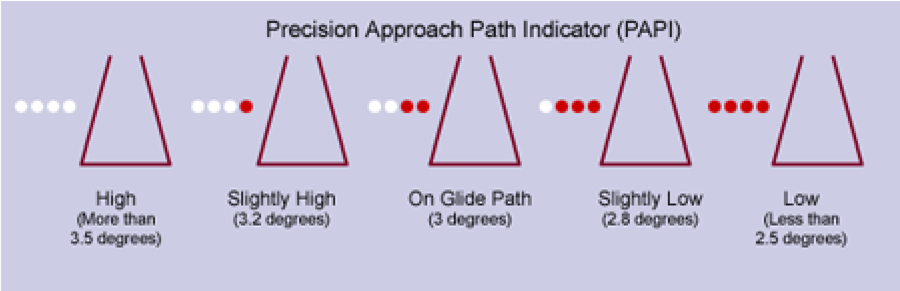


Figure 2-16

Since this is a short field approach, I suggest you use the *slightly high* PAPI light arrangement to fly this approach. This should help keep you above the obstacles along the final approach.

Keep in mind that this is still a complex airplane and you should always do your "GUMP" verbal check on final to ensure the airplane is properly configured for landing. Landing with the gear up will certainly get you points for making the shortest possible landing. It won't, however, get you points for keeping the airplane in flyable condition.

It's also important to remember that you're making the final approach at a steep angle and close to the airplane's stalling speed. As a result, once you're clear of any obstacles and ready to begin the roundout and flare for landing, you must be careful not to fly the airplane right into the ground or stall it onto the runway. Since you're close to the stall speed, a reduction in power will most likely result in an additional speed reduction followed by an increase in sink rate. Therefore, when you're ready to roundout and flare the airplane, you'll want to reduce power gradually and be prepared for a larger rearward movement of the elevator control. You certainly don't want to reduce power prematurely and flare at too high an altitude. This will result in an excessive sinking feeling and not only get you onto the runway, but possibly *into* it as well. If the reduction of power and the flare results in little or no floating, then your approach and airspeed control were excellent. Floating during landing is one sign that you had excessive airspeed on final.

If you performed the touchdown correctly, there should be little or no floating during the roundout and flare. Touchdown should occur near the airplane's stall speed with a pitch attitude similar to what you'd experience in a typical power-off stall. Upon touchdown, you should gently lower the nose and apply brakes, all the while increasing back pressure on the elevator to prevent the nose gear strut from experiencing excessive pressures. The objective is to stop the airplane within the shortest distance possible without harming the airplane.

That's the basic idea behind short field landings. Of course, if there are no obstacles on final, your only objective is to get the airplane on the very beginning of the usable landing surface. These types of landings don't normally require a steep descent to clear obstacles, since there are no obstacles present. Practical experience will tell you that the runways are often short because obstacles prevent them from being longer. Cashmere is a good example. Therefore, where you have a short field, there's a good chance that you'll also have obstacles on final to make the landing even more challenging.

Now you're prepared for the flight lesson. Have fun! Click the **Fly This Lesson** link to practice what you've just learned.

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