CFI LESSON PLANS

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Areas of Operation I: Fundamentals of Instructing

Task A: Human Behavior and Effective Communication

Content

- Definitions of **human behavior**: the result of a person's attempt to satisfy certain needs.
- Human **needs** and motivation: Maslow's hierarchy—physiological, security, belonging, self-esteem, cognitive, aesthetic, and self-actualization.
  - Discuss how to motivate in light of Maslow's hierarchy of human needs.
- **Defense mechanisms**: ego-protecting reactions—repression, denial, compensation, projection, rationalization, reaction formation, fantasy, and displacement.
- Student emotional reactions: **anxiety**: how to deal with it and normal/abnormal reactions to stress/anxiety.
- Basic **elements of communication**: source, symbol, and receiver. Communication has only taken place when the learner exhibits the desired change in behavior.
- Barriers to effective communication (**COIL**).
  - **C**onfusion between the symbol and the symbolized object.
  - **O**veruse of abstractions.
  - **I**nterference.
  - **L**ack of common experience.
  - For successful communication, need to know the student's attitude, ability, and experience.
- Developing communication skills.
  - Role playing.
  - Monitoring if the student's behavior is changing as desired by the instructor.
  - Listening.
  - Questioning.
  - Depth of knowledge.

Task B: The Learning Process

Content

- Definition of **learning**: change in behavior of the learner as a result of experience.
- Learning theory developed from two main concepts.
  - Behaviorism: reinforcing desired behavior (stimulus and response).
  - Cognitive theory: what goes on in the mind.
- **Perceptions** are the basis of learning. They are the result of giving meaning to sensations. Thus, the flight instructor should understand what factors affect perceptions.
  - Physical organism.
  - Goals and values.
  - Self-concept.
  - Time and opportunity.
  - Element of threat.

- One of the flight instructor's primary responsibilities is to help the student understand how knowledge and skills in one area relate to other areas. This grouping of perceptions into meaningful wholes is known as **insights**.
  - A flight instructor can help the learner create insights by removing barriers to perceptions and then pointing out how these perceptions are related.
- Knowledge is acquired in three phases: **memorization, understanding, and application**. How can the flight instructor help the learner acquire knowledge?
  - Ask questions.
  - Present opportunities to apply knowledge.
  - Demonstrate the benefit/relevance of the knowledge.
  - Time the introduction of topics to support learning objectives.
- The **laws of learning** describe general principles concerning the learning process (**REEPIR**).
  - **R**eadiness.
  - **E**xercise.
  - **E**ffect.
  - **P**rimacy.
  - **I**ntensity.
  - **R**ecency.
- Learning can be grouped into three **domains**: cognitive, affective, and psychomotor (CAP).
  - Each domain consists of four basic levels of learning (**RUAC**).
    - **R**ote.
    - **U**nderstanding.
    - **A**pplication.
    - **C**orrelation.
- Characteristics of learning (**PEMA**).
  - **P**urposeful.
  - **E**xperience.
  - **M**ultifaceted.
  - **A**ctive process.
- **Skill knowledge** is a specific type of knowledge that is acquired in three stages.
  - Cognitive.
  - Associative.
  - Automatic response stage.
- Learners progress through these phases as a result of practice. There are three **types of practice**.
  - Deliberate—practice aimed at a goal.
  - Blocked—drilling a movement until it becomes automatic.
  - Random—mixing it up to help learner make connections between different skills.
- Discuss over-practice.
- Discuss learning plateaus.
- **Scenario-based training (SBT)**: uses real-life scenarios to help make the application of the skills being learned more obvious. This helps the student form insights.
  - Discuss the ratchet example.
- **Errors** come in two forms: slips and mistakes.

    - Slips can be prevented by better processes (flows, checklists, SOP's, etc.).
    - Mistakes can be prevented by better knowledge and understanding.
- Discuss how errors can be used as a valuable teaching tool.
- **Memory** is defined as the ability to encode, store, and retrieve information. There are three types of memory.
    - Sensory register—filters the signals from the noise.
    - Short-term memory—working memory (about 30 seconds).
    - Long-term memory—can be there for a lifetime.
- Forgetting information can be caused by many factors.
    - Lack of frequency or recency (fading).
    - Lack of understanding.
    - Interference (one memory overshadowed by another).
    - Repression (involuntary) or suppression (voluntary).
    - Retrieval failure.
- The flight instructor can help the student remember by understanding these principles that facilitate retention of knowledge (**PRAAMS**).
    - **P**raise.
    - **R**epetition.
    - **A**ssociations—making connection to previously learned information.
    - **A**ttitude.
    - **M**nemonics
    - **S**enses—learning with all five senses.
- Discuss **transfer of learning** (positive and negative).

Task C: The Teaching Process

Content

- The **teaching process**: preparation, presentation, application, and evaluation.
    - Preparation—objective, completion standards, content, and common errors.
        - Performance-based vs decision-based objectives.
    - Presentation—lecture method, guided discussion method, computer-assisted learning method, demonstration-performance method, drill and practice method.
        - Demonstration-performance method—explanation, demonstration, student performance, instructor supervision, and evaluation.
        - A variation of demonstration-performance is telling and doing—instructor tells, instructor does; student tells, instructor does; student tells, student does; instructor evaluates, student does.
    - Application.
    - Evaluation.
- Organization of material: past to present, simple to complex, known to unknown, most frequently used to least used.
- **Problem-based learning**: scenario-based, collaborative problem solving, case study. A good scenario:
    - Is not a test.
    - Will not have one right answer.

    - Does not offer an obvious answer.
    - Should not promote errors.
    - Should promote situational awareness and opportunities for decision-making.
- Instruction aids vs. training media.

Task D: Assessment and Critique

Content

- **Assessment** is defined as the process of gathering measurable information to meet evaluation needs. An assessment is a formal documentation of performance.
    - Purpose is to:
        - Inform the student and instructor of progress.
        - Provide feedback on how to improve performance.
        - Develop student judgment by comparing the student's assessment to the instructor's assessment.
        - Highlight areas needing more emphasis.
- Characteristics of an effective assessment (**FASTCOCO**).
    - **F**lexible.
    - **A**cceptable.
    - **S**pecific.
    - **T**houghtful.
    - **C**omprehensive.
    - **O**bjective.
    - **C**onstructive.
    - **O**rganized.
- Two types of assessments.
    - Traditional—typically used to test the rote and understanding levels of learning (**DR. COVU**).
        - **D**iscrimination.
        - **R**eliability.
        - **C**omprehensive.
        - **O**bjective.
        - **V**alidity.
        - **U**sability.
    - Authentic—typically used to test the application and correlation levels of learning.
- Oral assessment.
    - Most common means of assessment.
    - Fact questions or HOTS (higher order thinking skills) questions.
- Characteristics of effective questions.
    - Applicable.
    - Brief and concise.
    - Adapted to progress within the syllabus.
    - Centers on one idea (who, what, when, etc., but not a combination).
    - Challenging.
- Questions to avoid (**TOPBIT**).

    - **T**oss-up questions.
    - **O**versized questions.
    - **P**uzzling questions.
    - **B**ewildering questions.
    - **I**rrelevant questions.
    - **T**rick questions.
- A **critique** is an informal discussion of performance. A critique should cover the individual parts as well as the whole and should come immediately after the student's performance. There are several types of critiques.
    - Instructor/student critique—class is invited to critique the performance.
    - Student-led critique.
    - Small group critique—different small groups critique different areas of performance.
    - Individual student critique by another student.
    - Self-critique.
    - Written critique—advantages are that it is more thoughtful and can be referred back to at a later date.

Task E: Instructor Responsibilities and Professionalism

Content

- The **responsibilities** of the ***aviation*** instructor—help learners reach their goals by giving tailored instruction, minimizing frustrations, and providing clear objectives and completion standards.
    - Help students learn—make learning enjoyable. Remove barriers to perceptions.
    - Provide adequate instruction—tailor the instruction to the needs of the student.
    - Demand appropriate standards of performance.
    - Minimizing student frustrations (**MACKBAG**).
        - **M**otivate.
        - **A**pproach students as individuals.
        - **C**riticize constructively.
        - **K**eep students informed.
        - **B**e consistent.
        - **A**dmit errors.
        - **G**ive credit when due.
- The **responsibilities** of the ***flight*** instructor.
    - Help the student deal with physiological issues—fear, nausea, anxiety.
    - Ensure student ability—soloing a student pilot is a huge responsibility.
- **Professionalism**.
    - Sincere concern for the student.
    - Acceptance of the student.
    - Good personal hygiene.
    - Professional attitude.
    - Proper language.
    - Admits errors.
- Evaluation of student performance.
    - Use established standards of performance modified for student's experience.

    - Consider the elements involved in a skill—not only the overall performance.
    - Keep the student informed of progress and provide constructive feedback.
- Aviation instructors and exams.
    - Endorsing students for written exams or practical exams is a responsibility to be taken seriously. A check ride cannot measure every area—thus the role of the recommending instructor is critical in producing quality pilots.
- Professional development.
    - Instructors undergo comprehensive evaluations to become an instructor. However, they should not be complacent and should seek out professional development throughout their flight instructor career. This will help keep the instruction interesting and up to date.
        - Government—WINGS, Gold Seal, FAA safety seminars.
        - Commercial training platforms—King, Sporty's, etc.
        - Industry—AOPA, ASI, etc.
        - Books—FAR/AIM, all the FAA handbooks, and others.

Task F: Techniques of Flight Instruction

Content

- **Obstacles** to learning during flight instruction.
    - Feeling of unfair treatment.
    - Learner impatience—emphasize the needs to master the building blocks.
    - Worry or lack of interest—Discuss principle of 'readiness'.
    - Physiological—sickness, fatigue, nausea, dehydration, hunger. Discuss Maslow.
    - Apathy due to inadequate instruction—lack of respect for the instructor due to inadequate instructor preparation.
    - Anxiety.
- **Demonstration-performance**—students learn skills by practicing them.
    - Explanation.
    - Demonstration.
    - Learner performance and instructor supervision.
    - Evaluation
- **Positive exchange** of flight controls.
    - Discuss the three-step transfer process and why this is necessary.
- Sterile cockpit rule.
    - Part 121 rule is to refrain from non-essential activities during critical phases of flight: taxi, takeoff, landing, and all operations below 10,000 ft except for cruise flight. Not required for part 91 ops, but pilots should implement a sterile cockpit rule that takes these 121 rules into consideration.
        - My rules are sterile cockpit for taxi, takeoff, landing, and for climbs/descents when within 1,000 ft of target altitude.
    - **Use of distractions**—the instructor should use distraction to teach the learner how to deal with them.
        - **Drop a pencil.**
        - Determine a heading to an airport using a chart.

        - Reset the clock.
        - Get something from the back seat.
        - Compute TAS using E6-B.
        - **Distracting conversations.**
    - **Integrated flight instruction**—students are, in the same session, taught to perform a maneuver by visual reference and by instruments.
- Assessment of piloting ability.
    - Review.
    - Collaborative assessment.
    - Written tests.
    - Performance-based tests.
- Aeronautical decision making (**ADM**)—the systematic approach used by pilots to consistently determine the best course of action.

Task G: Risk Management

Content

- **Risk management** is the process of weighing potential costs against potential benefits. The four basic principles of risk management are.
    - Accept no unnecessary risk.
    - Make risks decisions at the appropriate level.
    - Accept risks when benefits outweigh the cost.
    - Integrate risk management into planning at all levels.
- Hazard vs. Risk—hazard is the potential condition that can cause something to go bad and risk is the future impact of a hazard.
- **Identify, Assess, and Mitigate** (Similar to perceive, process, perform (3P's)).
    - Identify: **P**ilot, **A**ircraft, En**V**ironment, **E**xternal Pressures (**PAVE**).
        - Pilot
            - **I**llness, **M**edication, **S**tress, **A**lcohol, **F**atigue, **E**motion (**IMSAFE**).
            - Hazardous attitudes (**RAIIM**): **R**esignation *(I can make a difference)*, **A**nti-authority *(follow the rules—they are usually right)*, **I**nvulnerability *(it can happen to me)*, **I**mpulsivity *(not so fast—think first)*, **M**acho *(taking chances is foolish)*.
        - PAVE can be supplemented by the 5P's (Plan, Plane, Pilot, Passengers, Programming).
    - Assess: Flight Risk Assessment Tool (FRAT).
        - **Probability** (improbable, remote, occasional, probable) vs. **Severity** (negligible, marginal, critical, catastrophic) to assess the risk (red, yellow, green).
    - Mitigate: **T**ransfer (possibly consult with a more experienced pilot), **E**liminate, **A**ccept, **M**itigate (**TEAM**).
        - Use single pilot resource management (**SRM**) to mitigate risks.
            - 9 Standard operating procedures (**SOP's**)
                - The final walk around.
                - Pre-taxi briefing.
                    - Review taxi route.

    - Taxi turns.
    - CIGARS.
    - Pre-takeoff briefing.
        - Brief takeoff speeds and abort plan and engine failure plan.
        - Verify runway heading against compass and heading indicator.
    - Takeoff callouts.
        - Power set.
        - Gauges checked.
        - Airspeed alive.
        - Abort point.
        - Rotate.
        - 400 ft. AGL.
        - 1,000 ft. AGL.
    - Checklists to back up flow checks.
        - Pre-takeoff flow.
        - Climb flow.
        - Cruise flow.
        - Descent flow.
        - Pre-landing flow.
    - 5T's (Turn, Time Twist, Throttle, Talk).
    - 5A's (ATIS, Altimeter, Approach briefing, Avionics, Airplane).
- **Personal minimums** (below is an example of mine).
    - > 5 hours of sleep.
    - Food in the last 18 hours.
    - Nearby runway aligned with the wind if crosswind for destination more than 20 kts (max demonstrated 15 kts).
    - The freezing level must be above MEA.
    - Approach down to minimums if feeling sharp.
    - No flying in widespread areas of yellow radar returns.
    - No flying at night in IMC.
    - No flying over widespread areas of LIFR (ceiling < 500 ft. and/or visibility < 1 mile).
    - 1 hour of VFR fuel reserves and 2 hours of IFR fuel reserves.

Areas of Operation II: Technical Subject Areas

Task A: Aeromedical Factors

Objective

Learn about and understand the aeromedical factor affecting pilots.

Content

- How to obtain an appropriate medical certificate.
  - Examination by an aviation medical examiner (AME). Go to https://medxpress.faa.gov/medxpress/ to fill out information prior to going for medical.
  - 1st, 2nd, or 3rd class. Beginning pilots should get the class medical they eventually will need. For example, if your goal is to become an airline pilot, go ahead and get a 1st class medical to ensure there are no medical deficiencies that stand between you and your goal.
  - Different classes of medical certificates are required to exercise the privileges of different certificates. A higher-class medical certificate can be used as a substitute for operations requiring a lower-class medical. For example, a 1st class medical would be valid for 60 months for a person under 40 to satisfy 3rd class medical privileges (61.23).
  - *To exercise the privileges of an ATP certificate*, a **1st class medical** is required.
    - Under 40, expires in 12 calendar months.
    - 40 and over, expires in 6 calendar months.
  - *To exercise the privileges of a commercial certificate*, a **2nd class medical** is required.
    - Except when acting as a flight instructor (only 3rd class or basic med required).
    - Expires in 12 calendar months.
  - *To exercise privileges of private, recreational, or student pilot certificate*, a **3rd class medical** is required (unless operating under Basic Med).
    - Under 40, expires in 60 calendar months.
    - 40 and over, expires in 24 calendar months.
  - **Basic Med**—no more than 5 passengers, gross weight no more than 6,000 pounds, aircraft certified for no more than 6 occupants, 250 KIAS or less, below 18,000 ft, and no flight for compensation or hire. Need a valid driver's license, an exam every 48 calendar-months, and a training course every 24 calendar-months.
- How to obtain a medical certificate in the event of a possible medical deficiency.
  - Students with **physical limitations** (vision impairment, hearing impairment, loss of limb, etc.) may be issued a medical certificate valid for "student pilot privileges only" while learning to fly. Upon meeting all the knowledge, experience, and proficiency requirements, the student can demonstrate the ability to operate the aircraft at a normal level of safety. This "statement of demonstrated ability" (**SODA**) can then be issued and this waiver will be valid as long as the physical disability necessitating the soda does not become worse.
  - Part 67 specifies fifteen mandatory **disqualifying medical conditions**. This list contains conditions such as heart disease, bipolar disorder, epilepsy, and others.

There are other conditions that aren't mandatory disqualifying events that can lead to disqualification as well. The important thing to remember is that for both types of disqualifications, the applicant can go through a "**Special Issuance Authorization.**" The details of this process are outlined in 67.401. The basic process is that special testing determined by the FAA is done to ensure that the pilot is safe to operate the aircraft for the duration of the medical.

- The causes, symptoms, effects, and corrective action of the following medical factors:
    - **Hypoxia**—hypoxia means "reduced oxygen." Hypoxia can be caused by lack of oxygen in the air being breathed, reduced ability to transport oxygen in the blood, or the reduced ability of the tissues to use the oxygen. Severe hypoxia can lead to death, but the negative effects of hypoxia occur much sooner because the brain is especially susceptible to lower-than-normal levels of oxygen.
    - There are several types of hypoxias based on the root cause:
        - **Hypoxic hypoxia**—caused by insufficient oxygen available to the body. For pilots, hypoxic hypoxia is associated with higher altitudes where the less-dense atmosphere lacks the oxygen required for normal brain function.
        - **Hypemic hypoxia**—caused by the blood cells being unable to transport sufficient levels of oxygen to the tissues of the body. The most common form of hypemic hypoxia to affect pilots is caused by carbon monoxide poisoning. CO binds much more strongly to the hemoglobin than oxygen does (about 200 times), which leaves the hemoglobin with reduced ability to transport the oxygen for which it has less affinity for.
        - **Stagnant hypoxia**—caused by the lack of blood flow. The blood has the oxygen needed, but the blood is not flowing to the tissues. This can be caused by heart failure, constricted arteries, excessive g-forces, etc.
        - **Histotoxic hypoxia**—caused by the reduced ability of the cells to use the oxygen that is being transported to them. Alcohol and other drugs can cause this form of hypoxia.
    - The symptoms of hypoxia vary from person to person. Thus, it is helpful if the pilot experiences hypoxia in a controlled environment to get a better understanding of his symptoms. Common symptoms are as follows:
        - Headache.
        - Impaired judgment.
        - Euphoria.
        - Visual impairment.
        - Drowsiness.
    - Hypoxic hypoxia is the most easily treatable form of hypoxia. By flying lower or by using supplemental oxygen, the pilot can increase the oxygen levels in the blood back to normal levels and immediately function at normal cognitive levels. Hypemic hypoxia caused by CO is more difficult to recover from. Even after stopping the exposure to CO, the CO remains in the blood for hours.
    - **Hyperventilation**—this occurs when too much carbon dioxide is lost from the blood. This is usually caused by an abnormally high breathing rate. Its symptoms are similar to hypoxia (plus lightheadedness, dizziness, and tingling). Hyperventilation is treated

by breathing normally, breathing deeply, or by breathing into a bag. All these methods help to rapidly restore normal levels of carbon dioxide to the blood.

  - **Middle ear and sinus problems**—discomfort commonly occurs in the ears while flying because of unequal pressure between the outer ear and middle ear. This difference is pressure causes the eardrum to bulge outward during climbs and inward during descents. Chewing, swallowing, and yawning can help open the Eustachian tube during the climbs and will allow the pressure to equalize. In the descent, pressure can be equalized by pinching the nose and gently blowing. This increases the pressure in the throat and gently forces air into the middle ear via the Eustachian tube. Sinus pain, like ear pain, is caused by the pressure not equalizing during climbs and descents. Sinus pain can be excruciating and is not easily treatable. Thus, pilots and passengers should not fly with any condition that is causing sinus congestion.
  - **Spatial disorientation**—the body uses three systems in conjunction to maintain orientation: the vestibular system (inner ear), the somatosensory system (seat of the pants), and the visual system. Typically, all three systems send agreeing information to the brain. The visual system is powerful and keeps in check any of the errors introduced by the vestibular or somatosensory system. During low/no visibility conditions, the pilot can easily become disoriented.
- Vestibular Illusions.
  - The leans—turn rate is too slow for the inner ear to recognize. Upon correction, it seems as if the aircraft is banking away from level flight in the opposite direction.
  - Coriolis illusion—an illusion of motion in another plane when moving the head after having been in an established turn.
  - Graveyard spiral—a more severe form of the leans leading to a descending spiral dive.
  - Somatogravic illusion—acceleration causes the sensation of pitching up. This causes the pilot to believe he needs to pitch down to avoid stalling.
  - Inversion illusion—leveling off after a climb created the illusion of tumbling backwards causing the pilot to pitch down even more.
  - Elevator illusion—a sudden acceleration upward, maybe from an updraft, caused the illusion of being in a nose high attitude. This causes the pilot to pitch down. The opposite occurs during a downward acceleration.
- Visual Illusions.
  - False horizon—caused by sloping cloud deck, confusing ground lights/starts at night, etc.
  - Autokinesis—at night, stationary lights that are stared at appear to move.
- Spatial disorientation can be avoided by first understanding how susceptible humans are to disorientation during these situations, learning to train your visual system to trust the instruments, being proficient in the use of instruments, and avoiding sudden head movements during instrument flying.
  - **Motion sickness**—caused by the brain receiving conflicting messages regarding the orientation of the body. Exposure, over time, normally makes this better. Keeping

your eyes on the horizon, avoiding unnecessary head movement, and cool air on the face all help with the symptoms of motion sickness.

  - **Carbon monoxide poisoning**—CO binds much more strongly to the hemoglobin than oxygen does **(about 200 times)**, which leaves the hemoglobin with reduced ability to transport the oxygen for which it has less affinity for. The body takes up to 48 hours to recover from CO poisoning. Thus, there is no quick cure for the pilot who has been exposed to too much CO. CO poisoning is commonly caused by exhaust leaking into the cabin from the heater. CO detectors are the only reliable way to be aware of CO exposure—all pilots should consider flying with one.
  - **Fatigue and stress**—acute stress, or short-term stress, can typically be safely dealt with by the pilot. This is normally stress that is dealt with by the "fight or flight" response. Chronic stress, on the other hand, is long term stress caused by unrelenting psychological problems such as loneliness, relationship problems, or financial issues. This type of stress can cause serious degradation in pilot performance. Thus, flying should be avoided if the pilot is suffering from chronic stress. Fatigue, like stress, comes in the acute and chronic variety. Both types reduce the pilot's ability to concentrate, impair coordination, and decrease the ability to communicate. Acute fatigue is a part of normal life and may result after a long, tiring day of work. A good night of rest cures acute fatigue. Chronic fatigue, on the other hand, is fatigue that goes unaddressed for a long period of time and usually results from serious stress or disease. Pilots suffering from acute fatigue should ensure they get the proper rest before flying. Pilots suffering from chronic fatigue suffer a more serious condition and should consult a physician to help solve the underlying issues.
  - **Dehydration**—the critical loss of water from the body. Dehydration can be caused by hot environments, lack of water consumption, or consumption of diuretics. Symptoms of dehydration are **headache, fatigue, cramps, sleepiness, and dizziness**. Fatigue is typically the first symptom. Flying at high altitudes and hot temperatures increase the loss rate of water from the body and can lead to dehydration. To avoid dehydration, the pilot should ensure that he is drinking a normal amount of water before and during flight.
- The effects of **alcohol and drugs**, and their relationship to flight safety—pilots are required to make hundreds of decisions during flight and alcohol adversely affects decision making ability. Alcohol can cause histotoxic hypoxia. Combined with altitude, which causes hypoxic hypoxia, the effects can be magnified. Part 91 required at least **8 hours** "from bottle to throttle." Also, blood alcohol levels must not be greater than **0.04**. Drugs that cause impairment or medical conditions that cause impairment that necessitate drugs prohibit one from acting as a required crew member per 61.53. **91.17 prohibits the use of any drug that affects the person's ability in any way contrary to safety**. The FAA offers some guidance on what drugs are unacceptable for pilots.
- The effects of nitrogen excesses incurred during **scuba dives** and how this affects pilots and passengers during flight—scuba diving exposes the body to higher-than-normal pressures. These pressures allow more nitrogen to dissolve in body tissues and fluids. If the transition from the high-pressure scuba environment to low-pressure flying environment happens too

quickly, decompression sickness (DCS) can occur. DCS occurs when the nitrogen in the blood and tissues come out of physical solution and form bubbles. This causes pain (most commonly joint pain) known as “the bends.” If flying after a dive that does not require controlled ascent, wait at least 12 hours before flying up to 8,000 ft. If flying after a dive that does require controlled ascent, wait at least 24 hours. Before flying up to 8,000 ft. If flying higher than 8,000 ft. after any dive, wait at least 24 hours.

Task B: Runway Incursion Avoidance

Content

- **Runway incursions**—Taxiing is unique phase of flight that has special challenges not found in other phases of flight. Traffic density is much higher on the airport surface and some airport layouts can be complex. At ground level, it is difficult to know where you are and where you want to go. Because of this, the pilot must be thoroughly briefed for the taxi to or from the runway and have the tools required to remain situationally aware throughout the taxi process. **Runway incursions are any occurrences involving the incorrect presence of an aircraft on a runway surface.** These events have become a topic of focus as the number of accidents due to runway incursions has increased. Below are some general guidelines followed by some standard operating procedures that will help reduce runway incursions.
    - **Focus on taxiing**. Keep your eyes outside and do not get distracted by cockpit tasks that can be done before or after taxi. Centerline discipline is important.
    - Always **brief the taxi**. Identify where you are at, where you are going, and how you are getting there. Know how to use airport diagrams on ForeFlight. Know how to identify **Hot Spots**.
    - Keep your feet in a position **where you can reach the toe brakes**. Do not ride the brakes. Only use as necessary. Taxi at a speed appropriate for the situation.
    - Understand **taxiway sign/markings**—location signs, direction signs, hold short marking, and runway holding position signs.
    - **Runway and Taxiway Lighting**—Chapter 2, section 1 of the AIM is an excellent resource for information about all the different types of airport lighting. Review this thoroughly. The basics that will help with runway incursions are as follows:
        - Taxiway centerline lights are green (not all airports have centerline lighting).
        - Runway centerline lights are white (not all airports have centerline lighting).
        - **Taxiway edge lights are blue.**
        - **Runway edge lights are white.**
        - Taxiway centerline lead-off / lead-on lights are alternating green and yellow and indicate a taxiway exiting the runway or taxiway entering the runway.
        - Not all entrances to runways have special lighting around the hold short line. Always look for the lighted runway holding position sign and look for the hold short line painted on the pavement.
    - **During taxi to the runway**—Avoiding runway incursions starts with proper pre-taxi planning. After receiving and reading back the taxi instructions, prepare for the taxi by reviewing the taxi route on an airport diagram. Busier airports may have ‘hot spots’ listed on the airport diagram. These hot spots are areas prone to runway incursions. Review these areas carefully. Having a visual picture of where you are going and where hot spots

will be is a helpful first step in avoiding runway incursions. Remember that a runway cannot be crossed during taxi without an explicit clearance to cross that runway. That clearance may be given with the initial taxi instructions, or you may be asked to hold short of a certain runway. If asked to hold short, then do not cross the hold short line until the controller gives you the clearance. If in doubt whether you are cleared to cross a runway, ask the controller. Do not confuse your **actual taxi instructions with your expected taxi instructions**. During taxi, focus solely on taxiing. Do not get distracted with texting, phone calls, passenger conversations, etc. Keep workload during taxi to a minimum by proper cockpit organization prior to the taxi. Do not try to perform pre-takeoff checklists while taxiing. Trying to do multiple tasks while taxiing is not appropriate for single pilot ops and may lead to collisions with other aircraft or airport equipment.

- **During taxi from the runway**—Many pilots are prepared for the taxi to the runway for takeoff, but not many are prepared for the taxi to parking after the landing is complete. While briefing the approach, take a moment to review the airport diagram to become familiar with the hot spots and likely taxi routes to the destination on the ground. Brief the location of any **intersecting runways** that could be easily confused for a taxiway. After clearing the runway after landing, review the assigned taxi route on the airport diagram to get a visual of what is ahead. Pay careful attention to any runways that may be along the taxi route.
- **Distractions**—Distraction during taxi can lead to runway incursions even if the taxi was well-briefed ahead of time. During single-pilot ops, it is rarely wise to try to accomplish anything other than taxiing during the taxi. Set up radios and navigation equipment prior to taxi and complete the runup items in a designated runup area or while holding short of the departure runway. It is advisable to **maintain a sterile cockpit during the taxi**.
- **Clearing the runway**—When taxiing clear of the runway, make sure the entire aircraft has crossed over the hold short line. Make sure not to confuse an intersecting runway with a taxiway.
- **Progressive taxi**—If the pilot is confused by the taxi instructions, progressive taxi should be requested. During progressive taxi, the controller will give step-by-step instructions to the pilot.
- **Aircraft lighting**—To provide visual aids to other pilots, turn the aircraft's beacon light on prior to engine start. Leave the beacon light on throughout the flight. Before taxi, turn on the taxi light. Turn on the NAV light as well if operating between sunset and sunrise. Strobe lights can adversely affect the vision of other pilots and thus should not be turned on until entering the runway.
- Additional factors to discuss.
  - Specific procedures for operations at an airport with an operating air traffic control tower with emphasis on ATC.
  - Operations and non-towered airports.
  - ATC communication and pilot action at towered and non-towered airport before takeoff, after takeoff, and after landing.
  - Low visibility operations.

Task C: Visual Scanning and Collision Avoidance

Objective

Learn the elements of visual scanning and collision avoidance.

Content

- Relationship between a pilot's **physical condition and vision**—to see and avoid traffic, a pilot must have good vision. Complete the **IMSAFE** checklist to assess how pilot performance may be impaired by different factors.
- **Environmental conditions** that degrade vision—haze, glare from the sun, dirty windshields, dim light, eyes not adjusted to night, etc. can degrade the pilot's ability to see other aircraft.
- Vestibular and visual illusions—the leans, runway width illusion, upslope illusion, and featureless terrain illusion.
- **"See and avoid"** concept 91.113—Most small GA aircraft cruise around in class E airspace. In this airspace, ATC does not separate VFR-VFR traffic or IFR-VFR traffic. If on flight following, traffic advisories will be given, but this may not include advisories for all traffic conflicts. Thus, in most situations, it is the pilot's responsibility to see and avoid other aircraft.
- Proper visual scanning procedure—short, regularly spaced intervals of **no more than 10° for at least 1 second**. This allows the eye time to notice movement within the visual field before moving onto the next scanning sector.
- Relationship between poor visual scanning habits and increased collision risk—poor scanning leads to lower probability of detecting conflicting traffic which leads to an increased collision risk.
- Proper **clearing procedures**.
    - Before taxiing onto the runway for takeoff, clear the approach area.
    - During climbs and descents, gentle banks to the left and the rights help in the detection of traffic.
    - Before maneuvering, perform clearing turns—either a 90° left (right) turn followed by a 90° right (left) turn, or a single 180° or 360° turn.
- Importance of knowing aircraft **blind spots**—low wing aircraft cannot easily see traffic below and high wing aircraft cannot easily see traffic above. Thus, each should be aware of how these blinds spots can cause collision conflicts. A low wing descending on top of a high is a scenario that the pilot should be aware of. Before starting a turn, pilots of either high wing or low wing aircraft should raise or lower their wings, respectively, to check for traffic in the direction of the turn.
- Relationship between aircraft **speed differential and collision risk**—aircraft on a head-on course have a closing rate of the sum of the two aircraft's speed. Thus, the closure rate may be faster than the pilot initially anticipates. Because of this, pilots should maneuver as early as possible to avoid conflicting traffic.
- **Situations that involve the greatest collision risk**—flight in congested areas create the most likely scenarios for collision. This included operating in the vicinity of airports, VOR's, and training areas.

Task D: Principles of Flight

Objective

Learn the principles of flight.

Content

- **Airfoil design characteristics**—lift is created when the wing takes the air it is meeting and redirects it downward. Redirecting the air downward causes an equal and opposite force on the wing. This force is the lifting force. How the airfoil redirects the air down is actually quite complex. Essentially, there are two components: the wing, acting as a flat plate, obviously redirects the air downward if it meets the air with a positive angle of attack. The more significant contribution, however, is described by Bernoulli. Air flowing over the top of the wing travels faster than air under the wing. Air moving faster, according to Bernoulli, has less pressure. Thus, the upper surface of the wing is an area of low pressure relative to the pressure beneath the wing. This "suction" redirects air downward as it flows over the wing.
    - Discuss l**eading edge, trailing edge, chord line, angle of attack, angle of incidence, symmetrical airfoils, and cambered airfoils**.
    - Discuss the **four forces of flight**.
    - Discuss stalls and how aircrafts wings are designed to tame stalling behavior.
- Airplane stability and controllability—discuss **static stability** and **dynamic stability** and how these concept tie into controllability.
    - Discuss **pitch stability**— The location of the CG is a major factor in pitch stability and controllability. Pitch stability results from the tail being at a lower angle of attack than the wing (it is a myth that the tail must create negative lift for the airplane to be stable—the CG does not have to be forward of the center of lift). This difference in angle of attack between the wing and the tail is known as *decalage*. As the CG moves aft, the tail has to operate at a higher angle of attack in order to balance the torques. Eventually, the tail will be at the same angle of attack as the wing. Because there is no more decalage, the pitch stability will disappear making the aircraft difficult to control. As CG moves forward, the airplane becomes more stable in pitch. With a CG too far forward, the tail will not have enough authority to command the proper pitch attitude for landing. The CG limitations of the airplane are designed such that the aft CG limit still provided acceptable aircraft stability while the forward CG limit provides adequate pitch authority for high angle of attack operations such as during the landing flare. Exceeding the fore or aft CG limits can lead to unrecoverable loss of control.
    - Discuss **yaw stability**—weathervaning.
    - Discuss **roll stability**—roll stability is weak or perhaps even unstable. Discuss slip-roll coupling (Dutch roll) and the long-tail slip effect which adds positive roll stability. Discuss the overbanking tendency which tends to negate the stability generated by the long-tail slip effect.
- Turning tendencies.
    - **Torque effect**—propeller spins clockwise which causes the aircraft to be twisted counter-clockwise.
    - **Gyroscopic effect**—creates a torque 90° ahead of the direction of rotation in the same direction as the applied force. The means raising the tail of a taildragger causes a yaw to the left.
    - **Propeller slipstream**—clockwise flow of air around the aircraft strikes the vertical stabilizer in a way that causes a left turning tendency.

- **P-factor**—at high angle of attack, the AOA of the descending blade is higher than the AOA of the ascending blade which causes a left turning tendency.

- **Load factor** in airplane design—each wing has a maximum angle of attack it can fly at before it stalls and ceases to generate enough lift for flight. At high speeds during unaccelerated flight, the AOA will be low. In this condition, there is substantial margin between the current AOA and the stalling AOA. Thus, significant load could be put on the aircraft if the controls were quickly deflected or if turbulence were encountered. In contrast, flying slowly leads to a high AOA with little margin before reaching the stall AOA (such as slow flight). Any increase in load factor caused by the pilot or by the environment will cause the aircraft to stall. This concept explains why **maneuvering speed** is higher for higher gross weights.
  - Normal Category: -1.52 to +3.8
  - Utility Category: -1.76 to +4.4
  - Aerobatic Category: -3.0 to +6.0
- **Wingtip vortices and precautions to be taken**—all aircraft create wake turbulence the moment the wings begin to generate lift (yes, even before the aircraft leaves the ground). The wake turbulence is caused by vortices that roll off the high-pressure bottom surface of the wing around to the low-pressure top surface of the wing (see image below).

  - The vortices from heavy and slow aircraft are the strongest. When departing or landing behind these types of aircraft, have a plan to avoid their wake. These types of vortices are strong enough to invert a small aircraft. Wake vortices drift with the wind and typically descend several hundred feet per minute. If the vortices reach the ground, they typically move laterally over the ground at 2-3 knots. Use this knowledge to offset away from the wake turbulence. When landing behind a heavy aircraft, touch down beyond the large aircraft's touchdown point. When taking off behind a heavy aircraft, lift off before the preceding aircraft and offset to the upwind side of the aircraft. **Light,**

quartering tailwinds are the worst-case scenario—the winds aren't strong enough to blow the vortices away, but just strong enough to stop the lateral movement. This can potentially keep vortices over the runway for an extended period. Be careful when taking off on parallel runways. Wake turbulence from aircraft using the parallel runway can drift over to your runway. Consider delaying takeoff for a couple of minutes if wake turbulence on departure is a concern. Refer to PHAK chapter 14 for more scenarios on wake turbulence avoidance.

Task E: Airplane Flight Controls

Objective

Learn about the airplane's flight controls.

Content

- **Primary flight controls**—The standard primary flight controls are the **ailerons, elevator, and rudder**. The ailerons control the roll about the longitudinal axis. The elevator controls the pitch about the lateral axis, and the rudder controls the yaw about the vertical axis. These flight controls exhibit varying degrees of **coupling**. For example, roll induces yaw and yaw induces roll and pitching up in a bank induces roll. Thus, it is clear that flight controls have a **primary effect and a secondary effect**. Primary flight controls in small GA aircraft are most commonly controlled via cables and pulleys and/or pushrods.
- **Secondary flight controls**—The secondary flight controls comprise the **flaps, leading edge devices, spoilers, and trim**. Flaps are used to achieve a higher coefficient of lift allowing for slower takeoff and landing speeds. In addition, flaps allow for steeper approach angles because of the additional drag created. Leading edge devices are commonly used on jet aircraft to help modify the wing for better low-speed handling characteristics. Slots, movable slats, leading-edge flaps, and leading-edge cuffs are the various leading-edge devices. Spoilers are panels on the upper surface of the wing that, when raised, act to spoil some of the lift from that wing. Spoilers can be used asymmetrically to either augment aileron roll control or used in place of aileron roll control. Spoilers used symmetrically help aircraft, such as jets, descend more rapidly without increasing speed and help transfer weight from the wings to the wheels during rollout to help shorten the ground roll. Trim systems reduce pilot workload by adjusting the aerodynamic forces on the control surfaces.
- Trim controls—trim is a secondary flight control as discussed above. Some aircraft only have elevator trim, but others may additionally have either rudder trim, aileron trim, or both. Trim systems operate in various methods, but the Cessna 182S has an elevator trim tab controlled by a trim wheel. Rudder trim in the C182S is accomplished via a bungee connected to the rudder control system and is also controlled by a trim wheel.

Task F: Airplane Weight and Balance

Objective

Learn the element of airplane weight and balance.

Content

- Weight and balance **terms**.
    - Datum—point from which arms are measured.
    - Arm—distance from the datum to a particular station.
    - Station—a particular location such as front seats, fuel, baggage, etc.
    - Moment—arm times weight at that station.
    - Moment index—divide by 100, 1,000, or 10,000 to make moments more manageable.
    - Center of gravity—balance point of the aircraft.
    - CG limits—fore and aft.
    - CG range—distance between fore and aft limits.
    - Standard empty weight—aircraft empty weight with full oil and unusable fuel.
    - **Basic empty weight**—standard empty weight plus optional equipment.
    - **Useful load**—Gross weight minus basic empty weight.
    - Mean aerodynamic chord (MAC)—average distance of the chord. The leading-edge MAC (LEMAC) and the trailing-edge MAC (TEMAC) can be defined in reference to a datum and then CG location can be expressed as percentage of MAC. For example, a CG of 2.5ft aft of the LEMAC on a wing with a 10 ft MAC would have a CG location of 25% of the MAC.
- **Effects of weight and balance on performance**— virtually every aspect of performance is decreased as weight increases. Ground roll, rate of climb, stalling speed, landing speed, etc. are all adversely affected by increased weight. Exceeding the maximum certified gross weight takes the airplane into a regime of flight that it has not been certified to operate in. Takeoff distances, landing distances, and stall speed are unknown. The location of the CG is a major factor in pitch stability and controllability. Pitch stability results from the tail being at a lower angle of attack than the wing (it is a myth that the tail must create negative lift for the airplane to be stable—the CG does not have to be forward of the center of lift). This difference in angle of attack between the wing and the tail is known as *decalage*. As the CG moves aft, the tail must operate at a higher angle of attack in order to balance the torques. Eventually, the tail will be at the same angle of attack as the wing. Because there is no more decalage, the pitch stability will disappear making the aircraft difficult to control. As CG moves forward, the airplane becomes more stable in pitch. With a CG too far forward, the tail will not have enough authority to command the proper pitch attitude for landing. The CG limitations of the airplane are designed such that the aft CG limit still provided acceptable aircraft stability while the forward CG limit provides adequate pitch authority for high angle of attack operations such as during the landing flare. Exceeding the fore or aft CG limits can lead to unrecoverable loss of control.
- Methods of **weight and balance control**—weight and balance can be controlled by the careful monitoring and adjustment of passenger and cargo load, fuel load, and distribution of weight throughout the cabin. Shorter legs and more fuel stops may be required when needing to carry a larger load. Always ensure that beginning CG and ending CG is withing the CG envelope as fuel is burned throughout the flight.
- Determination of total weight and center of gravity and the changes that occur when adding, removing, or shifting weight—CG is best calculated using an EFB, such as ForeFlight, but all these tools use one basic formula:

$$Moment = Weight\ x\ Arm$$

From this, the weight shift formula can be derived. This formula can help the pilot determine how much weight needs to be moved from one station to another to change the CG by the required amount. That formula is as follows:

$$Weight_{moved} = Weight_{total}\ x\ \frac{\Delta CG}{Distance\ Moved}$$

Task G: Navigation and Flight Planning

Objective

Learn the elements of navigation and flight planning.

Content

- **Terms** used in navigation.
    - Lines of latitude—lines parallel to the equator. Measured in degrees N or S of equator.
    - Lines of longitude—lines from pole to pole perpendicular to the equator. Measured in degrees E or W from the Prime Meridian.
    - Course—the **desired path** or track over the ground.
    - Heading—the direction the aircraft is pointed.
    - Track—**actual path** or track over the ground.
    - Drift angle—the angle between the heading and the track.
    - Wind correction angle—the correction in heading to align the actual track with the desired course.
    - Isogonic line—lines connecting points of equal magnetic variation.
    - Magnetic variation—errors induced because of the difference in location between magnetic north and true north.
    - Magnetic deviation—deviation caused by the aircraft interference with the magnetic compass.
    - Airspeed—IAS, CAS, TAS.
    - Groundspeed.
- Features of **aeronautical charts**—VFR sectional charts have a scale of 1:500,000 (1 inch = 6.86 nautical miles). These sectionals depict latitude and longitude, terrain, airspace, airports, airport information, etc.
- Importance of using the proper and current aeronautical charts—VFR sectional charts are updated every 56 days. Updated charts ensure updated information, some of which may be critical (i.e., location of new towers).
- Method of plotting a course, selection of fuel stops and alternates, and appropriate actions in the event of unforeseen situations.
    - **Plotting a course**—draw a line on the chart between the origin point and the first checkpoint (this checkpoint may or may not be the destination point). The true course is determined by measuring the angle of the course relative to a line of longitude on the chart. Because lines of longitude converge towards the poles, it is important to measure this angle from the midpoint of the course. This helps minimize the errors for northerly and southerly flights. Depending on the type of navigation, selection of the course will vary. While direct routes are the shortest, risk can oftentimes be mitigated by choosing

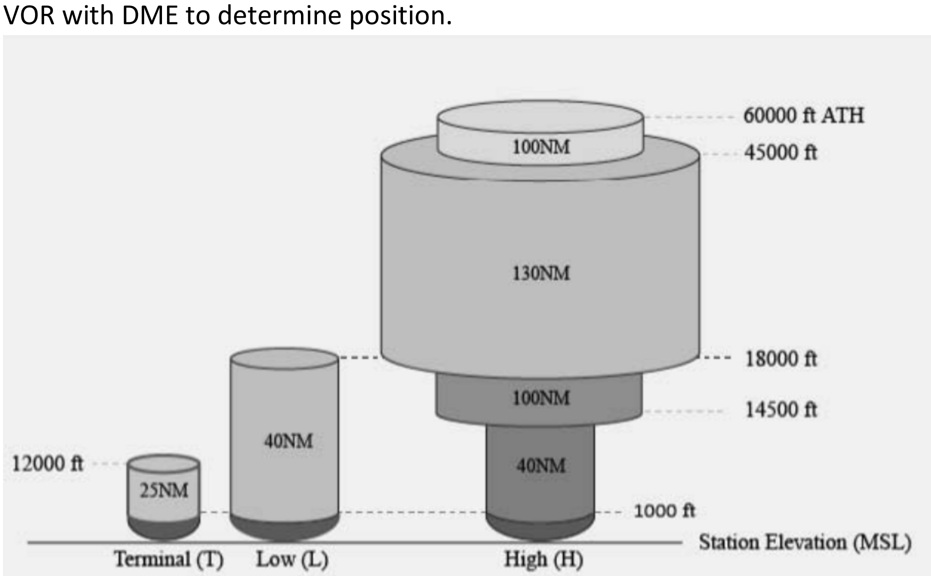
a route near other airports, near better checkpoints, over better terrain, in better weather, etc.
  - **Fuel stops and alternates**—fuel stops must be chosen that allow for proper fuel reserves. Location, fuel pricing, and services available are the primary factors in this decision-making process. In areas without other airports nearby, consider the ramifications if the fuel pumps are out of service (NOTAMS aren't always issued).
  - **Unforeseen situations**—unexpected poor weather, unexpected headwinds, sick passengers, or a malfunctioning airplane are a few types of situations that will require a backup plan. When flight planning, the pilot should choose his course with these types of eventualities in mind.
- Fundamentals of **pilotage** and **dead reckoning**—in the early days of air navigation, pilotage and dead reckoning were commonly used in conjunction to help maximize the probability of staying on course. With the advent of radio navigation and GPS, these techniques are now less relevant.
  - Pilotage—Choose a course that crosses recognizable landmarks (roads, railroad tracks, major rivers, lakes, power lines, etc.). Use these landmarks to navigate to destination.
  - Dead reckoning—Calculate the compass heading (CH) by starting with a true course (TC). The true heading (TH) is found by adjusting the TC by the wind correction angle (WCA). The magnetic heading (MH) is found by adjusting the TH for magnetic variation (VAR). The compass heading (CH) is found by adjusting the MH for compass deviation (DEV).

$$TC \pm WCA = TH$$

$$TH \pm VAR = MH$$

$$MH \pm DEV = CH$$

- Fundamentals of radio navigation—**VOR navigation** is ground-based and relies of line of sight between the VOR station and the aircraft. VOR are classified as either terminal (T), low altitude (L), or high altitude (H). VOR's should be identified before using. CDI's have a sensitivity of 2° per reference line. Pilots can track to or from VOR's on specific radials and can use two VOR's or one VOR with DME to determine position.



- **Diversion to an alternate**—GPS (either panel or ForeFlight) or ATC vectors is the best method. VOR's and pilotage/dead reckoning are good back ups to GPS.
- Lost procedures—have a backup GPS as the first line of defense. Stay in contact with ATC as a second line of defense. Use sectional charts to find VOR's in the general area to triangulate location as a final line of defense.
- Computation of fuel consumption—ForeFlight has very accurate fuel burn calculations if the profile for the airplane is set up correctly. The pilot should know how to calculate late fuel burn for taxi, climb, cruise, and descent and to ensure that the fuel load gives ample reserves (legal VFR reserves at minimum, but generally wise to have more). Fuel burn rate is mostly consistent from one flight to the next, but groundspeed varies widely. It is important to update fuel burn calculations if groundspeeds are different than estimated during flight planning.
- Importance of preparing and properly using a **flight log**—a flight log is an organized way of presenting the pilot the relevant information for each leg of the flight plan. The flight log will show items such as distance between legs, time between legs, distance remaining, course, heading, total fuel used, etc. An example VFR flight log is in Thomas' CFI folder.
- Importance of a weather check and the use of good judgment in making a **"go/no-go" decision**.
    - Weather briefings should be performed before every flight. Foreflight is the most common tool for obtaining weather briefings. Calling a briefer at 1-800-WXBRIEF is still an option, but most will find the graphical weather presentation in Foreflight (or other EFB's) more helpful than listening to a briefer give a verbal description of the weather conditions.
    - Both ADS-B and Sirius XM datalink weather have revolutionized **in-flight decision making**. Every pilot now has multiple affordable options to access cockpit weather consisting of NEXRAD radar, METARS, TAFS, AIRMETS, SIGMETS, PIREPS, Winds Aloft, and more. For cross-country flying, it would be a mistake not to have an iPad coupled with some type of datalink weather receiver such as the Sentry or the Stratus.
    - Common **weather hazards** may vary according to the region. The primary weather concern in the Southeast is thunderstorms. The California coastal area has fog. The Midwest has strong winds. Because of our region, thunderstorms will be the focus. Often, individual or localized clusters of thunderstorm cells will develop. Remain in visual conditions and navigate around these cells. Stay at least 20 miles from the cells. Gust fronts from thunderstorms are particularly dangerous in the takeoff or landing phase. The wind shear from the gust front can cause a sudden loss of airspeed. At the lower speeds used for approach, this may cause a stall and subsequent loss of control. For this reason, do not takeoff or land in the face of an approaching storm. If a thunderstorm is inadvertently entered, set power for the recommended turbulence penetration speed. Maintain constant pitch attitude and allow altitude to vary with the updrafts and downdrafts. Choose the best heading to get through the most tolerable part of the storm as quickly as possible. A squall line is a narrow line of thunderstorms that typically precedes a cold front. This line of storms is often too long to navigate around and too severe to navigate through. In these situations, turn around or land and wait for the squall line to pass.
    - The **"go/no-go decision"** requires judgment. Judgment comes from experience. Thus, a new pilot will need help developing judgment regarding when to fly vs. when to stay on

the ground. Some common factors to consider are ceiling, visibility, wind speed, and any changes in the current weather that may happen along the route over the course of the flight. With experience, a learning pilot will be able to better understand what conditions are acceptable for his current capabilities. Until the learning pilot is comfortable with making these go/no-go decisions, he should welcome the advice of his instructor and other mentor pilots.

- Purpose of and procedures used in **filing a flight plan**—not many pilots file VFR flight plans anymore. With the advent of widespread radar coverage allowing for VFR flight following, 406 MHz ELT's, and PLB's, the need for VFR flight plans certainly isn't what it once was. However, as a good backup, it is a good idea to file a VFR flight plan with flight service. This plan will be on record with flight service and flight service will initiate search and rescue **(SAR) for aircraft overdue by more than 30 minutes**. VRF flight plans can be filed, activated, and closed using ForeFlight. Alternatively, flight service can be used to file, open, and close VFR flight plans. In most situations, ForeFlight will be most convenient.

Task H: Night Operations

Objective

Learn the elements of night operations.

Content

- Factors related to **night vision**—the retina has light-sensitive cells known as **rods and cones**. Cones are concentrated at the fovea and are responsible for all color vision. Rods, on the other hand, are unable to detect color. However, they are very sensitive to light and enable vision in dim environments. Rods take time to adjust to low-light conditions. After about **5-10 minutes**, rods become about **100 times** more sensitive to the dim light. After **30 minutes**, rods become **100,000 times** more sensitive to the dim light. Because cones are concentrated at the fovea (the center of vision), seeing dim objects at night is best accomplished by off-centered viewing.
- Disorientation and night optical illusions
    - **False horizon**—the horizon generally cannot be seen at night. Thus, lighting on the ground is used to establish the horizon. Strange shapes in ground lighting, uneven cloud layers, or lights moving on the ground can cause disorientation.
    - **Autokinesis**—occurs when lights appear to move when stared at. This can be avoided by not focusing on a specific point of light, but rather using a scanning technique.
    - **Reversible perspective illusion—**aircraft on parallel courses may appear to be moving away from one another when in fact they are getting closer. Observing light intensity is one way to help determine true relative motion (lights get dimmer as they get farther away).
    - **Size-distance illusion—**lights increasing in brightness appear to get closer and vice versa.
    - **Fixation—**focusing on instruments, for example, during a night landing and not observing the closure rate with the ground.
    - **Flickering vertigo**—flickering lights can cause the pilot to become dizzy and disoriented. Proper scanning techniques can prevent flicker vertigo.

  - **Black-hole approaches**—approaches to a runway surrounded by either water or unlighted terrain. With only the runway lights, the pilot can easily become disoriented. **Bright runways—**create the illusion of less distance and tend to cause a higher-than-normal approach angle.
- Proper adjustment of interior lights—for rods to be as sensitive as possible, cockpit lights should be as dim as possible.
- Importance of having a flashlight with a red lens—the rods in the retina are least-sensitive to the wavelength of red light. Thus, using red light helps preserve night vision compared to white light or other colors of light.
- Night preflight inspection—the pilot should have multiple sources of back-up light available in the cockpit. Check their functionality prior to flight. For night flights, especially under VFR, weather planning is critical to avoid inadvertent IMC. Pay attention to the temperature/dewpoint spread for potential development of fog. Check all the NAV lights and landing light. Give the eyes at least 30 minutes to adjust to the dark environment. Check extra carefully for obstacles on the ground around the aircraft (wheel chocks, towbars, etc.).
- Engine starting procedures, including use of positions and anti-collision lights prior to start—visually and verbally clear the area around the aircraft before start. Turn on the beacon and NAV lights prior to start.
- Taxiing and orientation on an airport—use taxi diagrams and follow taxiway marking and lighting. Use taxi lights. Be aware of movement during runup because a rolling aircraft is more difficult to detect at night.
- **Takeoff and climb-out**—the pilot should more frequently monitor the instruments during a night departure. There are fewer ground references to help orient the pilot. Thus, attitude, airspeed, and vertical speed are all key parameters that the pilot should closely monitor. Note: black-hole departures (over water or unlighted terrain) are equivalent to an IMC departure and should be treated as thus.
- In-flight orientation—the largest risk of disorientation during night flying is from **inadvertent entry into IMC**. If ground lights become dim or have halos around them, it is likely that the aircraft is entering IMC. Also, flight over large bodies of water or unlighted terrain can be disorienting due to no lights to establish the horizon.
- Importance of verifying the airplane's attitude by reference to flight instruments—for the reasons listed above, competency in flying by instruments is required before flying at night.
- **Night emergency procedures**—an engine failure at night requires the same response as during the day except for a few details. First, choosing a landing location is more difficult. Lighted roads are good options. Otherwise, aim for unlighted terrain near a populated area. Unlight terrain means that buildings are unlikely to be encountered. Landing near a populated area will expedite the after-landing rescue. Keep the master switch on so that the landing light can be used for the landing. After landing, turn the master switch off.
- Traffic patterns—distance is more difficult to judge at night making flying a traffic pattern more difficult. The pilot should fly towards the airport's beacon until the runway lights are identified. From this point, the runway should be kept in sight while the pilot carefully monitors airspeed, altitude, and distance from the runway. Set a heading bug for the runway heading to help maintain proper orientation during the legs of the traffic pattern.

- Approaches and landings with and without landing lights—it is difficult to judge approach path angle at night. Because of this, a VASI or PAPI is extremely helpful to maintain the proper approach angle. Garmin's "visual approach" feature is also helpful during night approached. Fly the approach as normal. Note that judging height during the round out is more difficult at night. The tendency is to round out too high. A good rule of thumb is to start the round out when the landing lights clearly illuminate the tire marks on the runway surface. Without a landing light, use the runway edge lights to judge height above the runway.
- **Go-around**—at night, go-arounds are the same except the pilot must rely more heavily on the instruments to positively identify the attitude of the airplane.

Task I: High Altitude Operations

Objective

Learn the elements of high-altitude operations.

Content

- Regulatory **requirements for use of oxygen** (91.211)—if above a cabin pressure altitude of 12,500 ft. MSL and up to 14,000 ft. MSL for more than 30 minutes, the flight crew must use supplemental oxygen. Above 14,000 ft MSL, the crew must use oxygen at all times. Above 15,000 ft. MSL, all passengers must be provided supplemental oxygen.
- Physiological hazards associated with high-altitude operations—**hypoxic hypoxia** as discussed in the aeromedical factors.
- Characteristics of a pressurized airplane and various types of **supplemental oxygen systems**—pressurized aircraft have a sealed cabin that is pressurized by, in the case of a turbine, bleed air, or, in the case of a piston, the turbocharger. The cabin can be maintained at a cabin altitude that is lower than the pressure altitude outside the cabin. Because of this, supplemental oxygen is not required to be used. In a non-pressurized cabin, supplemental oxygen will have to be used at the altitudes discussed above. These systems come in various forms including the **diluter demand system, pressure demand system, and the continuous flow system**.
- Importance of "aviator's breathing oxygen."—this is a myth.
- Care and storage of high-pressure oxygen bottles—they should be chained up and the valve protected. The high-pressure can turn the bottle into a rocket if the valve is broken off.
- Problems associated with rapid **decompression** and corresponding solutions. Explosive decompression is defined as depressurization within ½ second. This is caused by structural failure of the pressure vessel or a door opening. This can cause damage to the lungs. Rapid decompression will not cause damage to the lungs because they can depressurize faster than the cabin. This type of depressurization can be caused by a failure in the pressurization system or by leaks in the pressure vessel. In either case, supplemental oxygen should be immediately donned. If at high enough altitudes, pilot incapacitation can happen in seconds.
- Fundamental concept of cabin pressurization—bleed air from the turbine or pressurized air from the turbocharger pressurizes the sealed cabin. A cabin outflow valve regulates the flow of the air out of the cabin helping regulate the cabin pressure.
- Operation of a cabin pressurization system—operation will vary depending on the aircraft, but essentially the pilot selects the desired cruising altitude in the pressurization control panel.

Depending on the cruising altitude and the maximum differential pressure of the system, this will correspond to a specific cabin altitude during cruise flight. The pressurization system will pressurize the cabin such that the rate of climb of the cabin is less than the actual rate of climb. This will rate will be indicated on the cabin rate of climb instrument. If the rate of climb of the cabin is kept reasonably low, passengers should experience minimal discomfort during the climb to cruise altitude.

Task J: 14 CFR and Publications

Objective

Learn the elements related to the Code of Federal Regulations and related publications (see marked up 2023 FAR/AIM for study notes.

Content

- Availability and method of revision of 14 CFR parts 1, 61, 91, and NTSB part 830 be describing:
  - Purpose.
  - General content.
- Availability of flight information publications, advisory circulars, practical test standards, pilot operating handbooks, and FAA-approved airplane flight manuals by describing:
  - Availability.
  - Purpose.
  - General content.

Task K: National Airspace System

Objective

Learn the elements of the national airspace system (NAS).

Content

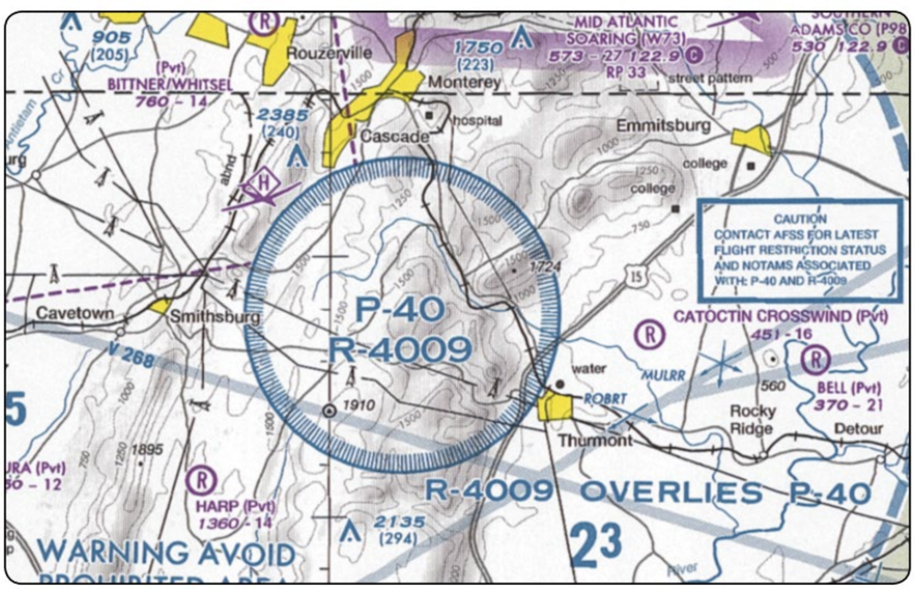
- **Basic VFR weather minimums** for all classes of airspace.

Air Space			Mnemonic
Class A			No VFR
Class B			3, CoC
Class C			3, 152's
Class D			3, 152's
Class E	less than 10,000 MSL		3, 152's
	at or above 10,000 MSL		5, 111
Class G	1,200 feet or less AGL	Day	1, CoC
		Night	3, 152's
	more than 1,200 AGL but less than 10,000 MSL	Day	1, 152's
		Night	3, 152's
	10,000 MSL		5, 111

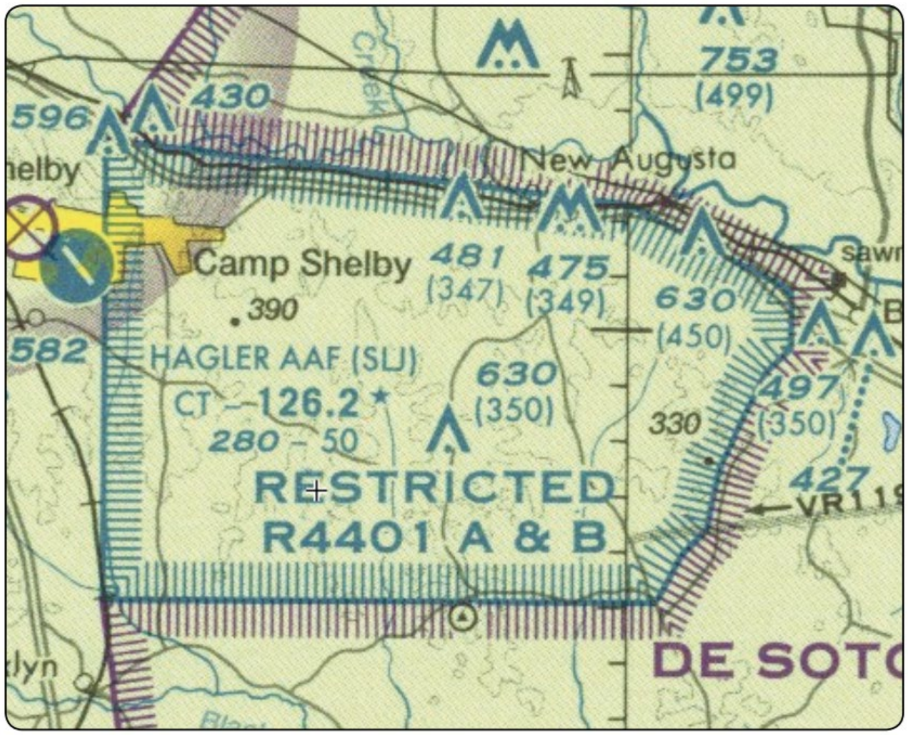
- Airspace classes—the operating rules, pilot certification, and airplane equipment requirements for the following:

Class Airspace	Entry Requirements	Equipment*	Minimum Pilot Certificate
Class A	ATC clearance	IFR equipped	Instrument rating
Class B	ATC clearance	Two-way radio, transponder with altitude reporting capability	Private—(However, a student or recreational pilot may operate at other than the primary airport if seeking private pilot certification and if regulatory requirements are met.)
Class C	Two-way radio communications prior to entry	Two-way radio, transponder with altitude reporting capability	No specific requirement
Class D	Two-way radio communications prior to entry	Two-way radio	No specific requirement
Class E	None for VFR	No specific requirement	No specific requirement
Class G	None	No specific requirement	No specific requirement
*Beginning January 1, 2020, ADS-B Out equipment may be required in accordance with 14 CFR part 91, section 91.225.			

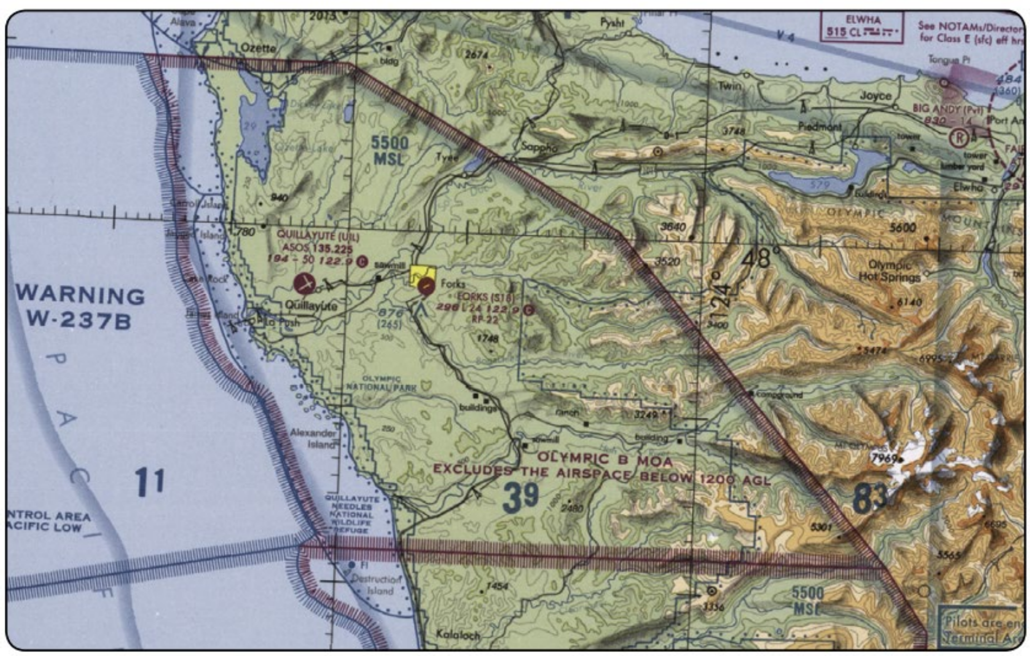
- **Special Use Airspace (MCPRAWN)**
  - **Prohibited areas**—flight in these areas is absolutely prohibited (i.e., Washington D.C. White House Area).



  - **Restricted areas**—flight in these areas is not entirely prohibited but is restricted. ATC can grant permission to fly through a restricted area.

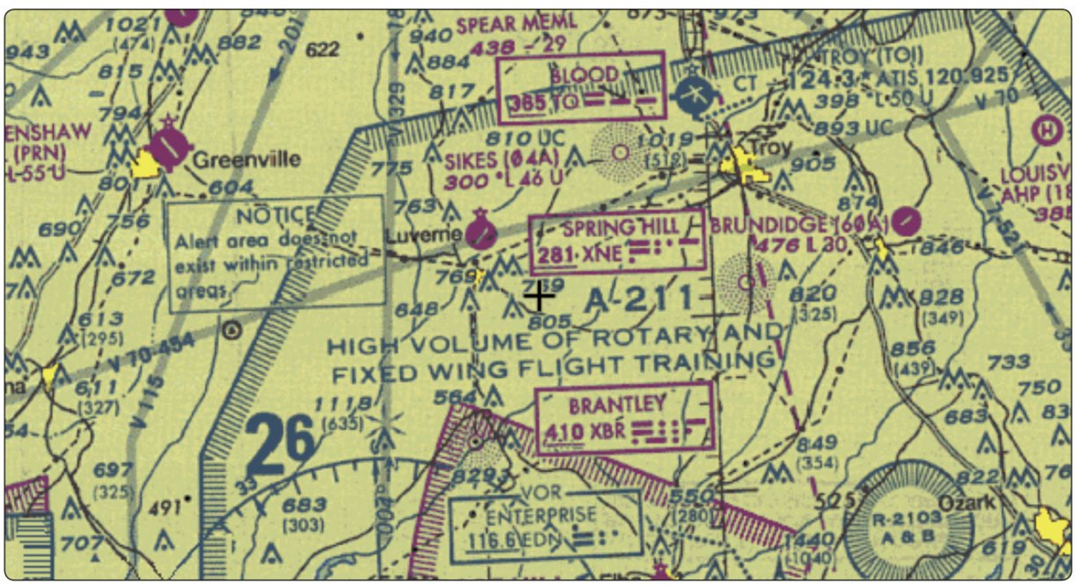


- **Warning areas**—extending from 3nm outward from the coast of the United States. Flight in these areas is allowed, but not advised unless talking with ATC.



- **Military operation areas (MOAs)**—designed to separate military training activity from IFR traffic. IFR traffic may be cleared through MOA's if separation can be provided. VFR can operate in MOA's without restriction.

- **Alert areas**—designed to alert pilots of areas containing a high volume of pilot training or other types of aerial activity. These areas are advisory and therefore do not restrict operations.



- **Controlled firing areas (CFAs)**—these areas are not charted. Spotters on the ground will stop the ground activity if an approaching aircraft presents a hazard.
- **National Security Areas**—flight over these areas is discouraged.

- **Temporary flight restrictions (TFR's)**—much more commonly used after 9/11. Commonly used for sporting events (to avoid unnecessary congestion), president, vice-president, public figures, space launches, disaster relief areas, etc.

Task L: Navigation Systems and Radar Services

Objective

Learn the elements related to navigation systems and radar service.

Content

- Ground-based navigational systems (VOR/VORTAC, NDB, and DME).
    - **VOR/VORTAC**—very high frequency omnidirectional range. VOR's are ground-based NAVAID's that transmit radials in all directions. These radials are referenced to magnetic north and allow specific radials either to or from the station to be intercepted and tracked using the navigation radio and CDI in the aircraft. Range is limited to line of sight. VOR's come in three varieties—terminal, low altitude, and high altitude.
    - **NDB—**simple ground-based NAVAID that interfaces with the ADF in the aircraft. The ADF needle simply points to the NDB. Thus, the pilot can home into the station by tuning in the NDB and tracking inbound using the ADF.
    - **DME—**some VOR stations are equipped with distance measuring equipment (DME). These are either VOR/DME or VORTAC. If the aircraft is equipped with DME, tuning the VOR station will allow the DME to calculate the slant-range distance to the station. Pulses are sent from the DME. Based on the time delay between the pulse and the response from the DME station, distance is calculated.
- Satellite-based navigation system— **Global positioning system (GPS)**—the United States has a constellation of 24 GPS satellites allowing at least 5 to be receivable by a user anywhere in the world at any time. These along with the ground-based augmentation systems are generically known as GNSS (global navigation satellite system). **GPS receivers need 4 satellites to compute latitude, longitude, and altitude. An additional satellite can be used to provide integrity monitoring (RAIM).**
- Radar service and procedures—VFR flight following, TRSA, class B, and class C airspace. **Primary radar** relies on radar reflections. **Secondary radar** interrogates the aircraft's transponder which generates a response. This makes smaller traffic more visible compared to primary radar.

Task M: Logbook Entries and Certificate Endorsements

Content

- Logbook entries and endorsements are one of the major responsibilities of the flight instructor. Knowledge of common entries as well as the ability to research more complicated entries is essential.
- Required **logbook entries for instruction given (61.51(h))**—The flight instructor must log a description of the training and the total time of the training along with his certificate number, certificate expiration date, and signature.
    - Details needed in logbook entry.
        - Instead of giving a description of the training, it is acceptable, maybe preferred, to simply reference the FAR's (i.e., "training per 61.87(d)(3)" instead of "training on normal and crosswind takeoffs and landings").
- **Student pilot endorsements** and logbook entries.
    - **TIM LOVES BCN**

            - **T**SA endorsement (AC 61-65H-**A.14**; 1552.3(h)).
                - Typically, either a U.S. passport or a birth certificate and driver's license.
                - Must be done prior to giving flight training.
            - **I**ACRA Application (to get student pilot certificate).
            - **M**edical
            - **BCN**—61.87(b,c,n). These are discussed below.
        - There are three basic **endorsements needed for a student pilot prior to solo**.
            - Pre-solo aeronautical knowledge endorsement (AC 61-65H-**A.3**; 61.87(b)).
                - Test must cover the applicable parts of part 61 and 91, airspace rules and procedures for the airport where the solo flight will take place, and the flight characteristics and operational limitations for the make and model of the aircraft to be used (see test example in CFI folder).
            - Pre-solo flight training endorsement (AC 61-65H-**A.4**; 61.87(c)).
                - Specific to the make and model and must be given by the instructor who did the training.
                - Specific training logged as specified in 61.87(d).
            - Solo flight endorsement (AC 61-65H-**A.6**; 61.87(n)).
                - Specific to the make and model and must be renewed by the flight instructor every 90 days.
        - There are two additional endorsements needed to authorize **solo cross-country** flights (for student pilots, this means flights to another airport or flying greater than 25 nm from departure airport). Note: make sure the initial 90-day solo endorsement is still current. If not, re-endorse for an additional 90 days.
            - Solo cross-country flight (training and proficiency - AC 61-65H-**A.9**; 61.93(c)(1) and 61.93(c)(2)).
                - From the flight instructor who did the training.
                - Specific training logged as specified in 61.93(e).
            - Solo cross-country flight (flight planning review AC 61-65H-**A.10**; 61.93(c)(3)).
- Initial pilot certification (i.e., first certificate)—can be a sport, recreational, or private pilot.
    - **Private pilot endorsements**.
        - Prerequisites for practical test endorsement (AC 61-65H-**A.1**; 61.39(a)(6)(i-ii)).
            - This is the endorsement for training within the 2 calendar months preceding the practical test.
        - Review of deficiencies endorsement (AC 61-65H-**A.2**; 61.39(a)(6)(iii)).
        - Aeronautical knowledge test endorsement (AC 61-65H-**A.32**; 61.35(a)(1), 61.103(d), 61.105)).
            - 61.105 lists all the required aeronautical knowledge areas.
        - Flight proficiency/practical test endorsement (AC 61-65H-**A.33**; 61.103(f), 61.107(b), 61.109).
            - 61.107(b) lists all the required areas of training.
            - 61.109 lists the required aeronautical experience.
- Additional pilot certification—pilot already has a certificate but is wanting to add a new certificate (i.e., private pilot wanting to become a commercial pilot).
    - **Commercial pilot endorsements**.

        - Prerequisites for practical test endorsement (AC 61-65H-**A.1**; 61.39(a)(6)(i-ii)).
            - This is the endorsement for training within the 2 calendar months preceding the practical test.
        - Review of deficiencies endorsement (AC 61-65H-**A.2**; 61.39(a)(6)(iii)).
        - Aeronautical knowledge test endorsement (AC 61-65H-**A.34**; 61.35(a)(1), 61.123(c), 61.125)).
            - 61.125 lists all the required areas of training.
        - Flight proficiency/practical test endorsement (AC 61-65H-**A.35**; 61.123(e), 61.127, 61.129).
            - 61.127(b) lists all the required areas of training.
            - 61.129 lists the required aeronautical experience.
- Additional aircraft qualification—pilot is wanting to **add a category or class** to an existing certificate (i.e., adding rotorcraft to airplane, or adding ASES to ASEL, or adding AMEL to ASEL).
    - 61.63(b) covers the requirements for adding an aircraft category.
    - 61.63(c) covers the requirements for adding an aircraft class.
        - As with any practical test, AC 61-65H-**A.1** is required (training logged in the 2 months prior to the practical test).
        - Adding either a category or class is covered by the AC 61-65H-**A.74** endorsement.
        - AC 61-65H-**A.72** will be required if solo flight is required for a category or class that the pilot does not have.
- Endorsement of a pilot logbook for a satisfactory **flight review**.
    - If the pilot satisfactorily completes the flight review, endorse per AC 61-65H-**A.65**.
    - The requirements of the flight review are specified in 61.56.
        - At least one hour of ground and one hour of flight.
        - Covers some of the areas in part 91.
        - Covers maneuvers that, according to the discretion of the CFI, are necessary to demonstrate safe exercise of the privileges of the certificate.
    - Log the training as normal.
        - If the flight review was not satisfactorily completed, only log the training—do not give the endorsement.
    - Reference the FAA document **"Conducting an Effective Flight Review"** found in the CFI folder.
- Required **flight instructor records** (61.189).
    - Keep a record of the name for solo endorsement, knowledge tests, and practical tests. Log the result of the knowledge and practical tests (pass of fail)
    - Retain these records for **3 years**.

Task N: Water and Seaplane Characteristics (N/A)

Task O: Seaplane Bases, Rules, and Aids to Marine Navigation (N/A)

Areas of Operation III: Preflight Preparation

Task A: Certificates and Documents

Lesson Objective

1. Learn the training requirements for the issuance of a recreational, private, and commercial pilot certificates (whichever is applicable).
2. Learn the privileges and limitations of pilot certificates and ratings at recreational, private, and commercial levels.
3. Learn about the class and duration of medical certificates.
4. Learn about the required recency of flight experience.
5. Learn about the required entries in pilot's logbook.

Completion Standards

1. Learner understands the training requirements and privileges and limitations of the certificate being sought.
2. Learner understands medical class required for the certificate being sought and knows how to determine how long the medical is valid for.
3. Learner understands recency of flight experience required to carry passengers and understands the logbook entries that are legally required.

CONTENT

General

- CFR Part 61 deals with the certification of airmen. It describes in detail the requirements for the issuance of certificates and ratings.
- When acting as pilot in command or as a required crew member, the following must be readily accessible **(61.3)**:
    - Pilot certificate.
    - Photo ID.
    - Medical certificate.

Training Requirements / Privileges and Limitations

- Recreational Pilot Requirements (61.96(b)).
    - Must be at least 17 years old (b)(1).
    - Must be able to read, speak, write, and understand English (b)(2).
    - Pass the knowledge test (endorsement is required to take the test) (b)(3,4).
    - Receive flight training and logbook endorsement to take practical test (b)(5).
    - Hold a student pilot or sport pilot certificate (b)(9).
    - Meet the aeronautical experience requirements (61.99) (b)(6).
- Recreational Pilot Privileges and Limitations (61.101).
    - No more than one passenger.
    - May not pay less than the pro rata share of the operating expenses of a flight with passengers, provided the expenses involve only fuel, oil, airport expenses, or rental fees.

- Must remain within 50 nm of departure airport and outside of class B, C, and D airports unless further training and endorsements are received.
- Day VFR at less than 10,000 ft.
- Single engine, 180 HP or less, fixed gear, with 4 four or fewer seats (see 61.101 for detailed list of all limitations).

- **Private Pilot Requirements (61.103).**
    - Must be at least 17 years old.
    - Must be able to read, speak, write, and understand English.
    - Pass the knowledge test (endorsement is required to take the test).
    - Receive the 61.107(b) flight training and logbook endorsement to take practical test.
    - Hold a student pilot, sport pilot, or recreational pilot certificate.
    - Meet the **aeronautical experience requirements (61.109)**. For ASEL, must have 40 hours of flight time with at least 20 hours being flight training, and at least 10 hours being solo.
        - 3 hours of cross-country flight training.
        - 3 hours of night flight training.
            - One cross-country flight of over 100nm total distance.
            - 10 takeoffs and 10 landings to a full stop.
        - 3 hours of instrument training.
        - 3 hours of flight training in preparation for the practical test within the preceding 2 calendar months from the month of the test.
        - 10 hours of solo flight time.
            - 5 hours of solo cross-country time.
            - One solo cross-country flight of 150 nm total distance, with full-stop landings at three points, and one segment of the flight consisting of a straight-line distance of more than 50 nm between the takeoff and landing locations.
            - Three takeoffs and three landings to a full stop at an airport with an operating control tower.
- Private Pilot Privileges and Limitations (61.113)
    - A private pilot may not pay less than the pro rata share of the operating expenses of a flight with passengers, provided the expenses involve only fuel, oil, airport expenditures, or rental fees.
    - May not act as PIC of an aircraft carrying passengers or property for compensation or hire.
- **Commercial Pilot Requirements (61.123).**
    - Must be at least 18 years old.
    - Must be able to read, speak, write, and understand English.
    - Pass the knowledge test (endorsement is required to take the test).
    - Receive flight training and logbook endorsement to take practical test.
    - Hold at least a private pilot certificate.
    - Meet the **aeronautical experience requirements (61.129)**. For ASEL, must have 250 hours of flight time as a pilot that consists of at least:
        - 100 hours in powered aircraft, of which 50 hours must be in airplanes.

        - 100 hours of PIC which includes 50 hours in airplanes and 50 hours of cross-country flight (of which at least 10 hours must be in airplanes).
        - 20 hours of training on the areas of operation listed in 61.127(b)(1) including:
            - 10 hours of instrument training.
            - 10 hours of training in a complex airplane, turbine airplane, or TAA (or any combination).
            - One 2-hour daytime cross country that consists of a total straight-line distance of more than 100 nm from the point of departure.
            - One 2-hour nighttime cross country that consists of a total straight-line distance of more than 100 nm from the point of departure.
            - 3 hours of flight training in preparation for the practical test within the preceding 2 calendar months from the month of the test.
        - 10 hours of solo flight time including:
            - One cross-country flight of not less than 300 nm total distance, with landings at a minimum of three points, one of which is a straight-line distance of at least 250 nm from the original departure point.
            - 5 hours in night VFR with 10 takeoffs and landings at an airport with an operating control tower.
- Commercial Pilot Privileges and Limitations (61.133)
    - Cross-country flights for hire at night or in excess of 50 nm or prohibited without an instrument rating.
    - May act as PIC of an aircraft carrying person or property for hire.
        - Be aware of limitations here. Just because you can operate the aircraft doesn't mean the operation you are operating the aircraft for is legal. Are you holding out a willingness to transport people or property from place to place for compensation or hire? If so, the operation is acting as a part 135 commercial service and would need to be certified as a part 135 operator. As a commercial pilot, you can work for a part 135 operation, but you cannot provide this service without the operation being properly certified.

Medical Certificates

- Different classes of medical certificates are required to exercise the privileges of different certificates. A higher-class medical certificate can be used as a substitute for operations requiring a lower-class medical. For example, a 1st class medical would be valid for 60 months for a person under 40 to satisfy 3rd class medical privileges (61.23).
    - *To exercise the privileges of an ATP certificate*, a **1st class medical** is required.
        - Under 40, expires in 12 calendar months.
        - 40 and over, expires in 6 calendar months.
    - *To exercise the privileges of a commercial certificate*, a **2nd class medical** is required.
        - Except when acting as a flight instructor (only 3rd class or basic med required).
        - Expires in 12 calendar months.
    - *To exercise privileges of private, recreational, or student pilot certificate*, a **3rd class medical** is required (unless operating under Basic Med).
        - Under 40, expires in 60 calendar months.

        - 40 and over, expires in 24 calendar months.
    - **Basic Med**—no more than 5 passengers, gross weight no more than 6,000 pounds, aircraft certified for no more than 6 occupants, 250 KIAS or less, below 18,000 ft, and no flight for compensation or hire. Need a valid driver's license, an exam every 48 calendar-months, and a training course every 24 calendar-months.

Required Flight Experience and Logbook Entries

- To carry passengers, a pilot in command must have completed three takeoffs and landings within the previous 90 days. These takeoffs and landings must be in the same category, class, and type (if type rating is required) (61.57).
    - If in a tailwheel aircraft, the landings must be made to a full stop.
    - To carry passengers at night (1 hours after sunset to 1 hour before sunrise), three takeoffs and landings to a full stop at night as defined above.
- To act as pilot in command of an aircraft, a person must have completed a flight review in the preceding 24 calendar months. Any practical tests leading to the issuance of a certificate or rating is a substitute for the flight review (61.56).
- Pilots are not required to log every flight—only the experience/training used to satisfy recent flight experience requirements and to meet the requirements for a certificate, rating, or flight review (61.51)

Common Errors

- Failure to be able to demonstrate that the training requirements for the rating being sought have been satisfied.
- Failure to understand recency of flight requirements.

Task B: Weather Information

Lesson Objective

1. Learn how to incorporate a pre-flight weather briefing into every flight.
2. Learn how to incorporate in-flight weather into decision making.
3. Learn about common weather hazards.
4. Learn about some of the factors used in "go/no-go" decisions.

Completion Standards

1. Learner consistently incorporates a pre-flight weather briefing for every flight.
2. Learner demonstrates proper use of in-flight weather into decision making.
3. Learner is aware of common weather hazards.
4. Learner shows developing judgment in evaluating factors for "go/no-go decisions."

Content

- Weather briefings should be performed before every flight. Foreflight is the most common tool for obtaining weather briefings. Calling a briefer at 1-800-WXBRIEF is still an option, but most will find the graphical weather presentation in Foreflight (or other EFB's) more helpful than listening to a briefer give a verbal description of the weather conditions.

- Both ADS-B and Sirius XM datalink weather have revolutionized in-flight decision making. Every pilot now has multiple affordable options to access cockpit weather consisting of NEXRAD radar, METARS, TAFS, AIRMETS, SIGMETS, PIREPS, Winds Aloft, and more. For cross-country flying, it would be a mistake not to have an iPad coupled with some type of datalink weather receiver such as the Sentry or the Stratus.
- Common weather hazards may vary according to the region. The primary weather concern in the Southeast is thunderstorms. The California coastal area has fog. The Midwest has strong winds. Because of our region, thunderstorms will be the focus. Often, individual or localized clusters of thunderstorm cells will develop. Remain in visual conditions and navigate around these cells. Stay at least 20 miles from the cells. Gust fronts from thunderstorms are particularly dangerous in the takeoff or landing phase. The wind shear from the gust front can cause a sudden loss of airspeed. At the lower speeds used for approach, this may cause a stall and subsequent loss of control. For this reason, do not takeoff or land in the face of an approaching storm. If a thunderstorm is inadvertently entered, set power for the recommended turbulence penetration speed. Maintain constant pitch attitude and allow altitude to vary with the updrafts and downdrafts. Choose the best heading to get through the most tolerable part of the storm as quickly as possible. A squall lines is a narrow line of thunderstorms that typically precedes a cold front. This line of storms is often too long to navigate around and too severe to navigate through. In these situations, turn around or land and wait for the squall line to pass.
- The “go/no-go decision” requires judgment. Judgment comes from experience. Thus, a new pilot will need help developing judgment regarding when to fly vs. when to stay on the ground. Some common factors to consider are ceiling, visibility, wind speed, and any changes in the current weather that may happen along the route over the course of the flight. With experience, a learning pilot will be able to better understand what conditions are acceptable for his current capabilities. Until the learning pilot is comfortable with making these go/no-go decisions, he should welcome the advice of his instructor and other mentor pilots.

Common Errors

- Failure to perform pre-flight weather briefing.
- Failure to utilize the in-flight weather resources afforded by datalink weather.
- Failure to understand the limitations a new pilot has when making go/no-go decisions.

Task C: Operation of Systems

Lesson Objective

1. Learn the fundamentals for the following aircraft systems.
    a. Primary and secondary flight controls.
    b. Trim.
    c. Powerplant and propeller.
    d. Landing gear.
    e. Fuel, oil, and hydraulic.
    f. Electrical.
    g. Avionics including autopilot.
    h. Pitot static, vacuum/pressure and associate instruments.
    i. Environmental.

    j. Deicing and anti-icing
2. Learn how to operate these systems.

Completion Standards

1. Learner understands the fundamentals and knows how to operate the aircraft systems.

Content

- Primary and secondary flight controls—The Cessna 182S employs conventional primary flight controls consisting of ailerons, elevator, and rudder. These surfaces are controlled via mechanical linkages (cables and pulleys). The yoke controls the ailerons and elevator, while the pedals control the rudder. The elevator employs a “down spring” that puts force on the elevator in the nose-down direction helping to expand the aft limit of the aircraft’s center-of-gravity. Down springs are a simple example of a stability augmentation system. How it works is fascinating. More can be learned here. The secondary flight controls comprise the trim and the flaps. Trim systems reduce pilot workload by adjusting the aerodynamic forces on the control surfaces. The Cessna 182S has an elevator trim tab controlled by a trim wheel. Rudder trim in the C182S is accomplished via a bungee connected to the rudder control system and is also controlled by a trim wheel. Flaps are used to achieve a higher coefficient of lift allowing for slower takeoff and landing speeds. In addition, flaps allow for steeper approach angles because of the additional drag created. For more information on airplane flight controls, check out Chapter 6 of the FAA *Pilot’s Handbook of Aeronautical Knowledge.*
- Powerplant and propeller—The Cessna 182S is equipped with the Lycoming IO-540-AB1A5. This is a 6 cylinder, horizontally opposed, 540 cubic inch engine that produces 230 brake horsepower at its maximum speed of 2,400 RPM. Attached to the engine is a 3-bladed McCauley constant speed propeller. Read this article for a great explanation of how constant-speed propellers operate.
- Landing gear**—**The C182S is equipped with tricycle landing gear. Tubular spring steel provides shock absorption for the main gear while an air/oil strut provides shock absorption for the nose gear. The nose gear is steerable and is controlled by the rudder pedals through a spring-loaded bungee connection. Nosewheel steering allows for turns up to 11 degrees. Use of differential braking can tighten the turn radius by allowing rotation up to 29 degrees left and right of center. Braking is accomplished through disk brakes attached to each main wheel.
- Fuel, oil, and hydraulic—The fuel for the Cessna 182S comes from two vented fuel tanks—one tank in each wing. Because of the high-wing design, gravity supplies fuel through the fuel selector, through a fuel strainer, through the auxiliary pump, and then to the engine-driven fuel pump. The auxiliary pump is used to prime the engine for start and for emergencies. The engine-driven pump supplies the fuel/air control unit with fuel during normal operation. This control unit meters the fuel in proportion to the induction air. This metered fuel then goes through a flow divider that delivers the fuel to each cylinder’s fuel injector.
  The Cessna 182S uses a wet-sump type oil system with a capacity of 9 quarts. Oil is pulled from the oil pan through an oil screen and then into the engine-driven oil pump. After the oil pump, the oil goes through the filter and then through the oil cooler (unless the thermostatic valve is closed). Next, the oil goes to both the propeller governor and to the oil galleries where the

engine components are lubricated. Gravity causes this oil to drain back into the sump after completing its course through the oil galleries. The cycle continues.
Hydraulics are employed in two primary systems—the propeller and the brakes. Oil is used by the propeller governor to actuate a hydraulic piston in the prop dome which in turns causes a change in pitch of the propellers. More details can be found here. The second hydraulic system on the C182S is the brakes. These disc brakes found on the main gear are actuated by a hydraulic piston controlled by the top portion of the rudder pedals.

- Electrical—The electrical system on the Cessna 182S is a 28-volt DC system with a 24-volt battery. A standard 182S comes with a 60-amp alternator, but N882SP has been upgraded to a 95-amp alternator required by the aftermarket electric Kelly Air Conditioner that was installed in 2016. The electrical system consists of two primary electrical bus bars, an essential/crossfeed bus, and two avionics bus bars. The two primary bus bars are connected to power via the master switch. These bus bars power most of the general electrical circuits. Between the two primary bus bars is the essential bus that gets its power from both or either of the primary bus bars. In the event of a failure of either primary bus, the other remaining bus will power the essential bus and, therefore, its associated components. In the 182S, these essential circuits are the annunciators, instrument/interior lights, and the alternator. The primary bus 1 and bus 2 discussed above are connected to avionics bus 1 and avionics bus 2 respectively via the avionics master switch. Failure of either primary bus 1 or 2 will cause a failure of its respective avionics bus.
- Avionics including autopilot— N882SP in equipped with a mixture of old and new avionics. The factor GPS has been replaced with the Garmin GTN 650. Garmin makes a GTN 650 simulator that can be loaded onto an iPad. Practicing on this simulator is a great way to learn the layout of the GTN 650. In addition to being a GPS, the GTN 650 also serves as COM-1 and NAV-1. An original King KX-155A serves as the COM-2 and NAV-2. The original transponder has been replaced by a GTX 345 with ADS B In/Out plus Bluetooth. Other added equipment include a storm scope and a JPI 930 engine monitor. The engine monitor is especially useful because it allows for the careful monitoring of the CHT's and EGT's on all six cylinders in addition to a host of other useful data. N882SP is equipped with the KAP-140 factory autopilot. This is rate-based, 2-axis autopilot with altitude preselect. Roll rate is supplied to the autopilot by the turn coordinator. Pitch information is derived from a pressure sensor and an accelerometer. It is important to note that this autopilot does not use the attitude indicator. Thus, the autopilot will continue to function normally in the event of a vacuum failure. The Aspen EFD has increased the capability of this autopilot by allowing for GPS steering (GPSS). To engage this mode, the autopilot must be in HDG mode with GPSS selected on the Aspen display. In this mode, the autopilot will follow whatever course is programmed into the GPS.
- Pitot static, vacuum/pressure and associated instruments—N882SP has a combination of original and retrofit flight instruments. First, the original instruments will be discussed. The pitot-static system instruments are the airspeed indicator, altimeter, and vertical speed indicator. A standard 182S has two vacuum instruments—the attitude indicator and the directional indicator. The turn coordinator is powered by the electrical system. N882SP has had one big upgrade—the Aspen EFD 1000. The Aspen uses an air data, attitude, and heading reference system (ADAHRS) to calculate and a screen to display the same information as the standard pitot-static and gyro instruments. The only original flight instrument that has been

removed is the heading indicator. All the other original flight instruments remain in N882SP and serve as backups to the Aspen EFD 1000.

- Environmental—Ventilating air is supplied to the cabin by ram air from either an air door located on the right side of the airplane's nose or from the vents located on the inboard leading edge of the left and right wing. The air door controlled by the CABIN AIR knob supplies ventilating air to the cabin floor outlets and the defroster. Warm air from the exhaust shroud controlled by the CABIN HT knob can be mixed with this air to obtain the desired temperature. The wing vents supply ventilating air to the forward cabin upper and lower outlets. N882SP has been retrofitted with a Kelly Aerospace electric air conditioning system. This air is supplied to the cabin by two forward and two rearward overhead adjustable vents.
- Deicing and anti-icing—The C182S is not certified for flight into known icing. However, there are a few systems to help if ice is inadvertently encountered. The pitot tube and the stall warning horn are both heated and are controlled by the pitot heat switch. Ice on the windscreen can be combatted by redirecting warm air to the windscreen by turning the defroster knob clockwise. Finally, alternate induction air is available if the primary induction filter becomes blocked by ice. This spring-loaded air door is automatically opened by the suction created during an intake blockage.

Common Errors

- Failure to understand how the systems work which in turn causes a deficiency in ability to troubleshoot system failures.

Task D: Performance and Limitations

Lesson Objective

1. Learn how to perform weight and balance.
2. Learn how to use performance charts for takeoff, climb, cruise, and landing.
3. Learn effects of exceeding aircraft limitations.
4. Learn effects of atmospheric conditions on aircraft performance.
5. Learn how to determine if performance required is within the aircraft's capabilities.

Completion Standards

1. Learner understands the limitations of the aircraft and knows how to determine if the performance required exceeds these limitations.
2. Learner understands the perils of operating the aircraft in a manner that exceeds the limitations.

Content

- Weight and balance—These calculations always begin with knowing the empty weight and empty center of gravity (CG) of the airplane. Even for the same model of aircraft, the weight and CG of the empty airplane varies. The CG can be thought of as the balance point of the aircraft. The location of the CG is measured from an arbitrary reference point called the datum. The location of the datum for a particular aircraft is usually chosen as a convenient point from which distances can be measured (such as the firewall). As passengers, cargo, fuel, etc. are added to the empty weight, the pilot must ensure that the total weight of the aircraft does not exceed the limitations and that the location of the CG is within the airplane's fore and aft limits. Remember, you must know the location of the CG and the empty weight *for your specific aircraft* before being able to perform a weight and balance calculation. Calculating the weight and balance for a particular loading scenario is best accomplished using an electronic flight bag (EFB) such as Foreflight. Tools like Foreflight allow you to quickly calculate the weight and balance once the profile for the particular aircraft has been created. This makes it easy to do a weight and balance before every single flight and gives graphical details on how the weight and CG changes as fuel is being burned during the flight. Examples in the POH will show you how to do these calculations by hand. Doing some examples by hand will be helpful in understanding weight and balance. Chapter 10 of the PHAK is a great resource for more details.

  - Weight Limitations—Virtually every aspect of performance is decreased as weight increases. Ground roll, rate of climb, stalling speed, landing speed, etc. are all adversely affected by increased weight. Exceeding the maximum certified gross weight takes the airplane into a regime of flight that it has not been certified to operate in. Takeoff distances, landing distances, and stall speed are unknown.
  - CG Limitations—The location of the CG is a major factor in pitch stability and controllability. Pitch stability results from the tail being at a lower angle of attack than the wing (it is a myth that the tail must create negative lift for the airplane to be stable—the CG does not have to be forward of the center of lift). This difference in angle of attack between the wing and the tail is known as *decalage*. As the CG moves aft, the tail has to operate at a higher angle of attack in order to balance the torques. Eventually, the tail will be at the same angle of attack as the wing. Because there is no more decalage, the pitch stability will be disappear making the aircraft difficult to control. As CG moves forward, the airplane becomes more stable in pitch. With a CG too far forward, the tail will not have enough authority to command the proper pitch attitude for landing. The CG limitations of the airplane are designed such that the aft CG limit still provided acceptable aircraft stability while the forward CG limit provides adequate pitch authority for high angle of attack operations such as during the landing flare. Exceeding the fore or aft CG limits can lead to unrecoverable loss of control.

- Performance—Section 5 of the pilots operating handbook (POH) is dedicated to airplane performance. This section of the POH is laid out in a logical order—takeoff distance, climb performance, cruise performance, and then landing distance. Takeoff and landing performance usually gets most of the attention during flight planning, but cruise performance becomes more important for longer trips where fuel calculations are crucial to planning appropriate fuel stops. Again, an EFB such as Foreflight does all these calculations with ease, but it's important to work through some examples from the POH to get an understanding of the important factors behind such calculations. Of particular importance is understanding how headwinds and tailwinds affect takeoff and landing performance. For example, the POH for the C182S recommends decreasing calculated takeoff distance by 10% for each 9 knots of headwind. Conversely, it suggests increasing the takeoff distance by 10% for each 2 knots of tailwind. From these figures, it becomes clear how detrimental a tailwind is to takeoff performance. Doing several calculations under different conditions will be important to get a feel for how the different factors such as temperate, weight, wind, surface type, runway slope, etc. have on airplane performance.

- <u>Limitations</u>— Always be sure that the performance required is within the capabilities of the airplane for the actual conditions of the day. Remember, performance numbers in the POH may be optimistic because of brand new airplanes flown by skilled test pilots. It is possible that the actual performance may be lower than the performance advertised in the POH. For this reason, it is generally wise to build in a safety margin into the performance calculations. For example, if the POH shows that the airplane will require a 1,500-foot ground roll, it would be unwise to takeoff from a 1,200-foot runway. Consider using a 50% margin for the required takeoff and landing distances. If the performance chart shows 1,500 ft, multiply by 1.5 and make sure you've got at least 2,250 feet available for takeoff. Not following the POH and not including safety margins in calculations can lead to not clearing takeoff obstacles, fuel exhaustion in flight, or going off the end of a runway during landing. Always know the performance required for a given mission and make sure this required performance is within the capabilities of the airplane and the pilot.
- <u>Atmospheric Considerations</u>—Airplane performance is heavily affected by atmospheric conditions. An airplane's engine and propeller create the most thrust when the air is most dense. What are the primary factors in determining air density? The answer is pressure and temperate. Therefore, pressure altitude and temperature are major factors in all the performance charts. In fact, pressure altitude corrected for non-standard temperature has its own name—density altitude! Density altitude is one of the most important figures when determining how an airplane will perform. On high density altitude days, double check the performance calculations. The performance might be worse than imagined.

Common Errors

- Failure to perform a weight and balance calculation before every flight.
- Failure to understand the importance of CG location.
- Failure to build margins into performance calculations.
- Failure to understand how severely atmospheric conditions can change aircraft performance.

Task E: Airworthiness Requirements

Lesson Objective

1. Learn required instruments and equipment for day/night VFR.
2. Learn how to determine airworthiness with inoperative instruments and equipment.
3. Learn required maintenance/inspections for continued airworthiness.
4. Learn about special flight permits.

Completion Standards

1. Learner understands how to determine what instruments and equipment are required for flight.
2. Learner understands how to systematically address airworthiness concerns for inoperative instruments and equipment.
3. Learner understands what types of maintenance and inspections are required to maintain airworthiness.

4. Learner understands how special flight permits may be used for airplanes that are not in airworthy condition.

Content

- Airworthiness Certificate—After being manufactured, an aircraft's airworthiness certificate is issued once it passes inspection from the FAA. This airworthiness certificate remains valid as long as the aircraft meets its approved type designed, is in condition for safe operation, and has been maintained according to the regulations. The bullet points below go over some of the requirements for an airplane to remain airworthy.
- Required Instruments and Equipment (91.205)—For day VFR, the following instruments and equipment are required: airspeed indicator, altimeter, magnetic direction indicator, tachometer, oil pressure gauge, oil temperature gauge for air-cooled engine, coolant temperature gauge for liquid-cooled engine, manifold pressure gauge for altitude engine (turbocharged or supercharged), fuel gauge, landing gear position indicator, anticollision lights if aircraft was certified after March 11, 1996, flotation gear for each occupant and a pyrotechnic signaling device if operated for hire away from gliding distance to shore, seats belts for each occupant 2 years or older, shoulder harnesses for front seats of airplanes manufactured after July 18, 1978 (all seats if after December 12, 1986), and an ELT. For night VFR, all the above instruments are required in addition to the following**:** position lights, anticollision light system, landing light (if operated for hire), adequate source of energy for all installed electrical and radio equipment, and spare fuses accessible in flight (unless aircraft uses circuit breakers that can be reset).
- Inoperative Instruments and Equipment (91.213)—If an aircraft has a minimum equipment list (MEL), refer to this list to determine airworthiness with inoperative instruments and/or equipment. The MEL lists the instruments and equipment that may be inoperative while still maintaining airworthiness. If it is determined that the failed instrument and/or equipment is not required, an entry describing the inoperable instrument and/or equipment must be made into the aircraft's records. MEL's are typically available for larger aircraft used in part 121 and part 135 operations. For airplanes that don't have an MEL, the task of determining airworthiness is more complicated. In these situations, the job is best accomplished by following the flow chart from AC 91-67 shown in the image below. An inoperative instrument not required for flight must be removed or deactivated and placarded as inoperative before flying the aircraft.

AC 91-67 6/28/91

During the preflight inspection, the pilot recognizes inoperative instruments or equipment.		
↓		
Is the equipment required by the aircraft's equipment list or the kinds of equipment list? (FAR § 91.213(d)(2)(ii).)	→	If **YES**, the aircraft is unairworthy and maintenance is required.
↓		
If **NO**, is the equipment required by the VFR-day type certificate requirements prescribed in the airworthiness certification regulations? (FAR § 91.213(d)(2)(ii).) See appendix 1 of this AC.	→	If **YES**, the aircraft is unairworthy and maintenance is required.
↓		
If **NO**, is the equipment required by AD? (FAR § 91.213(d)(2)(iv).)	→	If **YES**, the aircraft is unairworthy and maintenance is required.
↓		
If **NO**, is the equipment required by FAR §§ 91.205, 91.207, etc.? (FAR § 91.213(d)(2)(iii).)	→	If **YES**, the aircraft is unairworthy and maintenance is required.
↓		
If **NO**, the inoperative equipment must be removed from the aircraft (FAR § 91.213(d)(3)(i)) or deactivated (FAR § 91.213(d)(3)(ii)) and placarded as inoperative.		
↓ ↓ ↓ ↓ ↓		
At this point the pilot shall make a final determination to confirm that the inoperative instrument/equipment does not constitute a hazard under the anticipated operational conditions before release for departure.		

Figure 2. Pilot Decision Sequence When Operating Without An MEL

- Annual Inspection—Piston engine or single-engine turboprop/jet aircraft weighing 12,500 pounds or less are required to undergo an annual inspection every 12 calendar months.
    - If an aircraft is overdue for its annual inspection, a special flight permit (ferry permit) will be required in order to fly the plane to the maintenance shop. All AD's must be complied with before the flight. Special flight permits are issued by the FSDO having jurisdiction over the area from which the flight will originate.
- 100-Hour Inspection—If the airplane is used to carry passengers for hire or for flight instruction for hire, it must undergo a 100-hour inspection. This rule applies to all aircraft under 12,500

pounds except for multi-engine turboprops and jets.The 100-hour limit cannot be exceeded by more than ten hours. Any time in excess of 100 hours does not extend the time requirement for the following 100-hour inspection.

- Altimeter Inspection (91.411)—The altimeter system must be inspected within the preceding 24 months if the aircraft is to be used in controlled airspace under instrument flight rules (IFR).
- Transponder Inspection (91.413)—Before a transponder can be used, it must have been tested within the preceding 24 calendar months.
- Emergency Locator Transmitter (ELT) Inspection (91.207)—ELT's are required equipment for flight and must be inspected within 12 calendar months from the last inspection. ELT batteries must be replaced or recharged if:
  - Transmitter has been in use for more than 1 cumulative hour.
  - 50% of useful life or 50% of charge has been used.
- Airworthiness Directives (AD's) —AD's are issued by the FAA to correct certain deficiencies that may have been found in specific types of aircraft. Some AD's are emergency AD's that must be addressed before further flight while others only require compliance within a specific time frame. Some AD's are one-time while others are recurring meaning periodic inspections/replacements are required. To remain airworthy, all AD's for the aircraft must be complied with.

Common Errors

- Incomplete understanding of how to determine required instruments for aircraft not having an MEL.

Areas of Operation IV: Preflight Lesson on a Maneuver to be Performed in Flight

Task A: Maneuver Lesson

Areas of Operation V: Preflight Procedures

Task A: Preflight Inspection

Lesson Objective

Learn the procedures used to determine if the aircraft is both safe and legal to fly.

Completion Standards

1. Learner maintains awareness of the "big picture."
2. Learner checks for required documents (AROW).
3. Learner follows a logical flow as the cabin, empennage, right wing, nose, and left wing are inspected before flight to verify the aircraft conforms to its type design.
4. Learner backs up preflight inspection with a written checklist.
5. Learner performs a final walk around.
6. Learner exercises risk management by using the PAVE and IMSAFE checklists.

Content

- The preflight begins as you approach the aircraft. Make sure to take in the "big picture."
- When the master switch is turned on, notice which instruments work and which don't. The electrical system is on, but the engine is not running. This is your chance to observe failure modes. The vacuum-driven gyro instruments will not work and should be flagged. There should be a vacuum failure annunciation. There will be no oil pressure so you should also get an oil pressure annunciation as well. The turn coordinator in most aircraft is powered by the electrical system. It should function normally. The ammeter should indicate a discharge and the voltage annunciator should be on.
- Remember to cross check the fuel gauges against the fuel totalizer (if equipped).
- Check for smoking rivets.
- Check the fuel tank with a stick and confirm it matches fuel gauges and totalizer.
- Exercise propeller safety in the vicinity of the nose.
- Follow up with a written checklist and complete any missed steps.
- Understand how to deal with inoperative components found during the preflight.
- An extremely important part of the preflight inspection is the final walk around. On the final walk around, you will check that tie downs/chock have been removed, pitot cover is off, baggage door is shut, trim tab is in normal takeoff position, fuel caps are secured, tow bar is removed, and cowl plugs are removed. These items checked during the final walk around are the items most often overlooked during a preflight.
- Wrap the preflight up with an overall assessment using the PAVE and IMSAFE checklist.

Common Errors

- Failure to back up inspection flows with a written checklist.
- Failure to perform the final walk around.
- Failure to understand inoperative equipment.
- Failure to use the PAVE and IMSAFE checklists to help manage risks.

Task B: Cockpit Management

Lesson Objective

Learn strategies to help organize the cockpit for flight.

Completion Standards

1. Learner integrates cockpit management skills into their routine.

Content

- Common tools used for flight are pen and paper, iPad, checklists, and sometimes paper charts.
- Kneeboards or clipboards are needed to help secure and organize these items while at the same time keeping them readily available for use.
- Always have extra pens—you can clip them to your shoulder harness.
- iPads and iPhones have become almost essential in the cockpit. Have battery banks and/or chargers onboard for these devices.
- Most planes have adjustable seats. Know how to get the seat into the same position for each flight and make sure the seat is locked. Make sure the rudder pedals are in easy reach and understand the two feet positions (one for taxi, one for takeoff and flight).
- Many throttles have friction adjustments. Know how this works.
- Passenger briefings are important and required. Get in a routine of briefing your passengers on how to operate the seatbelts and how to egress in the event of an emergency.

Common Errors

- Failure to have essential flight tools organized and readily available.
- Failure to provide passenger briefings.

Task C: Engine Starting

Objective

Learn the normal start procedure for your aircraft. Understand the systems related to the start to help troubleshoot difficult starts.

Completion Standards

1. Learner understands limitations to related to engine starting.
2. Learner can execute normal starts.
3. Learner understands common problems encountered during engine start.

Content

- Aircraft positioning for start.
- It's important to understand how to start the engine. Do not blindly follow the checklist.
- Execute flow check to ensure aircraft is configured for start. Back this up with a checklist.
- Propeller safety—always yell "clear prop!" Do not let the airplane roll during the start.
- Do not let the engine rev up excessively immediately after the start.
- Check oil pressure and positive charge on the battery after startup.
- Understand different techniques for cold and hot starts.

- Understand starter limitations.
- Checklist usage during and after the start.

Common Errors

- Failure to clear the area before start.
- Failure to set proper power immediately after startup.

Task D: Taxiing—Landplane

Objective

Learn the aeronautical fundamentals of taxiing the airplane and understand the importance of pre-taxi briefs. Learn about the turning instruments that need to be checked during the taxi.

Completion Standards

1. Learner consistently performs pre-taxi briefings.
2. Learning does not get distracted during taxi and maintains centerline.
3. Learner demonstrates positive aircraft control without excessive brake use.
4. Learner checks gyroscopic instruments during the turns incidental to the taxi.

Content

- Always brief the taxi. Identify where you are at, where you are going, and how you are getting there. Know how to use airport diagrams on ForeFlight. Know how to identify Hot Spots.
- Brake check must be done after the initial roll.
- Focus on taxiing. Keep your eyes outside and do not get distracted with cockpit tasks that can be done before or after taxi. Centerline discipline is important.
- Positioning the controls for the wind. If winds are calm, full after elevator.
- Keep your feet in a position where you can reach the toe brakes. Do not ride the brakes. Only use as necessary.
- Taxi at the pace of a brisk walk.
- During the turns incidental to the taxi, check for proper function of the turning instruments. Turn coordinate should show a turn in the direction of the turn with the ball to the outside of the turn. Heading indicator and compass should increase for right turns and decrease for left turns. Attitude indicator should stay stable during turns (indicated banks of more than 5 degrees should be cause for concern).
- Understand taxiway markings.

Common Errors

- Riding the brakes.
- Becoming distracted during the taxi.
- Failure to position the controls for the wind.
- Failure to check the gyroscopic instruments during the turn.

Task E: N/A – Seaplanes

Task F: N/A – Seaplanes

Task G: Before Takeoff Check

Objective

Learn the procedures that make up the Before Takeoff Check. Understand the reasoning behind these procedures.

Completion Standards

1. Learner completes the Before Takeoff Check using the CIGARS acronym and then backs this up with a written checklist.

Content

- **CIGARS** is a great acronym to add redundancy to the Before Takeoff Check. Perform a flow using this acronym and then back it up with a written checklist.
    - **C**ontrols (box the controls. Check that they are free and correct).
        - Flaps are a control. Set flaps appropriately here.
    - **I**nstruments (check and set the standard flight instruments).
    - **G**as (fuel tank selection, quantity, fuel totalizer, fuel pumps, etc.).
    - **A**utopilot (verify heading modes work, that it can be overpowered, and that A/P disconnect works), **A**nnunciators (test that annunciator lights work and then see if any are indicating), **A**ll trims (verify trim is set for takeoff).
    - **R**adios (frequencies are set, GPS is set, transponder code is set), **R**unup.
    - **S**eatbelts, **S**ecurity (doors and windows locked), and **S**witches (lights).
- Follow up CIGARS with a written checklist.
- Be aware of your surroundings when performing the runup.
- Position the aircraft appropriately considering surroundings and wind.
- Be aware of your surroundings.
- If your aircraft has an engine analyzer, check that all cylinder's EGT rises on a single magneto.

Common Errors

- Failure to check the flaps during the "C" for controls.
- Failure to be aware of surroundings during the runup.
- Failure to backup CIGARS with a written checklist.

Areas of Operation VI: Airport and Seaplane Base Operations

Task A: Radio Communications and ATC Light Signals

Objective

1. Learn the elements of radio communications and ATC light signals.
    a. Selection of radio frequencies.
    b. Phraseology for common radio communications.
    c. ATC readbacks.
    d. Interpretation and compliance with ATC light signals.

Completion Standards

1. Learner demonstrates radio proficiency by knowing how to select and tune radio frequencies.
2. Learner demonstrates use of standard radio phraseology and proper readback of ATC instructions.
3. Learner understands how ATC light signals are to be used in the event of a radio failure when landing at a towered airport.

Content

- Radio frequencies can be found in a variety of ways. One common way to find a radio frequency is to look on the VFR sectional chart. Here, tower frequencies, CTAF frequencies, and ATIS/AWOS/ASOS frequencies are shown underneath the airport name. The chart supplement provides more details if needed. In the chart supplement, you will find additional frequencies (approach and departure control, for example). In most cases, though, frequencies are most conveniently found using the airport information section in ForeFlight. Here, all the frequencies are conveniently listed and labeled in a way that is more useful than both the VFR chart and the chart supplement. Tuning radios is as simple as twisting knobs, but if using a radio with standby frequency capabilities, make sure the desired frequency is the active frequency.
- ATC and pilots use standardized phraseology that, to the learning pilot, may sound intimidating. Fear not: there are only a few types of radio communication that the VFR pilot needs to master. Chapter 4, section 2 of the AIM provides some helpful examples and will make it easier to understand the phraseology for the operations listed below.
    - Non-towered airport communications—Most of the airports in the United States are non-towered. At these airports, it is up to the pilots to coordinate with each other via the radio to ensure an orderly flow of traffic to and from the airport. The basic concept is for the pilot to self-announce his position at key positions in the airport environment. The pilot will announce his position on the ground when taxiing, his position in the air when approaching the airport, and his position throughout the traffic pattern. Based on these announcements, other pilots can adjust their position and work out sequencing with other pilots to ensure smooth operations at the airport. Advisory circular 90-66B is a helpful reference for non-towered airport communications.
    - Towered airport communications—Before entering an airport's controlled airspace (class B, C, or D), a pilot must do some work. For class D, all that is required is radio contact with the tower. Radio contact, by definition, is established once the tower controller responds using your aircraft's call sign. You do not need a specific clearance.

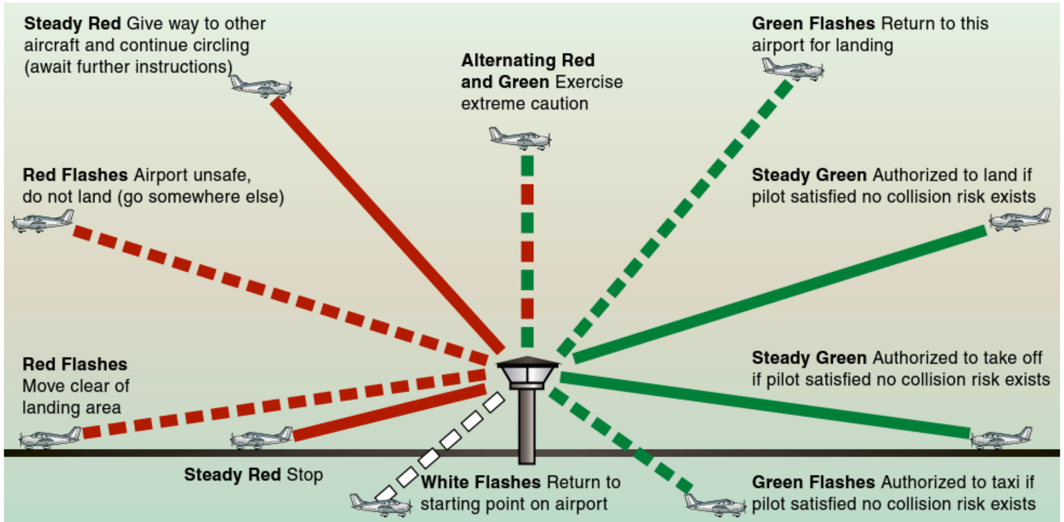
For class C, the same procedure applies but you will be talking with the class C approach controller rather than the tower. Class B, however, is different. To enter class B airspace, the approach controller must give you an explicit clearance to enter the class B airspace. Whether in Class B, C, or D, the tower will eventually give some instructions on how to approach the airport followed by a clearance to land. Once landed, this will be followed by a taxi clearance. When departing a towered airport, communication typically starts with the ground controller who will issue taxi instruction. Next, tower will issue the takeoff clearance. Once clear of the airspace, you are free to resume unhampered VFR flight.

- VFR flight following—VFR flight following is an extremely valuable tool that should be used on most, if not all, cross country flights. VFR flight following allows the VFR pilot to get many of the same services that an IFR pilot would get. Weather advisories, traffic advisories, and emergency services are the primary benefits of using VFR flight following. Additionally, flight following is a convenient way to establish communication with ATC and be seamlessly handed off to different controllers throughout flight making the terminal phase of flight less busy. Class B and class C airports have their own approach controllers. As you near your destination in one of these types of airports, you will be handed off to the appropriate approach controller that, in the case of class B airspace, will be responsible for issuing (or not) your clearance into the class B airspace. For class C, communication with the approach controller is, in itself, permission to enter the class C airspace. Eventually, you will be handed over to tower for the landing clearance, but you don’t have to talk to the tower to get the initial clearance into the airspace. Class D has a tricky detail. Class D airspace does not have its own approach control. Because of this, you are responsible for establishing communication with the class D tower before entering the airspace even if you are using flight following. That being said, it is common practice for the approach controller to hand you off to the tower before entering their airspace so you can make contact in order to enter the airspace. However, if the approach controller does not hand you off early enough for you to establish contact with the tower, then you will have to stay out of the class D until you can cancel flight following and establish contact with the tower controller.
- Flight service—Flight service is not as popular as it once was, but it still exists and is one of the tools a pilot should know how to use. Flight service stations can provide pilot briefings, process flight plans, give enroute weather advisories, and relay ATC clearances. Most pilots simply use a tool such as ForeFlight to get weather briefing, file flight plans, and obtain in-flight weather. For that reason, you may never find yourself needing the services provided by flight service stations. Contacting flight service can be confusing. The universal flight service frequency is 122.2, but this frequency may not have good reception depending on your altitude. The more common approach is to contact flight service station on a local frequency shown at the top of some VOR boxes on VFR charts. The frequency at the top and the name at the bottom of the VOR box give you the frequency of the station and the name of the ‘radio’ you are calling. If the frequency at the top of the box has an R listed behind it, then it means that flight service can only receive on that frequency but cannot transmit back to you on that frequency.

In this case, you would tune your NAV radio to the VOR frequency in the box and listen over the NAV radio.

- ATC readbacks—Certain instructions given by ATC must be read back by the pilot to the controller. This process helps catch misunderstandings and errors that may happen during the communication process. Pilots only have to readback certain types of ATC instruction. AIM 4-4-7 states that "pilots of airborne aircraft should read back *those parts* of ATC clearances and instructions containing altitude assignments, vectors, or runway assignments." If ATC tell you to climb to a certain altitude, read back the altitude they told you to climb to. If ATC tells you to fly a certain heading, read back that heading. If ATC tells give you a landing clearance, read back the landing clearance. On the ground, read back runway assignments and taxi instructions. Do not get hung up on exactly what needs to be read back and what does not. The idea is to avoid miscommunications, so if you think it's important, read it back. Make sure to readback, at minimum, what is listed above, but don't be overly concerned about reading back too much. With experience, you will start to grasp the key elements that need to be read back to the controller.

- ATC light signals—While uncommon, radio failures do happen. In this event, try to land at an uncontrolled airport because they typically have less traffic. Unless it's an emergency, avoid landing at class C or class B airports unless already within that airspace such that breaking off the approach would cause more conflict than continuing to land. Regardless, squawk 7600. If landing at a controlled airport, light gun signals will be used by the tower to communicate instructions to the pilot. AIM 4-2-13 provides detailed instructions on how the pilot should handle this scenario. If you suspect that only the radio receiver has failed, then advise the tower of intentions. Remain outside of the controlled airspace until you can figure out the flow of traffic. Let the tower know when you are inbound and watch for light signals. Announce your position throughout the approach and pattern to landing. If only the radio transmitter has failed, remain outside the airspace to determine traffic flow. Listen for instructions over the radio and watch for light signals. Acknowledge receipt of either by rocking the wings during the day or flashing the landing light at night. If both the transmitter and receiver has failed, remain outside of the airspace and determine the traffic flow. Join the traffic pattern while watching for light signals using the above-mentioned methods to acknowledge light signals that are received. The image below shows the different light signal instructions that the tower can issue.



Common Errors

- Failure to utilize the full capabilities of the airplane by being too timid to fly into tower-controlled airports or by being too timid to use flight following.
- Failure to understand how ATC light signals can be used in the event of a radio failure.

Task B: Traffic Patterns

Objective

1. Learn the elements of traffic patterns.
    a. Operations without control towers.
    b. Operations with control towers.
    c. Traffic pattern procedures.
    d. Aircraft spacing.
    e. Maintaining proper ground track during the pattern.
    f. Wind shear and wake turbulence.
    g. Checklists.

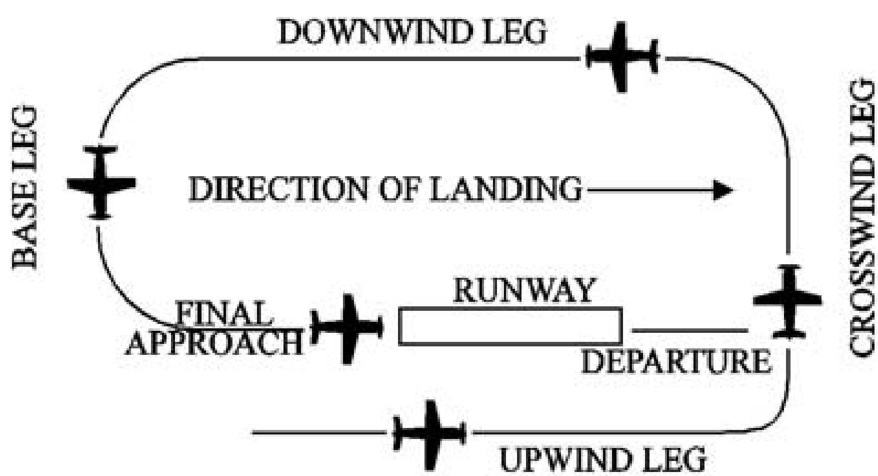
Completion Standards

1. Learner demonstrates proficiency operating in traffic patterns at controlled and uncontrolled airports.
2. Learner understands traffic pattern hazards.

Content

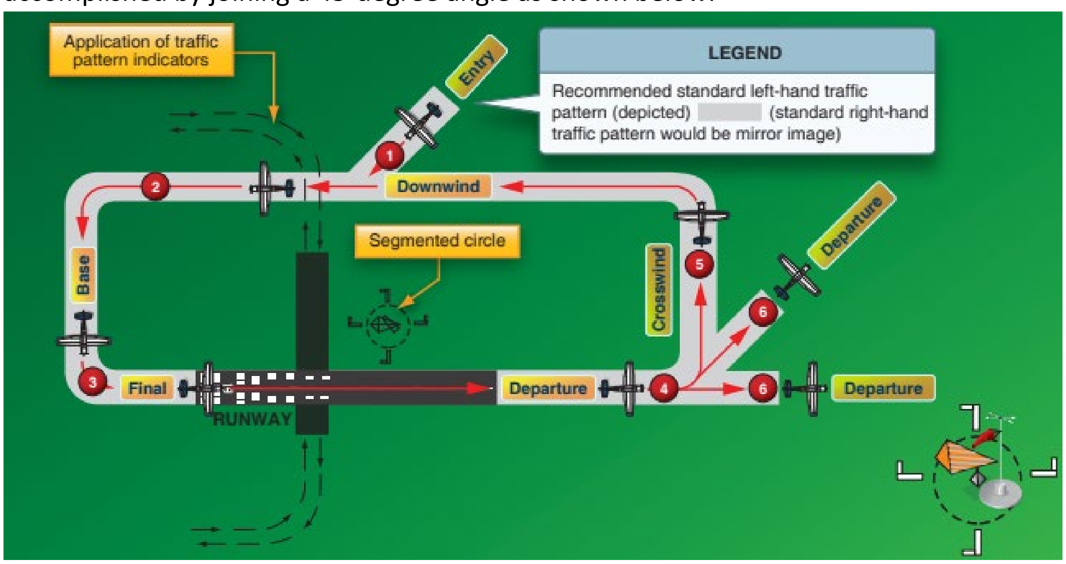
- Non-towered operations—Most of the airports in the United States are non-towered. At these airports, it is up to the pilots to coordinate with each other via the radio (CTAF) to ensure an orderly flow of traffic to and from the airport. The basic concept is for the pilot to self-announce his position at key positions in the airport environment. The pilot will announce his position on the ground when taxiing, his position in the air when approaching the airport, and his position throughout the traffic pattern. Based on these announcements, other pilots can adjust their position and work out sequencing with other pilots to ensure smooth operations at the airport. Advisory circular 90-66B is a helpful reference for non-towered airport operations.

- Towered operations—At non-towered airports, pilots self-announce their intentions. But at towered airports, the control tower is responsible for organizing the flow of traffic into and out of the airport. Because of this, pilots do not have to self-announce intentions. Rather, they talk to the controller in the control tower who gives the pilot instruction for landing and takeoff. Before entering an airport's controlled airspace (class B, C, or D), a pilot must do some work. For class D, all that is required is radio contact with the tower. Radio contact, by definition, is established once the tower controller responds using your aircraft's call sign. You do not need a specific clearance. For class C, the same procedure applies but you will be talking with the class C approach controller rather than the tower. Class B, however, is different. To enter class B airspace, the approach controller must give you an explicit clearance to enter the class B airspace. Whether in Class B, C, or D, the tower will eventually give some instructions on how to approach the airport followed by a clearance to land. Once landed, this will be followed by a taxi clearance. When departing a towered airport, communication typically starts with the ground controller who will issue taxi instruction. Next, tower will issue the takeoff clearance. Once clear of the airspace, you are free to resume unhampered VFR flight.
- Traffic pattern procedures—A traffic pattern is a rectangular course around the airport. Standard traffic patterns are flown making all left turns. At airports without control towers, the standard traffic pattern (left turns) should be flown unless the chart specifically indicates right traffic (right turns). The legs of the rectangular traffic pattern are shown below.

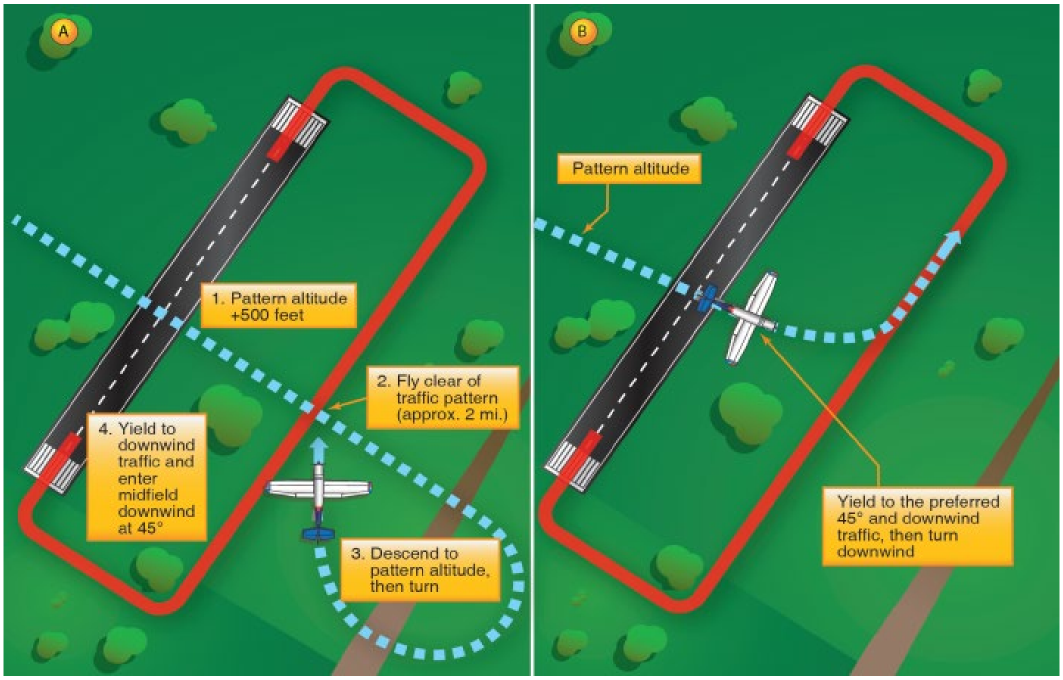


Proper airspeed and altitude control in the traffic pattern is crucial. Being at the same altitude makes it easier to identify other aircraft and gives the pilot a consistent starting point from which to begin his final descent to the airport. Being at the proper speeds throughout the pattern, and especially on final, is crucial to consistent landings. Keeping as many variables as possible constant makes each landing look more familiar to the pilot so that variations from the norm can be easily spotted. As mentioned above, control towers will regulate the flow of traffic into the traffic pattern at controlled airports. Depending on the situation, the tower controller may instruct the pilot to enter the pattern on a left downwind, or a right base, or a straight in final. At controlled airports, there is no standard way to join the pattern. The tower will generally instruct the pilot to join in a way that makes the most sense given the position of the aircraft relative to the active runway. At busier airport, the controller may have to vector the aircraft to create proper spacing for traffic flow into the airport. At uncontrolled airports, there are no rules on how to enter the traffic pattern—only that all turns are made to the left, unless otherwise noted (91.126). if pattern is to be flown with right traffic, the VFR sectional will show "RP" next to the runway number. Also, both the chart supplement and ForeFlight will indicate right pattern as well. Despite there being no regulations on how to enter the traffic pattern, there are best practices that most pilots follow to help with orderly traffic flow to and from the airport. Some of these best practices are as follows:

1. Join the pattern in a way that does not disrupt the flow of other aircraft already in the traffic pattern.
2. Fly the traffic pattern at 1,000 ft. AGL for propeller aircraft (unless listed otherwise in the chart supplement). Descend to the pattern altitude about 2 miles from the airport.
3. Join the traffic pattern in level flight at midfield on the downwind leg. This is generally accomplished by joining a 45-degree angle as shown below.



4. Crossing over midfield to join the downwind is an alternate way of joining the pattern if the pattern is not busy. There are a couple of ways to do this as shown in the image below.



5. Maintain pattern altitude until abeam the landing point. Reduce power at this point and then make the base turn when on a 45-degree angle from intended landing point.
6. If departing the pattern, fly straight out or at a 45-degree angle in the direction of the turns for the traffic pattern.

- Aircraft spacing—At controlled airports, the tower controller helps aircraft maintain proper spacing. At non-controlled airports, spacing is left up to the pilots. One tool a pilot can use to adjust spacing is to extend the downwind leg. A good rule of thumb is to let an aircraft ahead of you in the pattern pass behind your wing on his final approach leg before you turn your base. This generally gives enough spacing so the aircraft ahead has time to exit the runway before you are on a short final. Gentle S-turns on final will create more space, too. If all fails and the aircraft ahead of you still isn't clear of the runway before you are on short final, then perform a go-around. Do not land with another aircraft still on the runway surface. Offset to the right during the go-around to keep the aircraft on the ground in sight—they might be doing a go-around too.
- Maintaining ground track—the effects of wind on an aircraft's ground track is hard to understand until it is experienced. As the aircraft makes its turns through the pattern, tailwinds become crosswinds, crosswinds become headwinds, etc. Winds at pattern altitude can often be strong even with calm conditions on the ground. Turn radius is proportional to the square of the groundspeed. Thus, winds can dramatically alter the ground track of the aircraft by either increasing or decreasing the turn radius for a given bank angle. One common problem is overshooting the extended final approach course if the wind direction causes a tailwind on the base leg. This can lead to aggressive banking or uncoordinated rudder input in attempt to salvage the approach. If this happens, go around. Understanding the winds aloft prior to entering the traffic pattern is the key to maintaining the proper ground track throughout the trip around the traffic pattern.
- Windshear and wake turbulence
    - Windshear is a sudden change in wind velocity over a short distance either horizontally or vertically. This sudden change in wind can temporarily cause either an increase or

decrease in airspeed. The most concerning situation is a shearing tailwind at low altitudes. This can cause the aircraft to lose enough airspeed leaving the pilot with only one bad option—lower the nose, add full power, and hope there is enough altitude to recover. Avoid a stall-spin at all costs. Avoidance of windshear is the best tactic. Windshear can be caused by thunderstorms, temperature inversion with low-level jet streams, and surface obstructions. Avoid conditions conducive to wind shear. If shear is suspected and the runway is long enough, consider increasing the approach speed to achieve a higher margin above the stall speed. Be spring loaded for the go-around should wind shear be encountered.

- All aircraft create wake turbulence the moment the wings begin to generate lift (yes, even before the aircraft leaves the ground). The wake turbulence is caused by vortices that roll off the high-pressure bottom surface of the wing around to the low-pressure top surface of the wing (see image below).

The vortices from heavy and slow aircraft are the strongest. When departing or landing behind these types of aircraft, have a plan to avoid their wake. These types of vortices are strong enough to invert a small aircraft. Wake vortices drift with the wind and typically descend several hundred feet per minutes. If the vortices reach the ground, they typically move laterally over the ground at 2-3 knots. Use this knowledge to offset away from the wake turbulence. When landing behind a heavy aircraft, touch down beyond the large aircraft’s touchdown point. When taking off behind a heavy aircraft, lift off before the preceding aircraft and offset to the upwind side of the aircraft. Light, quartering tailwinds are the worst-case scenario—the winds aren’t strong enough to blow the vortices away, but just strong enough to stop the lateral movement. This can potentially keep vortices over the runway for an extended period. Be careful when taking off on parallel runways. Wake turbulence from aircraft using the parallel runway can drift over to your runway. Consider delaying takeoff for a couple of minutes if wake turbulence on departure is a concern. Refer to PHAK chapter 14 for more scenarios on wake turbulence avoidance.

- Checklists—Before reaching the runway environment, the pilot should have completed the 5 A's. They help bring together the big picture items and ensure that the pilot and aircraft are prepared for the landing. The 5 A's are as follows:
    - ATIS—obtain the airport weather.
    - Altimeter—set the altimeter to the altimeter setting from the airport weather (wait until cleared for the approach if IFR).
    - Approach Briefing—Review how you expect the approach will be flown as well as the go-around procedure.
    - Avionics—Set up the avionics for the approach to the airport (tune frequencies and load the approach if applicable).
    - Airplane—Complete the airplane's before-landing checklist before entering the traffic pattern. After entering the pattern, do not use get distracted by checklist use. Instead, look for traffic and perform a GUMPS check at least twice during the pattern or inside the FAF.

Common Errors

- Failure to fly a standard traffic pattern.
- Failure to compensate for wind drift while flying in the traffic pattern.
- Failure to precisely control altitude and airspeed during the traffic pattern.

Task C: Airport/Seaplane Base, Runway and Taxiway Signs, Markings, and Lighting

Lesson Objective

1. Learn the elements of runway and taxiway signs, markings, and lighting.

Completion Standards

1. Learner understands how to interpret runway and taxiway signs and markings.
2. Learner understands how to interpret runway and taxiway lighting.
3. Learner understands techniques to avoid runway incursions (AC 91-73)

Content

- Sign and markings—The basic function of taxiway signs and markings is to help the pilot navigate to his destination (usually either to the runway or to parking). At non-towered airports, the pilot will select the best route from the airport diagram and use taxiway signs and markings to follow that route to the destination. At towered airports, the controller will be responsible for assigning the taxi instructions and the pilot will use the taxiway signs and marking to follow this assigned route. Foreflight, and other EFB's, will show the aircraft's position on the airport diagram and thus serves as an excellent situational awareness tool during the taxi. The PHAK Chapter 14 and the AIM chapter 2 section 3 is an excellent reference for learning about the different runway and taxiway signs and marking. Review both of these thoroughly.

AIRPORT SIGN AND MARKING – QUICK REFERENCE GUIDE

EXAMPLE	TYPE OF SIGN	PURPOSE	LOCATION/CONVENTION
4 - 22	Mandatory: Hold position for taxiway/ runway intersection.	Denotes entrance to runway from a taxiway.	Located L side of taxiway within 10 feet of hold position markings.
22 - 4	Mandatory: Holding position for runway/runway intersection.	Denotes intersecting runway.	Located L side of rwy prior to intersection, & R side if rwy more than 150' wide, used as taxiway, or has "land & hold short" ops.
4 - APCH	Mandatory: Holding position for runway approach area.	Denotes area to be protected for aircraft approaching or departing a runway.	Located on taxiways crossing thru runway approach areas where an aircraft would enter an RSA or apch/ departure airspace.
ILS	Mandatory: Holding position for ILS critical area/precision obstacle free zone.	Denotes entrance to area to be protected for an ILS signal or approach airspace.	Located on twys where the twys enter the NAVAID critical area or where aircraft on taxiway would violate ILS apch airspace (including POFZ).
⊖	Mandatory: No entry.	Denotes aircraft entry is prohibited.	Located on paved areas that aircraft should not enter.
B	Taxiway Location.	Identifies taxiway on which the aircraft is located.	Located along taxiway by itself, as part of an array of taxiway direction signs, or combined with a runway/ taxiway hold sign.
22	Runway Location.	Identifies the runway on which the aircraft is located.	Normally located where the proximity of two rwys to one another could cause confusion.
	Runway Safety Area / OFZ and Runway Approach Area Boundary.	Identifies exit boundary for an RSA / OFZ or rwy approach.	Located on taxiways on back side of certain runway/ taxiway holding position signs or runway approach area signs.
	ILS Critical Area/POFZ Boundary.	Identifies ILS critical area exit boundary.	Located on taxiways on back side of ILS critical area signs.
J →	Direction: Taxiway.	Defines designation/direction of intersecting taxiway(s).	Located on L side, prior to intersection, with an array L to R in clockwise manner.
↖ L	Runway Exit.	Defines designation/direction of exit taxiways from the rwy.	Located on same side of runway as exit, prior to exit.
22 ↑	Outbound Destination.	Defines directions to take-off runway(s).	Located on taxi routes to runway(s). Never collocated or combined with other signs.
FBO ↘	Inbound Destination.	Defines directions to airport destinations for arriving aircraft.	Located on taxi routes to airport destinations. Never collocated or combined with other types of signs.
NOISE ABATEMENT PROCEDURES IN EFFECT 2300 - 0500	Information.	Provides procedural or other specialized information.	Located along taxi routes or aircraft parking/staging areas. May not be lighted.
	Taxiway Ending Marker.	Indicates taxiway does not continue beyond intersection.	Installed at taxiway end or far side of intersection, if visual cues are inadequate.
7	Distance Remaining.	Distance remaining info for take-off/landing.	Located along the sides of runways at 1000' increments.

EXAMPLE	TYPE OF MARKING	PURPOSE	LOCATION/CONVENTION
	Holding Position.	Denotes entrance to runway from a taxiway.	Located across centerline within 10 feet of hold sign on taxiways and on certain runways.
	ILS Critical Area/POFZ Boundary.	Denotes entrance to area to be protected for an ILS signal or approach airspace.	Located on twys where the twys enter the NAVAID critical area or where aircraft on taxiway would violate ILS apch airspace (including POFZ).
	Taxiway/Taxiway Holding Position.	Denotes location on taxiway or apron where aircraft hold short of another taxiway.	Used at ATCT airports where needed to hold traffic at a twy/twy intersection. Installed provides wing clearance.
	Non-Movement Area Boundary.	Delineates movement area under control of ATCT, from non-movement area.	Located on boundary between movement and non-movement area. Located to ensure wing clearance for taxiing aircraft.
	Taxiway Edge.	Defines edge of usable, full strength taxiway.	Located along twy edge where contiguous shoulder or other paved surface NOT intended for use by aircraft.
	Dashed Taxiway Edge.	Defines taxiway edge where adjoining pavement is usable.	Located along twy edge where contiguous paved surface or apron is intended for use by aircraft.
4-22 4-22	Surface Painted Holding Position.	Denotes entrance to runway from a taxiway.	Supplements elevated holding position signs. Required where hold line exceeds 200'. Also useful at complex intersections.
	Enhanced Taxiway Centerline.	Provides visual cue to help identify location of hold position.	Taxiway centerlines are enhanced 150' prior to a runway holding position marking.
↖ T	Surface Painted Taxiway Direction.	Defines designation/direction of intersecting taxiway(s).	Located L side for turns to left. R side for turns to right. Installed prior to intersection.
	Surface Painted Taxiway Location.	Identifies taxiway on which the aircraft is located.	Located R side. Can be installed on L side if combined with surface painted hold sign.

Ref. AC 150/5340-1J *Standards for Airport Markings*, and AC 150/5340-18D *Standards for Airport Signs Systems*

Federal Aviation Administration

OK-08-0403

- Lighting—Airports are not lit up like parking lots. In fact, a runway at night in the middle of a city will be dark in comparison to the surrounding city lights. Because of the dimness of the airport environment, airport use specific types of lighting to help the pilot identify runways, taxiways, runway length remaining, etc. Chapter 2, section 1 of the AIM is an excellent resource for information about all the different types of airport lighting. Review this thoroughly.
- Runway incursions—Runway incursions are any occurrences involving the incorrect presence of an aircraft on a runway surface. These events have become a topic of focus as the number of accidents to due to runway incursions have increased. Below are some standard operating procedures that will help reduce runway incursions.
  - During taxi to the runway—Avoiding runway incursions starts with proper pre-taxi planning. After receiving and reading back the taxi instructions, prepare for the taxi by reviewing the taxi route on an airport diagram. Busier airports may have 'hot spots' listed on the airport diagram. These hot spots are areas prone to runway incursions. Review these areas carefully. Having a visual picture of where you are going and where hot spots will be is helpful first step in avoiding runway incursions. Remember that a runway cannot be crossed during taxi without an explicit clearance to cross that runway. That clearance may be given with the initial taxi instructions, or you may be asked to hold short of a certain runway. If asked to hold short, then do not cross the hold short line until the controller gives you the clearance. If in doubt whether you are cleared to cross a runway, ask the controller.
  - During taxi from the runway—Many pilots are prepared for the taxi to the runway for takeoff, but not many are prepared for the taxi to parking after the landing is complete. While briefing the approach, take a moment to review the airport diagram to become familiar with the hot spots and likely taxi routes to the destination on the ground. After clearing the runway after landing, review the assigned taxi route on the airport diagram to get a visual of what is ahead.
  - Distractions—Distraction during taxi can lead to runway incursions even if the taxi was well-briefed ahead of time. During single-pilot ops, it is rarely wise to try to accomplish anything other than taxiing during the taxi. Set up radios and navigation equipment prior to taxi and complete the runup items in a designated runup area or while holding short of the departure runway. It is advisable to maintain a sterile cockpit during the taxi.
  - Clearing the runway—When taxiing clear of the runway, make sure the entire aircraft has crossed over the hold short line.
  - Progressive taxi—If the pilot is confused by the taxi instructions, progressive taxi should be requested. During progressive taxi, the controller will give step-by-step instructions to the pilot.
  - Aircraft lighting—To provide visual aids to other pilots, turn the aircraft's beacon light on prior to engine start. Leave the beacon light on throughout flight. Before taxi, turn on the taxi light. Turn on the NAV light as well if operating between sunset and sunrise. Strobe lights can adversely affect the vision of other pilots and thus should not be turned on until entering the runway.

Common Errors

- Failure to follow standard operating procedures designed to reduce runway incursions.

Areas of Operation VII: Takeoffs, Landings, and Go-Arounds

Task A: Normal and Crosswind Takeoff and Climb

A1: Positioning the Aircraft for Takeoff

Lesson Objective

Learn how to exercise good airmanship when positioning the aircraft for takeoff.

Completion Standards

While holding short:

1. Learner is actively looking for traffic on the final approach path.
2. Learner ensures that no part of the aircraft is crossing the hold-short line.

While taxiing onto the runway:

1. Learner uses all available runway.
2. Learner cross-checks compass and heading indicator against runway heading.
3. Learn completes "Lights, Camera, Action."
4. Learner transitions feet to "position 2" to prepare for the takeoff roll.

Content

- At a controlled airport, common clearances are to "hold short" or to "line up and wait." When told to hold short, make sure that no part of the aircraft is across the hold-short line. If cleared to line up and wait, taxi onto the runway and line up the aircraft on the centerline of the runway. Do not start the takeoff roll until given the takeoff clearance.
- At both controlled and uncontrolled fields, always check for traffic on final before taking the runway. Angle the aircraft toward the final approach course to make it easier to spot traffic.
- It is best to make a habit of using all available runway even if the runway is much longer than required. Do not round your turn on to the runway such that you leave hundreds of feet of runway behind the aircraft. Always keep as much runway in front of you as possible. This runway will be useful in the event of an emergency.
- Once aligned with the runway, visually confirm the runway number. Cross-check the magnetic compass and heading indicator against this visually confirmed runway heading. This accomplishes two things. First, it confirms that you are on the correct runway. Second, it checks the accuracy of your compass and heading indicator against a known heading. "Lights, Camera, Action" is a helpful memory aid to make sure the anti-collision light are on, the transponder is set, and that the mixture is set for best power. Shift your feet into "position 2" when starting the takeoff roll. This will keep your toes away from the toe brakes ensuring that brakes are not accidentally used when accelerating down the runway.

Common Errors

- Failure to use the whole runway.
- Failure to cross-check the magnetic compass and heading indicator against the runway heading.
- Failure to verify the final approach path is clear.

A2: The Takeoff and Initial Climb

Lesson Objective

Learn to control the aircraft throughout the takeoff and initial climb during both normal and crosswind conditions. Understand the key elements of the takeoff and climb needed to exercise good judgment.

Completion Standards

4. Learner understands how atmospheric conditions affect takeoff and climb performance.
5. Learner understands V_x and V_y.
6. Learner is proficient with flow checks, checklists, and callouts for takeoff and climb.
7. Learner is proficient with configuring the airplane for takeoff and climb.
8. Takeoff Roll: Learner maintains centerline. Proper aileron inputs for the wind.
9. Lift-off: Learner smoothly rotates at the appropriate airspeed and pitches for V_y.
10. Initial Climb: Learner maintains a pitch attitude to achieve V_y +10/-5 knots until a safe altitude is reached.
11. Learner understands and demonstrates proper crosswind technique throughout all three phases listed above.

Content

- Effects of wind on aircraft performance during takeoff and climb.
- Factors to consider when selecting a runway for takeoff at an uncontrolled field.
- Takeoff and climb configurations.
- V_x and V_y.
- Flow checks, checklists, and takeoff calls outs (refer to *Setting the Standard* by Jason Miller).
- Fly with a light grip. This will make it necessary to make proper use of the trim.
- Phases of the takeoff and climb.
    - Takeoff Roll: After smoothly setting takeoff power, use the rudder to maintain centerline while maintaining proper aileron inputs for the wind. *Callouts for this phase are 1. "Power Set", 2. "Gauges Checked", 3. "Airspeed Alive", and 4. "Abort Point."* Rule of thumb is that 70% of the rotation speed should be achieved prior to reaching the half-way point of the runway. If not, abort the takeoff.
    - Lift-off: As the airplane accelerates, the controls will become progressively more responsive. Keep the nose "light" by maintaining slight nose up pressure. As the airplane approaches the rotation speed, the airplane will smoothly lift off. A smooth lift-off is not difficult but requires practice in order to get the "feel" of the airplane. Do not force the aircraft off the ground. Use the "Lindbergh Reference" to set proper pitch and to maintain coordination. Until reaching 1,000 feet, keep your hand on the throttle to prevent it from creeping back. *Callouts for this phase are 5. "Rotate."*
    - Initial Climb: After lift-off, pitch should be maintained to achieve V_y. Maintain coordination and track the extended centerline on the upwind leg. Raise flaps, if applicable, at 400'. Do not begin a turn from runway heading prior to reaching 400'. At 1,000', configure for cruise climb followed by a flow check and checklist. *Callouts for this phase are 6. "No Runway", 7. "400 feet", and 8. "1,000 feet."*

- Crosswind Considerations
    - Apply full aileron into the wind during the initial phase of the takeoff roll. This prevents the crosswind from lifting the upwind wing. As the airplane accelerates and the ailerons become more effective, aileron deflection should be reduced to whatever is required to keep the upwind wing lowered into the wind. Maintain longitudinal alignment with the runway using the rudder. At lift-off, the airplane should be in a side slip to prevent wind drift. After a positive rate of climb is established, this side slip will transition into coordinated flight as the airplane is crabbed into the wind and the wings are brought level.

Common Errors

- Failure to smoothly set takeoff power.
- Failure to place heels on the floor.
- Failure to perform the takeoff and climb callouts.
- Failure to maintain centerline.
- Failure to use adequate right rudder.
- Failure to attain proper lift-off attitude at the rotation speed.
- Failure to use outside references to establish proper V_y pitch—don't chase the airspeed.
- Failure to maintain light grip on the yoke leading to overcontrolling of the elevator.
- Failure to account for the wind in order to track the extended centerline on the upwind leg.

Task B: Short-Field Takeoff and Maximum Performance Climb

Lesson Objective

Learn how a short-field takeoff and maximum performance climb is different from the normal takeoff and climb. Understand the elements of this maneuver and the logic behind the technique. Learn how to perform the short-field takeoff and maximum performance climb and understand when it is appropriate to use this technique.

Completion Standards

1. Learner understands the purpose of the short-field takeoff and maximum performance climb.
2. Learner demonstrates proficiency in configuring the airplane properly throughout the maneuver.
3. Learner maintains V_x +10/-5 knots until 50 feet or the obstacle is cleared.
4. Learner maintains V_y +10/-5 knots after the obstacle is cleared until reaching a safe altitude.
5. Learner understands the risk elements of a V_x climb.

Content

- When operating from a short field, the goal is liftoff and establish a V_x climb in the shortest distance possible. To do this, hold the brakes and establish takeoff power. Once engine instruments have been checked, begin the takeoff roll. After accelerating to the normal rotation speed, establish the pitch sight picture required for a V_x climb. Glance at the airspeed and make the required correction in order to maintain V_x until the obstacle is cleared.
- The short-field technique has a few key differences when compared to a normal takeoff.

    - Use *all* available runway.
    - Full power while holding the brakes.
    - V_x is used for clearing an obstacle because it provides the steepest climb angle.
    - Transitioning to V_y.
- Discuss the risk behind a V_x climb. See the document titled "Dangers of a Vx Climb" in Thomas' aviation folder.

Common Errors

- Premature lift off resulting in high drag.
- Failure to rotate to a high enough pitch causing the aircraft to exceed the V_x speed.
- Failure to maintain V_x until the obstacle is cleared.

Task C: Soft-Field Takeoff and Climb

Lesson Objective

Learn how a soft-field takeoff is different from the normal takeoff and climb. Understand the elements of this maneuver and the logic behind the technique. Learn how to perform the soft-field takeoff and understand when it is appropriate to use this technique.

Completion Standards

1. Learner understands the purpose of the soft-field takeoff.
2. Learner demonstrates proficiency in configuring the airplane properly throughout the maneuver.
3. Learner understands ground effect and how to use it.
4. Learner maintains V_x +10/-5 knots or V_y +10/-5 knots (whichever is appropriate).

Content

- In a normal takeoff, ground friction is minimal. Because of this, the airplane is easily accelerated on the ground up until the point the airplane is ready to fly away at a normal climb attitude from the runway surface. However, if the departure field is a soft field, like wet/soft turf or tall grass, then ground friction during the takeoff roll becomes a significant hindrance to the airplane's ability to reach its normal rotation speed. Thus, when operating from a soft field, a new technique is needed.
- The basic technique of the soft-field takeoff is to keep the airplane rolling (don't get stuck!), to transfer weight from the wheels to the wings as early as possible, and to achieve lift-off at the lowest practical speed. Breaking free of the ground eliminates the ground friction problem. However, at this slower-than-normal liftoff speed, the airplane does not have enough energy to be able to immediately launch into a V_x or V_y climb. For this reason, the airplane should be leveled off immediately after liftoff so that the airplane can accelerate to its desired climb speed while in ground effect. Once the desired climb speed is reached (V_x or V_y), begin the climb.
- A wing generating lift creates vortices as a byproduct (think of the analogy of a paddle being pulled through water). The creation of these vortices requires energy and this energy imparted to the air from the wing comes at a cost. This cost is known as induced drag. When flying within about a wingspan's distance from the ground, the airplane will experience a phenomenon known as ground effect. In ground effect, induced drag is reduced primarily due to the ground's

interaction with the aircraft's vortices. The ground largely cancels these vortices generated by the wing and thus reduces the amount of induced drag. Because of this, an airplane will be able to fly in ground effect at speeds that would not generate sufficient lift outside of ground effect. This phenomenon is used to the pilot's advantage during the soft-field takeoff. *See How It Flies* has some wonderful insight on induced drag, soft-field takeoffs, and ground effect.

- If the condition of the surface is unknown, perform a low approach to inspect the field.

Common Errors

- Failure to raise nose-wheel as soon as possible.
- Allowing the airplane to settle back on the runway after liftoff.
- Failure to remain in ground effect until proper climb speed has been attained.

Task D: N/A – Seaplanes

Task E: N/A – Seaplanes

Task F: Normal and Crosswind Approach and Landing

F1: Normal Approach and Landing

Lesson Objective

Learn the five phases of a normal approach and landing. These phases are used in non-normal approaches and landings as well but are discussed in the context of a normal approach and landing for simplicity.

Completion Standards

1. Leaner understand the five phases of the approach and landing.
2. Learner understands the various risks that accompany these five phases.
3. Learner is always prepared for a go-around.

Content

- The approach and landing is best understood by dividing it into five phases. These phases are as follows:
  - The final approach.
  - The round out.
  - The flare.
  - The touchdown.
  - The after-landing roll.
- The final approach—For a normal traffic pattern, the final approach portion should be *stabilized.* The idea behind a stabilized approach is to have a consistent airspeed and descent rate down to a specified aiming point without big swings in power settings. The aiming point should be a couple hundred feet, depending on the airplane, before the desired touchdown point to allow for the round out and flare. If airspeed or descent rate is not stable, a go-around is likely in order. Note: long straight in finals for small GA aircraft may not need to be stable as defined above. For these types of approaches, the airplane will probably best be flown at a higher speed until short final. An example is a Cessna 182. It is probably not best to fly a 5-mile straight-in approach at full flaps and 65 kts.

    - ACS standards are to maintain recommended approach speed (gust factor included) to +10/-5 kts.
- The round out—The final approach ends with the airplane in a nose down attitude over the reference point (the point about 100 feet prior to the aiming point). When the reference point disappears under the nose, the round out phase begins. During the round out, the airplane's nose is raised so that the airplane flies level to the runway. Keep your eye at a point way down the runway—this will help to judge height above runway. Rounding out too high can lead to "dropping it in" and rounding out too late can result in forceful impact with the ground because there is not enough time to round out the decent. Raising the nose too much or too quickly can lead to ballooning. If minor, the back pressure can be reduced (don't push forward!) so that the aircraft begins a controlled and slow decent back to the runway. A small amount of power can be added if needed. If the balloon leads to the aircraft being too high and slow, it is best to go around. Use the "Lindbergh reference" to be able to easily detect when the aircraft is ballooning. If trying to save a bad landing leads to any signs of porpoising, then go around immediately.
- The flare—During the round out, the descent was arrested. With the airplane flying level with no power, airspeed will diminish. As the airspeed diminishes, the pitch of the aircraft will have to be increased to maintain an angle of attack required for level flight. The steady increase in pitch as the airspeed slows is known as the flare. Continue to increase the pitch until the landing attitude is reached. As the aircraft slows, the controls become "sloppy" and will require more movement to achieve the desired effect. Use the "Lindbergh reference" to judge which control movements are needed (you won't be able to see over the nose). The flare begins very quickly after the round out if the approach is flown at the proper speed. This all needs to be done about one foot above the runway surface. Do not round out too high and blend the round out into the flare. This leads to the aircraft being too slow too high over the runway while mushing to a touchdown. With the air
- The touchdown—Eventually, no more lift can be teased out of the wing. At this point, touchdown is inevitable. Hopefully this occurs exactly on top of the touchdown point. A perfect landing in a light GA aircraft is one in which the main wheels of the airplane contact the ground the exact moment the wing stalls while having the longitudinal axis of the airplane parallel with and exactly over the centerline of the runway. If all this happens just inches over the runway, then the touchdown will be a greaser. Too high, and the touchdown will be a thud. Getting this right is a matter of experience.
    - ACS standards are to touch down within 400 feet beyond or on the desired touchdown point.
- The after-landing roll—All too often, the pilot considers his work done after the main wheels touch down. Not so! After the touchdown, the nose-wheel should be held off the ground for as long as possible. Once the tail starts to lose it's effect, gently lower the nose so that it doesn't suddenly drop. As the airplane slows, maintain centerline with rudder and proper inputs for the wind. Do not reconfigure the airplane until stopped clear of the runway.

Common Errors

- Failure to maintain a stabilized approach.
- Failure to pick out a reference point that results in touchdown at the desired aiming point.

- Failure to recognizing ballooning during the round out (use Lindbergh reference)
- Failure to attain the proper landing attitude prior to touchdown.
- Failure to align the aircraft with the runway over the centerline during touchdown.
- Failure to properly control the aircraft during the rollout.

F2: Crosswind Approach and Landing

Lesson Objective

Learn how to use the sideslip to deal with crosswinds during the approach and landing phase of flight.

Completion Standards

1. Learner understands why a side slip is needed during crosswind landings.
2. Learner demonstrates proper use of sideslip to cancel the wind drift to achieve touchdown with the airplane aligned with the runway, over the centerline, with no drift.
3. Learner can demonstrate proficiency in 1.) while still properly executing the five phases of landing as discussed in F2 above.

Content

- Aircraft fly in the airmass over the earth's surface. A vehicle moves with respect to the earth because the tires fix that car to the earth. It is tempting to think of an aircraft's movement only in terms that are relative to the earth's surface. But, to truly understand how the aircraft flies, one must understand how the airplane moves relative to the airmass in which it is traveling. If an aircraft is in straight and level, coordinated flight in an airmass that is moving, the aircraft will still be going straight with respect to the moving airmass. However, with respect to the ground, the aircraft will be moving in a different way. If the airmass is moving with the direction of flight, the groundspeed will be faster than the actual speed of the aircraft through the airmass. If the airmass is moving against the direction of flight, then the groundspeed will be slower than true airspeed. If the airmass is moving left or right, then the airplane will drift left or right relative to the ground. In all these cases, the aircraft relative to the air is flying the exact same way. The direction of the airplane over the ground in each case, however, is different. Thus, when landing during a crosswind (an airmass moving at an angle to the runway), the aircraft must fly in a way that eliminates the drift over the ground.
- When lining up on the final approach course with a crosswind from the left, the airplane must be turned at enough of an angle into the wind so that the drift over the ground is eliminated. If, for example, the airplane in landing on runway 36, it may have to be on a heading of 350 with wings level in order to maintain a track on the extended centerline of the runway. The airplane is flying sideways relative to the direction of the runway. This angle between the airplane's heading and it's track over the ground is known as the "crab angle."
- An airplane should not be landed when it is sideways relative to the runway. This causes sideload on the landing gear and makes for a harsh touchdown. At some point before touch down the airplane must intentionally be put into uncoordinated flight so that both the drift over the ground is eliminate and the airplane is lined up with the runway (no crab angle). This is known as a sideslip. During the sideslip, the upwind wing is banked into the wind to eliminate drift across the ground. Opposite rudder is used to prevent the nose from turning into the

direction of the bank. When this is done properly, the aircraft will be traveling to the side relative to the airmass, but relative to the ground it will be going in the direction it is pointing. This allows for the airplane to be aligned with the direction of the runway with no wind drift.

- When reading about crosswind techniques, you will see numerous articles about the crab method versus the sideslip method. There is not really two different techniques as this debate seems to suggest. The only difference is at what point do you transition from the crab to the sideslip. Newer pilots may find it helpful to transition from the crab angle to the sideslip while on a half-mile final. Experienced pilots are likely to stay in the crab until just before touchdown at which point the airplane will be put into the sideslip. Both methods transition from the crab to the sideslip before touchdown, but different pilots like to do this transition at different times.
- As the aircraft slows after touchdown, continue to position the controls for the effects of the wind. Note that the controls lose effectiveness as the aircraft slows requiring the use of more control deflection. Ailerons should be fully into the wind by the time the aircraft slows to taxi speeds.

Common Errors

- Failure to use enough bank to stop the drift caused by the crosswind.
- Failure to use the right amount of rudder to align the aircraft with the runway.
- Failure to realize control inputs will have to be exaggerated as the aircraft slows and the controls lose some of their effectiveness.
- Failure to position the controls for wind after the touchdown.

Task G: Slip to a Landing

Lesson Objective

Learn how to intentionally use slips to dissipate altitude without increasing airspeed and to adjust ground track during crosswind landings.

Completion Standards

1. Learn how to use forward slips to increase rate of descent without increase airspeed.
2. Learn how to enter forward slips during turns and in crosswinds.
3. Learn the difference in forward slips and side slips.

Content

- An airplane is slipping anytime it is moving sideways relative to the airmass it is flying in. This was discussed in detail during the Crosswind Approach and Landing lesson. Slips, however, have more applications than crosswind landings. A slip can be used to dramatically increase the drag on the airframe by exposing the side of the aircraft to the relative wind. This allows the airplane to enter a steeper descent without picking up excess airspeed. This technique is useful for airplanes without flaps, airplanes too high on an approach, emergency landings in confined fields, etc. This technique is known as a forward slip. Forward slips are performed by using full rudder deflection and enough bank in the opposite direction to maintain the desired ground track. If in a turn, enter the forward slip by using top rudder. *Never use inside rudder. This will*

create a skidding turn which could lead to a stall/spin. When wings level on final with a crosswind, a forward slip should be entered so that the wings bank into the wind. This will set the airplane up for a smoother transition to the side slide for landing. During transition to the side slip, bank should be used to stop the wind drift and rudder should be used to align the nose with the runway. Varying the bank angle can be used to side slip the aircraft to the left or right if the airplane is not directly over the centerline.
    - ACS standards are to correlate crosswind with direction of forward slip and transition to sideslip before touchdown (this assumes a crosswind exists—if it doesn't, a slip in either direction is acceptable). Touch down within 400 feet beyond or on the specified touchdown point.
- A useful tip to remember the difference between forward and side slips is that during a forward slip you will be looking out of the side of the airplane and during a side slip you will be looking forward out of the airplane. The conceptual difference is that during a forward slip, maximum rudder input is used to create the most drag possible. During a side slip, only enough rudder is used to align the nose with the runway.
- During a forward slip to landing, the pitot tube is not directly into the relative wind. Thus, airspeed indications generally indicate slower than actual. Don't fixate on airspeed—keep the nose slightly down and the airplane won't stall. Practice at altitude to see what effects forward slips have on indicated airspeed.

Common Errors

- Pitching down too much during forward slips and gaining excessive airspeed.
- Failure to use full rudder during forward slips.
- Failure to forward slip in the appropriate direction during crosswind approaches.

Task H: Go-Around/Rejected Landing

Lesson Objective

1. Learn how to be spring-loaded for a go-around.
2. Learn common reasons that necessitate a go-around.
3. Learn how to perform the go around.

Completion Standards

Content

- A pilot should always be spring-loaded for the go-around. The vast majority of approaches end with a landing making it easy for the pilot to fixate on landing the airplane even when the situation may clearly indicate the need for a go-around. Brief the go-around before every approach and be spring-loaded to perform the go-around should the need arise.
    - Another way to think about this is to consider the go-around the default ending to an approach. If everything looks right, then execute the landing.
- The most basic need for a go-around is a bad approach. If the approach is too high, too low, too fast, too slow, or sloppy in any kind of way, a go-around is the right choice. A good rule of thumb is to go-around if the wheel aren't down before the halfway point of the runway. Other factors out of the pilot's control such as a traffic conflict, hazards on the runway, wind shear, wake

turbulence, etc., are all good reasons for rejecting the landing and performing a go-around. Be alert for these situations and others that signal the need for a go-around. Do not try to salvage a bad situation—go around and try again.

- The cardinal rule for performing the go around is power, attitude, and configuration. Add takeoff power, pitch for the proper attitude, and configure the plane for the climb out.
    - Power—Add maximum takeoff power. This requires a lot of rudder—be prepared.
    - Attitude—Initially, bring the nose to the horizon. The goal here is to accelerate so that flaps can be reduced allowing the airplane to climb at a faster rate. Dumping the flaps with the airplane slow will cause the aircraft to sink. Note that some airplanes, the 182 for example, pitch up dramatically when full power is applied while trimmed for landing with full flaps. A strong nose down control input will be needed to keep the proper attitude. Trim away this pressure once time allows.
    - Configuration—Airplanes do not climb well with full flaps (some will not climb at all). A crucial step is to reduce flaps to a takeoff configuration to establish the proper climb. Do not dump all the flaps at once. As the airplane accelerates and the flaps are raised, the airplane can be put into a standard V_x or V_y climb attitude.
        - ACS standards are to establish the appropriate V_x or V_y airspeed +10/-5 kts.
- The three steps listed above happen in quick succession. In the C182, power is added, and flaps are immediately raised from full to 20 degrees while pitching for a V_x or V_y climb (whichever is appropriate).

Common Errors

- Failure to recognize the need for a go-around.
- Failure to promptly initiate the go-around.
- Failure to maintain coordinated flight during the go-around.
- Failure to establish the proper pitch during the go-around.
- Failure to configure the airplane properly for the go-around.
- Failure to announce the go-around (either on CTAF or to the tower).

Task I: Short-Field Approach and Landing

Lesson Objective

Learn the short-field approach and landing procedure that is used when landing in confined areas that have an approach over obstacles.

Completion Standards

1. Learner maintains precise control over the airspeed during the approach.
2. Learner descends at a steeper-than-normal angle to avoid the simulated 50-foot obstacle.
3. Learner demonstrates consistency in landing within 200 feet beyond or on the desired touchdown point.
4. Learner follows short-field procedures after the touchdown all the way until the airplane is stopped.
5. Learned promptly initiates a go-around if the landing cannot be made within 200 feet beyond or on the specified landing point.

Content

- The short-field approach should be flown at a steeper than normal descent to clear either the actual or simulated obstacle. This is done by flying an approach speed slower than the standard speed used in a normal approach. This slower speed not only help with the approach angle, but it also helps to minimize float during the round out and flare. Both the steeper approach angle and the minimized float allows for more of the landing surface to be used by the pilot.
- Precise airspeed control at a slower than normal approach speed is the key to a successful short-field approach and landing. Flying the approach too fast leads to overshooting the touchdown point because of excessive float.
    - ACS standard are to maintain the recommended approach speed +10/-5 kts.
- During the round out and flare, there will be less float than normal. The aiming point will need to be closer to the target touchdown point than it is during a normal approach and landing (remember that a runway strip is 120 feet and the space between stripes is 80 feet).
    - ACS standards are to touchdown with minimal float within 200 feet beyond or on the specified landing point.
- Like all landings, it isn't over when the wheels touch the ground. For the short-field landing, the flaps should be raised, the stick back, with maximum effort braking. Stop as soon as possible without skidding the tires.
- Often, the seriousness of choosing an abort point is lost due to most runways being much longer than required for standard training aircraft. However, in an actual short-field landing scenario there will be little margin for sloppy technique. If the airplane is not on the ground by the abort point, go around!

Common Errors

- Flying the approach at too fast of an airspeed leading to excessive float.
- Failure to have the airplane configured early enough and overshooting aiming point.
- Failure to simulate the obstacle and instead dragging the airplane in with too much power.
- Failure to follow short-field procedures after the touchdown.
- Failure to reject the landing and go around when touchdown before the abort point is improbable.

Task J: Soft-Field Approach and Landing

Lesson Objective

Learn the soft-field approach and landing technique that is used when accessing runways or fields that are either soft or rough (or both).

Completion Standards

1. Learner understands when the soft-field technique is appropriate.
2. Learner flies the approach at the appropriate speed.
3. Learner touches down at minimum speed using power to cushion the descent making touch down as smooth as possible with no side load.
4. Learner protects the nose wheel with full aft elevator during the roll out while maintaining sufficient taxi speed until clear of the soft area.

Content

- Common surfaces appropriate for the soft-field technique are tall grass, wet or soft turf, or any type of rough surface that warrants extra care during the approach and touchdown. When performing a soft-field approach and landing, the objective is for a buttery-smooth touchdown at the lowest speed possible.
- Because soft fields are often short fields too, it is usually appropriate to use the short-field approach speed for the soft-field landing. Unless an obstacle is present, there is no requirement to fly a steeper-than-normal approach path. This means a shallower approach with power is acceptable if no obstacles are present.
    - ACS standard are to maintain the recommended approach speed +10/-5 kts.

  During the round out and flare, the goal is to touch down as smoothly and slowly as possible. A little bit of extra power should be used to cushion the touchdown *(just a little bit!).* Power can help the pilot transition the weight from the wings to the wheels in a smooth and controlled manner at the minimum touchdown speed.
- After touchdown, keep the nose off the ground for as long as possible to protect the nosewheel. Brakes will not be needed because the soft surfaces will slow the aircraft sufficiently. In fact, on a true soft surface power will be needed to keep the plane rolling. Keep the aircraft rolling until off the soft surface.
    - ACS standards are to maintain elevator aft pressure and sufficient speed until exiting the soft area.

Common Errors

- Adding too much power during the round out and flare.
- Failure to protect the nose wheel.

Task K: Power-Off 180 Accuracy Approach and Landing

Lesson Objective

Learn to land on a predetermined spot without the use of power starting from the position abeam the aiming point all the way until the landing.

Completion Standards

1. Learner flies a consistent traffic pattern at standard speeds.
2. Learner intuitively manages the descent profile of the approach by using approach geometry, flaps, and forward slips.
3. Learner understands how to adjust the approach for varying wind conditions.

Content

- Landing on the desired touchdown point without the use of power requires judgment in estimating distances, glide ratio, effects of wind, etc. This judgment is developed through thoughtful practice.
- A successful power-off 180 accuracy approach and landing starts with consistency in the traffic pattern. The first key position is on the downwind abeam the aiming point. This is where power

will be pulled to idle. Arrive at this “gate” at the appropriate altitude and airspeed to provide a familiar starting point for each power-off 180.

- Wind is an uncontrollable variable that must be accounted for. Headwinds decrease glide ratio and tailwinds increase glide ratio. Know where the winds are from and anticipate their effect on the glide. Approach geometry, flaps, forward slips, and the propeller pitch are a few ways that the power-off approach can be managed.
- Turn base at a distance appropriate for the conditions of the day. If turning on to the base will be accompanied by a tailwind, more space will be needed to not overshoot the aiming point. It is best to be slightly high on the approach than slightly low. The base leg is the second key position. From this base leg position, the decision can be made on what flap setting is needed and what approach geometry is needed to maintain a glide to the aiming point at the desired airspeed. If too low, delay flaps and round the base turn into the final. If too high, add full flaps and square the turn from base to final. If still too high, a forward slip can bleed off extra altitude while maintaining an appropriate approach speed.

Common Errors

- Failure to consistently fly a standard traffic pattern at standard speeds.
- Failure to adjust the approach for changing wind conditions.
- Turning base too soon and ending up too high over final.
- Attempting to “stretch” the glide.

Task L: N/A – Seaplanes

Task M: N/A – Seaplanes

Areas of Operation VIII: Fundamentals of Flight

Have student read *Stick and Rudder* - Part IV: The Basic Maneuvers.

Task A: Straight-and-Level Flight

Lesson Objective

Learn to fly straight and level. Straight and level flight is the first of four fundamental maneuvers (the other three being level turns, climbs, and descents). Straight flight is accomplished by keeping the wings level while maintaining coordinated flight. Level flight is accomplished by maintaining a pitch and power combination that results in neither a climb nor a descent. During straight and level flight, the heading and the altitude will be constant.

Completion Standards

1. Learn how to choose external reference points to help maintain straight and level flight.
2. Learn how to cross-check visual sight picture against flight instruments to determine any adjustments needed.
3. Learn to hold the yoke lightly and to trim the airplane for level flight.
    a. Learn the proper technique for trimming for cruise after the climb.
4. Learn to maintain a specified heading ±20°, ±10 kts airspeed, and altitude ±200 feet.

Content

- Use external reference points to maintain the proper attitude for straight and level flight. Cross-check the instruments to verify that the attitude is appropriate to maintain straight and level flight. Drawing reference points on the windscreen with a dry erase marker will be helpful. Most of the pilot's focus should be outside the cockpit. In fact, the FAA recommends looking outside 90% of the time and looking inside at the instruments only 10% of the time.
    - Incorporating the flight instruments into a maneuver is known as the integrated method of flight instruction. This helps the student understand how the visual maneuvers correlate to instrument indications. As mentioned above, the majority of the time should be spent looking at external reference points—not the instruments.
    - Rapidly diving attention between outside reference points and the instruments allows the pilot to quickly identify undesirable trends and to fix them before a major deviation occurs. "The only different between a good pilot and a bad pilot is that a good pilot fixes mistakes before anybody else notices them."
- To fly straight, fly towards a point that is picked out in the distance. Don't get distracted by the massive field of view—pick out a point and fly to it. Cross-check against the heading to verify straight flight.
- To fly level, determine the amount of space between the cowling (or some other reference point) and the horizon. Cross-check against the altimeter and make small adjustments as necessary.
- Trim is crucial to maintaining level flight. Do not fight the airplane. Trim away any forces that are required to maintain level flight. Keeping a light grip on the yoke is essential to being sensitive to nose up or nose down forces that need to be trimmed away.

- Private pilot ACS standards are to maintain a specified heading ±20°, ±10 kts airspeed, and altitude ±200 feet.

Common Errors

- Failure to fly straight and level due to either not using external visual references or not cross checking these references against the instruments to determine the adjustments needed.
- Failure to grip the yoke lightly leading to a tendency to overcontrol and to a lack of sensitivity.
  - Lack of sensitivity results in not knowing if the airplane is properly trimmed.
- Failure to accelerate to cruise speed during the level off before trimming the airplane.

Task B: Level Turns

Lesson Objective

Learn to turn the airplane while maintaining level flight.

Completion Standards

1. Learner understands how the airplane turns.
2. Learner understands what adverse yaw is and the purpose of the rudder in counteracting it.
3. Learner clears the area before starting the maneuver.
4. Learner maintains altitude ±200 feet, maintains a standard rate turn, and rolls out on assigned heading ±10° all while maintaining airspeed ±10 kts.

Content

- How does an airplane turn? The book *Stick and Rudder* explains it like this: "An airplane is turned by laying it over on its side and lifting it around through back pressure on the stick." Chapter 12 of *Stick and Rudder* is highly recommended to get a better understanding of this concept. Ailerons put the airplane into the bank and the lift from the wings, now angled in the direction of the bank, pulls the airplane sideways through the air. The tail on the airplane then makes the airplane weathercock so that it flies straight into the relative wind. Thus, the wing tilted on its side pulls the aircraft sideways while the tail forces the nose to constantly realign itself into the wind. To maintain level flight during the turn, the wing must be flown at a higher angle of attack because the lift vector now is being split it both a horizontal and vertical component. The vertical component can only maintain its original magnitude if the total lift is increased. This total lift is increased by increasing the angle of attack by using the elevator. Thus, a level turn is entered by banking the aircraft and increasing the angle of attack through back pressure on the yoke. The amount of back pressure depends on the angle of bank. Steep turns will require significantly more back pressure than shallow turns. The only function of rudder during the turn is to counter adverse yaw.
- Adverse yaw is created by the difference in drag between the left wing and the right wing. Drag is a byproduct of lift. Ailerons move differentially. Entering a left bank, for example, causes the right aileron to deflect down and left aileron to deflect up. In the increased drag on the right wing relative to the left wing creates a yawing moment to the right. To maintain coordinated flight, this yawing must be corrected by use of left rudder. Rolling to the left requires left rudder; rolling to the right requires right rudder. This holds for rolling both into and out of banks. The

roll rate affects the amount of rudder needed. The faster the roll rate, the more rudder that is required to maintain coordinated flight.

- When turning to a heading, the rollout has to be timed so that the wings are level when the desired heading is reached. A good rule of thumb is to lead the rollout by half the bank angle. If turning with a 30° bank, start the rollout about 15° before the desired heading.
- In steeper banks at low speeds, the airplane will tend to overbank. This is caused because the wing towards the outside of the turn has a larger radius and therefore faster speed than the inside wing. This increased speed leads to increased lift which makes the airplane tend to increase its bank. Opposite aileron may be needed to counteract this effect.
- Perform a clearing turn before starting the maneuver. In a high wing aircraft, check for traffic in the direction of the turn by lifting the wing before starting the bank.
- Use the sight picture of the horizon on the glareshield to measure bank angle and pitch attitude. Cross-check this sight picture against the instruments and make adjustments as necessary.

Common Errors

- Failure to use the proper amount of rudder when rolling into and out of a bank.
- Failure to clear the area.
- Failure to use visual references to establish and maintain the appropriate sight picture.
- Failure to cross-check the sight picture against the instruments to ensure the sight picture is achieving the desired results.

Task C: Straight Climbs and Climbing Turns

Lesson Objective

Learn to climb during straight flight and during turns.

Completion Standards

1. Learner understands how the airplane climbs.
2. Learner clears the area before starting the maneuver if involving turns.
3. Learner transitions to the climb pitch attitude and power setting while maintaining heading and cross-checks against the flight instruments.
4. Learner climbs at a constant airspeed during straight flight and turns.
5. Learner levels off at the assigned altitude and maintains altitude ±200 feet, heading ±20°, and airspeed ±10 kts (private pilot ACS).
6. Learner understands how to transition from the climb to level flight.

Content

- At a given airspeed, more power is required to climb than to maintain level flight. This is fairly intuitive because we all know going uphill is more difficult than traveling along level ground. The thrust from the propeller no longer has to exclusively balance the drag force, but now must balance the drag force and the component of gravity along the climb gradient. Airplanes are trimmed to fly at a specific angle of attack. Thus, the aircraft will attempt to maintain the same airspeed regardless of the power setting (ignoring, for a moment, the changes in the slipstream). Adding power to an aircraft trimmed for cruise will result in a climb at that same airspeed. If the power is already at the maximum setting, then a climb can only be commended by flying at a higher angle of attack (and thus slower airspeed). A new trim setting will be required to fly at this new angle of attack. At the slower speeds, with higher power and angle of attack, the left turning tendencies (asymmetric thrust, spiraling slipstream, and torque) become more pronounced. Thus, climbs will require right rudder to maintain coordinated flight.

- Climbs are typically flown at a constant airspeed—not a constant vertical speed. Monitor to VSI as a measure of the climb performance, but pitch for the airspeed to get that desired performance.
- To enter a climb, pitch up, add power, and add rudder. This all happens simultaneously. Pitch for the familiar sight picture and trim for the new airspeed. Verify the pitch by cross-checking the airspeed indicator. After establishing the climb, perform and flow check followed by a checklist.
    - Use a dry-erase marker to put a dot in the "Lindbergh reference." Looking out the "Lindbergh reference" will be essential in maintaining the sight picture for the climb because it will be difficult, if not impossible, to see over the nose.
- During a climb, the airplane will be (or at least should be) trimmed for flight at the climb angle of attack. When leveling out for cruise flight, the airplane will accelerate and the angle of attack will need to be smaller. Thus, a trim change will be required. Rather than fight with the trim as the airplane builds speed, the best technique is to hold the airplane at the proper attitude with the yoke while maintaining the climb power setting and wait for the airplane to accelerate to cruise speed. When cruise speed is achieved, the power should be reduced to the cruise setting and the airplane should be trimmed for level flight.
    - A good rule of thumb is to lead the level off by about 10% of the vertical speed. If climbing at 500 feet per minute, start the level off 50 feet before desired cruising altitude.
- To turn while climbing, incorporate the same principles learned in the lesson on turns while maintaining the pitch attitude needed for the airspeed desired for the climb. The idea is simple, but connecting these two fundamentals will require some practice. Before starting the maneuver, perform a clearing turn.

Common Errors

- Failure to perform a clearing turn before performing a climbing turn.
- Failure to compensate for left turning tendencies during the climb.
- Failure to maintain the proper climb attitude for the desired airspeed throughout the climb.
- Failure to follow the proper procedure for levelling off after the climb.
- Failure to perform a flow check and checklist after establishing the climb and after the level off.
- Failure to maintain heading during the straight climb.
- Failure to maintain desired turn rate during the turning climb.

Task D: Straight Descents and Descending Turns

Lesson Objective

Learn to descend during straight flight and during turns.

Completion Standards

1. Learner understands how the airplane descends.
2. Learner clears the area before starting the maneuver if involving turns.
3. Learner maintains primary focus outside of the cockpit and reference the appropriate instruments to verify that the desired results are being achieved.
4. Learner establishes and maintains a descent at the desired descent rate and at the desired airspeed.
5. Learner performs and flow check backed up by a checklist after establishing the descent.
6. Learner can level off at the desired airspeed. ACS private pilot standards are to level off at the assigned altitude and maintain altitude ±200 feet; heading ±20°; and airspeed ±10 kts.

Content

- The typical way to start a descent is by reducing power. During cruise, the aircraft is trimmed for the angle of attack which gives level flight at the cruise power setting. When the power is reduced, the aircraft is still trimmed for the same angle of attack as during cruise. The only way to maintain the same angle of attack at the lower power setting is for the aircraft to maintain its airspeed by dropping the nose. This will happen automatically without any input from the pilot. Thus, reducing the power is a natural way to start a descent at an airspeed approximately the same as the cruise airspeed. Slight variations in speed will occur because power affects the slipstream which acts on the horizontal stabilizer.
    - Descent at airspeeds higher than cruise will require flying at a lower angle of attack. This can be accomplished by leaving the power at the cruise setting and lower the nose with the yoke and trimming away the pressure.
    - Descent at airspeeds slower than cruise will require flying at a higher angle of attach. This can be accomplished by reducing power, pitching for the desired airspeed (angle of attack), and trimming away the pressure.
- Use the horizon as the reference point to hold the pitch that gives the desired airspeed for the descent rate needed. At lower power setting, left rudder may be needed. This is because the aircraft is set up during cruise to fly coordinated with no rudder pressure. Reducing the power reduces the normal left turning tendencies. Thus, the aircraft's design and trim condition will likely lead to excessive yaw to the right. Correct with left rudder and trim away the pressure if rudder trim is available.
- Keep the descent stable by pitching for the desired airspeed for the needed descent rate. Hold this sight picture and occasionally reference the instruments. This, under normal circumstances, will lead to a constant rate of descent if the power is held constant. If flying in updrafts and downdrafts, power will need to be adjusted to maintain a constant rate of descent at a constant airspeed. A standard descent rate in a small plane is 500 feet per minute.
- During straight descents, fly to the external reference point off in the distance as discussed in Task A. In turning descents, clear the area first. Couple the descent with the same turning process learned in Task B.
- As always, once trimmed for the desired descent profile, perform a flow check backed up by the descent checklist.
- Start the level-off procedure at an altitude 10% of the vertical above the desired level off altitude. Start the level off by adding power and adjusting pitch as necessary. Adjust trim as necessary once the airspeed has stabilized in level flight.

   - ACS standards are to level off at the assigned altitude and maintain altitude ±200 feet; heading ±20°; and airspeed ±10 kts.

Common Errors

- Failure to maintain the desired descent rate. There is a tendency to let the descent shallow out.
- Failure to maintain coordinated flight during the descent (left rudder may be needed).
- Failure to perform a flow check backed up by a checklist after the descent is established.

Areas of Operation IX: Performance Maneuvers

Task A: Steep Turns

Lesson Objective

Learn to smoothly control the airplane in steep-banked turns to the left and right. The bank angle will be between 45° and 60°.

Completion Standards

1. Learner understands the elements of the steep turn.
2. Learner properly divides attention between external reference points and instruments.
3. Private pilot ACS: Speed no greater than V_A. Maintain the entry altitude ±100 feet, airspeed ±10 kts, bank angle of 45° ±5°, and roll out on heading ±10°.
4. Commercial pilot ACS: Speed no greater than V_A. Maintain the entry altitude ±100 feet, airspeed ±10 kts, bank angle of 50° ±5°, and roll out on heading ±10°. Immediately roll into the opposite direction turn after completion of the first turn.

Content

- There are a couple of tendencies an airplane has in turning flight that the pilot has to account for. The first is the need to fly at an increased angle of attack. In a turn, the lift vector no longer points straight up. Instead, the lift vector points in a direction perpendicular to the banked wing. If the airplane is put into a bank without changing the angle of attack, then the lift vector will be the same magnitude as before the turn but will now be split up into a horizontal component and a vertical component. To remain in level flight, though, the vertical component still has to be the same magnitude as it was before the turn. To accomplish this, the pilot must fly the wing at a higher angle of attack (pull back slightly on the yoke). If this is not done, the airplane will enter a turning descent. This is true of shallow turns as well, but the effects are less pronounced and can sometimes almost be unnoticeable. Flying at a higher angle of attack at the same airspeed as before the turn creates more lift than weight. Unbalanced forces mean that the airplane is accelerating (not in speed, but via change in direction in the turn). This acceleration will be felt by the pilot as increased load factor. Load factor, and thus stall speed, increases with bank angle. At 30° of bank the load factor is 1.15, at 45° the load factor is 1.4, and at 60° the load factor is 2.0. Remember that the stalling angle of attack only corresponds to the published stall airspeed for a load factor of 1.0. At higher load factors, the stall speed will increase. The second tendency a pilot must account for is the overbanking tendency. In a turn, the outside wing travels a farther distance in the turn than the inside wing. Because both wings fly the circle in the same amount of time, it can be deduced that the outside wing travels through the air at a higher airspeed than the inside wing. This leads to more lift being generate by the outside wing relative to the inside wing. This creates an overbanking tendency. This is usually only noticeable in steep-banked turns. Opposite aileron is required for the bank not to become steeper. It can feel odd to hold right aileron in a left turn! If the pilot enters a steep turn without compensating for both the needed increase in lift or for the overbanking tendency, the airplane will naturally go into a spiral descent. In this descent the bank angle will steepen, the load factor will increase, and the airspeed will increase. This can get bad very quickly if not recovered from correctly (level the wings and slowly get the pitch back level).

- Clear the area before performing the maneuver. Pick out a reference point and note the heading. Entry speed should be no greater than V_A. If the manufacturer recommends an airspeed, use it. Power will need to be increased slightly to maintain the entry airspeed throughout the turn. Fly the sight picture that gives the appropriate bank angle and maintains altitude. If the airplane starts descending, decrease the bank and increase pitch. Reestablish the bank once the descent has been corrected for. If climbing, a combination of increasing bank and decreasing pitch will help.
- Begin the rollout at a heading of about half the bank angle before the desired final heading.

Common Errors

- Failure to clear the area before starting the maneuver.
- Failure to pick a clear external reference point for the maneuver.
- Failure to increase angle of attack enough to keep the aircraft from descending.
- Failure to properly correct for altitude deviations.
- Failure to maintain entry airspeed.
- Failure to compensate for the overbanking tendency.

Task B: Steep Spirals

Lesson Objective

Steep spirals allow the aircraft to descend rapidly while maintaining flight around a pre-selected point on the ground. This maneuver is especially useful for emergency descents and landings. The objective for this lesson is to understand the concepts and learn the techniques of flying the steep spirals maneuver.

Completion Standards

1. Learner understands the key elements of steep spirals.
2. Learner selects an altitude sufficient to complete three 360° turns before reaching 1,500 feet AGL.
3. Learner clears the area before starting the maneuver.
4. Learner maintains a constant-radius ground track around the point by making adjustment in bank for the wind while not exceeding 60° of bank at the steepest part of the turn.
5. Learner appropriately divided attention between maintaining ground track and maintaining aircraft control.
6. Commercial pilot ACS standards: maintains airspeed ±10 kts, and rolls out on desired heading ±10° (the heading at the end of the maneuver should match the heading at the beginning of the maneuver)

Content

- Steep spirals are a ground reference maneuver. Assuming the winds are not calm, the bank angle will need to be varied throughout the turn to maintain a constant radius from the selected point on the ground. The steepest bank will be needed during the downwind portion of the turn. The shallowest bank will be during the upwind portion of the turn. This is because turn radius is proportional to the square of the groundspeed. With groundspeed increasing, the only way to hold the radius constant is by increasing the bank angle.

- This maneuver is flown with power at idle to expedite the descent, but short bursts of power are recommended to clear the engine after each full turn (preferably during the upwind portion of the turn). No particular speed is required by the ACS, but an airspeed at or slightly above best-glide airspeed would be appropriate to maintain a relatively small radius without requiring excessively steep bank angles.
- Maintaining the target airspeed during this maneuver can be a challenge because of the changing bank angle. As the bank changes, different amounts of back pressure will be needed to control the airspeed. Not controlling the airspeed will lead to even more variables to control for when trying to maintain a constant-radius turn.

Common Errors

- Failure to clear the area for traffic before starting maneuver.
- Failure to control the airspeed as bank angle is increased and decreased throughout the turn.
- Failure to choose a proper radius from the point to ensure the steepest bank will not exceed 60°.
- Failure to maintain orientation to the reference point during the spirals.

Task C: Chandelles

Lesson Objective

Mastering chandelles requires the pilot to be intimately familiar with the characteristics of the airplane. This maximum-performance maneuver involves varying airspeeds and attitudes and requires skillful control by the pilot. Flown to the proper standards, the chandelle will result in a 180° change in direction while gaining the most altitude possible. The objective of this lesson is to understand chandelles and master the skills required to fly them.

Completion Standards

1. Learner understands the key elements of the chandelle.
2. Learner selects an altitude of at least 1,500 feet AGL to begin the maneuver.
3. After clearing the area for traffic, the learner configures the airplane for cruise flight (flaps and gear up) and selects a power setting appropriate to start the maneuver at V_A.
4. Learner immediately establishes a 30° bank at the beginning of the maneuver and simultaneously applies full power and pitches up at a steady rate in a climbing turn to the 90° reference point. This first half of the maneuver should have the bank constant at 30°.
5. After the 90° reference point, pitch should be held constant while the bank is brought back to level at a constant rate. The maneuver should end with wings coming level at the 180° reference point, with pitch still at the maximum angle from the 90° reference point, with airspeed just above the stalling speed.
6. Learner resumes straight-and-level flight at the end of the maneuver.
7. Commercial pilot ACS: roll out at the 180° point ±10° just above the stall airspeed.

Content

- Chandelles are best understood by dividing the maneuver into two halves—the first 90° and the second 90°. As such, a clear reference point at the 90° point is essential. As always, clear the area before beginning the maneuver. The first half of the 180° maneuver is characterized by constant bank and increasing pitch. The second half of the 180° climbing turn is characterized by constant pitch and decreasing bank. The maximum pitch up attitude occurs at the 90° reference point. After this, the same pitch attitude must be maintained throughout the second half of the maneuver. Because of this, timing the rate of pitch increase during the first 90° of the maneuver is essential. Too much pitch results in stalling before completing the 180° turn. Too little pitch and the airspeed won't be close enough to stall at the end of the maneuver. The goal is to have the airplane almost at stalling speed at the conclusion of the chandelle. Being barely above the stall speed at the end of the chandelle shows that all the energy of the aircraft was converted into altitude. At the conclusion of the maneuver, momentarily hold wings level just above the stall speed before transitioning into straight and level flight.
- Maintaining coordinated flight throughout the chandelle can be challenging. "Setting and forgetting" the rudder will not work. At maximum power, the airplane's left turning tendencies will become more pronounced as the airspeed slows. Add rudder as needed to coordinate the turn.
- The chandelle is another maneuver where the overbanking tendency must be accounted for. During the first half of the maneuver, the bank angle is supposed to be constant at 30°. The overbanking tendency becomes more pronounced at slower airspeed. As the airspeed slows because of increasing pitch, there will be a tendency for the aircraft to bank beyond the 30° point. Make adjustments in the ailerons as needed to maintain the correct bank angle.

Common Errors

- Failure to clear the area before starting the maneuver.
- Failure to maintain 30° of bank throughout the first half of the maneuver.
- Failure to properly time pitch and bank changes.
- Failure to maintain constant pitch in the second half of the maneuver.
- Failure to maintain coordinated flight throughout the maneuver.

Task D: Lazy Eights

Lesson Objective

The hallmark feature of lazy eights is that everything is changing. Pitch, bank, airspeed, and altitude are all changing throughout the maneuver. Lazy eights demonstrate that the pilot has finesse in controlling the aircraft through a wide range of airspeeds and attitudes. This maneuver teaches the learner about the overbanking tendency and about the secondary effects of the flight controls. The objective of this lesson is to understand lazy eights and master the skills required to fly them.

Completion Standards

1. Learner understands the key elements of the lazy eights maneuver.
2. Learner selects an altitude that allows the task to be completed no lower than 1,500 feet AGL.

3. Learner clears the area and begins the maneuver in level flight with the power set for an airspeed not greater than V_A.
4. Learner maintains coordination throughout the maneuver.
5. Learner performs as many lazy eights as specified by the examiner and then resumes straight and level flight.
6. Commercial pilot ACS: approximately 30° of bank at the steepest point in the maneuver; constant change of pitch, roll rate, and airspeed; at the 180° points altitude must be the same as entry altitude ±100 feet, airspeed the same ±10 kts, and heading ±10°.

Content

- Flying lazy eights can be difficult if the pilot works too hard and tries to force the airplane through the maneuver. Instead, a gentler approach can almost result in the airplane flying the maneuver automatically with the pilot simply coaxing the airplane along. The channel *The Finer Points* on YouTube has a video on lazy eights that is extremely helpful. Watch it. In a turn, especially at slow airspeeds, the airplane tends to overbank. This tendency was dealt with in detail in the Steep Turns lesson plan. In lazy eights, the overbanking tendency can be used to the pilot's advantage. After clearing the area, the lazy eight will begin in level flight at a speed not above V_A. Make sure to have picked out clear reference points for 45°, 90°, and 135°. The first 45° of the turn consists of introducing an almost unnoticeable amount of bank (approximately 5°) and pitching up. As the airplane is slowing because of the pitching up, the overbanking tendency will increase the bank angle without any aileron input from the pilot. The goal is to be at about 15° of bank and at the maximum pitch-up attitude at the 45° point of the maneuver. As the airplane continues its turn to the 90° reference point, the overbanking tendency will increase the bank angle. During this second portion of the maneuver, back pressure should be slowly released so that the nose of the airplane gently falls through the horizon at the 90° reference point. The bank angle at this point should be approximately 30° and the airspeed should be at its minimum for the maneuver. The next portion of the maneuver is the turn to the 135° reference point. This turn is characterized by decreasing bank, lowering pitch, and increasing airspeed. At the 135° point, the airplane should be at about a 15° bank and at its maximum pitch-down attitude. The final portion of the maneuver is the completion of the 180° turn. During this last portion, the remaining bank is slowly removed and the pitch is slowly increased so that at the 180° point the airspeed and altitude matched the airspeed and altitude at the beginning of the maneuver. The initial 90° reference point is a good reference point to use to time this rollout. If starting the maneuver with a left turn, then the 90° reference point should be off the right wing at the conclusion of the first half of the lazy eight. Next, the same procedure as outlined above is followed except the turn will be to the right. One noticeable difference, however, is the amount of right rudder needed to maintain coordinated flight. In the right turn, not only is right rudder needed to counteract the adverse yaw from the roll rate, but right rudder is also needed to counteract the left turning tendencies that become more pronounced as the aircraft pitches up and slows down. Take extra care to maintain coordinated flight in the right turning portion of the lazy eight. If not using enough right rudder to stay coordinated, the bank and the turn will not progress as expected and the whole maneuver will fall apart.

- Timing is critical to properly perform a lazy eight. How fast pitch is increased and decreased, and the rate of rollout from the bank are all extremely important to the success of the maneuver. Practice is required to get this timing figured out.
- Lazy eights can teach the observant student about the secondary effects of the flight controls. These effects are called “secondary” because they are not the primary purpose of the flight controls that are being deflected. For example, the primary effect of the elevator is to control the angle of attack of the wing. The secondary effect of increasing the angle of attack, though, is a decrease in airspeed. The primary function of the ailerons is to induce a roll rate to establish a bank angle. The secondary effect, however, is adverse aileron yaw due to the roll rate (there are some other effects caused by the bank angle itself that induce yaw). The primary effect of the rudder is to yaw the aircraft. However, a secondary effect of yaw is that it creates a rolling moment in the direction of the yaw. Lazy eights demonstrate all these secondary effects.

Common Errors

- Failure to clear the area.
- Failure to perform the maneuver with finesse.
- Failure to allow the airplane to bank enough. Do not get hung up on being at exactly the bank angles suggested by the ACS.
- Failure to pick out appropriate reference points.
- Failure to use enough right rudder during the right turning portion of the lazy eight.
- Failure to time the release of the back pressure and the roll out such that the airspeed and altitude at the conclusion of the left and right turn match the entry airspeed and altitude.

Areas of Operation X: Ground Reference Maneuvers

Task A: Rectangular Course

Lesson Objective

The rectangular course is a ground reference maneuver that helps prepare the learner for flight in the traffic pattern. In this maneuver, the learner flies the airplane such that it maintains an equal distance from the selected rectangular reference on the ground. The objective of this lesson is for the learner to develop the knowledge and skills required to fly the rectangular course while maintaining constant altitude, airspeed, and distance from the ground references.

Completion Standards

1. Learner understands the elements of the rectangular course.
2. Leaner selects a suitable reference area.
3. Learner clears the area before performing the maneuver.
4. Learner enters the maneuver on the 45° to the downwind.
5. Learner enters the maneuver at 600 to 1,000 feet AGL.
6. Learner maintains a constant distance from the edges of the reference area.
7. Learner divides attention between airplane control and the ground track while maintaining coordinated flight.
8. Private pilot ACS: Maintain altitude ±100 feet and airspeed ±10 kts.

Content

- In the traffic pattern, it is critical to have the skills required to fly the desired track over the ground. In cruising flight, maintaining a ground track is relatively simple because the direction of flight remains the same. All you do is figure out the wind correction angle and then make slight adjustments as needed. However, in a typical traffic pattern, a rectangular course is flown causing the effects of wind on the ground track to change during each turn.
- The rectangular course should be flown between 600 and 1,000 feet AGL over a suitable rectangular reference point (perhaps a large field). Obstacles permitting, 800 feet AGL will be the standard altitude used. Clear the area before beginning the maneuver. Because of the low altitude required, select a suitable emergency landing area before starting the maneuver.
- Visualize the effects of the wind on the rectangular course to prepare for the maneuver. Have an expectation of what the different turns and headings will look like before starting the rectangular course.
- All ground reference maneuvers are entered downwind after clearing the area for traffic. Join the downwind on a 45° angle.
- If there are winds aloft, then the bank angle for each corner of the rectangular course will need to vary in order to maintain the equal distance from the reference. Turn radius for a given bank angle is proportional to the square of the groundspeed. Using this knowledge, it becomes apparent that the turn from downwind requires the steepest bank angle. Conversely, the turn from the upwind leg requires the shallowest bank. Bank angles during the turn will need to be adjusted as ground speed either increases or decreases due to the wind's effect on groundspeed. This will become second nature with practice. The amount of heading change in the turn will be more or less than 90° depending on if turning into a crosswind from the left or

right. Adjust the heading as necessary to maintain a ground track equal distance from the edges of the rectangular reference area. Picture in your mind a laser beam shooting straight down from the airplane—you want this laser beam to etch a rectangular course equal distance from the edges of the ground reference.

- Maintain coordinated flight throughout the turns.

Common Errors

- Failure to clear the area for traffic.
- Failure to establish level altitude at a constant airspeed before starting the maneuver.
- Failure to properly divide attention between airplane control and ground track.
- Failure to maintain coordinated flight—do not use the rudder for anything else during this maneuver!
- Failure to allow enough time before starting the turn from upwind to crosswind. This turn will be a shallower more gradual bank relative to the turn from downwind.
- Failure to plan for the effects of the wind and to apply the correct wind correction angles.
- Failure to maintain constant altitude and airspeed throughout the maneuver.

Task B: S-Turns Across a Road

Lesson Objective

Like the rectangular course, the objective of S-turns across a road is to develop the learner's ability to maintain precise control of ground track while operating at relatively low altitudes. These skills will transfer to the traffic pattern.

Completion Standards

1. Learner understands the elements of S-turns across a road.
2. Leaner selects a suitable road or reference line perpendicular to the wind.
3. Learner clears the area before performing the maneuver.
4. Learner enters the maneuver on the downwind perpendicular to the reference line.
5. Learner enters the maneuver at 600 to 1,000 feet AGL.
6. Learner adjusts the bank angle so that two equal-sized semi-circles are formed on either side of the reference line.
7. Learner reverses the direction of the turn when passing over the chosen reference line.
8. Learner divides attention between airplane control and the ground track while maintaining coordinated flight.
9. Private pilot ACS: Maintain altitude ±100 feet and airspeed ±10 kts.

Content

- S-turns across a road are performed by finding a road (or other reference line) that is perpendicular to the wind direction. Find a suitable road and clear the area before starting the maneuver. Because of the low altitude required, select a suitable emergency landing area before starting the maneuver.
- This maneuver should be flown between 600 and 1,000 feet AGL and should be entered on the downwind crossing perpendicular to the road. After crossing the road to start the maneuver,

there will be no more straight and level flight. Enter a bank immediately after crossing the road. Because ground speed is highest during the downwind entry, this initial bank will be the steepest of the maneuver. Use the airplane's ground track to trace out a semi-circle. The wings should come back level after the first 180° change in ground track at the same time as the road is crossed. The wings should pass through level and immediately go into a bank in the opposite direction.

- The second half of the maneuver is the same as the first half except the turn will be made in the opposite direction. This time, however, the airplane is traveling upwind. For the two semi-circles to be the same radius, the bank angle will need to be smaller during the turn from upwind. Be patient here and do not bank too much. Depending on the wind, the difference in bank angles required between the two semi-circles can be drastically different. Adjust the bank as needed to trace out the second semi-circle so that the airplane crosses the road wings level as the second course change of 180° is completed.
- The bank angle throughout both turns will need to constantly change as the effects of wind try to alter the ground track. When turning from the downwind, the steepest bank will be required. As the downwind transitions into a crosswind, the bank angle will need to be shallowed. Turning into the headwind requires patience. Here the required bank angle may need to be very shallow. The second semi-circle must be the same size as the semi-circle created during the first part of the maneuver. The initial bank from the headwind into the crosswind may need to be very shallow. Not being patient here will leave you with a tiny semi-circle. As the headwind transitions into a crosswind and then a tailwind, the ground speed will increase requiring an increase in bank angle.

Common Errors

- Failure to clear the area for traffic.
- Failure to take the time required to pick out a good reference line.
- Failure to establish level altitude at a constant airspeed before starting the maneuver.
- Failure to properly divide attention between airplane control and ground track.
- Failure to maintain coordinated flight—do not use the rudder for anything else during this maneuver!
- Failure to plan for the effects of the wind and adjust bank accordingly.
- Failure to achieve equal radius turns over both sides of the road.
- Failure to maintain constant altitude and airspeed throughout the maneuver.

Task C: Turns Around a Point

Lesson Objective

Like the rectangular course and S-turns across a road, the objective of turns around a point is to develop the learner's ability to maintain precise control of ground track while operating at relatively low altitudes. These skills will transfer to the traffic pattern. The objective of this lesson is to develop the skills required to make a turn around a reference point on the ground while maintaining a constant radius between the aircraft and the point on the ground.

Completion Standards

1. Learner understands the elements of turns around a point.
2. Leaner selects a prominent reference point on the ground.
3. Learner clears the area before performing the maneuver.
4. Learner enters the maneuver at 600 to 1,000 feet AGL on the downwind at the desired radius from the reference point.
5. Abeam the reference point, the learner immediately rolls into the bank angle required to maintain a constant radius from the reference point.
6. Learner maintains a constant radius from the ground reference point throughout the maneuver.
7. Learner completes at least two 360° turns in the direction specified.
8. Learner divides attention between airplane control and the ground track while maintaining coordinated flight.
9. Private pilot ACS: Maintain altitude ±100 feet and airspeed ±10 kts.

Content

- Turns around a point are performed by finding a prominent reference point on the ground (cross-roads, tree, irrigation pivot, etc.). Clear the surrounding area before starting the maneuver. This maneuver, like the other ground reference maneuvers, should be performed between 600 to 1,000 feet AGL. Because of the low altitude required, select a suitable emergency landing area before starting the maneuver.
- When abeam the reference point, bank the aircraft to maintain a constant radius turn around the point. The initial bank will be the steepest required for the maneuver because the ground speed will be the highest due to entering the maneuver downwind. Proper spacing from the point while setting up for the maneuver should allow for the steepest bank angle not to exceed 45°. If more than 45° is required, the maneuver is likely being flown at too short of a radius from the reference point.
- As the aircraft turns, the tailwind will turn into a crosswind and then into a headwind. As the ground speed slows, the bank angle will need to be reduced to maintain a constant turn radius. As the ground speed increases, the bank angle will need to be increased.
- Complete at least two 360° turns in whichever direction specified by the instructor or examiner.
- Throughout the maneuver, the airspeed and altitude should be constant.

Common Errors

- Failure to clear the area for traffic.
- Failure to establish level altitude at a constant airspeed before starting the maneuver.
- Failure to properly divide attention between airplane control and ground track.
- Failure to maintain coordinated flight—do not use the rudder for anything else during this maneuver!
- Failure to plan for the effects of the wind and adjust bank accordingly. Don't "get squashed" on the upwind portion of the turn. The bank angle needed may be very small because of the slow ground speed. It is easy to get too close to the reference point on the upwind.
- Failure to maintain a constant turn radius.
- Failure to maintain constant altitude and airspeed throughout the maneuver.

Task D: Eights on Pylons

Lesson Objective

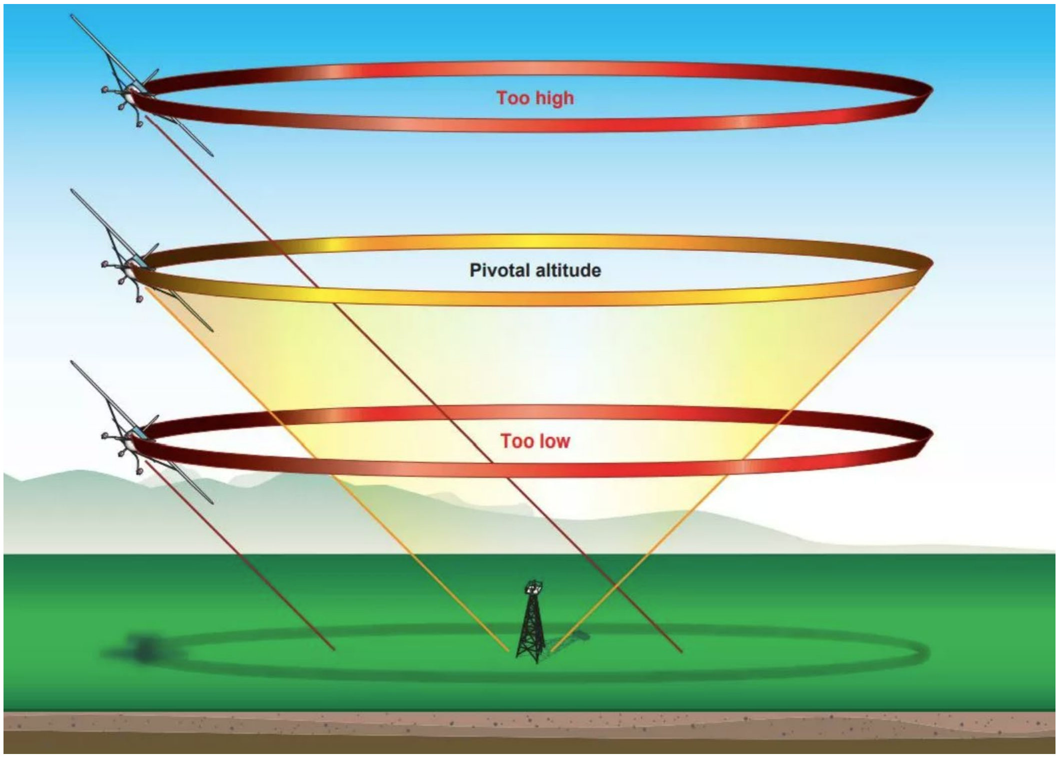
Eights on pylons are the most complex of the ground reference maneuvers. The lesson objective is for the learner to understand pivotal altitude and to learn the skills required to keep the airplane at the pivotal altitude, which is constantly changing, throughout the maneuver. Successfully flying the eights on pylons maneuver challenges the learner to maintain a pivotal position on the selected pylons while smoothly and carefully controlling the aircraft.

Completion Standards

1. Learner understands what the pivotal altitude is and why it is special.
2. Learner selects two reference points on the ground to serve as the pylons for the maneuver. These should be far enough apart to allow for 3-5 seconds of level flight between turns.
3. Learner clears the area before performing the maneuver.
4. Learner calculates the pivotal altitude for the start of the maneuver.
5. Learner enters the maneuver at the pivotal altitude for the initial groundspeed. Bank angle should not exceed 40° at the steepest point.
6. Learner maintains pylon position by using appropriate pivotal altitude, avoiding slips and skids.
7. Learner maintains coordination.
8. Learner divides attention between airplane control and ground references.

Content

- The pivotal altitude is a special altitude that can be difficult to understand. The image below will help. The first concept to understand is the line-of-sight reference line that is parallel to the lateral axis of the airplane. This is represented in the image below by the red line from the airplane down to the ground. The lateral axis of the airplane is the axis that the airplane pitches around. The line-of-sight reference line is formed by the pilot looking out from his position in the cockpit along a line parallel to this lateral axis. In the figure below, the tower represents the center of the turn. In the general case, the line-of-sight reference line does not point towards this reference point (as shown in the “Too high” and “Too low” turn in the figure). Only at the special pivotal altitude does the line-of-sight reference line point towards the reference point at the center of the circle. When flying at the pivotal altitude around a point, it will look as if a string is tethering the aircraft to that point on the ground as it circles overhead.

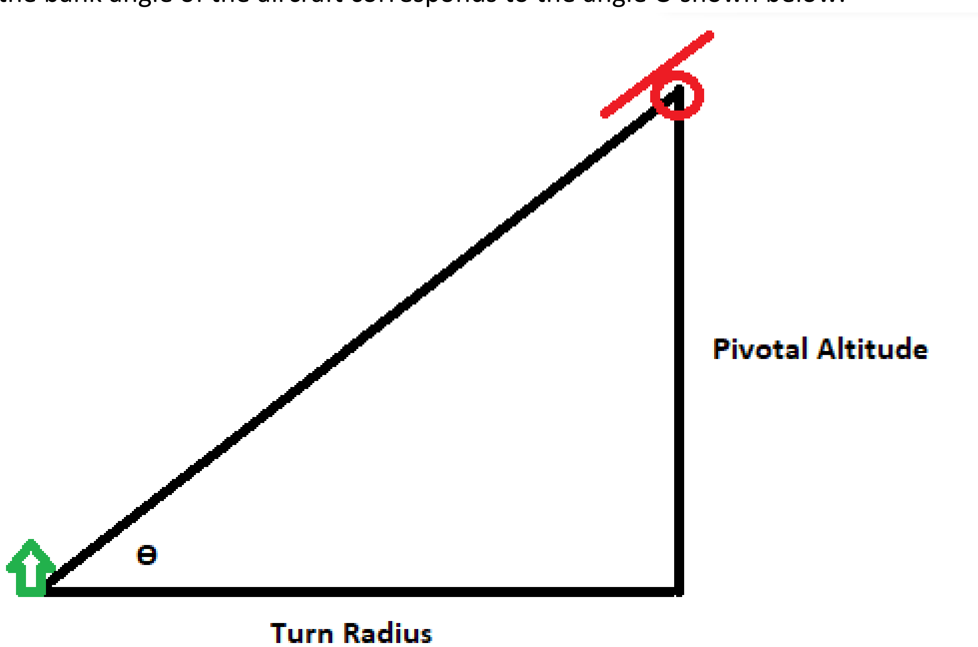


- The formula to determine pivotal altitude is:

$$\boldsymbol{pivotal\ altitude} = \frac{(\boldsymbol{groundspeed})^2}{\mathbf{11.3}}$$

Equation 1.

- This equation is not hard to derive. When circling the reference point while flying at the pivotal altitude, the bank angle of the aircraft corresponds to the angle ϴ shown below.



- Trigonometry reveals that:

$$\tan\boldsymbol{\theta} = \frac{\boldsymbol{pivotal\ altitude}}{\boldsymbol{turn\ radius}}$$

Equation 2.

- The formula for turn radius can be found by using the equations of motion for a level turn.
    - For this derivation, see iCloud > Documents > College Courses > Spring 2016 > AE 3310-A-Saleh > Lectures > Fixed Wing > 9-Level Turn

$$\boldsymbol{turn\ radius} = \frac{(\boldsymbol{groundspeed})^2}{\boldsymbol{g}\tan\boldsymbol{\theta}}$$

Equation 3.

- Substituting equation 3 for the 'turn radius' term in equation 2 and then solving for 'pivotal altitude gives the following equation.

$$\boldsymbol{pivotal\ altitude} = \frac{(\boldsymbol{groundspeed})^2}{\boldsymbol{g}}$$

Equation 4.

- In equation 4, *g* is a constant—the acceleration due to gravity and is $9.8\frac{m}{s^2}$. Solving in terms of pivotal altitude in feet with an input of groundspeed in knots (do the dimensional analysis as an exercise) gives the final form of the equation.

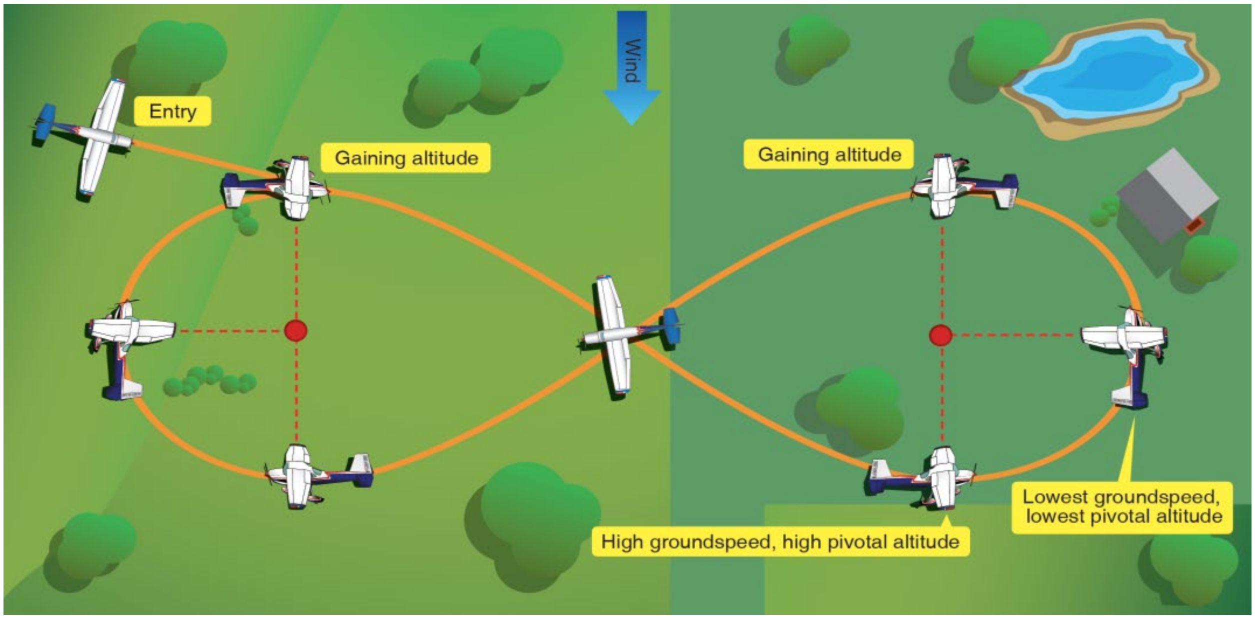
$$\boldsymbol{pivotal\ altitude} = \frac{(\boldsymbol{groundspeed})^2}{\mathbf{11.3}}$$

Equation 5.

- Equation 5 can be used to build a convenient table that gives pivotal altitude as a function of groundspeed for common ranges of groundspeed in training aircraft. The table is shown below.

Groundspeed (kts)	Pivotal Altitude (ft)
85	639
90	717
95	799
100	885
105	976
110	1,071
115	1,170
120	1,274
125	1,383

- Take time to carefully pick out appropriate pylons for the eights on pylons maneuver. The points should be perpendicular to the wind and be spaced far enough apart to allow for 3-5 seconds of level flight between the pylons. The image below gives an overview of what this maneuver should look like from above.



- As with all maneuvers, clear the area prior to starting. Because of the low altitude required, select a suitable emergency landing area before starting the maneuver.
- The maneuver should be entered by flying diagonally crosswind between the two pylons such that the first turn is made into the wind. The altitude flown at this point should be the pivotal altitude for the initial ground speed. Choose an appropriate radius from the pylon so that the initial turn does not exceed 40° of bank angle.
- Abeam the pylon, the airplane is banked such that the sight line is parallel to the lateral axis and is on the pylon. This sight picture should be maintained throughout the turn around the pylon. After entering the initial bank, no attempt is made to maintain a constant radius from the pylon—only to keep the aircraft at the pivotal altitude with the sight line on the pylon. If there are winds aloft, the groundspeed will vary throughout the turn causing the pivotal altitude to change (remember, pivotal altitude is proportional to the square of the groundspeed). The first turn should be an upwind turn if the maneuver was set up correctly. This means groundspeed will decrease causing the pivotal altitude to decrease. The need to lower the altitude will be apparent because the pylon will appear to move in front of the sight line. Lowering the nose will decrease the altitude and increase the groundspeed both of which will aid in bringing the altitude closer to the ever-changing pivotal altitude. Conversely, as the turn is made downwind, groundspeed increases causing the pivotal altitude to increase. This will cause the pylon to move behind the sight line. Raising the nose will increase altitude and decrease groundspeed both of which will aid in bringing the altitude closer to the pivotal altitude.
- Throughout the turns around the pylons, the altitude of the airplane should be adjusted so that the sight line remains directly on the pylon. If the pylon moves ahead of the sight line, lower the nose. If the pylon moves behind the sight line, raise the nose. Be careful to divide attention between the control of the aircraft while maintaining the appropriate sight picture.

- When traveling wings level from the first pylon to the second pylon, the appropriate correction for wind drift is essential so that the radius at the start of the turn around the second pylon is the same as the radius at the start of the initial turn at the first pylon.
- During the turns around the pylons, rudder should only be used no maintain coordinated flight. No attempt should be made to “hold the pylon” by slipping or skidding the aircraft.
- Exit the maneuver on the same leg as the entry was made on unless the instructor or examiner requests another trip around the pylons.

Common Errors

- Poor pylon selection.
- Failure to clear the area before starting the maneuver.
- Failure to make adjustment to altitude to maintain the pivotal altitude.
- Losing sight of the pylons.
- Attempting to hold the line-of-sight reference line on the pylon by entering a slip or a skid.
- Improper division of attention between inside and outside of the airplane.
- Use of an improper line-of-sight reference (it should be parallel to the lateral axis of the airplane).
- Failure to correct for wind drift during the straight and level portion between pylons.

Areas of Operation XI: Slow Flight, Stalls, and Spins

Task A: Maneuvering During Slow Flight

Lesson Objective

The objective of slow flight is to learn how the airplane flies at speeds less than V_y and, in particular, at speeds near stall. Flying at these speeds is often referred to as flying in "the region of reverse command" or flying on "the back side of the power curve." The skills learned while becoming a master of slow flight will transfer to the skills required for managing the elements of the approach and landing.

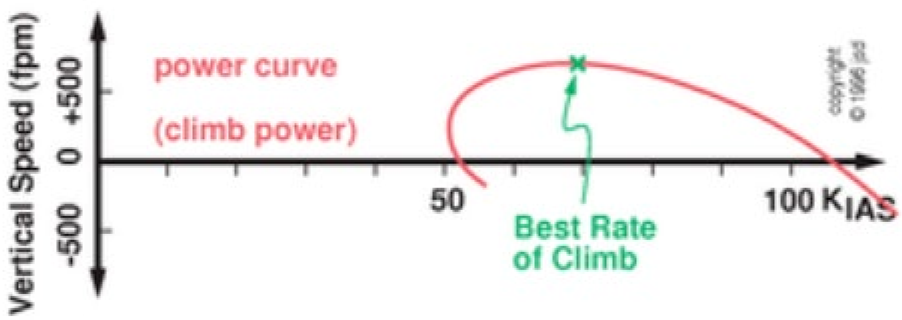
Completion Standards

1. Learner understands the fundamental differences between operating on the front side and back side of the power curve.
2. Learner develops the skills required to control the aircraft when operating on the back side of the power curve.
3. Learner is aware of collision hazards during this maneuver (it is a good idea to occasionally make a turn since visibility over the nose may be impossible).
4. Learner selected an altitude that allows the task to be completed at no lower than 1,500 feet AGL (ASEL, ASES).
5. Learner maintains an airspeed at which a further increase in angle of attack would results in a stall warning.
6. Learner accomplishes coordinated straight-and-level flight, turns, climbs, and descents with the airplane configured as specified by the evaluator without a stall warning.
7. Private pilot ACS: Maintain specified altitude ±100 feet, specified heading ±10°, airspeed +10/-0 kts, and specified bank angle ±10°.
8. Commercial pilot ACS: Maintain specified altitude ±50 feet, specified heading ±10°, airspeed +5/-0 kts, and specified bank angle ±5°.

Content

- Being proficient in handling the airplane at low speeds is essential before attempting to land the aircraft. Flight at these mushing speeds helps the learner understand the flight characteristics of the airplane when operating on the back side of the power curve. The power curve shows the power required for some fixed flight condition as a function of airspeed. Vertical speed depends on excess power and happens to be a parameter that can be observed from the cockpit. Thus, in the graph below, vertical speed is substituted for power required and is shown as a function of airspeed. The highest point in the curve represents V_y—it is the speed for the angle of attack that gives the highest rate of climb. Said differently, it is the speed that has the most excess power available for the climb. Speeds higher than V_y result in decreased vertical speeds because more power is required to simply maintain level flight. This leaves less excess power available for the climb. Speeds lower than V_y also result in decreased vertical speeds. This happens for the same reasons—more power is required to maintain level flight at speeds less than V_y. The airplane behaves very differently depending on whether the airplane is operated on the front side of the power curve (higher than V_y) or on the back side of the power curve (less than V_y).

On the front side of the power curve, pitching up results in a decreased airspeed. At this lower airspeed, the power required for level flight decreases giving the airplane more excess power which results in a sustained rate of climb. Thus, at speeds greater than V_y, the elevator can be used effectively to control altitude. However, on the back side of the power curve, these relationships are opposite. At speeds less than V_y, pitching up causes a slower airspeed which further increases the power required for level flight. This results in a decrease of excess power and will cause the vertical speed to decrease. Because of this, at speeds less than V_y, the elevator is ineffective at controlling altitude—in fact is does the opposite of what the learner would expect. Thus, when operating on the back side of the power curve, also know as "the region of reverse command", the airplane must be controlled by pitching for airspeed and adjusting power to maintain altitude.



- During this maneuver, the stall warning horn should not be heard at all. The *Airplane Flying Handbook* recommends a speed 5-10 kts above the 1-g speed where a stall indication would normally be found (typically, the first indication is the stall warning horn).
- As with all maneuvers, clear the area before starting the maneuver. To start the maneuver, reduce power and add back pressure to maintain level flight as the airspeed decays. Note the change in sound as the airspeed decreases. Controls will become "mushy" as the airspeed continues to decrease. Once the airspeed reaches the appropriate slow flight airspeed, add power to maintain altitude. Adjust pitch to maintain airspeed. ***Pitch for airspeed, power for altitude.***
- Slow flight is typically performed in the landing configuration, but should be practiced in configurations for takeoffs, climbs, descents, approaches to landing, and go-arounds. The learner should be able to change configuration while in slow flight. Typically, full flaps are introduced as the airplane is being slowed for the maneuver entry.
- Maneuvering during slow flight involves all combinations of turns, climbs, and descents. Bank angles should be smaller than normal (no more than 20°) to avoid too much of an increase in load factor which could result in a stall.
- During slow flight, a lot of right rudder will be required. In fact, when making turns to the left, often, all that is need when entering the bank is a relaxing of the pressure on the right rudder.
- Control movements should be gradual and smooth. Too aggressive and a stall may result.
- If at any point a stall warning is recognized, call it out and initiate a recovery (lower nose and add power).
- Recovery from slow flight is the same as the stall recovery.
    - Lower the nose to reduce angle of attack.

- Level the wings while maintaining coordinated flight.
- Apply power as necessary.
- As the airspeed builds, raise the flaps.

Common Errors

- Failure to clear the area.
- Failure to maintain altitude during transition from cruise to slow flight and from slow flight to cruise.
- Insufficient right rudder.
- Failure to maintain proper control as flaps are extended or retracted.
- Failure to pitch for airspeed and power for altitude.
- Failure to avoid or respond to a stall indication.

Task B: Power-On Stalls (Proficiency)

Lesson Objective

The objective of performing power-on stalls is for the learner to become familiar with the conditions that lead to stalls while in the takeoff or climb configuration. The learner will understand how to recognize and promptly recover from power-on stalls.

Completion Standards

1. Learner understands aerodynamically what a stall is and understands the elements of the power-on stall.
2. Learner selects an altitude that ensures recovery no lower than 1,500 feet AGL (ASEL, ASES).
3. Learner establishes takeoff or departure configuration. Power should be set to full unless doing so results in an unusually high pitch attitude (with high performance aircraft, for example). In these cases, power should be set to no less than 65%.
4. Learner smoothly transitions from normal departure attitude to a pitch attitude that will result in a stall.
5. When recovering from a stall, learner follows the manufacturer's recommendations.
6. Learner establishes V_x or V_y climb before the final flap retraction and returns the airplane back to the desired altitude where cruise flight will be resumed.
7. Private pilot ACS: In straight flight, learner maintains heading ±10°. If performing a stall in turning flight, bank angle is not to exceed 20° ±10°
    a. Learner acknowledges queues leading up to full stall, and recovers after onset of the fully developed stall.
8. Commercial pilot ACS: In straight flight, learner maintains heading ±10°. If performing a stall in turning flight, bank angle is not to exceed 20° ±10°
    a. Learner acknowledges queues leading up to full stall and recovers either at the first indication of a stall or at full stall, whichever is specified by the evaluator.

Content

- A given wing stalls at a specific angle of attack. At different g-loadings and at different aircraft weights, the speed corresponding to this angle of attack will change. But the stalling angle of attack remains constant. At stall, the airflow separates from the wing leading to a loss of lift. The angle of attack must be lowered for the airflow to reattach. In all types of stalls, remember that the angle of attack *must* be reduced. It is not power that recovers the airplane from a stall, it is a reduction in angle of attack. This means *release the back pressure.* If the yoke is pulled all the way back to your gut, then, regardless of speed, a stall is imminent. This simple idea can be reinforced by flying around at minimum controllable airspeed and then pulling the aircraft into a stall and then recovering by simply releasing back pressure. This can be done over and over again without touching the power and is a great skill building exercise for creating the muscle memory to release back pressure to recover from a stall.

- A power-on stall simulates what can happen if during a climb the nose is raised to a pitch attitude at which a flying airspeed cannot be maintained. Power-on stalls can occur during takeoffs, go-arounds, cruise climbs, or when trying to clear obstacles. In takeoff, improper trim can result in the unexpected need for nose-down force to maintain the proper attitude. Power added during a go-around can cause the need for significant nose-down force until the aircraft is re-trimmed. Both of these situations can lead to stalls without the proper action from the pilot. Power-on stalls during cruise climbs can be particularly insidious. A normally aspirated engine will have significantly degraded climb performance at higher altitudes. The distracted pilot can easily ask the autopilot to climb at an unsustainable climb rate. This can happen with climbs assigned by ATC or during climbs to clear obstacles, such as mountains, out in the distance. The distracted pilot may not notice the airspeed slowly decreasing getting closer and closer to the point of stall. Learning power-on stalls helps familiarize the pilot with the indications leading up to a stall, what a full stall feels like, and how to safely recover.
- When recovering from a stall, excessive altitude should not be lost. However, pilots do not die in real stall scenarios because they recover with too aggressive of a nose-down push. Almost without exception, pilots die because they do not get the nose down enough. The wing remains stalled which usually leads to a spin. Very few people will survive a crash resulting from a spin. Accordingly, stall recovery should not emphasize maintaining altitude or losing as little altitude as possible. Push the nose down enough to get light in the seat. This idea of getting "light in the seat" will stick with the pilot and hopefully help in the moment of a real emergency when the pilot is unlike to have the focus or finesse required to fly the airplane out of the stall without losing altitude. This might be easy in training, but not in an actual emergency.
- To begin the maneuver, select an altitude allowing for recovery no lower than 1,500 feet AGL. As always, clear the area.
- To start the maneuver, power should be reduced allowing the aircraft to slow to a normal lift-off speed. Once this speed is achieved, power should be applied, and the nose should be raised to an attitude that will eventually result in a stall. Hold this attitude until the stall occurs. Remain coordinated as the airspeed slows.
    - Note: A stall can be brought on more rapidly by pitching up to an excessively nose-high attitude. This is an unrealistic sight picture, however, and should be avoided. This does not simulate the common situations that can lead to a power-on stall.
- The private pilot ACS specifies starting the recovery after a full stall has developed. The commercial pilot ACS gives the examiner the option of specifying a recovery at the first indication of a stall or at full stall. Regardless, recovery is the same. To recover:
    - Nose should be immediately lowered to break the stall.

- Level the wings *after* the AOA is reduced below the stall AOA.
  - Directional control should be maintained using the rudders. Ailerons should not be used to level the wings until after the stall has been broken. Rudder can be used to maintain wings level through the stall, but this should not be the primary emphasis. Simply pushing the nose down is the simplest and quickest way to get the airplane flying again so that ailerons become effective in roll control.
- Maximum power should be confirmed/applied.
  - Maximum power should already be set whether it is at actual maximum power for takeoff or simulated maximum power for a high-altitude climb.
- Once the airplane has returned to flying speed and the wings are level, the descent should be stopped and a V_x or V_y climb should be established. After a positive rate of climb is established, retract gear/flaps as required to configure for a normal climb back to the desired altitude.

- Power-on stalls and recoveries should be practiced from straight climbs and climbing turns (15° to 20° of bank).
  - This bank can be added once the airspeed slows closer to stall speed. If the bank is added early on, the overbanking tendency as the aircraft slows will have to be accounted for. If this tendency is not corrected for, the aircraft will start a descent while in a steep bank and the turning stall will turn into an accelerated stall. See Jason Miller's Ground School app lesson on Accelerated Stalls.

Common Errors

- Failure to clear the area before starting the maneuver.
- Failure to establish the correct airplane configuration for the maneuver.
- Not initially reducing power to slow to a normal climb speed prior before initiating the power-on climb to stall.
- Pitching up too much too quickly leading to an unrealistically high nose attitude.
- Failure to maintain coordinated flight (a lot of right rudder needed).
- Failure to maintain specified heading or bank angle.
- Failure to announce first indications of a stall (usually the stall warning horn).
- Using ailerons to maintain wings level during the stall. Do not do this!
- Failure to recognize the indications leading up to the full stall.
- Failure to achieve a full stall or initiating a stall recovery too early.
- Excessive loss of altitude during recovery.
- Pitching up too quickly after stall recovery leading to a secondary stall.

Task C: Power-Off Stalls (Proficiency)

Lesson Objective

The objective of performing power-off stalls is for the learner to become familiar with the conditions that lead to stalls while in the landing configuration. The learner will understand how to recognize and promptly recover from power-off stalls.

Completion Standards

1. Learner understands the aerodynamics of stalls and understands the elements of the power-off stall.
2. Learner selects an altitude that ensures recovery no lower than 1,500 feet AGL (ASEL, ASES).
3. Learner establishes a stabilized descent rate in the landing configuration (this descent should simulate the approach to landing).
4. Learner transitions smoothly from the descent pitch attitude to a pitch attitude that will induce a stall.
5. Private pilot ACS: In straight flight, learner maintains heading ±10°. If performing a stall in turning flight, bank angle is not to exceed 20° ±10°
    a. Learner acknowledges queues leading up to full stall, and recovers after onset of the fully developed stall.
6. Commercial pilot ACS: In straight flight, learner maintains heading ±10°. If performing a stall in turning flight, bank angle is not to exceed 20° ±5°
    a. Learner acknowledges queues leading up to full stall and recovers either at the first indication of a stall or at full stall, whichever is specified by the evaluator.
7. During the recovery, configure the airplane as recommended by the manufacturer. This typically means raising flaps by one notch after adding full power, establishing a positive rate of climb followed by gear up, raising flaps to normal climb setting while climbing at V_x or V_y until the desired altitude is reached.

Content

- Stalls are always caused by exceeding the critical angle of attack of the wing. In this respect, all types of stalls are fundamentally the same. The primary difference is the situation that leads to exceeding the critical angle of attack. Power-off stalls simulate stalls that occur during the approach and landing phase of flight. Scenarios leading to these stalls could be the pilot getting distracted, attempting to stretch a glide, or attempting to salvage a turn from base that overshoots final. No matter the scenario, recovery is always initiated by reducing the angle of attack.
- When recovering from a stall, excessive altitude should not be lost. However, pilots do not die in real stall scenarios because they recover with too aggressive of a nose-down push. Almost without exception, pilots die because they do not get the nose down enough. The wing remains stalled which usually leads to a spin. Very few people will survive a crash resulting from a spin. Accordingly, stall recovery should not emphasize maintaining altitude or losing as little altitude as possible. Push the nose down enough to get light in the seat. This idea of getting “light in the seat” will stick with the pilot and hopefully help in the moment of a real emergency when the pilot is unlike to have the focus or finesse required to fly the airplane out of the stall without losing altitude. This might be easy in training, but not in an actual emergency.
- To begin the maneuver, select an altitude allowing for recovery no lower than 1,500 feet AGL. As always, clear the area.
- To start the maneuver, the power is reduced to idle and the altitude is held constant until the airspeed slows enough for the airplane to be configured for a normal landing at a normal descent rate and approach speed. Once established in the descent in the landing configuration, the nose should be raised to an attitude that will eventually result in a stall. Hold this attitude until the stall occurs. Remain coordinated as the airspeed slows.

  - Note: A stall can be brought on more rapidly by pitching up to an excessively nose-high attitude. This is an unrealistic sight picture, however, and should be avoided. This does not simulate the common situations that can lead to a power-off stall. The more subtle stall that creeps up on the pilot is more sinister than the excessive nose-high attitude that is easily recognizable as one that will induce a stall.
  - Power-off stalls can be practiced while trimmed for the descent. This is good to practice so the learner understands the pitching-up tendency of the aircraft when full power is added. Depending on the aircraft, significant nose-down force may be needed to maintain the proper attitude for the climb.
- The private pilot ACS specifies starting the recovery after a full stall has developed. The commercial pilot ACS gives the examiner the option of specifying a recovery at the first indication of a stall or at full stall. Regardless, recovery is the same. To recover:
  - Nose should be immediately lowered to break the stall.
  - Level the wings *after* the AOA is reduced below the stall AOA.
    - Directional control should be maintained using the rudders. Ailerons should not be used to level the wings until after the stall has been broken. Rudder can be used to maintain wings level through the stall, but this should not be the primary emphasis. Simply pushing the nose down is the simplest and quickest way to get the airplane flying again so that ailerons become effective in roll control.
  - Apply maximum power.
    - Maintain coordination throughout the application of power.
  - Once the airplane has returned to flying speed and the wings are level, the procedure is the same as the go-around. Full power, flaps up incrementally to normal climb configuration, and a V_x or V_y climb back to the desired altitude.
- Power-off stalls and recoveries should be practiced in straight flight and in shallow banked turns.
  - This bank can be added once the airspeed slows closer to stall speed. If the bank is added early on, the overbanking tendency as the aircraft slows will have to be accounted for. If this tendency is not corrected for, the aircraft will start a descent while in a steep bank and the turning stall will turn into an accelerated stall. See Jason Miller's Ground School app lesson on Accelerated Stalls.

Common Errors

- Failure to clear the area before starting the maneuver.
- Failure to establish the correct airplane configuration for the maneuver.
- Not initially reducing power to slow to a normal approach speed.
- Pitching up too much too quickly leading to an unrealistically high nose attitude.
- Failure to maintain coordinated flight (a lot of right rudder needed).
- Failure to maintain specified heading or bank angle.
- Failure to announce first indications of a stall (usually the stall warning horn).
- Using ailerons to maintain wings level during the stall. Do not do this!
- Failure to recognize the indications leading up to the full stall.
- Failure to achieve a full stall or initiating a stall recovery too early.

- Excessive loss of altitude during recovery.
- Pitching up too quickly after stall recovery leading to a secondary stall.

Task D: Cross-Controlled Stalls (Demonstration)

Lesson Objective

In the private pilot ACS, several types of stalls are required to be demonstrated by the instructor but not performed by the learner. Cross-controlled stalls are one of these stalls. The objective of this lesson is to demonstrate to the student the dangers of stalling while in uncoordinated flight.

Completion Standards

1. Instructor exhibits instructional knowledge of:
    a. Aerodynamics of cross-controlled stalls.
    b. Effect of crossed controls in gliding or reduced airspeed descending turns.
    c. Scenarios that can lead to cross-controlled stalls.
    d. Appropriate entry procedure and entry altitude.
    e. Recognition of cross-controlled stalls.
    f. Recovery procedure and minimum recovery altitude.

Content

- Cross controlling an aircraft means using ailerons in one direction and rudder in the other. In most situations, cross-controlling leads to uncoordinated flight. A cross-controlled stall is a stall that occurs during uncoordinated flight. The uncoordinated flight is caused by cross controlling the aircraft. Uncoordinated flight alone will not cause a stall, but exceeding the critical angle of attack will. Exceeding the critical angle of attack while uncoordinated can cause the stall break to be more aggressive than normal causing a rapid wing-drop that can result in a spin if not properly recovered from.
- Cross-controlled stalls are most likely to happen during the base to final turn on an approach to landing. If the pilot overshoots final, there is a tendency to use excessive rudder to hasten the turn. Excessive rudder leads to excessive bank that is typically countered by using opposite aileron. This series of events has led to a cross-controlled aircraft and now the only item left for a stall/spin is the pilot pulling the nose up into the turn in an attempt to salvage the bad approach.
- Before starting the maneuver, establish an altitude that allows a safe recovery from an inadvertent spin.
- Perform clearing turns.
- Lower the landing gear (if applicable).
- Pull the throttle to idle and maintain altitude until reaching normal glide speed.
    - Flaps are not used in this maneuver in order to avoid exceeding design limitations on flaps.
- Trim the aircraft once established in the glide and then roll into a medium banked turn simulating a turn from base to final.

- In the bank, add excessive rudder in the direction of the turn and use opposite aileron to maintain the medium bank angle. The airplane is now uncoordinated because of the cross-controlling.
- Add back pressure to keep the nose from falling. Keep increasing control pressure until the aircraft stalls.
- Recovery is the same as power-off stalls:
  - Lower the nose to reduce angle of attack.
    - Control yaw with the rudder.
  - Level the wings with ailerons using coordinated control inputs.
  - Full power while reconfiguring for a V_x or V_y climb back to the desired altitude.

Common Errors

- Failure to clear the area before beginning the maneuver.
- Failure to properly configure the aircraft for the maneuver.
- Failure to establish the cross-controlled condition required to demonstrate the dangers of a cross-controlled stall.
  - Failure to slow to a normal glide speed.
  - Failure to use enough cross-control pressure and back pressure to induce a stall.
- Improper recovery from the cross-controlled stall.
- Failure to explain to the learner the scenarios that can lead to a cross-controlled stall.

Task E: Elevator Trim Stalls (Demonstration)

Lesson Objective

Elevator trim stalls are another type of stall required to be demonstrated by the instructor but not performed by the learner. The objective of demonstrating elevator trim stalls is to show the learner the dangers of excessive nose-up trim during takeoffs and go-arounds.

Completion Standards

1. Instructor exhibits instructional knowledge of:
   a. Aerodynamics of elevator trim stalls.
   b. Hazards of inadequate control pressures to compensate for thrust, torque, and up-elevator trim during takeoffs or go-arounds.
   c. Entry procedure and minimum entry altitude.
   d. Recognition of elevator trim stalls.
   e. Recovery from elevator trim stalls.

Content

- Two common scenarios can result in elevator trim stalls. The first is improperly set trim during takeoff. Trim that is set to an excessively nose-high attitude can lead to too steep of a climb angle after rotation. Unless significant nose-down pressure is applied by the pilot, the aircraft may stall. The second scenario is during a go-around with normal trim. In this situation, the pilot has not set the trim incorrectly. However, when full power is applied for the go-around, the spiraling slipstream from the propeller creates a downward force on the elevator causing the pitch of the aircraft to increase. In aircraft like the Cessna 182, this pitch increase caused by the addition of power can be dramatic and will require significant nose down force until the aircraft is trimmed for the new power setting.

- Before starting the maneuver, establish an altitude that allows recovery no lower than 1,500 feet AGL.
- Perform clearing turns.
- Close the throttle and extend the landing gear (if applicable).
- Maintain altitude and add flaps as the speed slows to a normal glide speed.
    - The airplane flying handbook recommend ½ to full flaps.
- Establish the aircraft in a normal glide and trim.
- Simulate a go-around by adding full power and demonstrate to the learner what can happen if the pilot does not maintain control. Without intervention, the nose will rise sharply and the aircraft will yaw to the left.
- When a stall is imminent, apply forward pressure and recover using normal stall recovery techniques.
- After the stall is recovered from, normal go-around procedures apply.

Common Errors

- Failure to clear the area before beginning the maneuver.
- Failure to explain the common scenarios that lead to elevator trim stalls resulting in the learner failing to grasp the importance of stall awareness during takeoffs and go-arounds.
- Failure to establish the proper configuration for the maneuver.
- Improper demonstration of or recovery from the elevator trim stall.
    - Not allowing the pitch to increase enough to properly demonstrate the dangers of the elevator trim stall.
    - Not maintaining control of the aircraft while retrimming and retracting flaps.

Task F: Secondary Stalls (Demonstration)

Lesson Objective

Secondary stalls can occur in the process of recovering from the initial stall. These secondary stalls typically occur because the learner pitches up too aggressively during the recovery or because the learner does not fully break the stall in the first place. In either case, the critical angle of attack of the wing is exceeded after during the process of recovering from the initial stall. The objective of the secondary stall demonstration is to show the learner how to avoid secondary stalls.

Completion Standards

1. Instructor exhibits instructional knowledge of:
    a. Aerodynamics of secondary stalls.
    b. Flight situations where secondary stalls may occur.
    c. Hazards of secondary stalls during normal stall or spin recovery.
    d. Entry procedure and minimum entry altitude.
    e. Recognition of a secondary stall.

f. Recovery procedure and minimum recovery altitude.

Content

- All stalls are caused by exceeding the wing's critical angle of attack. Secondary stalls are no exception.
- One reason why a secondary stall may occur is because the pilot recovers too aggressively from the primary stall. Recovering from a stall involves decreasing the angle of attack of the wing below the critical angle of attack. After the wing has resumed flying, the aircraft is brought back to a normal climb attitude. If this transition from releasing back pressure to break the stall to reapplying back pressure for the climb is too quick or aggressive, the wing may stall a second time.
- Another scenario that can lead to a secondary stall is not fully breaking the initial stall before pitching back up to the normal climb attitude. In this case, the wing may stall again because the angle of attack is being increased on a wing that hasn't even fully recovered from the primary stall.
- In both cases, the critical angle of attack is exceeded—the first case because the pitch up during the recovery is too aggressive and the second case because of an insufficient lowering of the angle of attack during recovery from the primary stall.
- Secondary stalls can be demonstrated during the recovery from any of the basic stalls. The set up for these stalls is the same as the set up for whatever stall the secondary stall will be demonstrated for. During the demonstration, the instructor will induce the secondary stall by pulling the nose up too rapidly when recovering from the primary stall.

Common Errors

- Failure to clear the area.
- Failure to properly configure the aircraft for the maneuver.
- Failure to fully induce the secondary stall.
- Failure to properly demonstrate and explain the scenarios leading to secondary stalls.

Task G: Spins

Lesson Objective

Stalls are taught to pilots so that they can learn how to avoid them. Pilots are also taught how to recover from them should they accidentally enter one. Spins develop from an uncoordinated stall that is not properly recovered from. If a pilot is performing poorly enough to accidentally enter a stall, then it is very likely that the aircraft will be uncoordinated when it enters the stall. Without prompt recovery, the aircraft can enter a spin. The objective of this lesson is to educate the learner on spin avoidance and recovery. Spins are not required to be demonstrated by private or commercial applicants because the training value has been deemed by the FAA not worth the associated risk.

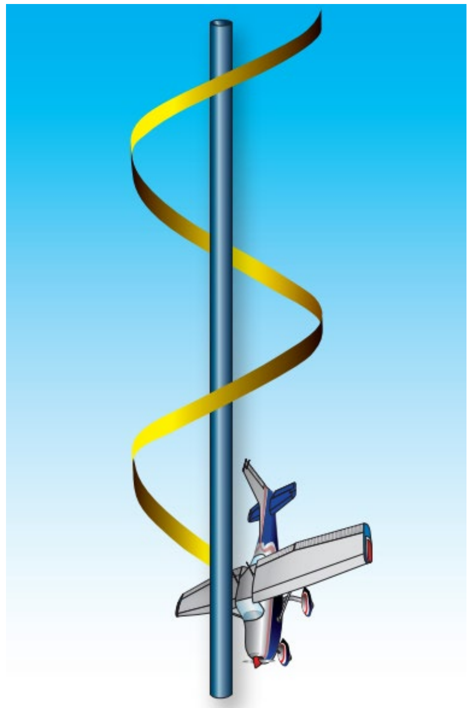
Completion Standards

1. Instructor exhibits instructional knowledge of:
    a. Anxiety associated with spin instruction.

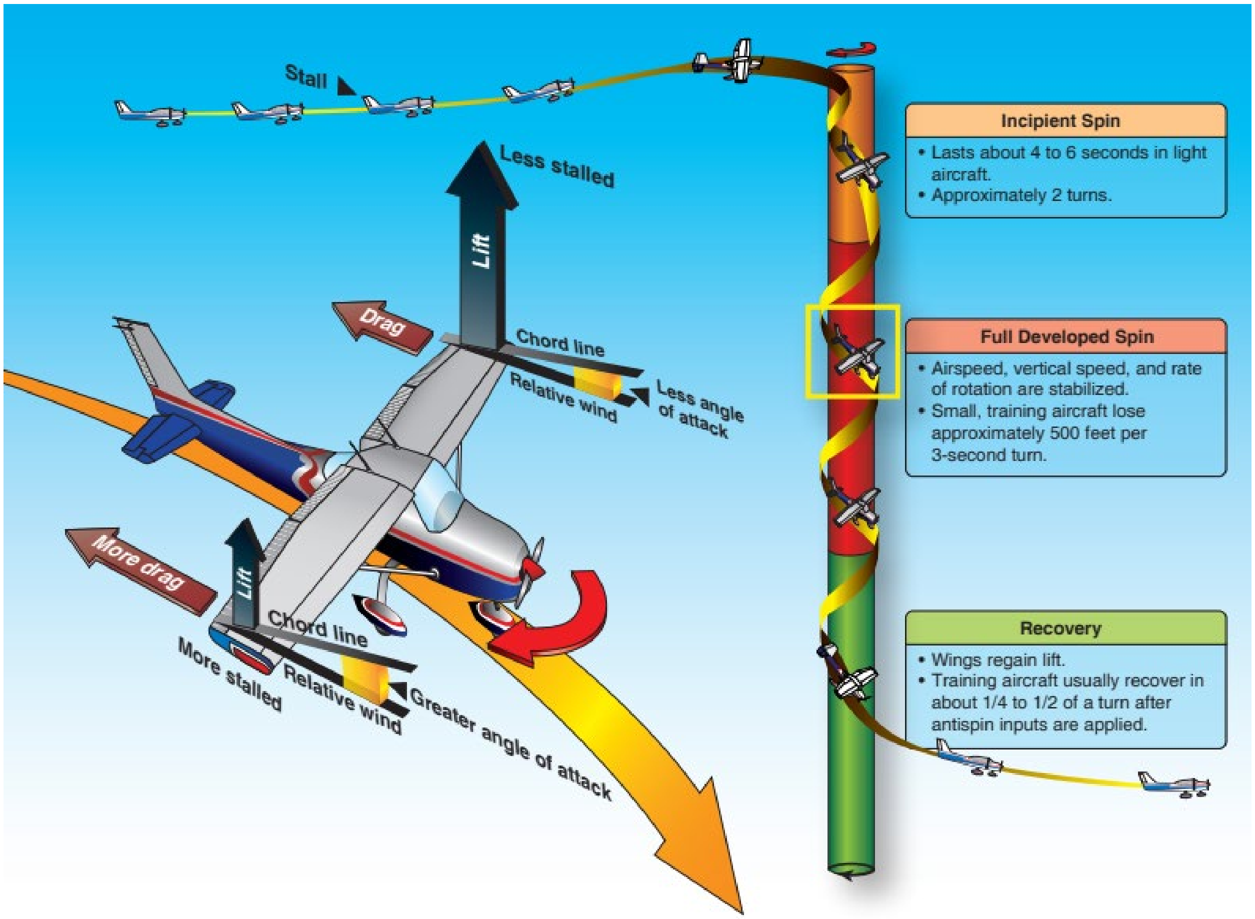
b. Aerodynamics of spins.
c. Airplanes approved for the spin maneuver based on airworthiness category and type certificate.
d. Relationship of various factors such as configuration, weight, center of gravity, and control coordination to spins.
e. Flight situations where unintentional spins may occur.
f. How to recognize and recover from imminent, unintentional spins.
g. Entry procedure and minimum entry altitude for spins.
h. Control procedure to maintain a stabilized spin.
i. Orientation during a spin.
j. Recovery procedure and minimum recovery altitude for intentional spins.

Content

- CFI applicants are the only applicants required to demonstrate entry and recovery from spins. This is typically accomplished by the applicant getting a spins endorsement from another CFI. Because of this, spins are not normally required to be demonstrated on the CFI check ride. Because CFI's have the capability of giving spins training and endorsements to other pilots, they must have instructional knowledge of teaching and demonstrating entry and recovery from spins. This knowledge is typically accomplished through a spins endorsement.
- Small aircraft (less than 12,500 lbs.) are typically certificated in the normal, utility, or aerobatic category. For single-engine aircraft, part 23.221 requires specific spins recovery capabilities depending on the certification category. These details can be further explored by the learner, but the important takeaway is that all aircraft in the normal, utility, and aerobatic category must be able to recover from, at minimum, incipient spins. For this reason, CFI's well-trained in spins instruction should respect, but not fear, spins. Pilots not trained in spins should seek out spin recovery training or should be confident in their ability to avoid unintentional stalls that could lead to spins.
- However, not all aircraft are authorized for *intentional* spins and some of the aircraft that are authorized for spins must be operated within specific weight and balance parameters. One important factor for spin recoverability is the location of the CG. If the CG is too far aft, it will be difficult or even impossible for the elevator to have enough control authority to lower the nose to break the stall. For example, some aircraft are certificated in the normal category for the full range of the weight and balance envelope but have been certificated in the utility category within only a certain portion of this envelope. These aircraft may be certified for intentional spins when operating in the utility range, but not authorized for intentional spins when operating in the normal category.
- Spins result from uncoordinated stalls that are not promptly recovered from. This is why maintaining coordination during maneuvering is critical. Being uncoordinated during a stall results in one wing stalling before the other. This results in asymmetrical lift between the left and right wing. This causes the stalled wing to drop and the wing that is still producing lift to rise. This process, if not immediately recovered from, leads to a rolling, yawing, and pitching motion as the airplanes corkscrews down to the ground (see image below).



- There are a couple of common scenarios leading to inadvertent spins. The first is when a pilot overshoots a base to final turn and then tries to salvage the approach using poor technique. The scenarios usually goes like this: Inside rudder is used in attempt to tighten the turn; opposite aileron is used to prevent overbanking from the rudder input; and back pressure is added to tighten the turn. This results in an uncoordinated stall which leads to a spin with insufficient altitude to recover. The remedy for this scenario is to go around and try again if the approach doesn't look right. Another common scenario leading to a spin is any emergency leading to a loss in power. At the prospect of a forced landing, there is an almost irresistible urge to pull back to maintain altitude. This leads to a sustained stall that develops into a spin as soon as the pilot loses coordination. The remedy for this scenario is for the pilot to understand that a controlled forced landing, even in the worst of terrain, is a far better option that an uncontrolled spin into the ground.
- To demonstrate spins, the CFI must first know how to induce a spin. Select an altitude that allows for recovery no lower than 1,500 feet AGL and, as always, clear the area. Spins are best thought of in four phases: entry, incipient, developed, and recovery.



- **Entry Phase—**Spins entry can be brought about intentionally by performing a power-off stall (don't use flaps). Once the aircraft is stalled, instead of initiating a stall recovery, hold full back elevator while applying full rudder in the desired direction for the spin. Maintain ailerons in the neutral position.
- **Incipient Phase—**The incipient phase occurs from the moment the rotation begins until the spin has stabilized. Up until this point, the dynamics of the maneuver have not stabilized. This may take two to four turns according to the *Airplane Flying Handbook*.
- **Developed Phase—**The spin has developed when the spin has stabilized into a steady rotation rate, airspeed, and descent rate. At this point the flight path will be nearly vertical. Note that some aircraft that resist spins may transition from the incipient spin into a spiral dive. Beware of this because g loading can increase rapidly during a spiral dive. Some pilots can get disoriented during a spin and not be able to tell which direction the aircraft is spinning in. In these cases, the turn indicator should be used to determine the spin direction.
- **Recovery Phase—**The recovery phase occurs once the rotation is stopped and the angle of attack of the wing is reduced below the critical angle of attack. The amount of time or number of rotations it takes to complete the recovery phase varies with the type of aircraft, how it is loaded, and the type of spin. Some airplanes have specific spin recovery guidelines, but the general steps for recovery from a spin are as follows:
    - **P**ower to idle (power causes a pitching-up moment that is undesirable for recovery).

    - **A**ilerons neutral.
    - **R**udder opposite the direction of spin.
    - **E**levator forward to break the stall.
- It is important to remember to fly coordinated after the rotation has been stopped. Full opposite rudder is needed to stop the rotation, but don't forget to take out this full rudder once the rotation has been stopped. Leaving full rudder in can lead to another spin in the opposite direction.
- Once the stall has been broken and the rotation has been stopped, do not pull the nose up to the horizon too aggressively and overstress the aircraft. Be deliberate, but don't overdo it.

Common Errors

- Failure to clear the area.
- Failure to configure the aircraft properly for spins.
- Failure to properly induce a spin leading to a steep spiral instead of a spin.
- Failure to power to idle after spin entry (it should already be at idle during intentional spins).
- Failure to recognize the conditions leading to imminent spins. Unintentional entry into spins due to uncoordinated flight and/or improper aileron use during spin recovery.
- Improper spin recovery techniques.
- Becoming disoriented during the spin and being unable to determine direction of rotation.
- Failure to distinguish the difference between a spin and a steep spiral.
- Not recovering quickly enough from the nose-low condition after the spin leading to excessive airspeed.
- Recovering too quickly from the nose-low condition after the spin leading to a secondary stall.
- Failure to recover from spins promptly leading to excessive loss of altitude.
- Failure to understand the danger of intentionally spinning an aircraft not approved for intentional spins.

Task H: Accelerated Maneuver Stalls (Demonstration)

Lesson Objective

In previous lessons, it has already been emphasized repeatedly that a wing stalls at a specific angle of attack—not at a specific airspeed. However, the learner may not fully grasp this concept since all the basic stalls are performed during unaccelerated flight. The objective of demonstrating accelerated stalls is to help the learner understand that the critical angle of attack can be exceeded at any airspeed.

Completion Standards

1. Learner understands the aerodynamics of accelerated stalls.
2. Learner understands the scenarios that can lead to accelerated stalls.
3. Learner understands the hazards of accelerated stalls during stall or spin recovery.
4. Learner understands the entry procedure and minimum entry altitude for accelerated stalls.

5. Learner develops the ability to recognize impending accelerated stalls and knows how to promptly recover from them.

Content

- During unaccelerated flight at a specific weight and balance, the aircraft will always exceed the critical angle of attack at the same airspeed. Because most of the learner's experience with stalls is during unaccelerated flight, the learner can be left with the incorrect conclusion that all stalls occur at the same airspeed. This, though, is incorrect and this fallacy is best put to rest with the accelerated stall demonstration.
- Load factor, and thus stall speed, increases with bank angle. At 30° of bank, the load factor is 1.15, at 45° the load factor is 1.4, and at 60° the load factor is 2.0. The stalling angle of attack only corresponds to the published stall airspeed for a load factor of 1.0. At higher load factors, the stall speed will increase by the square root of the load factor. For example, a load factor of 1.4 during a 45° level turn leads to an increase in stall speed 18%. For a 60° level turn, the load factor is 2.0 giving an increase in the stall speed of 41%. In all these examples, the angle of attack at which the wing stalls has not changed, but the speed at which this critical angle of attack is exceeded *has* changed.
- With this knowledge, it should now be apparent that any maneuvering leading to increased load factor will lead to an increase in the speed at which the critical angle of attack is exceeded. This means an aircraft that normally stalls at 40 kts might, for example, stall at 60 kts if the load factor is increased by either abrupt control movements or steeply banked turns.
- Accelerated stalls can also occur when recovering from stalls or spins. In both stall and spin recovery, an accelerated stall can be induced by pitching up too rapidly during recovery or by pitching up before the wings have been leveled. Pitching up before leveling the wings can lead to a spiral dive causing load factor to increase quickly.
- To set up for the demonstration, select an altitude that allows for recovery no lower than 1,500 feet AGL and, as always, clear the area.
- Establish straight and level flight at or below V_A and then roll into a steep level turn (about 45°). Do not use flaps because of lower airframe load limitations with flaps deployed.
- Once the steep turn has been established, induce the accelerated stall by firmly increasing back pressure until the stall occurs. Recovery can be initiated at first indication of the stall or immediately after the full stall.
    - Maintaining at or below maneuvering speed is important to avoid exceeding load limitation on the airframe.
    - Do not attempt to maintain altitude during the transition from the level turn to the pitching up that leads to the accelerated stall.
- Recovery is the same as for other stalls:
    - Unload the wing to decrease the angle of attack.
    - Level the wings.
    - Add power and return to the desired cruise altitude.
- Accelerated stalls may break more sharply than the other stalls, but the basic stall behavior is the same as other stalls. If slightly uncoordinated, one wing will tend to drop. Focus on lowering the nose to break the stall before using any ailerons to correct for the wing drop. Using ailerons while the wing is stalled can cause a spin.

Common Errors

- Failure to clear the area.
- Failure to properly configure the aircraft for the maneuver.
- Failure to properly demonstrate recognition of and recovery from accelerated stalls.
- Failure to present realistic scenarios that can lead to accelerated stalls.

Areas of Operation XII: Basic Instrument Maneuvers

Task A: Straight-and-Level Flight

Lesson Objective

Basic instrument skills are required of private pilots. This should not encourage non-instrument rated individuals to fly in marginal conditions, but rather should serve as a skillset for emergency use only. Being proficient in instrument flying requires more extensive training than that required by the private pilot ACS. The objective of this lesson is for the learner to understand the elements of and learn the skill required to maintain and pre-selected altitude and heading by sole reference to the instruments.

Completion Standards

1. Learner understands the elements of attitude instrument flying during straight-and-level flight.
2. Learner maintains straight-and-level flight solely by reference to the instruments while utilizing an appropriate instrument scan.
3. Private pilot ACS: Learner maintains altitude ±200 feet, heading ±20°, and airspeed ±10 kts.

Content

- The attitude indicator is the primary instrument used for all maneuvering in instrument flying. Setting the appropriate power and attitude is the first step of attitude instrument flying. After that, other instruments are used to provide the pilot the necessary feedback so that the attitude of the aircraft can be adjusted accordingly.
- The FAA breaks down attitude instrument flying into two basic techniques: "control and performance" and "primary and supporting." These two techniques accomplish the same end-goal but vary in the intermediate methods used in achieving these goals.
    - The "control and performance" method has the pilot use the attitude indicator and the power setting to "control" the aircraft and then has the pilot use the "performance" instruments to measure the effectiveness of these control inputs. Based on the feedback from the "performance" instruments, the pilot will adjust the attitude and/or power as appropriately. This feedback loop continues. The pilot will use different instruments to measure the performance based on the type of maneuvering (level, climb, descent, turn, etc.).
    - The "primary and supporting" method has the pilot group the instruments according to their control function. The "primary" instruments for a specific function are those considered the most important or useful while the "supporting" instruments serve as helpful cross-checks against the primary.
- Two fundamental skills are required for instrument flight—instrument cross-check and instrument interpretation.
    - **Instrument cross-check** is the concept of scanning the instrument to ensure the desired attitude and performance from the aircraft. An example of this would be setting the pitch for climb using the attitude indicator and cross-checking this pitch against the airspeed indicator. Based on the airspeed indication, pitch may need to be increased or decreased. These types of cross-checks are needed for straight-and-level flight, climbs, descents, and turns.

            - Common cross-check errors are fixation, omission, and emphasis.
                - **Fixation** occurs when a pilot focuses on only one instrument. Using the example of an instrument climb, a pilot would exhibit the fixation error if he focuses only on the airspeed, for example, and did not also reference the VSI to ensure that this climb speed was resulting in positive rate of climb. The danger of fixation should be obvious.
                - **Omission** occurs when a pilot leaves a pertinent instrument out of his scan.
                - **Emphasis** occurs when a pilot relies on one instrument too much. An example is a learner who focuses almost exclusively on the attitude indicator perhaps because it is the most familiar and easily understood instrument. Instead, the learner should force himself to become more familiar with the other instrument that are required to maintain precise aircraft control.
    - **Instrument interpretation** is crucial because a perfect instrument scan is no good if the pilot cannot interpret the meaning of the instruments being scanned. Study each instrument in isolation to understand how each instrument works and how each instrument responds to different control inputs.
- This lesson focuses on straight-and-level flight by reference to instruments. I think the "control and performance" method of attitude instrument flying is the most understandable method of teaching instruments. Therefore, I will use this method of instruction. The attitude of the aircraft, along with the power, should be set appropriately for the desired cruise configuration. For level flight, this means setting the desired cruise power and using the attitude indicator to establish wings level with the estimated pitch to maintain level flight. Level flight is verified primarily by cross-checking against the altimeter (the performance instrument). Based on the altimeter's indication, appropriate adjustments can be made in attitude and/or power. The VSI is also a good performance instrument to cross-check against the attitude indicator. For small altitude deviations, the VSI is not necessary, but for establishing an appropriate rate of climb for larger altitude deviations, the VSI can be helpful. Straight flight is confirmed by cross-checking the heading indicator. If the heading indicator is on the desired heading and staying there, the airplane is flying straight. Small deviations in heading are easy to see and correct for using the heading indicator. Larger deviations can be corrected by using the turn coordinator in conjunction with the heading indicator. The turn coordinator simply helps establish a constant rate turn back to the desired heading. In summary, straight-and-level flight is established and maintained by setting the estimated attitude and power required for the desired cruised condition. Then, in a constant feedback loop, the attitude and power setting of the aircraft are adjusted based on the performance shown on the altimeter, VSI, heading indicator, and turn coordinator.
- As during normal visual flight, trim is crucial to minimize pilot workload. Fly with a light touch and trim away excess pressure.

Common Errors

- Fixation, omission, and emphasis errors during instrument scan.
- Improper instrument interpretation.

- Improper control application.
- Failure to establish appropriate attitude and power settings for the desired flight condition.
- Failure to trim or using trim as a primary flight control.

Task B: Constant Airspeed Climbs

Lesson Objective

Basic instrument skills are required of private pilots. This should not encourage non-instrument rated individuals to fly in marginal conditions, but rather should serve as a skillset for emergency use only. Being proficient in instrument flying requires more extensive training than that required by the private pilot ACS. The objective of this lesson is for the learner to understand the elements of and learn the skill required to perform a constant airspeed climb by sole reference to the instruments.

Completion Standards

1. Learner understands the elements of attitude instrument flying during constant airspeed climbs.
2. Learner establishes the specified climb configuration.
3. Learner establishes and maintains a constant airspeed climb on a constant heading solely by reference to the instruments while utilizing an appropriate instrument scan.
4. Private pilot ACS: Learner levels off at the assigned altitude and maintains that altitude ±200 feet, heading ±20°, and airspeed ±10 kts.

Content

- The attitude indicator is the primary instrument used for all maneuvering in instrument flying. Setting the appropriate power and attitude is the first step of attitude instrument flying. After that, other instruments are used to provide the pilot the necessary feedback so that the attitude of the aircraft can be adjusted accordingly.
- The FAA breaks down attitude instrument flying into two basic techniques: “control and performance” and “primary and supporting.” These two techniques accomplish the same end-goal but vary in the intermediate methods used in achieving these goals.
    - The “control and performance” method has the pilot use the attitude indicator and the power setting to “control” the aircraft and then has the pilot use the “performance” instruments to measure the effectiveness of these control inputs. Based on the feedback from the “performance” instruments, the pilot will adjust the attitude and/or power as appropriately. This feedback loop continues. The pilot will use different instruments to measure the performance based on the type of maneuvering (level, climb, descent, turn, etc.).
    - The “primary and supporting” method has the pilot group the instruments according to their control function. The “primary” instruments for a specific function are those considered the most important or useful while the “supporting” instruments serve as helpful cross-checks against the primary.
- Two fundamental skills are required for instrument flight—instrument cross-check and instrument interpretation.
    - **Instrument cross-check** is the concept of scanning the instrument to ensure the desired attitude and performance from the aircraft. An example of this would be setting the

pitch for climb using the attitude indicator and cross-checking this pitch against the airspeed indicator. Based on the airspeed indication, pitch may need to be increased or decreased. These types of cross-checks are needed for straight-and-level flight, climbs, descents, and turns.

    - Common cross-check errors are fixation, omission, and emphasis.
        - **Fixation** occurs when a pilot focuses on only one instrument. Using the example of an instrument climb, a pilot would exhibit the fixation error if he focuses only on the airspeed, for example, and did not also reference the VSI to ensure that this climb speed was resulting in positive rate of climb. The danger of fixation should be obvious.
        - **Omission** occurs when a pilot leaves a pertinent instrument out of his scan.
        - **Emphasis** occurs when a pilot relies on one instrument too much. An example is a learner who focuses almost exclusively on the attitude indicator perhaps because it is the most familiar and easily understood instrument. Instead, the learner should force himself to become more familiar with the other instrument that are required to maintain precise aircraft control.
  - **Instrument interpretation** is crucial because a perfect instrument scan is no good if the pilot cannot interpret the meaning of the instruments being scanned. Study each instrument in isolation to understand how each instrument works and how each instrument responds to different control inputs.
- A constant airspeed climb is established by pitching for the estimated pitch required for the type of climb desired. Power should simultaneously be set to the appropriate climb setting. Airspeed is the primary instrument used to cross-check the pitch against. If the airspeed has stabilized at a speed less than the desired climb airspeed, then some combination of lowering the nose or adding power will be required. The opposite is true for an airspeed higher than desired. Monitor the VSI to ensure that the pitch and power combination results in an acceptable rate of climb. Monitor the altimeter to prepare for leveling off at the desired altitude. Maintaining straight flight involves the same technique as was used in the lesson on straight-and-level flight. Set wings level using the attitude indicator and cross-check using the heading indicator and the turn coordinator. Continue the process of adjusting the attitude using the supporting instrument for constant airspeed climbs. Transition to level flight at the desired altitude and then adjust the instrument scan for straight-and-level flight. Start this transition at an altitude about 10% of the vertical speed below the target altitude. After level-off, reduce the power to cruise power once the airplane has accelerated to the cruise airspeed. Now that the aircraft is stabilized in cruise, trim for level flight.

Common Errors

- Fixation, omission, and emphasis errors during instrument scan.
- Improper instrument interpretation.
- Improper control application.
- Failure to establish appropriate attitude and power settings for the desired flight condition.
- Failure to trim or using trim as a primary flight control.

- Overcontrolling pitch during climb entry.
- Failure to lead the level off by the correct altitude (10% of VSI).

Task C: Constant Airspeed Descents

Lesson Objective

Basic instrument skills are required of private pilots. This should not encourage non-instrument rated individuals to fly in marginal conditions, but rather should serve as a skillset for emergency use only. Being proficient in instrument flying requires more extensive training than that required by the private pilot ACS. The objective of this lesson is for the learner to understand the elements of and learn the skill required to perform a constant airspeed descent by sole reference to the instruments.

Completion Standards

1. Learner understands the elements of attitude instrument flying during constant airspeed descents.
2. Learner establishes the specified descent configuration.
3. Learner establishes and maintains a constant airspeed descent on a constant heading solely by reference to the instruments while utilizing an appropriate instrument scan.
4. Private pilot ACS: Learner levels off at the assigned altitude and maintains that altitude ±200 feet, heading ±20°, and airspeed ±10 kts.

Content

- The attitude indicator is the primary instrument used for all maneuvering in instrument flying. Setting the appropriate power and attitude is the first step of attitude instrument flying. After that, other instruments are used to provide the pilot the necessary feedback so that the attitude of the aircraft can be adjusted accordingly.
- The FAA breaks down attitude instrument flying into two basic techniques: “control and performance” and “primary and supporting.” These two techniques accomplish the same end-goal but vary in the intermediate methods used in achieving these goals.
    - The “control and performance” method has the pilot use the attitude indicator and the power setting to “control” the aircraft and then has the pilot use the “performance” instruments to measure the effectiveness of these control inputs. Based on the feedback from the “performance” instruments, the pilot will adjust the attitude and/or power as appropriately. This feedback loop continues. The pilot will use different instruments to measure the performance based on the type of maneuvering (level, climb, descent, turn, etc.).
    - The “primary and supporting” method has the pilot group the instruments according to their control function. The “primary” instruments for a specific function are those considered the most important or useful while the “supporting” instruments serve as helpful cross-checks against the primary.
- Two fundamental skills are required for instrument flight—instrument cross-check and instrument interpretation.
    - **Instrument cross-check** is the concept of scanning the instrument to ensure the desired attitude and performance from the aircraft. An example of this would be setting the

pitch for climb using the attitude indicator and cross-checking this pitch against the airspeed indicator. Based on the airspeed indication, pitch may need to be increased or decreased. These types of cross-checks are needed for straight-and-level flight, climbs, descents, and turns.

        - Common cross-check errors are fixation, omission, and emphasis.
            - **Fixation** occurs when a pilot focuses on only one instrument. Using the example of an instrument climb, a pilot would exhibit the fixation error if he focuses only on the airspeed, for example, and did not also reference the VSI to ensure that this climb speed was resulting in positive rate of climb. The danger of fixation should be obvious.
            - **Omission** occurs when a pilot leaves a pertinent instrument out of his scan.
            - **Emphasis** occurs when a pilot relies on one instrument too much. An example is a learner who focuses almost exclusively on the attitude indicator perhaps because it is the most familiar and easily understood instrument. Instead, the learner should force himself to become more familiar with the other instrument that are required to maintain precise aircraft control.
    - **Instrument interpretation** is crucial because a perfect instrument scan is no good if the pilot cannot interpret the meaning of the instruments being scanned. Study each instrument in isolation to understand how each instrument works and how each instrument responds to different control inputs.
- A constant airspeed descent is established by reducing the power and maintaining level flight while allowing the aircraft to slow to the desired airspeed for the descent. Once slowed to the descent airspeed, use the attitude indicator to lower the pitch to the estimated amount needed to maintain the descent airspeed. Airspeed is the primary instrument used to cross-check the pitch against. If the airspeed has stabilized at a speed more or less than the desired airspeed, then the pitch will need to be raised or lowered, respectively. Monitor the VSI to ensure that the pitch and power combination is resulting in an acceptable rate of descent. Monitor the altimeter to prepare for leveling off at the desired altitude. Maintaining straight flight involves the same technique as was used in the lesson on straight-and-level flight. Set wings level using the attitude indicator and cross-check using the heading indicator and the turn coordinator. Continue the process of adjusting the attitude using the supporting instrument for constant airspeed descents. Transition to level flight at the desired altitude and then adjust the instrument scan for straight-and-level flight. Start this transition at an altitude about 10% of the vertical speed above the target altitude. After level-off, increase the power to cruise power. Once the aircraft is stabilized in cruise, trim for level flight.

Common Errors

- Fixation, omission, and emphasis errors during instrument scan.
- Improper instrument interpretation.
- Improper control application.
- Failure to establish appropriate attitude and power settings for the desired flight condition.
- Failure to trim or using trim as a primary flight control.

- Overcontrolling pitch during descent entry.
- Failure to lead the level off by the correct altitude (10% of VSI).

Task D: Turns to Headings

Lesson Objective

Basic instrument skills are required of private pilots. This should not encourage non-instrument rated individuals to fly in marginal conditions, but rather should serve as a skillset for emergency use only. Being proficient in instrument flying requires more extensive training than that required by the private pilot ACS. The objective of this lesson is for the learner to understand the elements of and learn the skill required to perform turns to headings by sole reference to the instruments.

Completion Standards

1. Learner understands the elements of attitude instrument flying during turns to headings.
2. Learner transitions to the level-turn attitude using proper instrument cross-check and interpretation while using coordinated control application.
3. Private pilot ACS: Learner maintains altitude ±200 feet, maintains a standard rate turn and rolls out on the assigned heading ±10°, and maintains airspeed ±10 kts.

Content

- The attitude indicator is the primary instrument used for all maneuvering in instrument flying. Setting the appropriate power and attitude is the first step of attitude instrument flying. After that, other instruments are used to provide the pilot the necessary feedback so that the attitude of the aircraft can be adjusted accordingly.
- The FAA breaks down attitude instrument flying into two basic techniques: "control and performance" and "primary and supporting." These two techniques accomplish the same end-goal but vary in the intermediate methods used in achieving these goals.
    - The "control and performance" method has the pilot use the attitude indicator and the power setting to "control" the aircraft and then has the pilot use the "performance" instruments to measure the effectiveness of these control inputs. Based on the feedback from the "performance" instruments, the pilot will adjust the attitude and/or power as appropriately. This feedback loop continues. The pilot will use different instruments to measure the performance based on the type of maneuvering (level, climb, descent, turn, etc.).
    - The "primary and supporting" method has the pilot group the instruments according to their control function. The "primary" instruments for a specific function are those considered the most important or useful while the "supporting" instruments serve as helpful cross-checks against the primary.
- Two fundamental skills are required for instrument flight—instrument cross-check and instrument interpretation.
    - **Instrument cross-check** is the concept of scanning the instrument to ensure the desired attitude and performance from the aircraft. An example of this would be setting the pitch for climb using the attitude indicator and cross-checking this pitch against the airspeed indicator. Based on the airspeed indication, pitch may need to be increased or

decreased. These types of cross-checks are needed for straight-and-level flight, climbs, descents, and turns.

        - Common cross-check errors are fixation, omission, and emphasis.
            - **Fixation** occurs when a pilot focuses on only one instrument. Using the example of an instrument climb, a pilot would exhibit the fixation error if he focuses only on the airspeed, for example, and did not also reference the VSI to ensure that this climb speed was resulting in positive rate of climb. The danger of fixation should be obvious.
            - **Omission** occurs when a pilot leaves a pertinent instrument out of his scan.
            - **Emphasis** occurs when a pilot relies on one instrument too much. An example is a learner who focuses almost exclusively on the attitude indicator perhaps because it is the most familiar and easily understood instrument. Instead, the learner should force himself to become more familiar with the other instrument that are required to maintain precise aircraft control.
    - **Instrument interpretation** is crucial because a perfect instrument scan is no good if the pilot cannot interpret the meaning of the instruments being scanned. Study each instrument in isolation to understand how each instrument works and how each instrument responds to different control inputs.
- If a VFR pilot accidentally flies into IMC, then a 180° turn is typically the best option to return to VMC. Additionally, a VFR pilot who gets disoriented in IMC may need to fly specific headings (vectors) given by ATC in order to get out of the clouds. In both examples, the pilot needs to possess the skills to be able to turn the aircraft to a specific heading.
- Turns in instrument conditions are done at a standard rate of 3°/sec. This means when turning at the standard rate, it will take 1 minute to complete a 180° turn or 2 minutes to complete a 360° turn. The turn rate is measured by the turn coordinator instrument.
- The bank angle required for a standard rate turn varies with airspeed. The higher the airspeed, the higher the required bank angle. A good rule of thumb is that the bank angle should be about 15% of the true airspeed for a standard rate turn. For example, a true airspeed of 100 kts would require about a 15° bank angle for a standard rate turn.
- If attempting to make a 180° turn to escape an inadvertent entry into IMC, first note the present heading. This will be crucial in knowing when to roll out of the turn. Otherwise, the pilot may turn too much or too little and end up flying into worsening condition rather than reversing course back to known better weather. Additionally, start a timer at the entry of the turn. A 180° turn at standard rate will take 1 minute.
- To turn to a heading while in IMC, use the attitude indicator to establish a bank in the desired direction of the turn. The amount of bank needed for a standard rate turn can be estimated using the method explained above. Use rudder as required to maintain coordination.
- Once the bank is established, use the turn coordinator to verify a standard rate turn. Adjust the bank angle as needed based on the indication from the turn coordinator. Use the attitude indicator to establish a steeper bank if the rate of turn is below standard or establish a shallower bank if the rate of turn is above standard.

- Maintain level flight during the turn. The same instruments used for "level" in straight-and-level flight will be used for the level turn. The altimeter will be the best instrument to cross check for level flight. Based on the indications from the altimeter, pitch can be adjusted slightly to correct for small deviations. The VSI will be helpful in ensuring an adequate rate of climb or descent when recovering from larger altitude deviations. Power should not need to be adjusted during the level turn unless having to make significant altitude corrections.
- Monitor the heading indicator and start a coordinated roll back to wings level once about half the bank angle away from the desired heading. Monitor altitude during the rollout.
- Once on the desired heading, transition to the straight-and-level instrument cross-check.

Common Errors

- Fixation, omission, and emphasis errors during instrument scan.
- Improper instrument interpretation.
- Improper control application.
- Failure to establish the appropriate initial attitude for the turn.
- Failure to adjust pitch to maintain altitude during the turn.
- Overcontrolling pitch during the turn or rollout.
- Failure to lead the rollout to prevent overshooting the desired heading.

Task E: Recovery from Unusual Flight Attitudes

Lesson Objective

Unexpected entry into IMC can easily lead to disorientation. If the pilot becomes disoriented, the airplane will soon be in an unusual attitude. The objective of this lesson is to train the learner how to recognize and recover from the common unusual attitudes.

Completion Standards

1. Learner understands the elements of unusual attitudes.
2. Learner demonstrates proficiency in recognizing and recovering from unusual attitudes by sole reference to instruments.
3. Learner understands the counterintuitive concept of possibly needing to push the nose down when recovering from a spiral dive.
4. Learner understands how to use the turn coordinator to level the wings in the event of a tumbled attitude indicator.

Content

- Unusual attitudes typically come in two basic varieties: Nose-high decreasing airspeed and nose-low increasing airspeed. While there are others, these are the two common situations that will be studied in the lesson.
- **Nose-high decreasing airspeed—**In this unusual attitude, the aircraft is at risk of stalling if not promptly recovered. This unusual attitude is recognized by decreasing airspeed on the airspeed indicator, increasing altitude on the altimeter, positive rate of climb on the VSI, a bank on the attitude indicator (if not tumbled), changing heading on the heading indicator, and a turn on the turn coordinator. To recover:

- Reduce pitch while simultaneously adding power.
  - Level the wings.
- **Nose-low increasing airspeed—**In this unusual attitude, the aircraft is at risk of exceeding the design envelope due to excessive speed and excessive load factor. If not promptly recovered from, this can lead to structural failure. This unusual attitude can quickly lead to a spiral dive that is popularly known as the "graveyard spiral." This unusual attitude is recognized by increasing airspeed on the airspeed indicator, decreasing altitude on the altimeter, negative rate of climb on the VSI, a bank on the attitude indicator (if not tumbled), changing heading on the heading indicator, and a turn on the turn coordinator. To recover:
  - Reduce power (the immediate concern is overstressing the aircraft).
  - Level the wings (this must be done before pitching up to avoid tightening the spiral).
  - Manage the rate of pitch change as the nose is carefully brought back to the horizon. If this done too fast, it can overstress the aircraft leading to structural failure.
    - If the unusual attitude leads to well-developed spiral dive, there are a few special considerations that the FAA totally misses in their publications.
      - First, the attitude indicator gyro could tumble. It is important to be able to recover wings level using only the turn coordinator. Don't be totally dependent on the attitude indicator for recovery. In training, it works fine. But in a severe unusual attitude, the attitude indicator may not be functional.
      - Second, in recovering from a spiral dive, the nose may have to be *pushed down* after bringing the wings level. The FAA mentions in their publications that the pilot will have to raise the nose back to the horizon. This may be true in the types of unusual attitudes used in training, but in a bad spiral dive, the airspeed will be so high that rolling wings level will cause a severe pitch-up moment (without the pilot's input). The pilot will need to push forward to slow the rate that the airplane pitches up in order to avoid overstressing the aircraft. This nose-down force can slowly be relaxed as the airspeed slows back to normal cruise speed.

Common Errors

- Failure to trim properly leading to an unusual attitude.
- Distraction due to pilot disorganization leading to an unusual attitude.
- Failure to utilize an appropriate instrument scan which leads to an unusual attitude.
- Failure to use the instruments when recovering from an unusual attitude.
- Failure to use basic instrument skills which leads to entering, or difficulty in recovering from, an unusual attitude.
- Failure to immediately lower the nose and add power during a nose-high decreasing airspeed unusual attitude.
- Failure to level the wings before attempting to stop the descent when in a nose-low increasing airspeed unusual attitude.

Areas of Operation XIII: Emergency Operations

Task A: Emergency Approach and Landing (Simulated)

Lesson Objective

Pilots should be aware that almost any terrain can be considered survivable in the event of an emergency landing. The key is to maintain control of the aircraft, touchdown with the lowest energy possible, and dissipate this energy over the longest distance possible. The objective of this lesson is for the student to understand the elements and demonstrate the skills required to successfully perform a simulated emergency approach and landing.

Completion Standards

1. Learner understands the elements of the emergency approach and landing.
2. Learner reacts appropriately to the situation and chooses a suitable course of action.
3. Learner established the best glide airspeed ±10 kts.
4. Learner selects a suitable landing area considering altitude, wind, terrain, and obstacles.
5. Learner completes the appropriate checklist.
6. Learner plans and executes a flight pattern to the selected area.
7. Learner lands or executes a go-around as specified by the instructor or examiner.

Content

- An emergency approach and landing can be divided into three basic categories: a forced landing, a precautionary landing, and a ditching.
    - A forced landing occurs when the pilot is left with no alternative other than to land immediately. This can be because of an engine failure, engine fire, or some other type of major failure.
    - A precautionary landing is a landing performed when continued flight is possible but inadvisable. This situation could arise with an impending engine failure. The pilot may choose to land now with a suitable field below rather than to try to continue into uncertain terrain ahead. Weather is another factor that could lead to a precautionary landing. A VFR pilot faced with low ceilings and worsening weather might decide to land in a field rather than continue into deteriorating conditions.
    - A ditching is either a forced or precautionary landing on water.
- **ABCD** is a good acronym for prioritizing the steps for an emergency approach and landing.
    - **A** is for **Airspeed**. Whether dealing with an emergency that leads to a forced landing, precautionary landing, or ditching, the number one priority is control of the aircraft. Maintain the best glide airspeed—do not get slow. This could lead to a stall/spin accident that almost certainly will result in death.
    - **B** is for **Best Field**. Choose the best landing option that is within easy gliding distance. Consider wind, terrain, and obstacles when choosing this location. Do not pick a spot too far away and try to “stretch the glide.” This leads to violating rule A. Picking a spot within easy gliding distance will give the pilot margin to enter a normal traffic pattern for the approach into the desired landing spot.

    - **C** is for **Checklist**. After establishing the best glide airspeed and selecting the best field, the pilot should complete the appropriate flow backed up by the checklist. This will likely be a flow/checklist to address the system failure, if there is one, and then a flow/checklist to prepare the airplane for the emergency landing.
    - **D** is for **Declare an Emergency**. If time is remaining, declare an emergency, squawk 7700, and turn on the ELT.
- One of the most common situations leading to a forced landing would be an engine failure. The learner should know from memory the critical items to check. These will depend on the airplane, but typically involve checking the fuel, air, and ignition sources.
    - Fuel—Check the mixture, fuel tank selector, and boost pump.
    - Air—Check the alternate air, if controllable by the pilot. Check the carb heat if applicable.
    - Ignition—Try the magnetos in all positions.
- All the techniques learned in the landing portion of the syllabus can and should be used to adjust the airplane's glide appropriately. In confined areas, this skill is crucial.
- No simulated emergency approach is to be continued below 500 feet AGL, unless over an area where a safe landing can be accomplished in compliance with 14 CFR Part 91, section 91.119.

Common Errors

- Failure to control the airspeed.
- Poor judgment in the selection of the emergency landing area.
- Failure to be aware of wind speed and direction.
- Failure to accomplish the emergency checklist.
- Failure to fly a normal pattern (altitude permitting).
- Overshooting or undershooting the selected landing area.

Task B: Systems and Equipment Malfunctions

Lesson Objective

It is difficult to troubleshoot a system that is not understood by the pilot. For that reason, knowledge of the aircraft's systems and equipment is important. The objective of this lesson is to ensure that the learner understands the aircraft's systems and equipment and uses the appropriate checklists to troubleshoot malfunctions.

Completion Standards

1. Learner exhibits knowledge of the elements related to systems and equipment malfunctions appropriate to the airplane provided for the practical test.
2. Learner analyzes and takes appropriate action for the following simulated emergencies (if applicable to the airplane type used for the practical test):
    a. Partial or complete power loss.
    b. Engine roughness or overheat.
    c. Carburetor or induction icing.
    d. Loss of oil pressure.
    e. Fuel starvation.

f. Electrical malfunction.
g. Vacuum failure.
h. Pitot/static.
i. Landing gear or flap malfunction.
j. Inoperative trim.
k. Inadvertent door or window opening.
l. Structural icing.
m. Smoke/fire/engine compartment fire.
n. Any other emergency appropriate to the airplane.

3. Learner follows the appropriate checklist or procedure.

Content

Each of the emergencies below are addressed in section 3 of the POH. The boldface items in each checklist should be committed to memory so they can be promptly performed in the event of an emergency. In all cases, if time allows, the memory items and any additional items should be checked using the checklist. The discussion below will help the learner understand more of "why" behind the general action items in the various emergency checklists. For detailed steps for each of these emergencies, refer to section 3 of the POH.

- **Power loss**—When dealing with any form of power loss, the immediate concern is to stay in control of the airplane by maintaining a safe flying speed. While trimming for the best glide airspeed and maneuvering to a suitable landing area, the pilot can go through a flow check to rule out the common culprits: fuel tank selector, mixture, boost pump, and magnetos. If the flow check does not identify the problem, declare an emergency, squawk 7700, turn on the ELT and then work through the manufacturer's "engine failure" checklist and the "emergency landing without engine power checklist."
    - Partial power loss situations can be especially tricky. If the engine completely fails, the pilot is only faced with one option—land the plane. With partial power, the pilot can perform a precautionary landing or try to continue on to the nearest runway. With little altitude and insufficient power to maintain altitude, it might be best for the pilot to shut down the engine and commit to the emergency landing.
    - With a power loss immediately after takeoff, the pilot should prioritize maintaining control. Get the nose down and do not stall. If time allows, complete the memory items to secure the engine and electrical system and to prepare for the landing.
- **Engine roughness / overheat**—Engine roughness can most likely be corrected by enrichening the mixture. This will solve the problem if the engine is running rough because the mixture is too lean. But the problem may be fouled spark plugs because of operation at too rich of a mixture. If that is the case, leaning may help clear the spark plugs and eliminate the roughness. If that doesn't work, the magnetos could be the issue. If one of the two magnetos has fallen out of time, switching to the other magneto can restore smoothness to the engine. An overheating engine is best dealt with by enrichening the mixture, opening the cowl flaps and shallowing the climb to increase airflow through the engine.
- **Carburetor or induction icing**—The C182S does not have a carburetor, but induction icing is a possibility. In the event of induction icing, the alternate air door should automatically open because of the low pressure created between the engine and the induction air filter. This

vacuum opens the door that is normally held shut by a spring and allows the induction air to bypass the air filter. This results in about a 10% power loss at full throttle.

- **Loss of oil pressure**—An actual loss of oil pressure is a serious emergency because the engine will not last long without oil. A low oil pressure annunciator could be a false indication. Check the oil pressure gauge to see if it confirms the annunciator. The common wisdom is that an actual loss of oil pressure will be accompanied by a rise in oil temperature. If it is determined that a true loss of oil pressure has occurred, prepare for a forced landing. If a malfunctioning oil pressure gauge is suspected, land at the nearest airport and have the airplane checked.
- **Fuel Starvation**—fuel starvation is different than fuel exhaustion. Fuel exhaustion means there is no fuel onboard, but fuel starvation means there is fuel on board, but it's not getting to the engine. Fuel starvation typically occurs when the pilot forgets to swap tanks or selects the wrong tank. Thus, in the event of an engine failing in flight, one of the first things a pilot should check is the fuel selector—swap to a different tank and see what happens!
- **Electrical malfunction**—An alternator failure is the most common electrical malfunction. This problems presents itself in the form of a low voltage annunciation, a low voltage reading on the voltmeter, and a discharge on the ammeter. An alternator can fail to charge the system because of a broken belt or a broken wire. An overvoltage sensor is designed to take the alternator offline in the event of a voltage spike, but occasionally this sensor malfunctions and removes the alternator from the circuit without good cause. For this reason, the pilot should attempt to reset the alternator. This is accomplished by turning off the avionics master switch, verifying the alternator circuit breaker is in, turn off the master switch, and then switching the master switch back on. If the voltage indications are now normal, the avionics can be brought back on. If the alternator is taken offline again, something is likely wrong, and the plane should be landed at the nearest suitable field. Conserve battery as necessary in order to have electricity for any critical items (radio, flaps, lights, etc.). Another electrical malfunction that could occur is an excessive rate of charge. As described above, the overvoltage sensor in the alternator control unit will typically shut down the alternator if the voltage spikes (this cutoff value in the C182S is around 31.5 Volts). However, should this sensor fail, the alternator may continue to put out excessive voltage which may cause electrical components to overheat and/or fail. For that reason, shut off the alternator and land at the nearest suitable field. Conserve battery as required. As always, back up memory items with the checklist.
- **Vacuum failure**—The vacuum instruments are the attitude indicator and the heading indicator. Without a vacuum from the vacuum pump, these instruments will give erroneous readings and should be ignored. A vacuum failure can be confirmed by the vacuum pressure gauge. Place a piece of paper over the instruments to eliminate the distraction these indications would cause. Fly the airplane by outside visual references.
- **Pitot/static**—The pitot/static system measures ram pressure and static pressure to power the airspeed indicator (ASI), the vertical speed indicator (VSI), and the altimeter. The static source alone powers the VSI and the altimeter, but both the static source and the pitot source is used to power the ASI. If the static source is suspected of being blocked, use the alternate static source. Any small errors caused by this alternate static source can be corrected for by referring to the calibration chart in the POH. A blocked pitot tube may not be as easily remedied. If the problem is ice, pitot heat is an easy fix, but if the pilot left the pitot tube cover on or if a bug has lodged

into the pitot tube, then the problem will have to be fixed on the ground. Fly the plane using known power and pitch settings and ignore the erroneous airspeed indications.

- **Landing gear or flap malfunction**—The C182S has fixed gear, so landing gear issues will not be an issue other than possibly having to land with a flat tire. Flap malfunctions can be dealt with by simply performing a no-flap landing. The approach will be shallower, the float longer, and the pitch in the flare higher, but overall should be easily performed. Add about 5 kts to the approach speed since the stall speed will be higher than a normal landing with flaps. If the flaps do no retract after takeoff, then leave the flaps in that position for the landing. Do not lower the flaps further for the landing because full flaps that cannot be retracted during a possible go around could prevent the aircraft from climbing.
- **Inoperative trim—**Aircraft with electric trim can have a "runaway" trim if the trim switch gets stuck. This dangerous failure can quickly lead to loss of control of the aircraft if the pilot does not act quickly. The pilot should immediately control the airplane using whatever control forces are required while locating and pulling the autopilot circuit breaker. This circuit breaker will disable the electric trim feature and will allow the pilot to use the manual trim wheel to retrim the aircraft for normal flight. The pilot should know from memory where the autopilot circuit breaker is located.
- **Inadvertent door or window opening**—The pilot should continue to fly the airplane if the door or window opens inadvertently. Do not get distracted trying to shut a door in flight at low altitudes right after takeoff. The aircraft will fly completely normal—it will simply startle the pilot and passengers and cause a lot of noise. Once at a safe altitude, the plane can be slowed to about 80 kts which should allow the door to be closed and latched. Alternatively, land the airplane normally and shut the door.
- **Structural icing**—The Cessna 182 is not certified for flight into known icing conditions. The only ice protection it has is pitot heat, stall warning heat, defrost, and alternate air. The wing, tail, and propeller have no protection. Thus, if icing conditions are encountered, take immediate action (reverse course or change altitude) to exit the icing conditions. Turn on the pitot heat and cabin heat/defrost and increase the propeller RPM to minimize ice accumulation. If significant ice is still on the wings or tail when approaching to land, leave the flaps up and fly the approach at a higher-than-normal airspeed (80-90 kts). As always, back up memory items with the checklist.
- **Smoke/fire/engine compartment fire**—First, the source of the smoke or fire needs to be determined. If its an oily smelling fire with black smoke, it is likely an engine/fuel related fire. In this case, the engine should be immediately secured and the airplane should be put into a descent at 100 kts (higher if needed to extinguish the fire). Complete the checklists and perform a forced landing. An electrical fire will have an acrid odor from the wiring insulation that is burning. In this event, the master switch should be turned off and all air to the cabin should be cut off. Use a fire extinguisher to eliminate the fire. Once eliminated, leave all electrical devices off unless necessary for flight to the nearest airport. As always, back up memory items with the checklist.

Common Errors

- Failure to recognize the system or equipment malfunction.
- Inadequate knowledge of the aircraft's systems and equipment.
- Failure to accomplish the appropriate checklist or procedure.

Task C: Emergency Equipment and Survival Gear

Lesson Objective

Airplanes operate in a variety of environments. These different environments may require specialized emergency equipment and survival gear. Thus, the objective of this lesson is to educate the learner on basic emergency equipment and survival gear that may be needed in the various types of environments the pilot may encounter.

Completion Standards

1. Learner exhibits knowledge of the elements related to emergency equipment and survival gear appropriate to the airplane and environment encountered during flight.
2. Learner identifies appropriate equipment that should be on board the airplane.

Content

- The best survival plan after an emergency landing is to be rescued as soon as possible. This is often overlooked. Carry a basic first aid kit to deal with any immediate medical issues and have a few bottles of water in the airplane to keep hydrated. These basics should be on the airplane for every flight. This is because even routine flights between populated areas commonly have areas of barren wilderness between the departure and destination. That is something that most non-pilots do not understand. Most land is uninhabited. Thus, in an emergency landing it should not come as a surprise that help may be many miles away.
- In order to get rescued as soon as possible, carry some type of personal locating device. Many pilots choose to carry a Garmin inReach. In the event of no cell service, this will allow the pilot to send out an SOS over the satellite network which should result in a quick rescue. Also, try to fly in airplanes with updated 406 ELT's. These ELT's broadcast GPS location unlike the old 121.5 ELT's. In the event that the crash incapacitates the pilot, the 406 ELT will activate and send a precise location to rescuers.
- Even with these locator devices, the pilot, depending on the area, may have to survive for many hours until rescue arrives. For this reason, carry the essentials for the environment you are in. As discussed above, this always includes a first aid kit and water, but may also include some of the following:
    - Over water: life vests and/or rafts.
    - Over terrain that is cold or gets cold and night: Extra clothes, emergency blankets, fire starting material, etc.
- With the items listed above, the pilot will be successful in most environments that airplanes encounter. Obviously, in extreme or very remote environments, further planning may be necessary.

Common Errors

- Failure to understand that even routine flights may require basic emergency equipment/survival gear.
- Failure to understand the need to focus on being rescued rather than the need to focus on "surviving."
- Failure to give special consideration to the specific types of terrain the pilot will be flying over.

- Failure to know how to operate or service the equipment/gear that is carried during flight.

Task D: Emergency Descent

Lesson Objective

In some types of emergencies, it may be necessary to get the plane on the ground as soon as possible. One reason, for example, could be an engine fire. In these situations, the pilot should know the procedures needed to execute the emergency descent. The objective for this lesson is for the learner to understand the elements of and learn the skills needed for the emergency descent.

Completion Standards

1. Learner understands what an emergency descent is and when an emergency approach should be used.
    a. Cockpit smoke that can't be cleared, uncontrollable fire, depressurization.
2. Learner understands the emergency descent procedure for the specific airplane being flown.
    a. Learners clears the area before beginning the maneuver.
    b. When initiating the descent, the learner establishes a bank angle between 30 to 45° to maintain a positive load factor.
        i. For simulated emergency descents, continue in a turning descent to help aid in the search for traffic.
    c. Learner maintains the appropriate descent speed +0/-10 kts and does not exceed any airspeed limitations.
    d. Learner exhibits orientation, division of attention, and proper planning.
    e. Learner stops the descent at the specified altitude ±100 feet or at an altitude appropriate to set up for the forced landing.
    f. Learner completed the appropriate checklist(s),

Content

- The purpose of the emergency descent is to lose altitude as rapidly as possible while staying within the aircraft's limitations. The need to perform an emergency descent could be because of a fire that cannot be controlled, cockpit smoke that can't be cleared, or because of cabin depressurization. In the event of a fire that cannot be controlled, get on the ground as soon as possible—do not try to continue to the nearest airport unless that airport is beneath you.
- *Commercial/Private Pilot ACS:* Maintain appropriate airspeed +0/-10 kts and level off at specified altitude ±100 ft. Maintain positive load factor. Complete appropriate checklist.
- Flow Check (LCGUMPS).
    - Prop Full Forward.
    - Cowl Flaps Closed.
- Pitch for 100 kts while entering a 30°-45° bank (faster if needed to extinguish an engine fire). Consider descending at V_{NE} if the absolute maximum rate of descent is needed.
- Engine Fire Checklist (if that is the emergency).
    - Mixture idle cutoff.
    - Fuel selector off.
    - Boost pump off.

    - Master off.
    - Cabin air and heat off except overhead vents.
- Stop the descent at the specified altitude ±100 feet or at an altitude appropriate to set up for the forced landing. Pitch for best glide (75 kts) while maneuvering for downwind key position of emergency landing point.

Common Errors

- Failure to clear the area before starting the maneuver.
- Failure to maintain bank angle.
- Failure to use appropriate checklists.
- Failure to properly divide attention between the inside and outside of the aircraft.
- Failure to pitch down enough to maintain the appropriate airspeed for the emergency descent.
- Failure to prepare for the inevitable forced landing.

Areas of Operation XIV: Postflight Procedures

Task A: Postflight Procedures

Lesson Objective

The flight is not yet over once the landing is done. The airplane has to be parked and shutdown, and passengers, if any, have to be deplaned. The airplane may need to be tied down and additional fuel may be required before the next flight. The objective of this lesson is for the learner to understand the common postflight procedures and be familiar with best practices.

Completion Standards

1. Learner understands parking procedures.
2. Learner demonstrates knowledge of shutdown procedure and securing the cockpit.
3. Learner understands how to properly deplane passengers.
4. Learner demonstrates ability to secure the airplane.
5. Learner performs a postflight inspection.
6. Learner knows how to ensure proper refueling when at full-service pumps and also knows how to operate self-serve pumps.

Content

- When parking on an airport ramp, sometimes the pilot chooses where to park and sometimes a marshaller will direct the pilot where to park. Sometimes the space will be marked with a 'T'. If marked with a 'T', the wings should be positioned over the top of the 'T' and the tail should be aligned with the 'I' portion of the 'T'.
- Follow the manufacturer's instructions for engine shutdown. The typical flow is to turn off the avionics master, mixture to cutoff, mags off, and master off.
- If passengers are on the flight, make sure that the engine is off and the keys are removed from the ignition before deplaning. There are numerous instances of passengers being killed by propellers after the pilot allowed his passengers to exit with the engine running. Yes, fuel injected piston engines can be trouble to restart when hot, but do not let that deter you from ensuring passenger safety.
- Securing the airplane with tie downs is often a good idea when leaving the airplane on a ramp. This is most commonly accomplished by tying two half-hitch knots spaced about 6 to 12 inches apart. At some FBO's, tie downs are not available where the marshallers parks the airplane, but the staff will move and tie down the aircraft if necessary. Additional factors to consider are control locks, cowl plugs, pitot covers, sunshades for windows, etc. Use a checklist to ensure the airplane is properly secured before leaving the aircraft.
- Postflight inspections are a good way for the pilot to check for any discrepancies in the condition of the aircraft. The pilot should do a brief walk-around and ensure that the general appearance of the aircraft is normal, that no unusual fluids are dripping, tires are properly inflated, no oil streaks down the cowling, etc. Doing this check allows the pilot to observe certain items that may not be able to be noticed once the aircraft has been sitting for several days or after the FBO has moved the aircraft. Thus, take this opportunity to give the aircraft a brief looking over.
- Fuel is either self-serve (pumped by the pilot) or full-service (pumped by airport staff). When the airport staff is refueling the plane, it is essential that fuel type and quantity is verified. Accidents

have been caused by an airport refueling with the wrong type of fuel or by refueling the wrong aircraft. Thus, always check on the receipt for fuel type and quantity, check the fuel level, and test the fuel type before flying away after a refuel.

Common Errors

- Failure to understand the risks of deplaning passengers with the engine running.
- Failure to perform a brief postflight inspection.
- Failure to verify fuel type and fuel quantity after refueling.