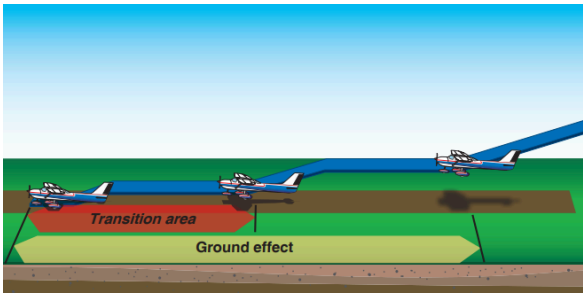
Soft-Field Approach and Landing

Objective

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

Purpose

The soft field landing maneuver is used when landing on grass or other soft landing surfaces. It demonstrates how the airplane needs to be handled differently on these high-drag surfaces. Mastering this maneuver will help pilots become comfortable operating to and from grass strips.



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 how the nose wheel is protected, flying behind the power curve, a stabilized approach, ground effect, and the soft field touchdown procedure.
- **Flight**: Student can perform the maneuver to the applicable ACS standards.
  - Performs a normal approach to land at published approach airspeed (or 1.3 Vso) +10/-5 knots.
  - Transitions into ground effect and safely touches down softly.
  - Holds the nose wheel off the ground during rollout and taxi.
  - See expanded Completion Standards below.

References

- MzeroA Flight Training - “Soft Field Landing”
  - YouTube - https://www.youtube.com/watch?v=FzOLrxwV6gc
- FAA-H-8083-3C (Airplane Flying Handbook) - Chapter 9, Page 23-24 [Soft-Field Approach and Landing], Chapter 9, Page 30-37 [Faulty Approaches and Landings]
- FAA-H-8083-25C (Pilot’s Handbook of Aeronautical Knowledge) - Chapter 11, Page 16-18 [Landing Performance], Chapter 11, Page 19-28 [Performance Charts]
- FAA Advisory Circular AC 91-79A (Mitigating Risks of Runway Overruns) - Page 8-9
- FAA-S-ACS-6C (Private Pilot ACS) - Area IV Task D
- FAA-S-ACS-7B (Commercial Pilot ACS) - Area IV Task D
- FAA-S-ACS-25 (CFI ACS) - Area VII Task D

Ground Lesson Outline

- What are Soft Field landings?
  - Protecting the nose wheel
- Importance of Estimating Field Conditions
- Airspeed Control and Trim
- Behind the Power Curve - Energy Management
- Importance of a Stabilized Approach
- Ground Effect
- Dangers of Floating
- Landing Performance
  - Density Altitude
  - Calculating landing performance data
  - Soft fields affect performance
- Safety considerations
  - Use of checklists
  - Visual traffic scanning - awareness of obstacles and field condition
  - Runway incursion avoidance
  - Windshear, Tailwinds, Wake Turbulence
  - 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 establish and maintain a stabilized approach.**
- Failure to consider the effect of wind and landing surface.
- Improper procedure in use of power, wing flaps, and trim.
- **Inappropriate removal of hand from throttle.**
- Improper procedure during roundout and touchdown.
- **Excessive airspeed or floating.**
- Failure to hold back elevator pressure after touchdown.
- Closing the throttle too soon after touchdown.
- **Poor directional control after touchdown.**
- **Improper use of brakes.**

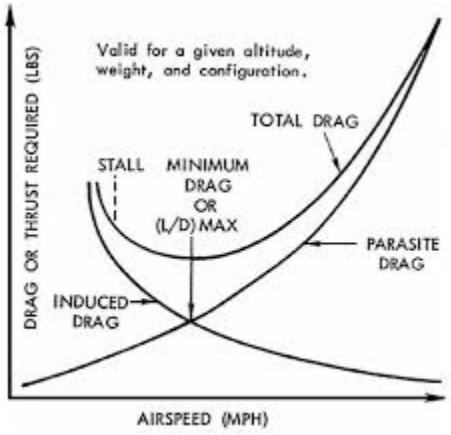
Ground Lesson Content

- **What are Soft-Field Landings?** - Landing on a grass or other soft-surface runway (*soft field*) has a few important differences from normal landings made on paved runways. Pilots may generally assume that paved runways are maintained in acceptable conditions, however soft fields have no such guarantees. Soft fields may be contaminated with water, mud, rocks, or covered in potholes or other hazards. Even fields which may from a distance appear quite dry can be unexpectedly muddy or wet.

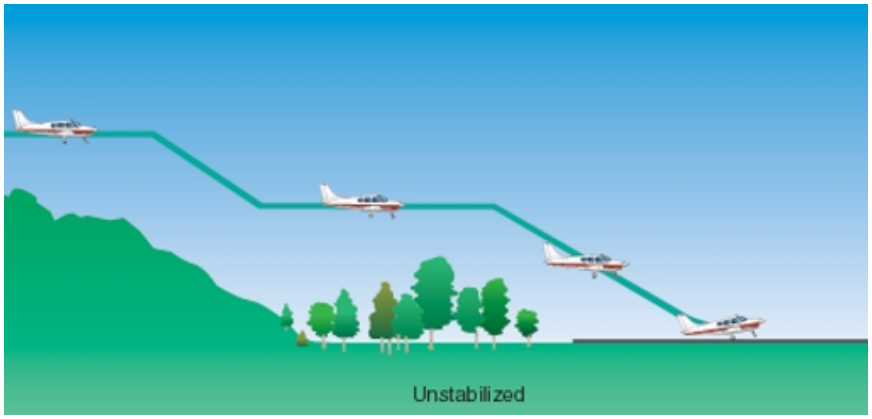
- Because most common training airplanes have *tricycle* landing gear, with heavy engines resting above small nose wheels, special care must be taken to prevent the nose wheel from sinking into the grass or mud and slowing the airplane excessively.

- Grass and other soft surfaces, such as dirt, provide a significant amount of increased drag or rolling resistance as compared to paved runway surfaces. Therefore, landing distances will be improved, however takeoff distances can be lengthened dramatically. Taxiing will also require considerably more power, and require careful attention to keeping weight off of the nosewheel!
- The best way to protect the nose wheel on soft-surface fields is to **touch down softly** on the main wheels only, keep **full back elevator pressure** when rolling out after landing to keep the nose wheel raised, remaining in motion when leaving the runway after landing, **avoiding wheel braking**, and retaining back elevator pressure during taxiing.
- **Importance of Estimating Field Condition** - If the condition of a soft field is not already known, it is generally a good idea to perform a low approach to take a close look at the field conditions. The surface should appear **dry**, the **grass properly mowed**, and **free of potholes and rocks**.

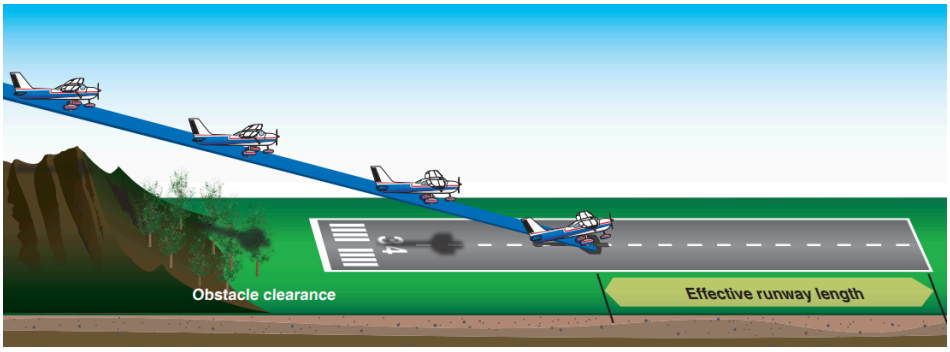
- **Airspeed Control and Trim** - When approaching to land, it is important to be aware of the proper final approach airspeed. This will often be specified by the POH, but otherwise airspeed on final approach should be no higher than 1.3 x Vso, and in landing configuration (usually full flaps). **It is important to use the elevator trim to hold approach speed throughout the maneuver!**
- **Behind the Power Curve** - When flying at approach airspeeds, particularly lower short-field approach airspeeds, it is important to remember that the airplane will be *behind the power curve*. The power curve represents the amount of power required to maintain a given airspeed without accelerating. This is at a minimum when the amount of total drag is at a minimum.
    - Airspeeds below the minimum drag speed (the best glide speed) are sometimes called the *region of reverse command*. This is because any increase in pitch, and therefore angle of attack, will result in more total drag, which will *increase* the rate of descent.
    - When behind the power curve, in order to control descent rate and glide path, the first action must be to increase or decrease the throttle! **Add or remove power to control the descent, and pitch to maintain airspeed.**
    - 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.
        - See the lesson on *Area 10 (X) - Task B - Demonstration of Flight Characteristics at Various Configurations and Airspeeds* for more details on energy management.



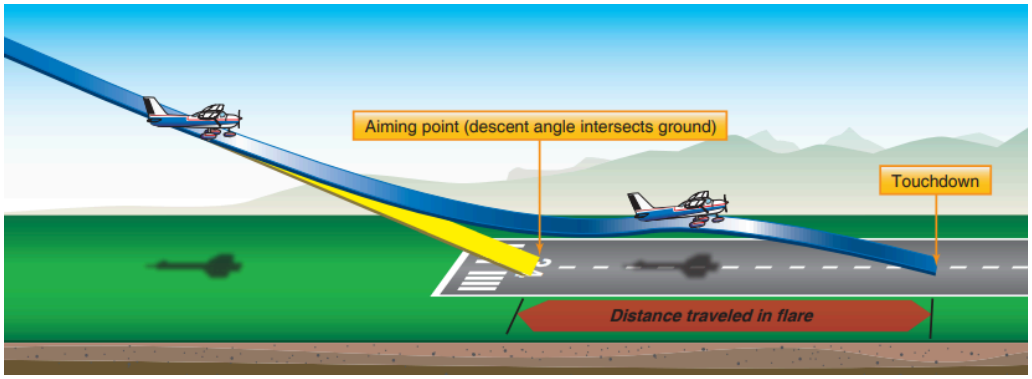
- **Importance of a Stabilized Approach** - As with all landings, the quality of the landing begins with the quality of the approach. It is critically important to maintain a *stabilized approach*.
    - **Unstable approaches are a leading cause of accidents and incidents during landing!**
    - The approach should involve smooth, gentle pattern turns, while maintaining the proper approach airspeed and avoiding dramatic forward slips or other maneuvers the entire time. It is important that the airplane be fully configured to land and flying at approach speed, and at a stable rate of descent, at least ½ mile before reaching the runway threshold. Generally, the approach should be stabilized before reaching 400ft AGL.



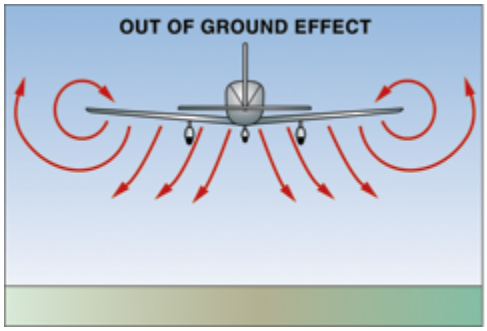
    - Even though obstacles on final approach, such as terrain or trees, may require a steeper descent, it is still preferable to fly a *stabilized approach* that will clear obstacles, rather than stepping down or otherwise flying an unstable approach. **Final approach should be flown in a *stable* descent, properly aligned with the runway or landing area!**

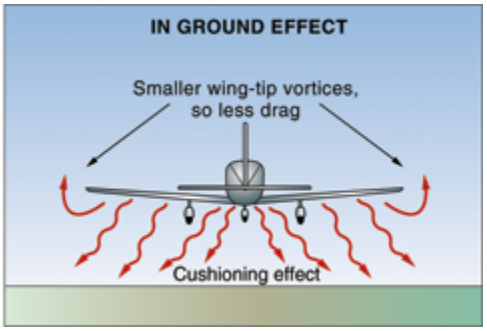


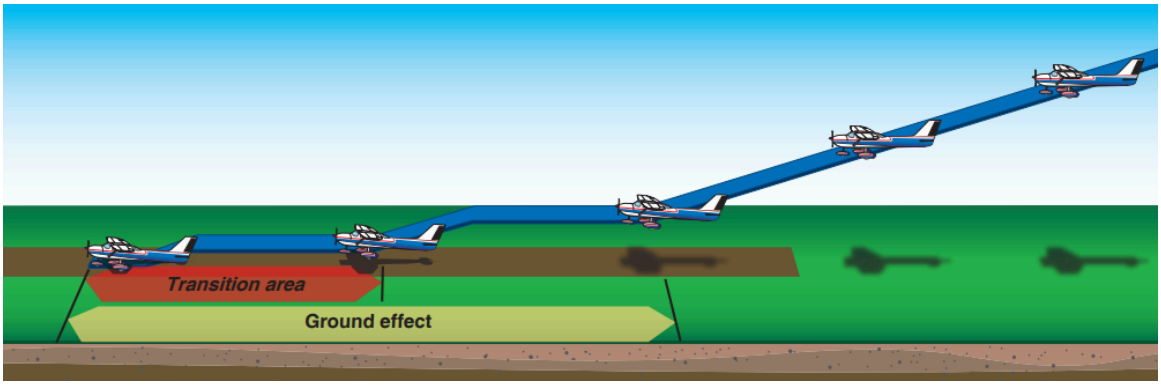
- As the airplane approaches the runway on final, the pilot should identify a point before the desired touchdown point and use it as an aiming point. As the airplane reaches the aiming point, a normal roundout and flare can be conducted, such that the airplane touches down at the touchdown point. Aiming at the touchdown point would result in landing long, because it does not account for the landing roundout and flare.



- Pilots should conduct all landings to hit a designated spot, whether or not they are performing a high-performance landing. For a soft-field landing, the designated spot should be in the first ⅓ of the available landing area. During the roundout and flare, the pilot should hold just enough back pressure to keep the airplane from touching down until the desired touchdown point is reached.
- **Ground Effect** - For a soft-field landing, touchdown should be made in a **nose-high attitude, as softly as possible, at the minimum safe airspeed**. It will help cushion the landing if a bit of power is held through the roundout, flare, and touchdown. As the airplane flies into *ground effect*, it should round out and fly level to gently bleed off speed and altitude, such that touchdown occurs with minimum sink rate.
    - *Ground effect* is a phenomenon where the proximity of an airplane's wing to the ground interrupts the usual wing tip vortices and provides a cushioning effect.







- **Dangers of Floating** - According to the FAA's AC 91-79A, **"A 10 percent excess landing speed causes at least a 21 percent increase in landing distance"**. Being *on speed* is crucial to proper landing performance. Even more dangerous is excessive *floating* or delaying the touchdown. Although good soft field technique does not emphasize landing in a particular distance, **excessive floating on a landing is unacceptable!** A good rule to follow is that if the airplane has not touched down within the first ⅓ of the runway surface, **go around**!

Condition	Effect on landing distance
Excess airspeed	
On dry runway	300 feet (90 meters) per 10 knots
On wet runway	500 feet (150 meters) per 10 knots
Extended flare (floating)	2500 feet (760 meters) per 10 knots
Delayed touchdown (at normal speed)	230 feet (70 meters) per second
Excessive height over threshold (at normal speed)	200 feet (60 meters) per 10 feet above normal over-threshold height

- **Landing Performance** - Determining exactly how much distance will be required for the landing is crucial to ensure the chosen runway will be long enough to make the landing safely. An airplane's landing performance is highly dependent on several changing factors, such as **weight, wind, and density altitude.** Aircraft performance at heavier weights or higher altitudes is greatly reduced.
    - *Density altitude,* which is a correction for atmospheric conditions, is the altitude that an airplane 'feels'.
    - At higher altitudes or on hot days, the density of the air will be less and therefore the airplane will need to move more air to stay aloft. Because the airspeed indicator is also affected by density altitude, it will show the same values, however the true airspeed will be higher.
    - **The difference between field altitude and the density altitude can be significant!**
        - See the related lesson on Density Altitude.
- The POH for every aircraft will contain performance charts that detail how many feet of landing distance is required for various weights, winds, and weather conditions. It also prescribes an airplane configuration that should be used.
    - To use the performance charts, first find the *pressure altitude*, by setting the altimeter to 29.92" or using the conversion. Then, find the cell in the table that matches the airplane gross weight with the pressure altitude and the current temperature.
    - It is best to add a 'safety factor' to the performance figures obtained from the POH performance charts. Generally, it is a good idea to overestimate the pressure altitude and temperature for a worst case scenario, and add 20-30% to account for the possibility of floating, however as noted above, **floating must be avoided if performance numbers are to be valid!**
    - Soft-field approaches are usually helped by the vastly increased surface friction of the grass or other soft surface. Landing performance is usually much better, and takeoff performance is considerably worse.
    - **Don't forget to consider wind!** A tailwind dramatically increases takeoff and landing distances. Likewise, a strong headwind can greatly improve performance.

LANDING DISTANCE

SHORT FIELD

CONDITIONS:
Flaps 30°
Power Off
Maximum Braking
Paved, Level, Dry Runway
Zero Wind

NOTES:
1. Short field technique as specified in Section 4.
2. Decrease distances 10% for each 9 knots headwind. For operation with tailwinds up to 10 knots, increase distances by 10% for each 2 knots.
3. For operation on a dry, grass runway, increase distances by 45% of the "ground roll" figure.

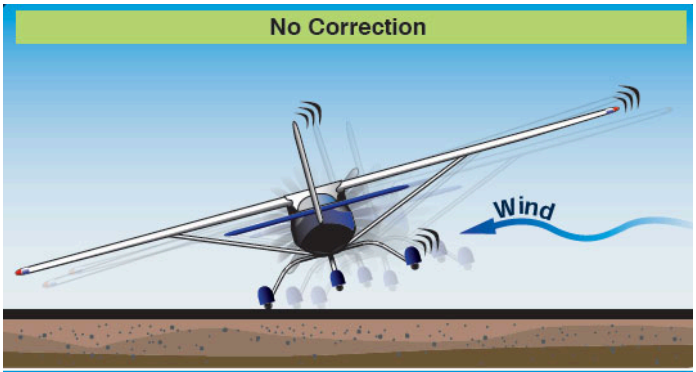
WEIGHT LBS	SPEED AT 50 FT KIAS	PRESS ALT FT	0°C		10°C		20°C		30°C		40°C	
			GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS	GRND ROLL	TOTAL TO CLEAR 50 FT OBS
1670	54	S.L.	450	1160	465	1185	485	1215	500	1240	515	1265
		1000	465	1185	485	1215	500	1240	520	1270	535	1295
		2000	485	1215	500	1240	520	1270	535	1300	555	1330
		3000	500	1240	520	1275	540	1305	560	1335	575	1360
		4000	520	1275	540	1305	560	1335	580	1370	600	1400
		5000	540	1305	560	1335	580	1370	600	1400	620	1435
		6000	560	1340	580	1370	605	1410	625	1440	645	1475
		7000	585	1375	605	1410	625	1440	650	1480	670	1515
		8000	605	1410	630	1450	650	1480	675	1520	695	1555

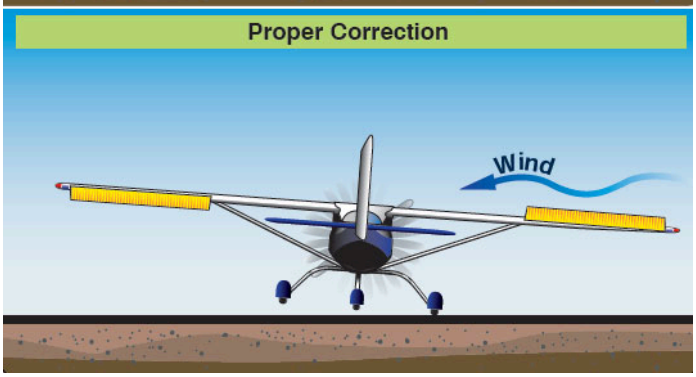
Figure 5-10. Landing Distance

- **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.
  - **Soft-field landings require special caution to be exercised for adequate field surface conditions and watching for obstacles on or near the field!** Powerlines, tall trees, or other obstacles may be quite close to the runway environment!
  - It is crucial to not become so focused on the maneuver 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. **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.

Maneuver Description

- **Selecting a Suitable Surface** - Select a runway or suitable soft field surface that will allow landing into the wind, or with a manageable crosswind. When using an actual soft-field, it is best to first perform a low approach to verify that it is free from large potholes, ruts, mud, or other debris that may damage the airplane.
- **Selecting a Touchdown Point** - When landing on an actual soft field, there will likely be no runway markings, so touchdown should be planned in the first ⅓ of the available landing area. Until proficiency is developed, select a spot that is not directly at the start of the landing area, 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** - The maneuver must be started at less than **Va** (maneuvering speed). Choose a normal level cruise flight airspeed and power setting, at least 5-10 knots below Va. Ideally, begin this maneuver at a normal traffic pattern airspeed.
- **Checklists** - Pilots must perform a before-landing checklist before beginning the maneuver, and an after-landing checklist after taxiing safely clear of the runway or landing area, for full-stop landings.
- **Airspeed** - Airspeed should be kept at the soft field landing 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, or within a reasonable distance beyond it. Allow the airplane to enter ground effect and hold back elevator pressure bleed speed and altitude slowly. The landing should be **gentle**, at a proper pitch angle (*keep the nose up*), 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 back elevator pressure to ensure the nose wheel remains free and to provide aerodynamic braking, as specified by the POH. The primary consideration is to keep the weight off the nose wheel. **Avoid using wheel braking!**
- **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 soft-field landing maneuver and how wind and other factors affect the performance of the maneuver.
- The pilot can perform the maneuver to the following standards:
    - Pilot selects a runway or field 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.
    - At the normal abeam point on the downwind, the pilot closes the throttle, applies carb heat as necessary, and establishes a descent at the normal approach airspeed +10/-5 knots.
    - Pilot makes a safe, soft touchdown on the main gear while holding the nosewheel off the ground.
    - Pilot continues holding the nosewheel off the ground until loss of elevator effectiveness, and retains back elevator pressure during taxi clear of the runway or soft field surface.
    - Pilot divides attention between accurate, *coordinated airplane control* and outside visual references.
    - Pilot performs a timely go-around if the safe completion of the maneuver *within standards* is in doubt.