Certificated Flight Instructor – Airplane (CFI-A)
Private and Commercial Pilot Lesson Plans

Derek W Beck
June 2008

PRIVATE PILOT INTRODUCTION

Objective

Familiarize the student with the privileges, obligations and responsibilities of a private pilot.

Elements

- Typical VFR flight
- Privileges
- Training requirements
- Currency requirements

Schedule

Discussion 0:30

Instructor Actions

Explain objectives.

Evaluation

Insure understanding of private pilot flying, its objectives, etc.

PILOTING CONSIDERATIONS

Objective

To familiarize the student with currency requirements, health requirements, medical requirements, etc.

Elements

- Health ("I'M SAFE")
- Medical requirements
- Aeromedical physiology
- Currency requirements
- Log books

Schedule

Discussion 0:30

Equipment

14 CFR (FAR/AIM)

Instructor Actions

Discuss the following regulations and requirements:

Health considerations: "I'M SAFE": Illness (14 CFR 61.53, 91.17), Medication (14 CFR 91.17; the best list is at AOPA's members section or http://www.leftseat.com/medcat1.htm; FAA has no official list), Stress, Alcohol (14 CFR 91.17; none within 8 hrs, < 0.04% BAC), Fatigue, Emotion.

Medical requirements: (14 CFR 61.23) 3rd class medical lasts 36 calendar months (< age 40) or 24 calendar months (> age 40). A current medical is required to exercise the privileges allowed by the pilot certificates held.

Aeromedical physiology: (chapter 8 of the AIM) hypoxia, ear block, sinus block, decompression sickness, hyperventilation, carbon monoxide poisoning and disorientation.

Currency requirements: (14 CFR 61.57) 3 take-off's and landings every 90 days for daytime, 3 full-stop take-off's and landings every 90 days for nighttime to fly with passengers. Also, a biennial flight review (14 CFR 61.56) consisting of 1 hour of ground that at least covers 14 CFR 91 and 1 hour of flight maneuvers as deemed adequate by the instructor. The pilot certificate (other than student certificate) lasts indefinitely (14 CFR 61.19). Moving requires an update sent to the FAA within 30 days (14 CFR 61.60).

Log book requirements: (14 CFR 61.51) Only requirement is training and experience required to obtain certificates, ratings, a flight review, or currency requirements. Expand on how to log time and what to log.

Evaluation

Insure understanding of piloting considerations, currency requirements, etc.

References

AIM Chapter 8, 14 CFR 61 and 91

PRE-FLIGHT

Objective

To teach the student with the airplane and the necessary steps for pre-flight.

Elements

- Checklists
- Pre-flight procedures

Schedule

Instructor demonstrate 0:30

Equipment

Aircraft, airplane Pilot Operating Handbook or FAA-approved Airplane Flight Manual

Instructor Actions

Discuss the POH/AFM. Discuss the importance of checklists.

Discuss required documents (AROW).

Discuss the need for all the steps as outlined in the POH. Discuss the instrument tolerances inside the cockpit. Discuss the inspection of the wing and control surfaces. Discuss fuel and oil, grades, types, contaminants, etc. Discuss landing gear, tires, brakes, etc. Discuss the engine and propeller.

Discuss engine run-up.

Discuss other items of operation in the POH/AFM.

Student Actions

Demonstrate a pre-flight inspection.

Evaluation

Lesson is complete when student can demonstrate and explain the need for each procedure and checklist item that is listed as part of the pre-flight of the aircraft.

References

Pilot Operating Handbook or FAA-approved Airplane Flight Manual, FAA-H-8083-3A Airplane Flying Handbook Chapter 2

AERODYNAMICS

Objective

To teach basic aerodynamic principles.

Elements

- Four forces
- Airfoils
- Drag
- Stability & controllability
- Turning tendencies
- Climbs, descents and turns
- Load factors
- Ground effect
- Adverse yaw
- Wingtip vortices

Schedule

Discussion 1:00

Equipment

Model aircraft

Instructor Actions

Discuss the following:

Aerodynamics is the branch of physics that deals with the motion of a solid body through fluids.

Four forces: lift, weight, thrust, drag

Newton's laws of motion: first: an object in motion stays in motion, second: force equals mass times acceleration, third: for every action there is an equal and opposite reaction.

In steady flight, the sum of these opposing forces is equal to zero. (Newton's first law) Lift = weight, thrust = drag.

Bernoulli's principle: an increase in the speed of the fluid occurs simultaneously with a decrease in pressure.

An airfoil is a structure designed to obtain reaction upon its surface from the air through which it moves or that moves past it. (Bernoulli)

Discuss the wing definitions: leading edge, trailing edge, camber, chord line.

- Aspect ratio—wingspan to mean chord line
    - High aspect ratio = more lift, less drag.
- Angle of incidence—angle between the chord and the longitudinal axis
- Angle of attack (AoA)
- Wing always stalls at the critical angle of attack

Drag:

- Parasite—increases as the square of the airspeed
    - Form drag—shape of the aircraft, i.e. streamlined object
    - Skin friction—surface finish
    - Interference—if two objects are placed adjacent to one another, the resulting turbulence produced may be 50 to 200% greater than the parts tested separately
- Induced—byproduct of lift (horizontal component of lift), varies inversely as the square of the airspeed, also caused by downwash from wingtip vortices

Discuss the L/Dmax drag graph. (See figure 3-5 in PHAK)

Discuss stability (see PHAK 3-10) (Use marble and bowl analogy):

- Stability is the inherent quality of an airplane to correct for conditions that may disturb its equilibrium, and to return or to continue on the original flightpath
- Static:
    - Static stability is the initial tendency of an object to return to its original position after being disturbed
    - Positive, neutral, negative
    - Push controls: positive returns to original state; neutral: remains at new state; negative: keeps moving beyond
- Dynamic:
    - Tendency after equilibrium is disturbed (stability in motion)
    - Positive, neutral, negative
    - Positive: dampened, pattern of movements become smaller; neutral: pattern continues unchanged; negative: pattern diverges

Discuss axes of rotation: longitudinal (roll/ailerons), lateral (pitch/elevator), vertical (yaw/rudder).

Longitudinal stability (pitch):

- Most affected by pilot, especially aircraft loading
- Draw CL, CG, horizontal stabilizer down force
- Horizontal stabilizer is an upside-down wing, provides longitudinal stability with a down force
- Nose moves up (tail down), horizontal stabilizer's AoA decreases, reduces lift and the nose moves back down
- Nose moves down (tail up), horizontal stabilizer's AoA increases, produces more lift and the pushes the nose moves back up
- Unstable if CG moves too close to or behind the center of lift

Lateral stability (roll)

- Most common design factor for positive stability is wing dihedral (see PHAK Fig. 3-17)
- Positive dihedral is when the wing tips are higher than the wing root
- Wing position—high wing aircraft are more laterally stable than low wings (everything held constant)
- High wing aircraft require less dihedral than low wing aircraft

Vertical stability (yaw)

- Vertical stabilizer, and the fuselage behind the CG to a lesser extent, provide directional stability
- Vertical stabilizer acts like the tail feathers on an arrow
- Swept back wings, and double taper wings to a lesser extent, also provide directional stability
- Increased induced drag on the wing that is moved forward pulls it back, Causes Dutch roll tendency

Controllability versus Maneuverability (PHAK 3-10)

- Controllability—capability of an aircraft to respond to the pilot's control inputs, especially with regard to flightpath and attitude
- Maneuverability—quality of an airplane that allows it to be easily controlled and maneuvered and withstand stresses imposed by maneuvers
- An F-16 sacrifices stability for controllability, maneuverability

Turning tendencies (PHAK 3-23)

- Torque—opposite reaction to the engine (Newton's third law): leads to a left roll
- Spiraling slipstream—pushes on port side of vertical stabilizer, causing left yaw
- Gyroscopic action (precession)—a pitch down will cause a left yaw 90º from the top of the propeller, a pitch up will cause a right yaw 90º from the bottom of the propeller disk
- P-factor—downward blade has a higher angle of attack during a high pitch attitude, causing greater thrust on the right side of the propeller disk, creating a left yaw (and vice versa)

Climbs: Initially lift is greater, then it stabilizes in steady-state.

Descents: Initially lift is reduced, then it stabilizes in steady-state.

Turns: Show a vector diagram with horizontal component of lift.

Load factor: Any force applied to an airplane to deflect its flight from a straight line. Ratio of total load acting on the airplane to the gross weight. Discuss maneuvering speed V_A.

Limit load factors: Normal 3.8 to -1.52, Utility 4.4 to -1.76, Aerobatic 6.0 to -3.0. 1.5 factor of safety built in. See load factor chart (PHAK Fig. 3-36), noting 60º of bank equals 2G's. Discuss Vg diagram (PHAK Fig. 3-38).

Ground effect (PHAK 3-7):

- Within one wingspan of earth's surface, wingtip vortices are reduced
- Provides decrease in induced drag
- Wing will require a lower angle of attack in ground effect to produce the same lift

Adverse yaw (PHAK 4-2):

- Purpose of the rudder is to counteract adverse yaw and control movement around the vertical axis
- Raised wing in a turn has a higher angle of attack, more lift, more induced drag
- Differential ailerons, Frise-type ailerons, and coupled ailerons and rudder reduce adverse yaw

Wingtip vortices (PHAK 3-6):

- Spanwise movement of air along wing due to pressure differential
- Air from bottom of wing moves outward from fuselage and "spills" over the wingtips, creating a vortex
- Air from the top of the wing flows in toward the fuselage and spills off the trailing edge—vortex is insignificant because fuselage limits the flow
- Vortices increase drag because of energy spent in producing turbulence
- High angle of attack = more violent vortices
- Heavier and slower aircraft = more violet vortices

Wake turbulence on take-off/landing:

- Stay above glidepath
- Land beyond the point of landing of the preceding heavier aircraft—look for puffs of tire smoke
- Liftoff prior to the point a larger aircraft took off
- Light quartering tailwind keeps vortices on the runway the longest (the most dangerous)

Evaluation

Lesson is complete when student can demonstrate fundamental understanding of aerodynamics.

References

FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge (PHAK) Chapter 3, FAA-H-8083-3A Airplane Flying Handbook Chapter 3, Aeronautical Information Manual (AIM) 7-3-1

AIRCRAFT SYSTEMS

Objective

To teach the student the basics of aircraft systems.

Elements

- Primary flight controls and trim
- Flaps, leading edge devices, spoilers
- Power plant
- Oil
- Avionics

Schedule

Discussion 0:45

Equipment

Aircraft, Pilot Operating Handbook (POH) or FAA-approved Airplane Flight Manual (AFM)

Instructor Actions

Discuss the components:

- Primary flight controls—elevator, rudder, and ailerons
    - Movement of the control surfaces changes the airflow and pressure distribution over and around the airfoil (relate to CG):

Primary control surface	Airplane movement	Axis of rotation	Type of stability
aileron	roll	longitudinal	lateral
elevator	pitch	lateral	longitudinal
rudder	yaw	vertical	directional

- Ailerons:
    - Control roll about longitudinal axis
    - Most light airplanes have two ailerons, one on the trailing edge of each wing
    - Connected to control wheel through cables and pulleys
    - Move in opposite directions
    - Discuss how ailerons change angle of attack and cause roll
    - Adverse yaw can be counter acted with rudder use, or special aileron designs: differential ailerons, Frise-type ailerons, coupled ailerons and rudder
    - Aileron trim: not common on light airplanes
- Elevator:
    - Controls pitch about lateral axis
    - Main purpose is to change the wing's angle of attack
    - Most light airplanes have one elevator, located on the trailing edge of the horizontal stabilizer
    - Some aircraft (e.g. Pipers) use a stabilator, or movable horizontal stabilizer
    - Control wheel connected to the elevator by bell cranks, cables and pulleys
    - Horizontal stabilizer has a negative angle of attack to provide downward force
    - Elevator moves up to increase this downward push and move the nose up, and therefore increase the wing's angle of attack, and vice versa
    - Discuss how elevator movement affects pitch attitude

    - Elevator trim: almost all light aircraft are equipped with some form of elevator trim; moves in the opposite direction of the control surface, deflecting the control surface to relieve control pressure and maintain a constant pitch attitude
- Rudder:
    - Controls the airplane about its vertical axis – yaw
    - Most light airplanes have one rudder, located on the trailing edge of the vertical stabilizer
    - Controlled through the use of foot pedals, connected to the rudder by bell cranks, cables and pulleys
    - Rudder does not turn the airplane, only yaws it
    - Used in conjunction with the ailerons for properly turning the airplane
    - Rudder trim: most light aircraft are equipped with some form of rudder trim; trim tabs move in the opposite direction of the control surface, deflecting the control surface to relieve control pressure and maintain a constant yaw attitude; some may be a "manual rudder trim" or a piece of metal that is manually adjusted before flight
- Flaps:
    - Increase lift and drag
    - Flaps have three main functions: permit a slower landing speed, allow for a steep angle on descent without an increase in airspeed, shorten takeoff distance and allow for a steeper climb
    - Plain—simplest, changes camber, increases lift, greatly increases drag
    - Split—greater increase in lift vs. plain, more drag
    - Slotted—(most common) increases lift coefficient significantly more than plain or split (high-energy air is ducted to the flap's upper surface, delaying airflow separation)
    - Fowler flap—a variety of slotted flap; changes camber and increases wing area
    - Most flaps are located on the trailing edge of the wing in-between the fuselage and aileron
    - In light aircraft they are controlled manually or electrically
    - Extending the flaps will increase lift, cause a pitch up and loss of airspeed
    - Retracting the flaps will decrease lift cause a pitch down and increase in airspeed
- Leading edge devices:
    - Fixed slots—direct airflow to upper wing surface and delay airflow separation; stall is delayed to greater angle of attack
    - Moveable slats—leading edge segments on tracks; may be automatic or pilot-operated
    - Leading edge flaps—increase coefficient of lift and camber
- Spoilers:
    - High-drag device; reduces lift, increases drag
    - Used for roll control on some aircraft by eliminating adverse yaw
    - Can shorten ground roll
- Power plant:
    - Reciprocating engines classified by cylinder arrangement (radial, inline, v-type, opposed), method of cooling (liquid or air), method of intake (carburetor, fuel-injection, turbo-charged), etc
    - Main components: cylinders (contain intake/exhaust valves, spark plugs, pistons); crankcase (contains crankshaft, connecting rods); accessory housing (contains magnetos)
    - Four-stroke operating cycle: intake, compression, power, exhaust
- Oil:
    - Lubricates, reduces friction, cools, provides a seal, and carries away contaminants
    - Wet-sump system—sump is an integral part of the engine (in a dry system, it's a separate tank)
    - Filter, cooler, filler cap/dipstick, quick-drain valve (bottom of sump)
    - Pressure and temperature gauges (required instruments)
- Avionics:
    - Communication and navigation radios
    - VOR, ADF, GPS

- Transponder
- Autopilot (if available)
- Avionics cooling fan—cools and eliminates moisture (if available)
- Microphone/headset intercom
- Static dischargers (wicks)

Evaluation

Lesson is complete when student can demonstrate and discuss aircraft control surfaces, power plant and other major systems.

References

FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge Chapter 4-5, POH / AFM Chapter 7

FUEL SYSTEM (C172RG)

Objective

To teach the components and operating procedures of the fuel system.

Elements

- Components
- Pre-flight
- Normal operation
- Emergency operation

Schedule

Discussion 0:30

Equipment

Aircraft, Pilot Operating Handbook (POH) or FAA-approved Airplane Flight Manual (AFM)

Instructor Actions

Discuss the following:

Components:

- Two vented integral fuel tanks—fuel flows by gravity from the tanks
    - Standard tank capacity is 33 gallons (total 62 gal), and useable capacity is 24 gallons (total 44 gal)
- Fuel tank vent—venting is accomplished by an interconnected line from the right fuel tank to the left tank, the left tank is vented overboard though a vent line, which protrudes from the bottom surface of the wing; the right fuel tank filler cap is also vented
- Fuel gauges—indicate the amount of fuel measured by a sensing unit in each tank and is displayed in gallons and pounds.
- Fuel sumps and drains—allow for checks at preflight to be made in the fuel tanks, selector, and strains, of visible moisture and/or sediments, as well as check for the proper grade of fuel
- Four-position selector valve—the selector can be set to OFF, BOTH, LEFT, and RIGHT; when the selector is not set to OFF, fuel is able to flow through to the rest of the system
- Fuel strainer—(inside oil compartment) removes any impurities, including moisture and other sediments that might be present in the fuel
- Manual primer—takes fuel directly from the strainer and vaporizes it directly into three of the cylinders
- Fuel pressure gauge—shows the fuel flow in PSI and can be used to indicate a failure in of the fuel pump
- Engine-driven fuel pump—driven by the engine to pump fuel to the carburetor
- Electric auxiliary fuel pump—electrically drives fuel to the carburetor and should be used when the fuel flow drops below 0.5 PSI

Discuss fuel grades: Aviation gasoline (AVGAS) is identified by an octane or performance number (grade). The higher the grade of gasoline, the more pressure the fuel can withstand without detonating. If the proper grade of fuel is not available, use the next higher grade as a substitute (but not JET A). Never use a lower grade. This can cause the cylinder head temperature and engine oil temperature to exceed their normal operating range, which may result in detonation. Available AVGAS is 80 (dyed red), 100 (dyed green), and 100LL (dyed blue). The C172RG used 100LL.

Discuss pre-ignition and detonation.

Discuss refueling, including grounding, use of a ladder, etc. Note that if refueling before flight, should redo sumping after the fuel has settled (at least 10 minutes).

Discuss preflight of the fuel system per POH.

Evaluation

Lesson is complete when student can demonstrate and discuss proper use of fuel system.

References

FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge p. 5-13, POH / AFM p. 7-23

ELECTRICAL SYSTEM (C172RG)

Objective

To teach the components and operating procedures of the electrical system.

Elements

- Components
- Pre-flight
- Emergency operation

Schedule

Discussion 0:30

Equipment

Aircraft, Pilot Operating Handbook (POH) or FAA-approved Airplane Flight Manual (AFM)

Instructor Actions

Discuss the following components:

- 28V DC System
- Battery – 24V Located aft of the rear cabin wall
- Alternator – 60A Belt-driven
- Buses: Primary and Avionics (interconnected with primary via avionics power switch/breaker)
- Master Switch – split switch: battery and alternator
- Avionics Power Switch – power from primary to avionics bus; is also a circuit breaker
- Ammeter – indicates battery charging rate when alternator is on and working, or rate of battery discharge when alternator is off or malfunctioning
- Alternator Control Unit (ACU) & Low Voltage Warning – combo alternator regulator and high-low voltage control unit; mounted on engine side of firewall
- “LOW VOLTAGE” light on instrument panel
- Circuit Breakers and Fuses – Most are “push to reset” except “Alternator Output” and “Landing Gear” which are “pull-off” type and the ”AVN PWR” which is a rocker switch; cigarette lighter and control wheel map light uses fuses as well as breakers
- Ground Service Plug Receptacle (Optional) – for use with external power during cold weather starting or lengthy maintenance work
- Lighting System: 3 navigation, taxi, landing, rotating beacon, strobes, courtesy, interior, flood, post lights (outside instruments), integral (inside instruments)
- Electrical instruments (turn coordinator, clock)
- Radio and navigation devices

Discuss pre-flight checklist in POH/AFM as it pertains to electrical system items. In particular, note the ammeter during run-up with and without an electrical load. Discuss the electrical fire checklist in the POH/AFM. Discuss if the ammeter shows excessive rate of charge. Discuss if the low voltage light illuminates during low RPM operations on the ground and goes off as RPM in increased, this is not a problem. Otherwise, follow checklist procedures.

Evaluation

Lesson is complete when student can demonstrate and discuss proper use of electrical system.

References

FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge p. 5-19, POH / AFM pp. 3-6, 3-10, 4-21, 7-27, 7-29 thru 7-34, POH Supplement: Ground Service Receptacle 1 thru 4, electrical diagram on p. 7-30

LANDING GEAR (C172RG)

Objective

To teach the components and operating procedures of the landing gear system.

Elements

- Components
- Pre-flight
- Normal operation
- Emergency operation

Schedule

Discussion 0:45
In-flight 0:20

Equipment

Aircraft, Pilot Operating Handbook (POH) or FAA-approved Airplane Flight Manual (AFM)

Instructor Actions

Discuss the components (show hydraulic schematic, POH 7-28):

- Nose gear—nitrogen/oil nose gear shock strut, positive mechanical down lock
- Nose gear doors—mechanically opened and closed by nose gear
- Main gear—tubular spring steel struts, positive mechanical down locks
- Hydraulic power pack—electrically driven, located aft of firewall between pilot and copilot's rudder pedals
    - Pressurized between 1000-1500 psi
    - Pressure switch causes electric pump to turn on
    - If the pump stays on there is a problem
    - MIL-H-5606, red color, hydraulic fluid
- Hydraulic actuators—one for each gear
- Landing gear lever—directs pressure
- Landing gear position indicator lights—required for flight
    - Amber = up, green = down (some models, red gear unsafe light and green down light for other models)
    - Lights are interchangeable
    - Up and down switches for each gear, in series
- Nose gear safety squat switch—open on the ground, prevents inadvertent gear retraction
- Gear-up warning system—intermittent tone through the speaker if manifold pressure <12" Hg or flaps ≥20º
    - Push green light to turn off the tone
- Emergency extension hand pump—double action hydraulic pump
    - Can't retract the gear with pump
- Circuit breakers—"pull off" for gear pump, separate breaker for position lights

Discuss pre-flight of landing gear:

- Cockpit—push to test gear indicator lights
- Check that gear handle is down
- Check reservoir at 25 hour intervals
- Outside—check for leaks
- Clear the wheel wells

- Make sure squat switch is open

Discuss normal operation:

- V_{LO} 140 (just below top of green arc), V_{LE} 164 (redline)
- 5-7 seconds to extend or retract
- Keep hand on lever until operation is complete
- Tap brakes before retraction—tires expand due to centrifugal force and heat
- Mains swing down 2' during retraction
- Extend gear before entering traffic pattern
- Leave gear extended for continuous traffic pattern operations

Discuss manual gear extension:

- Not an emergency
- Follow the checklist:
    - Master ON
    - Landing gear lever DOWN
    - Breakers IN
    - Hand pump—pump about 35 times until gear down light indicates

Student Actions

Demonstrate and explain adequate gear pre-flight. Demonstrate proper use of landing gear during flight. Conduct a manual gear extension in-flight.

Evaluation

Lesson is complete when student can demonstrate and discuss proper use of landing gear in all flight scenarios.

References

FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge p. 5-22, FAA-H-8083-15A Airplane Flying Handbook p. 11-9, POH / AFM pp. 3-8, 4-18, 4-21, 7-11, 7-27

PROPELLER SYSTEM

Objective

To familiarize the student with common propeller systems.

Elements

- Propeller basics
- Pre-flight
- Constant-speed propellers

Schedule

Discussion 0:45

Equipment

Aircraft, Pilot Operating Handbook (POH) or FAA-approved Airplane Flight Manual (AFM)

Instructor Actions

Discuss the two main types of propellers: fixed pitch and constant speed. Others include full-feathering, reversing, and ground-adjustable.

Discuss basics of propellers: materials (typically wood, composite or aluminum alloy).

The hub is the center of the propeller, and the spinner mounts above and covers the hub. Propeller blades are airfoils, and have camber like any airfoil.

Blade twist: the hub has less pitch than the tips. That is, the pitch on each blade changes the further you go from the hub. This is necessary to give the relative same thrust across the blade despite the increased speed as you move out towards the tips.

Discuss pre-flight of propellers: if a knick exists from one side to the other side at the propeller's edge, or if any is, in your judgment, too significant (recommended: greater than a quarter inch or greater than two tenths an inch deep), it must be looked at by a mechanic. Knicks in the last third of the propeller are extremely worrisome. This is because the outside of the propeller travels faster than the inside, leading to higher stresses in the metal, which can cause fatigue at the knick. At 2500 RPM, a typical single-engine propeller's tips travel at nearly 650 knots. Knicks are shaved off, which is why blades have a tolerance for how long they can be. If one blade is shaved down, the other(s) must be as well to remain balanced. Knicks that are not dealt with can grow to bigger ones. The worse-case scenario is propeller separation during flight, shearing the blade and causing such imbalance that the engine is then sheared from the airplane. Other pre-flight considerations: corrosion (painted propellers prevents corrosion), leaking oil at the hub, etc. Also try to twist constant speed propellers (hold them at their midpoint, not their tips as this can cause damage)…they should resist rotation and not rotate more than a quarter inch. The blades should also not move forward or aft more than a quarter inch.

Propellers are subject to periodic inspections based on tachometer and on calendar months. Consult the logbooks to see the propeller inspections.

Discuss the mechanics of the constant speed propeller and the governor system. Discuss the flyweight system, speeder spring, and how these mechanisms control high-pressure oil to the propeller hub. Discuss how the propeller hub's internal piston moves the blades' pitch against the propeller spring. Discuss loss of engine oil or governor, and the resulting safe condition of high-RPM low-pitch. Discuss which settings are ideal for take-off and landing, and consult the AFM/POH for more discussion.

Evaluation

Lesson is complete when student can discuss a constant speed propeller system.

References

http://www.mccauley.textron.com/prop/prop-tech/pg00intro.html, http://flash.aopa.org/asf/engine_prop/

VFR INSTRUMENTS

Objective

To teach the student about VFR instruments, their function, and the requirements.

Elements

- VFR required instruments
- Vacuum-driven gyroscopic instruments
- Electric-driven gyroscopic instruments
- Pitot-static system
- Compass errors

Schedule

Discussion 1:30

Equipment

Aircraft

Instructor Actions

Explain required instruments ("A-GOOSEACAT": Anti-collision lights, Gas gauges, Oil pressure gauge, Oil temperature gauge, Seatbelts with should harnesses, ELT, Airspeed indicator, Compass, Altimeter, Tachometer for each engine), plus night requirements ("APES": Anti-collision lights, Position lights, Electrical source, Spare fuses as required). For complex aircraft: landing gear position indicators. For commercial flights: landing light. Other requirements: manifold pressure gauge for each altitude engine and temperature gauge for each liquid-cooled engine. Source: 14 CFR 91.205.

Explain Vacuum-Driven Gyroscopic Instruments:

Attitude Indicator: Explain construction, demonstrate and explain behavior and indications.

Directional Gryo (Heading Indicator): Explain construction, demonstrate and explain behavior, indications, tick marks (i.e. 45º tick marks), precession (check with magnetic compass every 15 minutes). Note: Heading indicator is always the primary instrument for bank.

Explain Electric Gyroscopic Instruments:

Turn Coordinator (with Inclinometer): Explain needle and ball construction. Demonstrate and explain needle and ball behavior under all conditions. Discuss and explain needle and ball indications.

Explain Pitot-Static System:

Airspeed Indicator: Explain construction, demonstrate and explain behavior, indications (V-Speeds), types of airspeed, errors (pitot tube at high pitch attitude). In straight and level flight the airspeed indicator is the primary power instrument. In climbs and descents at a specific airspeed, the airspeed indicator is the primary pitch instrument.

Altimeter: Explain construction, demonstrate and explain behavior, types of altitudes, errors ("High to Low or Hot to Cold, Look Out Below!") In straight and level flight the altimeter is the primary pitch instrument. Altimeter should be within 75' of field elevation.

Vertical Speed Indicator: Explain construction, demonstrate and explain behavior, rate information (vertical speed) versus trend information (changes of vertical speed), 6-9 second lag. During constant rate climbs and descents, the vertical speed indicator is the primary pitch instrument.

Explain Pitot-Static System Blockages:

- Complete blockage (Pitot tube and drain, static ports): airspeed and altimeter will stay constant and VSI will indicate zero
- Pitot tube complete blockage (static port open): altimeter and VSI will indicate correctly but airspeed will react like an altimeter
- Pitot tube blocked, drain clear (static port open): altimeter and VSI will indicate correctly but airspeed will decrease to zero
- Static port blocked (only): airspeed continues to operate but will be erroneous; at higher altitude than when the blockage occurred, airspeed will show slower, and vice versa

Discuss magnetic compass errors. Explain construction, demonstrate and explain behavior, variation (magnetic versus true north), deviation, magnetic dip errors, Northerly Turning Error ("Lag from the North, Lead from the South"; When determining to lag or lead, remember OSUN: "Overshoot when turning to South, undershoot when turning to North"), Acceleration Errors (On an east or west heading, ANDS: Accelerate turns to the North, Decelerate turns to the South).

Evaluation

Lesson is complete when student has a thorough knowledge of required instruments and compass errors.

References

FAA-H-8083-15A Instrument Flying Handbook Chapter 3

AIRCRAFT DOCUMENTS AND MAINTENANCE

Objective

To familiarize the student about the required documents needed to legally operate an aircraft as well as the maintenance required to keep the aircraft in a legal status.

Elements

- Certification and documentation required
- Maintenance and inspections
- Preventative maintenance

Schedule

Discussion 0:45

Equipment

Aircraft, Aircraft Maintenance Records

Instructor Actions

The pilot in command ultimately decides if the aircraft is airworthy (14 CFR 91.7).

Discuss required documents “AROW”: **A**irworthiness certificate (14 CFR 91.203), **R**egistration certificate (14 CFR 91.203), **O**perating manual and placards (FAA-approved Airplane Flight Manual, serial number specific) (14 CFR 91.9), **W**eight and balance, current and specific for the exact aircraft serial number (part of the AFM, covered under 14 CFR 91.9).

Discuss required inspections “AVIATE-A”:

A Annual Inspection (12 calendar months) (14 CFR 91.409)
V VOR (30 days for IFR, annual for VFR) (14 CFR 91.171)
I Inspection at 100 Hours off of tachometer (14 CFR 91.409)
A Altimeter/Pitot Static System (24 calendar months) 91.411)
T Transponder/Mode C (24 calendar months) (14 CFR 91.413)
E ELT (50% battery life/1 hr cum. use, annual) (14 CFR 91.207)
A Airworthiness Directives (AD’s, aka Recalls) (14 CFR 91.403),

AD’s may be divided into two categories:

- those of an emergency nature requiring immediate compliance prior to further flight, and
- those of a less urgent nature requiring compliance within a specified period of time

Preventative maintenance can be accomplished by any certificated pilot (14 CFR 43 Appendix A). Repairs must be completed by FAA-certified mechanics. If they are major or minor repairs, as defined by 14 CFR 43 Appendix A, defines what level of oversight and qualification is required of the mechanic or repair facility.

A special flight permit is a Special Airworthiness Certificate issued authorizing operation of an aircraft that does not currently meet applicable airworthiness requirements but is safe for a specific flight (e.g. to a repair facility).

Evaluation

Lesson is complete when student can demonstrate and comprehend emergency considerations.

References

FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge Chapter 7

WEIGHT AND BALANCE

Objective

To teach the student aircraft weight and balance considerations.

Elements

- Weight and balance definitions
- Effects of greater weight
- Effects of CG location
- Discuss how to calculate weight and balance

Schedule

Discussion 1:00

Equipment

Aircraft, airplane Pilot Operating Handbook or FAA-approved Airplane Flight Manual

Instructor Actions

Discuss weight and balance limitations (max weights determined by structural strength and performance). Discuss CG and the CG envelope. Define center of pressure (lift) and its relation to angle of attack (center of lift moves forward with higher AoA). CG is always ahead of center of pressure (otherwise an airplane would tumble). Compare lift on the wing, CG, and lift generated from the horizontal stabilizer.

Define weight definitions (empty weight, payload, zero fuel weight, fuel load, useful load). Define standard weights: Fuel (Avgas) 1 gallon = 6 lbs, Oil 1 gallon = 7.5 lbs (approx. 2 lbs per quart). Define moment (tendency to rotate), arm (distance at which a force is applied), station (arm, measured in reference to datum on aircraft).

Discuss the effects of greater weight (higher take-off speeds, longer take-off run, reduced rate and angle of climb, lower maximum altitude, shorter range, reduced cruising speed, reduced maneuverability, higher stalling speed, higher approach and landing speed, longer landing roll, excessive weight on nose/tailwheel).

Discuss effects of CG location. Discuss how this can shift due to weight shift during flight, fuel burn, etc. Forward CG: nose heavy, increased take-off and landing speed, higher stall speed, good stall recovery, higher angle of attack, less range and endurance, increased stability. Aft CG: tail heavy, decreased take-off and landing speed, lower stall speed, poor stall recovery, smaller angle of attack, greater range and endurance, decreased stability.

Discuss calculations using examples from the POH. Discuss the “WAM” equation: W x A = M. Weight times Arm equals Moment. Discuss how this simple setup can be used for weight shift, weight change, as well as standard CG calculations. Discuss how lateral CG is not computed but can cause wing heaviness.

Student Actions

Calculate weight and balance under a variety of scenarios or as directed.

Evaluation

Lesson is complete when student can demonstrate and calculate weight and balance.

References

FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge Chapter 8

WEATHER THEORY

Objective

To teach student about basic weather theory and how to anticipate possible weather conditions.

Elements

- Atmosphere
- Wind
- Moisture and stability
- Clouds
- Fronts

Schedule

Discussion 2:00

Equipment

FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge, AC 00-6A Aviation Weather

Instructor Actions

Discuss the following:

- Nature of the atmosphere (78% nitrogen, 21% oxygen, 1% other)
- Troposphere, the first layer of the atmosphere, contains most of the weather, and goes up from 20,000' to 48,000' MSL at the poles
- Pressure
- The cause of weather: uneven heating by the sun
- Convection
- How air flows from high (clockwise) to low (counterclockwise, i.e. cyclonic) – wind
- How oceans and mountains affect wind
- Turbulence due to mountains and man-made objects
- Moisture, humidity and relative humidity
- Stability, inversions
- Temperature and dew point
- Fog
- Cloud formation (vapor in the air, refer to condensation nuclei), types of clouds (cumulus, stratus, cirrus, nimbus, etc)
- Relate stability to clouds (unstable = cumuliform, stable = stratiform)
- Thunderstorms
- Cloud cover (few, scattered) and ceilings (broken, overcast)
- Precipitation
- Air masses
- Fronts (boundaries between air masses); flying across a front will lead to wind shift and likely some form of weather (always know where the fronts are in a long-distance flight)
- Warm fronts:
    - Prior to passage: cirriform or stratiform clouds, fog, etc, plus cumulonimbus in summer; light to moderate precipitation; poor visibility; winds from south-southeast
    - At passage: pressure falling; stratiform clouds; drizzle; poor visibility but improving; rising temperature
    - After passage: stratocumulus clouds; rain showers possible; visibility improving but hazy; wind from the south-southwest; slight rise in pressure
- Cold fronts:

    - Prior to passage: cirriform or towering cumulus clouds, cumulonimbus also possible; rain showers and haze; wind from south-southwest; high dew point; falling pressure
    - At passage: towering cumulus or cumulonimbus; heavy rain, hail, thunderstorms possible; more severe cold fronts produce tornadoes; poor visibility; winds variable and gusting; temperature and dew point falling rapidly; pressure falling rapidly
    - After passage: clouds dissipate with corresponding decrease in precipitation; good visibility; winds from the west-northwest; temperatures remain cooler; pressure begins to rise
- Stationary fronts: two air masses holding position for days; the weather at the front is usually a mix of warm and cold front weather
- Occluded fronts (when a fast-moving cold front catches up to a slow-moving warm front):
    - Temperatures of the colliding fronts play a large part in the weather of occluded fronts
    - Conditions vary depending on the air mass ahead of the warm front being overtaken
    - Cold front occlusion: the fast-moving cold front is colder than the cold mass ahead of the warm front; the weather at this front is usually a mix of warm followed by cold front weather and is relatively stable
    - Warm front occlusion: the fast-moving cold front is less cool than the cold mass ahead of the warm front, resulting in the most severe weather including embedded thunderstorms, rain, fog, etc

Evaluation

Lesson is complete when student can discuss various aspects of weather phenomena.

References

FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge, AC 00-6A Aviation Weather

WEATHER SERVICES

Objective

To teach sources of weather information.

Elements

- Four forces

Schedule

Discussion 2:00

Equipment

AC 00-6A Aviation Weather, Sectional or Terminal chart

Instructor Actions

Discuss the following, and in the case of each weather source, go through real examples.

Preflight actions: 14 CFR 91.103 requires that the PIC shall become familiar with all available information concerning that flight including weather information when flying beyond the vicinity of an airport.

To contact FSS: 1-800-WX-BRIEF, Duat, Duats, Visit in person, 122.2 or discrete frequency (see sectional chart). A FSS standard briefing gives complete and customized description of all conditions that may affect the proposed flight, based on route and altitude to by flown. Includes adverse conditions, synopsis, current and forecast conditions, winds and temps aloft, NOTAM's, anything else requested.

Briefing formats:

Time	Visualize	Compare	Briefing
6+ hours before departure	big picture	n/a	outlook
1-4 hours before departure	detailed picture	big picture	standard
just before departure & during flight	updated picture	detailed picture	abbreviated

CURRENT WEATHER PRODUCTS:

- Satellite Weather picture:
  - graphically display cloud position and approx. thickness and height
  - issued every 30 minutes and as needed
  - valid at time of report
- Radar Summary Chart:
  - graphically display areas of precipitation—not clouds
  - issued hourly and as needed
  - valid at time of report
  - contours indicate intensity of precipitation
- Weather Depiction Chart:
  - same as significant weather chart
  - issued every 3 hours
  - valid at time of report
- Freezing Level Chart
- Aviation Routine Weather Report (METAR) (AIM 7-1-30):

    - aviation routine weather report at the surface, issued hourly
    - SPECI issued when certain significant changes occur
- Pilot Weather Report PIREP's (UA/UUA):
    - provide information on actual flight conditions as experienced by pilots
    - issued upon receipt
    - valid at time of report
    - UA = normal, UUA = urgent

FORECAST WEATHER:

- AIRMET (WA):
    - Airman's meteorological information
    - Moderate icing (zulu AIRMET), turbulence (tango AIRMET), IFR (sierra AIRMET), mountain obscuration, sustained surface winds >30 knots
- SIGMET (WS):
    - significant meteorological information
    - severe turbulence, icing, widespread duststorms, sandstorms, volcanic ash lowering visibility to <3 sm
    - valid 4 hours (except 6 hours for hurricanes)
- Convective SIGMET (WST):
    - severe thunderstorms with surface winds greater than 50 knots, hail at the surface greater than or equal to 3/4 inch in diameter, tornadoes, embedded thunderstorms, lines of thunderstorms, or thunderstorms with heavy or greater precipitation
    - valid 2 hours
- Prognostic Charts:
    - 24-, 36-, and 72-hour formats
    - graphically display general weather conditions for contiguous U.S.
    - 4 times daily
    - left panel valid 12 hours, right panel valid 24 hours
    - types and positions of fronts and pressure systems
    - pressures in millibars.
    - significant weather chart shows areas of VFR, MVFR, IFR, freezing level
- Convective Outlook Chart
- Area Forecast (FA):
    - describes forecast weather conditions for several states
    - issued 3 times daily
    - synopsis valid 18 hours, weather and clouds 12 hours, +6 hr outlook
- Terminal Aerodrome Forecast (TAF):
    - describes forecast weather for an area within 5sm of airport
    - issued 4 times daily
    - valid 24 hours
- Winds and Temperatures Aloft Forecast (FD):
    - provide estimated wind direction, speed, and temperatures at selected stations and altitudes
    - issued 2 times daily
    - valid as stated—6, 12, or 24 hours
    - winds greater than 100, subtract 50 from wind direction

IN-FLIGHT WEATHER SOURCES:

- Automatic Terminal Information System ATIS:
    - airport name, time (UTC), wind direction and speed, visibility and obstructions, cloud coverage, temp and dew point, altimeter, remarks.
    - different from AWOS/ASOS in that ATIS is usually only issued hourly and includes NOTAM's
- AWOS, ASOS:
    - AWOS—automated weather observation system (AIM 4-3-26, 7-1-12)

    - ASOS—automated surface observation system
- EFAS
    - en-route flight advisory service (aka “Flight Watch”)
    - 122.0 MHz above 5000’ AGL
    - operated by the local center, e.g. “Los Angeles Flight Watch”
- TWEB:
    - continuous transcribed weather broadcast.
    - available over selected NAVAID’s (T on chart)
- HIWAS
    - Hazardous In-flight Weather Advisories Services HIWAS
    - recorded severe weather advisories
    - “H” on NAVAID on charts

NOTAM’s:

- Notification of unforeseen changes in the national airspace system, not known in sufficiently in advance to publicize by other means, that may affect the pilot’s decision to make a flight
- May be divided into three categories: local (e.g. taxi way closures), distant (e.g. VOR out of service), FDC (issued by the Flight Data Center, regulatory in nature such as temporary flight restrictions, instrument approach procedure changes, etc)
- Obtain the same way a briefing can be obtained (FSS, Duats, Duat, etc)

Evaluation

- Exhibit knowledge of the elements related to weather information by analyzing weather reports, charts, and forecasts from various sources with emphasis on—
    - METAR, TAF, and FA.
    - surface analysis chart.
    - radar summary chart.
    - winds and temperature aloft chart.
    - significant weather prognostic charts.
    - convective outlook chart.
    - AWOS, ASOS, and ATIS reports.
- Make a competent “go/no-go” decision based on available weather information.

References

AC 00-6A Aviation Weather, FAA-H-8083-25 Pilot’s Handbook of Aeronautical Knowledge Chapter 12

AIRSPACE

Objective

To familiarize the student with night operation considerations for flight.

Elements

- Class A,B,C,D,E,G
- Special-Use Airspace
- Other airspace
- Special VFR

Schedule

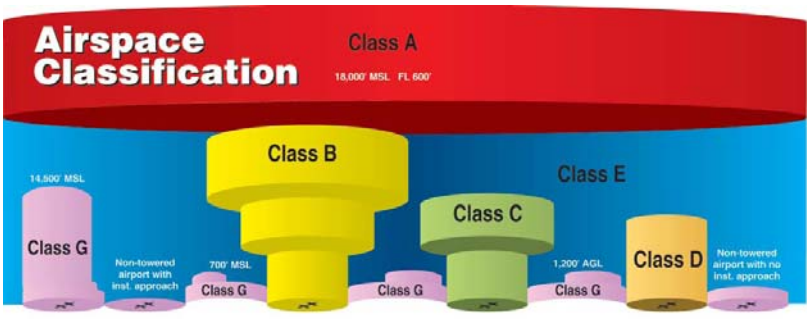
Discussion 0:40

Equipment

Sectional and/or Terminal Charts

Instructor Actions

Discuss each of the controlled airspaces A-E, and G, and their visibility and cloud requirements, entry requirements, etc. (Below is from FAA-H-8083-15A Instrument Flying Handbook Fig. 8-1.)



	Class A	Class B	Class C	Class D	Class E	Class G
Entry Requirements	ATC clearance	ATC clearance	Prior two-way communications	Prior two-way communications	Prior two-way communications*	Prior two-way communications*
Minimum Pilot Qualifications	Instrument Rating	Private or Student certification—local restrictions apply.	Student certificate	Student certificate	Student certificate	Student certificate
Two-Way Radio Communications	Yes	Yes	Yes	Yes	Yes, under IFR flight plan*	Yes*
Special VFR Allowed	No	Yes	Yes	Yes	Yes	N/A
VFR Visibility Minimum	N/A	3 statute miles	3 statute miles	3 statute miles	3 statute miles**	1 statute mile†
VFR Minimum Distance from Clouds	N/A	Clear of clouds	500' below, 1,000' above, 2,000' horizontal	500' below, 1,000' above, 2,000' horizontal	500' below,** 1,000' above, 2,000' horizontal	Clear of clouds†
VFR Aircraft Separation	N/A	All	IFR aircraft	Runway operations	None	None
Traffic Advisories	Yes	Yes	Yes	Workload permitting	Workload permitting	Workload permitting
Airport Application	N/A	• Radar • Instrument approaches • Weather • Control tower • High density	• Radar • Instrument approaches • Weather • Control tower	• Instrument approaches • Weather • Control tower	• Instrument approaches • Weather	• Control tower

*Exception: temporary tower or control tower present
**True only below 10,000 feet
†True only during day at or below 1,200 feet AGL (see 14 CFR part 91)

AGL—above ground level
FL—flight level
MSL—mean sea level

Airspace speed limits (14 CFR 91.117)

- Class B—surface to 10,000' MSL, max speed 250 kts (200 kts underlying)
- Class C—surface to 4000' AGL, max speed 200 kts within 4nm, 2500 AGL
- Class D—surface to 2500' AGL, max speed 200 kts
- Otherwise, no civil aircraft may operate greater than Mach 1 (14 CFR 91.817)

Special Use Airspace (AIM 3-4-1)

- Prohibited areas—flight not permitted
- Restricted areas—flight subject to restrictions (artillery, aerial gunnery, etc.), permission required
- Warning areas—3nm beyond coast, similar to restricted, but no permission required
- MOA—military training activities, a military version of "warning areas"
- Alert areas—ok to enter, high volume of activity (pilot training, unusual aerial activity)
- Controlled firing areas—not charted, activities are suspended if aircraft approach, no permission required

Other Airspace Areas (AIM 3-5-1)

- MTR—military training route; military aircraft > 250 kts; 4 digits < 1500AGL
- TFR—temporary flight restriction
- Parachute jump operations
- Published VFR routes
- VFR flyways—back of TAC chart
- VFR corridors—(e.g. Los Angeles Special Flight Rules)
- Class B VFR transition routes—(e.g. San Diego, mini route, Hollywood Park route)
- TRSA—(e.g. Palm Springs); participation is voluntary but recommended (AIM 4-1-17)
- National Security Areas—requested not to fly through; flight may be prohibited at certain times, check NOTAMs

Special VFR (14 CFR 91.157, AIM 4-4-6)

- 1sm visibility, clear of clouds
- At night, must have an instrument rating and IFR-equipped aircraft
- Must ask for it, ATC cannot offer
- Not allowed at some airports—see sectional or terminal chart

Marginal VFR (not a clearance)

- Visibility between 3-5 statute miles and/or ceiling between 1000-3000' AGL

Evaluation

Lesson is complete when student can demonstrate and comprehend night operations considerations.

References

FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge Chapter 13, FAA-H-8083-15A Instrument Flying Handbook Chapter 8, Aeronautical Information Manual (AIM) Chapter 3

AIRPORT OPERATIONS

Objective

To teach the student with the operations in and around the runway environment.

Elements

- Taxi considerations (wind correction)
- Airports and airport information
- Runway signs and markings
- Runway lights
- Runway incursion avoidance
- Wake turbulence
- Lost communications

Schedule

Discussion 0:30

Equipment

FAA-H-8083-3A Airplane Flying Handbook, FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge, Airport/Facility Directory, Aeronautical Information Manual (AIM)

Instructor Actions

Discuss taxing and flight control position during taxi (turn into for headwinds, dive away from tailwinds). Reference variations for tailwheel airplanes. Discuss braking. Discuss radio calls.

Discuss types of airports (controlled, uncontrolled). Discuss Airport/Facility Directory information. Discuss runway markings and signs. Discuss airport beacons (and what it means if they are on in daytime). Discuss runway lights.

Discuss runway incursions, Land And Hold Short Operations (LAHSO), clearances.

Discuss wake turbulence avoidance. (Land beyond the heavier aircraft's touchdown, or take off before the heavier aircraft's rotation point; wingtip vortices the most dangerous from a clean, heavy, slow airplane.)

Discuss lost communications procedures (light gun signals). (14 CFR 91.125) Be sure to use 7600 on the transponder.

Evaluation

Lesson is complete when student can demonstrate and comprehend runway signage, lighting and exhibit good judgment in wake turbulence avoidance.

References

FAA-H-8083-3A Airplane Flying Handbook p. 2-9, FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge Chapter 12, Aeronautical Information Manual 7-3

EMERGENCY PROCEDURES

Objective

To familiarize the student with emergency considerations for flight.

Elements

- Airplane emergency scenarios
- ELT
- Transponder
- 121.5 MHz
- Survival supplies and considerations
- Night flight considerations

Schedule

Discussion 0:30

Equipment

Airplane's Aircraft Flight Manual or Pilot Operating Handbook

Instructor Actions

Discuss emergency procedures listed in the AFM/POH. Discuss various scenarios.

Discuss the ELT, its required checks (12 calendar months, 50% of life, or 1 hour of cumulative use, per 14 CFR 91.207). Transmits on 121.5 and 243.0 MHz. In the event of an emergency, stay with the ELT. Bring it with you if you have to leave a crash site. The antenna is flexible on most airplanes to survive the crash. The ELT should be removable. Flying on a flight plan dramatically increase odds of being found quickly.

Discuss use of transponder frequencies: 7500 Hijack, 7600 Lost Communications, 7700 Emergency. Avoid other 7000-series squawk settings.

Emergency radio frequency is 121.5 MHz (and 243.0 MHz for military radios).

Consider carrying food and water and survival supplies depending on the terrain flown, the season, the availability of services along the route, etc. Examples include coats or blankets, flares, flotation devices if over water, etc. A first aid kit is also a good idea. A mirror or reflector (or a CD), a knife, and a Leatherman are also good ideas.

For night flights, always have multiple sources of light (flashlights, etc).

Evaluation

Lesson is complete when student can demonstrate and comprehend emergency considerations.

References

Airplane's Aircraft Flight Manual or Pilot Operating Handbook

FLIGHT ILLUSIONS AND VISION OF FLIGHT

Objective

To familiarize the student with currency requirements, health requirements, medical requirements, etc.

Elements

- VFR flight illusions
- Vision of flight considerations

Schedule

Discussion 0:30

Equipment

14 CFR (FAR/AIM)

Instructor Actions

Discuss the following:

- Illusions Leading to Landing Errors
    - False horizon – clouds or at night, lights on terrain, gives the sense of a horizon other than the actual horizon
    - Autokenesis – staring at a point of light at night, the point will appear to dance around
    - Runway width illusions – narrow-than-usual runways give the illusion the aircraft is higher than actual, and vice versa
    - Runway and terrain slopes illusion – an upsloping runway, terrain, or both, give the illusion the aircraft is higher than actual, and vice versa
    - Featureless terrain illusion – lack of terrain features give the illusion that an aircraft is higher than it is
    - Atmospheric illusions – rain on the windscreen can create the illusion of greater height, haze can give illusion of greater distance
    - Ground lighting illusions – lights along a straight path can be mistaken for a runway
- Vision of Flight
    - In dim light, eyes require 30 minutes to adjust
    - Consider red cockpit lighting for optimum night vision
    - If lightening nearby, adjust the cockpit lights to brightest as your eyes will be quickly adjusted to bright light
    - In VFR: for bright days, wear sunglasses that absorb 85% visible light
    - In VFR: scanning for other aircraft: from left to right, 10º for at least 1 second
    - Due to the increased use of oxygen by the human eye in dark settings, night vision can be impaired by the less oxygen at as low as 5000’

Evaluation

Insure understanding of illusions of VFR flight and vision of flight.

References

AIM Chapter 8

SPIN AWARENESS AND AVOIDANCE

Objective

To teach the student the avoidance and proper recovery from spins.

Elements

- Uncoordinated stalls
- Aerodynamics of a spin
- Recovery procedure

Schedule

Discussion 0:30

Equipment

Model airplane

Instructor Actions

Discuss what is a spin (an aggravated stall that results in autorotation). Autorotation results from unequal angles of attack on the wings. The key is aggravated (i.e. uncoordinated). Draw or show the corkscrew/helical flight path of a spin. The difference between a spin and a steep spiral: spin—airspeed low, wings stalled; spiral—airspeed increasing, not stalled.

Discuss the aerodynamics of a spin. Draw a wing in straight-and-level flight and in slow flight. Use actual angles of attack. Typical light aircraft wings stall at 18-22º. How can you enter a spin? Wing exceeds critical angle of attack with yaw acting on aircraft (uncoordinated). That is, a stall when in a slipping or skidding turn. Danger of base to final turn—cross controlled stall leading to spin.

The high wing has the greatest lift due to the greater airspeed, and overall less drag and lower angle of attack. The low wing has the least lift (due to lower airspeed) and greatest parasitic drag due to its higher angle of attack.

Center of gravity affects the spin characteristics. An aft CG makes spin recovery more difficult. The worst case is the aircraft may enter into a flat spin if CG is too far back, making recovery impossible.

Phases of a spin:

- Entry—pilot provides input for the spin
- Incipient—aircraft stalls, rotation starts to develop; may take 2 turns in most aircraft, usually 5-6 seconds
- Developed—rotation rate, airspeed, vertical speed are constant, typically 500 fpm altitude loss, just above 1G load factor; airspeed at or below stall speed; rotation is around all 3 axes, as high as 7000 fpm descent
- Recovery—lower angle of attack below the critical value, may take from a quarter to several turns to recover

The recovery process is as follows (“PARE”):

- **Power** – reduce to idle
- **Ailerons** – position to neutral
- **Rudder** – full opposite against the rotation
- **Elevator** – brisk elevator control full forward to brake stall
- **After spin rotation stops, neutralize the rudder**
- **Smoothly apply back-elevator pressure to raise the nose to level flight**

How do you know which direction you're spinning? Use the turn coordinator. The inclinometer ball is unreliable, and the attitude indicator will likely tumble. Also, look at top of windshield to see the horizon.

Avoid spins by maintaining coordination during practice stalls, and avoid stalls other than practicing.

Evaluation

Lesson is complete when student can recite recovery procedure and can identify hazardous situations that may lead to a spin.

References

FAA-H-8083-3A Airplane Flying Handbook p. 4-12

VFR FLIGHT PLANNING

Objective

To teach judgment and considerations when planning a VFR cross-country flight.

Elements

- Weather considerations
- Sectional charts and the A/FD
- Airspace and visibility requirements
- Terrain, altitude, cruising requirements and right-of-way rules
- POH performance charts and density altitude
- Fuel requirements
- Pilotage and De'd (Dead) Reckoning
- Plotting a flight and using a navigational log
- True courses, magnetic headings and wind
- E6-B
- Discuss advanced navigation methods (in brief)
- FAA Flight Plans
- Flight Following
- Lost procedures
- Aeronautical Decision Making

Schedule

Discussion 3:00
Pre-flight instruction 0:40
VFR Cross-Country Flight (as needed)
Post-flight instruction 0:20

Equipment

14 CFR and Aeronautical Information Manual (FAR/AIM), Sectional charts, Airport/Facility Directory, FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge, E6-B circular slide rule, navigation log, chart plotter, aircraft pilot operating handbook (POH)

Instructor Actions

Discuss weather requirements, how to obtain weather, weather considerations. Discuss basic weather minimums (14 CFR 91.155). *(A separate lesson plan discusses weather theory and services in detail.)*

Discuss sectional charts and their legend in detail. Discuss the airport/facility directory.

Discuss airspace and visibility requirements. *(A separate lesson plan discusses airspace in detail.)*

Discuss terrain considerations (and how this relates to POH and performance charts), altitude requirements (14 CFR 91.119), VFR altitudes (14 CFR 91.159), altimeter settings (14 CFR 91.121) and right-of-way rules (14 CFR 91.113). Discuss when to safely descend before arriving at an airport environment.

Discuss performance charts from the POH and density altitude.

Discuss fuel requirements (14 CFR 91.151): 30 minutes extra fuel for day VFR, 45 minutes for night VFR. Discuss the definition of night (Pilot/Controller Glossary). Relate to POH performance charts.

Discuss navigation methods: pilotage (purely visual, following landmarks), de'd ("dead", derived from "deduced") reckoning (navigation using compass headings and checkpoints). (See Chapter 14 of FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge.) Discuss latitude and longitude.

Discuss how to use a plotter with a chart. Introduce the navigation log.

Discuss true courses, magnetic headings, variation and deviation. Discuss wind correction.

Discuss E6-B circular slide rule, and in particular, making wind calculations.

Briefly discuss other means of navigation, including VOR and GPS (and possibly NDB). This should be a separate lesson and should not be incorporated into the initial cross-country flights.

Discuss the FAA Flight Plan (14 CFR 91.153, AIM 5-1-4), how to file it, how to complete it, how to close it, and results if it isn't closed. Discuss changes in a Flight Plan (AIM 5-1-14). Discuss Zulu (GMT) time.

Discuss Flight Following and ATC communications in cross-country flight.

Discuss lost procedures.

Discuss Aeronautical Decision Making (ADM) (see Chapter 16 of FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge).

Discuss "Aviate, Navigate, Communicate."

Student Actions

Exhibit knowledge on all aspects of flight planning. Plan then fly a dual VFR cross-country flight.

Evaluation

Evaluate based on planning and success of an actual VFR dual cross-country flight per the requirements listened in 14 CFR 61.109.

Common Errors

- Failure to plan appropriately based on the weather
- Failure to create an adequate navigation plan that considers fuel, winds, terrain, etc
- Failure to have all necessary publications available during flight
- Failure to understand the complexities of the airspace system

References

AIM, 14 CFR 91, FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge Chapter 14 and 16

VOR NAVIGATION

Objective

To train the student in VOR navigation and intercepting VOR courses.

Elements

- VOR background
- Tuning and indentifying
- Selecting a radial
- Turning to a VOR
- Station passage
- Reverse sensing
- Intercepting radials
- VOR intersections
- VOR failure

Schedule

Pre-flight instruction 1:00
Instructor demonstrate 0:30
Student practice 1:00
Post-flight instruction 0:30

Equipment

Aircraft equipped with VOR, Sectional chart

Instructor Actions

Explain what a VOR is, what it looks like, what it provides (“highways in the sky”). Explain and demonstrate how to find VOR information, tune it and indentify it. Explain what a radial (FROM) is and how to fly to a station (simple case: 360º). Explain station passage and cone of confusion. Explain and demonstrate interpretation of CDI (10-12º full deflection). Explain effect of heading on VOR usage. Explain and demonstrate intercepting and track of a pre-determined course. Explain and demonstrate wind correction. Explain and demonstrate reverse sensing. Explain and demonstrate identification of VOR intersections. Explain how to identify VOR failures.

Student Actions

Tune and ID a VOR. Identify position of aircraft relative to a VOR. Fly a course direct to a VOR and identify station passage. Identify reverse sensing and demonstrate how to correct for it. Intercept and track a VOR course as directed. Identify a VOR intersection.

Evaluation

Exhibits knowledge of VOR usage. Can demonstrate tracking to a VOR. Adequate demonstration of counteracting VOR reverse sensing.

Common Errors

- Careless tuning and identification of station
- Failure to check receiver for accuracy/sensitivity
- Turning in the wrong direction during orientation (common when visualizing position rather than heading)
- Failure to check ambiguity (TO/FROM) indicator (reverse sensing)

- Failure to parallel desired course on a track interception (this step allows for turning left or right of course in an intuitive way)
- Overshooting or undershooting radials on interception
- Overcontrolling corrections during track, especially close to the station
- Misinterpretation of station passage
- Chasing the CDI, resulting in homing instead of tracking

References

FAA-H-8083-15A Instrument Flying Handbook p. 7-23

NIGHT OPERATIONS

Objective

To familiarize the student with night operation considerations for flight.

Elements

- Night and aeromedical physiology
- Airplane night requirements
- Taxiing considerations
- Flight considerations
- Airport operations considerations

Schedule

Discussion 0:30

Instructor Actions

Discuss flight operations at night. Return to discussions of aeromedical physiology as it applies to night.

Discuss lighting on airplane, and the need to pre-flight all lighting. Return to aircraft equipment requirements as it applies to night. Position lights are required for use between sunset and sunrise.

Consider holding off use of strobes during taxi to protect your night vision and that of other pilots. An airport diagram is valuable for taxiing. Use the taxi light (if there is one) otherwise the landing light for taxiing.

At night, a greater emphasis on instruments is important. Use the landing light for take-off and landing. For cruise, use well-lit checkpoints. The first indication of poor visibility is gradual disappearance of ground lights. Navigation using VOR's or GPS is especially helpful for night operations. Avoid flights over water and mountainous terrain when possible. Verify attitude by reference to flight instruments. Consider flight following and filing a flight plan for all night operations. If the weather is marginal, don't fly.

For airport operations, check the Airport/Facility Directory for information on lighting, hours of operation, and pilot-controlled lighting (PCL). Discuss PCL (7 clicks in 5 seconds = high, 5 clicks = medium, 3 clicks = low). Discuss airport beacons and return the discussions of airport lighting. Do not descend until within the airspace of the airport to avoid obstructions. Be familiar with terrain around the airport.

For night landings, use the approach lights and VASI or PAPI to help you down safely. Use the landing light if available to help judge the ground so as not to flare to high or low. All night landings are to full stop.

For night flights, always have multiple sources of light (flashlights, etc).

Evaluation

Lesson is complete when student can demonstrate and comprehend night operations considerations.

References

FAA-H-8083-25 Pilot's Handbook of Aeronautical Knowledge Chapter 15, FAA-H-8083-3A Airplane Flying Handbook Chapter 10