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Contents

Instructions

This sample eBook was put together to show you our eBooks functionality, how our they're put together, and to provide sample lessons from each of the different FAA PTS and ACS documents.

Loading the Lesson Plans

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We use GoodReader and Adobe Reader Apps

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CFI eBooks

The CFI eBooks cover each of the tasks outlined in the FAA's PTS for the CFI, CFII, and MEI ratings. Common Errors are listed at the end of each lesson and are annotated throughout the lessons by CE.

ACS eBooks

The ACS eBooks include all of the Tasks in the FAA's Private Pilot and Instrument Rating ACS, and cover both the Knowledge and Risk Management areas. The Commercial Pilot ACS is expected to be released in June of 2017.

CFI LESSONS

II.D. Principles of Flight

References: FAA-H-8083-3; FAA-H-8083-25

Objectives	The student should develop knowledge of the elements related to the principles of flight. The student should understand why airplanes are designed in certain ways as well as the forces acting on airplanes and the use of those forces in flight.
Key Elements	1. Stability vs. Maneuverability 2. Left Turning Tendency 3. Load Factors
Elements	1. Airfoil Design Characteristics 2. Airplane Stability and Controllability 3. Turning Tendency (Torque Effect – Left Turning Tendency) 4. Load Factors in Airplane Design 5. Wingtip Vortices and Precautions to be Taken
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References 3. Model Airplane
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the principles to flight.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention grabbing story

Everything you ever wanted to know about the science of the airplane which will result in a considerably better understanding of the airplane and make you a considerably better pilot.

Overview

Review Objectives and Elements/Key ideas

What

The Principles of Flight are the characteristic forces of flight as well as why and how the airplane performs certain ways.

Why

To become a pilot, a detailed technical course in the science of aerodynamics is not necessary. However, with the responsibilities for the safety of passengers, the competent pilot must have a well-founded concept of the forces which act on the airplane, and the advantageous use of these forces, as well as the operating limitations of the particular airplane.

How:

1. **Airfoil Design Characteristics**
    - A. Planform is the term that describes the wings outline as seen from above
        - i. Many factors affect shape: including purpose, load factors, speeds, construction and maintenance costs, maneuverability/stability, stall/spin characteristics, fuel tanks, high lift devices, gear, etc.
        - ii. There are many different shapes and advantages/disadvantages to each (many shapes are combined)
    - B. Taper – The ratio of the root chord to the tip chord
        - i. Rectangular wings have a taper ratio of 1
            - a. Simpler and more economical to produce and repair (ribs are same size)
            - b. The root stalls first providing more warning and control during recovery
        - ii. Ellipse (Tapered)
            - a. Provides the best span wise load distribution and lowest induced drag
            - b. But, the whole wing stalls at the same time and they are very expensive/complex to build
    - C. Aspect Ratio – divide the wingspan by the average chord
        - i. The greater the aspect ratio, the less induced drag (more lift)
        - ii. Increasing wingspan (with the same area) results in smaller wingtips, generating smaller vortices
            - a. Reduces induced drag and are more efficient
            - b. Planes requiring extreme maneuverability and strength have much lower aspect ratios
                - Ex: Fighter, and aerobatic aircraft
    - D. Sweep – When the line connecting the 25% chord points of the ribs isn't perpendicular to the longitudinal axis
        - i. The sweep can be forward, but it is usually backward

ii. Help in flying near the speed of sound but also contributes to lateral stability in low-speed planes

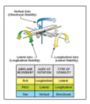
2. Airplane Stability and Controllability

A. Controllability - Capability to respond to the pilot's control especially in regard to flight path and attitude
   i. Quality of response to control application when maneuvering regardless of stability characteristics

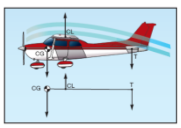
B. Maneuverability - Quality that permits a plane to be maneuvered easily and withstand stresses imposed
   i. Governed by the weight, inertia, size/location of flight controls, structural strength and power plant
   ii. It is a design characteristic

C. Stability
   i. The inherent quality of an airplane to correct for conditions that may disturb its equilibrium, and return to or continue on the original flight path (This tendency is primarily a design characteristic)
      a. In other words, a stable plane will tend to return to its original condition if disturbed
         - The more stability, the easier to fly, but too much results in significant effort to maneuver
            a Therefore, stability and maneuverability must be balanced
   ii. There are two types of stability: Static and Dynamic
   iii. Static Stability (SS)
      a. Equilibrium: All opposing forces are balanced (Steady unaccelerated flight conditions)
      b. SS: The *initial tendency* that airplane displays after its equilibrium is disturbed
         - Positive SS: The initial tendency to return to the original state of equilibrium after being disturbed (to return to the trimmed condition)
         - Negative SS: The initial tendency to continue away from original equilibrium after being disturbed (the aircraft moves farther and farther away from the trimmed position)
         - Neutral SS: The initial tendency to remain in a new condition after equilibrium has been disturbed (the aircraft remains in a new position and does not return or trend away from the original trimmed position)
      c. Positive SS is the most desirable - The plane attempts to return to the original trimmed attitude
   iv. Dynamic Stability (DS)
      a. SS refers to the initial response, DS describes how the system responds over time
         - Refers to whether the disturbed system returns to equilibrium over time or not
         - The degree of stability can be gauged in terms of how quickly it returns to equilibrium
         - Referred to as Positive, Negative, and Neutral – Same as SS but over time (overall tendency)
      b. DS can be further divided into oscillatory and non-oscillatory modes
         - Oscillatory: Smooth bowl with a marble on the bottom – the system is in equilibrium
            a If moved up the side and let go (disturb equilibrium) it comes to rest after some oscillations
               1. Positive static, and oscillatory positive dynamic stability

        - b The longer oscillations (time), the easier the plane is to control (long period > 10 sec)
        - c The shorter oscillations, the more difficult, to control (short period < 1-2 sec)
        - d Neutral/Divergent short oscillation is dangerous as structural failure can result
    - Non-Oscillatory: Do the same thing with a cotton ball, it simply returns with no oscillations
  - c. Most desirable is Positive Dynamic Stability
- v. Longitudinal Stability (LS)



  - a. LS makes an airplane stable about its lateral axis and involves the pitching motion
    - A Longitudinally unstable plane has a tendency to dive and climb progressively steeper making it difficult/dangerous to fly
  - b. To obtain LS the relation of the wing and tail moments must be such that, if the moments are initially balanced and the airplane is suddenly nosed up, the wing moments and tail moments will change so that their forces will provide a restoring moment bringing the nose down again
    - And, if the plane is nosed down, the change in moments will bring the nose back up
  - c. Static LS or instability is dependent on 3 factors:



    - Location of the wing in relation to the Center of Gravity (CG)
      - a The CG is usually ahead of the wing's Center of Lift (CL) resulting in nose down pitch
      - b This nose heaviness is balanced by a downward force generated by the horizontal tail
        1. The horizontal stabilizer is often designed with a negative AOA to create a natural tail-down force
        2. Remember, the tail down force lifts the nose of the aircraft up (pitch up motion)
      - c CG-CL-Tail-down force line is like a lever with an upward force at CL and 2 downward forces (CG and Tail-down) on either side balancing each other
        1. The stronger down force is at the CG; the Tail down force is weaker (but has a longer arm)
      - d If the nose is pitched up (with no other change in controls/power), airspeed will begin to decrease. As airspeed decreases the tail-down force of the elevator will decrease. As the tail-down force decreases, the nose of the aircraft will begin to pitch down, resulting in increased airspeed. As airspeed increases, the tail-down force of the stabilizer will increase lifting the nose back up. If left untouched, this process will continue and each pitch up/down will diminish until the aircraft returns to stabilized flight.
    - Location of the horizontal tail surfaces with respect the CG
      - a If the plane is loaded with the CG farther forward, more tail down force is necessary
        1. This adds to longitudinal stability since the nose heaviness makes it more difficult to raise the nose and the additional tail down forces makes it difficult to pitch down
           - a. Any small disturbances are opposed by larger forces, dampening them quickly
      - b If the plane is loaded farther aft, the plane becomes less stable in pitch
        1. If the CG is behind the CL, the tail must exert an upward force so the nose doesn't pitch up

        2. If a gust pitches the nose up, less airflow over the tail will cause the nose to pitch further
        3. This is an extremely dangerous situation
    - The area or size of the tail surfaces
        a The larger the area/size of the tail surface, the more force exerted

vi. Lateral Stability (About the Longitudinal Axis)

  a. Lateral stability about the longitudinal axis is affected by:
    - Dihedral; Sweepback Angles; Keel Effect; Weight Distribution

  b. Dihedral is the angle at which the wings are slanted upward from the root to the tip
    - Dihedral balances lift created by the wings' AOA on each side of the longitudinal axis
        a The airplane tends to sideslip or slide downward toward the lowered wing
        b Dihedral causes the air to strike the low wing at a greater AOA than the high wing
        c This increases the low wing lift/decreases high wing lift restoring the original attitude
    - Shallow turn: the increased AOA increases lift on the low wing with a tendency to return the aircraft to Straight and Level flight

  c. Sweepback is the angle at which the wings are slanted rearward from the root tip
    - Sweepback increases dihedral to achieve stability, but the effect is not as pronounced

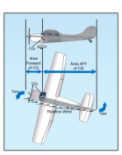
  d. Keel effect depends on the action of the relative wind on the side area of the fuselage
    - Laterally stable airplanes: The greater portion of the keel area is above and behind the CG
        a When the plane slips to one side, the combo of the plane's weight and the pressure of the airflow against the upper portion of the keel area rolls the plane back to wings level
    - To Summarize: The fuselage is forced by keel effect to parallel the wind

  e. Weight Distribution
    - If more weight is located on one side, it will have a tendency to bank that direction

vii. Directional Stability (DS - Stability about the vertical axis)

  a. DS is affected by the area of the vertical fin and the sides of the fuselage aft of the CG
    - Makes the airplane act like a weathervane, pointing the nose into the relative wind

  b. SIDE - For a weathervane to work, a greater surface area must be aft of the pivot point



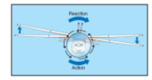
    - Therefore, the side surface must be greater aft of the CG than ahead of the CG
    - Ex: If the nose yaws left it will pivot around the CG. As the aircraft yaws, the relative wind will push on the right side of the fuselage. Since there is more surface area behind the pivot point (CG), there is more force applied behind the CG and the nose will be pushed back to the right

  c. VERTICAL FIN – the vertical fin acts like a feather on an arrow in maintaining straight flight
    - The farther aft the fin is placed and the larger its size, the greater the DS
    - As the plane yaws in one direction, the air strikes the opposite side of the vertical fin
        a This puts pressure on vertical fin stopping the motion and then returning the nose into the relative wind (like a weathervane)
        b Ex: If the nose yaws right, the relative wind puts pressure on the left side of the vertical stabilizer stopping the movement and moving the nose of the aircraft back to the left

3. Turning Tendency (Torque Effect – Left Turning Tendency)

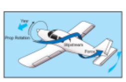
A. Torque is made up of 4 elements which produce a twisting axis around at least 1 of the planes 3 axes
  - i. Torque Reaction, Corkscrew Effect of the Slipstream, Gyroscopic Action of the Prop, and P-Factor

B. Torque Reaction



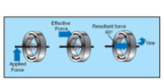
  - i. Newton's 3rd Law – For every action there is an equal and opposite reaction
    - a. The engine parts/propeller rotate one way; an equal force attempts to rotate the plane the opposite direction
  - ii. When airborne, this force acts around the longitudinal axis, resulting in a left rolling tendency
  - iii. On the ground, during takeoff, the left side is being forced down resulting in more ground friction
    - a. This causes a turning moment to the left that is corrected with rudder
      - Strength is dependent on engine size/hp, propeller size/rpm, plane size and ground surface
        - a The higher the power setting, the greater the left turning tendency
  - iv. Torque is corrected by offsetting the engine, and using aileron trim tabs, and aileron/rudder use
    - a. Most aircraft engines are not installed on the centerline of the aircraft (on the longitudinal axis), they are offset in order to counteract a portion of the rolling motion caused by torque
    - b. Trim tabs can be adjusted to counter the turning tendency in level flight
    - c. Torque not countered by the engine and trim tab position must be corrected with coordinate rudder and aileron inputs

C. Corkscrew/Slipstream Effect
  - i. The high-speed rotation of the propeller sends the air in a corkscrew/spiraling rotation to the rear of the aircraft
    - a. The air strikes the left side of the vertical stabilizer, pushing the nose of aircraft left
  - ii. At high prop speeds/low forward speeds the rotation is very compact
    - a. This exerts a strong sideward force on the vertical tail causing a left turn around the vertical axis



    - b. The corkscrew flow also creates a rolling moment around the longitudinal axis
      - The rolling moment is to the right and may counteract torque to an extent
  - iii. As the forward speed increases, the spiral elongates and becomes less effective
  - iv. The slipstream effect is countered with coordinate rudder and aileron and is most pronounced in climbs (high prop speed and low forward speed)

D. Gyroscopic Action
  - i. Gyroscopes are based on two fundamental principles:
    - a. Rigidity in space (not applicable to this discussion)
    - b. Precession - The resultant action of a spinning rotor when a force is applied to its rim
      - If a force is applied, it takes effect 90° ahead of, and in the direction of turn
        - a This causes a pitch/yaw moment or combo of the two depending on where applied
        - b Ex: This most often occurs with tail wheel aircraft when the tail is being raised on the takeoff roll



          1. The change in pitch (lifting the tail wheel) has the same effect as applying a forward force to the top of the propeller

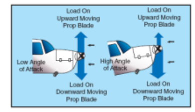
a. This force is felt 90° in the direction of rotation (clockwise as viewed from the cockpit)

2. The forward force will take effect on the Right side of the propeller, yawing the aircraft Left

ii. Any yawing around the vertical axis results in a pitching moment

iii. Any pitching around the lateral axis results in a yawing moment

iv. Correction is made with necessary elevator and rudder pressures



E. Asymmetric Loading (P Factor)

i. When flying with a high AOA, the bite of the down moving blade is greater than the up-moving blade

a. This moves the center of thrust to the right of the propeller disc area (causing a yaw to the left)

ii. This is caused by the resultant velocity, which is generated by the combination of the prop blade velocity in its rotation and the velocity of the air passing horizontally through the prop disc

a. At positive AOA, the R blade is passing through an area of resultant velocity greater than the L

b. Since the prop is an airfoil, increased velocity means increased lift

- Therefore, the down blade has more lift and tends to yaw the plane to the left

iii. EXAMPLE: Visualize the prop shaft mounted perpendicular to the ground (like a helicopter)

a. If there were no air movement at all, except that generated by the prop, identical sections of the blade would have the same airspeed

b. But, with air moving horizontally across the vertically mounted prop, the blade proceeding forward into the flow of air will have a higher airspeed than the blade retreating

- The blade proceeding is creating more lift or thrust, moving the center of lift toward it

c. Visualize rotating the prop to shallower angles relative to the moving air (as on an airplane)

- The unbalanced thrust gets smaller until it reaches zero when horizontal to the airflow

iv. Summary: The descending blade of the propeller has a higher AOA, resulting in a bigger bite of air, therefore the center of thrust is moved to the right side of the aircraft's centerline and the aircraft will have a tendency to yaw to the left

4. Load Factors (LF) in Airplane Design

A. LF – The force applied to an aircraft to deflect its flight from a straight line that produces a stress on its structure

i. Load factor is the ratio of the total air load acting on the airplane to the gross weight of the airplane

a. EX: a LF of 3 means that total load on the structure is 3x its gross weight; expressed as 3 G's

- Subjecting a plane to 3 G's will result in being pressed into the seat by 3x your weight

B. LF is important to the pilot for two distinct reasons

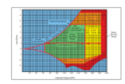
i. The obviously dangerous overload that is possible for a pilot to impose on the structure

a. An excessive load can result in the structural failure of an aircraft

ii. An increased LF increases the stall speed and makes stalls possible at seemingly safe speeds

C. Airplane Design

        i. How strong an airplane should be is determine largely by the use it will be subjected to
            a. This is difficult as maximum possible loads are much too high to incorporate in efficient design
                - If planes are to be built efficiently, extremely excessive loads must be dismissed
                - The problem becomes determining the highest LF that can be expected in normal operation under various operational situations – These are ‘Limit Load Factors’
                    a Planes must be designed to withstand Limit Load Factors with no structural damage
        ii. Airplane’s are designed in accordance with the Category System:
            a. Normal Category limit load factors are -1.52 G’s to 3.8 G’s
            b. Utility Category limit load factors are -1.76 G’s to 4.4 G’s (Mild acrobatics, including spins)
            c. Acrobatic Category limit load factors are -3.0 G’s to 6.0 G’s
        iii. The more severe the maneuvers, the high the load factors
    D. The Vg diagram shows the flight operating strength of a plane that is valid for a certain weight/altitude
        i. It presents the allowable combination of AS and LF for safe operation



5. Wingtip Vortices and Precautions to be Taken

    A. Whenever the wing is producing lift, pressure on the lower surface of the wing is greater than the upper
        i. The air tends to flow from the high-pressure area below, upward to the low-pressure area above
        ii. This causes a rollup of the airflow aft of the wing and swirling air masses trailing behind the wingtips
            a. The wake consists of 2 counter-rotating cylindrical vortices, one emanating from each wingtip
    B. The strength of the vortex is governed by the weight, speed, and shape of the wing
        i. The AOA directly affects the strength
            a. As weight increases, AOA increases
            b. A wing in the clean configuration has a greater AOA than with flaps, slats, etc. in use
            c. As airspeed decreases, AOA increases
        ii. The greatest vortex strength occurs when heavy, clean, and slow (during takeoff and landing)
    C. Vortices Behavior
        i. Sink at a rate of several hundred fpm, slowing/diminishing the further they get behind an aircraft
        ii. When vortices sink to the ground they tend to move laterally with the wind
            a. A X-wind will decrease lateral movement of the upwind and increase movement of downwind
                - Be cautious, this could move another aircraft’s vortices into your path
            b. A tailwind can move the vortices of the preceding aircraft forward into the touchdown zone
    D. Avoidance
        i. Wake turbulence can be a hazard to any aircraft significantly lighter than the generating aircraft
            a. Could result in major structural damage, or induced rolling making the aircraft uncontrollable

ii. Landing – Stay above and land beyond a landing jet's touchdown point; land prior to a departing jet's takeoff point
    a. Parallel runways – stay at and above the other jet's flight path for the possibility of drift
    b. Crossing runways – cross above the larger jet's flight path
iii. Takeoff – Takeoff after a landing jet's touchdown point, and takeoff before and stay above another departing jet's path

Conclusion:
Brief review of the main points
The competent pilot must have a well-founded concept of the forces which act on the airplane, and the advantageous use of these forces, as well as the operating limitations of the particular airplane.

PTS Requirements:
To determine that the applicant exhibits instructional knowledge of the elements of principles of flight by describing:

1. Airfoil design characteristics.
2. Airplane stability and controllability.
3. Turning tendency (torque effect).
4. Load factors in airplane design.
5. Wingtip vortices and precautions to be taken.

VII.C. Soft-Field Takeoff and Climb

References: FAA-H-8083-3; POH/AFM

Objectives: To develop the understanding of and skills needed to perform takeoffs from soft fields. The student should be able to demonstrate this takeoff to PTS standards making corrections for any crosswind that may exist.

Key Elements

1. Constant back pressure
2. Transfer weight from the wheels to the wings
3. Stay in ground effect until reaching V_Y or V_X

Elements

1. Overview
2. Taxi
3. Takeoff Roll
4. Lift-Off
5. Initial Climb

Schedule

1. Discuss Objectives
2. Review material
3. Development
4. Conclusion

Equipment

1. White board and markers
2. References

IP's Actions

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

SP's Actions

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

Completion Standards: The lesson is complete when the student can demonstrate the knowledge of, and has shown proficiency in soft field takeoffs and climbs, with and without an obstacle and without the assistance of a flight instructor. The student must be able to maintain positive control of the airplane in ground effect until reaching the proper speed for climb out while demonstrating the proper use of checklists, traffic scan and safety procedures.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention grabbing story

Have you ever got your car stuck off-roading? Why did it happen? So, what do we do when we have to takeoff an airplane in off-road conditions?

Overview

Review Objectives and Elements/Key ideas

What

A takeoff from a "soft" field - just like it says, we are attempting to takeoff from a soft, often uneven surface which could produce enough drag to prevent the airplane from reaching normal takeoff speeds.

Why

Soft surfaces or long wet grass can reduce the aircraft's acceleration so much during the takeoff roll that adequate takeoff speed might not be attained if normal takeoff techniques were employed. As a maneuver, this will greatly improve takeoffs, landings, and aircraft control.

How:

1. Overview

- A. The goals of a soft field takeoff are:
  - i. To get the airplane airborne as quickly as possible in order to eliminate drag caused by tall grass, soft sand, mud, and snow
    - a. Soft surfaces, grass, etc. reduce the airplane's acceleration during the takeoff roll so much that adequate takeoff speed may not be attained in a normal takeoff
    - b. The soft field takeoff is also used on a rough field where it is advisable to get the plane off the ground as soon as possible to avoid damaging the gear
  - ii. To transfer as much weight as possible to the wings
    - a. This minimizes drag caused by the surface
- B. The soft field takeoff makes judicious use of ground effect
  - i. Requires a feel for the plane and fine control touch
    - a. Leaving ground effect early could result in settling back to the runway or stalling
- C. Basics
  - i. Keep the aircraft moving
    - a. Stopping on a soft surface might bog the airplane down or get it completely stuck
  - ii. Maintain back pressure
    - a. Keep as much weight off the nose as possible to prevent it getting stuck, or digging in
  - iii. Do a wheelie down the runway
    - a. Establish and maintain a relatively high angle of attack or nose-high pitch as early as possible
    - b. Transfer the airplane's weight rapidly as possible from the wheels to the wings
  - iv. Accelerate in ground effect until reaching climb speed

2. Taxi

- A. At a towered field, don't cross the hold short bars unless cleared to
- B. If uncontrolled, announce your intentions before taxiing onto the runway

C. Before taxiing onto the runway visually clear the area
    i. Check the final approach and the rest of runway for traffic
        a. Never taxi out with another plane on final approach
    ii. CE - Improper runway incursion avoidance procedures
    iii. CE - Failure to adequately clear the area
D. Keep the elevator fully aft for the entire taxi
    i. This keeps as much weight as possible off the main wheel keeping it from getting stuck or bogged down
E. More power is necessary due to the increased ground friction/drag
    i. This also increases control effectiveness due to larger displacement of air
F. Keep turns shallow and Don't stop
    i. Stopping on a soft surface, such as mud or snow, might bog the airplane down; therefore, it should be kept in continuous motion with sufficient power while lining up for the takeoff roll

3. Takeoff Roll

A. Determine the crosswind condition and apply the appropriate correction
    i. Done the same as a normal takeoff
B. Maintain back elevator pressure and maintain movement
    i. Don't let the nose wheel settle or the aircraft come to a stop
C. While aligning the aircraft with the centerline, takeoff power is accelerated smoothly and rapidly
    i. Don't stop to align the aircraft with the centerline
    ii. CE – Failure to cross check engine instruments for indications of proper operation after applying power
        a. Ensure proper engine operation
    iii. CE - Poor directional control
        a. Use proactive rudder pressure to counteract the yawing forces and keep the airplane moving straight down the center of the runway
D. The initial momentum required for takeoff is going to require much more power than normal
    i. Anticipate a slow acceleration
E. Back elevator pressure is initially held full aft
    i. As the plane accelerates and the nose lifts off the ground the elevator pressure is relaxed as necessary (Half back pressure in DA20) to maintain a nose high pitch attitude keeping the nose wheel off the ground (maintaining full back pressure during acceleration would result in the tail striking the ground)
        a. Site Picture: The cowling should be on the horizon
            - Approximately 5-6^{o} of pitch
        b. CE – Insufficient back elevator pressure during the initial takeoff roll resulting in an inadequate angle of attack
            - As speed increases, back pressure must be reduced to avoid an excessive angle of attack
                a Too much back pressure can increase drag or drag the tail
        c. Important to continue to use rudder to control direction
            - Use rudders to control direction during the ground roll
                a Do not use ailerons
    ii. With the nose-high attitude throughout the takeoff run, the wings will, as speed increases and lift develops, progressively relieve the wheels of more and more of the airplane's weight
        a. This minimizes the drag caused by the soft, unstable surface

iii. The airplane will effectively fly itself off the ground at a speed slower than the normal rotation speed because of ground effect

4. Lift-Off

A. After the airplane initially becomes airborne, the nose should be lowered gently with the wheels clear of the surface to allow the airplane to accelerate to V_X or V_Y in ground effect
  i. V_X if an obstacle must be cleared
  ii. CE - Abrupt or excessive elevator control while attempting to level off and accelerate after lift-off
    a. Smoothly apply forward pressure to keep the aircraft close to the ground
    b. Abrupt/excessive control movements could easily put the aircraft back into the ground

B. Site Picture: The nose will be point further downward, toward the runway, as airspeed, and lift increase
  i. Forward pressure is required to stay in ground effect
    a. Forward pressure combined with the nose pointing down while close to the ground can be VERY uncomfortable, especially to a new pilot
    b. Necessary to stay in ground effect

C. Ailerons and Rudder
  i. While over the runway, use rudder to correct drifting tendencies
    a. Not ailerons

D. Trying to climb out of ground effect too early or too steeply may result in the airplane settling back onto the surface
  i. In ground effect, the vertical component of the airflow about the wing is restricted
    a. Alters up wash, downwash, and wingtip vortices
  ii. Reduces Induced Drag
    a. Requiring a lower angle of attack and less required thrust
  iii. For ground effect to be effective, the wing must be within ½ of its wingspan of the ground
    a. If the airplane tries to climb out of ground effect without enough speed, the greater induced drag may result in marginal to no climb performance

E. The airplane must remain in ground effect until at least V_X is reached
  i. CE - Attempting to climb out of ground effect area before attaining sufficient climb speed
  ii. CE - Allowing the airplane to "mush" or settle resulting in an inadvertent touchdown after lift-off
    a. Maintain back pressure to remain in ground effect, and do not attempt to climb out of ground effect until reaching a safe climb airspeed
  iii. CE - Improper lift-off procedures
    a. Maintain back pressure, adjust as necessary to keep the nose wheel off the ground without striking the tail, once airborne apply forward pressure as necessary in order to remain in ground effect until reaching the required climb speed

5. Initial Climb

A. When leaving ground effect
  i. CE - Attempting to climb out of ground effect area before attaining sufficient climb speed
    a. Do not leave ground effect until reaching V_X or V_Y
  ii. CE - Improper climb attitude, power setting, and airspeed (V_X or V_Y)
    a. Set the pitch attitude for the airspeed desired (V_X or V_Y)
    b. Leave max power (takeoff power)
  iii. CE - Failure to anticipate an increase in pitch attitude as the airplane climbs out of ground effect
    a. As the aircraft climbs out of ground effect, back pressure will have to be increased

B. In the case of a crosswind, maintain the runway centerline in a slip until at least out of ground effect or until clear of obstacles
   i. Then transition into a crab
C. After a positive rate of climb is established, and the airplane has accelerated to V_X or V_Y climb out as normal
   i. Soft field runways are often short field runways (V_X may be necessary more often than not)
   ii. If departing from a wet/slushy airstrip, the gear should not be retracted immediately, allowing it to air dry
      a. If cold, cycle multiple times to avoid freezing
   iii. If climbing out to avoid an obstacle, the climb out is performed at V_X until the obstacle is cleared
      a. After clearing the obstacle, the pitch attitude is adjusted to V_Y and the power may be set to the normal climb setting
D. Climb Checklist
   i. CE - Improper use of checklists
      a. Be sure the airplane is properly configured for the climb

Common Errors (CE):

- Improper runway incursion avoidance procedures
- Failure to adequately clear the area
- Insufficient back elevator pressure during the initial takeoff roll resulting in an inadequate angle of attack
- Failure to cross check engine instruments for indications of proper operation after applying power
- Poor directional control
- Improper lift-off procedures
- Climbing too steeply after lift-off
- Abrupt and/or excessive elevator control while attempting to level off and accelerate after lift-off
- Allowing the airplane to "mush" or settle resulting in an inadvertent touchdown after lift-off
- Attempting to climb out of ground effect area before attaining sufficient climb speed
- Improper climb attitude, power setting, and airspeed (V_X or V_Y)
- Failure to anticipate an increase in pitch attitude as the airplane climbs out of ground effect
- Improper use of checklists

Conclusion:

Brief review of the main points

Anytime we are taking off from a soft field runway, we need to as efficiently as possible get the weight off the wheels of the airplane and onto the wings, therefore reducing drag and allowing the airplane to accelerate to a safe takeoff speed before attempting to climb out, otherwise it may not be possible to accelerate to the speed required.

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of the elements of a soft-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 correct takeoff runway positioning of the airplane with consideration for other aircraft, surface conditions, and wind.
   b. Soft-field takeoff and lift-off procedures.
   c. Initial climb attitude and airspeed, (V_x, if an obstacle is present (50 feet AGL), or V_y).
   d. Proper use of checklist.
2. Exhibits instructional knowledge of common errors related to a soft-field takeoff and climb by describing:
   a. Improper runway incursion avoidance procedures.
   b. Improper use of controls during a soft-field takeoff.
   c. Improper lift-off procedures.
   d. Improper climb attitude, power setting, and airspeed (V_y or V_x).
   e. Improper use of checklist.
3. Demonstrates and simultaneously explains a soft-field takeoff and climb from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to a soft-field takeoff and climb.

X.A. Rectangular Course

References: FAA-H-8083-3

Objectives	The student should develop knowledge of the elements related to the rectangular course and the elements involved in maintaining a proper ground track. The student will have the ability to perform the maneuver as required in the PTS.
Key Elements	1. Plan Ahead 2. Wind Corrections 3. Coordination
Elements	1. Selecting a Suitable Altitude 2. Selecting a Suitable Reference Point 3. The Basics 4. Prior to Entry 5. The Maneuver 6. Coordination
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands how wind can affect the ground track of the airplane and has the ability to make the necessary corrections in order to maintain a uniform ground track, especially while in the traffic pattern.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention grabbing story

This maneuver will make the traffic pattern much more natural and easy…

Overview

Review Objectives and Elements/Key ideas

What

A training maneuver in which the ground track of the airplane is equidistant from all sides of a selected rectangular area on the ground.

Why

This maneuver simulates the conditions encountered in a traffic pattern and therefore prepares the student for traffic pattern work. It assists in perfecting:

- The practical application of the turn
- The division of attention between the flight path, ground objects, and handling of the airplane
- The timing of the start of the turn so that it will be fully established at a definite point over the ground
- The timing of the recovery from a turn so that a definite ground track will be maintained
- The establishing of a ground track and the determination of the appropriate crab angle

How:

1. **Selecting a Suitable Altitude**
   A. Entry altitude should be 600' - 1,000' AGL (per the PTS)
      i. ± 100' restrictions
         a. At 600' AGL, there is no room for error below; At 1,000' AGL, there is no room above
         b. 800'AGL is a good altitude
2. **Selecting a Suitable Reference Point**
   A. A square or rectangular field, or an area bounded by 4 sides by section lines or roads should be selected
      i. The sides should be approximately 1 mile in length
   B. Wind direction must be estimated (METAR, smoke, water, or a 360° turn noting ground track)
      i. If possible, one leg should be parallel with the wind
   C. Only use references clear of populated areas, obstructions, and anything that could pose a hazard
   D. The reference should allow for a nearby landing area in case of an emergency during the maneuver
   E. CE - Selection of a ground reference without a suitable emergency landing area within gliding distance
      i. Part of poor planning, always be prepared for any type of emergency
      ii. Select a reference field and an emergency landing area
3. **The Basics**
   A. The rectangular course is designed to be similar to a traffic pattern
   B. The aircraft should be flown parallel to and at a uniform distance, about ¼ to ½ mile, from the boundaries

    i. Not directly above the boundaries since this will not provide useable reference points for turning
    ii. The pilot should be able to see the edges of the rectangle easily
C. All turns should be started when the aircraft is abeam the corner of the field boundaries
    i. The closer the track to the boundaries, the steeper the bank necessary at the turning points
        a. Bank should be limited to 45° maximum
D. Wind Correction
    i. To maintain a course parallel/of equal distance to the boundaries wind must be accounted for
        a. Whenever there is any crosswind, the plane will have to be crabbed into the wind
        b. The amount of bank in a turn will vary depending on groundspeed
            - The faster the groundspeed (tailwind), the steeper the bank required to maintain the desired ground track
            - The slower the groundspeed (headwind), the shallower the bank required to maintain the desired ground track
            - During turns, to maintain altitude, increase back pressure as necessary
                a Use visual references and the instrument indications
    ii. CE - Improper correction for wind drift
        a. This occurs either from not understanding the effects of wind or from not dividing attention
E. Airspeed is maintained by increasing or decreasing power as necessary
F. CE - Failure to maintain selected altitude or airspeed
    i. This is due to poor division of attention and/or lack of proper pitch awareness (Learn/use visual references)
    ii. Not exceeding 45° of bank should help maintain airspeed
G. The maneuver requires you to divide attention between the distance, turns, altitude, and airspeed
    i. Plan ahead and do not focus on one part of the maneuver (e.g. watching the ground)
    ii. CE - Poor planning, orientation, division of attention - PLAN AHEAD
        a. This results in not beginning/ending the turns properly, crosswind correction is not established
        b. Altitude, airspeed, and ground track are hindered

4. Prior to Entry

A. Pre-Maneuver Checklist - Lights ON; Fuel Pump ON; Mixture FULL RICH; Gauges GREEN
B. Clearing Turns
C. Airspeed - 95 knots and trimmed for hands off, level flight
D. Orientation - Orient yourself in relation to the wind, plan to enter on a 45° entry to the downwind

5. The Maneuver

A. Entry is made at a 45° to the downwind (like a traffic pattern)
    i. Upon reaching ¼ to ½ mile from the field, turn to a downwind heading parallel to the field
B. Downwind Leg
    i. Since the airplane has a direct tailwind, no wind correction is needed
    ii. While the airplane is on the downwind leg, observe the next boundary and plan the turn
        a. The tailwind results in a higher groundspeed (relative to the other legs)
            - Thus, the turn to the next leg is entered with a fast rate of roll-in and relatively steep bank

            - a Higher groundspeed = steeper bank to maintain the desired track over the ground
        - As the turn progresses, bank is reduced slowly since the tailwind (and therefore groundspeed) are reducing
            - a Decreasing ground speed = decreasing bank to maintain the same ground track

C. Base Leg (Or equivalent to a base leg)
    i. On the base leg, the wind will tend to push the aircraft away from the field
        a. To compensate for the drift, the turn to the base leg will have to be more than 90°
            - A crab will have to be established into the wind
        b. When rolling out onto this leg, the airplane will be turned slightly toward the field/into the wind
            - The amount of crab will vary based on the strength of the wind, adjust the crab based on movement toward or away from the field
    ii. The airplane should maintain the same distance from the field boundary and the same altitude
    iii. The base leg is continued until the upwind leg boundary is being approached
        a. Again, anticipate the drift and turning radius of the next turn and leg
        b. Since drift correction was held on the base leg, the turn to the upwind leg will be less than 90°
            - Start the turn with medium bank and gradually reduce to a shallow bank
                - a Groundspeed further decreases as the crosswind becomes a headwind, therefore less bank is required as the aircraft becomes established on the upwind leg
        c. The rollout should be timed to parallel the boundary of the field as the wings come level

D. Upwind Leg
    i. When on the upwind leg, no wind correction is needed as the plane is headed directly into the wind
    ii. Maintain distance and altitude
        a. Use visual references to maintain altitude and heading, cross check with the instruments
    iii. Observe the next boundary as it is being approached in order to plan the turn to crosswind
        a. Due to the headwind (slowest groundspeed), the turn to the crosswind leg will begin with shallow bank
            - This is because the groundspeed is reduced and the wind will try to push the aircraft toward the field
            - As the turn progresses, the headwind decreases, allowing the groundspeed to increase
                - a Therefore, bank must be gradually increased to keep the proper distance from the field
        b. The turn will be stopped at a point before reaching 90°
            - The wind will be pushing the aircraft toward the field
                - a The aircraft must be crabbed into the wind to maintain the rectangular ground track

E. Crosswind Leg
    i. While on the crosswind leg, the wind correction angle should be adjusted to keep proper distance
    ii. The pilot should be planning the turn onto the downwind leg

a. Since a wind correction angle is being held into the wind, this turn will be more than 90°
b. The crosswind becomes a tailwind, so bank is initially medium and steepened through the turn
c. The rollout is timed so wings are level when aligned with the downwind leg as the longitudinal axis of the plane is parallel to the field boundary

F. Anomalies
   i. Usually, drift should not be encountered on the upwind/downwind legs
      a. It may be difficult to find a situation where the wind is blowing exactly parallel to the boundaries
      b. Therefore, slight wind correction may be necessary on all the legs

6. Coordination

A. The airplane must remain in coordinated flight at all times
   i. Don't use the rudder to correct for wind drift, turn the plane with coordinated controls
   ii. Don't use the rudder to encourage a turn, this could result in a dangerous crossed-control situation

B. CE - Uncoordinated flight control application
   i. This normally occurs when fixating on the boundaries and attempt to use rudder to correct drift

Common Errors (CE):

- Poor planning, orientation, division of attention
- Uncoordinated flight control application
- Improper correction for wind drift
- Failure to maintain selected altitude or airspeed
- Selection of a ground reference without a suitable emergency landing area within gliding distance

Conclusion:

Brief review of the main points

It is important to anticipate turns to correct for ground speed, drift, and turning radius. When the wind is blowing with the aircraft, turns must be steeper; when it's blowing against, turns must be slow/shallow. The same techniques apply in traffic patterns.

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of the elements of a rectangular course by describing:
   a. How to select a suitable altitude.
   b. How to select a suitable ground reference with consideration given to emergency landing areas.
   c. Orientation, division of attention, and planning.
   d. Configuration and airspeed prior to entry.
   e. Relationship of a rectangular course to an airport traffic pattern.
   f. Wind drifts correction.
   g. How to maintain desired altitude, airspeed, and distance from ground reference boundaries.
   h. Timing of turn entries and rollouts.

i. Coordination of flight controls.

2. Exhibits instructional knowledge of common errors related to a rectangular course by describing:
    a. Poor planning, orientation, or division of attention.
    b. Uncoordinated use of flight controls.
    c. Improper correction for wind drift.
    d. Failure to maintain selected altitude or airspeed.
    e. Selection of a ground reference where there is no suitable emergency landing area within gliding distance.
3. Demonstrates and simultaneously explains a rectangular course from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to a rectangular course.

CFII LESSONS

VI.A-E. Basic Attitude Instrument Flight

References: FAA-H-8083-3; FAA-8083-3-15

Objectives	The student should develop knowledge of the elements related to attitude flight and have the ability to smoothly and steadily control the airplane without the use of outside references. The student will be able to perform this as required in the PTS.
Key Elements	1. Pitch + Power = Performance 2. Trim 3. Crosscheck 4. Adjust
Elements	1. Control and Performance 2. Procedural Steps 3. Establish 4. Trim 5. Crosscheck 6. Adjust 7. Straight-and-Level Flight 8. Constant Airspeed Climbs 9. Constant Airspeed Descents 10. Turns to Headings
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can smoothly and steadily control the airplane by reference to the instruments only. He or she will be able to establish and maintain a thorough crosscheck and make the required adjustments to the flight attitude.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention grabbing story

Overview

Review Objectives and Elements/Key ideas

What

Attitude instrument flying may be defined as the control of an aircraft's spatial position by using instruments rather than outside visual references.

Why

Flying without visual reference is dependent on the instruments. Your ability to fly IFR will depend on this.

Note

Because lessons VI.A-E are often taught together, they have been combined into a single lesson plan. The lessons are presented individually as well in the eBook.

How:

1. **Control and Performance**
   A. Aircraft performance is achieved by controlling the aircraft attitude and power (AOA and thrust to drag) to produce the desired performance
      i. Pitch + Power = Performance
   B. The three general categories of instruments are control, performance, and navigation instruments
      i. Control – Display immediate attitude and power indications and are permit precise adjustments
         a. Control is determined by reference to the AI and power indicators
      ii. Performance – Indicate the aircraft's actual performance
         a. Performance is determined by reference to the Altimeter, ASI, VSI, HI, and TC
      iii. Navigation - Indicate the position in relation to a selected nav facility or fix
         a. Determined by course indicators, range indicators, glide-slope indicators and bearing points
2. **Procedural Steps**
   A. *Establish* - an attitude/power setting on the control instruments resulting in the desired performance
      i. Known or computed attitude changes and approximate power settings will help reduce workload
   B. *Trim* - until control pressures are neutralized.
      i. Trimming is essential for smooth, precise control and allows attention to be diverted elsewhere
   C. *Crosscheck* – the performance instruments to determine if the desired performance is being obtained
      i. Involves seeing and interpreting
      ii. If a deviation is noted, determine the magnitude and direction of correction necessary

D. *Adjust* – the attitude or power setting on the control instruments as necessary

3. **Establish**
   A. The control instruments are used to set up whatever pitch and bank attitudes are necessary
      i. Aircraft attitude control is accomplished by properly using the AI
         a. Provides an immediate, direct, and corresponding indication of any change in pitch or bank
   B. Pitch Control
      i. Changes are made by changing the pitch attitude by precise amounts in relation to the horizon
         a. Changes are measured in degrees or bar widths
         b. The amount of deviation from that desired will determine the magnitude of correction
   C. Bank Control
      i. Changes are made by changing the bank attitude by precise amounts in relation to the bank scale
         a. Normally use a bank angle that does not exceed 30°
   D. Power Control
      i. Made by throttle adjustments and reference to the power indicators
         a. Little attention is necessary to ensure the power setting remains constant
      ii. From experience, you know how far to move the throttles to change the power a given amount
         a. Make power changes primarily by throttle movement and then crosscheck the indicators
            - DON'T FIXATE on the indicators while setting the power
   E. CE – Applying control inputs without reference to the AI
4. **Trim**
   A. Trim the plane out for hands off flights
   B. CE – Not trimming or over/under controlling but not so much flying with the trim in the DA20
   C. CE – Frequently and in small amounts
5. **Instrument Crosscheck**
   A. The continuous and logical observation of instruments for attitude and performance information
      i. The pilot maintains an attitude by reference to instruments that will give the desired performance
   B. It is impossible to establish an attitude and have performance remain constant for a long period of time
      i. It is therefore necessary to constantly check the instruments and make appropriate changes
   C. Different Crosschecks
      i. Select Radial Crosscheck
         a. Based off the AI
            - Eyes never travel directly between the flight instruments, but move by way of the AI
         b. Begin with the AI, scan an instrument and return to the AI before moving to another
      ii. Inverted V Crosscheck
         a. Moving your eyes from the AI to the TC, up to the AI, to the VSI, and back to the AI
      iii. Rectangular Crosscheck
         a. Move your eyes across the top three instruments and drop down to scan the bottom three
         b. This gives equal weight to each instrument, regardless of its importance to the maneuver

c. But, this method lengthens the time for your eyes to return to a maneuver's critical instrument

D. Crosscheck and Bank
   i. After establishing, check the HI and TC to ensure the airplane is performing as desired

E. Crosscheck and Pitch
   i. After establishing, check the Altimeter, VSI and ASI to ensure the airplane is performing as desired

F. Crosscheck Errors
   i. CE - Fixation
      a. Staring at a single instrument (AI is the most common)
      b. This occurs for a variety of reasons and eliminates the crosscheck of other pertinent instruments
   ii. CE - Omission
      a. Omitting an instrument from the crosscheck
      b. May be caused by failure to anticipate major instrument indications following attitude changes
   iii. CE – Emphasis (VSI -chasing- is common or emphasizing pitch or bank instruments)
      a. Putting emphasis on a single instrument, instead of the necessary combination of instruments
      b. You may naturally tend to rely on the instrument most understood

G. Instrument Interpretation
      a. Understanding each instrument's construction and operating principles and applying this
      b. CE - Tendency to chase the VSI thinking it's an instantaneous reading (but it's a lag instrument**)**
   ii. As the performance capabilities of the aircraft are learned, the instrument indications will be interpreted appropriately in terms of the attitude of the aircraft
      a. If the pitch is to be determined, the ASI, Alt, VSI and AI provide the necessary information
      b. If the bank attitude is to be determined, the HI, TC, and AI must be interpreted
   iii. For each maneuver, you will learn what performance to expect and the combination of instruments to interpret to control the aircraft

6. Adjust

A. Make the adjustments necessary in relation to the AI then go through the process again
   i. The amount of deviation from the desired performance will determine the magnitude of correction
      a. Restrict the AI's displacement to 1 bar or ½ bar width up or down
      b. Use a bank angle that approximates the degrees to turn, not to exceed 30^{o}

B. CE – Incorrect interpretation of instruments and improper controls to correct (EX: rudder to fix heading)

7. Straight-and-Level Flight

Pitch + Power = Desired Performance

Nose on Horizon + Cruise Power = Straight and Level

Pitch		Bank	
A/I	On Horizon	A/I	Wings Level
Alt	Constant	DG	Constant
VSI	0	Compass	Constant
A/S	Constant Cruise AS	T/C	Level/Coordinated

A. Establish - Use the AI to establish a wings level, nose on the horizon attitude adjusting power as needed
B. Trim – Trim to relieve the control pressures
C. Crosscheck
D. Adjust – Correct any performance errors as necessary and retrim the airplane, then crosscheck again

8. Constant Airspeed Climbs

Pitch + Power = Desired Performance

10° Nose Up + Full Power = Constant Airspeed Climb

Pitch		Bank	
A/I	10° Nose Up	A/I	Wings Level
Alt	Climbing	DG	Constant
VSI	Positive Climb	Compass	Constant
A/S	Constant Climb AS	T/C	Level/Coordinated

A. Establish – Raise the nose of the aircraft to the approximate pitch attitude for the desired climb speed
   i. As the AS approaches the desired climb speed, set the power to the climb setting (full)
B. Trim – Trim to relieve the control pressures
C. Crosscheck
D. Adjust – Correct any performance errors as necessary and retrim the airplane, then crosscheck again
      a. Adjust the pitch attitude to maintain the desired climb AS (1 bar or ½ bar width movements)
E. Leveling Off
   i. Lead the altitude by 10% of the vertical speed (EX: 500 fpm climb is lead by 50')
   ii. Use the same procedure to level off the plane
      a. Establish – Reduce power and apply smooth steady elevator pressure toward a level attitude
      b. Crosscheck – VSI, Altimeter and AI should show level flight
      c. Then Trim the airplane and maintain straight and level flight

9. Constant Airspeed Descents

Pitch + Power = Desired Performance

3° Nose Down + Descent Power = Constant Airspeed Descent

Pitch		Bank	
A/I	3° Nose Down	A/I	Wings Level
Alt	Descending	DG	Constant
VSI	Negative Climb	Compass	Constant
A/S	Constant Descent AS	T/C	Level/Coordinated

A. Establish – Reduce power to a predetermined setting for the descent and maintain S&L as AS decreases
    i. As the AS approaches the desired level, lower the nose with the AI to maintain a constant speed
B. Trim – Trim to relieve the control pressures
C. Crosscheck
D. Adjust – Correct any performance errors as necessary and retrim the airplane, then crosscheck again
    i. Adjust the pitch attitude to maintain the desired climb AS
E. Leveling Off
    i. Lead the altitude by 10% of the vertical speed (EX: 500 fpm climb is lead by 50')
    ii. Use the same procedure to level off the plane
        a. Establish – Introduce power and apply smooth steady elevator pressure toward a level attitude
        b. Crosscheck – VSI, Altimeter and AI should show level flight
        c. Then Trim the airplane and maintain straight and level flight

10. Turns to Headings

Pitch + Power = Desired Performance

Wings Banked/Nose Slightly High + Cruise Power = Turn to Heading

Pitch		Bank	
A/I	Nose Slightly High	A/I	Wings Banked
Alt	Constant	DG	Turning to Heading
VSI	0	Compass	Turning to Heading
A/S	Constant Cruise AS	T/C	Banked/Coordinated

A. Prior to entering, determine which direction the turn should be made and the angle of bank required
    i. Use an angle of bank equal to the number of degrees to turn, not to exceed 30°
B. Establish – coordinated aileron and rudder pressure to establish the desired bank angle on the AI
    i. If standard rate, use the TC to check
    ii. Adjust pitch as necessary (probably increase) to maintain level flight
C. Trim – Trim the airplane
D. Crosscheck
E. Adjust – Correct any performance errors as necessary and go through the process again
F. Rolling Out
    i. Apply coordinated rudder and aileron pressure to level the wings on the AI
        a. Depending on the amount of turn, rollout about 10° before the desired heading

- Or use ½ the bank angle or less for small turns

ii. Adjust the pitch to maintain level flight

Common Errors (CE):

- "Fixation," "Omission," and "Emphasis" errors during instrument crosscheck
- Improper instrument interpretation
- Improper control applications
- Failure to establish proper pitch, bank, or power adjustments during altitude, heading, or AS corrections
- Faulty trim procedure

Conclusion:
Brief review of the main points

VII.B. Holding Procedures

References: 14 CFR part 91; FAA-H-8083-9; FAA-H-8083-15; AIM

Objectives
The student should develop knowledge of the elements related to holding procedures.

Key Elements
1. Use the entry that makes the most sense
2. Standard turns are to the Right
3. Triple the wind correction on the outbound leg

Elements
1. General
2. Holding Instructions
3. Navigation Equipment
4. Holding Airspeeds
5. Standard Entry Procedures
6. Recognition of Arrival at the Holding Fix
7. Timing Procedure
8. Wind Drift Correction
9. DME in a Holding Pattern
10. Lost Comms - FAR 91.185

Schedule
1. Discuss Objectives
2. Review material
3. Development
4. Conclusion

Equipment
1. White board and markers
2. References

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

SP's Actions
1. Participate in discussion
2. Take notes
3. Ask and respond to questions

Completion Standards
The student has the ability to draw a hold based on given holding instructions, can choose and perform the necessary entry into the hold, and maintain the hold making the corrections required for wind and time.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention grabbing story

Overview

Review Objectives and Elements/Key ideas

What

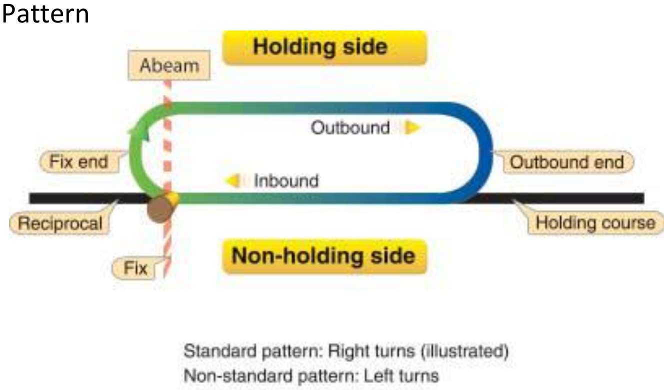
A hold is an IFR maneuver used to keep an airplane in a specific, protected area for a certain amount of time. There are various reasons an aircraft may be requested to hold, including over congestion at the destination airport, weather, runway closures, another aircraft on the IFR approach into an uncontrolled airport, etc.

Why

Since aircraft do not have the ability to pull over (like a car) a hold is used to wait in the air. Delays or various other criteria can result in an aircraft being requested to hold. It is important an understanding of holds is obtained in order to competently work with ATC during holding situations.

How:

1. **General**
   A. Holding is a predetermined maneuver which keeps aircraft within a specified airspace while awaiting further clearance from ATC
   B. The Standard Holding Pattern



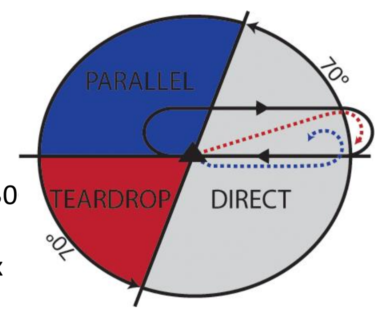
      i. The standard pattern is a race track
         a. You follow the specified course inbound to the holding fix, turn 180° to the R, flies a parallel straight course outbound for 1 min, turns 180° to the R, and flies the inbound course to the fix
      ii. Standard Holding Pattern uses Right Turns
         a. Non-Standard uses Left Turns
         b. The ATC clearance will always specify left turns when non-standard holding is necessary

2. **Holding Instructions**
   A. If you arrive at your clearance limit before receiving clearance beyond the fix, ATC expects you to
      i. Maintain the last altitude
      ii. Begin holding in accordance with the depicted pattern

        a. If the pattern is not depicted, hold in a standard pattern on the course you approached on
            - Immediately request further clearance
    B. When a holding pattern is not depicted, ATC clearance will specify the following:
        i. Direction of holding from the fix in terms of the 8 cardinal compass points (N, NE, E, SE, etc)
        ii. Holding fix
        iii. Radial, course, bearing, airway, or route on which the aircraft is to hold
        iv. Leg length in miles if DME or RNAV is to be used
        v. Direction of turns if L turns are to be made
        vi. Time to EFC and any pertinent additional delay info

3. **Navigation Equipment**
    A. Navigation equipment is set up based on the hold specified
        i. If the hold will be off a VOR, tune and identify the VOR
            a. Select the inbound course with the OBS
        ii. If the holding fix is a DME distance from a VOR, tune and identify the VOR
            a. Follow the radial you will hold on to the DME distance fix and perform the hold there

4. **Holding Airspeeds**
    A. MHA – 6,000’ = 200 knots
    B. 6,001’ – 14,000’ = 230 knots
        i. May be restricted to 210 knots
    C. 14,001’ and above = 265 knots
    D. Holding patterns may be restricted to 175 knots (rare)
    E. DA40 – Hold at approximately 100 knots, power set at 18” MP and 230



5. **Standard Entry Procedure**
    A. Reduce airspeed to holding speed w/in 3 min of ETA at the holding fix
        i. This prevents overshooting the holding airspace limits
    B. Parallel Procedure
        i. When approaching the holding fix from anywhere in the blue
        ii. Turn to a heading parallel the holding course outbound on the non-holding side for approximately 1 minute
        iii. Then, turn in the direction of the holding pattern through more than 180^{o}
        iv. Return to the holding fix or intercept the course inbound
    C. Teardrop Procedure
        i. When approaching the holding fix from anywhere in the red
        ii. Fly to the fix, turn outbound using course guidance when available, or to a heading for a 30^{o} teardrop entry within the pattern (on the holding side) for approximately 1 min
        iii. Then, turn in the direction of the holding patter to intercept the inbound holding course
    D. Direct Entry Procedure
        i. When approaching the holding fix from anywhere in grey
        ii. Fly directly to the fix, and turn to follow the holding pattern
    E. Turns
        i. All turns during entry and while holding should be made at
            a. 3^{o} per second, or
            b. 30^{o} bank angle, whichever is less

6. **Recognition of Arrival at the Holding Fix**
    A. If the holding fix is a VOR, when the To/From flag switches you have reached the holding fix
    B. At a DME distance, once the readout indicates the distance desired you have reached the holding fix

C. Once you have reached the fix, promptly enter the turn to begin the entry to the hold
    i. Directly over the fix (don't wait)

7. Timing Procedure

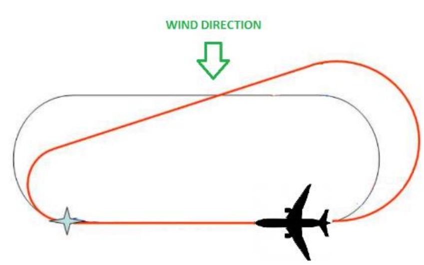
A. Upon entering a holding pattern, the initial outbound leg is flow for 1 min at or below 14,000' MSL
    i. 1 ½ min above 14,000'

B. Timing for subsequent outbound legs should be adjusted as necessary to achieve proper inbound time
    i. Begin timing outbound over or abeam the fix, whichever occurs later
        a. VOR: outbound timing begins when the To/From flag reverses
        b. Airway intersection: Outbound timing begins at completion of outbound turn
            - The 90° point cannot be measured from an airway intersection like with a VOR
        c. Compass Locator: Outbound timing starts when ADF RB is 90° minus drift correction
    ii. If the abeam position cannot be determined, start timing when the turn outbound is completed

8. Wind Drift Correction

A. Continue to adjust the outbound timing to achieve a 1 min inbound leg

B. The effect of wind is counteracted by applying drift correction to the inbound leg to maintain course
    i. Triple the wind correction angle for the outbound leg
        a. EX. If 4° of wind correction is necessary to maintain the course inbound, apply 12° correction outbound
    ii. Why Triple the Drift?
        a. The wind has an opposite effect on your groundspeed in each of the turns in the hold
        b. For example, as pictured below, there is a crosswind from the North
            - As you make the turn from the inbound to the outbound leg, groundspeed will decrease, and as you make the turn from the outbound leg to the inbound leg groundspeed will increase
                a A slower groundspeed has a smaller turn radius
                b A faster groundspeed has a larger turn radius
            - Because of the change in groundspeed, and therefore the different sized turns, it is necessary to overcorrect on the outbound leg
            - Not correcting in this case, would result in the aircraft consistently being blown past the inbound leg



9. DME in a Holding Pattern

A. The same entry and holding procedures apply to DME except distances are substituted for time

B. The length of the outbound leg will be specified by the controller
    i. The end of the leg is determined by the DME readout

10. Lost COMMs - 91.185

A. Leave the clearance limit
   i. If the clearance limit is a fix from which an approach begins
      a. Leave as close as possible to the EFC time, if one has been issued
      b. If one has not been issued, leave as close as possible to the ETA calculated on the flight plan
   ii. If the clearance limit is not a fix from which the approach begins
      a. Leave the fix as close as possible to the EFC time if one has been issued
      b. If there was no EFC time to leave, depart the fix to where an approach begins and begin descent/approach as close as possible to the ETA calculated on the flight plan

Common Errors

- Incorrect setting of aircraft navigation equipment
- Inappropriate altitude, airspeed, and bank control
- Improper timing
- Improper wind drift correction
- Failure to recognize holding fix passage
- Failure to comply with ATC instructions

Conclusion:

Brief review of the main points

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of holding procedures by describing-
   A. setting of aircraft navigation equipment.
   B. requirement for establishing the appropriate holding airspeed for the aircraft and altitude.
   C. recognition of arrival at the holding fix and the prompt initiation of entry into the holding pattern.
   D. timing procedure.
   E. correction for wind drift.
   F. use of DME in a holding pattern.
   G. compliance with ATC reporting requirements.
2. Exhibits instructional knowledge of common errors related to holding procedures by describing-
   A. incorrect setting of aircraft navigation equipment.
   B. inappropriate altitude, airspeed, and bank control.
   C. improper timing.
   D. improper wind drift correction.
   E. failure to recognize holding fix passage.
   F. failure to comply with ATC instructions.
3. Demonstrates and simultaneously explains holding procedures from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to holding procedures.
5. Exhibits instructional knowledge on the use of the MFD and other graphical navigational displays, if installed, to monitor position in relation to the desired flightpath during holding.

VIII.D. Circling Approach

References: 14 CFR part 91; FAA-H-8083-9; FAA-H-8083-15; AIM

Objectives

The student should develop knowledge of the elements related to executing a circling approach.

Key Elements

1. Use the Circling Minimums (not straight-in)
2. Lose Visual, Go Missed
3. Normal descent using normal maneuvers or Go Missed

Elements

1. General
2. Selection of the Appropriate Circling Maneuver
3. Compliance with Advisories, Clearances, Restrictions
4. Circling Approach Minimums and the IAP Chart
5. Circling Rules
6. Stay within the Published Visibility Criteria and Maintain Altitude Above the Circling MDA
7. Circling Area of Protection

Schedule

1. Discuss Objectives
2. Review material
3. Development
4. Conclusion

Equipment

1. White board and markers
2. References

IP's Actions

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

SP's Actions

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

Completion Standards

The student understands and can perform a circling approach to landing or a missed approach.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention grabbing story

Overview

Review Objectives and Elements/Key ideas

What

Circling approaches are designed when the final approach course is not aligned with the landing runway or a steep descent gradient is required to reach the runway from the FAF. In this case you are expected to circle, or visually fly a traffic pattern to align yourself with the landing runway.

Why

Many airports have approaches that bring you to the airport rather than to a specific runway. Once you have visual contact with the airport it is your responsibility to realign with the landing runway per the tower instructions (or based on traffic at an uncontrolled field). Other situations which can result in a circling approach are low weather combined with the wind favoring a different runway (ILS to Runway 02, but the wind is out of the south. In this case, you have to fly the ILS to runway 02 and circle to land on runway 20 since it does not have an ILS), or steep descent gradients from the FAF (in which case a normal descent rate may not get you onto the runway, and you have to circle to make a normal landing).

How:

1. **General**
   A. Approaches that do not have straight-in-landing minimums are identified by the type of approach followed by a letter
      i. The 1st approach of this type created at the airport will be labeled with the letter A
      ii. The lettering will continue in alphabetical order as needed
   B. Circling Only Approaches are normally designed for the following reasons
      i. The final approach course alignment with the runway centerline exceeds 30º
      ii. The descent gradient is greater than 400 feet per nautical mile from the FAF to the threshold crossing height (TCH)
      iii. The final approach course does not cross the extended runway centerline prior to the runway threshold
      iv. A runway is not clearly defined on the airfield
   C. Circling minimums apply when it's necessary to circle the airport or maneuver to land, or when no straight-in-minimums are specified
      i. Circling minimums provide a minimum of 300' of obstacle clearance in the circling area
   D. Circling may require maneuvers at low altitude, at low AS, and in marginal weather conditions
      i. Use sound judgment, have an in-depth knowledge of their capabilities, and fully understand the aircraft performance to determine the exact circling maneuver since weather, unique airport design, and the aircraft position, altitude and airspeed must all be considered
2. **Selection of the Appropriate Circling Maneuver**
   A. If a circling approach has been assigned to you by ATC (i.e. VOR-A) select the corresponding chart

B. If you have been cleared for an approach with a circle to land on another runway, use the appropriate chart for the approach you have been cleared on
    i. But, use the circling minimums rather than the straight-in minimums when descending
        a. Once the airport complex is visible, circle to the appropriate runway for landing

3. Compliance with Advisories, Clearances, Restrictions

A. Comply with the clearances, restrictions, etc. given by ATC
B. In the case that the clearance seems unsafe question ATC or reply Unable

4. Circling Approach Minimums and the IAP Chart

A. Use the appropriate circling minimums, rather than the straight-in minimums

5. Circling Rules

A. Maneuver the shortest path to the base or downwind leg, weather permitting
    i. There is no restriction to passing over the airport or other runways
B. Circling maneuvers may be made while VFR or other flying is in progress at the airport
    i. Standard left turns or specific instruction from the controller must be considered when landing
C. At airports without a control tower, it may be desirable to fly over the airport to observe wind and turn indicators and other traffic which may be in the vicinity

6. Stay within the Published Visibility Criteria and Maintain Altitude Above the Circling MDA

A. During a circling approach, maintain visual contact with the runway of intended landing
    i. If visual contact is lost, go missed
        a. The first turn on the missed from a circling maneuver should be toward the landing runway
        b. When the airplane is reestablished on course, the published missed approach should be flown
B. Fly no lower than the circling minimums until you are in a position to make a final descent for a landing
    i. Remain at or above until a normal rate of descent and normal maneuvers will allow for landing
    ii. Minimums are the lowest you can fly, if allowable, fly at an altitude close to a VFR pattern

7. Circling Area of Protection

A. Aircraft must remain in their respective Category protected areas
    i. Protected areas are designed based on approach speed (category) to provide maneuvering airspace at or above the MDA
B. Standard Circling Minimums
    i. Circling approach protected areas use the radius distance shown in the table on page B2 of the U.S. TPP
    ii. Standard minimums are based on fixed radius distances, dependent on aircraft category
    iii. Circling Radius:

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
All Altitudes	1.3	1.5	1.7	2.3	4.5

C. Enhanced Circling Minimums
    i. Circling approach areas developed after late 2012 use enhanced circling minimums (also shown on page B2 of the U.S. TPP)
        a. Enhanced circling minimums are identified by the presence of the “negative C” symbol on the circling line of minima
            - The “negative C” is a black box with a white C inscribed inside it

b. These minimums are also dependent on aircraft category, but also take into account the altitude of the circling MDA which accounts for true airspeed increases with altitude

ii. Circling Radius:

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
1000 or less	1.3	1.7	2.7	3.6	4.5
1001-3000	1.3	1.8	2.8	3.7	4.6
3001-5000	1.3	1.8	2.9	3.8	4.8
5001-7000	1.3	1.9	3.0	4.0	5.0
7001-9000	1.4	2.0	3.2	4.2	5.3
9001 and above	1.4	2.1	3.3	4.4	5.5

Common Errors (CE):

- Failure to have essential knowledge of the circling approach information on the approach chart
- Failure to adhere to the published MDA and visibility criteria during the circling approach maneuver
- Inappropriate pilot technique during the transition from the circling maneuver to the landing approach

Conclusion:

Brief review of the main points

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of the elements of a circling approach by describing-
   A. selection of the appropriate circling approach maneuver considering the maneuvering capabilities of the aircraft.
   B. circling approach minimums on the selected instrument approach chart.
   C. compliance with advisories, clearance instructions, and/or restrictions.
   D. importance of flying a circling approach pattern that does not exceed the published visibility criteria.
   E. maintenance of an altitude no lower than the circling MDA until in a position from which a descent to a normal landing can be made.
2. Exhibits instructional knowledge of common errors related to a circling approach by describing-
   A. failure to have essential knowledge of the circling approach information on the instrument approach chart.
   B. failure to adhere to the published MDA and visibility criteria during the circling approach maneuver.
   C. inappropriate pilot technique during transition from the circling maneuver to the landing approach.
3. Demonstrates and simultaneously explains a circling approach from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to a circling approach.

MEI LESSONS

XIII.C. Engine Failure after Lift-Off

References: FAA-H-8083-3; POH/AFM

Objectives	The student should develop knowledge of the elements related to handling an engine failure while airborne.
Key Elements	1. Fly First 2. Zero Side Slip 3. Don't approach V_{MC}
Elements	1. Maintaining Aircraft Control after an Engine Failure 2. Engine Failure After Lift Off
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can safely maintain control of the aircraft and properly handle the checklists in the event of an engine failure while airborne.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention grabbing story

Overview

Review Objectives and Elements/Key ideas

What

This lesson will cover the elements involved with safely handling an engine failure while airborne, whether that includes landing on the remaining runway, returning to land, or en route.

Why

In the case of an engine failure it is essential that a pilot understands the elements involved and can maintain control of the airplane.

How:

1. **Maintaining Aircraft Control after an Engine Failure**
   - A. Recognize the Engine Failure and Maintain Directional Control
     - i. The easiest way to recognize an engine failure is visually (if in V_{MC})
       - a. The pilot will recognize an un-commanded yaw in the direction of the dead engine
       - b. Visual recognition allows for better control, don't stare at the engine instruments, fly the plane
       - c. If in IMC, the engine failure will be recognized on the instruments, the aircraft will yaw toward the dead engine, the nose will drop, engine gauges will indicate a failure
       - d. CE – Failure to recognize an inoperative engine
     - ii. When an engine fails use rudder and aileron to maintain directional control
       - a. Establish a zero-sideslip configuration by adding approximately 2-3° of bank to counteract the roll and maintaining heading visually with rudder pressure (the aircraft will almost fall into a sideslip)
         - After a couple degrees of bank are established and rudder pressure is set to maintain heading double check the zero sideslip on the instruments and make changes needed
           - a A zero sideslip will vary based on the aircraft flown, but 1-3° bank toward the operating engine and ½ ball deflection (on the turn coordinator) toward the operating engine should be close
       - b. CE – Failure to establish and maintain proper bank for best performance
         - Additional bank or too little bank will create excess drag on the airframe (since it is no longer coordinated), thus reducing performance
   - B. Set the Controls (Full Power)
     - i. Initially this means add full power on both engines
       - a. Increasing power means increasing rudder
       - b. The more power, the more yaw created, don't increase the power and lose control of heading
       - c. Smoothly increase the power and rudder pressure (fast movements are hard to control)
   - C. Reduce Drag
     - i. Verify Gear and Flaps are UP

ii. CE – Failure to properly adjust engine controls and reduce drag
    a. Full power is necessary due to the loss of an engine
    b. Reducing drag is necessary to prevent altitude loss
    c. In an engine failure always add full power and reduce drag immediately
        - Unless landing straight ahead
        - Maintain control of the aircraft, add right rudder with the increase in power

D. Identify
    i. Dead Foot, Dead Engine
        a. Whichever foot is not being used on the rudder correlates to the engine that has failed
            - If the right foot is "dead" on the ground, the right engine is the failed engine

E. Verify
    i. To verify, reduce the throttle for the dead engine to idle
        a. There should be no change
            - You'll know if you got the wrong throttle when the aircraft yaws rapidly in the wrong direction
        b. Reduce the throttle gently, if you accidentally got the wrong engine it will be easier to maintain control (again, fast movements are hard to control)
    ii. CE – Hazards of improperly identifying and verifying the inoperative engine
        a. Choosing the wrong engine can be very dangerous
        b. One engine is already failed, if you feather the incorrect engine (because you skipped or didn't properly identify/verify the failed engine) you will be in a situation with zero engines operating

F. Fix or Feather
    i. If there is time and altitude attempt to fix the failed engine
        a. Follow manufacturer procedures
            - CE - Failure to follow prescribed emergency checklist
        b. Take a break from the checklist every step or two to check airspeed, altitude, heading, zero sideslip and engine instruments
            - There's no rush to getting the checklist done, flying is most important
    ii. If it cannot be fixed (or if time does not allow it) then feather the engine
        a. Follow manufacturer procedures
            - CE - Failure to follow prescribed emergency checklist
        b. Take a break from the checklist every step or two to check airspeed, altitude, heading, zero sideslip and engine instruments
            - There's no rush to getting the checklist done, flying is most important
    iii. Before feathering the engine ALWAYS verify you have the correct engine
    iv. When feathered, rudder can be reduced
        a. Yaw toward the dead engine is reduced since the drag on the inoperative propeller is reduced
        b. Adjust the controls to maintain the zero sideslip

G. Restart the Inoperative Engine
    i. Follow manufacturer Procedures
        a. CE - Failure to follow prescribed emergency checklist
    ii. Maintain control during the process
        a. When the engine restarts rudder will have to be increased as yaw and drag will increase
    iii. As you increase the power, adjust rudder
        a. Maintain directional control with the rudder/aileron visually

H. Overview: Maintain control, full power, gear up, flaps up, identify, verify, fix or feather

2. Engine Failure After Lift-Off

A. Engine failures after lift-off can be summarized into four scenarios
   i. Landing Gear Down
   ii. Landing Gear Up, single engine climb inadequate
   iii. Landing Gear Up, single engine climb adequate
   iv. En route (at a safe altitude)

B. Engine Failure After Lift-Off with the Gear Down
   i. A takeoff or go around is the most critical time to suffer an engine loss
      a. The airplane will be slow, close to the ground and flaps and gear may be extended
      b. Altitude and time will be minimal
   ii. If failure occurs before selecting the gear up, close both throttles and land on the remaining runway
      a. Landing gear should be retracted when a positive rate of climb is established AND no remaining runway is available to land on
         - Therefore, if the landing gear is up the decision has been made to continue the flight if an engine fails

C. Landing gear up, single engine climb inadequate
   i. A landing must be accomplished on whatever lies ahead
      a. Maintain control, clean up excess drag, establish zero side slip, pitch for V_{YSE}
   ii. A descent at V_{YSE} can increase the distance the aircraft can fly before reaching the ground
   iii. If necessary (and better than landing gear up), lower the gear for landing

D. Landing Gear Up, single engine climb adequate
   i. The procedures for continued flight should be followed
      a Control
         1. Use rudder and aileron as necessary in order to maintain control/zero side slip
            a. CE - Failure to establish and maintain proper bank for best performance
         2. Fly the plane first, checklists second
      b Configuration - Full Power, Gear, Flaps, Identify (dead foot, dead engine), Verify (reduce throttle), Fix or Feather
         1. CE – Failure to properly identify and verify the inoperative engine
         2. CE – Failure to properly adjust engine controls and reduce drag
      c Perform the appropriate checklist
         1. CE – failure to follow prescribed emergency checklist
         2. Do not attempt to fix the failed engine unless time and altitude allow
      d Maintain V_{YSE}
         1. CE – Failure to establish and maintain a pitch attitude that will result in best engine inoperative airspeed, considering the height of obstructions
      e Return to land

E. En route
   i. The procedures for continued flight should be followed
      a. Control
         - Use rudder and aileron as necessary in order to maintain control/zero side slip
         - Maintain altitude (if necessary climb at V_{YSE})
            a Pitch will have to increase in order to maintain altitude due to the lost engine
         - Fly the plane first, checklists second

b. Configuration - Full Power, Gear, Flaps, Identify (dead foot, dead engine), Verify (reduce throttle), Fix
    - Follow the checklists to attempt to fix the engine
        a. After every step or two return to flying the aircraft
            1. Check altitude, airspeed, heading, zero sideslip, and engine indications
            2. There's NO rush to finish the checklist, controlling the aircraft is the #1 priority

c. If the engine cannot be fixed proceed to feather the engine as described in the POH/emergency procedures and land as necessary

Common Errors:

- Failure to follow prescribed emergency checklist
- Failure to properly identify and verify the inoperative engine
- Failure to properly adjust engine controls and reduce drag
- Failure to maintain directional control
- Failure to establish and maintain a pitch attitude that will result in best engine inoperative airspeed, considering the height of obstructions
- Failure to establish and maintain proper bank for best performance

Conclusion:

Brief review of the main points

Control is the most important aspect of any engine failure. No matter where the engine failure occurs, maintain control before, during and after any checklists are completed.

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of the elements related to engine failure after lift-off by describing:
    a. Use of prescribed emergency checklist to verify accomplishment of procedures for securing the inoperative engine.
    b. Proper adjustment of engine controls, reduction of drag, and identification and verification of the inoperative engine.
    c. How to establish and maintain a pitch attitude that will result in the best engine inoperative airspeed, considering the height of obstructions.
    d. How to establish and maintain a bank as required for best performance.
    e. How to maintain directional control.
    f. Methods to be used for determining reason for malfunction.
    g. Monitoring and proper use of the operating engine.
    h. An emergency approach and landing, if a climb or level flight is not within the airplane's performance capability.
    i. Positive airplane control.
    j. How to obtain assistance from the appropriate facility.
2. Exhibits instructional knowledge of common errors related to engine failure after lift-off by describing:
    a. Failure to follow prescribed emergency checklist.
    b. Failure to properly identify and verify the inoperative engine.
    c. Failure to properly adjust engine controls and reduce drag.

   d. Failure to maintain directional control.
   e. Failure to establish and maintain a pitch attitude that will result in best engine inoperative airspeed, considering the height of obstructions.
   f. Failure to establish and maintain proper bank for best performance.
3. Demonstrates and simultaneously explains a simulated engine failure after lift-off from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to engine failure after lift-off.

XIV.C. Flight Principles – Engine Inoperative

References: FAA-H-8083-3; POH/AFM

Objectives The student should develop knowledge of the elements related to single engine operation.

Key Elements
1. Left Engine is Critical
2. Never go below V_{MC}
3. Maintain directional control (Fly the Airplane!)

Elements
1. Critical Engine
2. V_{MC} Demonstration
3. V_{MC} and the Loss of Control
4. V_{MC} and Stall Speed
5. Engine Failure During/After Lift-Off

Schedule
1. Discuss Objectives
2. Review material
3. Development
4. Conclusion

Equipment
1. White board and markers
2. References

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

SP's Actions
1. Participate in discussion
2. Take notes
3. Ask and respond to questions

Completion Standards The student understands the differences between a single and multiengine airplane as well as the elements of an engine failure, the critical engine, and V_{MC}.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention grabbing story

Overview

Review Objectives and Elements/Key ideas

What

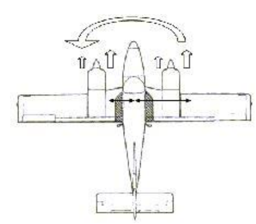
Having an additional engine is helpful for better climb performance and greater speeds, but a failure of one of the engines introduces a situation very different from losing an engine in a single engine airplane. In this lesson, you will learn which engine has a more adverse effect on control and performance when lost and why, as well as what the minimum controllable airspeed is, and finally how to manage an engine failure.

Why

In the case of an engine failure it is essential a pilot understands the elements involved and can maintain control of the airplane.

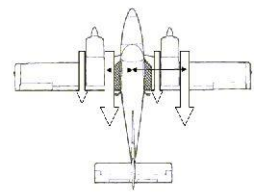
How:

1. **Critical Engine**
   A. Definition: The engine whose failure would most adversely affect the performance or handling qualities of an aircraft
   B. In a conventional twin, with both props rotating clockwise, this is the LEFT engine
      i. Other twins overcome the problem of a critical engine with counter-rotating propellers
   C. There are 4 factors responsible for the left engine being critical on a conventional twin
      i. P-Factor, Accelerated Slipstream, Spiraling Slipstream, and Torque (Remember: PAST)
   D. P-Factor
      i. The descending blade of each propeller produces more thrust than the ascending blade
         a. Therefore, in a conventional twin, the center of thrust is offset to the right of each engine
      ii. There is a greater distance (arm) between the center of thrust and the longitudinal axis on the right engine than on the left
         a. The greater the distance, or arm, the greater the leverage
      iii. If the right engine fails, the leverage associated with P-Factor is not as great as if the left engine fails
      iv. If the left engine fails the yaw from P-Factor is most adverse, therefore the left engine is critical



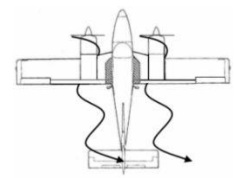
   E. Accelerated Slipstream
      i. Due to P-Factor, there is greater airflow (more lift) over the wings on the right side of each engine

ii. There is a greater distance (arm) between the excess lift and the longitudinal axis on the right engine than on the left engine
    a. The greater the distance, or arm, the greater the leverage



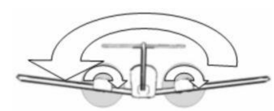
iii. If the left engine fails, there is a stronger rolling action than if the right engine fails, therefore the left engine is critical

F. Spiraling Slipstream
   i. Each propeller produces a spiraling slipstream of air behind it (picture)
   ii. The left engine's slipstream strikes the rudder on the left side creating a left turning tendency
   iii. The right engine's slipstream has no affect on the aircraft



   iv. If the right engine fails, the left engine's slipstream will counteract some of the yaw toward the dead engine
   v. If the left engine fails the airplane will yaw uninhibited toward the dead engine, therefore the left engine is critical

G. Torque
   i. Torque is based on Newton's 3rd law: For every action, there is an equal and opposite reaction
   ii. When the propellers spin clockwise, torque will cause the plane to roll counter-clockwise (CCW) (picture)



   iii. If the right engine fails the plane will roll to the right, but the CCW torque will offset some of the force
   iv. If the left engine fails, the counter-clockwise torque will encourage the roll toward the left engine
   v. The left engine is critical since torque most adversely affects control when the left engine fails

2. V_{MC} Demonstration

A. In aircraft certification, V_{MC} is the sea level calibrated airspeed at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the airplane with that engine still inoperative and then maintain straight flight at the same speed with an angle of bank of not more than 5^o

B. V_{MC} is not a fixed airspeed under all conditions
   i. It is only a fixed airspeed for the very specific set of circumstances under which it was tested during aircraft certification
   ii. V_{MC} varies with a variety of factors

C. Factors
   i. Critical Engine Wind Milling
      a. V_{MC} increases with increased drag on the inoperative engine
         - V_{MC} is therefore the highest when the critical engine prop is wind milling at the low pitch, high rpm blade angle
   ii. Maximum Available Takeoff Power
      a. V_{MC} increases as power is increased on the operating engine
   iii. Density Altitude
      a. V_{MC} decreases with increases in altitude or a decrease in density
         - Due to the lessened thrust at higher density altitudes, less yaw is experienced in relation to P-Factor
   iv. Most Unfavorable Weight
      a. V_{MC} is increased as weight is reduced
         - A heavier plane is a more stable and controllable plane

- Also, the weight of the airplane assists in establishing and maintaining a zero-side slip

v. Most Unfavorable CG
   a. V_{MC} increases as the CG is moved aft
      - The moment of the rudder arm is reduced, and therefore its effectivity is reduced
      - AND, the moment arm of the propeller blade is increased, aggravating asymmetrical thrust

vi. Landing Gear Retracted
   a. V_{MC} increases when the landing gear is retracted
      - Extended gear aids in directional stability, which tends to decrease V_{MC}

vii. Flaps in the takeoff Position
   a. Flaps in the takeoff position decreases V_{MC}
   b. Creates extra drag on the operating engine
      - This reduces the tendency to yaw toward the inoperative engine

viii. Cowl Flaps in the T/O position
   a. Open cowl flaps will produce more drag on the operative engine, therefore decreasing V_{MC}

ix. Airplane Trimmed for Takeoff
   a. This varies between aircraft due to different T-tail, low tail, type of elevator and trim setting

x. Airplane Airborne and Out of Ground Effect
   a. If in Ground Effect, as the airplane is banked into the operative engine it would generate more lift on the lowered wing, increasing the rolling tendency toward the inoperative engine (V_{MC} increases)

xi. Maximum 5° of Bank
   a. V_{MC} is highly sensitive to bank angle
      - To prevent claims of unrealistically low speeds, the bank into the operating engine is limited
   b. The horizontal component of lift from the bank assists the rudder in counteracting the asymmetrical thrust
   c. The bank angle works in the manufacturer's favor, lowering V_{MC}
   d. V_{MC} is reduced significantly with increases in bank and increases significantly with decreases
      - Tests have shown that V_{MC} may increase > 3 knots for each degree of bank less than 5°

Factor	Control	V_{MC}	Performance
CG – Forward	Increases	Decreases (Good)	Decreases
CG – Aft	Decreases	Increases (Bad)	Increases
Weight – Increase	Increases	Decreases (Good)	Decreases
Density Altitude – High	Increases	Decreases (Good)	Decreases
Gear – Up	Decreases	Increases (Bad)	Increases
Flaps – Up	Decreases	Increases (Bad)	Increase
Wind Milling Prop	Decreases	Increases (Bad)	Decreases
Max T/O Power	Depends	Increases (Bad)	Increases
Cowl Flaps Open	Increases (?)	Decreases (Good)	Decreases
Bank Angle (Up to 5°)	Increases	Decreases (Good)	Increases
Airborne/Out of GE	Decreases	Increases (Bad)	Decreases

Trimmed for T/O	Could go either way →		

3. V_{MC} and the Loss of Control

A. Control is lost when the moment of the thrust arm of the operating engine exceeds that of the rudder
   i. The rudder cannot maintain control and the plane yaws in the direction of the inoperative engine

B. Loss of control is indicated when full rudder is applied into the operating engine and the airplane continues to yaw toward the inoperative engine
   i. It can be seen visually with a visual reference point or on the heading indicator

C. The proper pitch and bank attitude should be maintained in order to obtain an accurate V_{MC} speed
   i. Without the zero-side slip condition, V_{MC} will increase and directional control may be lost early

D. Recovery
   i. The moment uncontrollable yaw or any symptom associated with a stall is recognized, recover
   ii. The operating engine throttle should be retarded as pitch attitude is decreased
      a. Retarding the throttle will tend to fix the yawing problem (the thrust moment is reduced)
      b. Decreasing pitch increases airspeed, making the rudder more effective
      c. By reducing power, you are decreasing the amount of yaw the rudder has to overcome and by pitching forward you are increasing the amount of force the rudder can produce
   iii. Recovery is made to straight flight at V_{YSE} with the operating engine throttle reintroduced
   iv. Once complete, scissor the power levers back together

4. V_{MC} and Stall Speed

A. V_{MC} decreases with altitude, while stall speed remains the same
   i. The margin between stall speed and V_{MC} decreases with altitude
   ii. There is an altitude where V_{MC} and V_S are the same, and above that altitude, V_{MC} will occur after a stall
      a. The altitude where V_{MC}=V_S (and above) is extremely dangerous; the aircraft will stall and the pilot will have no directional control… game over.

5. Engine Failure During/After Lift-Off

A. A takeoff or go around is the most critical time to suffer an engine loss
   i. The airplane will be slow, close to the ground and flaps and gear may even be extended
   ii. Altitude and time will be minimal

B. Complete failure of an engine can be summarized into three scenarios:
   i. Landing Gear Down (if gear is still down, runway is still remaining to land on)
      a. If failure occurs before selecting the Gear Up, close both throttles and land on the remaining runway
   ii. Landing Gear Up, single engine climb inadequate
      a. A landing must be accomplished on whatever lies ahead
      b. A descent at V_{YSE} is possible to extend the time before reaching the ground
   iii. Landing Gear Up, single engine climb adequate
      a. The procedures for continued flight should be followed
         - Control
         - Configuration - Full Power, Gear up, Flaps up, Identify, Verify, Fix, Feather
         - Climb
         - Checklist (If time)

C. If an engine is lost on the roll, reduce power to idle, maintain directional control
D. If an engine is lost after rotation and the gear is still down, maintain control and land ahead
E. If an engine is lost after rotation and the gear is up, maintain control and configure to return for landing

Conclusion:
Brief review of the main points

PTS Requirements:

To determine that the applicant exhibits instructional knowledge of the elements related to flight principles engine-inoperative by describing:

1. Meaning of the term "critical engine."
2. Effects of density altitude on the V_{MC} demonstration.
3. Effects of airplane weight and center of gravity on control.
4. Effects of bank angle on V_{MC}.
5. Relationship of V_{MC} to stall speed.
6. Reasons for loss of directional control.
7. Indications of loss of directional control.
8. Importance of maintaining the proper pitch and bank attitude, and the proper coordination of controls.
9. Loss of directional control recovery procedures.
10. Engine failure during takeoff including planning, decisions, and single-engine operations.

ACS LESSONS

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I.A. Pilot Qualifications

1. **Currency, Regulatory Compliance, Privileges and Limitations**
    A. Currency
        i. Pilot in Command (FAR 61.57)
            a. To carry passengers - day
                - 3 takeoffs and landings within the preceding 90 days as the sole manipulator of the flight controls in the same category, class, and type (if required)
                    a Tailwheel landings must be to a full stop
            b. To carry passengers - 1 hour after sunset to 1 hour before sunrise
                - 3 takeoffs and landings to a full stop from 1 hour after sunset to 1 hour before sunset within the preceding 90 days to a full stop as the sole manipulator of the flight controls in the same category, class, and type (if required)
        ii. Flight Reviews (FAR 61.56)
            a. No person may act as PIC unless, within the preceding 24 calendar months he/she has accomplished a flight review and received a log book endorsement certifying it was completed
            b. Flight review must be given by an authorized instructor
            c. Consists of a minimum of 1 hour of flight training and 1 hour of ground training and must include:
                - A review of the current general operating rules and flight rules of Part 91 and a review of those maneuvers and procedures necessary to demonstrate the safe exercise of the certificate
            d. A flight review is not necessary, if in the past 24 calendar months, the pilot has passed any of the following:
                - A pilot proficiency check or practical test for a pilot certificate, rating, or operating privilege
                - A practical test for the issuance of a flight instructor certificate, and additional rating on a flight instructor certificate, renewal of a flight instructor certificate, or reinstatement of a flight instructor certificate
                - If one or more phase of an FAA sponsored pilot proficiency award program has been accomplished a flight review is not required
                - A student pilot undergoing training for a certificate and has a current solo flight endorsement does not need a flight review
            e. A flight review may be accomplished in combination with the PIC currency requirements mentioned above (3 T/O & LDG) and in FAR 61.57
    B. **Regulatory Compliance** (FAR 61.59)
        i. False entries to maintain currency are basis for suspension/revocation of certificates, licenses, ratings, or authorizations
            a. No person may make any fraudulent or intentionally false entry into any logbook, record, or report that is required to be kept, made, or used to show compliance with any requirement for the issuance or exercise of the privileges of any certificate, rating, or authorization
            b. This is grounds for suspending or revoking any airman certificate, rating, or authorization held by that person
        ii. The FAA can and does perform random logbook/currency checks
            a. Not maintaining the required currency can get your license revoked

iii. Regulatory compliance is for your own and others safety. Maintain currency!

C. **Privileges and Limitations** (61.113)
   i. May not:
      a. Act as PIC of an aircraft carrying passengers or property for compensation or hire
      b. Pay less than the pro rata share of the operating expenses of a flight provided the expenses involve only fuel, oil, airport expenditures, or rental fees
   ii. May:
      a. Act as PIC for compensation/hire if incidental to the business and no passengers or property are carried for compensation or hire
      b. Be reimbursed for operating expenses directly related to search and location operations
         - Provided it's controlled by Federal agency or an org that conducts search and locate ops
      c. Demo an aircraft to a potential buyer if have over 200 hours and are an aircraft salesman
      d. Act as PIC to conduct a production flight test in a light-sport aircraft intended for light sport certification provided that:
         - Aircraft is a powered parachute or weight shift control aircraft
         - The person has at least 100 hours of PIC time in the category and class of aircraft flown
         - The person is familiar with processes/procedures applicable to flight testing
      e. Act as PIC for a charitable, nonprofit, or community event (under FAR 91.146)
      f. Act as PIC of an aircraft towing a glider (under FAR 61.69)

2. Location of airman documents and identification required when exercising private pilot privileges

A. FAR 61.3
   i. A Private Pilot must have a pilot certificate, photo identification, and medical certificate in their possession (or readily accessible in the aircraft)
      a. Photo ID: Driver's License, US Armed Forces ID card, official passport, or other form that the Administrator finds acceptable

B. FAR 61.51
   i. Upon a reasonable request from the Administrator, an authorized NTSB rep, or any Federal, State, or local law enforcement officer you must present your:
      a. Pilot Certificate
      b. Medical Certificate
      c. Logbook (or any other record required)

C. So, at a minimum carry your Certificate, Photo ID, Medical, and Logbook

3. The required documents to provide upon inspection (FAR 61.51)

A. Upon a reasonable request from the Administrator, an authorized NTSB rep, or any Federal, State, or local law enforcement officer you must present your:
   i. Pilot Certificate
   ii. Medical Certificate
   iii. Logbook (or any other record required)

4. Pilot logbook/record keeping

A. Must document and record training and aeronautical experience used to meet the requirements for a certificate, rating, or review
   i. In the logbook, you must enter
      a. General:

- Date, Total flight/lesson time; location of departure/arrival (for a simulator, the location where the lesson occurred); type and identification of aircraft, simulator, or training device; and the name of the safety pilot (if necessary)

b. Type of pilot experience or training
- Solo, PIC, SIC, Flight and ground training received, training in a simulator or flight training device

c. Conditions of Flight
- Day/Night, Actual Instrument, Simulated Instrument in flight or a simulator/FTD

5. **Compensation**
   A. See Privileges and Limitations
6. **Towing** (FAR 61.60)
   A. In order to act as PIC towing a glider or unpowered ultralight you must:
      i. Have at least a Private Certificate for powered aircraft
      ii. Have logged at 100 hours of PIC in the aircraft category, class and type
      iii. Have a logbook endorsement certifying that ground and flight training was received and you are proficient in the requirements of 61.69
      iv. Have logged at least 3 flights as the sole manipulator of the controls while towing a glider or unpowered ultralight (or simulated towing procedures while accompanied by a pilot meeting the requirements of 61.69)
      v. Have a logbook endorsement stating you did the 3 flights above
      vi. Within the last 24 months:
         a. Have made at least 3 actual or simulated tows of a glider or unpowered ultralight while accompanied by a qualified pilot
         b. Made at least 3 flights as PIC of a glider or unpowered ultralight towed by an aircraft
7. **Category and Class**
   A. Both Category and Class can be defined in relation to airmen certification and aircraft certification
   B. Category
      i. With respect to the certification, ratings, privileges and limitations of airmen:
         a. A broad classification of aircraft. Examples include airplane, rotocraft, glider, and lighter-than-air
      ii. With respect to the certification of aircraft:
         a. A grouping of aircraft based upon the intended use or operation limitations
            - Examples include transport, normal, utility, acrobatic, limited, restricted, and provisional
   C. Class
      i. With respect to the certification, ratings, privileges and limitations of airmen:
         a. A classification of aircraft within a category having similar operating characteristics
            - Examples include single engine, multiengine, land, water, helicopter, airship, etc.
      ii. With respect to the certification of aircraft:
         a. A broad grouping of aircraft having similar characteristics of propulsion, flight, or landing
            - Examples include airplane, rotocraft, glider, balloon, landplane, and seaplane
8. **Endorsements**
   A. Private Pilot Checkride (FAR 61.103)
      i. Knowledge Test Endorsement
      ii. Flight Training Endorsement
   B. Student Pilot Endorsements

i. Presolo aeronautical knowledge
ii. Presolo flight training/Presolo flight training at night
iii. Solo Flight
iv. Solo TO and LDG at another airport within 25 nm
v. Initial Solo XC/Repeated solo XC flights
vi. Solo in Class B airspace/Solo to or from an airport in Class B
vii. TSA Endorsement

9. Medical Certificates (61.123)

A. Requirements
   i. A First-Class Medical Certificate is required when:
      a. Exercising the PIC privileges of an airline transport pilot certificate
      b. Exercising the second- in-command privileges of an airline transport pilot certificate that requires 3 or more pilots, or when serving as a required flight crewmember under Part 121 and 60 years old or older
   ii. A Second-Class Medical Certificate is required when:
      a. Exercising Second-in-command privileges of an airline transport pilot certificate under Part 121
      b. Exercising the privileges of a commercial pilot certificate
   iii. **A Third-Class Medical Certificate is required when:**
      a. **Exercising the privileges of a private pilot**, recreational pilot, or student pilot certificate
      b. Exercising the privileges of a flight instructor certificate and acting as PIC
      c. Exercising the privileges of a flight instructor certificate and serving as a required flight crewmember
      d. Taking a practical test in an aircraft for a recreational pilot, private pilot, commercial pilot, airline transport pilot, or flight instructor certificate
      e. When performing the duties as an Examiner in an aircraft when administering a practical test or proficiency check
   iv. A medical is not required when:
      a. Exercising the privileges of a flight instructor certificate if the person is not acting as PIC or serving as a required flight crewmember
      b. Exercising the privileges of a ground instructor certificate
      c. When a military pilot of the US Armed Forces can show evidence of an up-to-date medical examination authorizing pilot flight status issued by the US Armed Forces and
         - The flight does not require higher than a 3rd class medical certificate
         - The flight conducted is a domestic flight within US airspace
   v. Operations requiring a Medical OR U.S. Driver's License
      a. A person must hold and possess either a medical certificate or a U.S. driver's license when:
         - Exercising the privileges of a student pilot certificate while seeking sport pilot privileges in a light-sport aircraft other than a glider or balloon
         - Exercising the privileges of a sport pilot certificate in a light sport aircraft other than a glider or a balloon
         - Exercising the privileges of a flight instructor certificate with a sport pilot rating while acting as PIC or serving as a required flight crewmember of a light-sport aircraft other than a glider or a balloon
         - Serving as an examiner and administering a practical test for the issuance of a sport pilot certificate in a light-sport aircraft other than a glider or a balloon

b. A person using a U.S. driver's license must:
   - Comply with each restriction and limitation imposed by the driver's license and any judicial or administrative order applying to the operation of a motor vehicle
   - Have been found eligible for at least a 3rd class medical certificate at the time of the most recent application (if the person has applied for a medical certificate)
   - Not have had the most recently issued medical certificate suspended or revoked or most recent Authorization for a Special Issuance of a Medical Certificate withdrawn
   - Not know or have reason to know of any medical condition that would make the person unable to operate a light-sport aircraft in a safe manner

B. Class and Duration (61.23(d))
   i. First Class
      a. Under 40 on the date of the examination - Expires at the end of the last day of the:
         - 12th month for 1st class activities
         - 12th month for 2nd class activities
         - 60th month for 3rd class activities (under 40 years old)
      b. Over 40 on the date of the examination - Expires at the end of the last day of the:
         - 6th month for 1st class activities
         - 12th month for 2nd class activities
         - 24th month for 3rd class activities (over 40 years old)
   ii. Second Class
      a. When exercising the privileges of Commercial certificate
      b. Under 40 on the date of the examination - Expires at the end of the last day of the:
         - 12th month for 2nd class activities
         - 60th month for 3rd class activities
      c. Over 40 on the date of the examination - Expires at the end of the last day of the:
         - 12th month for 2nd class activities
         - 24th month for 3rd class activities
   iii. Third Class
      a. When exercising the privileges of a CFI, Private, Recreational, Student certificate, etc.
      b. Under 40 on the date of the examination - Expires at the end of the last day of the:
         - 60th month
      c. Over 40 on the date of the examination - Expires at the end of the last day of the:
         - 24th month

C. BasicMed
   i. Overview
      a. Beginning May 1, 2017, pilots may take advantage of the regulatory relief in the new BasicMed rule and operate without an FAA medical certificate, or opt to continue to use their FAA medical certificate
         - Under BasicMed, a pilot will be required to complete a medical education course, undergo a medical examination every four years, and comply with aircraft and operating restrictions
      b. FAA BasicMed Info
      c. FAA BasicMed FAQ
   ii. Pilot Requirements
      a. Possess a U.S. driver's license
      b. Have held a medical that was valid at any time after July 15, 2006.

   c. Have not had the most recently held medical certificate revoked, suspended, or withdrawn.
   d. Have not had the most recent application for medical certification completed and denied.
   e. Have completed a medical education course described in FESSA within the past 24 calendar months
   f. Have received a comprehensive medical examination from a State-licensed physician within the previous 48 months.
   g. Be under the care and treatment of a physician for certain conditions
   h. When applicable, have been found eligible for special issuance of a medical certificate for certain specified mental health, neurological, or cardiovascular conditions
   i. Make certain health attestations and agree to a National Driver Register check
  iii. Aircraft Requirements
   a. Any aircraft authorized under federal law to carry not more than 6 occupants
   b. Has a maximum certificated takeoff weight of not more than 6,000 pounds
  iv. Basic Operating Requirements
   a. Carries not more than 5 passengers
   b. Operates under VFR or IFR, within the United States, at less than 18,000' MSL, and not exceeding 250 knots
   c. Flight not operated for compensation or hire

10. Drugs and Alcohol

A. FAR 61.15: An alcohol or drug conviction is grounds for the denial, suspension or revocation of an application for any certificate, rating or authorization
B. FAR 91.17:
  i. You may not act or attempt to act as a crewmember:
   a. Within 8 hours after the consumption of any alcoholic beverage
   b. While under the influence of alcohol
   c. While using any drug that affects your faculties in any way contrary to safety
   d. While having an alcohol concentration of 0.04 or greater
  ii. Except in an emergency, no pilot may allow a person who appears to be intoxicated or under the influence of drugs to be carried in an aircraft (except for a medical patient under care)

RISK MANAGEMENT

1. Proficiency vs Currency

A. Currency is the minimum required by law to legally fly
  i. Although legal, more practice may be needed in order to be proficient and safe
B. Proficiency is a level of understanding and ability that creates a safe and competent pilot
  i. Be proficient, not just current
  ii. Even in the air, your mistakes can affect others

2. Personal Minimums

A. The regulations provide legal minimums to protect the pilot as well as the passengers and people on the ground. The same minimums apply to a brand-new pilot on the first hour of flight time after earning his or her certificate as well as a far more experienced pilot 1,000+ hours down the road.
  i. Therefore, set minimums that agree with your experience level – just because you can do something doesn't mean you should

    ii. Personal Minimums can be set for things such as visibility, wind/cross wind, fuel levels, rest, day/night flying, etc.
    iii. Always err on the side of caution

3. Maintaining Fitness to Fly

A. The medical certificate is the minimum health level required by the FAA in order to fly an aircraft
    i. Once you have the medical you make the decision as to whether you're healthy enough to fly

B. Your passengers, and others on the ground and in the air depend on you to be healthy when you fly

C. In addition to overall health, there are health factors specific to flight that can adversely affect your ability to fly
    i. For example, smoking and hypoxia, the leans/spatial disorientation, etc.

4. Flying Unfamiliar Aircraft

A. Not all planes fly the same – different speeds, power settings, stall characteristics, procedures, etc.

B. The first few flights in an unfamiliar aircraft should be with a CFI
    i. Fly with a CFI until both you and the CFI feel you're comfortable, safe and, competent

C. Thoroughly review the Flight manual – know the airplane

5. Operating Unfamiliar Displays/Avionics

A. The same mentality as operating unfamiliar aircraft applies
    i. A thorough understanding is necessary before taking the aircraft solo or with passengers
    ii. Take as many flights as necessary until both you and the CFI feel you're comfortable, safe, and competent

II.B. Cockpit Management

1. **Safety Restraint Systems, Requirements and Operational Considerations**
   A. Safety Restraint Systems
      i. When seated, the seat belt/harness should be adjusted to a comfortable, snug fit
         a. Shoulder harness must be worn at least for taxi, takeoff, and landing
         b. The safety belt must be worn all times at the controls
      ii. Passengers and Safety Restraints Requirements and Considerations
         a. Each person must be briefed on how to fasten and unfasten the safety belt/harness (91.107)
            - You cannot taxi, takeoff, or land without notifying/ensuring each person has fastened their safety belt
2. **Oxygen**
   A. Regulatory Requirements
      i. No person may operate a civil aircraft of US registry at cabin pressure altitudes above:
         a. 12,500' MSL up to/including 14,000' unless the required minimum flight crew is provided with and uses supplemental oxygen for the part of the flight at those altitudes over 30 minutes
         b. 14,000' unless the required min flight crew is provided with and uses supplemental oxygen during the entire flight time at those altitudes
         c. 15,000' unless each occupant of the aircraft is provided with supplemental oxygen
      ii. No person may operate a civil aircraft of US registry with a pressurized cabin at flight altitudes above:
         a. FL 250 unless at least a 10-minute supply of supplemental oxygen is available for each occupant of the aircraft for use in the event that a descent is necessitated by a loss of cabin pressure
            - This is in addition to oxygen required above
         b. FL 350, unless one pilot at the controls of the airplane is wearing and using an oxygen mask that is secured and sealed
            - The mask must supply oxygen at all times or automatically supply oxygen whenever the cabin pressure altitude of the airplane exceeds 14,000' MSL
            - Exception: One pilot need not wear and use an oxygen mask while at or below FL 410 if there are two pilots at the controls and each pilot has a quick donning type of oxygen mask that can be placed on the face with one hand from the ready position within 5 seconds, supplying oxygen and properly secured and sealed
            - If one pilot leaves the controls, the remaining pilot shall put on and use and oxygen mask until the other pilot has returned
   B. System Operational Guidelines
      i. Refer to the guidelines associated with the specific system to be used
      ii. General Overview
         a. Types of Oxygen Systems
            - Continuous Flow
               a Most common in GA planes
               b Usually for passengers and has a reservoir bag which collects oxygen from the system when exhaling
               c Ambient air is added to the oxygen during inhalation after the reservoir oxygen supply is depleted

        d. Exhaled air is released into the cabin
    - Diluter Demand – Supply oxygen only when the user inhales through the mask
        a. Depending on the altitude, the regulator can provide 100% oxygen or mix cabin air and the oxygen
        b. The mask provides a tight seal and can be used safely up to 40,000'
    - Pressure Demand – oxygen is supplied to the mask under pressure at cabin altitudes above 34,000'
        a. Provide a positive pressure application of oxygen that allow the lungs to be pressurized with oxygen
        b. Safe at altitudes above 40,000'
        c. Some systems include the regulator on the mask to eliminate purging a long hose of air

b. Aviator's Breathing Oxygen
    - Aviators oxygen is specified at 99.5% pure oxygen and not more than .005mg of water per liter
        a. It is recommended that aviator's breathing oxygen be used at all times, medical and industrial oxygen may not be safe
    - Medical oxygen has too much water, which can collect in various parts of the system and freeze
        a. Freezing may reduce/stop the flow of oxygen
    - Industrial oxygen is not intended for breathing and may have impurities in it (metal shavings, etc.)

C. System Checks
   i. Refer to the guidelines associated with the specific system to be used
   ii. General Guidelines
      a. Care and Storage of High-Pressure Oxygen Bottles
         - If the airplane does not have a fixed installation bottle, portable oxygen equipment must be accessible in flight
         - Oxygen is usually stored at 1,800 – 2,200 psi
             a. When the ambient temperature surrounding the cylinder decreases, pressure within will decrease
                 1. If a drop in indicated pressure is noted due to temperature, there is no reason to suspect depletion of the supply
             b. High pressure containers should be marked with the psi tolerance before filling to the pressure
         - Be aware of the danger of fire when using oxygen
             a. Materials that are nearly fire proof in ordinary air may be susceptible to burning in pure oxygen
                 1. Oils and greases may catch fire if exposed to pure oxygen and cannot be in oxygen systems
             b. Smoking during any kind of oxygen equipment use is prohibited
             c. Before each flight, thoroughly inspect and test all oxygen equipment
         - Examine the equipment - available supply, operational check, and assure it is readily available
         - To assure safety, periodic inspections and servicing should be done

3. Safety System Rules and Operational Considerations

A. A passenger briefing on the proper use of safety equipment and exit info must also be done

   i. Inform passengers what should be done before and after an off-airport landing
   ii. Ensure all passengers can open all exit doors and unfasten safety belts

4. **Passenger Briefings**
   A. Safety Belts
      i. Each person must be briefed on how to fasten and unfasten the safety belt/harness (FAR 91.107)
         a. You cannot taxi, takeoff, or land without notifying/ensuring each person has fastened their safety belt
   B. Emergency Procedures
      i. A passenger briefing on the proper use of safety equipment and exit info must also be done
         a. Inform passengers what should be done before and after an off-airport landing
         b. Ensure all passengers can open all exit doors and unfasten safety belts
      ii. Departure Plan
         a. Runway available, Runway Required, Emergency procedures during takeoff
5. **PIC Responsibility to have Available Material for the Flight as Planned**
   A. FAR 91.103
      i. Each PIC shall, before beginning a flight, become familiar with *all available information* concerning that flight. This information *must* include:
         a. Runway lengths at airports of intended use, and the following takeoff and landing distance information in the Flight Manual
   B. It is the PIC's responsibility to make the flight as safe as possible, do not fly without the available material for the flight as it was planned
6. **Purpose of a Checklist**
   A. The checklist is an aid to the memory and helps ensure that critical items necessary for the safe operation of aircraft are not overlooked or forgotten
      i. However, checklists are useless if the pilot is not committed to its use
   B. The importance of consistent checklist use cannot be overstated
   C. At a *minimum*, use checklists for:
      i. Preflight, before engine start, engine starting, before taxiing, before takeoff, after takeoff, cruise, descent, before landing, after landing, and engine shutdown and securing.

RISK MANAGEMENT

1. **Failure to Positively Exchange Flight Controls**
   A. There must always be a clear understanding as to who has control of the aircraft
   B. Prior to any flight, a briefing should be conducted that includes the procedures for exchanging the flight controls
   C. The following 3 step process is highly recommended (and used just about everywhere):
      i. To give the controls to another pilot, state "You have the flight controls"
      ii. The receiving pilot should acknowledge with, "I have the flight controls"
      iii. The giving pilot confirms by saying, "You have the flight controls"
   D. There should never be any doubt as to who has control of the aircraft
2. **Use of Portable Electronic Devices**
   A. FAR 91.21 - No person may operate, nor may any operator or pilot in command of an aircraft allow the operation of, any portable electronic device on any of the following U.S.-registered civil aircraft:
      i. Aircraft operated by a holder of an air carrier operating certificate or an operating certificate; or

        ii. Any other aircraft while it is operated under IFR.

3. **Use of Automation**
    A. Automation is a great tool, when it is used properly
        i. A proper understanding of the automation's capabilities and procedures is required
    B. Used incorrectly, automation can lead to an unsafe situation
        i. Don't let automation distract you from flying the airplane, if it's not doing what you want turn it off and hand fly
4. **Inappropriate Use of Technology**
    A. Like automation, technology can be a great tool to increase situational awareness, and competence in the cockpit
        i. Used inappropriately, it can quickly become a distraction
        ii. Always divide time between the aircraft and any technology in use (tablet, navigation apps, GPS, weather radar, etc.)
        iii. If it doesn't increase situational awareness/competence it doesn't belong in the cockpit
            a. For example, games on your tablet, social media, etc.
5. **Impact of Reported Discrepancies** – Aviation Safety Reporting System
    A. Pilots, controllers, Flight Attendants, maintenance personnel, dispatchers, other users of the National Airspace System, or any other person, can report potential discrepancies and deficiencies involving the safety of aviation operations
        i. Ensures the confidentiality and anonymity of the reporter, and other parties as appropriate, involved in a reported occurrence or incident
            a. The FAA believes that by submitting a report you have recognized the mistake you made and have learned from the situation. They are not looking to punish you (FAR 91.25) as long as the discrepancy was inadvertent and not criminal, but are looking for trends and deficiencies that can be corrected.
    B. Based on information obtained from this program, the FAA will take corrective action as necessary to remedy defects or deficiencies in the NAS. The reports may also provide data for improving the current system and planning for a future system.
6. **Passenger Behavior that Could affect Safety**
    A. Often times passengers are unfamiliar with how their actions may impact the safety of a flight
        i. Passengers talking over ATC
            a. Inform passengers of the call sign so they are aware as to when ATC is communicating with you
        ii. Critical Phases of Flight
            a. At a minimum, Taxi, Takeoff and Landing should be distraction free
            b. Inform the passengers as to when they should be quiet
        iii. Passengers can be used to increase safety
            a. Have them look for other traffic both on the ground and in the air
            b. Have them listen for your call sign on the radio

ACS LESSONS

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III.A. Compliance with Air Traffic Control Clearances

1. **The Responsibilities Associated with Accepting an ATC Clearance**
    A. An ATC clearance means an authorization by ATC, for the purpose of preventing collision between known aircraft, for an aircraft to proceed under specified conditions within controlled airspace
        i. It is not authorization for a pilot to deviate from any rule, regulation, or minimum altitude nor to conduct unsafe operation of the aircraft
        ii. FAR 91.3: The PIC is directly responsible for, and is the final authority as to, the operation of that aircraft
            a. If ATC issues a clearance that would cause a pilot to deviate from a rule or regulation, or in the pilot's opinion, would place the aircraft in jeopardy, it is the pilot's responsibility to request an amended clearance
    B. Record the ATC Clearance
        i. When conducting an IFR operation, make a written record of your clearance
    C. Acknowledge, receipt and understanding of an ATC clearance
    D. Request clarification or amendment, as appropriate, any time clearance is not fully understood, or considered unacceptable from a safety standpoint
    E. Promptly comply with ATC clearance upon receipt, except as necessary to cope with an emergency
        i. Advise ATC as soon as possible and obtain an amended clearance, if deviation is necessary
    F. Pilot is always responsible to see and avoid traffic when operating in VMC
2. **The Requirements to Read back an ATC Clearance**
    A. Pilots of airborne aircraft should read back those parts of ATC clearances and instructions containing altitude assignments, vectors, or runway assignments as a means of mutual verification
        i. The read back of the "numbers" serves as a double check between pilots and controllers and reduces the kinds of communication errors that occur when a number is either misheard or incorrect
    B. Include the aircraft identification in all readbacks and acknowledgements
        i. This aids controllers in ensuring the correct aircraft received the clearance
    C. Readback altitudes, altitude restrictions, and vectors in the same sequence as they are given in the clearance or instruction
    D. Altitudes contained in charted procedures, such as DPs, instrument approaches, etc., should not be read back unless they are specifically stated by the controller
    E. Initial read back of a taxi, departure, or landing clearance should include the runway assignment including left, right, center, etc. if applicable
    F. It is the responsibility of the pilot to accept or refuse the clearance issued
3. **Pilot in Command Emergency Authority**
    A. FAR 91.3: The PIC is directly responsible for and the final authority as to the operation of the aircraft
        i. In emergencies, PIC may deviate from 14 CFR to the extent necessary to maintain safety and then, if requested, send a written report to the Administrator
4. **The Methods to Obtain an ATC Clearance**
    A. Clearance Delivery/Ground
        i. An IFR clearance is normally picked up from Clearance Delivery

ii. Not all airports have a designated clearance delivery frequency, in which case Ground Control handles ATC clearances

B. From ATC (on the ground or airborne)
  i. Many airports are uncontrolled, and therefore pilots are unable to get clearance from clearance delivery or ground control
    a. In this case the pilot can attempt to contact ATC from the ground (radio strength permitting), for their clearance
      - If practical, pilots departing uncontrolled fields should obtain IFR clearances prior to becoming airborne
      - Talk to local pilots to see if this is an option. The radio signal may not be sufficient to communicate with ATC from the ground
    b. Or, the pilot can depart VFR and establish communication with ATC to obtain their clearance
      - You must maintain VFR cloud clearance requirements you are on an IFR flight plan
  ii. This clearance will be issued with a clearance void time (if you are not off the ground by your clearance void time, your clearance is void)
C. By Phone
  i. You can make a phone call to get your IFR clearance: (888) 726-8267
    a. This clearance will be issued with a clearance void time (if you are not off the ground by your clearance void time, your clearance is void)

5. **Terrain Clearance Requirements Associated with Departure Procedures**
  A. When an instrument approach is initially developed for an airport, the need for Departure Procedures (DPs) is assessed. If an aircraft may turn in any direction from the runway within the limits of the assessment area and remain clear of obstacles, that runway passes what is called a diverse departure assessment and no Obstacle Departure Procedure (ODP) will be published.
    i. However, if an obstacle penetrates what is called the 40:1 obstacle identification surface (OCS), then the procedure designer chooses whether to:
      a. Establish a steeper than normal climb gradient, or
      b. Establish a steeper than normal climb gradient with an alternative that increases takeoff minima to allow the pilot to visually remain clear of the obstacles, or
      c. Design and publish a specific departure route, or
      d. A combination of all the above
    ii. The 40:1 Obstacle Identification Surface begins at the departure end of the runway and slopes upward at 152 feet per nautical mile until reach the minimum IFR altitude or entering the en route structure
  B. Unless specified otherwise, required obstacle clearance for all departures, including diverse, is based on:
    i. The pilot crossing the runway at least 35' above the departure end
    ii. Climbing to 400' above the departure end before making a turn
    iii. Maintaining a minimum climb gradient of 200' per nautical mile
      a. Note that this is 48' per nautical mile above the 40:1 obstacle identification surface.
  C. Low Close in Obstacles
    i. Obstacles within 1 nautical mile of the departure end of the runway and penetrate the 40:1 OCS would require a climb gradient higher than the standard 200 fpm for a very short distance
      a. To eliminate publishing excessive climb gradients, the obstacle height and location are published to allow the pilot to avoid the obstacles by:
        - Sight

- Early takeoff (well prior to the departure end – ensure you're expected climb gradient will clear the obstacle)
- Preflight planning (turns or other maneuvers)

6. Lost Communication Procedures

A. General
  i. FAR 91.185 - IFR Operations: Two-way Radio Communication Failure
  ii. Pilots can use the transponder to alert ATC to a radio communication failure by squawking 7600

B. Recognition of Loss of Communications
  i. If it has been abnormally quiet on the radio check for a loss of communications
    a. Query ATC to see if it is a communication problem or just quiet
  ii. Do not immediately assume a loss of communications
    a. Check the volume, was it turned down
    b. Are you on the right frequency?
      - If you can hear someone else, but not ATC, transmit a message through them to ATC
        a A frequency change may be necessary as you could be out of range
    c. Check the other Com for operation
    d. Ensure proper set up of the Coms
  iii. You may be able to hear ATC but not transmit
    a. In this case, you can still receive ATC instruction
    b. A response or acknowledgement of the instruction may be made by using the Ident button

C. When to Continue as Filed and When to Deviate
  i. The primary objective of the regulations governing communication failure is to preclude extended IFR no-radio ops in the ATC system since these ops may adversely affect other users of the airspace
  ii. If the radio fails while operating on an IFR clearance, but in VFR conditions
    a. Continue the flight under VFR conditions, if possible, and land as soon as practicable
      - This does not mean land as soon as possible
  iii. If IFR conditions prevail, pilots must comply with the procedures designated in the CFRs
    a. This will ensure aircraft separation

D. The CFRs – 91.185
  i. Route (AVE F) - In order of importance, fly:
    a. The route assigned in the last ATC clearance received
    b. If being radar vectored, the direct route from the point of radio failure to the fix, route, or airway specified in the vector clearance
    c. The route that ATC has advised may be expected in a further clearance
    d. The route filed in the flight plan
  ii. Altitude (MEA) - fly the highest of the following for the route segment being flown:
    a. The minimum altitude for IFR operations
    b. The altitude ATC has advised may be expected
    c. The altitude assigned in the last ATC clearance received

E. Determining the Time to begin the Approach
  i. Leaving a Clearance Limit
    a. When the clearance limit is a fix from which an approach begins,
      - Commence descent as close as possible to the EFC time if one has been received
      - If one has not been received, as close as possible to the ETA filed

b. When the clearance limit is not a fix from which an approach begins,
    - Leave the clearance limit at the EFC time, if one has been received

F. If one has not been received, leave upon arrival over the clearance limit, and proceed to a fix from which an approach begins and commence descent as close as possible to the ETA on the filed flight plan

7. The Purpose of "Expect" in a Clearance

A. Used under certain conditions to provide a pilot with information to be used in the event of a two-way communications failure, and also provides information to assist the pilot in planning
  i. Often used in regards to altitudes

8. The Procedures involved for the Departure, En Route and Arrival Phases of Flight

A. Departure
  i. Clearance
    a. When "Ready to copy" inform the controller and copy as follows (CRAFT is a good memory aid):
      - **C**learance Limit
        a Occasionally a short-range clearance to a fix w/in or just outside the terminal area and provides frequency on which the long-range clearance will be received
      - **R**oute, including any departure procedure
        a Normally "as filed," but may be changed for established flow patterns or preferred routes
        b Pilot responsibility to notify ATC if unable to comply with clearance
          1. e.g., radio equipment unable to receive necessary signals
      - **A**ltitude, the initial altitude (to maintain)
        a The term cruise**,** instead of maintain, assigns a block of airspace from min IFR altitude to the cruise altitude
          1. Within this block climb, descent and level-off are at pilot's discretion
          2. Once pilot begins descent and verbally reports leaving an altitude, he may not climb back to that altitude w/o further clearance
      - **F**requency, for departure control
      - **T**ransponder Code
      - Often you will know most of these before copying
        a Clearance limit is usually the destination; Route is often what you provided; DPs/Initial Altitude/Frequency can be heard as other aircraft are given clearances
    b. Read Back
      - Promptly read back the clearance you just copied
      - Inform ATC of any items you missed; correct any errors and read back those items again for confirmation
      - Note "read back correct" from controller confirming correctness
      - Reading back of initial clearance does not imply acceptance
      - Ensure appropriate phraseology is used
        a AIM Pilot Controller Glossary
    c. Taxi Clearance
      - Obtain and readback the taxi clearance
  ii. Departure Control
    a. An approach control function responsible for ensuring separation between departures

b. Departure control utilizing radar will normally clear aircraft out of the terminal area using DPs via radio navigation aids
c. AT some airports when a departure will fly an RNAV SID that begins at the runway, ATC may advise aircraft of the initial fix/waypoint to remind pilots to verify the correct procedure is loaded
d. Types of Departures
    - Obstacle Departure Procedure
        a Recommended for obstruction clearance and may be flown without ATC clearance
    - Standard Instrument Departure
        a ATC procedures to provide obstruction clearance and transition from the terminal are to the appropriate en route structure
        b Primarily designed for system enhancement and to reduce pilot/controller workload
        c ATC clearance is required to fly a SID
    - Departure procedures in general are necessary to provide obstacle clearance and, at busier airports, increase efficiency and reduce communications, and departure delays through SIDs

iii. Departure Procedure

B. En Route
  i. ARTCC Communications
    a. ARTCC is divided into sectors. Each sector has its own discrete frequency. As a flight progresses from one sector to another, the pilot is requested to change to the appropriate frequency
    b. ATC may transmit instructions based on your route of flight, altitude, other traffic, airspeed, etc.
  ii. Position Reporting
    a. Described below
  iii. Navigation
    a. Navigate the route you were cleared in the IFR clearance
        - Adjust as instructed by ATC while en route (it is common for ATC to change your route of flight once airborne for various reasons. Read back the new information just as you would if you got the clearance on the ground)
  iv. Holding
    a. There are times an aircraft will be required to hold for various reasons (airport closure, delays, etc.)
        - If you need to hold for any reason query the controller and make the request
    b. The ATC controller will issue holding instructions and an EFC time and best estimate of any further delays

C. Arrival
  i. STAR (Standard Terminal Arrival) Procedures
    a. A STAR is an ATC coded arrival route established for application to arriving IFR aircraft destined for certain airports
    b. STARs simplify clearance delivery procedures, and also facilitate transition between en route and instrument approach procedures
  ii. Approach Control
    a. Responsible for controlling all instrument flight operating within its area of responsibility
  iii. Instrument Approach Procedure

a. The instrument approach is designed to transition the aircraft from the arrival procedure to an altitude from which the pilot can recognize the airport environment for landing
    - ATC will clear the pilot to fly a specific approach based on the traffic flow and aircraft capabilities
b. The design of instrument approaches takes into account the interrelationship between airports, facilities, and surrounding environment, terrain, obstacles, noise sensitivity, etc.

iv. Landing
  a. The transition from instrument flight to visual flight while close to the ground can take time to become comfortable with
  b. If the approach does not feel stable or safe, initiate a go around, inform ATC, and fly the missed approach procedure or instructions issued by ATC

v. Missed Approach Procedure
  a. When a landing cannot be accomplished, advise ATC and, upon reaching the missed approach point, comply with the missed approach procedures
  b. Often, the missed approach procedure will take the aircraft to a hold from which the pilot can determine and relay their intentions to ATC

9. Position Reporting

A. Position Reporting Points
  i. Reporting points are indicated by symbols on en route charts
  ii. Compulsory Reporting Points
    a. A solid triangle
    b. Required reporting points
  iii. "On Request" (non-compulsory) Reporting Points
    a. An open triangle
    b. Reports are only necessary when requested by ATC

B. Position Reporting Requirements
  i. Flights in a Radar Environment
    a. When informed by ATC that you are in "Radar Contact," no position reports are required
    b. Resume normal position reports when ATC advises "radar contact lost," or "radar services terminated."
  ii. Flights Along Airways or Routes
    a. A position report is required by all flights over each designated compulsory (solid triangle) reporting point along the route being flown
  iii. Flights Along a Direct Route
    a. Pilots must report over each reporting point used in the flight plan to define the route of flight
  iv. Flights in an Oceanic Environment (non-radar)
    a. Report over each point used in the flight plan to define the route of flight, even it is depicted as an "on request" reporting point

C. Position Report Items
  i. Include the following items in your position report:
    a. Identification
    b. Position
    c. Time
    d. Altitude or Flight Level
    e. Type of flight plan (not required for IFR)

f. ETA and the name of the next reporting point
g. Just the name of the next succeeding reporting point along the route of flight
h. Pertinent Remarks

ii. You end up reporting the point you're over, the next reporting point and when you expect to be there, as well as the reporting point after that (3 points)

10. The Purpose and Use of Clearance Void Times

A. You may receive a clearance when operating from an airport without a tower, which contains a provision for the clearance to be void if not airborne by a specific time (clearance void time)
   i. This is used by ATC to advise an aircraft that the departure clearance is automatically canceled if takeoff is not made prior to a specified time
   ii. The time period provides a window for the pilot to depart with ATC separation requirements
      a. Pilots departing outside of the clearance void time are not afforded IFR separation

B. If not off by the specified time, you must advise ATC of your intentions
   i. The pilot must obtain a new clearance or cancel the IFR flight plan if not off by the specified time
   ii. ATC will normally advise of the time allotted to notify ATC that you did not depart
      a. Failure to contact ATC within the 30 minutes after the void time will result in search and rescue
      b. Other IFR traffic for the airport where the clearance is issued is suspended until the aircraft has contacted ATC or 30 minutes after the clearance void time
      c. Pilots departing at or after their clearance void time are not afforded IFR separation and may be in violation of 91.173 which requires pilots to receive an appropriate clearance before operating IFR in controlled airspace

RISK MANAGEMENT

1. Failure to Fully Understand an ATC Clearance

A. Request clarification/amendment as appropriate anytime a clearance is not fully understood or unsafe
   i. Understanding is the basis for safe, competent skies
   ii. If you don't understand the clearance from ATC, ask. Don't assume.

2. Inappropriate, Incomplete, or Incorrect ATC Clearances

A. As mentioned above, if the clearance is not clear, ask for clarification
   i. Don't assume you know what the controller meant, clarify the instruction for your own safety and others

3. ATC Clearances Inconsistent with Aircraft Performance and/or Navigation Capability to Comply

A. Inform ATC (unable)
   i. If ATC issues instructions that are beyond the aircraft's capabilities, inform them that you are unable to comply and request alternate instructions
      a. Do not continue on the instructions

4. Short Clearance Void Times

A. Ask for a later Clearance Void Time
   i. It never hurts to ask

B. Don't rush
   i. Safety First – if the clearance void time will expire prior to being comfortable and ready for departure then delay the departure
   ii. Contact ATC to inform them of the delay and request a new clearance void time

a. Don't wait to contact ATC, after a maximum of 30 minutes search and rescue procedures will be initiated

5. **Airborne Clearances**
    A. Maintain VFR
        i. When departing without a clearance, the pilot is required to maintain VFR until on an IFR clearance
            a. This can be difficult in IMC conditions, do not sacrifice safety to pick up your clearance airborne
                - Use the radio or make a phone call to pick up your clearance on the ground
    B. Divide Attention
        i. Picking up a clearance airborne can overtask the pilot
            a. Divide attention between flying the aircraft, maintaining VMC, copying the clearance, and reprogramming the NAVAIDs or FMS for the route cleared
    C. Divide responsibilities
        i. If you have another pilot in the aircraft, ask them to handle the clearance while you fly the aircraft or vice versa
6. **Flying IFR in a Non-Radar Environment**
    A. See and Avoid
        i. The pilot always has the responsibility to see and avoid other traffic when in VMC conditions
            a. This is especially true outside of the radar environment
        ii. Be extra vigilant and divide attention between flying and scanning for traffic
    B. Position Reports
        i. Outside of radar contact, the pilot is required to make position reports as described above
7. **Similar Aircraft Call Signs and the Risks of Accepting Another Aircraft's ATC Instruction**
    A. Listen
        i. Occasionally two aircraft have very similar call signs leading to confusion and the wrong aircraft following the wrong radio calls
            a. ATC is usually very good about informing the pilots of the situation
        ii. Listen very carefully to the full call sign over the radio
            a. If unsure, ask
            b. If you think you took the wrong radio call or another aircraft took your radio call, ask ATC
    B. Clarify
        i. When repeating clearances or instructions be very clear in reading back your full call sign to minimize confusion
        ii. If you're ever not sure who the controller was talking to, clarify!
            a. ATC would much rather have you ask and get it right, than not ask and get violated
8. **The Use of Outdated Navigation Publications and Databases**
    A. Outdated information puts the pilot and other aircraft/people at risk. Do not use outdated publications or databases
        i. The information needs to be current to produce accurate information regarding procedures, NAVAIDS, waypoints, etc.
        ii. For example, arrival and departure procedures can change, sometimes drastically. A pilot flying with an outdated procedure could quickly and unknowingly create a hazardous situation or, worst case, mid-air collision
    B. Always update your database
        i. If it's not updated, the aircraft is not current to fly

ii. If you need to fly, get current paper charts and use the database as a backup for situational awareness

9. Collision, Obstacle, and Terrain Avoidance

A. Collision Avoidance
   i. ATC does an excellent job in mitigating traffic mishaps and collision avoidance, but it is always the job of the pilot to clear for other traffic when able (in VMC)
      a. The pilot may deviate from any rule to the extent required to meet an emergency
         - If necessary, the pilot can and is encouraged to deviate from their instructions in order to prevent a collision
            a Inform ATC if you deviate

B. Obstacle Departure Procedures (ODPs) and SIDs
   i. Obstacle Departure Procedures are specifically designed to keep the aircraft clear of obstacles (assuming the aircraft can maintain the climb gradients specified)
   ii. SIDs are primarily designed for system enhancement and to reduce pilot/controller workloads but also used for obstruction clearance
   iii. Use them!
      a. Ensure the aircraft can comply with the climb gradients required

C. Terrain Avoidance
   i. ATC does an excellent job in keeping aircraft safe in regards to terrain, but mistakes can be made
   ii. Be aware of the terrain in the areas you plan to fly, and the Minimum Safe Altitudes shown on the approach charts. Carefully study and review the departure, MEAs, arrival and approach procedures and comply with the altitudes posted
      a. Descending below MEAs or altitudes published on charts can endanger the aircraft and its occupants. The altitudes exist for a reason.
      b. Do not descend below minimums without the airport environment in sight!
   iii. TAWs
      a. Use terrain awareness systems to enhance situational awareness and help prevent flight into terrain

VI.D. Circling Approach

1. **The Procedures and Limitations Associated with a Circling Approach**
   A. Procedures
      i. Circling vs Straight-In
         a. Circling approaches are identified by the type of approach followed by a letter
            - For example, VOR-A. VOR-B is the second VOR circling approach for the airfield, VOR-C would be the third, and so on
         b. Typically, circling approaches are designed for one of the following reasons:
            - The final approach course alignment with the runway centerline exceeds 30 degrees
            - The descent gradient is greater than 400 feet per nautical mile from the FAF to the threshold crossing height
            - The final approach course does not cross the extended runway centerline prior to the runway threshold
            - A runway is not clearly defined on the airfield
      ii. Circling MDA
         a. Note the circling MDA, based on your aircraft category in the approach minimums
            - At the bottom of the minimums
            - Usually higher than the other minimums due to the increased terrain clearance area (more info below in Limitations)
               a The circling minimums published provide a minimum of 300' of obstacle clearance in the circling area
      iii. Starting the Circle
         a. It is important to remember that circling minimums are only minimums, if the ceiling allows it, fly at an altitude that more approximates the VFR traffic pattern altitude
            - This makes maneuvering safer and brings the view of the landing runway into a more normal perspective
         b. Start the circle prior to the missed approach point, with the airfield in sight from a position from which you can establish a normal pattern (as normal as possible for the weather conditions)
            - Maneuver the shortest path to the base or downwind leg, as appropriate, considering existing weather conditions
               a There is no restriction from passing over the airport or other runways
            - It should be recognized that circling maneuvers may be made while VFR or other flying is in progress at the airport. Standard left turns or specific instruction from the controller must be considered when circling to land
            - At airport without a control tower, it may be desirable to fly over the airport to observe the wind and turn indicators and other traffic which may be on the runway or flying in the vicinity
            - Regardless of the pattern flown, the pilot must maneuver the aircraft to remain within the designated circling area
      iv. Visual References
         a. During the circling approach, the pilot should maintain visual contact with the runway environment, especially the runway of intended landing, and fly no lower than the circling minimums until positioned to make a final descent for landing
      v. Going Missed
         a. A missed approach should immediately be executed when:

- The requirements for operating below DA/DH or MDA (FAR 91.175) are not met when the aircraft is below MDA, or upon arrival at the MAP and at any time after that until touchdown
- An identifiable part of the airport is not visible to the pilot during a circling maneuver at or above MDA
    - a If visual reference is lost while circling to land, execute the missed approach procedure for the approach that was flown (not the runway you're landing on)
        1. Make a turn toward the runway of intended landing and then maneuver to intercept and fly the missed approach course
- Directed by ATC

vi. The Descent

a. Pilots should remain at or above the circling altitude until the aircraft is continuously in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal maneuvers
- Because the aircraft will most likely be below the normal pattern altitude, the pilot will have to delay descent until a normal, stable, descent rate can be attained
    - a Use the 3-degree glideslope to estimate where to begin the descent. For example, if the aircraft is circling approximately 600' AGL, a 3-degree glidepath (300 feet per nautical mile) would start two miles from the runway threshold. Start your descent there. Estimate this distance based on the pattern you're flying (base, downwind, etc.)

B. Limitations

i. Circling Approach Protected Areas

a. Aircraft must remain in their respective Category protected areas
- Protected areas are designed based on approach speed (category) to provide maneuvering airspace at or above the MDA

b. Standard Circling Minimums
- Circling approach protected areas use the radius distance shown in the table on page B2 of the U.S. TPP
- Standard minimums are based on fixed radius distances, dependent on aircraft category
- Circling Radius:

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
All Altitudes	1.3	1.5	1.7	2.3	4.5

c. Enhanced Circling Minimums
- Circling approach areas developed after late 2012 use enhanced circling minimums (also shown on page B2 of the U.S. TPP)
    - a Enhanced circling minimums are identified by the presence of the "negative C" symbol on the circling line of minima
        1. The "negative C" is a black box with a white C inscribed inside it
    - b These minimums are also dependent on aircraft category, but also take into account the altitude of the circling MDA which accounts for true airspeed increases with altitude
- Circling Radius:

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
1000 or less	1.3	1.7	2.7	3.6	4.5
1001-3000	1.3	1.8	2.8	3.7	4.6
3001-5000	1.3	1.8	2.9	3.8	4.8
5001-7000	1.3	1.9	3.0	4.0	5.0
7001-9000	1.4	2.0	3.2	4.2	5.3
9001 and above	1.4	2.1	3.3	4.4	5.5

ii. Low Altitude Maneuvering
   a. Circling may require maneuvers at low altitude, low airspeed, and in marginal weather conditions. Pilots must use sound judgment, have an in-depth knowledge of their capabilities, and fully understand the aircraft performance to determine the exact circling maneuver since weather, unique airport design, and the aircraft position, altitude, and airspeed must all be considered

2. Approach Categories and Relevant Airspeed Limitations

A. The approach category is a grouping of aircraft based on a reference speed, if published, or 1.3 V_{SO} at the maximum certified landing weight
   i. Category A: Less than 91 knots
   ii. Category B: 91-120 knots
   iii. Category C: 121-140 knots
   iv. Category D: 141-165 knots
   v. Category E: 165+ knots

B. A pilot must use the minima corresponding to the category determined during certification or higher
   i. For example, if an aircraft's V_{REF}, or V_{SO} multiplied by 1.3 is 110 knots, that aircraft is considered a Category B aircraft. But, if that aircraft is flying an approach at 125 knots, it is considered a category C aircraft
   ii. A pilot can never go to a category lower than it was certified. In the example above, if the aircraft was flying the approach at 85 knots (probably very unsafe), it still would not be considered a Category A aircraft

RISK MANAGEMENT

1. Failure to Follow Prescribed Circling Approach Procedures

A. Procedures exist for a reason (usually safety). A departure from the prescribed procedures can put the aircraft, it's occupants and others at risk
   i. The procedures published have also likely been tested; operating outside of these procedures may lead to untested, unsafe situations

B. The primary source of information is the Pilot's Operating Handbook (POH)
   i. It is required to contain the manufacturer determined performance capabilities of the aircraft at each weight, altitude, and ambient temperature that are within the aircraft's listed limitations
   ii. Operating outside these procedures may not be possible

C. Follow the procedures. This is especially important when circling close to the ground and in marginal weather conditions

2. Executing a Circling Approach at Night

A. Visual References
   i. The runway environment will appear very different than during the day
      a. In some ways, this can be easier since the airport lights can stand out in the darkness
      b. Know what you're looking for (runways, approach light systems, tower location, etc.)

B. Instruments
   i. The pilot will have to rely more on the instruments than during the day since there may be little to no discernible horizon, especially in the case of a low ceiling or marginal visibility
   ii. Maintain your crosscheck, while dividing attention outside the aircraft to plan your approach to the landing runway

C. Situational Awareness
   i. Use whatever means available to increase situational awareness. Examples can include:
      a. Tower
         - Tower may be able to visually see you, or have you on radar. Ask for assistance if necessary
      b. GPS
         - The GPS can be a great situational awareness tool and can keep the pilot oriented with the airport, the landing runway, distance to the runway, missed approach procedure, etc.

3. Losing Sight of the Runway during a Circling Approach

A. If visual reference is lost while circling to land, the missed approach for that particular procedure must be followed (unless an alternate missed approach procedure is specified by ATC)
   i. Brief the missed approach prior to starting the approach
   ii. Set up as much of the must approach navaids, courses, etc. as possible to reduce your workload while trying to establish a climb, communicate with ATC, and fly the missed approach procedure

4. Performing a Circling Approach in Marginal Visibility

A. Visual References
   i. The runway environment may be harder to see
      a. Fly the pattern closer if necessary to keep maintain visual reference with the airport environment
         - Be cautious of flying too close and overshooting the runway when turning final

B. Instruments
   i. The pilot will have to rely more on the instruments since there may be little to no discernible horizon
   ii. Maintain your crosscheck, while dividing attention outside the aircraft to plan your approach to the landing runway

C. Situational Awareness
   i. Use whatever means available to increase situational awareness. Examples can include:
      a. Tower
         - Tower may be able to visually see you, or have you on radar. Ask for assistance if necessary
      b. GPS
         - The GPS can be a great situational awareness tool and can keep the pilot oriented with the airport, the landing runway, distance to the runway, missed approach procedure, etc.

5. **Failure to Manage Aircraft Automation**
    A. Before any pilot can master automation, he or she must first know how to fly the aircraft
        i. A safety issue identified by the FAA concerns pilots who apparently develop an unwarranted overreliance on their equipment, believing the equipment compensates for pilot shortcomings
            a. This is not the case as over half of all general aviation accidents occur in the takeoff or landing phase that does not involve programming a computer to execute
    B. Understand the Platform
        i. Read and understand the system's manuals and adhere to the AFM/POH procedures
    C. Automation System Requirements:
        i. Familiarity
            a. Familiarity with all equipment is critical in optimizing safety and efficiency
            b. Being unfamiliar adds to the pilot's workload and may contribute to a loss of situational awareness
        ii. Respect for Onboard Systems
            a. A thorough understanding is essential to gaining the benefits the system can offer
                - Understanding leads to respect
        iii. Reinforcement of Onboard Suites
            a. Practice what you've learned to gain experience; reinforcement yields dividends in the use of automation and reduces workload
        iv. Getting Beyond Rote Workmanship
            a. The desire is to become competent and know what to do without having to think about what you need to do next
            b. Operating with competency and comprehension benefits a pilot when situations become more diverse and tasks increase
        v. Understand the Platform
            a. Review and understand the different ways systems are used in a particular aircraft
    D. Turn it off, if necessary
        i. If the automation isn't doing what you intend in flight, turn it off and reset it, or leave it off and fly the plane
        ii. A failure to manage the automation can result in the aircraft going in a different direction than intended without the pilot's knowledge
            a. This is especially dangerous, on an instrument approach: in IMC, near the ground, and in a high traffic environment
        iii. For example, if you intend to fly a GPS or VOR course but the automation remains in a heading or roll mode
    E. If it becomes a distraction, especially in the way of flying the aircraft competently and also in the way of communicating either turn it off or ensure it is operating properly
6. **Failure to Maintain an Appropriate Airspeed While Circling**
    A. Stall
        i. As mentioned below, circling may require maneuvers at low altitude, low airspeed, and in marginal weather conditions.
            a. With numerous distractions, it can be easy to lose track of airspeed and potentially slow to stall speed
                - This is especially hazardous near the ground
        ii. Divide attention between your crosscheck and the outside references
            a. Keep your eyes moving
    B. Protected Circling Area

- i. Flying too fast can result in the aircraft exiting the protected circling environment for your category
  - a. This could lead to impacting terrain or an obstruction in the area
- ii. Higher category airspeeds often require a higher MDA
  - a. Ensure the aircraft maintains the proper airspeed and remains within the designated circling boundaries
- iii. Divide attention between your crosscheck and the outside references
  - a. Keep your eyes moving

7. Low Altitude Maneuvering

- A. Circling may require maneuvers at low altitude, low airspeed, and in marginal weather conditions. Pilots must use sound judgment, have an in-depth knowledge of their capabilities, and fully understand the aircraft performance to determine the exact circling maneuver since weather, unique airport design, and the aircraft position, altitude, and airspeed must all be considered
- B. If unsure, or if you feel unsafe, execute the missed and try again or divert

8. Executing a Missed Approach after the MAP while Circling

- A. To become established on the prescribed missed approach course, the pilot should make an initial climbing turn toward the landing runway and continue the turn until established on the missed approach course
  - i. Different patterns will be required to become established on the prescribed missed approach course depending on the aircraft position at the time visual reference is lost
  - ii. Adherence to the procedure will help assure than an aircraft will remain laterally within the circling and missed approach obstruction clearance areas

ACS LESSONS

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Coming June 2017

The FAA plans to publish the ACS for the Commercial Pilot Airplane on June 15, 2017

THANK YOU

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