Slip To A Landing

Objective

To ensure the applicant learns the purpose of and can exhibit a clear understanding of the slip to a landing maneuver and how to perform the maneuver properly.

Purpose

Sometimes pilots need to land an airplane immediately, and a go-around is not possible, for example, as during an engine-out emergency. Other times, a very steep descent may be needed to land in a very small field surrounded by trees. A forward slip to a landing is a tool which introduces forward slips, and how they can be used to lose altitude quickly without gaining excessive airspeed, as well as controlling the airplane during cross-controlled flight.

Schedule

- **Ground Lesson**: 15 minutes
- Initial
  - **Flight 1**: 40 minutes - *Introduction to Maneuver*
  - **Flight 2**: 50 minutes - *Improve Proficiency (Dual)*
- Solo
  - **Flight 3**: 30 minutes - *Improve Proficiency*
- Pre-Checkride
  - **Flight 4**: 20 minutes - *Demonstrate Proficiency*
- **Debrief**: 10 minutes (*per flight*)

Equipment

- Airplane POH and Checklist
- Whiteboard / Markers (optional)
- Model Airplane (optional)

Student Actions

- Ask any questions, receive study material for the next lesson.
- Watch linked video.
- Review listed references.

Instructor Actions

- Deliver the ground lesson (below).
- Demonstrate the maneuver in flight.
- Debrief after each flight.

Completion Standards

- **Ground**: Student can explain the purpose of the maneuver and how to execute it properly.
  - Can explain the forward slip, how to fly one and recover from one.
- **Flight**: Student can perform the maneuver to the applicable ACS standards.
  - Selects a touchdown point based on wind, landing surface, obstructions, and airplane limitations.
  - Performs a stabilized approach at published approach airspeed to a point on final above the normal glide path.
  - Transitions to a forward slip (correlated with wind direction) to descend more steeply to the runway.
  - Recovers from the forward slip and touches down safely at the designated touchdown point -0/+400 feet.
  - See expanded Completion Standards below.

References

- ERAUSpecialVFR - “Forward Slips”
  - YouTube - https://www.youtube.com/watch?v=yxy2MnUnfUM
- FAA-H-8083-3C (Airplane Flying Handbook) - Chapter 9, Page 12-13 [Intentional Slips], Chapter 9, Page 30-37 [Faulty Approaches and Landings]
- FAA-H-8083-25C (Pilot’s Handbook of Aeronautical Knowledge) - Chapter 5, Page 22-24 [Forces in Turns (Slips)]
- FAA-S-ACS-6B (Private Pilot ACS) - Area IV Task M
- FAA-S-ACS-25 (CFI ACS) - Area VII Task M

Ground Lesson Outline

- Slips to a landing can be a useful tool
- Slips
  - Forward slips vs side slips
  - Create drag
  - Inherently safe
  - Cause airspeed errors
- Entering a forward slip
- Correcting for wind drift
- Recovery
- Avoiding obstacles
- Slips should not replace a stabilized approach
  - Energy Management, Not a ‘band-aid’ for bad approaches
- Wake Turbulence
- Wind Shear
- Safety considerations
  - Use of checklists
  - Visual traffic scanning
  - Runway incursion avoidance
  - Windshear, Tailwinds, Wake Turbulence, Runway surface conditions
  - Be prepared to go around
- Maneuver Description - step-by-step
  - Entry position, airspeed, etc.
- Expanded Completion Standards

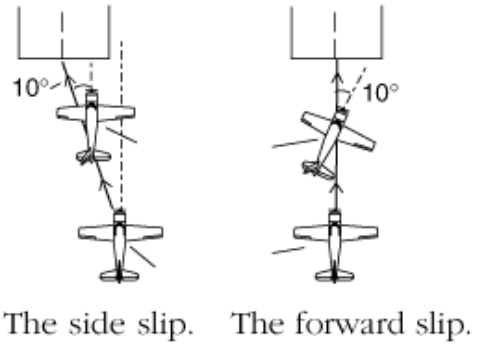
Common Errors

- Improper use of landing performance data and limitations.
- Failure to establish approach and landing configuration at appropriate time or in proper sequence.
- Failure to maintain a stabilized slip.
- Inappropriate removal of hand from throttle.
- Improper procedure during transition from the slip to the touchdown.
- Poor directional control after touchdown.
- Improper use of brakes (landplane).

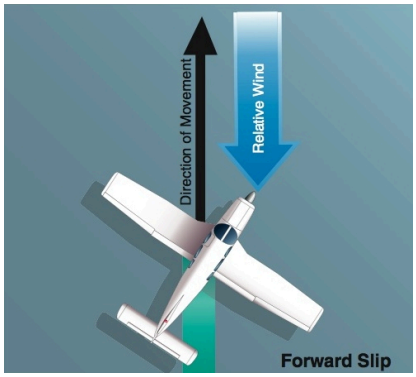
Ground Lesson Content

- **Slips to a landing can be a useful tool** - Although a conventional stabilized approach is generally preferred, forward slip landings can allow dramatically steep approach paths and are an important tool which pilots can use to perform landings that would otherwise be impossible.
    - **The most important use of a forward slip landing is in an emergency, where available landing area is very limited and a go-around is not possible.**
    - Forward slip landings can also be used to land on very confined airstrips that require excessively steep approach angles, or to briefly correct an approach which is too high.
    - When approaching a runway from a very high approach path, *if a go around is not possible*, a forward slip can allow the airplane to descend to a proper glide path without gaining excessive airspeed and causing floating or overrunning the available runway.

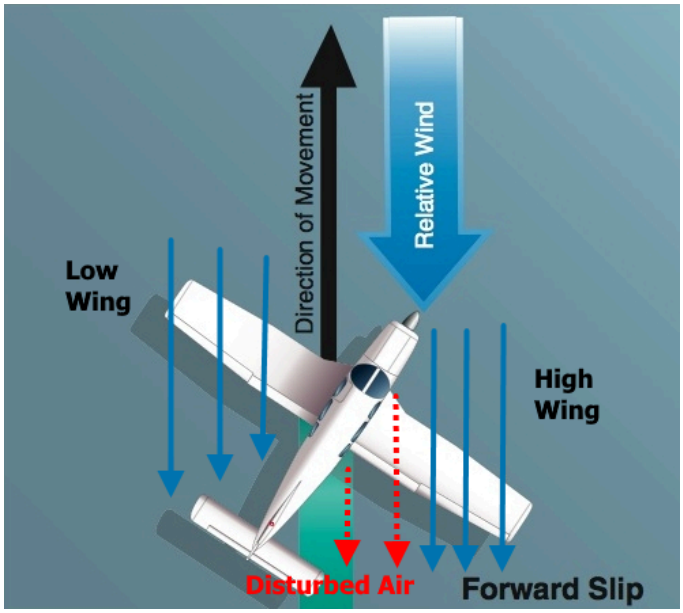
- Timing, judgment, and control procedure during transition from slip to touchdown.
- **Slips** - It is possible to fly an airplane such that it's nose points in one direction, but it flies through the air in a slightly different direction. This looks like a slight sideways motion (relative to the air), and is called a *slip*.
    - Slips happen when an airplane is banked, but the *rate of turn* is insufficient for the bank angle. Consider a normal banked turn, with the ball centered. The airplane will have a rate of turn which is related to the bank angle--*more bank, more rate of turn*. Normal turns require rudder to maintain the ball in the center.
    - **If, instead of applying rudder in the direction of the bank, the pilot does not use the rudder at all or applies rudder opposite the bank, the airplane will enter a slip.**
    - When in a slip, the airplane generally wants to return to normal flight, and pilots will have to hold opposite aileron and rudder controls to remain in the sideslip. This is called a *cross-controlled* condition.
    - The only difference between a *side slip* and a *forward slip* is the direction of travel along the ground. **Aerodynamically they are the same.**



The side slip. The forward slip.



- **Slips Create Drag** - The primary purpose of a *forward slip* is to generate drag. Specifically, by forcing the airplane to fly dramatically unaligned with the relative wind, the side of the fuselage of the airplane creates tremendous drag.
    - **The fuselage also blankets the other wing, and potentially the horizontal tail surfaces.**
    - Due to this drag, forward slips flown with fully crossed controls can generate **extreme rates of descent with minimal gains in airspeed.**
    - Because the primary purpose is the creation of drag, **it makes no sense to perform a forward slip when the power is not at idle.** Reducing power is the primary tool for slowing down and getting down. Engine power only opposes the drag created by forward slips.



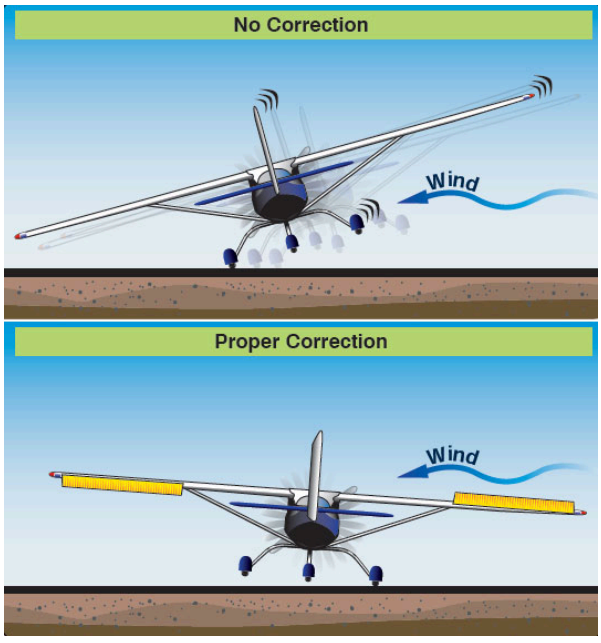
- **Slips Are Inherently Safe** - Because the airplane is banked towards the direction of travel, the high wing, away from the direction of the slip, flies with down aileron, at a higher angle of attack, and is blanketed by the fuselage. This blanketing may cause the high wing to produce less lift or even stall. However, if the high wing begins to stall, it will cause the bank to reduce, which naturally un-stalls the wing.
    - This naturally correcting tendency can be overcome, however, and so it is important that airspeed not be allowed to decay too much during a slip. **Forward slips should always be performed with the nose below the horizon to keep the airspeed from decreasing too much!**
- **Slips Cause Airspeed Errors** - Because airspeed is measured by comparing ram air pressure in a pitot tube, which normally points directly at the relative wind, with a static port, when flying in a slip

there is an inherent error in airspeed indication. This error can be even further exacerbated when the pitot tube is on the *high* side of the slip, which is flying in air disturbed by the fuselage. The position of the static port on the fuselage also affects the airspeed indications.
    - **The airspeed indicator should not be considered reliable during a slip!** Generally it will indicate lower than the real airspeed, however this is specific to each aircraft.
    - It is best if the airplane is properly trimmed to an appropriate airspeed before beginning the slip. Once the cross-controlled inputs are relaxed, the airplane will try to return to the previously trimmed airspeed.
- **Entering the Forward Slip** - Once the pilot has determined that a forward slip is necessary to lose altitude, **and reducing engine power or adding flaps or lowering landing gear is not sufficient**, the slip can be entered.
    - **Forward slips are entered by applying opposite aileron and rudder input**, and lowering the nose just below the horizon to prevent the airspeed from decaying excessively.
    - Although airspeed is difficult to judge accurately in a slip, a proper forward slip should not allow airspeed to build excessively either. **The point is to slow down, and get down.**
    - It is best to try to slip at approximately a normal approach airspeed.
    - When an airplane is landing with a crosswind, **it is best to slip with the airplane banked *towards* the direction of the wind**, so that recovery can transition seamlessly to a proper crosswind sideslip.
    - As the airplane flies in the slip, its ground track may be pushed left or right of course by the wind. Although the nose will not be pointing towards the runway, take note of the ground track. **Keep the airplane tracking straight towards the runway by varying the amount of bank.**
    - The amount of rudder determines the 'aggressiveness' of the slip. In a very aggressive slip, the airplane may 'run out of' rudder at some point. **When the airplane has 'run out of' rudder authority, it has reached the limit of it's forward slip capability.**
- **Recovery** - When the airplane has returned to the desired glide path, or once it has reached the roundout and landing flare, the cross-controlled inputs should be gently relaxed to recover from the slip.
    - The inputs should not be released suddenly, causing an upset.
    - As the airplane recovers to normal flight, it is possible that it will tend to balloon up, as it may have been flying at a higher speed than indicated.
- **Avoiding Obstacles** - Forward slip landings allow extremely steep landing approaches, which makes landing in very tight runway environments possible, however these environments are also frequently surrounded by tall trees, powerlines, terrain, or other obstacles which must be avoided.
    - Do not fly a curving or otherwise abnormal final approach. Try to make the approach as normal as possible.
- **Slips should not replace a stabilized approach** - Forward slip landings are a tool which should be used sparingly. **In most cases, rather than 'fixing' an unstable approach with a forward slip, it is safer to go around!**
    - It is useful to think about approaches in terms of **Energy Management**, where there is a fundamental difference between a *High Energy* and *Low Energy* approach, as these must be managed very differently. Slips are only applied in very high energy approaches, but these types of approaches have inherent risks!
        - See the lesson on *Area 10 (X) - Task B - Demonstration of Flight Characteristics at Various Configurations and Airspeeds* for more details on energy management.

- **Wake Turbulence** - Small airplanes are particularly vulnerable during takeoff and landing because they share the same runways as much larger, heavier aircraft. These aircraft can leave dangerous vortices behind them, called *wake turbulence.* These vortices begin at the wingtips of the heavier aircraft, tend to move with the wind, and gradually move apart and descend. **Therefore it is critical that when departing behind larger, heavier aircraft, sufficient time (usually 1-2 minutes) is allowed to pass in order to allow the wake turbulence to dissipate.**
    - When landing, wake turbulence of preceding airplanes can be avoided by remaining *above* the approach path of the heavier airplane.
- **Wind Shear** - Small aircraft are also particularly vulnerable to shifting wind directions, called *wind shear*. Because they are generally underpowered and cannot climb rapidly to safety, if an airplane is flying into a 10 knot headwind that suddenly dissipates or changes direction, it may end up in a situation where it descends rapidly and unexpectedly, and the angle of attack may increase to that of a stall.
    - When landing, large fluctuations (more than 5 knots) on the airspeed indicator are a warning sign of possible wind shear. **If you see large fluctuations in the airspeed indicator, go around!**
- **Safety Considerations**
    - As with any landing, the **use of checklists is important**. Before beginning the maneuver, the before landing checklist must be completed. After landing and rolling out to a safe point clear of the runway, the after landing checklist should be completed.
    - **All landings require caution for powerlines, tall trees, or other obstacles on final approach which may be near the runway environment.**
    - It is crucial to not become so focused on the landing that an unsafe situation is created. Maintain situational awareness, make appropriate radio calls, and ensure that landing clearance is obtained before landing. **Vigilance must be maintained after landing to avoid taxiing onto any intersecting runways beyond other hold short lines.** If there is a control tower, do not forget to contact ground control for taxi clearance after landing, and at uncontrolled fields, clearly communicate your taxi intentions on the radio. Remember that uncontrolled fields often have no-radio (NORDO) pattern traffic, so **always visually verify the runway and final approach path is clear!**
    - Maneuvering in the pattern at low airspeed creates a risk of a stalling situation. **If the stall warning sounds before the landing flare, go around!**
    - When executing any landing, there should be a point identified (*no further than the first 1/3 of the runway*) beyond which if the airplane has not touched down you will go around. If any unsafe situation develops, such as excessive ballooning or being blown off runway centerline, go around! **Always be prepared to go around!**
    - **Windshear, Tailwinds, Wake Turbulence** - During takeoffs and landings, we are operating near the ground at low speed. Pilots should exercise caution if there are indications of windshear, pay attention to situations where wake turbulence will be a factor. Additionally, taking off or landing with a tailwind creates a much higher ground speed, lengthening the ground roll, and increasing the danger.
    - **Runway Surface Conditions** - If the runway is wet or icy, it can be quite slippery, particularly in the touchdown zone where many preceding aircraft have deposited rubber. Exercise caution in these situations!

Maneuver Description

- **Selecting a Suitable Runway** - Select a runway that will allow landing into the wind, or with a manageable crosswind.
- **Selecting a Touchdown Point** - Select a prominent feature on the runway that is easy to identify from the downwind leg, and explicitly state it. Features like 1,000 foot markers, touchdown zone markers, or runway numbers are good choices. Until proficiency is developed, select a feature that is not directly at the start of the runway, in case of landing short.
- **Entry Position and Altitude** - The maneuver should be entered on a normal downwind leg, abeam the touchdown point, at normal pattern altitude.
- **Entry Airspeed** - Begin this maneuver at a normal traffic pattern airspeed, usually around 90 knots.
- **Checklists** - Pilots must perform a before-landing checklist before beginning the maneuver, and an after-landing checklist after taxiing safely clear of the runway, for full-stop landings.
- **Airspeed** - Airspeed should be kept at the approach airspeed designated by the POH, or slightly higher (add half the gust factor) to account for gusting wind conditions. *Be vigilant about maintaining airspeed, and if the stall indication is heard at any point before the final landing flare, discontinue the maneuver and go around!*
- **Bank** - Since this maneuver takes place in an airport traffic pattern and involves maneuvering at low speed and at low altitude, the bank angle should be *less than* **30 degrees**.
- **Approach Path** - Fly a normal, well-defined base leg and final approach segment. Avoid cutting the corners or overflying the final approach course.
- **Coordination** - The maneuver should be flown in coordinated flight. Attention should be given to proper rudder input during turns.
- **Touchdown** - Choose an aiming point such that the airplane will land *at, but not before*, the selected touchdown point. The landing should be at a proper nose-high pitch angle (*not on the nosewheel-- do not force it!*), safe, and under control. Positive aircraft control must be maintained at all times! **Apply *and hold* proper crosswind corrections to avoid sidewards drifting.**



- **After Touchdown** - Apply aerodynamic and wheel braking if making a full stop landing, or if making a touch-and-go, reconfigure the airplane for takeoff and apply full power promptly.
- **Be Prepared to Go Around!** The approach may not work out and a go-around is very possible. Be prepared to execute a go-around if needed.
- **This is a visual maneuver!** Eyes should remain outside the cockpit as much as possible to scan for traffic and ensure proper management of the approach path. *Monitoring for other traffic is especially critical when performing this maneuver at uncontrolled airfields.*

Expanded Completion Standards

- The pilot can explain the purpose of the forward slip to a landing maneuver and how the various factors affect the performance of the maneuver.
- The pilot can perform the maneuver to the following standards:
    - Pilot selects a runway suitable for the weather conditions, establishes the airplane on a downwind leg at pattern altitude, performs a pre-landing checklist, establishes a speed *below* **Va**, makes the appropriate radio calls, and designates a touchdown point.
    - At the normal abeam point on the downwind, the pilot closes the throttle, applies carb heat as necessary, and establishes a slow descent at the normal approach airspeed.
    - Pilot intentionally positions the airplane on final above the normal approach path, and transitions to a forward slip (correlated with the wind direction) to descend more steeply.
    - Pilot manages the forward slip and aims for a point so as to recover from the forward slip and make a safe, controlled landing **at or within 400 feet beyond the designated touchdown point**. (The pilot may not touch down before the designated point)
    - Pilot applies wheel and aerodynamic braking techniques.
    - Pilot divides attention between airplane control and outside visual references.
    - Pilot performs a timely go-around if the safe completion of the maneuver *within standards* is in doubt.