

Task VII.B: Short Field Takeoff and Maximum Performance Climb

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Lesson Overview

Objective

To familiarize the student with the proper procedures and techniques for short-field takeoff and climb.

Reference

Airplane Flying Handbook - Chapter 5 Aircraft Flight Manual / Pilot's Operating Handbook

Key Elements

1. Use the Entire Runway
2. Maximum Performance Climb at V_x
3. Focus Outside the Airplane

Elements

1. V_x (Best Angle of Climb Airspeed)
2. Runway Incursion Avoidance
3. Pre-Takeoff
4. Takeoff Roll
5. Lift-Off
6. Maximum Performance Climb

Schedule

1. Discuss Objectives
2. Review material

3. Development
4. Conclusion

Equipment

1. White board and markers
2. References

IP Actions

1. Discuss lesson objectives
2. Present Lecture
3. Ask and Answer Questions
4. Assign homework

SP Actions

1. Participate in discussion
2. Take notes
3. Ask and respond to questions

Completion Standards

The lesson is complete when the student is able to perform short-field takeoffs and climbs to the satisfaction of the instructor and in accordance with the current Practical Test Standards for the student's stage of training.

Instructor Notes

Attention

Maximum Performance Takeoff and Climb ... this is the mother of all takeoffs, where we put the airplane at its limits to obtain the most performance out of the airplane.

Overview

Review Objectives and Elements/Key ideas

What

Takeoffs and climbs from fields where the takeoff area is short or the available takeoff area is restricted by obstructions requiring the pilot to operate the airplane at the limit of its takeoff performance capabilities.

Why

Short Field Takeoffs develop the pilot's ability to operate the airplane at its maximum takeoff performance capabilities. This develops a better feel for the plane and results in improved takeoffs and airplane control.

Lesson Details

Short field takeoffs utilize a climb airspeed which results in the greatest gain in altitude for distance

traveled. This speed is denoted as V_x , and is usually slightly less than V_y for a given airplane. It should be recognized that even small variations in airspeed (as little as 5 knots) can result in significant differences in aircraft performance.

Prior to takeoff the aircraft should be configured for a short-field departure. In some aircraft the configuration is as in a normal takeoff, and in others there may be differences (eg. some flaps may be deployed). Consult the POH/AFM for the specifics of the aircraft being flown.

Using proper runway incursion avoidance procedures, enter the runway and position the aircraft as close to the beginning of the runway as possible. Waste no runway. Position the controls appropriately (for normal or crosswind conditions), and hold the brakes firmly. Advance the throttle to maximum power and confirm all gauges are in the GREEN.

Once you release the brakes, insure you maintain directional control with the rudder. Anticipate the torque and P-factor forces which want to turn the aircraft to the left. DO NOT HESITATE to abort immediately if anything is amiss, such as the airspeed not coming alive or any engine gauges not being in the GREEN.

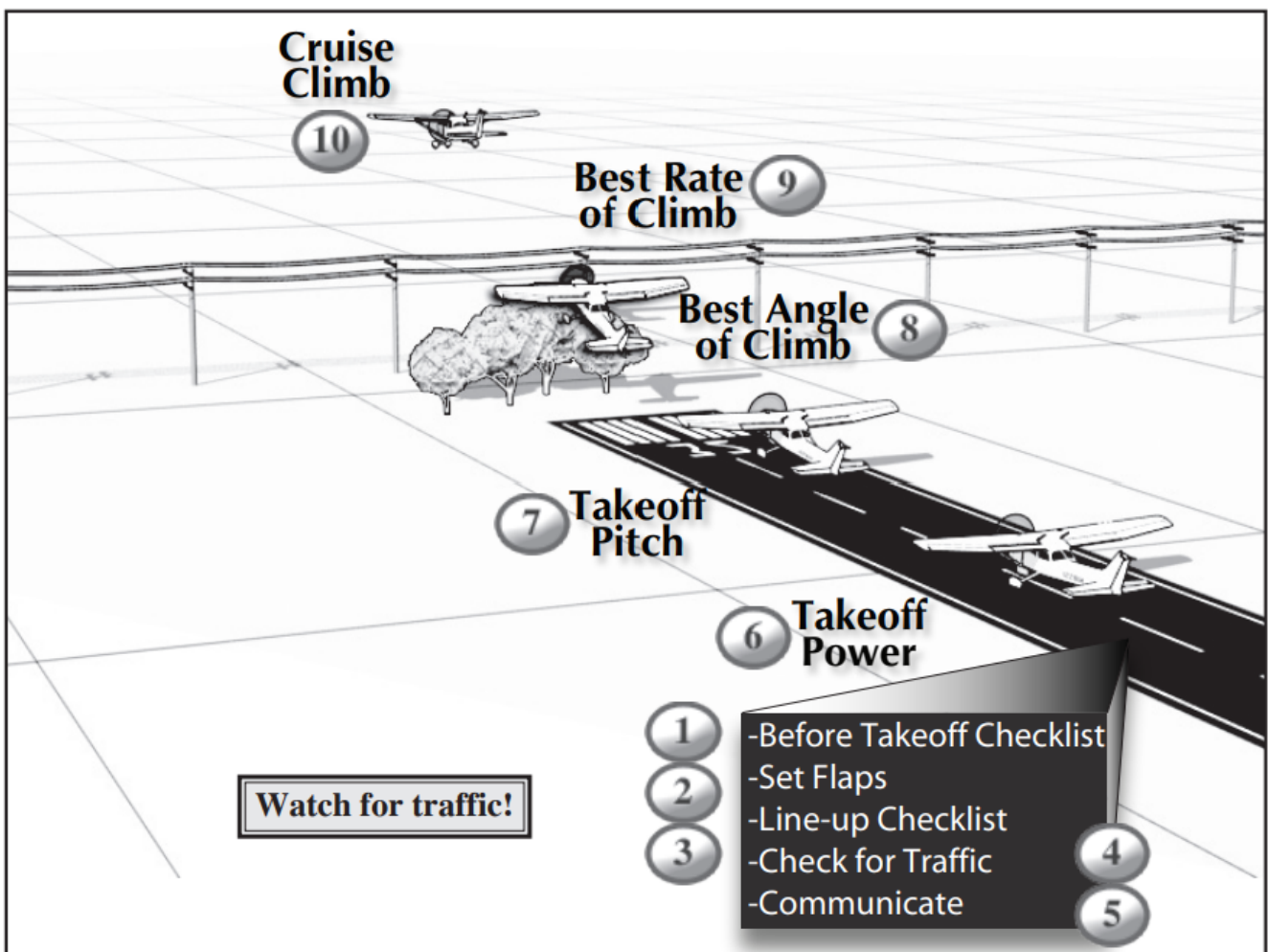
Let the aircraft accelerate to the short-field lift off speed, and then smoothly rotate to an attitude that will maintain V_x (or the speed proscribed for a short field takeoff in the POH/AFM). This will be higher than normal, in the range of 12° , and outside references will need to be used to maintain the correct pitch attitude.

During the roll keep the elevator neutral to reduce drag, and don't deflect the elevator prematurely. Doing so may allow the aircraft to lift off too soon. In the event that the aircraft lifts off prior to V_x lower the nose and let the aircraft accelerate in ground effect. Once at V_x continue to pitch up to maintain that airspeed.

Procedure

1. Ensure that the Before Takeoff Checklist has been completed.
2. Set flaps as appropriate – ensure that flaps come down equally.
3. Ensure that the items on the Line-up Checklist have been completed and/or reviewed.
4. Visually check for traffic on Downwind, Base, and Final in the active and other traffic patterns.
5. Communicate, as appropriate – non-towered airport make traffic advisory call, towered airport read back takeoff clearance.
 - a. Taxi onto the runway, as appropriate. Complete the items from the Line-up Checklist while taxiing. Use the phrase “lights, camera, action” to help remember the items deferred (lights = lights as appropriate, camera = transponder on/altitude, action = mixture rich as required).
 - b. Taxi the aircraft into position, centered on the runway with the nosewheel straight, as close to the approach end as possible.
 - c. Hold the brakes, preventing any movement of the aircraft.
6. Smoothly and positively apply full power. Keep a hand on the throttle in the event an abort becomes necessary.

- a. Check engine instruments (engine rpm and all other “engine instruments in the green”).
 - b. Immediately drop heels onto floor, release the brakes, and apply slight forward pressure on the yoke, allowing the aircraft to accelerate as quickly as possible.
 - c. Check airspeed indicator (“airspeed alive”).
7. Rotate at VLOF, then establish VX pitch attitude.
 - a. Once the aircraft lifts off, establish a Wind Correction Angle (WCA) to maintain the runway centerline with level wings.
 8. Maintain VX or manufacturer’s recommended airspeed until clear of obstacles and at least 50 feet above the surface.
 9. After clearing obstacles, establish VY pitch attitude. Maintain a ground track along the runway and extended centerline with coordinated use of rudder and aileron.
 - a. Retract flaps after clearing all obstacles and establishing the recommended airspeed, climb out at VY
 10. Establish cruise climb above a minimum safe altitude (500-1000’ AGL).



You should compute takeoff and landing performance data prior to all flights. Special emphasis should be placed on determining that adequate runway exists.

Common Errors

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1. Failing to maintain V_x for best angle of climb performance
2. Mishandling the controls in a crosswind situation
3. Failing to allow the aircraft to accelerate to V_x resulting in poor climb and risking a failure to clear obstacles
4. Excessive back pressure resulting in a high pitch attitude which delays liftoff

As the aircraft leaves the surface it will accelerate more rapidly, and this will require more back pressure to maintain V_x . Once liftoff occurs maintain V_x until all obstacles are cleared, then transition to a normal climb pitch attitude which should be V_y . If deployed, do not retract flaps until clear of obstacles. Also, if flaps are deployed, ensure that the aircraft is above the flaps up stall speed before retracting flaps as pulling them prior to that point may result in an immediate stall.

Checklists should be used, but during the takeoff process use should be delayed until at a safely clear of obstacles.

□□Common Errors□□

- Failure to adequately clear the area
- Failure to utilize all available runway/takeoff area
- Failure to have the airplane properly trimmed prior to takeoff
- Premature lift-off resulting in high drag
- Holding the airplane on the ground unnecessarily with excessive forward-elevator pressure
- Inadequate rotation resulting in excessive speed after lift-off
- Inability to attain/maintain best angle-of-climb airspeed
- Fixation on the airspeed indicator during initial climb
- Premature retraction of landing gear and/or wing flaps

Conclusion

The short-field takeoff and maximum performance climb is based on rotating near and pitching directly for V_x . This allows for the greatest climb in the shortest distance, providing obstacle clearance.

ACS Requirements

CFI PTS Standards

To determine that the applicant:

1. Exhibits instructional knowledge of the elements of a short-field takeoff and climb by

describing:

- a. Procedures before taxiing onto the runway or takeoff area to ensure runway incursion avoidance. Verify ATC clearance/no aircraft on final at non-towered airports before entering the runway, and ensure that correct takeoff runway positioning of the airplane with consideration for other aircraft, surface conditions, and wind.
 - b. Short-field takeoff and lift-off procedures.
 - c. Initial climb attitude and airspeed (V_x) until obstacle is cleared (50 feet AGL).
 - d. Proper use of checklist.
2. Exhibits instructional knowledge of common errors related to a short-field takeoff and climb by describing:
 - a. Improper runway incursion avoidance procedures.
 - b. Improper use of controls during a short-field takeoff.
 - c. Improper lift-off procedures.
 - d. Improper initial climb attitude, power setting, and airspeed (V_x) to clear obstacle.
 - e. Improper use of checklist.
 3. Demonstrates and simultaneously explains a short-field takeoff and climb from an instructional standpoint.
 4. Analyzes and corrects simulated common errors related to a short-field takeoff and climb.

Private Pilot ACS Skills Standards

1. Complete the appropriate checklist.
2. Make radio calls as appropriate.
3. Verify assigned/correct runway.
4. Ascertain wind direction with or without visible wind direction indicators.
5. Position the flight controls for the existing wind conditions.
6. Clear the area, taxi into takeoff position and align the airplane on the runway centerline utilizing maximum available takeoff area.
7. Apply brakes while setting aircraft power to achieve maximum performance.
8. Confirm takeoff power prior to brake release and verify proper engine and flight instrument indications prior to rotation
9. Rotate and lift off at the recommended airspeed and accelerate to the recommended obstacle clearance airspeed or $V_y +10/-5$ knots.
10. Establish a pitch attitude that will maintain the recommended obstacle clearance speed, or $V_x +10/-5$ knots, until the obstacle is cleared, or until the airplane is 50 feet above the surface.
11. After clearing the obstacle, establish the pitch attitude for V_y , accelerate to V_y , and

maintain V_y , +10/-5 knots, during the climb.

12. Retract landing gear and flaps after a positive rate of climb has been verified or in accordance with aircraft manufacturer's guidance.
13. Maintain V_y +10/-5 knots to a safe maneuvering altitude
14. Maintain directional control and proper wind drift correction throughout takeoff and climb.
15. Comply with noise abatement procedures.

Commercial Pilot ACS Skills Standards

The same as the Private Pilot, except:

1. Rotate and lift off at the recommended airspeed and accelerate to the recommended obstacle clearance airspeed or V_y +/-5 knots.
2. Establish a pitch attitude that will maintain the recommended obstacle clearance speed, or V_x +/-5 knots, until the obstacle is cleared, or until the airplane is 50 feet above the surface.
3. After clearing the obstacle, establish the pitch attitude for V_y , accelerate to V_y , and maintain V_y , +/-5 knots, during the climb.
4. Maintain V_y +/-5 knots to a safe maneuvering altitude