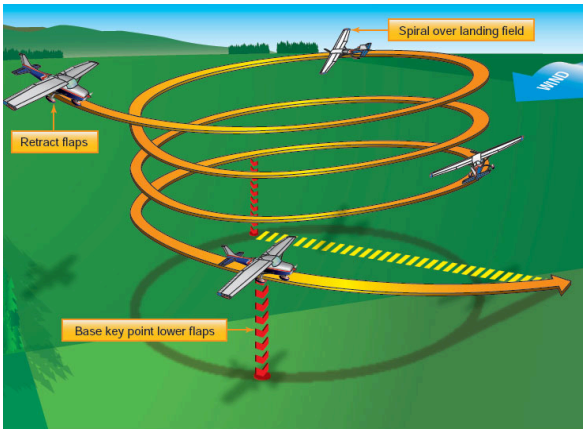
Emergency Approach and Landing (Simulated)

Objective

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

Purpose

Although no pilot ever hopes to encounter an engine failure, preparing for one is a crucial skill all pilots must develop. This maneuver will introduce pilots to gliding descents and how to plan and execute an emergency landing.



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 Checklist
- Whiteboard / Markers (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 emergency approach and landing maneuver and how wind and other factors affect the performance of the maneuver.
- **Flight**: Student can perform the maneuver to the applicable ACS standards.
  - After a simulated engine failure is declared, immediately establishes best glide airspeed +/- 10 kts.
  - Selects a suitable landing area and begins an approach, configures the airplane, performs an emergency checklist, and simulates the appropriate radio calls.
  - Uses a combination of approach geometry, slips, and flaps to manage the approach path, avoiding skidding turns at all times.
  - Manages the descent and aims for a point so as to make a safe, controlled landing (if performed at an airport), or discontinues the approach at 500 ft AGL, at the discretion of the instructor.
  - See expanded Completion Standards below.

References

- ERAUSpecialVFR - “Emergency Approach and Landing - Lesson 1”
    - YouTube - https://www.youtube.com/watch?v=HLx6MZmOBAE
- FAA-H-8083-3C (Airplane Flying Handbook) - Chapter 9, Page 12-13 [Intentional Slips], Chapter 9, Page 24-27 [Power Off Accuracy Approaches], Chapter 9, Page 30-37 [Faulty Approaches and Landings], Chapter 18, Page 2-5 [Basic Safety Concepts], Chapter 18, Page 5-7 [Terrain Types], Chapter 18, Page 7-8 [Engine Failure After Takeoff]
- FAA-H-8083-25C (Pilot’s Handbook of Aeronautical Knowledge) - Chapter 5, Page 5 [Lift/Drag Ratio], Chapter 5, Page 7 [Induced Drag], Chapter 5, Page 11-12 [Ground Effect]
- FAA-S-ACS-6C (Private Pilot ACS) - Area IX Task B
- FAA-S-ACS-7B (Commercial Pilot ACS) - Area IX Task B
- FAA-S-ACS-25 (CFI ACS) - Area XII Task B

Ground Lesson Outline

- Engine Failure During Flight
    - The A-B-C’s
- Best Glide Speed
    - L/Dmax
    - Minimum Sink Speed
- Selecting a Landing Area
    - Distance, Wind Direction, Terrain Type, Obstacles
- Emergency Checklists
    - Attempt to restore engine, declare emergency, prepare for off-airport landing
- Engine Failure After Takeoff
    - Don’t turn back below 800ft AGL!
- Determine the Cause
    - Many engine failures are carb ice, or easily solved fuel supply issues
- Planning the Approach
    - Spiral Down to Downwind, Setup for Power-Off 180
    - Key Positions, Estimating Glide Path, Tools for Managing Glide Path
        - Approach geometry, Airspeed, Configuration, Forward Slips
- Best Glide vs. Headwinds
- Safety considerations
    - Touchdown at Lowest Possible Airspeed
    - Emergency Checklist - divide attention with the approach
    - Maintain situational awareness, when practicing be prepared to Go Around!
- Maneuver Description - step-by-step
    - Entry position, airspeed, etc.
- Expanded Completion Standards
- Further Reading - Best Glide vs Wind (Expanded)

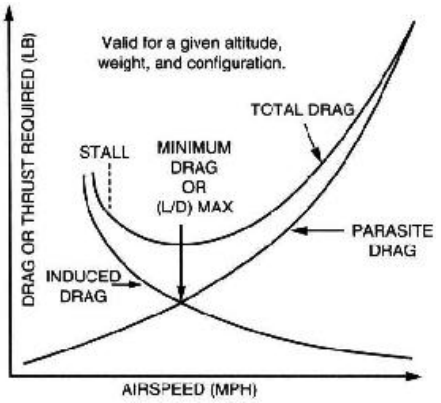
Common Errors

- **Improper airspeed control.**
- **Poor judgment in the selection of an emergency landing area.**
- Failure to estimate the approximate wind speed and direction.
- **Failure to fly the most suitable pattern for existing situation.**
- **Failure to accomplish the emergency checklist.**
- **Undershooting or overshooting selected emergency landing area.**

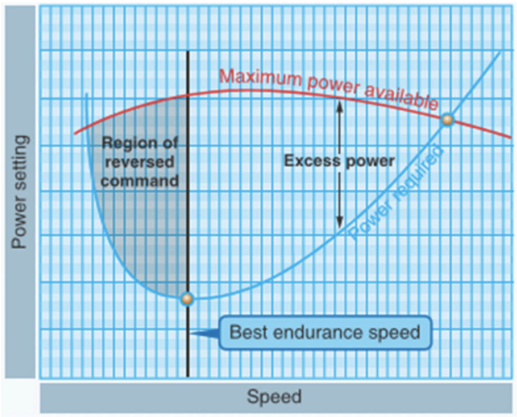
Ground Lesson Content

- **Engine Failure During Flight** - One thing every pilot never hopes to encounter is an engine failure during flight. Nonetheless, training for the possibility is important. Safe pilots have the initial steps of an engine failure memorized, so that they can spring into action without wasting precious time.
    - **The A-B-C's** - One way pilots remember the engine failure steps is using the A-B-C mnemonic:
        - Step 1. *Establish Best Glide **A**irspeed*
        - Step 2. *Select the **B**est Field (landing area)*
        - Step 3. *Perform the Emergency **C**hecklist*
            - For many carbureted airplanes, this can also refer to **Carb Heat**, which should be applied promptly as a first troubleshooting step!

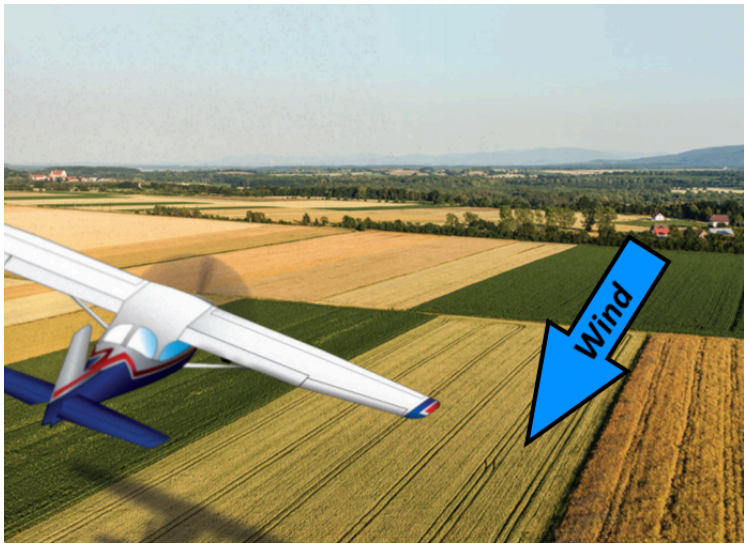
- **Best Glide Speed** - When gliding to land, the most important airspeed to remember is the *best glide speed*. Best glide speed is the airspeed that will, in the absence of wind, result in the airplane traveling the **furthest distance**. Generally a power-off approach should be flown at approximately best glide speed, and in the clean (lowest drag) configuration, until a safe landing is assured. It is best to trim to best glide speed immediately at the start of the maneuver.
    - The best glide speed is the airspeed at which the ratio of lift to drag is at maximum (sometimes called *L/D max*), and is often published only for the clean configuration.



- **Minimum Sink Speed** - There is another speed pertinent to gliding flight, the *Minimum Sink Speed*. This occurs at the Minimum Power Required speed, which is typically a bit slower than Best Glide. This speed will keep the aircraft aloft for the longest amount of time.



- **Selecting a Landing Area** - In the ideal case, the airplane is within gliding range of an airport or runway. However, this is unlikely to be the case in many situations. **When choosing a landing area, pilots should look for large, open areas, if available.** There are several other considerations when choosing a landing area:
    - **Distance** - Pilots must learn to judge how far they can glide, but it is generally safest to select an emergency landing area within approximately 1 mile of the airplane to ensure that sufficient time and altitude are available to plan a safe approach and landing.
    - **Wind Direction** - Landing at the lowest airspeed is best, and so pilots should attempt to determine the local wind direction. Fields which are aligned with the wind are ideal.
    - **Terrain Type** - Large, open fields are ideal. If the fields are plowed, pilots should attempt to land *with* the furrows, even if that is not directly into the wind.



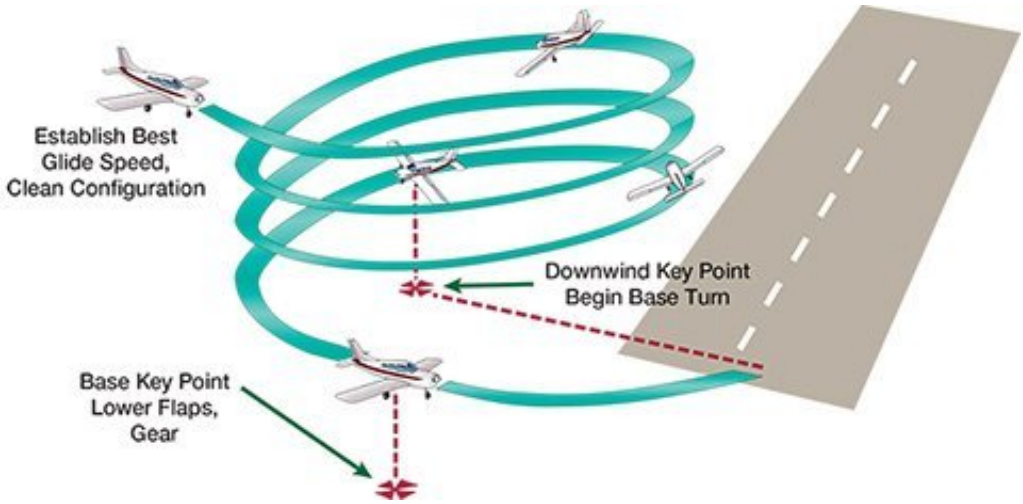
    - **Obstacles** - Not all open areas are suitable, or may be usable but only with extreme caution. Fields may be surrounded by high power lines, or filled with debris or other obstacles. Roads at first seem like ideal areas, however the presence of traffic makes them dangerous! **Pilots should never intentionally endanger people on the ground during emergencies!**

- **The Emergency Checklist** - If the engine failure happens at sufficient altitude, **while the airplane is gliding towards the emergency landing area**, pilots should perform the emergency checklist. Generally, the emergency checklist has items from a few categories:
    - **Diagnose or Fix the Engine Failure** - **Attempt to restore fuel flow** (switch tanks, switch on fuel pumps, enrichen mixture, etc), or increase airflow into the engine (carburetor heat), and finally, switching magnetos or attempting to restart manually.
    - **Declare an Emergency** - Emergency checklists will remind pilots that **they should declare an emergency** (“Mayday, Mayday”) to Air Traffic Control (if in communications), or on Guard (the Universal Emergency Frequency), **121.5 MHz** and advise others of the situation.
    - **Prepare for Emergency Landing** - Generally, if no restart can be accomplished, the checklist will walk the pilot through making the airplane safer for a rough landing. Most checklists advise pilots to cut off fuel supply to the engine to reduce the risk of fire, secure seatbelts, turn off the electrical system, and some airplane checklists advise pilots to unlatch the doors to make exit easier if the airplane structure is damaged.

- **Engine Failure After Takeoff** - When an engine failure occurs shortly after takeoff (when the airplane is below 800-1,000ft AGL), there is generally no time to accomplish an emergency checklist. **Pilots in this situation should focus directly on executing a safe landing on any suitable spot directly ahead of the airplane. Do not attempt to turn back to the airport!**

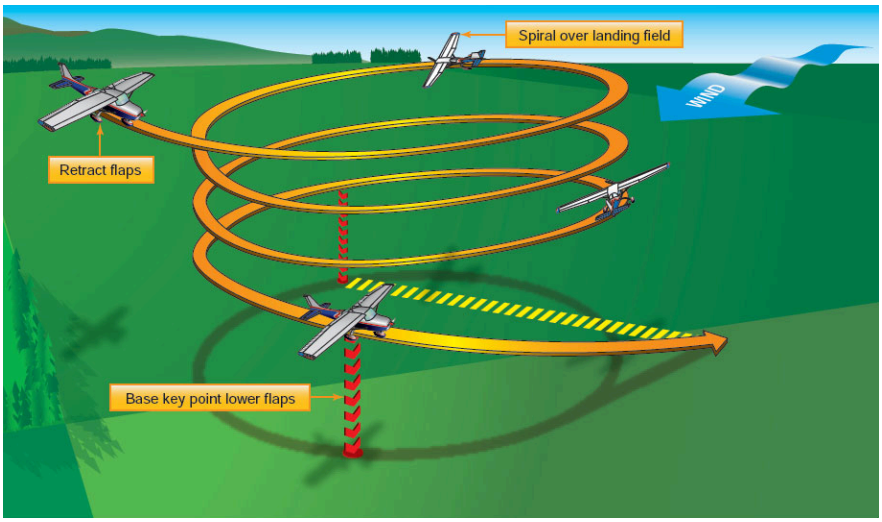
- **Determine the Cause** - If time and altitude allows, pilots should attempt to determine the reason for the engine failure. **The most common causes of engine failure in flight are carb ice and fuel flow issues. Simply switching fuel tanks or applying carburetor heat may restore engine power and eliminate the need for an emergency off-airport landing!** Performing the emergency checklist should take the pilot through all the normal troubleshooting steps that could successfully restore the engine, if it is possible.

- **Planning the Approach** - If sufficient altitude allows, **it is best to plan to enter into a 'normal' downwind, if possible**. Pilots have considerably more experience with landing from a downwind position, and executing a final approach from a downwind allows for easier estimation of the glide path, and provides opportunities to correct for an approach that would be too short.
    - **Spiral Down to a Downwind** - **The goal for any power-off approach should be to arrive at a point on the downwind, abeam the desired touchdown point, from which a "Power-Off 180" can be executed.** Fly directly to the downwind point and then execute a spiral, gliding descent to arrive at the point at approximately 1,000ft AGL. The amount of altitude lost per spiral turn can be adjusted by banking more (less altitude per turn), or banking less (more altitude per turn).

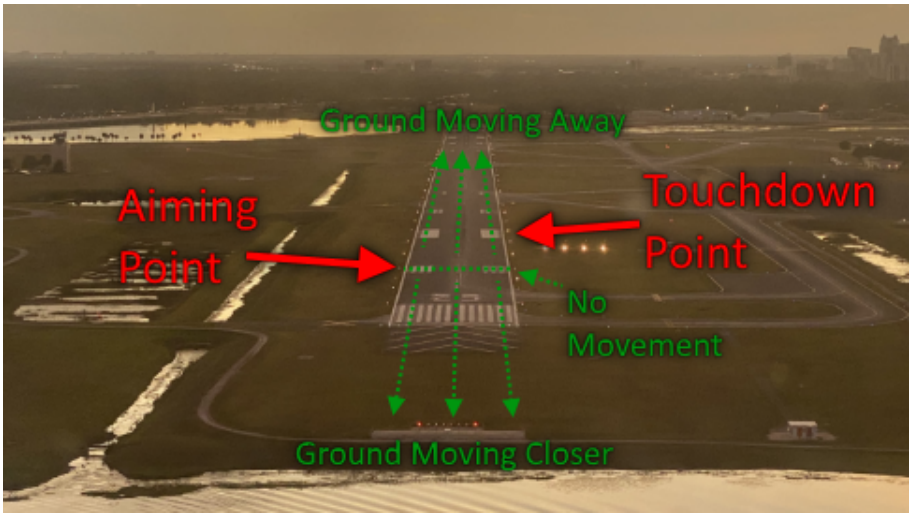


    - **What is a Power-Off 180?** The *Power-Off 180 maneuver* or *Power-Off Approach* is simply a landing approach executed from the downwind-abeam position without any engine power. Unlike a normal landing, there is no power available to manage the glide path, and so the approach to land is somewhat different than a normal landing:
        - *It will be steeper.* A normal 3 degree glide path is not possible in most aircraft.
        - *It will be tighter.* It is usually necessary to fly a closer, 'tighter', base leg than usual.
        - *It may require maneuvering.* S-turns or slips may be required to lose altitude.
    - **Key Positions** - The Power-Off Approach is begun from the downwind leg, at a point abeam the touchdown point. This point is called the ***downwind key position***. It is the position from which the pilot will initially estimate the distance to the runway, and plan the approach path. At the

base key position, the pilot is at a close-in base leg position. At the key position, the pilot again estimates the distance to the touchdown point, and modifies the approach path as necessary. Ideally, the airplane was in gliding distance to a runway, so the approach can be planned to a runway, however **if no runway is available, pilots should nonetheless plan the approach as if there was a runway in the chosen landing area.**

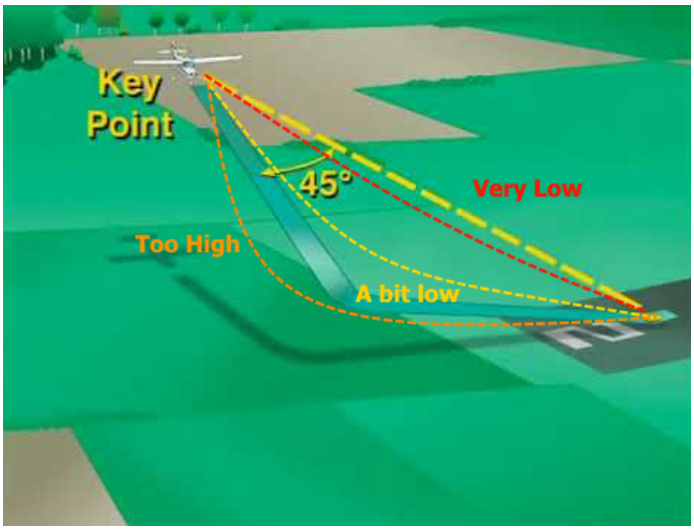


- **Estimating Glide Path** - In order to perform this maneuver successfully, pilots must develop their skills in visually estimating the airplane's glide path. This begins with finding an aiming point which is just before the desired touchdown point, to account for the roundout and flare. When in a stable descent, if the aim point is *moving away*, the landing will be short. When the aim point is *moving closer*, the landing will be too long. It is crucial to pay close attention to the movement of the aiming point and make the appropriate corrections. **Even when no runway is available, designate a point in the landing area as the touchdown point, and choose an aiming point before it.**

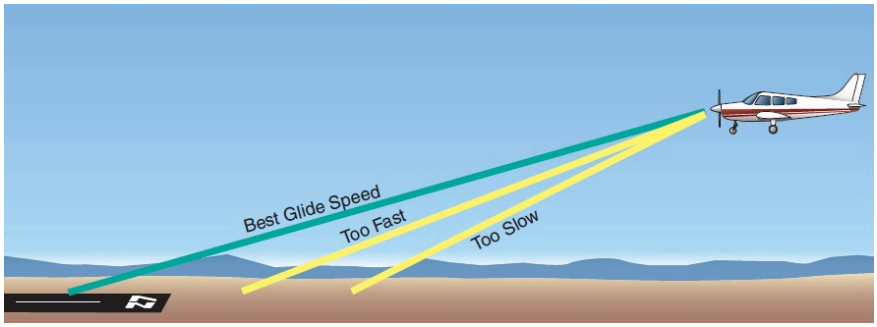


- **Tools for Managing Glide Path** - Because there is no power available, pilots have fewer tools to correct their glide path than in a normal powered approach, however, they do have a few important tools:
    - **Approach geometry** - Flying a longer or shorter path to the touchdown point can vary the amount of altitude dissipated in the glide. It is usually possible to 'cut off the corners' of the

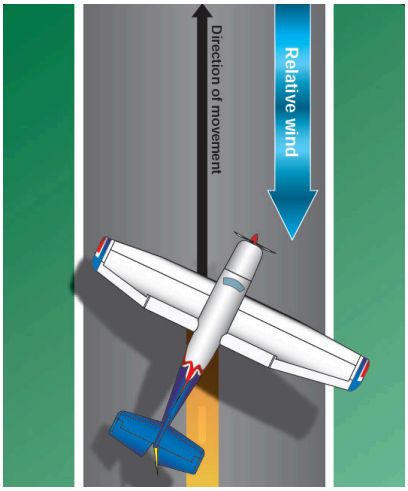
normal pattern turns if the glide appears too short, or if the glide appears too long, to fly past the approach path and turn back towards it, or perform S-turns.



- **Airspeed** - Flying at an airspeed faster than, or slower than, best glide speed will result in a shorter glide.

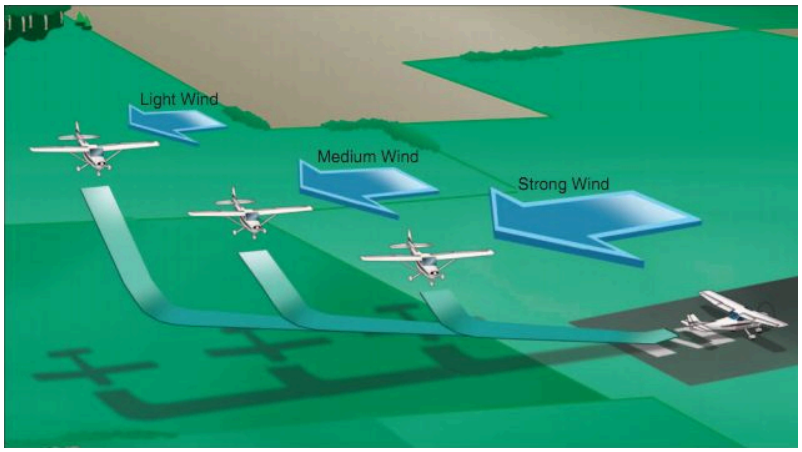


- **Aircraft configuration** - Flaps can be used to slow the airplane, and shorten the glide, if it appears the glide will be too long.
- **Forward slips** - Forward slips are another tool which increases drag and can dramatically shorten a glide.

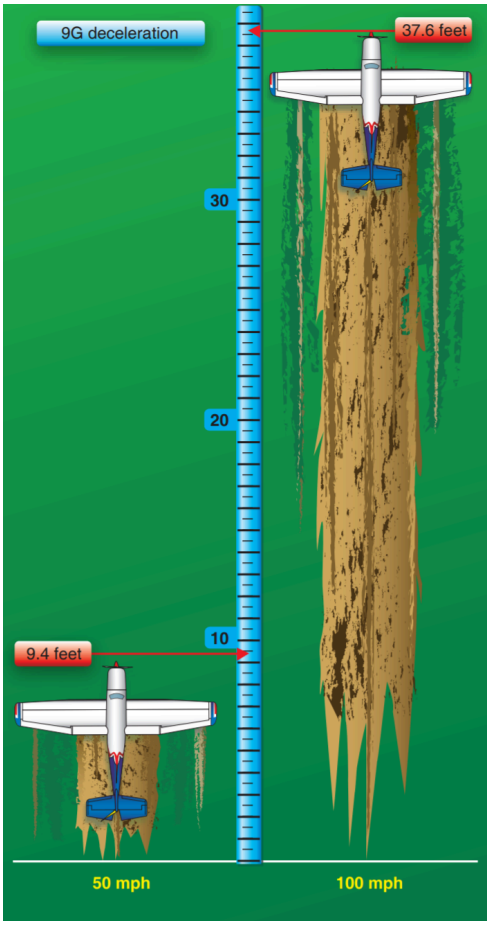


- **Glide Speed vs. Headwinds** - An important consideration for this maneuver is the wind speed. As with any landing, the power-off approach should be made such that landing is into the wind, however it is important to understand that **a headwind causes glide performance to decrease and best glide**

speed to increase! (See the *Further Reading* section below) Therefore, in situations where there is a strong wind, the base leg should be flown closer to the touchdown point.

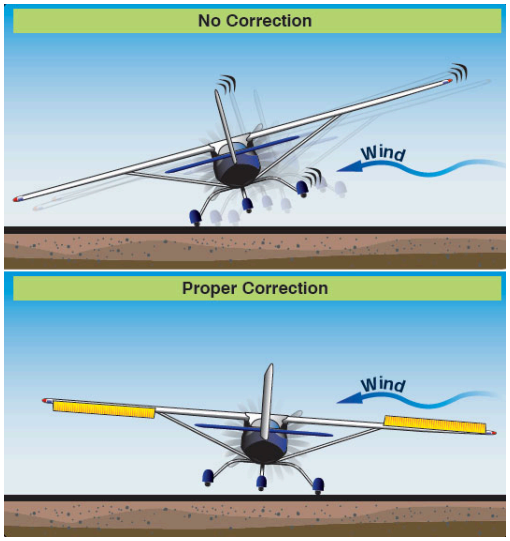


- **Safety Considerations**
  - **Touchdown at Lowest Possible Airspeed** - When a runway was not within gliding distance and the airplane will land in a field or other open area, **it is crucial that the landing be made at the lowest possible airspeed.** The amount of energy dissipated varies exponentially based on the speed.
  - **Emergency Checklist Usage** - **If time allows, the pilot should run the engine failure during flight emergency checklist.** After landing and rolling out to a safe point, the airplane should be shutdown in accordance with the normal checklist, if possible, to minimize the risk of fire. **Pilots must divide attention between performing the checklist and managing the approach.**
  - When practicing emergency landings, 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 when performing the landings at airports, ensure that landing clearance is obtained before landing. **When performing the maneuver away from gliding distance of an airport, the maneuver should be discontinued at 500ft AGL**.
  - Maneuvering at low airspeed, and performing forward slips or S-turns creates a risk of a stalling situation. If the stall warning sounds before the landing flare, go around! **Always be prepared to go around!**



Maneuver Description

- **Maneuver Start** - Usually the instructor or examiner will reduce power to idle and declare that an engine failure is being simulated. Always be prepared for an engine failure emergency!
- **Establish Best Glide Airspeed** - Immediately pitch for best glide airspeed until a landing at the desired area is assured. The final stages of the approach can be flown slightly faster or slower, as necessary, to make the glide work out. *Take care to allow sufficient margin above the stall, and if the stall indication is heard at any point before the final landing flare, discontinue the maneuver and go around!*
- **Select a Suitable Landing Area** - Find an open field or other area, free from obstacles, that will allow landing into the wind, or with a manageable crosswind.
- **Selecting a Touchdown Point** - Select a point in the landing area that is easy to identify from the downwind leg. Until proficiency is developed, select a point that is not directly at the start of the landing area, in case the glide comes up short.
- **Emergency Checklist** - If altitude allows, **generally above 1,500ft AGL**, pilots must perform the emergency checklist. If landing on an actual runway, an after-landing checklist should be performed after taxiing safely clear of the runway, for full-stop landings.
- **Bank** - Since this maneuver involves maneuvering in gliding flight at low altitude, the bank angle should be *less than* **30 degrees**.
- **Approach Path** - Any approach geometry may be used to make the glide work out as necessary. This may require turning for the landing site early, or potentially flying past final and turning back towards it. S-turns and forward slips on final are also acceptable.
- **Coordination** - Except for during forward slips, the maneuver should be flown in coordinated flight. Attention should be given to proper rudder input during turns.
- **Slips** - Forward slips may be used as long as care is taken to ensure the nose remains below the horizon to maintain a margin above the stall. **Do not skid.**
- **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 pitch angle (*not on the nosewheel-- do not force it!*), safe, and under control. **Touch down at the lowest possible airspeed.** 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 as necessary.

- **Be Prepared to Go Around!** The glide 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 glide path. *Monitoring for obstacles or other traffic is especially critical when performing this maneuver at low altitude or near uncontrolled airfields.*

Expanded Completion Standards

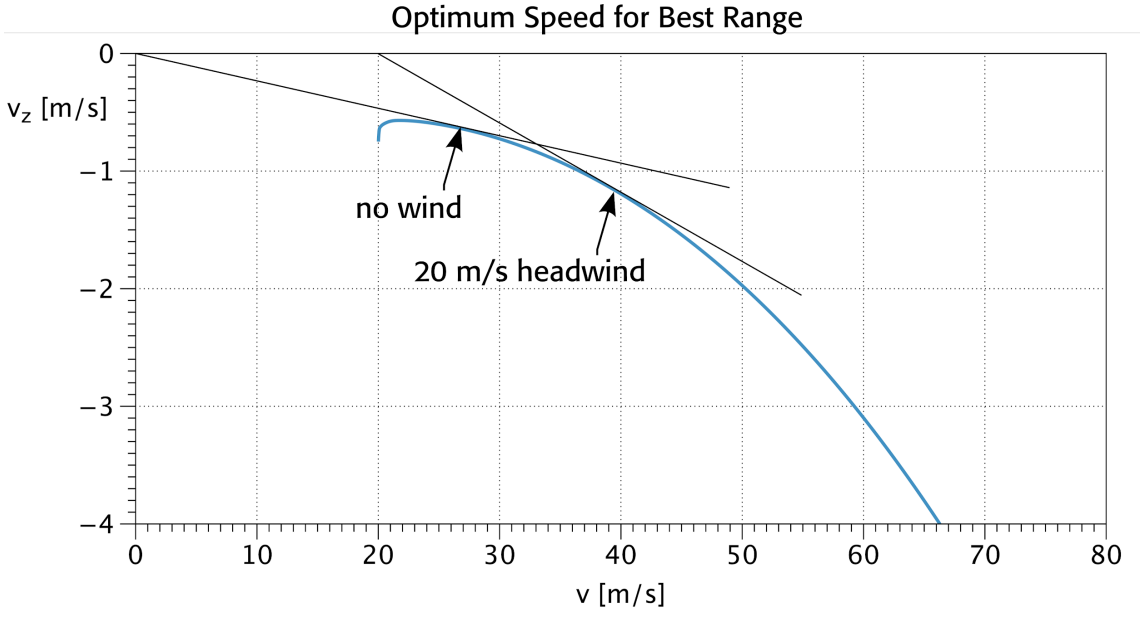
- The pilot can explain the purpose of the emergency approach and landing maneuver and how wind and other factors affect the performance of the maneuver.
- The pilot can perform the maneuver to the following standards:
    - After the instructor or examiner reduces engine power, the pilot **immediately establishes best glide airspeed +/- 10 kts**.
    - Pilot selects a suitable landing area and begins an approach, configures the airplane, performs an emergency checklist, and simulates the appropriate radio calls.
    - Pilot uses a combination of approach geometry, slips, and flaps to manage the approach path, **avoiding skidding turns at all times**.
    - Pilot manages the descent and aims for a point so as to make a safe, controlled landing (if performed at an airport), or discontinues the approach at 500 ft AGL, at the discretion of the instructor.
    - Pilot divides attention between accurate, *coordinated airplane control* and outside visual references.

Further Reading

Best Glide vs Wind (expanded)

- The reason that glide performance depends on wind is that an airplane's best glide speed is calculated such that the airplane travels the furthest distance *into the relative wind* for a given amount of altitude lost. However, when an airplane glides into the wind, some of its forward motion *along the ground* is in effect 'lost' due to the headwind. This results in a situation where, in a strong headwind, the airspeed which results in the longest glide distance *across the ground* is higher than the airspeed that results in the most glide distance *into the wind*.
    - *Example*: Imagine a scenario with an airplane with a best glide speed of **50 kts** and a **8:1 glide ratio**. For every 1,000 feet of altitude lost, the airplane will travel 8,000 feet into the relative wind when flying at best glide speed. At 50 kts, the airplane will travel ~5,063 feet per minute (50 nm/hr x 6,076 ft/nm / 60 min/hr) *through the relative wind*. The airplane begins its glide at **1,000 feet**.
        - **No Wind** - The airplane would reach the ground in ~ 1 minute, 35 seconds, and cover 8,000 feet *through the relative wind*, and 8,000 feet over the ground.
        - **25 kt Headwind** - The airplane would reach the ground *at the same time*, 1 minute, 35 seconds, traveling 8,000 feet through the relative wind, but *only 4,000 feet over the ground*. (25 kt ground speed during the glide)

        - **50 kt Headwind** - The airplane would reach the ground again **at the same time**, 1 minute, 35 seconds, traveling 8,000 feet through the relative wind, but travel **0 feet over the ground**. (0 kt ground speed during the glide)
    - Consider further now that at a speed of **60 kts**, the same airplane has a slightly worse **7.5:1 glide ratio**. For every 1,000 feet of altitude lost, the airplane will travel 7,500 feet into the relative wind when flying at this speed. At 60 kts, the airplane will travel ~6,076 feet per minute *through the relative wind.* The airplane begins its glide again at 1,000 feet.
        - **No Wind** - The airplane would reach the ground in ~ 1 minute, 14 seconds, and cover 7,500 feet through the air, and 7,500 feet over the ground, which is 500 feet less glide performance.
        - **25 kts Headwind** - The airplane again glides in ~ 1 minute, 14 seconds, covering the same 7,500 feet through the air, but now covers 4,666 feet *over the ground*. (35 kt ground speed in the glide) **This is an improvement of over 600 feet in total glide over the ground!**
        - **50 kts Headwind** - The airplane again glides in ~ 1 minute, 14 seconds, covering the same 7,500 feet through the air, but now covers 1,333 feet *over the ground*. (10 kt ground speed in the glide) **This is an improvement of over 1,300 feet in total glide over the ground!**
    - Notice that, for a given speed and glide ratio, the amount of time that the airplane remains aloft remains the same. The airplane 'feels' only the relative wind.
    - Also notice that, for a given speed and glide ratio, the amount of distance *into the relative wind* the airplane travels remains the same, regardless of wind, however the distance traveled *over the ground* varies greatly.
- This can be plotted using a 'polar curve'



- See: https://www.wikiwand.com/en/Polar_curve_(aerodynamics)