CFI LESSONS

One of the most common requests was for a more condensed, streamlined version of the lesson plans. These condensed lesson plans are the CFI lesson plans with considerably less explanations, aircraft specific information, details, and examples.

As you make your way through them, any input you can provide is appreciated and will go toward further improvements!

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NAVIGATING THE EBOOK

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LEGEND

* - The lessons are generally based off the DA20. DA20 specific information is denoted with an *.
Search for * to quickly find and update each area containing DA20 specific material

LINKS

Blue text in the body of a lesson (not the heading/header) is a web link. If you have internet access, holding the Control key and clicking on the text will take you to the website. For example: The Backseat Pilot

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CONTACT

If you come across any errors, or have any questions please contact us at Info@thebackseatpilot.com, or head to our website and send us a contact form (they both go to the same inbox).

TERMS AND CONDITIONS

RECENT UPDATES

Most of the recent updates are indicated with a red bar in the left margin (not shown in the PDF)
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DATE	LESSON(S)	UPDATE
April 2022	III.B. Weather Information	Updated Convective Outlook Chart information
Mar 2022	VI.B. Traffic Patterns	Reorganized pattern entries, added alternate entry proc.
Feb 2022	All lessons	Fixed FAR links
		Minor changes to mirror PowerPoint lessons
	II.E. Airplane Flight Controls	Minor updates to Elevator terminology
	XII. Slow Flight, Stalls, and Spins	Updated to common stall recovery procedure
	XV. Appendix	Added Appendix – Flight Review & Plan of Action

CONTENTS

FUNDAMENTALS OF INSTRUCTING

I.A. Human Behavior and Effective Communication

References: Aviation Instructor's Handbook (FAA-H-8083-9)

Objectives	The learner should develop knowledge of the elements related to human behavior and effective communication as required in the CFI PTS.
Elements	1. Definitions of Human Behavior 2. Human Needs and Motivation 3. Defense Mechanisms 4. Learner Emotional Reactions 5. Basic Elements of Communication 6. Barriers to Effective Communication 7. Developing Communication Skills
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The learner will understand the 3 basic elements of the communicative process, recognize the various barriers to communication, and develop communication skills in order to convey the desired information to future learners.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Years of thinking people have understood you. Unless you've known this stuff, they haven't.

Overview

Review Objectives and Elements/Key ideas

What

Basic human needs as well as defense mechanisms and effective communication.

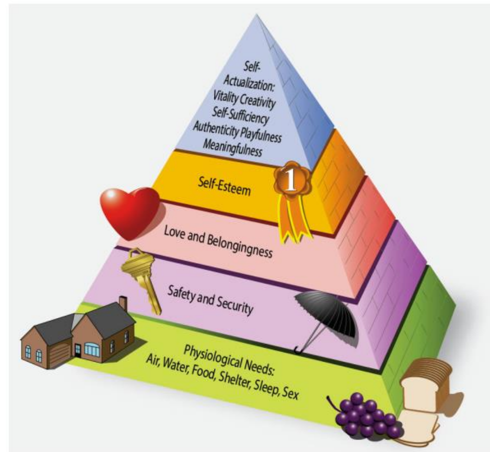
Why

Learning is a change of behavior as a result of experience. To successfully accomplish the task of helping bring about this change, the instructor must know why people act the way they do.

How:

1. **Definitions of Human Behavior**
   - A. The study of human behavior is an attempt to explain how and why human functions the way they do
   - B. Scientific World Definition
     - i. Product of factors that cause people to act in predictable ways
       - a. Ex: how people handle fear is a product of individual experiences
   - C. Satisfying Needs Definition
     - i. Human behavior is the result of attempts to satisfy certain needs
       - a. Behavior is driven by simple (food, water) and complex needs (respect and acceptance)
   - D. Life Course of Humans Definition
     - i. As humans grow, behavior changes
       - a. As an individual matures, their mode of actions moves from dependency to self-direction
       - b. Therefore, the age of the learner impacts how the curriculum is designed
   - E. Personality Types
     - i. Myers Briggs Type Indicator
       - a. Seeming random variation in human behavior is quite structured due to differences in way individuals prefer to use their perception & judgment
     - ii. Now used to discover future careers
   - F. Instructor and Learner Relationship
     - i. Instructor must understand their style of teaching and as much as possible adapt to learners
   - G. Control of Human Behavior
     - i. Learners tend to submit to authority as a valid means of control
       - a. The instructor's challenge is to know what controls are best for existing circumstances
       - b. Create an atmosphere that enables / encourages learners to help themselves toward their goals
     - ii. It is the instructor's responsibility to discover how to realize the potential in each learner
   - H. A working knowledge of behavior can help an instructor better understand a learner
2. **Human Needs and Motivation**
   - A. Hierarchy of Human Needs – An organization of human needs into levels of importance
     - i. Until the needs are satisfied, one can't focus fully on learning, self-expression, or any other task
       - a. Once a need is satisfied, it no longer provides motivation
   - B. **Physiological -** Biological needs: Food, rest, and protection from the elements

C. **Security -** Protection against danger, threats, deprivation affect learner behavior
    i. If a learner doesn't feel safe, they can't concentrate fully on learning
D. **Belonging -** Belong, to associate, and to give and receive friendship and love
    i. Ensure new learners feel at ease and their decision to pursue aviation is reinforced
E. **Esteem -** Two types:
    i. Internal - Relating to self-esteem: confidence, independence, achievement, competence, knowledge
    ii. External - Relating to reputation: status, recognition, appreciation, and respect of associates
    iii. May be the main reason for interest in aviation



F. **Cognitive and Aesthetic**
    i. This need was added years after the initial development of the theory
    ii. Cognitive: need to know and understand
        a. If a person understands, they can control the situation / make informed decisions
    iii. Aesthetic: Emotional needs
        a. If an instructor does not like a learner, this feeling may affect the instructor's ability to teach
G. **Self-Actualization**
    i. When all other needs are satisfied only then can self-actualization be attained
    ii. Realizing one's own potential for continued development / Reaching personal goals and potential
H. Help learners satisfy their own needs in a manner that will create a healthy learning environment

3. Defense Mechanisms

A. Subconscious, almost automatic, ego-protecting reactions to unpleasant situations
    i. Used to soften feelings of failure, to alleviate feelings of guilt, and to protect personal worth
B. **Repression -** Uncomfortable thoughts are placed in inaccessible areas of the unconscious mind
C. **Denial -** Refusal to accept a reality because it is too threatening
D. **Compensation -** Disguising the presence of a weak quality by emphasizing a more positive one
    i. May develop a less preferred / more attainable goal instead of one more preferred / less attainable
E. **Projection -** Blame is relegated to others for their own shortcomings, mistakes, and transgressions
F. **Rationalization -** Subconscious technique for justifying actions that otherwise would be unacceptable
    i. When true rationalization takes place, individuals sincerely believe in their excuses
G. **Reaction Formation** - Protect from dangerous desires by developing opposite attitudes / behaviors
H. **Fantasy -** Daydreaming about how things should be rather than doing something about how they are
I. **Displacement -** Unconscious shift in emotion from the original object to a less threatening substitute

4. Learner Emotional Reactions

A. Anxiety – "A state of mental uneasiness arising from fear…"
    i. Most significant psychological factor affecting flight instruction
    ii. Anxiety can be countered by reinforcing enjoyment of flying, and by teaching to cope with fear
    iii. Introduce maneuvers with care so the learner knows what to expect / what their reaction should be
B. Impatience
    i. Seeks only the ultimate objective without considering the means to reach it
    ii. Present training one step at a time, with clear goals for each step. Tailor instruction to learner's pace
C. Worry or Lack of Interest
    i. Those worried or emotionally upset are not ready to learn and derive little benefit from instruction
    ii. Instruction should be keyed to divert attention from their worries and troubles to the tasks at hand
    iii. Ensure the learner knows exactly how well they have progressed and what deficiencies are present
D. Physical Discomfort, Illness, Fatigue, and Dehydration

   i. Slow the rate of learning, and should be mitigated to the extent possible
   ii. Fatigue – one of the most treacherous hazards to flight safety. Impairs judgement / decision making
      a. Acute Fatigue: Normal occurrence of everyday living
      b. Chronic Fatigue: Combination of physiological / psychological problems (financial, home, etc.)
   iii. Dehydration and Heatstroke
      a. Dehydration: Critical loss of water to the body. Reduces alertness
      b. Heatstroke: Inability of the body to control its temperature
      c. Carry ample water on any long flight, keep the temperature cool, and wear light clothing
E. Apathy Due to Inadequate Instruction
   i. Provide well-planned, appropriate and accurate instruction
   ii. Instruction should be meaningful. Teach to the level of the learner. Be professional
   iii. Once the instructor loses confidence, it is difficult to regain and learning is diminished
F. Normal Reactions to Stress
   i. People respond rapidly and exactly, within the limits of their experience and training
      a. This is desired, stress should not overwhelm and cause abnormal reactions (below)
G. Abnormal Reactions to Stress
   i. Response may be random, illogical, completely absent or at least inadequate
   ii. Abnormal Reactions:
      a. Over-cooperation, extreme self-control, inappropriate laughter / singing, rapid emotion changes
H. Flight Instructors Actions Regarding Seriously Abnormal Learners
   i. Refrain from instructing the learner and assure they don't continue training / become certificated
   ii. This is done by:
      a. Arrange for another instructor to conduct an evaluation flight. After the flight, the instructors should confer to determine whether they agree that further investigation or action is justified

5. Basic Elements of Communication

A. Doesn't occur automatically, a communication style must be developed that can convey info to learners
B. Basic Elements
   i. Communication takes place when a person transmits ideas / feelings to another
   ii. Effectiveness is measured by the similarity between the idea transmitted and the idea received
      a. A change in behavior is the goal of communication
   iii. 3 elements of communication: The Source, The Symbols, The Receiver
   iv. **The Source** (the sender, speaker, transmitter, or instructor)
      a. Effectiveness as a communicator is related to 3 basic factors:
         - Ability to select / use language is essential for transmitting information
         - Communicators reveal information about themselves – self-image, views of ideas being communicated as well as the receiver (Basically, have a positive attitude!)
         - Material is accurate, up-to-date, and stimulating
   v. **The Symbols** (words or signs, or simple oral, visual, or tactile codes)
      a. Determine the symbols best to start / end and those best for explaining, clarifying, emphasizing
         - Determine which medium is best suited for transmission (hearing, seeing, touch)
      b. Monitor the feedback from a learner as symbols may need to be modified for clarity
      c. Learners need feedback on how they are doing (Negative feedback in private only)
   vi. **The Receiver** (the listener, reader, or learner)
      a. Effective communication: Receivers react with understanding / change behavior accordingly
      b. To change behavior, the learner's abilities, attitudes, and experiences need to be understood
         - Not all learners learn in the same way, using multiple approaches is most effective

6. Barriers to Effective Communication

A. Lack of Common Experience

    i. Greatest single barrier to effective communication
    ii. It is essential that instructors speak the same language as the learners
    iii. If specific terminology is needed, ensure understanding (especially common in aviation)
  B. Confusion Between the Symbol and the Symbolized Object
    i. This results when the meaning or intent of words and / or the context isn't clear (ex. Sarcasm)
  C. Overuse of Abstractions (Abstractions are words that are general rather than specific)
    i. The danger is that abstractions do not evoke the same items of experience in the minds of learners
  D. External Factors
    i. Factors outside the instructor's control that prevent an activity from being carried out properly
    ii. Physiological interference - physical problem inhibiting understanding (injury, hearing loss, etc.)
    iii. Environmental interference - caused by external physical conditions (like noise)
    iv. Psychological interference - product of how the learner / instructor feel
  E. Interference
    i. Occurs when the message gets disrupted, truncated. Ensure the learner understands the message
      a. Noise and other factors may distort the message; Psychological factors may interfere

7. Developing Communication Skills
  A. Role Playing
    i. Practice instructing to develop communication skills, techniques, etc.
  B. Instructional Communication
    i. Know the topic well; Do not be afraid to use examples of past experience to illustrate points
    ii. Determine the level of understanding by some sort of evaluation
  C. Listening
    i. Be a good listener
    ii. Listen to understand rather than refute
  D. Questioning
    i. Good questioning can determine how well a learner understands
    ii. Ask open ended and focused questions
      a. Open ended questions allow the learner to explain more fully
      b. Focused questions allow the instructor to concentrate on desired areas
    iii. Paraphrasing and perception checking can confirm understanding is in the same way
  E. Instructional Enhancement
    i. The deeper the knowledge about an area, the better the instructor is at conveying it

Conclusion:
Brief review of the main points
An awareness of the 3 basic elements indicates the beginning of the understanding required for the successful communicator. Recognizing the various barriers to communication further enhances the flow of ideas. The instructor must develop communication skills in order to convey desired info to learners and recognize that communication is a two-way process. The true test of whether successful communication has taken place is to determine if the desire results have been achieved and the learner's behavior has been changed.

I.B. The Learning Process

References: Aviation Instructor's Handbook (FAA-H-8083-9)

Objectives	The learner should develop knowledge of the elements related to the learning process as required in the CFI PTS.
Elements	1. Learning Theory 2. Perceptions and Insight 3. Acquiring Knowledge 4. The Laws of Learning 5. Domains of Learning 6. Characteristics of Learning 7. Acquiring Skill Knowledge 8. Types of Practice 9. Scenario Based Training 10. Errors 11. Memory and Forgetting 12. Retention of Learning 13. Transfer of Learning
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The learner understands the learning process and can integrate the knowledge when instructing learners.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

This will explain why you will or will not remember this lesson.

Overview

Review Objectives and Elements/Key ideas

What

Understanding how people learn, and applying that knowledge to the learning environment.

Why

As a flight instructor, the ability to effectively teach learners is imperative. Understanding how people learn and how to apply that knowledge is the basis for effective teaching.

How:

1. **Learning Theory**
   - A. Definition – A body of principles used to explain how people acquire skills, knowledge, and attitudes
   - B. How people learn is explained by 2 concepts: Behaviorism and Cognitive Theory
   - C. Behaviorism (Positive Reinforcement, rather than no reinforcement or punishment)
     - i. Stresses the importance of having particular behavior reinforced, to shape or control what is learned
     - ii. Encourage the learner's progress and learning with rewards
     - iii. Popularity of behaviorism has waned – learning is much more complex than simple rewards
   - D. Cognitive Theory (Focuses on what is going on inside the learner's mind)
     - i. Learning isn't just a behavior change, it's a change in the way a learner thinks / understands / feels
     - ii. Two Major Branches of the Cognitive Theory
       - a. The Information Processing Theory
         - Learner's brain has internal structures which select and process incoming material, store / retrieve it, use it to produce behavior, and receive / process feedback on the results
       - b. Constructivism
         - Learning is the result of matching new information against preexisting information and integrating it into meaningful connections
           - a Learners actively build or construct knowledge and skills based on their experiences
         - High Order Thinking Skills (HOTS) - also referred to as aeronautical decision making (ADM)
           - a Training based on problems or scenarios
           - b Important because a common thread in aviation accidents is the absence of HOTS
           - c Teaching HOTS
             1. To teach effectively involves strategies and methods that include:
                - a. Problem-based instruction
                - b. Authentic / real world problems
                - c. Active learning / Cooperative learning
                - d. Customized instruction to meet the individual learner's needs
           - d Scenario-Based Training (SBT)
             1. The heart of HOTS, and an example of Problem Based Learning
             2. Uses "real world" scenarios to address flight-training objectives

3. Other than the first flight or two, the scenario should be planned / led by the learner

E. Behavioral + Cognitive
   i. Plan, manage, and conduct aviation training with the best features of each theory
   ii. Provides a way to measure the behavioral outcomes and promote cognitive learning

2. Perceptions and Insight

A. Initially learning comes from perceptions (come from the senses); learner gives meaning to the senses
   i. New learners are overwhelmed and often focus on meaningless things, thus missing key info
      a. It is important to direct perceptions so that the learner obtains relevant information

B. Factors affecting perceptions
   i. Physical Organism - Provides the perceptual apparatus (body) for sensing the world around them
   ii. Goals and Values - Every experience is affected by the individual's values and beliefs
      a. Understand the learner's values and tailor teaching to those values
   iii. Self-Concept - Self-image has a great influence on perception
      a. Positive self-image allows the learner to remain open to new experiences
      b. Negative self-image has negative effect on learning
   iv. Time and Opportunity - Proper sequence and time are necessary for learning
   v. Element of Threat - Threat does not promote effective learning

C. Insight
   i. The 'aha!' moment, when the information 'clicks'
      a. Insight is one of the instructor's primary responsibilities
      b. Learning becomes more meaningful and more permanent

3. Acquiring Knowledge

A. Memorization - First attempt to acquire knowledge
   i. Not good for problem solving

B. Understanding - Stage 2 of acquiring knowledge
   i. Begins to organize knowledge in useful ways; memorized facts give way to understanding (insight)

C. Concept Learning - Tend to group objects, ideas, people, etc., that share one or more major attributes
   i. By grouping information into concepts, we create manageable categories

4. The Laws of Learning (REEPIR)

A. Laws of learning provide additional insight into what makes people learn most effectively

B. **R**eadiness
   i. The basic needs of the learner need to be met before they're ready or capable of learning
   ii. Learners best acquire new knowledge when they see a clear reason for doing so
   iii. Two steps to keep learners in a state or readiness:
      a. Communicate a clear set of objectives and relate each new topic to the objectives
      b. Introduce topics in a logical order and leave learners with a need to learn the next topic

C. **E**xercise
   i. Connections are strengthened with practice and weakened without it
   ii. Exercise is most effective when a skill is learned in the context of real-world applications

D. **E**ffect
   i. Behaviors that lead to satisfying outcomes are likely to be repeated, and vice versa
   ii. Teaching should contain elements that affect the learner positively / make them feel satisfaction

E. **P**rimacy
   i. What is learned first, often creates a strong, almost unshakable impression

F. **I**ntensity
   i. A vivid, dramatic, or exciting learning experience teaches more than a routine or boring experience
G. **R**ecency
   i. Things most recently learned are best remembered

5. **Domains of Learning** (What is to be learned: Knowledge, Change in Attitude, Physical Skill, or combo)
   A. **C**ognitive Domain (Knowledge)
      i. Cognitive knowledge includes ground school, reading a text book, etc.
      ii. 6 major categories, or levels, starting from the simplest to the most complex
      iii. Highest objective level may be shown by learning to properly evaluate a maneuver
   B. **A**ffective Domain (Change in Attitude)
      i. Emotions toward the educational experience
         a. Feelings, values, enthusiasms, motivations, and attitudes
      ii. Not easy to measure
      iii. Provides a framework for teaching in 5 levels
   C. **P**sychomotor Domain (Physical Skills)
      i. Skill based and includes physical movement, coordination, and use of the motor-skill areas
         a. Ex. learning to fly a precision approach, programming a GPS receiver

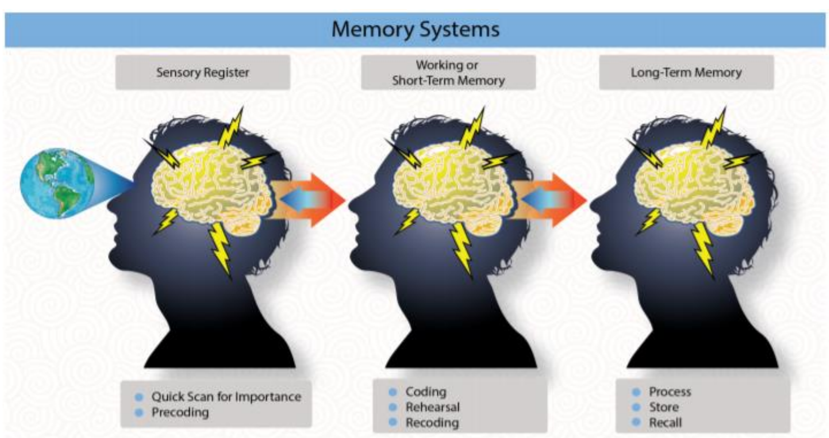
	Objective Level	Action Verbs for Each Level
COGNITIVE DOMAIN	Evaluation	Assess, evaluate, interpret, judge, rate, score, or write
	Synthesis	Compile, compose, design, reconstruct, or formulate
	Analysis	Compare, discriminate, distinguish, or separate
	Application	Compute, demonstrate, employ, operate, or solve
	Comprehension	Convert, explain, locate, report, restate, or select
	Knowledge	Describe, identify, name, point to, recognize, or recall
AFFECTIVE DOMAIN	Characterization	Assess, delegate, practice, influence, revise, and maintain
	Organization	Accept responsibility, adhere, defend, and formulate
	Valuing	Appreciate, follow, join, justify, show concern, or share
	Responding	Conform, greet, help, perform, recite, or write
	Receiving	Ask, choose, give, locate, select, rely, or use
PSYCHOMOTOR DOMAIN	Origination	Combine, compose, construct, design, or originate
	Adaptation	Adapt, alter, change, rearrange, reorganize, or revise
	Complex Overt Response	Same as guided response except more highly coordinated
	Mechanism	Same as guided response except with greater proficiency
	Guided Response	Assemble, build, calibrate, fix, grind, or mend
	Set	Begin, move, react, respond, start, or select
	Perception	Choose, detect, identify, isolate, or compare

6. **Characteristics of Learning** (PRMA)
   A. Learning should be purposeful, based on experience, multifaceted, and involve an active process
   B. **P**urposeful
      i. Learners learn from any activity that tends to further their goals
   C. **R**esult of Experience (Learn by doing)
      i. Learner can learn only from personal experiences
      ii. Provide learning experiences that are meaningful, varied, and appropriate to individual learners
   D. **M**ultifaceted
      i. Individuals learn much more than expected if they fully exercise their minds and feelings
         a. Verbal, conceptual, perceptual, emotional, and problem-solving elements all at once
   E. **A**ctive Process (Constantly Engage the Learner)
      i. Learners need to react / respond outwardly, inwardly, emotionally, or intellectually

7. **Acquiring Skill Knowledge**
   A. Skill knowledge: Skills that manifests themselves in the doing of something (Ex. riding a bike)
   B. Stages of Acquiring a Skill
      i. Cognitive Stage - Memorizing the steps to a skill (provide clear, step by step examples)
      ii. Associative Stage - Practice begins to store the skill
         a. The learner can assess progress and make adjustments instead of simply repeating steps
      iii. Automatic Response Stage - skill becomes automatic (allows more focus on other aspects of skill)
   C. Consistent practice develops skills
   D. Knowledge of Results
      i. The learner must be informed of their progress (both good and bad)
   E. Learning Plateaus

        i. They're normal and temporary, ensure the learner understands this and is prepared for them
        ii. Over-practice can bring on a learning plateau

8. **Types of Practice**
    A. 3 types of practice which yield results in acquiring skills
    B. Deliberate Practice - Practice specific areas for improvement and receive specific feedback after practice
    C. Blocked Practice - Practicing the same drill until it becomes automatic
        i. Enhances short-term performance
    D. Random Practice - Mixes up the skills to be acquired throughout the practice session
        i. Performing a series of separate skills in a random order leads to better retention
9. **Scenario Based Training**
    A. Scenarios that resemble the environment in which knowledge and skills are used are helpful to learning
    B. Good Scenario: clear objectives, tailored to learner's needs, captures nuances of local environment
10. **Errors**
    A. No matter the experience, errors will always occur
    B. Two Kinds of Errors
        i. Slip - A person plans to do one thing but inadvertently does something else
            a. Forms of Slips
                - Neglect to do something
                - Confuse two similar things
                - Asked to perform a routine in a slightly different way
                - Time pressure
        ii. Mistake - A person plans to do the wrong thing and succeeds
            a. Error of thought. Sometimes caused by a gap or misconception in learner's understanding
            b. Forms of Mistakes: Incorrect understanding; Incorrectly categorizing a specific situation
    C. Reducing Error
        i. Learning and practicing
        ii. Taking time
            a. Work at a comfortable pace
        iii. Checking for errors
        iv. Use reminders (checklists, bugs, notebook, etc.)
        v. Develop routines
        vi. Raise awareness of conditions / situations where errors are more likely to occur
    D. Error Recovery
        i. Do not let the error "snowball" and cause additional problems, or grow bigger than it is
        ii. Solve the problem, and focus on the tasks at hand / ahead
    E. Learning from Error – ask the learner why the error happened and what could have been done different
11. **Memory and Forgetting**
    A. Memory General
        i. Memory includes 3 parts: Sensory, Short-Term, and Long-Term Memory
        ii. The total system operates like a computer



        a. Accepts input, information is processed, storage capability, and an output function
  B. Sensory Memory (Quick Scan, Precoding)
    i. Receives stimuli from environment, quickly processes it based on personal idea of what is important
        a. Other factors can influence reception of info
            - If it is dramatic or impacts more than one sense it is more likely to make an impression
        b. Recognizes certain stimuli and immediately transmits them to short-term memory for action
    ii. Retains info for a very short time; within seconds the relevant info is passed to short-term memory
  C. Short-Term Memory (Coding, Rehearsal, Recoding)
    i. Resembles a control tower; is responsible for coordinating all incoming and outgoing flights
    ii. Info is stored for about 30 seconds, then it may rapidly fade or be sent into long-term memory
        a. Repetition of the info and sorting or categorization into chucks help with retention
        b. Time and Capacity limited (time limitation can be overcome by repetition)
    iii. The coding process may involve recoding to adjust information to individual experiences
        a. Recoding: relating incoming information to concepts or knowledge already in memory
        b. This is when actual learning begins to take place
    iv. Three basic operations of Short-term memory
        a. Iconic Memory: Brief sensory memory of visual images
        b. Acoustic Memory: Sound memory
        c. Working Memory: Active process to keep information until it is put to use
    v. Developing a logical strategy for coding information is a significant step in the learning process
  D. Long-Term Memory (Process, Store, Recall)
    i. Relatively permanent storage of unlimited information
        a. Information typically has some significance attached to it
    ii. For it to be useful, special effort must have been expended during the coding process
        a. The more effective the coding process, the easier the recall
        b. Long-term memory affects a person's perceptions of the world
    iii. Make training relevant / meaningful to transfer new information to long-term memory
  E. Memory and Usage
    i. The ability to retrieve knowledge or skills is primarily related to:
        a. How often and how recently the knowledge has been used
  F. Forgetting
    i. There are many theories regarding why people forget (FIIRS)
        a. **F**ading: Suggests that information that is not used for a period of time is forgotten
        b. **I**nterference: We forget things because an experience has overshadowed it, or the learning of similar things has intervened
            - Similar material seems to interfere with memory more than dissimilar material
            - Material not well learned suffers most from interference
        c. **R**etrieval Failure: Inability to retrieve the information
        d. **R**epression or **S**uppression: Don't want to remember feelings associated with a memory

12. Retention of Learning

  A. The instructor needs to make certain that learning is readily available for recall
    i. Teach thoroughly and with meaning
  B. Praise Stimulates Remembering
  C. Recall is Promoted by Association
  D. Favorable Attitudes Aid Retention
  E. Learning with all our Senses is most Effective
  F. Meaningful Repetition Aids Recall (3-4 repetitions provide the maximum effect)

13. Transfer of Learning

A. Primary Objective is to promote Positive Transfer
    i. Positive Transfer - Learning skill A helps to learn skill B (slow flight and short field landings)
    ii. Negative Transfer - Learning skill A hinders learning of skill B (landing an airplane vs a helicopter)
    iii. A degree of transfer is involved in all learning since all learning is based on prior learned experience
        a. People interpret new things in terms of what they already know
    iv. Achieving Positive Transfer
        a. Plan for transfer as a primary objective
        b. Ensure that learners understand that information can be applied in other situations
        c. Maintain high-order learning standards
        d. Avoid unnecessary rote learning
        e. Provide meaningful learning experiences
        f. Use material that helps form valid concepts and generalizations (make relationships clear)
B. Habit Formation - Insist on correct techniques/procedures to provide proper habit patterns
    i. Training traditionally has follows building block concept - Start with the basics and build from there
C. Understanding
    i. Ability to remember is greatly affected by the level of understanding
D. Remembering during Training
    i. Threat: Lack of frequent usage in the past
        a. Engage in regular practice of what was learned; short regularly spaced studying
    ii. Threat: Learner lacks a degree of understanding that may assist with recalling the knowledge
E. Remembering after Training
    i. Continued practice of knowledge and skill is the only means to retaining what was learned
F. Sources of Knowledge
    i. Books, photographs, videos, diagrams, charts, etc.
    ii. Encourage the learner to gain experience in the real-world
G. Summary of Instructor's Actions
    i. Discuss differences between short-term and long-term memory
    ii. Explain the effect of frequent and recent usage of knowledge on remembering and forgetting
    iii. Explain the effect of depth of understanding on remembering and forgetting
    iv. Encourage learner use of mnemonic devices while studying
    v. Explain the benefits of studying at regularly spaced intervals, and the disadvantages of cramming

Conclusion

Brief review of the main points

I.C. The Teaching Process

References: Aviation Instructor's Handbook (FAA-H-8083-9)

Objectives	The learner should develop knowledge of the elements related to the teaching process as required in the CFI PTS.
Elements	1. General 2. Preparation of a Lesson 3. Organization of Material 4. Training Delivery Methods 5. Problem Based Learning 6. Instruction Aids and Training Technologies 7. Review and Evaluation
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The learner understands the preparation of a lesson, the different presentation methods, how the learner applies the knowledge, and the importance and use of a review and evaluation.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

This is how one should structure a lesson in order to properly ensure the necessary knowledge is retained.

Overview

Review Objectives and Elements/Key ideas

What

The teaching process can be divided into steps; preparation, presentation, application, and review and evaluation.

Why

Effective teaching is necessary in order to provide a proper learning experience.

How:

1. **General**
    A. Four steps: Preparation, Presentation, Application, Review and Evaluation
2. **Preparation of a Lesson**
    A. Lesson must be planned – Objectives, procedures and facilities, goals to be attained, review / evaluation
    B. Performance Based Objectives
        i. Set measurable, reasonable standards describing the learner's desired performance
            a. Objectives must be clear, measurable, and repeatable
        ii. Elements of Performance Based Objectives:
            a. Description - Explains desired outcome as a change in knowledge, skill, or attitude
                - Concrete and measurable terms
            b. Conditions - Explain the rules for demonstration of the skill
                - Information such as equipment, tools, material, and limiting parameters should be included
            c. Criteria - The standards that measure the accomplishment of the objective
                - Should be no question whether the performance meets the objective

        iii. The PTS / ACS provides specific performance criteria to measure learner's actions
        iv. Decision Based Objectives
            a. Facilitate a higher level of learning and application
3. **Organization of Material**
    A. Intro – Sets the stage for everything to come. Consists of 3 elements:
        i. Attention – Story, video clip, etc. to direct attention to the lesson
        ii. Motivation – Specific reasons why the info is important
        iii. Overview – A clear, concise presentation of objectives and key ideas
    B. Development – Main body. The material should be organized logically, options include:

        i. Past to present
        ii. Simple to complex
        iii. Known to unknown
        iv. Most frequently used to least
    C. Conclusion
        i. Retraces important elements and relates them to the objective

4. Training Delivery Methods

    A. Lecture Method
        i. Suitable for presenting new material, for summarizing ideas, and for showing relationships
        ii. Most effective when combined with instructional aids and training devices
        iii. Different Types of Lectures:
            a. Illustrated Talk – Relies heavily on visual aids to convey ideas
            b. Formal Lecture – Purpose is to inform, persuade, or entertain with little learner participation
            c. Teaching Lecture – Delivered in a manner that allows some learner participation
    B. Guided Discussion Method
        i. Goal is to draw out the knowledge of the learner
            a. Encourages active participation of the learners
        ii. The instructor acts as a facilitator
        iii. Useful in areas where learners can use initiative and imagination in addressing problems
    C. Computer Assisted Learning Method
        i. Couples the computer with multimedia software to create a training device
        ii. Reduces manpower, Learners can move at their own rate
        iii. Not practical for an entire training program
    D. Demonstration-Performance Method
        i. Best used for the mastery of mental or physical skills that require practice
        ii. Many lessons can combine the lecture and demonstration-performance methods
            a. Initial information is given in a lecture; information is then demonstrated / applied in the plane
        iii. Five Phases: Explanation, Demonstration, Learner Performance, Instructor Supervision, Evaluation
    E. Drill and Practice Method
        i. Connections are strengthened with practice
        ii. Learn by practicing and applying what they have been told and shown
    F. Be familiar with as many methods as possible

5. Problem Based Learning

    A. Lessons involve problems encountered in real life and ask learners to find real-world solutions
        i. Starts with a carefully constructed problem to which there is no single solution
        ii. Learner gains a deeper understanding of the information and improves ability to recall information
    B. Effective Problems
        i. Relates to the real world
        ii. Open ended, not limited to one answer; Require learners to make decisions and think critically
        iii. Connect to previously learned knowledge and new knowledge
        iv. Reflect lesson objectives
    C. Teaching HOTS (Higher Order Thinking Skills)
        i. Basic Approach to Teaching HOTS:
            a. Set up the problem
            b. Determine learning outcomes for the problem
            c. Solve the Problem or Task
            d. Reflect on Problem solving process
            e. Consider additional solutions through guided discovery

f. Reevaluate solution with additional options
g. Reflect on this solution and why it is the best (Consider what best means)

D. Scenario Based Training
- i. Realistic scenarios allowing mental rehearsal / practical applications of knowledge
- ii. Good scenario:
  - a. Is not a test
  - b. Will not have one right answer, and does not offer an obvious answer
  - c. Should not promote errors
  - d. Should promote situational awareness and opportunities for decision making

E. Collaborative Problem Solving
- i. Two or more working together to solve a problem
- ii. Instructor provides assistance only when needed

F. Case Study Method
- i. Written or oral account of a real-world situation used to educate the learner
- ii. Learners analyze the situation, come to conclusions, and offer possible solutions

6. Instruction Aids and Training Technologies

A. Instructional aids:
- i. Assist the instructor in the teaching-learning process
- ii. Clarify relationships between material objects and concepts
- iii. Help learners remember information
- iv. Hold their attention
- v. Can utilize multiple senses (help learning)
- vi. Help solve language barriers

B. Guidelines for Use of Instructional Aids
- i. Clearly establish the objective
- ii. Gather necessary data
- iii. Organize the material
- iv. Select the ideas to be supported with aids

C. Types of Aids
- i. Chalk / Marker Board
- ii. Supplemental Print Material
- iii. Enhanced Training Materials
- iv. Projected Material; Video
- v. Interactive Systems; Computer Learning
- vi. Models, Mockups, Cut-Aways

Instructional Aids
Support the lesson objective.
Are learner centered.
Build on previous learning.
Contain useful and meaningful content that is consistent with sound principles of learning.
Appeal to learners.
Maintain learner attention and interest.
Encourage learner participation, when appropriate.
Lead learners in the direction of the behavior or outcomes specified in the learning objective.
Provide proper stimuli and reinforcement.
Contain quality photo, graphs, and text, as required.
Are checked prior to use for completeness and technical accuracy.
Contain appropriate terminology for the learner.
Are properly sequenced.
Are easy to understand.
Include appropriate safety precautions.

7. Review and Evaluation (no longer in PTS)

A. Learners should be made aware of the progress and ensure standards are met before moving on
B. Feedback must adequately compare the performance to the completion standards of the lesson
C. If deficiencies not associated with the present lesson are noted, they should be pointed out and fixed

Conclusion

Brief review of the main points

I.D. Assessment and Critique

References: Aviation Instructor's Handbook (FAA-H-8083-9)

Objectives	The learner should develop knowledge of the elements related to the critique and evaluation as required in the CFI PTS.
Elements	1. Assessment 2. Critique
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The learner has the ability to properly critique and evaluate learners using the methods and characteristics described.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

The dreaded tests and awful instructor critiques, this is how you do it.

Overview

Review Objectives and Elements/Key ideas

What

The instructor's role when assessing levels of learning. It describes methods of assessment, and discusses how to construct and conduct effective assessments and critiques.

Why

The instructor must be able to appraise learner performance and convey this information back to the learner to enhance the learner's ADM, judgement and flying skills.

How:

1. **Assessment**
   - A. Purpose – To determine how a learner is progressing in the course
     - i. Provides practical and specific feedback, including direction / guidance on how to raise performance
     - ii. Provides an opportunity for self-evaluation
   - B. Characteristics of an Effective Assessment
     - i. Must be honest, and based on the facts as they were, not as they could have been
     - ii. Flexible - Fit the tone, technique and content of the assessment to the specific occasion and learner
       - a. The ongoing challenge for the instructor is deciding what to say, omit, stress, and minimize
     - iii. Acceptable - Comes from confidence in qualifications, teaching, sincerity, competence / authority
       - a. Present the critique fairly, with authority, conviction, sincerity, from a position of competence
     - iv. Comprehensive - Covers strengths AND weaknesses
       - a. Tailor to the learner – what provides most benefit? A few major points or more minor points?
     - v. Constructive – Learner should benefit; information should have purpose
       - a. When identifying a mistake or weakness, give positive guidance for correction
     - vi. Organized - Follow a logical pattern of organization otherwise it may lose its impact
       - a. The sequence of the performance itself
       - b. Work backward from where the demonstration failed (or was successful)
       - c. Break the whole into parts or build the parts into a whole
     - vii. Thoughtful - Reflects thoughtfulness toward the need for self-esteem, recognition, and approval
     - viii. Specific (rather than general) – Should be no doubt what was good / poor, and how to improve
   - C. Traditional Assessment
     - i. Written testing, such as multiple choice, matching, fill in the blank, etc.
     - ii. Characteristics of a good test:
       - a. Reliability, Validity, Usability, Objectivity, Comprehensiveness, Discrimination
   - D. Authentic Assessment
     - i. Perform real-world tasks, and demonstrates a meaningful application of skills and competencies
     - ii. Open ended questions and set criteria are important characteristics
       - a. Four-step series of open-ended questions:

- Replay: Verbally replay the flight or procedure
- Reconstruct: Identify the things that could have been done differently
- Reflect: Reflect on the events to find insight
- Redirect: Relate the lessons learned to other experiences

E. Oral Assessment
   i. Most common means of assessment; direct or indirect questioning of the learner
      a. Reveals effectiveness of the training methods / checks retention and comprehension
      b. Reviews material already presented to the learner
      c. Can be used to retain learner interest and stimulate thinking
      d. Emphasizes the important points of training and identifies points that need more emphasis
      e. Promotes active learner participation, which is important to effective learning
   ii. Characteristics of Effective Oral Questions:
      a. Apply to the subject of instruction
      b. Brief, concise, clear, definite
      c. Adapted to the ability, experience, and stage of training, and presents a challenge to the learner
      d. Center on only one idea (limited to who, what, where, when, why, or how and not a combination)

F. Types of Questions to Avoid
   i. Yes / No questions, Puzzle, Oversize, Toss-up, Bewilderment, Trick, Irrelevant Questions

2. Critique

A. Instructor / Learner Critique - Instructor leads discussion where learners offer criticism of a performance
   i. This should be controlled carefully and directed with a firm purpose (not a free-for-all)

B. Learner Led Critique - A learner is asked to lead the assessment; Can generate interest and learning

C. Small Group Critique - Small groups are assigned a specific area to analyze and present their findings on
   i. The combined reports can result in a comprehensive critique

D. Critique by another Learner - Another learner is requested to present the entire assessment
   i. The instructor must maintain firm control over the process

E. Self-Critique - A learner critiques their own personal performance
   i. Do not leave controversial issues unresolved, or erroneous impressions uncorrected

F. Written Critique
   i. Instructor can devote more time and thought to it
   ii. Learners can keep assessments and refer to them whenever they wish
   iii. The learner has a record of suggestions, recommendations, and opinions of all other learners
   iv. Disadvantage is that other members of the class do not benefit

G. Ground Rules
   i. Do not extend the critique beyond its scheduled time limit (10-15 min, definitely less than 30 min)
   ii. Avoid trying to cover too much (4-5 things to correct at most)
   iii. Avoid absolute statements and controversies with the class (don't take sides)
   iv. Never allow yourself to be maneuvered into defending criticism
   v. If part of the critique is written, ensure it is consistent with the oral portion
   vi. Allow time for a summary of the critique to reemphasize the most important things to remember

Conclusion

Brief review of the main points

I.E. Instructor Responsibilities and Professionalism

References: Aviation Instructor's Handbook (FAA-H-8083-9)

Objectives	The learner should develop knowledge of the elements related to flight instructor characteristics and responsibilities as necessary in the CFI PTS.
Elements	1. Aviation Instructor Responsibilities 2. Flight Instructor Responsibilities 3. Professionalism 4. Evaluation of Learner Ability 5. Aviation Instructors and Exams 6. Professional Development
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The learner understands the responsibilities associated with instructing as well as the characteristics related to being a professional.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

These are the characteristics that will make you a great flight instructor, and the responsibilities of being one.

Overview

Review Objectives and Elements/Key ideas

What

This lesson discusses the scope of responsibilities for instructors and enumerates methods they can use to enhance their professional image and conduct.

Why

It is important that aviation instructors not only know how to teach, but they also need to project a knowledgeable and professional image.

How:

1. **Aviation Instructor Responsibilities**
    A. Helping Learners
        i. Learning should be enjoyable and interesting
        ii. Standards, and measurement against standards, are key to helping learners
    B. Providing Adequate Instruction
        i. Carefully and correctly analyze each learner's personality, thinking, and ability
        ii. Assign easier to attain sub-goals for learners experiencing slow progress
            a. As confidence and ability are gained, difficulty should be increased until progress is normal
        iii. Fast learners may assume correcting errors is unimportant since they make few mistakes
            a. For such learners, constantly raise the standard of performance
    C. Standards of Performance
        i. Do not allow learners to get by with substandard performance – helps no one
    D. Emphasize the positive because positive instruction results in positive learning
    E. Minimizing Learner Frustration (Encourage, rather than discourage)
        i. Motivate Learners
            a. More can be gained from wanting to learn than being forced to learn
        ii. Keep Learners Informed
            a. Learners feel insecure when they don't know what is expected or what will happen to them
                - Provide course overviews, progress updates, adequate notice for exams, assignments, etc.
                - Talk about money when necessary
        iii. Approach Learners as Individuals
        iv. Give Credit When Due
            a. Praise/credit from the instructor usually is ample reward and provides an incentive to do better
        v. Criticize Constructively
            a. If the learner is briefed on the errors AND is told how to correct them, progress can be made
        vi. Be Consistent
            a. The instructor's philosophy and actions must be consistent to avoid learner confusion
        vii. Admit Errors

a. Respect is earned by acknowledging mistakes; Covering up mistakes destroys confidence

viii. Be Well Prepared - Learners are spending *a lot* of money and deserve a well-prepared instructor

2. Flight Instructor Responsibilities

A. Physiological Obstacles for Flight Learners
   i. Do not ignore negative factors, like fear of small aircraft, strange noises, G-forces / motion sickness
   ii. Negative sensations can often be overcome by understanding

B. Ensuring Learner Skill Set (Formerly titled Ensure Student Ability)
   i. Flight instructors have the responsibility to provide guidance and restraint with respect to solo ops
      a. By far the most important responsibility
   ii. Provide instruction for each item in the applicable ACS/PTS, including "special emphasis areas"
   iii. Before solo flight, the learner should display consistent ability to handle responsibilities of solo flight
   iv. Be current on the latest procedures regarding training, certification, and safety
   v. Maintain a current library of information

3. Professionalism

A. The instructor is the central figure in aviation training and bears responsibility for all phases of training

Instructor Do's
Be professional at all times.
Be sincere.
Present a professional appearance and personal habits.
Maintain a calm demeanor.
Practice safety and accident prevention at all times.
Avoid profanity.
Define common terms.
Continue professional development.
Minimize learner frustration.
Motivate the learner.
Keep the learner informed.
Approach each learner as an individual.
Give credit when due.
Criticize constructively.
Be consistent.
Admit errors.

Instructor Don'ts
Ridicule the learner's performance.
Use profanity.
Model irresponsible flight behaviors.
Say one thing but do another.
Forget personal hygiene.
Disrespect the learner.
Demand unreasonable progress.
Forget the learner is new to aviation jargon.
Set the learner up for failure.
Correct errors without an explanation of what went wrong.

B. Sincerity - Be straight forward and honest at all times
   i. Do not attempt to hide inadequacy – can lead to loss of confidence and adversely affect learning

C. Acceptance of the Learner - Accept all learners as they are, including all faults and problems
   i. Acceptance, rather than ridicule, and support, rather than reproof, will encourage learning

D. Personal Appearance and Habits - Expected to be neat, clean, and appropriately dressed
   i. Personal habits have a significant effect (exercising common courtesy is most important)
      a. Personal cleanliness is important as well (it can be distracting)

E. Demeanor - Attitude and behavior can contribute much to a professional image
      a. Requires development of a calm, thoughtful, and disciplined, but not somber, demeanor
   ii. Portray competence in the subject matter and genuine interest in the learner's well being

F. Proper Language - Speak normally, without inhibitions; positively and descriptively, without profanity

4. Evaluation of Learner Ability

A. Demonstrated Ability
   i. Evaluation of ability during flight must be based on established standards of performance
      a. These standards should be modified to apply to the learner's experience

B. Keeping the Learner Informed
   i. Keep the learner up to date with progress (a record should be kept)
   ii. Kindly point out deficiencies and how to correct them

C. Correction of Learner Errors
    i. It is often better to let learners make a mistake and get out of it on their own (safety permitting)
    ii. If the procedure is performed correctly but not fully understood, require it to be varied

5. Aviation Instructors and Exams

A. Knowledge Test
    i. Learners will need to be endorsed for some knowledge tests (AC 61-65 for endorsements)
    ii. Instructor is held accountable for deficient instruction

B. Practical Test
    i. Signing a recommendation imposes a serious responsibility on the instructor
        a. Learners should show a thorough demonstration of the knowledge and skill level necessary
    ii. If a learner is unprepared, the instructor is accountable for deficient performance
    iii. Be very protective of your record – Never sign someone off who is not ready

C. Flight Instructor Endorsements (AC 61-65)
    i. Failure to ensure that a learner pilot meets the requirements of regulations prior to endorsing solo flight is a serious deficiency in performance - the instructor is held accountable
        a. This is also a breach of faith with the learner
    ii. Other endorsements
        a. Flight reviews, IPCs, additional ratings, completion of prerequisites for a practical test
        b. A record must be maintained of all endorsements

D. Additional Training Endorsements (AC 61-98)
    i. Flight Reviews
        a. Not a test / check ride, but an instructional service designed to assess knowledge and skill
        b. Must be based on specific objectives and standards
    ii. Instrument Proficiency Checks
        a. Use the Instrument ACS as the primary reference for the associated maneuvers and tolerances
    iii. Aircraft Checkouts / Transitions (High performance, tail wheel, high altitude training)
        a. By performing these, you are accepting a major responsibility for the safety of future passengers
        b. All checkouts should be conducted to the performance standards in the PTS / ACS
        c. Record in the pilot's logbook the exact extent of any checkout conducted
        d. If insufficient, thoroughly debrief the pilot and schedule further instruction

6. Professional Development

A. Be alert for ways to improve your qualifications, effectiveness, and services provided to learners

B. Maintain a steady supply of fresh material to make instruction interesting and up to date

C. Continuing Education - Continually update knowledge and skill
    i. Government
        a. Seminars, articles, regulations, ACs; Pilot Proficiency Award Program; Gold Seal Flight Certificate
    ii. Educational/Training Institutions - Attend classes at community colleges, technical schools, etc.
    iii. Commercial Organizations - Training material, and training courses
    iv. Industry Organizations - Articles, publications, training programs

D. Sources of Material
    i. Maintain access to current flight publications (Regulations, AIM, PTS, ACS, ACs, etc.)
    ii. Commercial handbooks, periodicals, technical journals

Conclusion

Brief review of the main points

I.F. Techniques of Flight Instruction

References: Aviation Instructor's Handbook (FAA-H-8083-9)

Objectives	The learner should develop knowledge of the elements related to the different techniques of flight instruction as described in the CFI PTS.
Elements	1. Obstacles in Learning During Flight Instruction 2. Demonstration-Performance Training Delivery 3. Positive Exchange of Controls 4. Sterile Cockpit 5. Use of Distractions 6. Integrated Flight Instruction 7. Assessment of Piloting Ability 8. Aeronautical Decision Making
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	4. Participate in discussion 5. Take notes 6. Ask and respond to questions
Completion Standards	The learner can competently explain and teach the range of topics discussed in this lesson.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

Practical strategies flight instructors can use to enhance their instruction, the demonstration-performance training delivery method of flight instruction, integrated flight instruction, positive exchange of flight controls, use of distractions, obstacles to learning encountered during flight training, and how to evaluate learners, followed by a look at Aeronautical Decision Making.

Why

Flight instructors are a critical part of the aviation system and must competently pass along standards and practices that encourage safe flying to encourage safer skies for all pilots.

How:

1. **Obstacles in Learning During Flight Instruction**
    A. Feeling of unfair treatment
        i. Instruction must be adequate; learner's efforts must be conscientiously considered and evaluated
    B. Impatience to proceed to more interesting operations
        i. Impatient learners don't understand the need for training and only desire their final goal
        ii. Disinterest grows from unnecessary repetition of operations that are adequately learned
    C. Worry or lack of interest
        i. Worried or emotionally upset learners are not ready to learn (outside influences can have an effect)
    D. Physical discomfort, illness, fatigue, and dehydration
    E. Apathy due to inadequate instruction
        i. Teach competently, learners are spending large amounts of money on training
    F. Anxiety
        i. Learners must be comfortable / confident in the instructor and the airplane
2. **Demonstration-Performance Training Delivery**
    A. Very effective at teaching kinesthetic skills. Four phases:
    B. Explanation Phase
        i. Discuss lesson objectives, completion standards, and a thorough preflight briefing
        ii. Learners need to know what they will learn, and how they will learn it
        iii. Encourage questions
    C. Demonstration Phase - Show the actions necessary to perform a skill
    D. Learner Performance and Instructor Supervision Phase
        i. Learner performs the skill and learns from repetition; Instructor supervises and offers advice
    E. Evaluation Phase - Evaluate learner performance and advise of progress
3. **Positive Exchange of Controls**
    A. Incident statistics show a need for emphasis on change of control
    B. Use 3-way exchange when giving (or taking) the controls:
        i. "You have the flight controls," "I have the flight controls," "You have the flight controls"

4. **Sterile Cockpit**
    A. Avoid non-essential activities during critical phases of flight
        i. Taxi, takeoff, landing and all other operations below 10,000’ other than cruise
5. **Use of Distractions**
    A. Most spin / stall accidents occur when distracted from flying the plane (sterile cockpit is important)
    B. The FAA encourages instructors to simulate scenarios that could cause the learner to be distracted
6. **Integrated Flight Instruction**
    A. The learner is taught to perform maneuvers by outside visual references and flight instruments
        i. Leads to better landings, cross-country navigation, coordination, overall competency
    B. Development of Habit Patterns - Teach it right the first time and reinforce desired behavior
    C. Operating Efficiency
        i. As learners get better at mastering their flight technique, aircraft performance also increases
    D. Procedures
        i. Explain control inputs used and the associated visual / instrument references (be detailed / specific)
    E. See and Avoid
        i. It is always the pilot’s responsibility to see and avoid
        ii. From the start, the instructor must ensure a habit of looking for other traffic at all times
        iii. Perform clearing turns before maneuvers; Understand and follow the right-of-way rules
7. **Assessment of Piloting Ability**
    A. It’s important to keep a learner up to date with their progress
        i. Provide direction and guidance to raise performance
        ii. Maintain a written record / grade of every flight and maneuver
    B. Demonstrated Ability
        i. The learner’s abilities must be based on standards of performance (ACS, PTS, syllabus, etc.)
    C. Postflight Evaluations
        i. Self-assessment and instructor assessment are beneficial
            a. Have the learner assess the flight; Provide input in areas lacking, be positive and honest
    D. Correction of Learner Errors
        i. Don’t immediately take controls during a mistake (safety permitting)
        ii. If a learner can perform a maneuver but doesn’t fully understand the principles, vary the performance slightly, combine it with other operations, or apply it to performing other maneuvers
    E. Pilot Supervision
        i. Before endorsing a learner for solo flight ensure consistent ability in all required maneuvers
    F. Dealing with Normal Challenges
        i. Learners must be able to handle challenges in the air
        ii. Ensure they are competent and confident with challenges on the ground
    G. Visualization
        i. Have learners visualize flight in normal conditions and add unforeseen events to challenge them
    H. Practice Landings
        i. Full stop landings (not just touch and goes)
        ii. Stress landing in the first third of the runway / centerline control, otherwise go around
    I. Practical Test Endorsements
        i. AC 61-65
        ii. Your job is to make sure the learner is prepared
8. **Aeronautical Decision Making (ADM)**
    A. A systematic approach to the mental process used by pilots to consistently determine the best course of action in response to a given set of circumstances
        i. It is estimated that approximately 80% of all aviation accidents are a result of human factors

B. Teaching pilots to make sound decisions is the key to preventing accidents

C. The Decision-Making Process
   - i. Defining the Problem
     - a. Recognize that a change has occurred and the expected result did not occur
     - b. Incorrectly defining the problem can create a worse problem
   - ii. Choosing a Course of Action
     - a. Evaluate the need to react; determine what actions can solve the problem in the time available
   - iii. Implementing the Decision and Evaluating the Outcome
     - a. Continue to evaluate how the decision will affect the flight

D. Factors Affecting Decision Making
   - i. Recognizing Hazardous Attitudes
     - a. Must be able to spot hazardous attitudes and remove them (shown to the right)
   - ii. Stress Management
     - a. A certain amount of stress is normal/good
     - b. Too much can be very bad
     - c. 3 types of stress that affect performance
       - Physical; Physiological; Psychological

E. Use of Resources
   - i. Use all resources (think outside the box)
   - ii. Internal Resources
     - a. Found in the flight deck during flight
     - b. Equipment, systems, charts, books, etc.
     - c. Other passengers
     - d. Ingenuity, knowledge and skill
   - iii. External Resources
     - a. ATC and flight service specialists
     - b. Traffic advisories, vectors, weather info, emergency assistance
   - iv. Workload Management
     - a. Plan and prioritize to prevent overload
     - b. Prompt learners to prepare for high workload situations
     - c. Be able to recognize high workloads
       - Faster paced work along with divided attention
       - Stay ahead as much as possible to prevent high workloads
       - Manage tasks in order of importance when behind

Hazardous Attitude	Antidotes
Macho Steve often brags to his friends about his skills as a pilot and how close to the ground he flies. During a local pleasure flight in his single-engine airplane, he decides to buzz some friends barbecuing at a nearby park.	Taking chances is foolish.
Anti-authority Although he knows that flying so low to the ground is prohibited by the regulations, he feels that the regulations are too restrictive in some circumstances.	Follow the rules. They are usually right.
Invulnerability Steve is not worried about an accident since he has flown this low many times before and he has not had any problems.	It could happen to me.
Impulsivity As he is buzzing the park, the airplane does not climb as well as Steve had anticipated and, without thinking, he pulls back hard on the yoke. The airspeed drops and the airplane is close to stalling as the wing brushes a power line.	Not so fast. Think first.
Resignation Although Steve manages to recover, the wing sustains minor damage. Steve thinks to himself, "It doesn't really matter how much effort I put in—the end result is the same whether I really try or not."	I'm not helpless. I can make a difference.

Stressors
Physical Stress Conditions associated with the environment, such as temperature and humidity extremes, noise, vibration, and lack of oxygen.
Physiological Stress Physical conditions, such as fatigue, lack of physical fitness, sleep loss, missed meals (leading to low blood sugar levels), and illness.
Psychological Stress Social or emotional factors, such as a death in the family, a divorce, a sick child, or a demotion at work. This type of stress may also be related to mental workload, such as analyzing a problem, navigating an aircraft, or making decisions.

Conclusion:

Brief review of the main points

I.G. Risk Management

References: Aviation Instructor's Handbook (FAA-H-8083-9)

Objectives	The learner should develop knowledge of the elements related to managing and mitigating risk.
Elements	1. Principles of Risk Management 2. Risk Management Process 3. Level of Risk 4. Assessing Risk 5. Mitigating Risk 6. IMSAFE Checklist 7. PAVE Checklist 8. 5P Checklist
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The learner can recognize potentially hazardous situations and effectively mitigate risk using the concepts and procedures listed here.

Instructor Notes:

Introduction:

Attention

We're pilots, we like the rush of flight and the sense of danger. All FAA operations in the United States involve risk; don't let the risk and danger get out of control.

Overview

Review Objectives and Elements/Key ideas

What

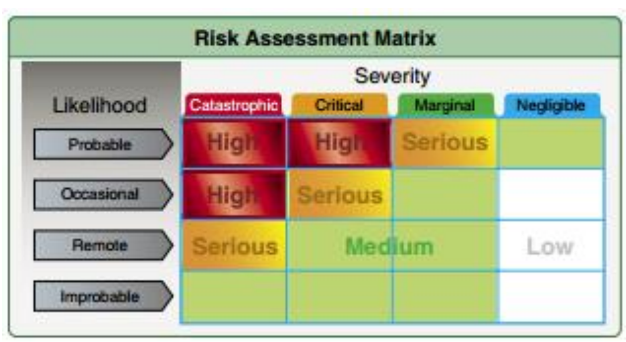
Risk management is a decision-making process designed to perceive hazards, systematically assess the degree of risk associated with a hazard, and determine the best course of action.

Why

Flying is inherently dangerous, but there is no reason to accept unnecessary risk. Risk management keeps the danger to an acceptable minimum for the situation.

How:

1. **Principles of Risk Management**
   - A. The goal of risk management is to proactively identify safety-related hazards and mitigate the risks
   - B. Accept no Unnecessary Risk, only accept the necessary risk
     - i. Flying is impossible without risk, do not make a situation more dangerous than necessary
   - C. Make Risk Decisions at the Appropriate Level
     - i. In single pilot situations, the pilot makes decisions (not ATC, or passengers)
     - ii. In other situations, it may be beneficial to "go up the ladder" for a decision (CFI, Chief Pilot, etc.)
   - D. Accept Risk When Benefits Outweigh the Costs
     - i. Analyze costs and benefits, make an informed decision
   - E. Integrate Risk Management into Planning at All Levels
     - i. Safety requires risk management planning in all stages of flight
2. **Risk Management Process**
   - A. Step 1: Identify the Hazard
     - i. Hazards can cause degradation, injury, illness, death, damage to or loss of equipment / property
   - B. Step 2: Assess the Risk
     - i. Determine the level of risk associated with the identified hazards
       - a. Assess in terms of its likelihood (probability) and its severity (consequences)
     - ii. Develop a method to tangibly measure risk (Risk Assessment Matrix, below)
   - C. Step 3: Mitigate the Risk
     - i. Look for ways to reduce, mitigate, or eliminate the risk
     - ii. Use the Cost / Benefit analysis to decide if it is worth accepting the risk
3. **Level of Risk**
   - A. The level of risk posed by a given hazard is measured in terms of:
     - i. Severity (extent of possible loss)
     - ii. Probability (likelihood that it will cause a loss)
4. **Assessing Risk**



A. Establish a review process and develop strategies to minimize risk
B. Risk Matrix - Assesses the likelihood of an event occurring and the consequences of that event
   i. Likelihood (probability of occurrence): Probable, Occasional, Remote, Improbable
   ii. Severity: Catastrophic, Critical, Marginal, Negligible

5. Mitigating Risk

A. After determining the level of risk, analyze options available to reduce the risk
B. Delay or cancel the flight, change the route / destination, bring a CFI or more experienced pilot, etc.

6. IMSAFE Checklist

A. Mitigate risk by determining your own physical and mental readiness for flight
   i. Illness – Symptoms?
   ii. Medication – Taking any?
   iii. Stress – Family, money, relationships, work, etc.
   iv. Alcohol – Been drinking?
   v. Fatigue – Well rested?
   vi. Eating – Properly nourished?

7. PAVE Checklist

A. Another way to mitigate risk
B. Risk is divided into 4 categories
   i. Decide whether the risks can be managed safely. If not, the flight should be cancelled
C. **P**ilot in Command: Am I ready? (IMSAFE Checklist, proficiency, recency, currency, etc.)
D. **A**ircraft: Is the aircraft appropriate for the trip?
   i. Maintenance, Landing Distance, Performance Capabilities, Equipment, Fuel load, Altitude, etc.
E. En**V**ironment: Weather, Terrain, Airports, Airspace, Day/Night, etc.
F. **E**xternal Pressures: Influences outside of the flight that create pressure to complete the flight
   i. This is the one risk factor that can cause a pilot to ignore all other risk factors
   ii. Follow your own personal operating procedures (don't bend the rules for anyone)

8. 5P Checklist

A. Used to evaluate the situation at key decision points during the flight, or when an emergency arises
   i. Very helpful portion of Single Pilot Resource Management (SRM)
   ii. At least 5 times, review the 5 P's and make a decision for the current situation
      a. Decision points: Preflight, pre-takeoff, hourly or at the midpoint of flight, pre-descent, and just prior to the final approach fix or entering the traffic pattern
B. The 5 P's:
   i. Plan - The mission. It contains: planning, weather, route, fuel, publication currency, etc.
      a. Always changing (weather changes, delays, restrictions, etc.), adjust with it
   ii. Plane - Condition, abilities (performance, automation, etc.), equipment, systems, etc.
   iii. Pilot - IMSAFE
   iv. Passengers - Passenger's desires can have an influence on decision making and risk management
      a. Ensure passengers understand the risk and are involved in decision making process
      b. Understand what passengers want to do (they may be more risk averse than you)
   v. Programming - Plan when and where programming should (and should not) be accomplished
      a. Always consider pilot capabilities in relation to programming

Conclusion:
Brief review of the main points
It is extremely important that a pilot (especially a learner pilot) has the ability to recognize and effectively mitigate risk in order to provide a safe flight for him/herself as well as the passengers. This chapter provided many factors to consider and ways to reduce the inherent risk associated with flying.

TECHNICAL SUBJECT AREAS

II.A. Aeromedical Factors

References: Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25); Airplane Flying Handbook (FAA-H-8083-3), AIM

Objectives	The student should exhibit knowledge regarding aeromedical factors as required in the PTS/ACS.
Key Elements	1. IM SAFE – Self Checklist 2. Trust the instruments 3. Carbon Monoxide is 200x more likely to bond with blood than oxygen 4. Drugs / Alcohol + Flying = Very Bad
Elements	1. Obtaining a Medical Certificate 2. Hypoxia 3. Hyperventilation 4. Middle Ear and Sinus Problems 5. Spatial Disorientation 6. Motion Sickness 7. Carbon Monoxide Poisoning 8. Fatigue and Stress 9. Dehydration 10. Alcohol and Other Drugs 11. Nitrogen and Scuba Diving 12. IM SAFE
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to explain different aeromedical factors, and their importance to flying and possible effects during flight.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Safety in the aircraft requires knowledge of the factors that can lead to negative consequences if we were unaware or unable to treat them. Hypoxia, for example, can result in symptoms of euphoria and the inability to make any sort of rational decision, which is obviously not a good thing while you're trying to fly a plane. (There are many good hyperbaric chamber/hypoxia videos on you tube)

Overview

Review Objectives and Elements/Key ideas

What

Aeromedical factors involve a number of health and physiological factors that can influence a pilot and his or her ability to fly safely. Some are minor, while others require special attention to ensure safety and survival.

Why

Many of these factors not only affect the health and well-being of the pilot, but can quickly lead to in-flight emergencies.

How:

1. **Obtaining a Medical Certificate**
   - A. Medical Certificate
     - i. What is it?
       - a. A routine medical exam from an FAA authorized Aviation Medical Examiner (AME)
       - b. 3 different classes – 1st, 2nd, 3rd class
     - ii. Who Needs it? (More details/requirements in FAR 61.23)
       - a. 3rd Class: Required when
         - Exercising privileges of a Private, Recreational, or Student pilot certificate
         - Taking a practical test for recreational, private, commercial, ATP, CFI certificates
         - Exercising privileges of CFI certificate as PIC or required crewmember
     - iii. How to find an AME - FAA.gov AME Locator
         - FAA Directory of AMEs can be found at FSDOs, FSSs, FAA Offices
     - iv. Once you have a medical, how is it regulated?
       - a. FAR 61.53 (Prohibition on operations during medical deficiency) prohibits flying if you:
         - Know of any medical condition that would prevent you from obtaining a medical
         - Are taking medication/receiving treatment that would prevent you from obtaining a medical
       - b. Once obtained, it is self-regulating (be safe, and conservative)
     - v. Medical Certificate with a Possible Medical Deficiency
       - a. Even with a medical deficiency, a medical certificate may be able to be issued
       - b. 15 disqualifying medical conditions (listed here)
         - Special Issuance Authorization is required (FAR 67.401)
   - B. BasicMed
       - a. Allows pilots to fly without holding a medical certificate, if they meet certain requirements
       - b. More info in III.A. Certificates and Documents
   - C. Driver's License

    i. A driver's license can be used in certain situations. More info in III.A. Certificates and Documents

2. Hypoxia

- A. Hypoxia means "reduced oxygen" or "not enough oxygen"
- B. Hypoxic Hypoxia
    - i. A result of insufficient oxygen available to the lungs (ex. blocked airway or drowning)
    - ii. For Pilots: The reduction in partial pressure of oxygen at high altitude is a common example
- C. Hypemic Hypoxia
    - i. The blood is not able to take up and transport sufficient oxygen to the cells in the body
    - ii. Causes:
        - a. Not enough blood volume, Blood diseases, Hemoglobin (the molecule that transports oxygen) is unable to bind oxygen molecules, Carbon monoxide poisoning
- D. Stagnant Hypoxia
    - i. Results when the blood isn't moving to the tissues that need it (ex. when your arm "falls asleep")
    - ii. This type of hypoxia can result from:
        - a. G-forces in flight, shock, the heart failing to pump blood effectively, a constricted artery
- E. Histotoxic Hypoxia
    - i. "Histo" refers to tissues or cells, and "Toxic" means poison
    - ii. Oxygen is being transported to the cells, but they are unable to use it
    - iii. Causes:
        - a. Alcohol and other drugs, such as narcotics and poison
- F. Symptoms of Hypoxia
    - i. Cyanosis (blue fingernails and lips)
    - ii. Headache
    - iii. Decreased reaction time
    - iv. Impaired judgment
    - v. Euphoria
    - vi. Visual Impairment
    - vii. Drowsiness
    - viii. Lightheaded or dizzy sensation
    - ix. Tingling in fingers or toes
    - x. Numbness

Altitude	Time of Useful Consciousness
45,000 ft. MSL	9 to 15 seconds
40,000 ft. MSL	15 to 20 seconds
35,000 ft. MSL	30 to 60 seconds
30,000 ft. MSL	1 to 2 minutes
28,000 ft. MSL	2 ½ minutes to 3 minutes
25,000 ft. MSL	3 to 5 minutes
22,000 ft. MSL	5 to 10 minutes
20,000 ft. MSL	30 minutes or more

- G. Useful Consciousness
    - i. The maximum time to make and carry out rational decisions without supplemental oxygen
- H. Treatment
    - i. Get to a lower altitude and use supplemental oxygen immediately
- I. FAA Physiology Training – One day course in OK with altitude chamber and vertigo demonstrations

3. Hyperventilation

- A. Occurs when experiencing emotional stress, fright, or pain, and the breathing rate and depth increase
    - i. Excessive loss of carbon dioxide from the body, which can lead to unconsciousness
- B. Symptoms can be very similar to hypoxia
- C. Common Symptoms:
    - i. Visual Impairment
    - ii. Unconsciousness
    - iii. Lightheaded or dizzy sensation
    - iv. Tingling sensations
    - v. Hot and cold sensations
    - vi. Muscle spasms
- D. Treatment

i. Breathing normally is both the best prevention and the best cure for hyperventilation
ii. Breath into a paper bag or talking aloud
iii. Because symptoms are so similar to hypoxia, if unsure, treat for hypoxia (more dangerous situation)

4. Middle Ear and Sinus Problems

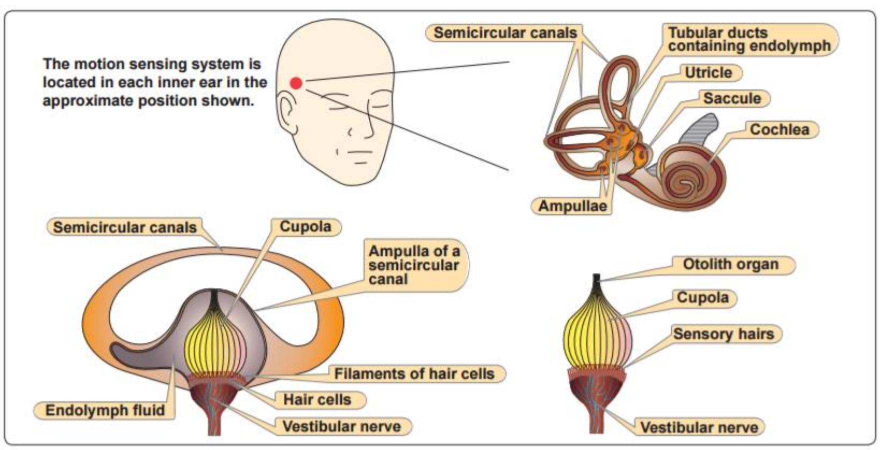
A. Middle Ear Problems
   i. Explanation
      a. Difference in the pressure of the air outside the body and inside the middle ear/nasal sinuses
   ii. Symptoms
      a. Pain is the primary indicator
      b. Temporary reduction in hearing sensitivity
   iii. Relation to flying
      a. During a climb, the difference in pressure causes the eardrum to bulge outward
      b. During a descent, the difference in pressure causes the eardrum to bulge inward
      c. Excessive pressure in either situation can result in pain and a ruptured ear drum
   iv. Treatment
      a. Chew gum, stretch the jaw
      b. Valsalva
      c. Medicines, nasal sprays, if approved for flight

B. Sinus Problems
   i. Explanation
      a. Congestion prevents pressure in the sinuses equalizing with the pressure in the cockpit
   ii. Symptoms
      a. Sinus pain/Upper teeth ache
      b. Bloody mucus from the nasal passages
   iii. Treatment
      a. Slower descent rates can reduce the pain
      b. Do not fly with sinus problems

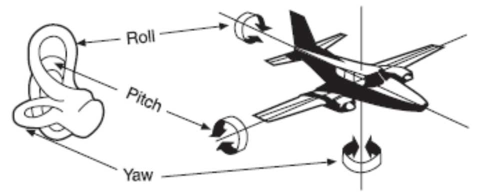
5. Spatial Disorientation

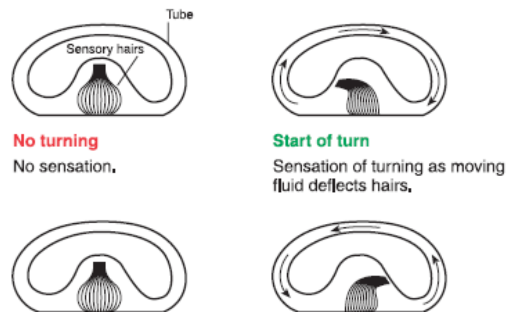
A. Explanation
   i. Spatial Disorientation - lack of orientation of the position/attitude/movement of the plane in space
   ii. The body uses three systems to ascertain orientation and movement in space
      a. Visual: The eye, by far the largest source of information
      b. Somatosensory: Nerves that sense position based on gravity, feeling, and sound
      c. Vestibular System: A very sensitive motion sensing system located in the inner ears
         - Reports head position, orientation, and movement

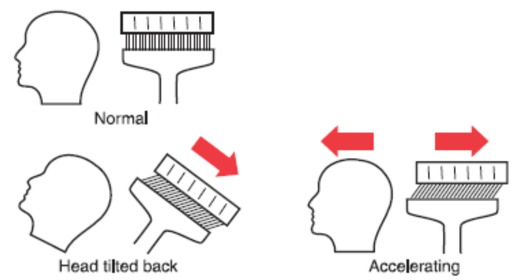
B. Relation to Flight
   i. Flying can result in conflicting information leading to disorientation
   ii. Visual System (eyes)
      a. VMC - Eyes can prevail over false sensations



The semicircular tubes are arranged at approximately right angles to each other, in the roll, pitch, and yaw axes.







  b. IMC - Eyes can't correct for false sensations which can lead to disorientation

iii. Vestibular System (inner ear – pictured, above/right)
  a. Senses movement / determines orientation
  b. Semicircular Canals
    - Detect angular acceleration (turns)
    - Only detects turns of a short duration
      a After approx. 20 seconds, the feeling of turning stops (pictured, right)
  c. Otolith Organs (pictured, bottom right)
    - Detect linear acceleration/gravity
    - Forward acceleration can give the illusion of the head tilting backward (climb)
    - Deceleration can give the illusion of the head tilting forward (descent)

iv. Somatosensory System (nerves)
  a. Nerves in the body constantly send info to the brain, which signals the body's relation to gravity
  b. The brain can't differentiate between the forces of a turn or turbulence, and the force of gravity

C. Countering the sensations
  i. Recognize the problem, disregard the false sensations, and rely on the flight instruments

6. Motion Sickness

A. Causes
  i. The brain receiving conflicting messages about the state of the body
  ii. Anxiety and stress

B. Symptoms
  i. General discomfort, Nausea, Dizziness, Paleness, Sweating, Vomiting

C. Treatment
  i. Open fresh air vents
  ii. Focus on objects outside the airplane and avoid unnecessary head movement
  iii. Take control of the aircraft and fly smooth, straight and level

7. Carbon Monoxide Poisoning

A. How it Happens – In the Plane
  i. Carbon Monoxide (CO) is a colorless, odorless gas produced by all internal combustion engines
  ii. Exhaust leak can allow CO to enter the cabin

B. How it Happens – In the Body
  i. CO attaches itself to the hemoglobin in the blood, preventing it from carrying oxygen to the cells

C. Effects of CO poisoning
  i. Hypemic hypoxia, Headache, Blurred vision, Dizziness, Drowsiness, Loss of muscle power

D. Detecting and Correction
  i. CO detector
  ii. If a strong odor of exhaust gases is detected, assume CO is present
  iii. If suspected:
    a. Turn off the heater and open fresh air vents and windows
    b. Use supplemental oxygen, if available
    c. Land

8. Fatigue and Stress

A. Fatigue
  i. Acute Fatigue (short term)
    a. Definition: Short term, and a normal occurrence in everyday life
    b. Skill Fatigue – A special type of acute fatigue affecting piloting skill. Effects include:
      - Timing Disruption: Performing a task, but the timing of each element is slightly off
      - Concentrating attention on the center of vision and neglecting the periphery
    c. Causes - Physical and Psychological stress, mild hypoxia
    d. Prevention - Proper diet, Adequate rest and sleep
  ii. Chronic Fatigue
    a. Definition
      - Fatigue over a long period of time, usually has psychological roots, or underlying disease
    b. Causes - Continuous high-stress levels
    c. Symptoms
      - Weakness, Tiredness, Headaches, Irritability, Breathlessness, Aches and pains
      - Heart palpitations, Stomach or intestinal problems
      - Emotional Illness (when conditions become serious enough)
    d. Prevention - Usually requires treatment by a physician

B. Stress
  i. The body's response to physical and psychological demands placed upon it
  ii. Stressors
    a. Physical stress (noise or vibration)
    b. Physiological stress (fatigue)
    c. Psychological stress (difficult work or personal situations)
  iii. Two Categories of Stress (Acute and Chronic)
    a. Acute Stress (short term)
      - Involves an immediate threat that is perceived as danger (fight or flight response)
      - Normally, a healthy person can cope with acute stress and prevent stress overload
      - On-going acute stress can develop into chronic stress
    b. Chronic Stress (long term)
      - Stress that exceeds the ability to cope, and causes performance to fall sharply
      - Unrelenting psychological pressures (ex. loneliness, financial worries, relationship problems)
      - Not safe to fly. Consult a physician

9. Dehydration

A. Definition: Critical loss of water from the body
B. Causes: Hot flight decks/flight lines, wind, humidity, diuretic drinks (coffee, tea, alcohol, soda)
C. Effects: Fatigue, inability to concentrate, headaches, cramps, tingling, sleepiness, and dizziness
D. Prevention: Primarily water
  i. Keep the cockpit well ventilated and protect yourself from the sun
  ii. Limit daily caffeine and alcohol intake

10. Alcohol and Other Drugs

A. DON'T drink and fly
  i. Alcohol interferes with the brains ability to utilize oxygen (histotoxic hypoxia)
  ii. Altitude multiples the effects of alcohol on the brain
  iii. FAR 91.17 – 8 hrs. 'from bottle to throttle' (8 hrs. and not feeling the effects of alcohol is better)
B. Medications
  i. FAR 61.53 prohibits flying if using meds/getting treatment that would prevent obtaining a medical

ii. FAR 91.17 prohibits the use of drugs that affect you in any way contrary to safety
iii. Do not fly while taking any medication(s), unless approved by the FAA

11. Nitrogen and Scuba Diving

A. Why it's a Danger
- i. Scuba diving results in a significant increase in the amount of nitrogen dissolved in the body

B. Scuba Diving and Flying
- i. Following scuba diving, if not enough time is allowed to eliminate the excess nitrogen, decompression sickness (DCS) can occur
- ii. Symptoms: severe pain and impairment, extreme cases can result in death
- iii. Wait times:
  - a. Wait 12 hrs. before flight up to 8,000' MSL; 24 hrs. for flight above 8,000'
  - b. Wait 24 hrs. after a dive that requires a controlled ascent before flight up to 8,000' MSL

12. IM SAFE

A. Always perform your own preflight
- i. Illness
- ii. Medication
- iii. Stress
- iv. Alcohol
- v. Fatigue
- vi. Emotion

Conclusion:

Brief review of the main points

There are many factors a pilot needs to be aware of in order to ensure a safe flight and to understand the medical risks involved with flying.

II.B. Runway Incursion Avoidance

References: Single Pilot Flight School Procedures During Taxi Operations (AC 91-73), AIM, Risk Management Handbook (FAA-H-8083-2), Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25)

Objectives	The student should develop knowledge of the elements related to proper incursion avoidance.
Key Elements	1. Read back all clearances 2. Head down activities only when stopped 3. Always have current Airport Diagram (AD)
Elements	1. Challenges Unique to Taxiing 2. Appropriate Cockpit Activities 3. Steering, Maneuvering, Maintaining Taxiway, Runway Position, and Situational Awareness 4. Hold Lines 5. Landing and Rollout 6. Airports with a Control Tower 7. Airports without a Control Tower 8. Exterior Lighting and Night Operations
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can safely and competently navigate towered and non-towered airports while effectively avoiding runway incursions.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Runway incursions have led to serious accidents with significant loss of life… (YouTube has many runway incursion recordings, incorrect taxi instructions, aircraft taxiing the wrong way, etc.)

Overview

Review Objectives and Elements/Key ideas

What

Runway incursion avoidance provides practical guidance with the goal of increasing safety and efficiency of aircraft movement on the airport surface while reducing the risk of runway incursions.

Why

Runway incursions can lead to serious accidents with significant damage to aircraft and even loss of life. Although they are not a new problem, with increasing air traffic, runway incursions have been on the rise.

How:

1. **Challenges Unique to Taxiing**
   - A. With increasing air traffic, runway incursions have been on the rise
   - B. Increased traffic and expansion at many airports create complex runway and taxiway layouts
2. **Appropriate Cockpit Activities**
   - A. For safety reasons the pilot's workload should be at a minimum during taxi operations
     - i. Focus on taxi – Keep heads up, and a sterile cockpit
   - B. Planning, Review and Briefing
     - i. Route Planning: Have a current Airport Diagram; review any pre-designated/anticipated taxi routes
     - ii. Review: Write down taxi instructions, and review the route - ask for help in case of confusion
     - iii. Briefing
       - a. Taxi operations briefings should include the following (prior to taxi, and prior to landing)
         - Ground Procedures
           - a Timing and execution of checklists/communications that will not interfere with taxiing
           - b Expected route/any abnormalities or unusual procedures
           - c Identify critical locations on the taxi route (hold short, hot spots, etc.)
           - d Address previous experience/unusual procedures or techniques
           - e During low visibility operations, brief the requirements and considerations
         - Expectations of others (pilots of passengers) in the plane
           - a Sterile cockpit procedures - encourage others to speak up if they see a potential conflict
           - b Use of airport diagrams (pilots)
           - c Cell phones/electronic devices should be off
   - C. Taxiing Near Other Aircraft
     - i. Keep eyes outside, taxi slowly and be alert to what's going on around you and the taxi route
     - ii. Stay ahead - Anticipate the next point requiring increased attention (i.e., hot spot, runway crossing)
3. **Steering, Maneuvering, Maintaining Taxiway, Runway Position, and Situational Awareness**
   - A. Steering: Use rudders to maintain the centerline (reference airplane site picture)

   B. Maintaining Position on the Airfield: Monitor position on the airfield and airport diagram
   C. Use all resources available to maintain situational awareness, especially in low visibility situations
4. **Hold Lines**
   A. Show where stop when approaching a runway. Cross the dashed side, stop on the solid side
   B. Always have a clearance to cross any runway
5. **Landing and Rollout**
   A. Brief the landing and runway exit/taxi plan (sterile cockpit during taxi)
   B. Exit the runway entirely, do not cross another runway without clearance
6. **Airports with a Control Tower**
   A. Perform all the above (planning, briefing, review, etc.)
   B. Communicating with ATC
      i. Use standard ATC phraseology (who you are, where you are, what you want)
   C. Read back all clearances and verify the route/clearance on the taxi diagram
7. **Airports without a Control Tower**
   A. Review Chart Supplement - Be familiar with local procedures
   B. Maintain situational awareness - Be aware of the route and where you/other aircraft are at all times
   C. Departing - Not all aircraft are radio-equipped. Scan the runway, including approach/departure paths
   D. Communicate intentions on the CTAF and listen for other aircraft (from engine start to 10 miles)
8. **Exterior Lighting and Night Operations**
   A. Exterior aircraft lights may be used to make an aircraft on the airport surface easier to see
      i. Engines Running: Turn on the rotating beacon whenever an engine is running
      ii. Taxiing: Prior to taxi, turn on navigation, position, and anti-collision lights
         a. Strobes should not be used during taxi if they will adversely affect the vision of others
      iii. Crossing a Runway: All exterior lights should be illuminated when crossing a runway
      iv. Entering the runway for takeoff: Turn on all lights, except for landing lights
      v. At night: Line up 3’ off centerline to allow landing aircraft to differentiate you from runway lights
      vi. Takeoff: Turn on landing lights when cleared for takeoff/starting the takeoff roll if no control tower
   B. Be more cautious at night
      i. Taxi slower, allow more time to stop
      ii. Ensure you remain on the assigned route – lights and signs can be confusing

Conclusion:
Brief review of the main points
One of the biggest safety concerns in aviation is the surface movement accident. By focusing resources to attack this problem head-on, the FAA hopes to reduce and eventually eliminate surface movement accidents.

II.C. Visual Scanning and Collision Avoidance

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), AIM, Pilot's Role in Collision Avoidance (AC 90-48)

Objectives	The student should develop knowledge of the elements related to proper visual scanning and collision threat avoidance. The student also will have knowledge regarding in flight and landing illusions as well as how to avoid trusting them.
Key Elements	1. "See and Avoid" 2. Clearing Procedures 3. Trust Your Instruments
Elements	1. "See and Avoid" Concept 2. Proper Visual Scanning 3. Clearing Procedures 4. Recognizing Hazards 5. Collision Avoidance 6. Conditions that Degrade Vision 7. In Flight Illusions 8. Landing Illusions
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign Next Study Material
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the importance of maintaining a vigilant traffic scan and consistently scans for traffic. In the onset of an illusion the student understands the illusion and maintains safe flight.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

AC90-48C Appendix 1:

How much time do you think you would have to react if two planes were approaching each other at 360 mph from 10 miles out? 100 seconds. How about from 4 miles? 40 seconds. 1 mile? 10 seconds. ½ Mile? 5 seconds

What if the planes were approaching at 600 MPH? 12 seconds from 2 miles; 3 seconds from ½ mile.

You can see that it's very important that we look out for other traffic.

Overview

Review Objectives and Elements/Key ideas

What

Visual scanning and collision avoidance is the ability to effectively scan the sky for potential collision threats.

Why

Safety. Visual scanning and collision avoidance is very important in creating safe skies. A diligent visual scan to avoid collision threats is paramount to the safety of all pilots.

How:

1. **"See and Avoid"** (FAR 91.113, AC 90-48)
    A. Vigilance shall be maintained at all times, by each person operating an aircraft
    B. Although often a shared job, the pilot is always responsible to see and avoid traffic
2. **Proper Visual Scanning** (AIM 8-1-6)
    A. Fovea vs Peripheral Viewing
        i. Fovea (your center of vision) - sends a clear, sharply focused image to the brain
            a. Most effective during daylight, but effectively a blind spot at night
        ii. Peripherals – outside of the center of vision, good for detecting motion/collision threats
            a. Most effective at night
    B. Effective scanning
        i. Short, regularly spaced eye movements (10°/1 sec) bringing successive areas of the sky into view
        ii. Day – Use the fovea/center of vision; Night – Use peripherals
3. **Clearing Procedures**
    A. Before Takeoff - Scan the approach/departure areas for traffic
    B. Climbs / Descents - Use gentle banks left and right to permit scanning
    C. Straight and Level - Execute clearing procedures at periodic intervals
    D. Traffic Patterns - Scan judiciously; Do not enter the pattern while descending
    E. Traffic at VOR Sites - Hight traffic area. Scan judiciously
    F. Training Operations – Be vigilant at all times. Use clearing turns prior to each maneuver
    G. Blind Spots - Momentarily raise/lower the wing as necessary to clear for traffic before turning
4. **Recognizing Hazards** (AC 90-48, AIM 8-1-8)
    A. Aircraft Speed and Collision Risk
        i. *Minimum* time to spot traffic, identify it, realize it's a threat, and respond – 12.5 seconds
    B. Recognize High Hazard Areas
        i. Aircraft tend to cluster near VORs, and Class B, C, D, and E surface areas (don't depend on ATC)
    C. Determining Relative Altitude

        i. If the aircraft is above the horizon, it is probably on a higher flight path, and vice versa
    D. Any aircraft that appears to have no relative motion is likely to be on a collision course
    E. Taking Appropriate Action
        i. If on a collision course, take immediate action
        ii. Safety comes first, but be familiar with Right-of-Way rules (FAR 91.113)

5. **Collision Avoidance** (AIM 8-1-8)
    A. Cockpit Management - Plan ahead/organize to minimize time spent with your eyes inside/head down
    B. Visual obstructions in the Cockpit
        i. Adjust for blind spots, do not block windows, keep windscreens clean
    C. Night: Use exterior lights and keep interior lights low to maintain night vision
    D. Use all tools at your disposal (use flight following whenever available, traffic information, etc.)

6. **Conditions that Degrade Vision** (AIM 8-1-6)
    A. Physical Conditions
        i. Medicines/drugs, exhaustion, poor physical conditioning, diet, missing meals, alcohol, tobacco, stressors, fatigue, lack of oxygen (hypoxia), etc.
        ii. CO poisoning, smoking, alcohol/drugs, and a lack of oxygen can decrease night vision
    B. Environmental Conditions
        i. Dim illumination – Small print and colors become unreadable unless adequate lighting is available
        ii. Dark Adaptation – Vision becomes more sensitive to light (30 min to adapt, few second to lose)
        iii. Excessive Illumination – Glare results in squinting, watering eyes, even temporary blindness
        iv. Visibility Conditions – Smoke, haze, dust, etc.
        v. Empty Field Myopia - With nothing to focus on, the eyes focus on a point slightly ahead of the plane
            a. Prevention
                - Day: Force your eyes to focus farther ahead, maintain your scan
                - Night: Search out and focus on distant light sources, no matter how dim

7. **Vestibular / In Flight / Visual Illusions**
    A. Preventing Spatial Disorientation
        i. Prevented by reference to flight instruments or reliable, fixed points on the ground
    B. The Leans: Abrupt correction of a bank entered too slowly to stimulate the senses in the inner ear
        i. Illusion: Can create the illusion of banking in the opposite direction
        ii. Result: Roll the back into the original attitude (turn), thinking it's straight and level
    C. Coriolis Illusion
        i. Reason: Abrupt head movement in a turn that has stopped stimulating the motion sensing system
        ii. Illusion: Can create the illusion of rotation or movement in an entirely different axis
        iii. Result: The pilot may maneuver into a dangerous attitude in order to stop the perceived rotation
    D. Graveyard Spin
        i. Reason: Recovery from a spin that has ceased stimulating the motion sensing system
        ii. Illusion: Can create the illusion of being in a spin in the opposite direction
        iii. Result: The disoriented pilot will return the aircraft to its original spin
    E. Graveyard Spiral
        i. Reason: Loss of altitude during a turn that has stopped stimulating the motion sensing system
        ii. Illusion: Can create the illusion of a wings level descent
        iii. Result: Pilot may pull back on the controls, tightening the spiral and increasing the loss of altitude
    F. Somatogravic Illusion
        i. Reason: A rapid acceleration, or a rapid deceleration
        ii. Illusion: Rapid acceleration can create the illusion of a nose up attitude (deceleration = nose down)
        iii. Result: May put the aircraft in a nose low/dive attitude (deceleration = nose up/stall attitude)
    G. Inversion Illusion

  i. Reason: An abrupt change from a climb to straight and level flight
  ii. Illusion: Can create the illusion of tumbling backwards
  iii. Result: The disoriented pilot will push the aircraft abruptly into a nose low attitude
- H. Elevator Illusion
  - i. Reason: Abrupt upward/downward vertical acceleration, due to an updraft /downdraft
  - ii. Illusion: Upward vertical acceleration can create the illusion of being in a climb (downward = decent)
  - iii. Result: The disoriented pilot will push the aircraft into a nose low attitude (downward = nose up)
- I. False Horizon
  - i. Reason: Sloping clouds, obscured horizon, certain patterns of lights
  - ii. Illusions: Can create the illusion of not being aligned correctly with the horizon
  - iii. Result: The disoriented pilot will put the aircraft in a dangerous attitude
- J. Autokinesis
  - i. Reason: Darkness
  - ii. Illusion: A static light when stared at for many seconds will appear to move about
  - iii. Result: The disoriented pilot may lose control of the aircraft in attempting to align it with the light

8. Landing / Visual Illusions
- A. Preventing landing Illusions
  - i. Anticipate them during approaches; Use glide slope or VASI/PAPI systems whenever possible
- B. Runway Width Illusion
  - i. Reason: A narrower or wider than usual runway
  - ii. Illusion: Narrow – Appear to be at a higher altitude than you are (appear lower with a wide runway)
  - iii. Result: Narrow – A lower than normal approach; Wider – A higher than normal approach
- C. Runway and Terrain Slope Illusion
  - i. Reason: A sloping runway, sloping terrain, or both
  - ii. Illusion: Upslope – Appear to be higher than you are (appear to be lower with a downslope)
  - iii. Result: Upslope – A lower than normal approach; Downslope – A higher than normal approach
- D. Featureless Terrain Illusion
  - i. Reason: An absence of ground features, as when landing over water, or darkened areas
  - ii. Illusion: Can create the illusion that the aircraft is at a higher altitude than it actually is
  - iii. Result: The pilot who doesn't recognize this will fly a lower approach
- E. Atmospheric Illusions
  - i. Reason: Rain on the windscreen, Atmospheric Haze, Penetration of fog
  - ii. Illusion: Rain - Illusion of greater height; Haze –Greater distance; Fog – Pitching up
  - iii. Result: Rain & Haze - A lower than normal approach; Fog – steepens the approach, often abruptly
- F. Ground Lighting Illusions
  - i. Reason: Lights along a straight path, such as a road, and even lights on moving trains
  - ii. Illusions: Can create the illusion of runway and approach lights
  - iii. Result: The pilot may attempt to land on a path, road, or train
  - iv. Reason: Bright runway and approach lighting systems
  - v. Illusion: Can create the illusion of less distance to the runway
  - vi. Result: The pilot who does not recognize this illusion will fly a higher approach

Conclusion:
Brief review of the main points
Maintaining a proper, efficient visual scanning and keeping an eye out for traffic is very important. Also, in the case of illusions, it is extremely important we understand when and where they may happen and how to best prevent them from getting us into a dangerous situation.

II.D. Principles of Flight

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25)

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

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

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

Overview

Review Objectives and Elements/Key ideas

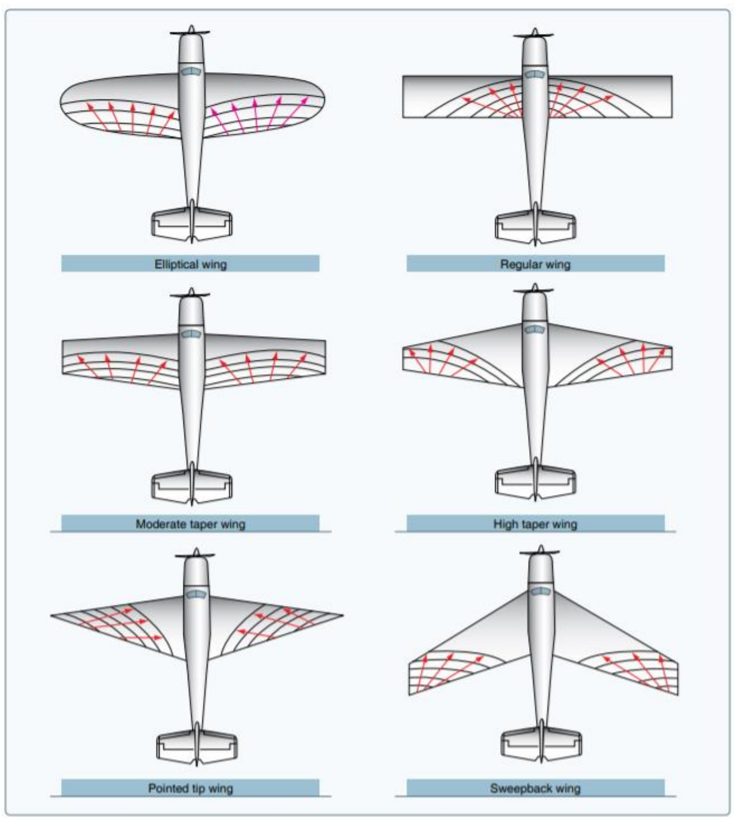
What

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

Why

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

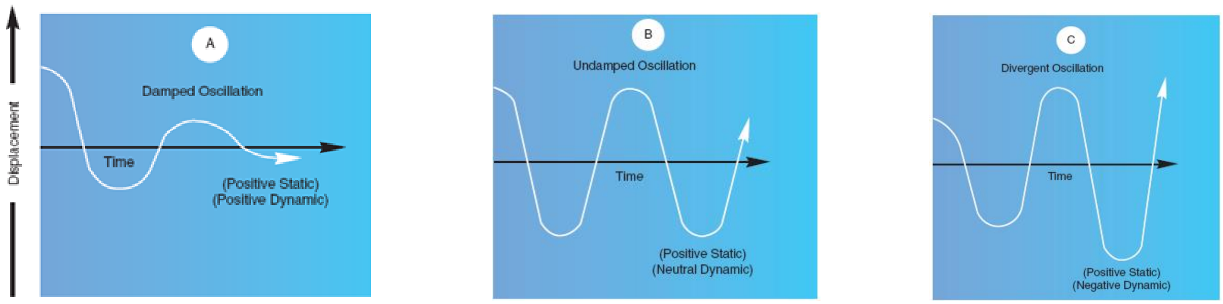
How:



1. **Airfoil Design Characteristics**
   A. Planform – Wing's outline from above
      i. Characteristics / advantages
      ii. Load factors, maneuverability and stability, stall/spin characteristics, fuel tanks, speed, gear, etc.
   B. Taper – Ratio of root chord to tip chord
      i. Decreases drag, increases lift
      ii. Decreases weight of the wing
   C. Aspect Ratio (Wingspan ÷ Ave Chord)
      i. High aspect ratio decreases drag
      ii. Low Aspect Ratio for extreme maneuverability and strength
   D. Sweep – Slant of the wing
      i. Usually rearward but can be forward
      ii. Helps flying near the speed of sound
      iii. Helps lateral stability in slow planes
      iv. Tends to stall at wingtips
2. **Airplane Stability and Controllability**
   A. Stability (Static and Dynamic)
      i. Inherent quality of the airplane to correct for disturbances and return the original flight path
         a. Primarily a design characteristic
      ii. Static Stability (SS): The *initial tendency*; aircraft's initial response when disturbed
         a. Positive SS: Initial tendency to return to the original state of equilibrium

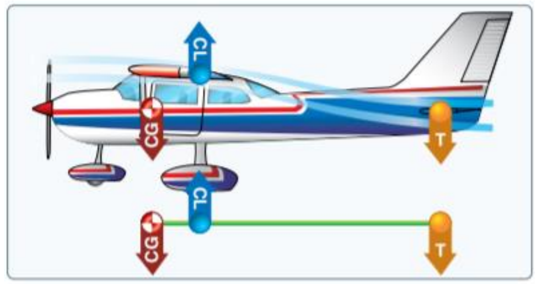
b. Negative SS: Initial tendency to continue away from the original state of equilibrium
c. Neutral SS: The initial tendency to remain in a new condition

iii. Dynamic Stability (DS)
a. The aircraft's response to a disturbance over time
- Positive, Negative, and Neutral – Same as SS, but over time (overall tendency)



iv. Must balance controllability and maneuverability

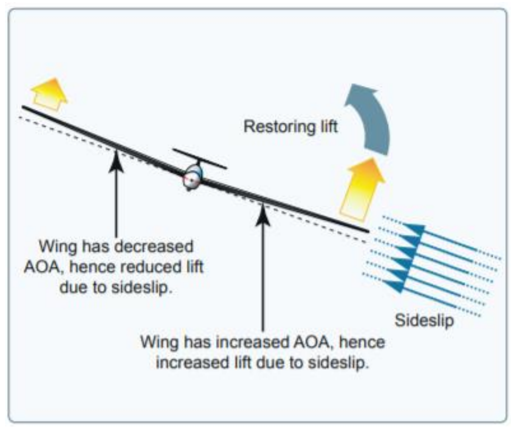
B. Longitudinal Stability (LS) – About the lateral axis



i. The wing and tail moments need to be balance
a. Ex: If nosed up, the wing / tail moments will change to bring the nose back down

ii. Static LS is dependent on 3 factors:
a. Location of the wing in relation to the CG
b. Location of the horizontal tail with the CG
c. The area or size of the tail surfaces

C. Lateral Stability - About the Longitudinal Axis



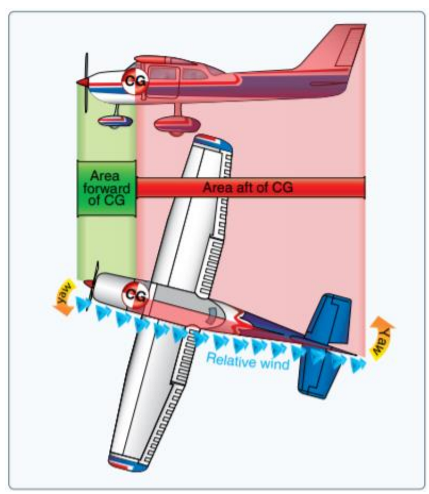
i. Dihedral - Angle the wings are slanted upward
a. Stabilizing - Balances lift in a sideslip (picture)

ii. Sweepback - angle the wings are slanted rearward
a. Effectively increases dihedral
- 10° of sweepback = about 1° of dihedral

iii. Keel effect
a. Fuselage acts like a keel, returning the aircraft toward straight and level

iv. Weight Distribution
a. The plane will bank toward a heavier loaded side

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



i. Affected by the area of the vertical fin and the sides of the fuselage aft of the CG (pictured, right)

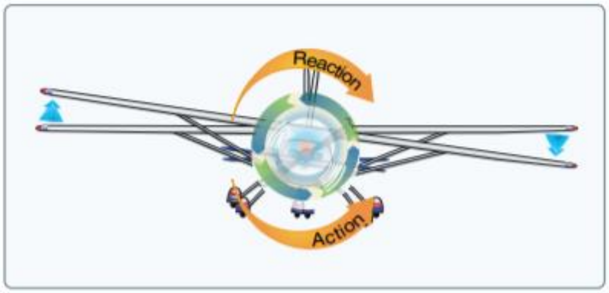
ii. Plane acts like a weathervane, nose points into relative wind

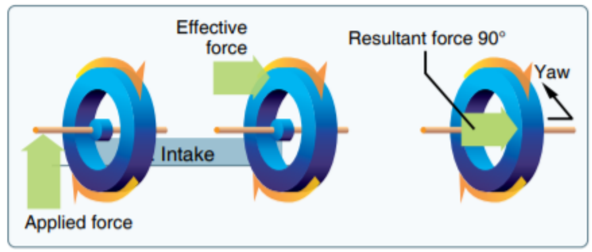
3. Turning Tendency

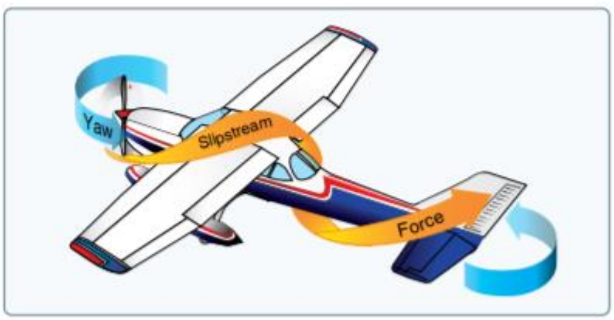
A. Torque Reaction – Based on Newton's 3rd Law
i. The engine parts/propeller rotate right, an equal force attempts to rotate the plane left
ii. In flight: left rolling tendency; On ground: left turning tendency
iii. Corrected by offsetting the engine, aileron trim tabs, and/or aileron and rudder use

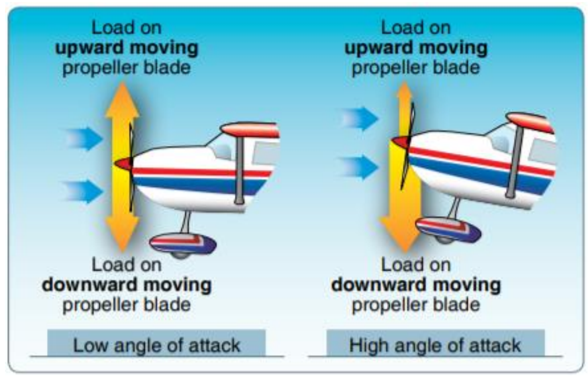
B. Corkscrew/Slipstream Effect
i. Corkscrewing propeller air strikes the left side of the vertical stabilizer - pushes nose left (shown below)

    ii. Strongest at high prop speeds/low forward speeds – correct with rudder
C. Gyroscopic Action
    i. Precession - Any force takes effect 90º ahead of, and in the direction of rotation
    ii. Pitch results in a yawing moment and vice versa
    iii. Correct with rudder/elevator
D. Asymmetric Loading (P Factor)
    i. At high AOAs, the bite of the down moving blade is greater than the up moving blade
    ii. Center of thrust moves to the right of the propeller disc, causing a yaw to the left
    iii. Correct with right rudder



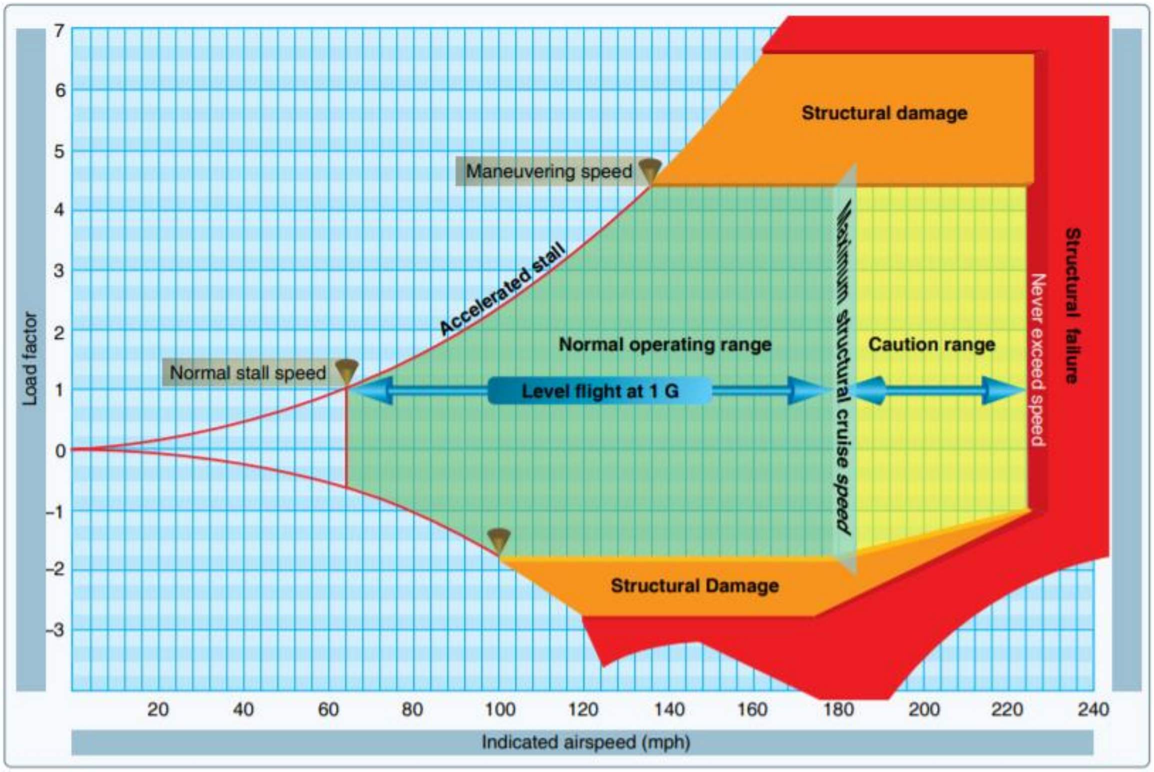






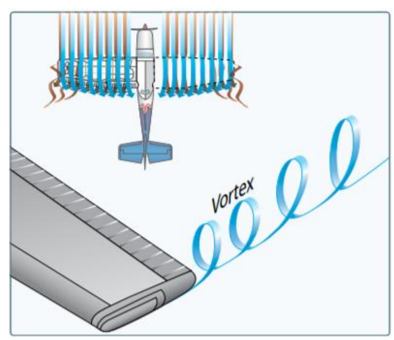
4. Load Factors (LF) in Airplane Design
A. General
    i. The ratio of the total air load acting on the airplane to the gross weight of the airplane (Gs)
    ii. Important to for two reasons:
        a. Increased load factor increases the stall speed making stalls possible at seemingly safe speeds
        b. It is possible for the pilot to impose a dangerous overload on the aircraft structures
B. Airplane Design
    i. How strong an airplane should be is determine largely by the use it will be subjected to
    ii. Airplanes are designed in accordance with the category system:
        a. Normal Category limit load factors are -1.52 Gs to 3.8 Gs
        b. Utility Category limit load factors are -1.76 Gs to 4.4 Gs (Mild acrobatics, including spins)
        c. Acrobatic Category limit load factors are -3.0 Gs to 6.0 Gs

C. The Vg diagram describes the allowable airspeed/LF combinations for safe flight
   i. Each aircraft has its own Vg diagram that is valid at a certain weight and altitude



   ii. Areas to note on the Vg diagram:
      a. Lines of Maximum Lift Capability (curved lines)
      b. Maneuvering Speed
      c. Intersection of the Negative Limit Load Factor and Line of Maximum Negative Lift Capability
      d. Limit Airspeed (redline)

5. Wingtip Vortices and Precautions to be Taken



A. How They Work
   i. At positive AOA, pressure differential exists above/below the wing
   ii. Air moves from higher to lower pressure, and the path of least resistance is the tips of the wings
   iii. Air curls upward around the wingtip and combines with downwash to form vortices (increases drag)

B. Strength of the Vortices
   i. The greater the AOA, the stronger the vortices
   ii. Heavy, clean, and slow = strongest vortices

C. Behavior
   i. Sink at a rate of several hundred fpm, slowing/diminishing over time
   ii. When vortices sink to the ground, they tend to move laterally with the wind
      a. Crosswind decreases lateral movement of upwind vortex, but increases downwind vortex
      b. Tailwind can move the vortices of a preceding aircraft forward into the touchdown zone

D. Avoidance
   i. Takeoff:
      a. Takeoff before the other aircraft's rotation point; climb above or away from their flight path
      b. Takeoff beyond a landing jet's touchdown point

ii. Enroute:
   a. Avoid flying through another aircraft's flight path
   b. Avoid following another aircraft on a similar flight path within 1,000' below
iii. Landing:
   a. Stay above a preceding aircraft's path, and land past their touch down point
   b. Parallel runways – stay at and above the other jet's flight path for the possibility of drift
   c. Crossing runways – cross above the larger jet's flight path
   d. Land prior to a departing aircraft's takeoff point

E. For more information, see lesson VI.B. Traffic Patterns, Section 6.B.

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

II.D. Forces of Flight and Maneuvers (Additional Info)

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25)

Objectives	The student should become familiar with the four forces of flight and the forces of flight maneuvers.
Key Elements	1. Pilot Control of Lift 2. Parasite vs. Induced Drag 3. Ground Effect
Elements	1. Intro 2. Lift 3. Airfoils 4. Pilot Control of Lift 5. Weight 6. Thrust 7. Drag 8. Ground Effect 9. Climbs 10. Descents 11. Turns 12. Stalls
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References 3. Model Airplane
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student displays the ability to explain the forces of flight and their interaction and effect on flight.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

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

Overview

Review Objectives and Elements/Key ideas

What:

The four forces of flight are in essence the fundamental principles that govern flight; they are what make an airplane fly.

Why:

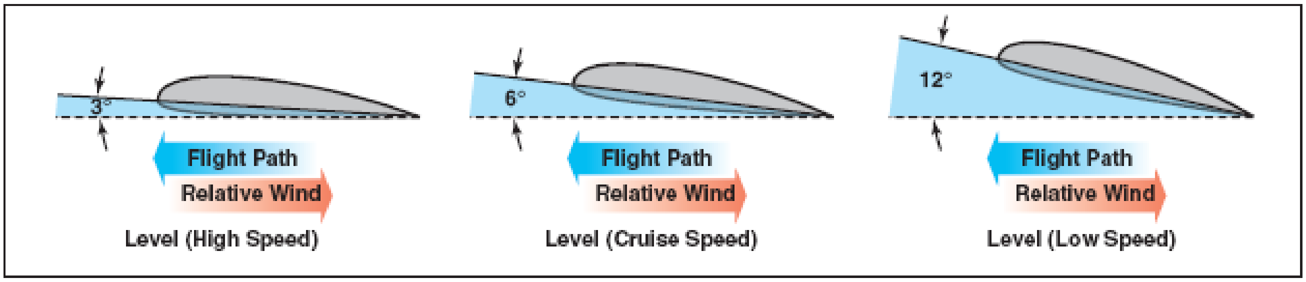
How well a pilot performs in flight depends on the ability to plan and coordinate the use of power and flight controls to change the forces of thrust, drag, lift, and weight. It is the balance between these forces that the pilot must always control. The better the understanding of the forces, the greater pilot's skill.

How:

1. **Intro - Forces of Flight**
   A. Lift – The upward force created by the effect of airflow as it passes over and under the wing
   B. Weight – Opposes lift, and is caused by the downward pull of gravity
   C. Thrust – The forward force which propels the airplane through the air
   D. Drag – Opposes thrust, and is the backward, or retarding force, which limits the speed of the airplane
   E. Terminology:
      i. Chord Line: The imaginary straight line joining the leading and trailing edges of an airfoil
      ii. Relative Wind: The direction of movement of the wind relative to the aircraft's flight path
      iii. Angle of Attack: The angle between the chord line and the relative wind
2. **Lift**
   A. The force that opposes weight
   B. Principles of Lift
      i. Newton's three laws of motion:
         a. 1st Law: A body at rest tends to remain at rest, and a body in motion tends to remain in motion
         b. 2nd Law: Force = Mass x Acceleration (F=ma)
         c. 3rd Law: For every action, there is an equal and opposite reaction
      ii. Bernoulli's Principle: As the velocity of a fluid (air) increases, its internal pressure decreases
3. **Airfoils and Lift**
   A. The wing's shape is designed to take advantage of Newton's Laws and Bernoulli's Principle
      i. Greater curvature on the upper portion causes air to accelerate as it passes over the wing (Bernoulli)
      ii. A downward-backward flow of air also is generated from the top surface of the wing
         a. The reaction to this downwash results in an upward force on the wing (Newton's 3rd Law)
      iii. Newton's 3rd law is also apparent as the airstream strikes the bottom of the wing when inclined
         a. The air is forced downward and therefore causes an upward force resulting in positive lift
4. **Pilot Control of Lift**
   A. Lift = ½ pC_Lv^2S (Memory Aid: **½ P**int, **C**hug a $_L$iter, **V**omit **twice**, **S**leep it off)
      i. P = Rho or a pressure constant

ii. C_L = Coefficient of Lift – A way to measure lift as it relates to the angle of attack
iii. V = Velocity
iv. S = Surface Area (Constant)

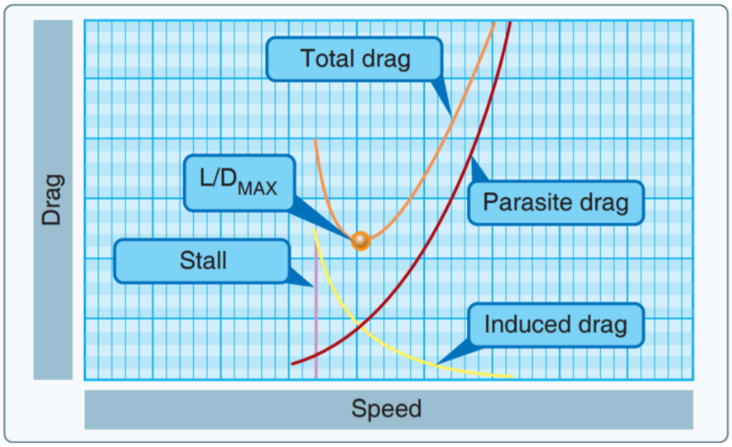
B. The amount of lift generated is controlled by the pilot and determined by aircraft design factors
   i. The pilot can change the Angle of Attack (AOA), the airspeed, and the shape of the wing (flaps)

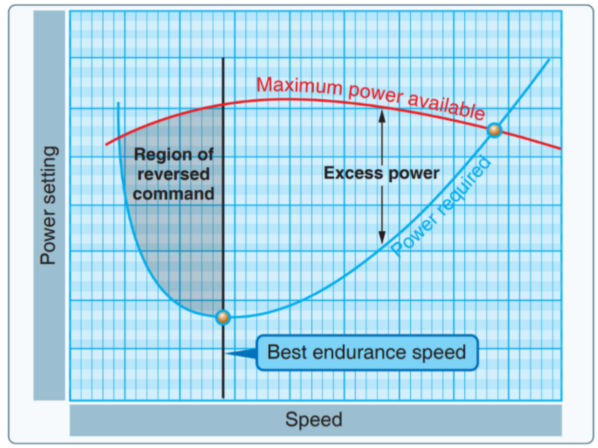


5. **Weight**
   A. The force of gravity which acts vertically through the center of the plane toward the center of earth
   B. When lift = weight, the plane is in equilibrium and doesn't gain or lose altitude
6. **Thrust**
   A. The forward-acting force which opposes drag and propels the airplane
      i. F=MA (Force comes from the engine, mass of air is accelerated opposite the direction of flight)
   B. Thrust starts the airplane moving, it continues to move and gain speed until thrust and drag are equal
7. **Drag**
   A. Rearward, retarding force, caused by disruption of airflow by the wing, fuselage, or other objects
      i. Opposes thrust, and acts rearward and parallel to the relative wind
   B. Two types of drag
      i. Parasite Drag - Caused by surfaces which deflect/interfere with the smooth airflow of the airplane
         a. Three Types of Parasite Drag
            - Form Drag: Shape of the aircraft/separation of airflow from the surface of the structure
            - Interference Drag: Occurs when varied currents or air over an airplane meet and interact
            - Skin Friction Drag: Caused by the roughness of the airplane's surfaces
         b. Parasite Drag and Airplane Speed – As airspeed increases, Parasite drag increases
            - Varies proportionately to the square of the airspeed

      ii. Induced Drag – As lift increases, induced drag increases
         a. Lift is produced at the expense of induced drag
         b. How it Works
            - Vortices create upward flow of air beyond the wingtip/downwash behind the trailing edge
               a This downwash = source of induced drag
            - Downwash – The source
               a Tilts the wing's vertical lift backward (induced drag)
               b The greater the vortices strength/downwash, the more the lift tilts back, and the greater induced drag
      iii. Total Drag
         a. The sum of induced and parasitic drag
         b. Region of Normal vs Reversed Command
            - Normal Command
               a As airspeed decreases, total drag decreases, until reaching a point (L/D_{MAX})
                  1. Higher speeds require higher power
            - Region of Reversed Command

a. As airspeed decreases below L/DMAX, total drag increases
b. Lower speeds require higher power

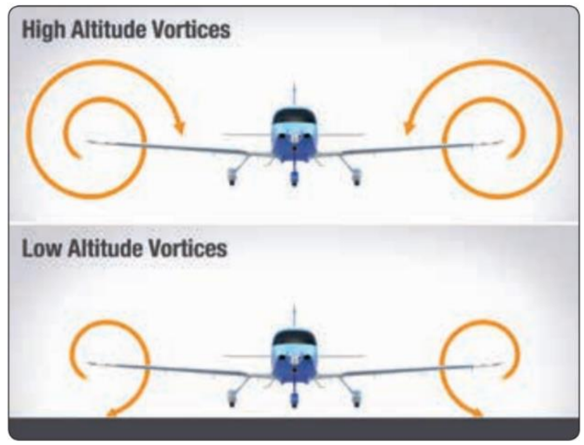




8. Ground Effect

A. Reduces induced drag
   i. The vertical component of the airflow around the wing is restricted by the ground
      a. Reduces wingtip vortices and decreases downwash which reduces induced drag

B. Effects on Flight
   i. Takeoff
      a. Capable of lift off at lower-than-normal speed
   ii. Landing
      a. Airplane seems to float in ground effect



9. Climbs

A. Raising the airplane's nose momentarily increases AOA and lift
   i. Lift at this moment is now greater than weight and starts the airplane climbing

B. Once the flight path is stabilized in a climb, AOA and lift revert back to approx. level flight values

C. Without a change in power, airspeed diminishes
   i. When inclined upward, a component of weight acts in the same direction, and parallel to, drag

D. The amount of reserve power determines the climb performance

10. Descents

A. When forward pressure is applied, AOA is decreased and lift is reduced

B. In a steady descent, the airfoil's AOA again approaches level flight values

C. Airspeed will gradually increase
   i. A component of weight is acting forward along the flight path

D. To maintain airspeed, power must be reduced

11. Turns

A. Like any moving object, an airplane requires a sideward force to make it turn (bank)

B. When the airplane banks, lift is divided inward and upward
   i. Vertical Component of Lift – Acts vertically and opposite to weight
   ii. Horizontal Component of Lift – Acts horizontally (makes the plane turn)
   iii. AOA must be increased to maintain altitude

C. Airspeed - Increasing AOA results in increased drag. Power is required to maintain airspeed in a turn

D. Rate of Turn - The rate of turns depends on the size of the horizontal component of lift

E. Turn Radius - Increased airspeed = increased turn radius and vice versa

F. Slipping Turns - Rate of turn is too slow for the bank angle, the plane is yawed to the outside of the turn
    i. Horizontal component of lift (H_{CL}) is greater than Centrifugal Force (CF)
G. Skidding Turns - Rate of turn is too great for the bank angle and the plane is yawed inside the turn
    i. There is excess centrifugal force compared to the H_{CL}

12. Stalls

A. The direct cause of every stall is an excessive angle of attack
B. The stalling speed of a particular airplane is not a fixed value for all flight situations
    i. Each plane has a particular AOA where airflow separates from the upper wing and it stalls (16^{o}-20^{o})
C. 3 situations where the critical AOA can be exceeded:
    i. Low Speed Flying - As airspeed is decreased, AOA must be increased to hold altitude
    ii. High Speed Flying - The wing can be brought to an excessive angle of attack at any speed
        a. Ex: High speed dive with a sudden increase in back elevator pressure
    iii. Turning Flight - The stalling speed is higher in a level turn than in straight and level flight
        a. In a turn, the necessary additional lift is acquired by applying back pressure, increasing AOA

Conclusion:
Brief review of each main point

II.E. Airplane Flight Controls

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25)

Objectives	The student should develop knowledge of the elements related to primary flight controls, secondary flight controls, and trim.
Key Elements	1. Primary Flight Controls – Airflow and Pressure Distribution 2. Trim relieves control pressures 3. Flaps increase lift and induced drag
Elements	1. Overview 2. Primary Flight Controls 3. Secondary Flight Controls 4. Trim Controls
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can explain the primary and secondary flight controls and their function. The student will also understand how trim works and can effectively use it.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Learning how the flight controls work and why the inputs you make result in the corresponding changes. This is what is actually going on when you move the control surfaces, adjust trim, or use the flaps.

Overview

Review Objectives and Elements/Key ideas

What

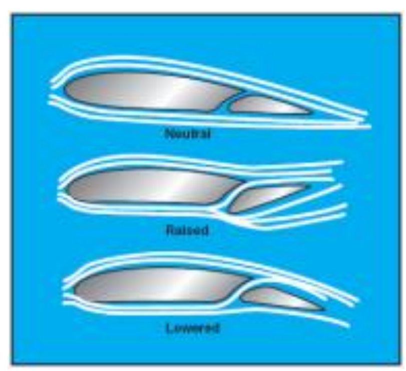
The airplane's attitude (rotation around the 3 axes) is controlled by deflection of the primary flight controls. These are hinged, moveable surfaces attached to the trailing edge of the wings and vertical and horizontal stabilizers. When deflected, the surfaces change the camber and angle of attack of the wing or stabilizer and thus change its lift and drag characteristics. Trim controls are used to relieve the control pressures, and flaps create a compromise between a high cruise speed and low landing speed.

Why

Understanding how the airplane functions and the effects each control input has on the airplane results in an understanding of how to control the airplane. Understanding how the airplane works results in a much more proficient pilot.

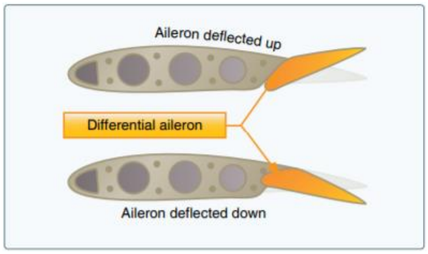
How:

1. **Overview**
   - A. Chord Line – An imaginary straight line drawn through an airfoil from the leading to the trailing edge
   - B. Camber – The characteristic curve of an airfoil's upper and lower surfaces
2. **Primary Flight Controls**
   - A. Primary flight controls are those required to safely control an airplane during flight
   - B. Ailerons
     - i. Control *roll* about the *longitudinal* axis
     - ii. Operated by cables, bell cranks, pulleys and/or push-pull tubes
     - iii. How they Work
       - a. One on each wing, move in opposite directions
       - b. Upward deflection decreases camber / lift, lowering the wing
       - c. Downward deflection increases camber / lift, raising the wing
     - iv. Adverse Yaw
       - a. The down deflected aileron produces more lift, and thus induced drag –yaws the nose toward the raised wing
       - b. Rudder is used to counter and maintain coordinated flight
     - v. 4 Types of Ailerons to counter Adverse Yaw
       - a. Differential Ailerons
         - The upward moving aileron raises higher than the downward moving aileron lowers
         - Produces increased drag on the descending wing (raised aileron) to reduce adverse yaw
       - b. Frise-Type Ailerons
         - Raised aileron projects its leading edge into the airflow (reduces adverse yaw)
         - Forms a slot so air flows smoothly over the lowered aileron (more effective at high AOA)



c. Coupled Ailerons and Rudder
- Ailerons and rudder are linked – rudder automatically deflects with ailerons

d. Flaperons (combine flaps and ailerons)
- Control the bank of the aircraft but can also be lowered together to act as flaps



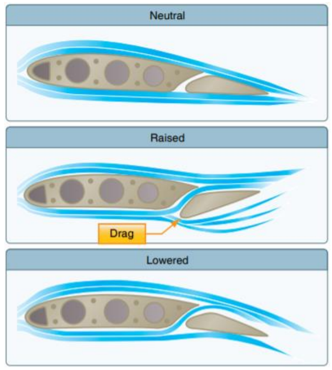


Figure 6-7. *Frise-type ailerons.*

Figure 6-9. *Flaperons on a Skystar Kitfox MK 7.*

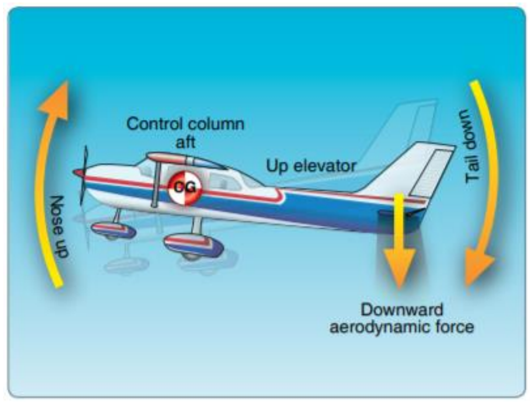
C. Elevator

i. Controls *pitch* about the *lateral* axis

ii. How It Works

a. Pulling back deflects the trailing edge up
- Changes the camber of the horizontal stab, creating a downward aerodynamic force
- Tail moves down and the nose moves up

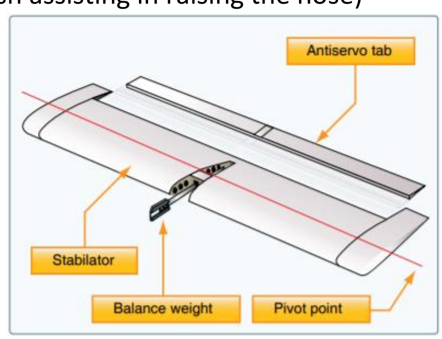
b. Pushing forward deflects the trailing edge down
- Changes the camber of the horizontal stab, creating an upward force
- Tail moves up and the nose moves down



iii. Types of Elevators

a. T-Tail
- Elevator is mounted above most effects of prop downwash/fuselage and wing airflow
  - a Makes for consistent control movements in most flight regimes
- At slow speeds, the elevator must be moved a greater degree to raise the nose a given amount vs a conventional tail (which has prop downwash assisting in raising the nose)

b. Stabilator - "All-moving tail"
- Essentially a one-piece horizontal stabilizer that pivots from a central hinge point
- Anti-servo tabs decrease sensitivity
  - a Stabilators are easier to move, anti-servo tabs add resistance



D. Rudder

i. Controls *yaw* about the *vertical* axis

a. Used to maintain coordination

ii. Often operated through cables, but can be operated by various mechanisms

iii. How it Works

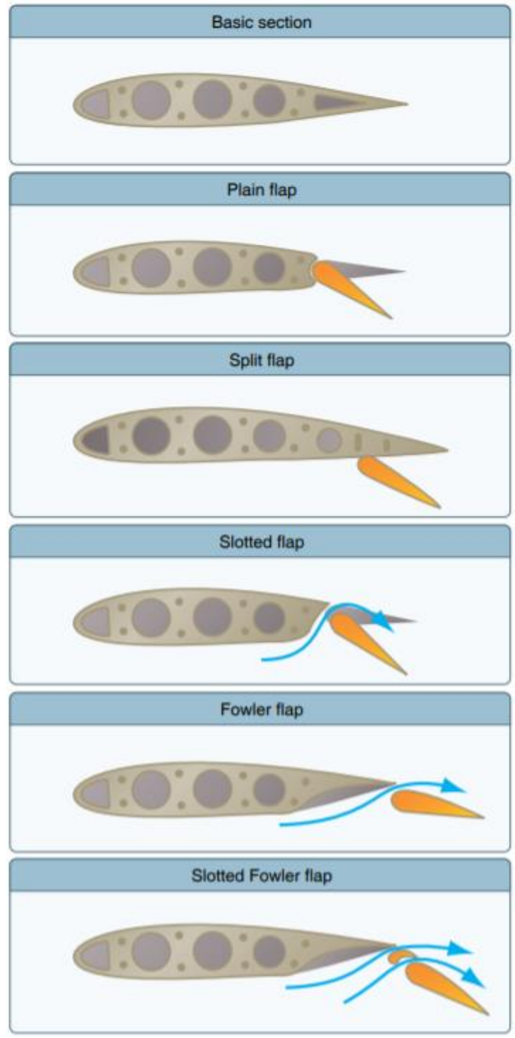
a. When deflected into the airflow, a horizontal force is exerted in the opposite direction

3. Secondary Flight Controls

A. Improve performance characteristics or relieve excessive control forces

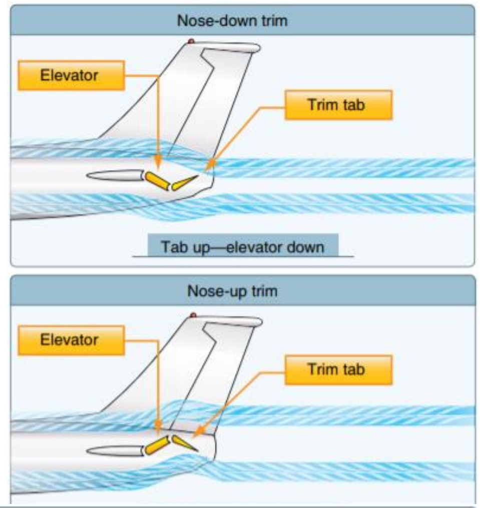
i. Wing Flaps, leading edge devices, spoilers and trim systems

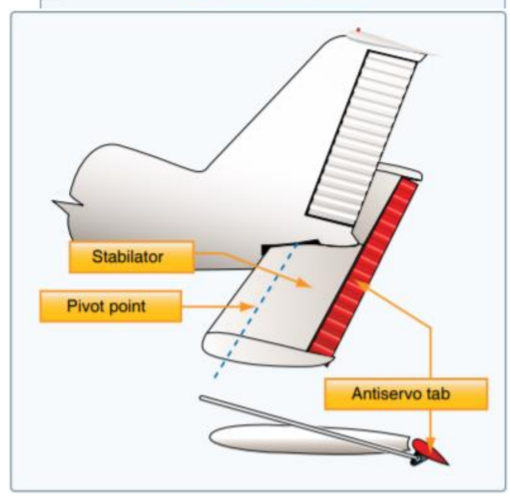
B. Flaps
   i. Increase induced drag and lift for any given AOA
   ii. Functions
      a. Get airborne at lower speeds, reduce takeoff runway required, improve climb performance
      b. Increased drag allows for steeper approaches
      c. Reduced landing speeds and landing distance
   iii. Plain Flaps
      a. Simplest of the types
      b. Increase camber results in a significant increase in lift and drag at a given AOA
   iv. Split Flaps
      a. Deflect from the lower surface of the airfoil
      b. Slightly more lift and drag vs plain flap
      c. When fully extended, both plain and split flaps produce high drag with little additional lift
   v. Slotted Flap (most popular)
      a. Increase lift significantly more vs plain/split flaps
      b. High energy air is ducted to the top, accelerating the boundary layer/delaying separation
   vi. Fowler Flaps
      a. Type of slotted flap which changes the camber of the wing and increases the wing area
      b. Slide backward, then downward
      c. First portion of extension considerably increases lift but has little effect on drag
      d. From there, drag increases with little change in lift
   vii. Flap Control
      a. Mechanical, electrical, or hydraulic operation
      b. Be aware of any flap operating speeds



C. Spoilers - High drag devices on the wings that reduce lift and increase drag
   i. Reduce airspeed at a higher-than-normal rate
   ii. Increased rate of descent - The aircraft can descend at a faster rate without increasing airspeed
   iii. Roll control – One wing's spoiler is used to reduce lift and create drag (eliminates adverse yaw)

4. Trim Controls





A. Relieves the need for constant pressure on the flight controls
B. How a Trim Tab Works
    i. Most common is a single trim tab attached to the trailing edge of the elevator
        a. Can be installed on ailerons, and rudder as well
    ii. Operation
        a. Often operated manually through a vertically mounted control wheel (or trim crank)
        b. Tim tab moves opposite the elevator surface
C. Cockpit Operation
    i. Establish desired power/pitch/configuration, then trim to relieve pressures
    ii. Re-trim any time power/pitch/configuration is changed
D. Balance Tabs
    i. Function like trim tabs, but coupled to the control rod
        a. The tab moves opposite flight control deflection
    ii. If adjustable by the pilot, it can be used as a trim tab too
E. Servo Tabs (primarily used in large aircraft)
    i. Small portion of a flight control that moves the entire flight control surface
    ii. Only the servo tab moves in response the flight controls
    iii. Airflow on the servo tab moves the control surface
F. Antiservo Tabs
    i. Decrease stabilator sensitivity/act as a trim device
    ii. Operation
        a. Like a balance tab, but moves in the same direction as the flight control
G. Ground Adjustable Tabs
    i. Metal trim tab on the rudder bent in either direction while on the ground to apply a trim force
H. Adjustable Stabilizer
    i. Some aircraft can adjust the entire stabilizer
    ii. Driven by a jackscrew

Conclusion:
Brief review of the main points
The airplane's attitude (rotation around the 3 axes) is controlled by deflection of the primary flight controls. When deflected, these surfaces change the camber and AOA of the wing or stabilizer and thus change its lift and drag characteristics. Trim controls are used to relieve the control pressures necessary and flaps increase lift and induced drag and create a compromise between a high cruise speed and low landing speed.

II.F. Airplane Weight and Balance

References: Weight and Balance Handbook (FAA-H-8083-1), Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), POH/AFM

Objectives	The student should develop knowledge of the elements related to weight and balance and have the ability to properly calculate an airplane's weight and balance for the given situation.
Key Elements	1. Performance 2. Calculating Weight and Balance 3. Adding, Removing, and Shifting Weight
Elements	1. Terms 2. Weight and Flight Performance 3. Weight and Balance Control 4. Determining Weight and Balance
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the factors relating to weight and balance and the airplane's control, stability and performance. The student also can calculate the weight and balance for a given situation and make adjustments as necessary.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

The earliest airplanes could barely lift the pilot and enough fuel for a few minutes of flight. Many could not get airborne on a warm day. The first Wright flyer could only carry the pilot and a few ounces of fuel if the headwind was at least 11 mph! Planes have come a long way and pilots still need to balance the plane's load.

Overview

Review Objectives and Elements/Key ideas

What

Airplane weight and balance is basically balancing the airplane within approved limits.

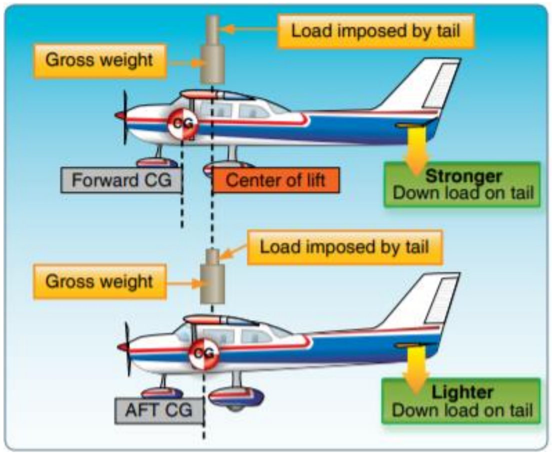
Why

Compliance with the weight and balance limits is critical to flight safety. Operating above the maximum weight limits compromises the structural integrity of the aircraft and affects performance. Operation with the center of gravity outside the approved limits results in control difficulty.

How:

1. **Terms**
   - A. Reference Datum (RD) - imaginary vertical plane or line from which all measurements of arm are taken
   - B. Center of Gravity (CG) – the point at which an airplane would balance if it were suspended at that point
   - C. Arm – the horizontal distance in inches from the reference datum line to the CG of an item
   - D. Basic Empty Weight –weight of the airplane, optional equipment, unusable fuel, full operating fluids
   - E. CG Limits – the specified forward and aft points within which the CG must be located during the flight
   - F. Maximum Landing Weight – the greatest weight that an aircraft is normally allowed to have at landing
   - G. Maximum Ramp Weight – the total permitted weight of a loaded aircraft, including all fuel
   - H. Maximum Takeoff Weight – the maximum allowable weight for takeoff
   - I. Maximum Zero Fuel Weight – the maximum weight, exclusive of usable fuel
   - J. Moment – the product of the weight of an item multiplied by its arm - expressed in pound-inches
   - K. Moment Index – a moment divided by a constant such as 100, 1,000 or 10,000 (simplifies calculations)
   - L. Payload – the weight of the occupants, cargo and baggage
   - M. Standard Weights – established weights for numerous items in weight and balance computations
     - i. Gas – 6lbs; Jet Fuel – 6.8 lbs.; Oil – 7.5 lbs.; Water – 8.35 lbs. (All per gallon)
   - N. Station - a location in the aircraft identified by a number designating its distance from the datum
   - O. Unusable Fuel – the fuel in the tanks that cannot be safely used in flight or drained on the ground
   - P. Usable Fuel – the fuel in the tanks that can be used for flight
   - Q. Useful Load – the basic empty weight subtracted from the maximum allowable gross weight
2. **Weight and Flight Performance**
   - A. Weight and Flight Performance
     - i. Heavier gross weight reduces takeoff, climb, cruise, landing performance and stresses the engine
     - ii. Overloading, even minorly, may make it impossible to meet required performance
   - B. Weight and Structure – Follow all manufacturer's guidelines and placards
     - i. Structural failure from overloading often occurs slowly, making it difficult to detect or repair
     - ii. Airworthiness requirements mandate an aircraft withstand a specific load factor (Normal: 3.8Gs)
       - a. Any overload is amplified in the case the aircraft is stressed to these G limits

C. Stability and Controllability
 i. Forward Loading
  a. Problems controlling and raising the nose, especially at slow airspeeds (takeoff and landing)
  b. “Heavier” and consequently slower than the same airplane with a further aft CG
  c. More controllable in a stall
 ii. Aft loading
  a. Very light control forces (easier to overstress)
  b. “Lighter” and consequently faster than the same airplane with a more forward CG
  c. Less controllable in a stall/spin
  d. Serious effect upon longitudinal stability
 iii. The CG and Lateral Loading
  a. Unbalanced loading can have adverse effects
  b. Trim, or maintain constant control pressure
   - Increases drag, decreases efficiency



3. Weight and Balance Control
A. The pilot is responsible
 i. 14 CFR Part 23.2100 requires establishment of ranges of weights and CGs within which aircraft may be safely operated - The manufacturer provides this information in the POH/AFM
 ii. Part 91.9 requires the PIC to comply with the operating limitations in the approved AFM
B. Aircraft owner/operator should ensure up to date information is available to the pilot

4. Determining Weight and Balance
A. CG = Total Moment divided by Total Weight
 i. Begin with the empty weight and make a list of everything that will be loaded in the airplane
 ii. Calculate the Moment of each item, then calculate the CG – (Total Moment/Total Weight)
B. Weight Change and/or CG Shift
 i. Shifting Weight
  a. Formula: $\frac{Weight\ to\ be\ Shifted}{Total\ Weight} = \frac{\Delta\ CG}{Distance\ Weight\ is\ Shifted}$
   - If you know 3 of the components, you can solve for the 4th
 ii. Adding or Removing Weight
  a. Formula: $\frac{Weight\ Added\ or\ Removed}{New\ Total\ Weight} = \frac{\Delta CG}{Distance\ between\ the\ Weight\ and\ old\ CG}$
   - Solve for the missing component

Conclusion:
Brief review of the main points
Weight and balance greatly affects flight and it is therefore very important we ensure that the airplane is correctly balanced before every flight.

II.G. Navigation and Flight Planning

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25)

Objectives	The student should develop knowledge of the elements related to navigation and flight planning as required in the applicable tasks in the ACS/PTS.
Key Elements	1. Time, Distance, and Fuel Calculations 2. Navigation 3. Lost Procedures
Elements	1. Terms 2. Aeronautical Charts 3. Pilotage and Dead Reckoning 4. Radio Navigation 5. Weather Check 6. Using a Flight Log 7. Flight Planning 8. Completing the Nav Log 9. GPS Navigation 10. Filing a Flight Plan 11. Diversion to an Alternate 12. Lost Procedures
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References 3. Aeronautical Charts (Sectional and Terminal Area Chart) 4. Navigation Log 5. Flight Computer
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can properly and confidently plan and execute a cross country flight to any chosen destination. The student also understands the procedures for diversions and lost situations.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

This is what leads into using everything you have learned so far and flying yourself somewhere!

Overview

Review Objectives and Elements/Key ideas

What

Navigation and flight planning is the process of planning and executing cross country flights, and will provide procedures for different situations that may arise during the flight.

Why

Navigation and flight planning is integral to flying from point to point. This information will make planning flights easier and more organized.

How:

1. **Terms**
   A. Navigation Terminology
      i. True Course – The direction of flight as measured on a chart clockwise from true North
      ii. True Heading – The direction the longitudinal axis of the airplane points with respect to true North
      iii. Magnetic Course – True course corrected for magnetic variation
      iv. Magnetic Heading – Magnetic Course corrected for wind (direction and speed)
      v. Compass Heading – Aircraft heading read from the compass
      vi. Deviation – Compass error due to magnetic disturbances from electrical/metal parts in the plane
      vii. Variation – The angular difference between true north and magnetic north; isogonic lines on charts
   B. Atmospheric Terminology
      i. Standard Pressure – 29.92" Hg (at sea level)
      ii. Standard Temperature – 15° C/59°F (at sea level)
   C. Altitude Terminology
      i. Indicated Alt –Altitude read directly from the altimeter after it's set to the current altimeter setting
      ii. Pressure Alt – Height above the standard pressure level of 29.92 in Hg - $1{,}000(29.92 - Alt) + Elev$
      iii. Density Alt – Pressure altitude corrected for nonstandard temperatures - $120(°C - 15°C) + PA$
      iv. True Altitude – The true vertical distance of the aircraft above sea level
      v. Absolute Altitude – The vertical distance of the aircraft above the surface of the earth (AGL)
   D. Airspeed Terminology
      i. Indicated (IAS) – The speed of an aircraft as shown on the airspeed Indicator
      ii. Calibrated (CAS) – Indicated airspeed of an aircraft, corrected for installation and instrument errors
      iii. Equivalent (EAS) – CAS corrected for adiabatic compressible flow for the particular altitude
      iv. True (TAS)– The speed an aircraft is moving relative to the surrounding air (CAS corrected for DA)
      v. Groundspeed (GS) – The speed of the aircraft in relation to the ground (TAS corrected for wind)
2. **Aeronautical Charts**
   A. The roadmap for a pilot flying VFR
      i. FAA Aeronautical Chart User's Guide
   B. Sectional Charts (Most commonly used by pilots) – revised every 56 days
      i. Information provided: Airport data, nav aids, airspace, and topography. Revised semiannually

   - ii. Scale is 1:500,000 (1" = 6.86 NM)
- C. VFR Terminal Area Charts – revised every 56 days
   - i. More detailed map/information. Helpful in busy airspace and flying in or near Class B airspace
   - ii. Scale is 1:250,000 (1" = 3.43 NM)
- D. World Aeronautical Charts – revised annually (except for Alaska, Mexican/Caribbean charts – 2 years)
   - i. Rarely used in general aviation (at a size/scale convenient for moderate speed aircraft)
   - ii. Scale is 1:1,000,000 - Similar to sectionals, but less detail due to the scale
- E. Proper and Current Aeronautical Charts
   - i. Always use current editions and discard obsolete charts and publications
   - ii. Check Aeronautical Chart Bulletins and NOTAMs for important updates between publication cycles

3. **Pilotage and Dead Reckoning**
   - A. Pilotage – Navigation by reference to landmarks or checkpoints
      - i. Checkpoints used should be prominent features common to the area of flight
         - a. Easily recognizable and spaced at a comfortable frequency
         - b. Use features that can create boundaries (rivers, roads, mountain ranges, etc.)
      - ii. Never place complete reliance on any single checkpoint
         - a. Turn based on time if the checkpoint is not in sight, do not continue blindly
   - B. Dead Reckoning – Navigation solely by computations based on time, airspeed, distance, and direction
   - C. Except for flights over water, dead reckoning is usually used with pilotage (ideally radio navigation too)
4. **Radio Navigation** – Navigation by which a predetermined flight path is followed
   - A. There are three primary navigation systems available: VOR, NDB, and GPS
      - i. For more detailed information, see II.L. Navigation Systems and Radar Services
5. **Weather Check**
   - A. Obtaining a preflight weather briefing is the first step to determine if the flight can be conducted safely
   - B. FAR 91.103 requires familiarity with weather reports and forecasts for the flight
   - C. Go/No Go
      - i. Good judgment is necessary in deciding whether or not to take the flight
      - ii. Weather factors, the aircraft and equipment to be used, as well as the pilot should be considered
      - iii. Set limits and don't bend them - Personal limitations will vary based on the pilot and the aircraft
      - iv. Continual process of decision making before and well as throughout the entire flight
6. **Using a Flight Log**
   - A. The flight log provides the pilot an organized, point by point plan of the flight and other useful info
7. **Flight Planning**
   - A. Plotting a Course
      - i. First, draw the route
      - ii. Choose cruise altitude based on the direction of flight, terrain, fuel, etc. (FAR 91.159)
   - B. Checkpoints – Recognizable points along your route of flight used to maintain your course
      - i. Top of Climb (TOC) and Top of Descent (TOD)
      - ii. Find additional checkpoints along the route to bridge the gap between the TOC and TOD
      - iii. Record your TOC, TOD, and additional checkpoints on your Nav Log
   - C. Fuel Stops
      - i. Longer flights will have to incorporate multiple legs for fuel stops (create a separate log for each leg)
      - ii. FAR 91.151 – fuel reserves (30 min during the day, 45 min during the night)
8. **Completing the Nav Log**
   - A. Start by finding the True Airspeed for the trip and record it on your Nav Log
   - B. Find and input the distance between each of the checkpoints
   - C. Next, find the true course for each leg of the flight plan
   - D. Adjust True Course for wind to get True Heading, and record ground speed

   E. Adjust the True Heading in order to obtain Magnetic Heading
   F. If necessary, get your Compass Heading by adjusting for Deviation with the correction card
   G. Calculate the estimated time for each leg
   H. Use the Time for each leg to find the fuel burn for each leg

9. **GPS Navigation**
   A. Before flight enter the flight plan waypoints into the GPS
   B. Ensure you don't get complacent with the GPS and lose situational awareness

10. **Filing a Flight Plan**
    A. Filing can be done on the ground or in the air
       i. On the ground: Call the FSS (1 800-WX BRIEF), various apps such as ForeFlight have this ability
       ii. After takeoff, contact the FSS by radio and give them the takeoff time to activate the flight plan
       iii. Once filed, the flight plan will be held for an hour after the proposed departure time
    B. Don't forget to close the flight plan
    C. ICAO Flight Plans
       i. As of June 2017, the FSS has transitioned to the ICAO Format for all VFR/IFR civil flights
       ii. For more information:
          a. A great, short ICAO flight plan instructional video from AOPA
          b. ICAO Flight Plan instructions
          c. FAA Aircraft Type Designators
          d. ICAO Flight Plan Form
          e. AIM 5-1-9 – International Flight Plan - IFR Flights

11. **Diversion to an Alternate**
    A. Diversions can result from weather, malfunctions, poor planning, fuel, fatigue/illness, etc.
    B. When planning, check the route for suitable landing areas that can be used in a diversion
    C. Take advantage of all shortcuts/rule of thumb computations when computing course/speed/distance
       i. Use your thumb to estimate distance
          a. Figure out approximately how far from the tip of your thumb (toward the knuckle) 10 nm is
          b. Use your thumb to quickly measure the number of 10 nm increments to the alternate
       ii. Use a compass rose, airway or any other reference to determine the approximate new heading
    D. Procedure
       i. Find your position on the sectional chart
       ii. Turn immediately toward the alternate using shortcuts/rule of thumb calculations
       iii. Once established on course, note the time
       iv. Use the winds aloft nearest the diversion point to calculate a heading and ground speed
       v. Calculate a new arrival time and fuel consumption
       vi. Determine a suitable altitude

12. **Lost Procedures**
    A. Plan ahead to avoid getting lost / Use flight following
    B. If Lost
       i. Don't Panic
       ii. The Five C's – Climb, Communicate, Confess, Comply, Conserve
       iii. Check the heading indicator against the magnetic compass in case of error
       iv. Use navigational radios (VOR/ADF) to attempt to plot your position (GPS if available)

Conclusion:
Brief review of the main points
Cross country flight planning requires a lot of preflight work but the flight itself is worth the time. It also helps to prevent getting lost and keeps us away from potentially dangerous or bad weather.

II.H. Night Operations

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), AIM

Objectives	The student should develop knowledge of the elements related to night operations and will understand the unique factors inherent to night flight.
Key Elements	1. Off Center Viewing 2. Instrument Indications 3. Maintain Orientation
Elements	1. Eyes at Night 2. Disorientation and Night Optical Illusions 3. Pilot Equipment 4. Preflight Inspection 5. Engine Starting 6. Taxiing, Airport Orientation, and The Run-up 7. Takeoff and Climb 8. In-Flight Orientation 9. Traffic Patterns 10. Approach and Landing 11. Go Around 12. Night Emergencies
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student is comfortable their understanding of the factors involved in night operations and can confidently and safely pilot an aircraft at night.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

A lot of people prefer night flying to day flying. The air tends to be smoother, the radios tend to be quieter, there's less traffic, and it's more relaxing.

Overview

Review Objectives and Elements/Key ideas

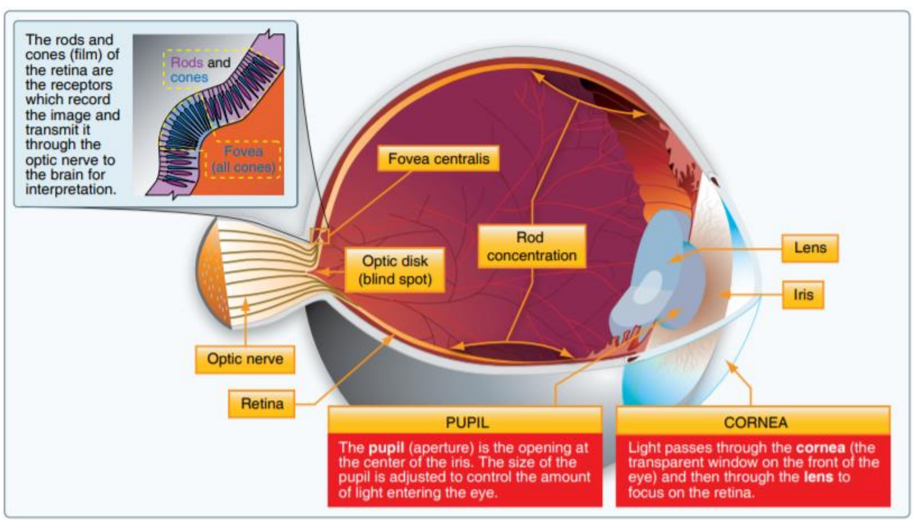
What

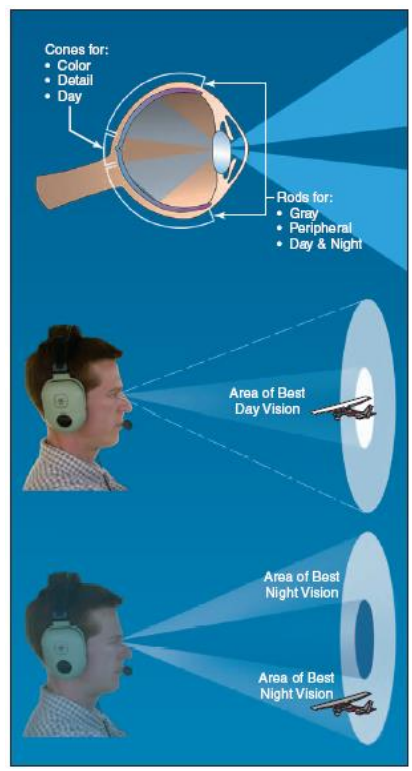
Night operations are the factors dealing with the operation of the airplane at night.

Why

Night flying is very different than day flying - The eyes function differently at night, references available in the day are no longer available at night, there are many illusions that can affect a pilot at night, and more. Flying at night presents unique situations which, if ignored, can lead to dangerous situations.

How:





1. **Eyes at Night**
   A. Rods and Cones
      i. Light enters the eye through the cornea, travels through the lens, and falls on the retina
      ii. The retina has light sensitive cells that convert light into electrical impulses that are sent to the brain
         a. Two types of light-sensitive cells:
            - Cones - Responsible for color, detail, far away objects; located in the center of the retina
            - Rods – Peripheral vision and provide vision in dim light; located in a ring around the cones
         b. Both the cones/rods are used in the day, but night vision is placed almost entirely on the rods
            - The cones need light to function
      iii. Rods, Cones, and Night Vision
         a. Cones – located in the center of the retina (center of vision)

b. Rods – Make night vision possible
   - Concentrated around the cones; used in dim light
     a Off center viewing is necessary at night
   - Slow to adapt to dark, but quick to lose adaptation

B. Cockpit Lighting – Min brightness allowing reading of the instruments without hindering outside vision

2. Disorientation and Night Optical Illusions

A. Combatting Disorientation / Illusions
   i. Verify attitude by reference to the flight instruments (best tactic to combat disorientation / illusions)
   ii. Use vertical guidance as much as possible, especially at night (VASI/PAPI, glide slope, etc.)
   iii. Go around if unsure of your position

B. Autokinesis
   i. Caused by staring at a single point of light on a dark background
   ii. The light appears to move on its own
   iii. Prevention: Focus on objects at varying distances / avoid fixating

C. Reversible Perspective Illusion
   i. At night, an aircraft may appear to be moving away when it is approaching
   ii. If the light intensity increases, the aircraft is approaching, if it dims, it is moving away

D. Size-Distance Illusion
   i. Light that is getting brighter or dimmer, may be interpreted as approaching or retreating

E. Flicker Vertigo
   i. A light flickering between 4 and 20 cycles per second can produce unpleasant, dangerous reactions
      a. Examples: nausea, vomiting, and vertigo. Convulsions/unconsciousness are possible, but rare
   ii. Proper scanning techniques at night can prevent flicker vertigo

F. Featureless Terrain
   i. An absence of ground features can create the illusion that the aircraft is higher than it actually is
   ii. Results in a tendency to fly a lower-than-normal approach

G. Ground Lighting
   i. Can be mistaken for airport / runway / approach lights
   ii. Bright runway or approach lights can create the illusion the airplane is closer to the runway
   iii. Maintain situational awareness - know what to expect to see, and where to see it

H. False Horizon
   i. The natural horizon is not readily apparent
   ii. Trust your instruments to maintain orientation

3. Pilot Equipment

A. Flashlight - Red and white light (White light is used to preflight, red is used in the cockpit)

B. Aeronautical Charts, Nav Logs
   i. Be cautious of washout (red color on the chart is difficult to distinguish with a red light)

C. Regardless of equipment, organization eases the burden on the pilot

4. Preflight Inspection (FAR 91.205)

A. Required equipment for VFR flight at night
   i. TOMATO FFLAMES (day VFR) and FLAPS (additional night VFR requirements)
      a. Fuses (if applicable)
      b. Landing Light
      c. Anti-Collision Lights
      d. Position Lights
      e. Source of Power
   ii. Instrument required equipment doesn't hurt (safer is smarter)

B. Walk Around – Just like a normal walk around but be more vigilant with night equipment
   i. Check all aircraft lights, and check the ramp for obstructions

5. Engine Starting

A. Take extra precaution to be sure the propeller area is clear (use lights, announce "clear prop")
B. To avoid excessive battery drain, leave all unnecessary electrical equipment off until after engine start

6. Taxiing, Airport Orientation, and the Run-up

A. Taxiing
   i. Turn on the taxi and/or landing light (be sure not to blind other pilots)
   ii. Taxi slowly, particularly in congested areas
B. Orientation
   i. Airport diagram (always have one out)
   ii. Understand the taxiway markings, lights, and signs
C. The Run-up
   i. The before takeoff run-up should be performed with the checklist as usual
   ii. Forward movement of the airplane may not be easy to detect at night

7. Takeoff and Climb

A. General
   i. The most noticeable difference is the limited availability of outside visual references
      a. Flight instruments should be used to a greater degree at night than in the day
   ii. Dim the cockpit lighting so the instruments are readable, without hindering night vision
B. Clear the final approach area for approaching traffic
C. After receiving clearance, turn on all lights, and align a few feet to the side of the centerline
   i. Verify the runway
D. Same as a day takeoff except many visual cues aren't available (compensate with instruments)
E. Climb
   i. Darkness makes it difficult to note whether the airplane is getting closer or farther from the surface
      a. Verify with the airspeed indicator, the VSI and the altimeter
   ii. Pitch/bank adjustments should be made by referencing the attitude/heading indicators

8. In-Flight Orientation

A. Clouds/Restricted Visibility
   i. It is difficult to see clouds at night – be cautious to avoid flying into MVFR/IFR weather conditions
   ii. Be conservative, don't expect to pop out the other side, take action to avoid flying into the clouds
B. Crossing Large Bodies of Water
   i. Very easy to become disoriented with little to no horizon, and false horizons
   ii. Rely more heavily on the instruments
   iii. In the event of an engine failure, the pilot may not have any option other than ditching
C. Ground Based Lighting
   i. Lighted runways, buildings, etc. may cause illusions when seen from different altitudes
D. Nav Lights - Used to orient another aircrafts direction in relation to your own
E. Navigating at Night
   i. Although numerous day references are unavailable, numerous night references can be used instead
      a. Anything with bright lights or a lot of lights - City light patterns, highways, airport beacons, etc.
   ii. Backup with NAVAIDS/GPS whenever possible

9. Traffic Patterns

A. Identify runway/airport lights as soon as possible
   i. It may be difficult to find the airport or runways (especially if they're buried within a city)
      a. Fly towards the beacon until you identify runway lights
      b. Compare the runway lights with heading indicator

        c. If possible, tune the localizer and/or use the GPS OBS function to view an extended centerline
        d. Use any additional means available to help orient yourself and maintain situational awareness
    B. Distance may be deceptive at night due to limited light conditions
        i. More trust must be put on the instruments (particularly the altimeter and airspeed indicator)
    C. Ensure appropriate lights are on for collision avoidance
    D. Fly a normal traffic pattern

10. Approach and Landing

- A. A stabilized approach should be made in the same manner as during the day
- B. Use flight instruments more often (especially altimeter/airspeed indicator)
- C. Final Approach
    - i. If there are no centerline lights, align the airplane between the edge lights
    - ii. Maintain a stabilized approach (use references as available – VASI, PAPI, glideslope, etc.)
- D. Roundout/Touchdown
    - i. A smooth, controlled roundout and touchdown should be made in the same manner as in the day
    - ii. Judgment of height, speed, and sink rate may be impaired due to lack of visual references
        - a. Tendency to round out high
    - iii. A good rule is to start the roundout when the landing lights reflect on the tire marks on the runway
        - a. If no landing light/can't see tire marks, start the roundout when the runway lights at the far end appear to be rising higher than the nose of the airplane

11. Go Around

- A. A prompt decision is even more necessary at night due to the restricted visibility
- B. Fly the go around as normal, with a greater emphasis on the instrument crosscheck

12. Night Emergencies

- A. General
    - i. Don't panic, maintain control, attempt to fix the problem/accomplish emergency procedures
    - ii. As the checklist is completed, crosscheck the outside visual references (if any), and the instruments to ensure a safe flight attitude is maintained
- B. Electrical Failure
    - i. In the case of a suspected problem, follow the checklist in the POH
        - a. Generally, reduce the electrical load as much as possible
    - ii. If total electrical failure is expected, land at the nearest airport immediately
        - a. Transition to backup instruments if applicable
- C. Engine Failure
    - i. Don't Panic - Establish a normal glide and turn toward an airport or suitable landing area
        - a. Away from congested areas
        - b. Consider an emergency landing area near public access (don't land where no one can get to you)
    - ii. Check to determine the cause and correct it immediately, if possible (Engine restart checklist)
    - iii. Maintain positive control of the airplane at all times!
    - iv. Announce the emergency to ATC, UNICOM, and/or guard
        - a. If already on a frequency, talk to them, don't change unless instructed to
    - v. Before landing checklist
    - vi. Touchdown at the slowest possible airspeed
    - vii. After landing, turn off all switches and evacuate as quickly as possible

Conclusion:
Brief review of the main points
Night operations present unique situations to a pilot and require diligence to maintain orientation and safety. Night flying is not inherently dangerous but it can require more effort. Overall, though, it is very enjoyable.

II.I. High Altitude Operations

References: 14 CFR Part 91, AC 61-107, Airplane Flying Handbook (FAA-H-8083-3), AIM, POH/AFM

Objectives	The student should develop knowledge of the elements related to high altitude operations and be able to explain the necessary elements as required in the ACS/PTS.
Key Elements	1. Regulations 2. Aviator's Oxygen 3. Decompression and Hypoxia
Elements	1. The High-Altitude Flight Environment 2. Regulatory Requirements 3. Physiological Factors 4. Pressurization in Airplanes 5. Types of Oxygen Systems 6. Aviator's Breathing Oxygen 7. Care and Storage of High-Pressure Oxygen Bottles 8. Rapid Decompression Problems and their Solutions
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands and can explain the elements involved with high altitude operations.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

So, you want to fly really high? It's not just that simple. A lot changes as the altitude increases.

Overview

Review Objectives and Elements/Key ideas

What

The required equipment, how it functions, the unique hazards and regulations associated with flying at high altitudes.

Why

There are many advantages to flying at high altitudes (jet engines are more efficient, weather and turbulence can be avoided, etc.). Many modern GA airplanes are being designed to operate in the high altitude environment, therefore it is important that pilots be familiar with at least the basic operating principles.

How:

1. **The High-Altitude Flight Environment**
   A. FAR 61.31(g) considers all flight operations conducted above 25,000' MSL to be high altitude, however many effects of higher altitudes can be felt well below 25,000'
2. **Regulatory Requirements** (FAR 91.211)
   A. Supplemental oxygen is required for the minimum required flight crew:
      i. From 12,500' MSL up to/including 14,000' MSL for greater than 30 minutes
      ii. At all times above 14,000' MSL
      iii. AND all occupants of the aircraft above 15,000' MSL cabin pressure altitude
   B. Cannot operate a pressurized cabin above:
      i. FL 250 without at least 10 minutes of supplemental oxygen plus any oxygen required above, in the case there is a loss of cabin pressure
      ii. FL 350, unless a pilot at the controls is using an oxygen mask
         a. Mask must supply oxygen at all times or automatically when cabin pressure exceeds 14,000'
         b. Exception: At/below FL410 with two pilots are at the controls and both have quick don masks
         c. Above 350, if one pilot leaves the controls, the other will wear their mask
3. **Physiological Hazards**
   A. The human body functions normally from sea level to 12,000' MSL
      i. Above 12,000' oxygen saturation continues to decrease and affect performance
   B. Hypoxia – See II.A. Aeromedical Factors - Hypoxia for types, symptoms and treatment of hypoxia
      i. Oxygen deficiency in the blood, tissues, or cells sufficient to cause impairment of body functions
      ii. The concern is getting enough oxygen to the brain, since it is particularly vulnerable to deprivation
   C. Vision tends to deteriorate with altitude
      i. Lack of oxygen to the rods significantly reduces their sensitivity
   D. Hyperventilation – See II.A. Aeromedical Factors – Hyperventilation for symptoms and treatment
      i. An increase in the rate and depth of breathing resulting in an excessive loss of carbon dioxide
   E. Trapped Gas
      i. Gases expand with a decrease in pressure (climb) and compress with increased pressure (descent)
      ii. The body has several cavities that contain varying amounts of gas

a. Most cavities can allow the gas to escape, but if the gas gets trapped it can result in pain
b. Problem areas include: middle ear, sinuses, teeth, and GI tract

F. Nitrogen Absorption (Decompression Sickness - DCS)
i. Pressure drops sufficiently, nitrogen in the body comes out of solution, forming bubbles in the body
ii. Symptoms include impairment or severe pain, but in extreme cases can result in death
iii. Scuba diving and Nitrogen
a. The increased pressure while scuba diving results in increased nitrogen dissolved in the body
b. Pilots need to provide time for the excess nitrogen to exit the body
- Wait 12 hrs. before flight up to 8,000' MSL, 24 hrs. for flight above 8,000'
- Wait 24 hrs. after a dive that requires a controlled ascent before flight up to 8,000' MSL

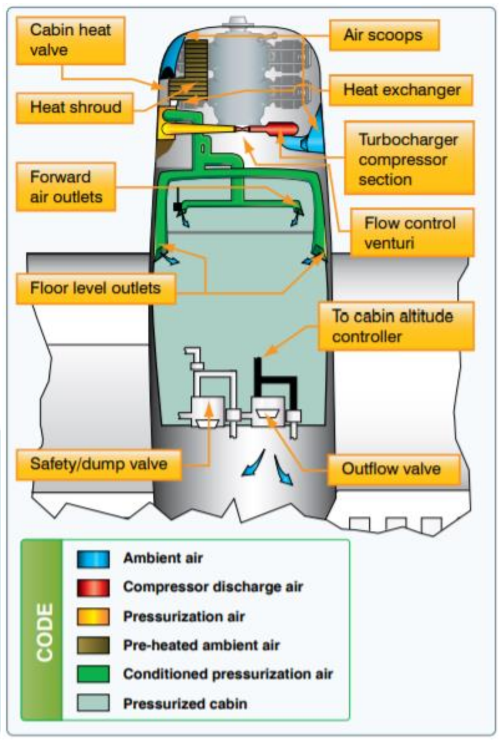
4. Pressurization in Airplanes

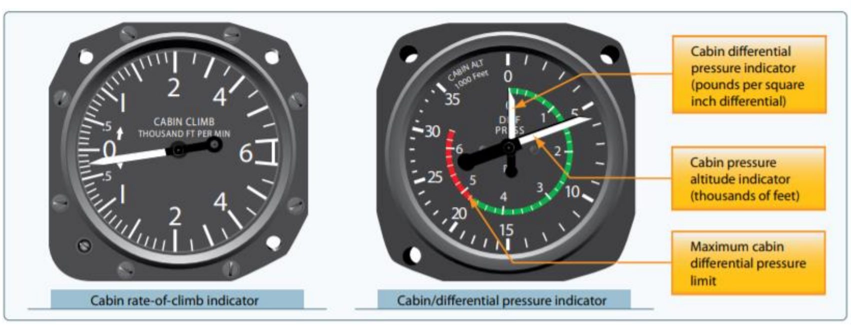
A. Compression of air to maintain a cabin altitude lower than the flight altitude
i. Differential Pressure – difference between cabin pressure and atmospheric pressure

B. How it Works
i. The cabin, flight, baggage compartments are a sealed unit that can withstand high pressure
ii. Compressed/Conditioned air is brought into the fuselage
a. Turbine aircraft use engine bleed air
b. Piston aircraft use turbocharger air
iii. Air exits at a controlled rate through an outflow valve
a. Allows the system to maintain constant pressure

C. Cabin pressure control system
i. Pressure regulation, pressure relief, vacuum relief, and the means for selecting the desired cabin altitude
ii. Safety Valve - Allows for pressure and vacuum relief

D. Instruments
i. Cabin differential pressure - difference between inside and outside pressure
ii. Cabin Altimeter – shows altitude inside the airplane
iii. Cabin Rate of Climb/Descent – cabin rate of change





5. Types of Oxygen Systems

A. Continuous Flow (usually provided for passengers)
i. Mix of oxygen and ambient air

B. Diluter Demand (useable to 40,000')
i. Supply oxygen only when the user inhales through the mask
ii. Can provide 100% oxygen or mix the cabin air and oxygen

C. Pressure Demand (safe above 40,000')
i. Oxygen is supplied under pressure at cabin altitudes above 34,000'

6. Aviator's Breathing Oxygen (Introduction to Aviation Physiology document)

   A. Min purity requirement of 99.5%, may not contain more than 0.005 mg of water vapor per liter
   B. Use Aviator's oxygen - Different requirements exist for different types of oxygen and their uses

7. **Care and Storage of High-Pressure Oxygen Bottles**
   A. If required, portable oxygen equipment must be accessible in flight
   B. Stored in high pressure containers at 1,800 – 2,200 psi
      i. High pressure containers should be marked with the psi tolerance before filling to that pressure
   C. Be aware of the danger of fire when using oxygen
   D. Thoroughly inspect/test all oxygen equipment before flight. Accomplish periodic inspections/servicing
8. **Rapid Decompression Problems and their Solutions**
   A. Decompression is the inability of the pressurization system to maintain its designed pressure differential
   B. Two categories of decompression
      i. Explosive Decompression – pressure changes faster than the lungs can decompress (< 0.5 seconds)
      ii. Rapid Decompression – lungs can decompress faster than the aircraft
   C. Indications of a Rapid or Explosive Decompression
      i. Noise, may feel dazed. The cabin will fill with fog, dust, flying debris.
      ii. Air will rush from the mouth and nose due to the escape of air from the lungs
   D. The primary danger of decompression is hypoxia – use oxygen equipment quickly and properly
      i. Another potential danger is decompression sickness, as discussed above
   E. Supplemental oxygen and a rapid emergency descent are necessary

Conclusion:
Brief review of the main points
The fundamental concept of cabin pressurization is that it is the compression of air in the airplane's cabin to maintain a cabin altitude lower than the actual flight altitude. If your airplane is equipped with a pressurization system, you must know the normal and emergency operating procedures.

II.J. 14 CFR and Publications

References: 14 CFR Parts 1, 61, 91, NTSB Part 830, Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), AIM

Objectives	The student should develop knowledge of the elements related to federal aviation regulations and publications.
Key Elements	1. Chart Supplement 2. ACs 3. NOTAMs
Elements	1. Fars Part 1, 61, 91 and NTSB Part 830 2. Aviation Publications
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student will understand the purpose and content of the FARs as well as useful publications.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Where everything you've been looking for and will ever need to know is kept.

Overview

Review Objectives and Elements/Key ideas

What

The Federal Aviation Regulations (FARs) and publications relevant to every pilot.

Why

This will provide a better understanding of these publications and their use in flying.

How:

1. **FARS 1, 61, 91 and NTSB Part 830**
    A. Part 1 – Definitions and Abbreviations
        i. Provides general definitions as well as abbreviations and symbols
        ii. Contents: General Definitions, Abbreviations and Symbols, Rules of Construction
    B. Part 61 – Certification: Pilots, Flight Instructors, and Ground Instructors
        i. Requirements for issuing pilot, flight instructor, ground instructor certificates and ratings
        ii. Privileges and limitations of those certificates and ratings, and authorizations
    C. Part 91 – General Operating and Flight Rules
        i. Rules governing the operation of aircraft in the US, including the waters within 3 nm of the coast
    D. NTSB (National Transportation Safety Board) Part 830
        i. Part 830 contains rules pertaining to:
            a. Initial notification and reporting of aircraft incidents and accidents
            b. Preservation of aircraft wreckage, mail, cargo, and records involving aircraft accidents
2. **Aviation Publications**
    A. Chart Supplement
        i. Provides the most comprehensive information on a given airport
            a. Contains information on airports, heliports, and seaplane bases that are open to the public
            b. Also contains information such as:
                - Special notices, NWS info, Preferred IFR routes, VFR waypoints, VOR checkpoints, Aeronautical chart bulletins, LAHSO, Parachute jump areas
        ii. Published in 7 books organized by region (NW, SW, NC, SC, EC, NE, SE); revised every 56 days
    B. Aeronautical Information Manual (AIM)
        i. Official guide to basic flight information and ATC procedures in the US
        ii. Contains information such as health and medical facts, flight safety, a pilot/controller glossary, information on safety, accidents, and reporting of hazards
    C. FAA Advisory Circular (AC)
        i. An informational document that the FAA wants to distribute to the aviation community
            a. Used for information only and are not regulations
        ii. May be used to:
            a. Provide an acceptable, clearly understood method for complying with a regulation

   b. Respond to a request from a government entity (NTSB, Office of the Inspector General, etc.)
   c. Expand on standards needed to promote aviation safety, including the safe operation of airports

D. Notice to Airmen (NOTAM)
   i. Time critical aeronautical information either temporary in nature or not sufficiently known in advance to permit publication on aeronautical charts or in other operational publications
   ii. Categories of NOTAMs
      a. NOTAM (D)
         - Disseminated for navigational facilities and public use airports
         - Includes information such as taxiway closures, personnel/equipment near or on runways, and airport lighting that does not affect instrument approach criteria, such as VASI
      b. FDC NOTAMs
         - Issued by the National Flight Data Center, and are regulatory in nature
            a Examples include: Interim IFR flight procedures (airways, approach changes), and TFRs
      c. Pointer NOTAMs
         - NOTAMs issued by a FSS to highlight/point out another NOTAM
         - Assists in cross-referencing info that may not be found under an airport/NAVAID identifier
      d. SAA NOTAMs – Issued when Special Activity Airspace will be active
      e. Military NOTAMs – NOTAMs pertaining to military navigational aids/airports

E. Notices to Airmen Publication (NTAP)
   i. Discontinued as of June 2020
   ii. Information for the international and domestic notices have been transferred to new websites:
      a. Domestic Notices
      b. International Notices

F. Airman Certification Standards (ACS) / Practical Test Standards (PTS)
   i. PTS/ACS Concept
      a. Part 61 specifies the Areas of Operation (knowledge/skill) required to be issued a certificate
         - The FARs provide the flexibility that permits the FAA to publish PTS/ACS containing specific Tasks in which competency must be demonstrated
   ii. Current PTSs for Airplanes
      a. Sport, Flight Instructor, Flight Instructor Instrument, and Type Rating
   iii. Airman Certification Standards (ACS)
      a. Essentially an “enhanced” version of the PTS. Updated and modernized certification standards
      b. So far, the FAA has released the Private Pilot, Instrument Rating, Commercial, and ATP ACS

G. Pilot’s Operating Handbook (POH)
   i. The POH is published by the manufacturer and describes the specific airplane and its operation

Conclusion:
Brief review of the main points
The FARs and publications provide many resources to help in flying, obtaining licenses, as well as building aeronautical knowledge.

II.K. National Airspace System

References: 14 CFR part 71, 91, AIM, Navigational Charts

Objectives	To develop knowledge of the elements related to the National Airspace System.
Key Elements	1. Entry Requirements 2. Communications Requirements 3. Visibility Requirements
Elements	1. Airspace Classes, Operating Rules, Certification, and Equipment Requirements 2. VFR Weather Minimums 3. Special Use Airspace 4. Other Airspace areas 5. ADS-B Requirements
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student displays the ability to differentiate between the different types of airspace and their respective weather minimums and requirements.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Each type of airspace is like a different country. Each type of airspace has its own controllers or rulers, its own rules for those in their 'territory,' and its own benefits or services which are provided to those within its borders. Borders are drawn and there are requirements and permission necessary to enter certain airspaces (e.g., Passport).

Overview

Review Objectives and Elements/Key ideas

What:

Airspace is defined as, "the portion of the atmosphere above a particular land area, especially above a nation." The atmosphere above the United States is divided into several sectors, or classes and in each different airspace class, specific rules apply.

Why:

Different airspaces have been defined to efficiently manage the large amount of air traffic that traverses the sky each day. In order to fly from place to place a pilot must know the rules and requirements regarding airspace.

How:

1. **Airspace Classes, Operating Rules, Certification, and Equipment Requirements** (Pilot's Handbook of Aeronautical Knowledge; AIM 3-2-1)
   A. Class E Airspace
      i. Definition
         a. Controlled airspace that is not designated A, B, C, or D
      ii. Operating Rules and Pilot/Equipment Requirements
         a. Transponder Requirements (91.215)
            - At or above 10,000' MSL
               a Excluding airspace below 2,500' AGL
               b In the contiguous 48 states & D.C.
            - Within 30 miles of class B primary airport, < 10,000' MSL
            - Within/above all Class C airspace, up to 10,000' MSL
            - Within 10 miles of certain designated airports
               a Excluding airspace outside Class D surface area / < 1,200' AGL
            - Flying into, within, or across the ADIZ
         b. Airspeeds Limits (91.117)
            - 250 knots below 10,000' MSL
            - 200 kts below 2,500' AGL within 4 nm of class C, D apt
            - 200 knots underlying Class B/VFR corridor through B
         c. Pilot Qualifications: Student Pilot
      iii. ATC Services

Airspace Features	Class E
VFR Minimum Visibility	Below 10,000' MSL - 3 s.m. Above 10,000' MSL - 5 s.m.
VFR Min Cloud Clearance	Below 10,000' - 500' Below 1000' Above 2,000' Horiz Above 10,000' - 1,000' Below 1,000' Above 1 s.m. Horiz
Min Pilot Qualifications	Student Pilot
VFR Entry and Equipment	None
ATC Services	IFR/IFR Separation VFR advisories on request (permitting)

a. VFR: No comm requirements, can request traffic advisories
b. IFR: ATC communication is required

iv. Vertical Limits
a. Unless designated lower, 14,500' to 17,999' MSL over:
- Contiguous 48 states including up to 12 miles off the coast
- The District of Columbia and Alaska

b. Extends from the surface or designated altitude to the overlying/adjacent controlled airspace

v. Segments of Class E Airspace
a. Class E and the Low Altitude Airway System
- Airways: 1,200' AGL up to, but not including, 18,000' MSL
- Normally 8 nm wide (4 nm each side of the centerline)

b. Class E and Airports
- Extension to a Surface Area
- Controlled airspace for IFR traffic transitioning between enroute / airport environments

c. When needed for IFR control purposes
- Enroute Domestic Areas - Provide IFR ATC services where the Airway System is inadequate
- Offshore Airspace Areas - Provide controlled airspace beyond 12 miles from the coast

B. Class D Airspace
i. Definition
a. Normally surface to 2,500' above field elevation / 4 nm radius
b. Part time control tower (Class E when closed)
c. Configured to the needs/instrument procedures of the area

ii. Operating Rules and Pilot/Equipment Requirements
a. Pilot Certification - No specific certification required
b. Equipment - Two-way radio

C. Class C Airspace
i. Definition
a. Surface to 4,000' AFE
b. Operational control tower and radar approach control
c. 5 NM core (sfc - 4,000' AFE), 10 NM shelf (1,200' - 4,000' AFE)

ii. Operating Rules and Pilot/Equipment Requirements
a. Pilot Certification - No specific certification required
b. Equipment - Two-way radio, Mode C transponder
- Communication required prior to entry

D. Class B Airspace
i. Definition
a. Surface to 10,000' MSL around nation's busiest airports
b. Configuration is tailored to the needs of the area
- Upside-down wedding cake
- Designed to contain all instrument procedures

ii. Operating Rules and Pilot/Equipment Requirements

Airspace Features	Class D
VFR Minimum Visibility	3 Statute Miles
VFR Min Cloud Clearance	500' Below 1000' Above 2,000' Horiz
Min Pilot Qualifications	Student Pilot
VFR Entry and Equipment	Establish Radio Communication
ATC Services	IFR/IFR Separation

Airspace Features	Class C
VFR Minimum Visibility	3 Statute Miles
VFR Min Cloud Clearance	500' Below 1000' Above 2,000' Horiz
Min Pilot Qualifications	Student Pilot
VFR Entry and Equipment	Establish Radio Communication Mode C Transponder
ATC Services	IFR/IFR & VFR Separation VFR Traffic advisories (permitting)

Airspace Features	Class B
VFR Minimum Visibility	3 Statute Miles
VFR Min Cloud Clearance	Clear of Clouds
Min Pilot Qualifications	Private Pilot Student w/Endorsement
VFR Entry and Equipment	ATC Clearance Mode C Transponder
ATC Services	All Aircraft Separation

a. For VFR Operations:
- At least a Private Pilot Certificate is required
- Or, student/recreational/sport pilot with endorsement
  - a AIM 3-2-3b: Solo student, sport, and recreational pilot operations are not permitted at certain class B airports (ATL, ORD, DFW, LAX, MIA, JFK, LGA, SFO, etc.)
- Specific ATC Clearance is required before entering
- Two-way radio, 4096-code Mode C transponder
- Mode C Veil transponder requirement
  - a 30 nm of Class B airport, surface to 10,000' MSL

b. For IFR operations:
- VOR or TACAN receiver
- Radar beacon transponder with auto altitude reporting

E. Class A Airspace
i. 18,000' MSL up to/including FL600, including 12 NM off the coast of 48 contiguous states and Alaska
ii. Operating Rules and Pilot/Equipment Requirements
a. Unless otherwise authorized, all operation is IFR

F. Class G Airspace
i. Definition: Uncontrolled Airspace (everything that isn't A-E)
ii. Surface to the base of the overlying Class E airspace

Airspace Features	Class G
VFR min Vis & Clearance 1,200' AGL or less	Day: 1 s.m. Clear of Clouds Night: 3 s.m. 500' Below 1,000' Above 2,000' Horiz
VFR Minimum Visibility	Below 10,000' MSL – Day: 1 s.m. Night: 3 s.m. At/Above 10,000 MSL – 5 s.m.
VFR Min Cloud Clearance	Below 10,000' - 500' Below 1000' Above 2,000' Horiz Above 10,000' – 1,000' Below 1,000' Above 1 s.m. Horiz
Min Pilot Qualifications	Student Pilot
VFR Entry and Equipment	None
ATC Services	VFR advisories on request (permitting)

Class	Entry Requirements	Equipment	Minimum Pilot Certificate
A	ATC Clearance	IFR Equipped	Instrument
B	ATC Clearance	Two-way radio, transponder with Altitude Reporting Capability	Private – with exception
C	Two-way radio communications prior to entry	Two-way radio, Transponder with Altitude reporting capability	No specific requirement
D	Two-way radio communications prior to entry	Two-way radio	No specific requirement
E	None for VFR	No specific requirement	No specific requirement
G	None	No specific requirement	No specific requirement

2. VFR Weather Minimums (Pilot's Handbook of Aeronautical Knowledge, FAR 91.155)

BASIC VFR WEATHER MINIMUMS		
Airspace	**Flight Visibility**	**Distance from Clouds**
CLASS A	Not Applicable	Not Applicable
CLASS B	3 Statute Miles	Clear of Clouds
CLASS C	3 Statute Miles	500 feet below 1,000 feet above 2,000 feet horizontal
CLASS D	3 Statute Miles	500 feet below 1,000 feet above 2,000 feet horizontal
CLASS E Less than 10,000 feet MSL	3 Statute Miles	500 feet below 1,000 feet above 2,000 feet horizontal
At or above 10,000 feet MSL	5 Statute Miles	1,000 feet below 1,000 feet above 1 mile horizontal
CLASS G 1,200 feet or less above the surface (regardless of MSL altitude) Day, except as provided in section 91.155(b)	1 Statute Mile	Clear of Clouds
Night, except as provided in section 91.155(b)	3 Statute Miles	500 feet below 1,000 feet above 2,000 feet horizontal
More than 1,200 feet above the surface but less than 10,000 feet MSL Day	1 Statute Mile	500 feet below 1,000 feet above 2,000 feet horizontal
Night	3 Statute Miles	500 feet below 1,000 feet above 2,000 feet horizontal
More than 1,200 feet above the surface and at or above 10,000 feet MSL .... -Exception – 91.155 (b)(2)	5 Statute Miles	1,000 feet below 1,000 feet above 1 mile horizontal

3. Special Use Airspace

A. Prohibited Areas - Published in the Federal Register and are depicted on aeronautical charts
   i. Flight is prohibited - Established for security or other reasons associated with the national welfare

B. Restricted Areas - Published in the Federal Register and are depicted on aeronautical charts
   i. Hazardous to nonparticipating aircraft, and while not wholly prohibited, are subject to restrictions

C. Warning Areas - Depicted on aeronautical charts
   i. Extend from 3 nm outward from the coast, contain potentially hazardous activity

D. MOAs (Military Operation Areas) - Depicted on aeronautical charts
   i. Separate military training activity from IFR traffic. No restriction against operating VFR

E. Alert Areas - Depicted on aeronautical charts
   i. Advise pilots that a high volume of pilot training or unusual aerial activity is taking place

F. Controlled Firing Areas – Not displayed on charts
   i. Activities that could be hazardous to aircraft, suspended when an aircraft is approaching the area

4. Other Airspace Areas

A. Local Airport Advisory (LAA)
   i. Area within 10 SM of airport without operating tower, but with an FSS (provides local advisories)

B. Military Training Routes (MTR)
   i. Routes used by military aircraft to maintain proficiency in tactical flying (IR and VR on sectional)

C. Temporary Flight Restrictions (TFRs) - www.tfr.faa.gov
   i. An FDC NOTAM will be issued to designate a TFR

D. Parachute Jump Areas - Published in the Chart Supplement, and depicted on sectional charts

E. Published VFR Routes - Generally found on VFR terminal area planning charts
   i. For transitioning around, under, or through complex airspace

F. Terminal Radar Service Areas (TRSA) – Depicted on sectionals/terminal area charts (solid black line)
   i. Areas where participating pilots can receive radar services (participation is voluntary)

G. National Security Areas
   i. Locations where there is a requirement for increased security and safety of ground facilities
   ii. Requested to voluntarily avoid - When necessary, flight can be temporarily prohibited

5. ADS-B Requirements

A. FAR 91.225 – Effective Jan 1 2020, ADS-B OUT is required in:
   i. Class A, B, and C airspace (and above the ceiling of Class B and C airspace up to 10,000' MSL)
   ii. Class E airspace at and above 10,000' MSL, excluding at and below 2,500' AGL
      a. At and above 3,000' MSL over the Gulf of Mexico within 12 nm of the coast

B. ADS-B IN is voluntary

Conclusion:
Brief review of each main point
Overview of the differences in airspace.

II.L. Navigation Systems and Radar Services

References: Airplane Flying Handbook (FAA-H-8083-3), Instrument Flying Handbook (FAA-H-8083-15), AIM

Objectives	The student should develop knowledge of the elements related to the navigation systems and radar services provided by ATC as required in the ACS/PTS.
Key Elements	1. VOR 2. GPS 3. Radar Services
Elements	1. VOR/VORTAC 2. DME 3. ADF & NDB 4. Satellite Based Navigation 5. Radar Services and Procedures 6. ADS-B Basics
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student will understand the operation of different navigation systems as well as their use in the airplane. The student also will understand and be able to utilize the radar services provided by ATC.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Understanding this will greatly decrease your chances of getting lost and provide more services for use.

Overview

Review Objectives and Elements/Key ideas

What

This lesson discusses the different navigation systems in use, as well as radar services provided by ATC when in radar coverage and with established communication.

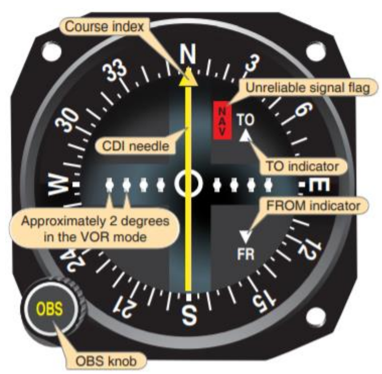
Why

It is important to understand how the navigation systems function in order to properly use them. It also is important to know the services provided by ATC to pilots.

How:

1. **VOR / VORTAC** (Very High Frequency Omnidirectional Range)
   - A. What is it?
     - i. Omni means all **-** VHF radio projecting straight line courses (radials) in *all* directions
     - ii. Referenced to magnetic north / 108.0 – 117.95 MHz
     - iii. 3 classes: Terminal, Low, High
   - A. Three variations of VORs:
     - i. VOR – The VOR, by itself (magnetic courses)
     - ii. VOR/DME – DME is installed with the VOR
     - iii. VORTAC – TACAN (DME) is installed with a VOR
   - B. VOR Components
     - i. VOR Components – Ground and Aircraft
       - a. Ground - VOR station; transmits on assigned frequency
       - b. Aircraft - Antenna, Receiver, and VOR navigation instrument
         - Antenna – Picks up the VOR signal
         - Receiver – Processes the signal into navigation information
         - VOR Instrument – Displays the navigation information
           - a OBS (Omnibearing Selector, or course selector)
             - 1. Dial used to select desired radial and/or determine the radial on
           - b CDI (Course Deviation Indicator) Needle
             - 1. Indicates the aircraft position in relation to the selected course/radial
             - 2. Full scale deflection = ≥ 12° off selected course (each dot = 2°)
           - c To/From Indicator
             - 1. Shows whether the selected course takes the aircraft To or From the VOR
             - 2. Does not indicate whether the aircraft is currently heading To or From the VOR
           - d Flags

Class	Altitudes	Radius (Miles)
T	12,000' and Below	25
L	Below 18,000'	40
H	Below 14,500'	40
H	14,500 – 17,999'	100
H	18,000' – FL 450	130
H	FL 450 – 60,000'	100



1. OFF flag indicates an unusable/unreliable signal

C. VOR Basics
   i. Tune and identify the VOR
   ii. Rotate the OBS to center the CDI with a "TO" indication
   iii. Turn to the heading indicated on the course selector
   iv. Adjust for any crosswinds
   v. Upon passing the VOR, the "TO" will change to "FROM"
   vi. Reverse Sensing (not applicable to HSI)
      a. If flying toward a VOR with a FROM indication, or away with TO, the CDI will indicate opposite

D. VOR Checks - FAR 91.171
   i. Not mandated for VFR flight
   ii. Checkpoints are listed in the Chart Supplement
      a. FAA VOR Test Facility, Airborne Checkpoints, Ground Checkpoints, Dual VOR check
      b. $\pm 4^o$ for ground checks, $\pm 6^o$ for airborne checks

2. DME (Distance Measuring Equipment)

A. Function – provides slant range distance from a station
   i. With VOR and DME, a pilot can determine bearing as well as distance TO or FROM a station

B. How it Works
   i. Aircraft transmits RF pulse to the DME on the ground, the DME responds with its own signal
   ii. Time between the sent signal and the reply signal determines distance
   iii. Ground speed can be provided on some systems
   iv. Operates on UHF frequencies between 962 MHz and 1213 MHz

C. Components
   i. Ground Equipment - VOR/DME, VORTAC, ILS/DME, and LOC/DME
   ii. Airborne Equipment - Antenna and Receiver

D. Limitations / Errors
   i. DME signals are line-of-sight
   ii. Slant Range Distance
      a. The mileage readout is the straight-line distance from the aircraft to the ground facility
      b. Not the same as the distance from the station to the point on the ground below the aircraft
      c. This error is the smallest at low altitudes and long range
         - Negligible if 1 mile or more away from the facility for each 1,000' above facility elevation

3. ADF (Automatic Direction Finder) & NDB (Nondirectional Radio Beacon)

A. An NDB is a ground-based radio transmitter that transmits radio energy in all directions

B. The ADF needle in the airplane points to the NDB ground station to determine the relative bearing

C. Magnetic Heading + Relative Bearing = Magnetic Bearing
   i. Mary Had + Roast Beef= Mary Barfed

D. NDB Components
   i. The ground equipment: the NDB (transmits between 190 to 535 KHz)
   ii. Aircraft must be in operational range of the NDB - dependent on the strength of the station

E. ADF Components
   i. The airborne equipment: 2 antennas, a receiver, and the indicator instrument
   ii. Two Antennas – used together to determine NDB direction

- iii. Receiver – Processes antenna information and to display on the instrument
- iv. Indicator Instrument
  - a. 3 kinds: Fixed card, Movable Card, or the RMI (1 or 2 needles)
  - b. Fixed Card ADF (or relative bearing indicator, RBI) (top picture)
    - Always indicates 0 at the top; Needle indicates RB to the station
    - Pilot must calculate MB based on MH and RB
  - c. Movable Card ADF (middle picture)
    - Automatically rotates to display aircraft heading
    - Head = MB to the station; Tail = MB from the station
    - Instrument provides MB, pilot doesn't have to calculate it
  - d. RMI (bottom picture)
    - Automatically rotates to display aircraft heading
    - Can have two needles (ADF and/or VOR information)
    - ADF needle:
      - a Head = MB To the station; Tail = MB From the station
    - VOR needle:
      - a Head of needle points the bearing TO the station
      - b Tail points to the radial the aircraft is currently on/crossing

F. Using the NDB
- i. Orientation (Fixed Card ADF)
  - a. The ADF needle points TO the station, showing Relative Bearing
  - b. Magnetic Heading + Relative Bearing = Magnetic Bearing
- ii. Movable Card/RMI
  - a. Turn toward the head of the needle indicating the MB to the station
  - b. Adjust for wind to maintain the desired course

4. Satellite Based Navigation - GPS, WAAS, LASS

A. GPS (Global Positioning System)
- i. The GPS system is composed of 3 major elements
  - a. Space Segment
    - 31 satellites, 5 in view at any time (4 needed for operation)
    - UHF: Unaffected by weather, but subject to line-of-sight reference
  - b. Control Segment
    - Master control station, 5 monitoring stations, and 3 ground antennas
      - a Updates / corrections are uplinked as satellites pass over ground antennas
  - c. User Segment
    - Consists of all components associated with GPS receivers (portable, hand held to installed)
- ii. Solving for Location
  - a. The receiver utilizes the signals of at least 4 satellites to yield Latitude, Longitude, and Altitude
- iii. Navigating
  - a. VFR navigation with GPS can be as simple as selecting a destination and tracking the course
  - b. Course deviation is linear - no increase in sensitivity when approaching a waypoint

B. WAAS (Wide Area Augmentation System)
- i. Basically, augmented GPS, to the point it may be used for precision approaches
  - a. Requires a position accuracy of 25' or less at least 95% of the time
- ii. Designed to improve the accuracy, integrity, and availability of GPS signals
- iii. Approach Capabilities
  - a. Improvement is sufficient to enable approach procedures with GPS/WAAS glidepaths

b. Eliminates cold temperature effects, incorrect altimeter setting / lack of a local altimeter source
c. Can be further enhanced with LAAS

C. LAAS (Local Area Augmentation System, also referred to as GBAS – Ground Based Augmentation System)
   i. Similar to WAAS, but with more ground augmentation
   ii. Receivers around the airport send data to a central location which distributes it to aircraft
      a. Aircraft uses the information fine tunes GPS signals

5. **Radar Services and Procedures** (AIM 4-1-17 & 18)
   A. Radar equipped ATC facilities provide radar assistance and navigation services to VFR aircraft, provided:
      i. You can communicate with ATC, are within radar coverage, and can be radar identified
   B. Other services include:
      i. Basic Radar Service – Safety alerts, traffic advisories, limited radar vectoring (workload permitting)
      ii. TRSA Service - Radar sequencing and separation for VFR aircraft in a TRSA
      iii. Class C services - Separation between IFR/VFR and sequencing of VFR traffic to the airport
      iv. Class B services - Separation based on IFR, VFR and/or weight and sequencing VFR arrivals

6. **ADS-B (Automatic Dependent Surveillance – Broadcast) Basics**
   A. What is it?
      i. Foundation for NextGen, moving from ground radar to satellites
         a. More precise tracking: Broadcasts every second vs a radar sweep every 5-12 seconds
      ii. ADS-B
         a. Automatic: Automatically transmits information
         b. Dependent: Position/velocity are derived from GPS/FMS
         c. Surveillance: Allows 3D position and identification
         d. Broadcast: Transmits the information to anyone with appropriate receiving equipment
      iii. ADS-B Out – Broadcasts GPS location, altitude, ground speed, more to ground stations/other aircraft
      iv. ADS-B In
         a. Pilots can see what controllers see in the air as well as on the ground, and can provide weather
         b. FIS-B (Flight Information Service Broadcast – available on 978 MHz UAT equipment)
            - Similar to XM weather, but more information
         c. TIS-B (Traffic Information Service Broadcast – available to 1090ES and UAT equipment users)
            - Provides traffic information on all transponder-based aircraft in the vicinity of the ADS-B
   B. Who Needs it?
      i. FAR 91.225 – Effective Jan 1 2020, ADS-B OUT is required in:
         a. Class A, B, and C airspace (and above the ceiling of Class B and C airspace up to 10,000' MSL)
         b. Class E airspace at and above 10,000' MSL, excluding at and below 2,500' AGL
            - At and above 3,000' MSL over the Gulf of Mexico within 12 nm of the coast
      ii. ADS-B IN is voluntary
   C. What do I need?
      i. Straight from the FAA: Equip ADS-B Installation
      ii. FAR 91.227 – ADS-B Out Equipment Performance Requirements

Conclusion:
Brief review of the main points
When navigating with a VOR and you wish to head toward the station ensure the flag indicates "TO" and follow the indicated heading. When it is necessary to track away from the station, ensure the flag indicates "FROM" and follow the heading indicated. Failing to do this could result in reverse sensing (not applicable to an HSI). GPS is a satellite-based system that used for navigation. WAAS and LAAS are also satellite based navigation systems but they augment the GPS system with ground-based stations allowing for more precise location information as well as vertical guidance. The radar services provided by ATC can be very helpful in almost any flight.

II.M. Logbook Entries and Certificate Endorsements

References: 14 CFR part 61, Certification: Pilots and Flight and Ground Instructors (AC 61-65), Currency Requirements and Guidance for the Flight Review and Instrument Proficiency Check (AC 61-98)

Objectives	The student should develop knowledge of the elements related to logbook entries and endorsements as required by the CFI ACS/PTS.
Key Elements	1. AC 61-65 2. Endorsements 3. Required Records
Elements	1. Logbook Entries 2. Student Pilot Certificate Endorsements 3. Preparation of a Practical Test Recommendation 4. Flight Review Endorsements 5. Flight Instructor Records
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands what is necessary in student's logbooks, what is necessary for student pilot certificates and preparing a student for a practical test, as well as the requirements for flight review endorsements and flight instructor records.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Don't get stuck with your student at a check ride without the proper endorsements! And, don't get stuck not retaining the necessary records in the case that the FAA comes knocking!

Overview

Review Objectives and Elements/Key ideas

What

Logbook entries and certificate endorsements discusses the necessary entries instructors must make in their student's logbooks as well as the endorsements required for different situations.

Why

It is important that the instructor understand the requirements to keep the student's logbook and training in order, not only for the student's well-being, but also to comply with the FARs.

How:

1. **Logbook Entries** (FAR 61.189)
   A. A flight instructor must sign the logbook of each person that instructor has given flight/ground training
   B. Logbook entries must include (FAR 61.51):
      - Date
      - Airplane Make and Model
      - Total Flight Time
      - Location of Departure and Arrival
      - Aircraft Identification
      - Type of Experience (Solo, PIC, etc.)
      - Flight Conditions (Day, Night, Instrument, etc.)
      - Name of safety pilot, if required
2. **Student Pilot Certificate Endorsements** (Including appropriate logbook entries)
   A. Student Pilot Endorsements (Examples are shown in AC 61-65)

Solo Flight Endorsements	XC Endorsements	Class B Endorsements
• Presolo Aeronautical Knowledge - 61.87(b)	• Initial Solo XC Flight – 61.93(c)(1)(2)(3)	
• Presolo Flight Training – 61.87(c)	• Solo XC Flight – 61.93(c)(2)	
• Presolo Flight Training at Night – 61.87(c) & (o)	• Repeated Solo XCs not > 50 nm from the departure – 61.93(b)(2)	
• Solo Flt (90-day period) – 61.87(n) – 1st 90 / (p) – addt'l 90		• Solo Flight in Class B Airspace – 61.95(a)
• Solo T/Os & LDGs at an Airport within 25 nm – 61.93(b)(1)		• Solo Flight, to/from/at a Class B airport – 61.95(a) & 91.131(b)(1)
• TSA US Citizenship – 49 CFR 1552.3(h)		

3. **Preparation of a Practical Test Recommendation**
   A. All applicants must have the required endorsements specified in Part 61 for the aircraft category, class, rating, or privilege of certification sought
   B. The instructor/student must complete the IACRA rating application online (iacra.faa.gov)
      i. Or, the instructor/student must complete/sign a Form 8710-1 (rarely used)
   C. Except in certain instances, the applicant must hold at least a current 3rd class medical certificate
   D. Reapplying
      i. Must have new endorsement stating the necessary training has been given and they are prepared for the practical test
   E. Practical Test Endorsements

Sport Pilot	**Flight Instructors (w/o Sport Rating)**
Knowledge Test - 61.307(a)	FOI Knowledge Test - 61.183(d), 61.185(a)(1)
Practical Test - 61.307(b)	Practical Test - 61.183(g), 61.187(a) & (b)
Recreational Pilot	Spin Training - 61.183(i)(1)
Knowledge Test - 61.35(a)(1), 61.96(b)(3), 61.97(b)	CFII Practical Test - 61.183(g), 61.187(a) & (b)(7)
Practical Test - 61.96(b)(5), 61.98(a) & (b), 61.99	**Flight Instructors (with Sport Rating)**
Private Pilot	FOI Knowledge Test - 61.405(a)(1)
Knowledge Test - 61.35(a)(1), 61.103(d), 61.105	Sport Pilot Knowledge Test - 61.35(a)(1), 61.405(a)
Practical Test - 61.103(f), 61.107(b), 61.109	Practical Test - 61.409, 61.411
Instrument Rating (CFII is Required)	Spin Training - 61.405(b)(1)(ii)
Knowledge Test - 61.35(a)(1), 61.65(a) & (b)	**Additional Qualifications**
Practical Test - 61.65(a)(6)	Additional Aircraft Rating (Not ATP) - 61.63(b) or (c)
Commercial Pilot	Additional Aircraft Rating (ATP) - 61.157(b)(1)
Knowledge Test - 61.35(a)(1), 61.123(c), 61.125	Type Rating Only (Not ATP) - 61.63(d)(2) & (3)
Practical Test - 61.123(e), 61.127, 61.129	Type Rating Only (ATP) - 61.157(b)(2)
-You may complete the endorsement in the space at the bottom of the computer test report in the case of a knowledge test failure. You must sign the block provided for the instructor's endorsement on the reverse side of the 8710 for each retake of a practical test. An applicant may retake a practical or knowledge test after receiving additional instruction and an instructor's endorsement.	Type Rating & Category/Class Rating - 61.63(d)(2) & (3) Practical Test Prerequisites Completion - 61.39(a)(6) Retesting for Knowledge/Practical - 61.49 Home Study Curriculum - 61.35(a)(1) Ground Instructor Experience Reqs - 61.217(b)

4. **Flight Review Endorsements**
   A. After a satisfactory completion of a flight review, the instructor must endorse the pilot's logbook
      i. Flight Review Endorsement- 61.56(a) & (c)
   B. Instrument Proficiency Checks (IPC)
      i. CFII is required to perform an IPC for instrument rated pilots
      ii. Instrument Proficiency Check Endorsement - 61.57(d)
   C. No logbook entry reflecting unsatisfactory performance is necessary for either flight review
5. **Flight Instructor Records** (FAR 61.189)
   A. Must maintain a record that contains the following:
      i. Name of each person endorsed for solo flight privileges, and the date of the endorsement
      ii. Name of each person endorsed for a knowledge or practical test, with the kind of test, date, results
   B. Each flight instructor must retain the records required for at least 3 years
6. **Maintaining your CFI Certificate**
   A. Not required in the PTS - See full CFI lesson plans document

Conclusion:
Brief review of the main points
It is important to know the necessary endorsement and logbook requirements for many common situations. This way, the instructor has an idea of what is necessary prior to sending a student to take a test.

PREFLIGHT PREPARATION

III.A. Certificates and Documents

References: 14 CFR parts 23, 43, 61, 67, 91, Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), POH/AFM

Objectives	The student should develop knowledge of the elements related to certificates and documents. Knowledge will be gained regarding the necessary requirements for each license, medical certificate, and recent flight experience.
Elements	1. Training Requirements 2. Privileges and Limitations 3. Medical Certificates 4. Recent Flight Experience Requirements 5. Required Logbook Entries
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student knows what to expect with each license issued and understands the requirements in logging time as well as obtaining a medical.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Understanding what is required with each certificate and document that a pilot may obtain is essential to obtaining that certificate.

Overview

Review Objectives and Elements/Key ideas

What

Certificates and Documents cover the knowledge necessary to obtain and maintain the recreational, private, and commercial license. This also covers medical certificates and required logbook entries.

Why

Each certificate and medical has different rules. The pilot should know what is required to obtain and maintain the desired certificate as well as the privileges and limitations associated with each certificate. It is also necessary to know how medical certificates work and what training must be logged.

How:

1. **Training Requirements**
   A. Student Pilot Certificate
      i. Eligibility - FAR 61.83
      ii. Application - FAR 61.85 (FAA Student Pilot Application Requirements)
      iii. Solo Requirements – FAR 61.87
      iv. Cross Country Requirements – FAR 61.93
   B. Recreational Certificate
      i. Eligibility Requirements – FAR 61.96
      ii. Aeronautical Knowledge – FAR 61.97
      iii. Flight Proficiency – FAR 61.98
      iv. Aeronautical Experience - FAR 61.99
   C. Private Pilot Certificate
      i. Eligibility Requirements – FAR 61.103
      ii. Aeronautical Knowledge – FAR 61.105
      iii. Flight Proficiency – FAR 61.107
      iv. Aeronautical Experience - FAR 61.109
   D. Commercial Certificate
      i. Eligibility Requirements – FAR 61.123
      ii. Aeronautical Knowledge – FAR 61.125
      iii. Flight Proficiency – FAR 61.127
      iv. Aeronautical Experience – FAR 61.129
   E. Flight Instructors
      i. Eligibility Requirements – FAR 61.183
      ii. Aeronautical Knowledge – FAR 61.185
      iii. Flight Proficiency – FAR 61.187
2. **Privileges and Limitations**
   A. Student – FAR 61.89

B. Recreational – FAR 61.101
C. Private – FAR 61.113
D. Commercial – FAR 61.133
E. Flight Instructor Privileges – FAR 61.193
F. Flight Instructor Limitations – FAR 61.195

3. **Medical Certificates** (FAR 61.23) **& Basic Med**
   A. Medical Certificates
      i. Classes
         a. 1st Class: Generally required when exercising PIC privileges of an ATP
         b. 2nd Class: Generally required when SIC at an airline or to use your commercial pilot certificate
         c. 3rd Class: Required when
            - Exercising the privileges of a Private, Recreational, or Student pilot certificate
            - Exercising the privileges of a CFI certificate as PIC or required crewmember
            - Taking a practical test
            - Performing duties as an Examiner
      ii. FAR 61.23(b) – A medical is not required when:
         a. Exercising privilege of a CFI certificate if not acting as PIC / serving as a required crewmember
         b. Exercising the privileges of a ground instructor certificate
         c. A military pilot can show evidence of an up-to-date medical examination
            - The flight cannot require higher than a 3rd class medical and must be in US airspace
      iii. Class and Duration (FAR 61.23(d))
         a. First Class
            - Under 40 on the date of the examination - Expires at the end of the last day of the:
               a 12th month for 1st class activities
               b 12th month for 2nd class activities
               c 60th month for 3rd class activities (under 40 years old)
            - 40 or older on the date of the examination - Expires at the end of the last day of the:
               a 6th month for 1st class activities
               b 12th month for 2nd class activities
               c 24th month for 3rd class activities (over 40 years old)
         b. Second Class
            - Under 40 on the date of the examination - Expires at the end of the last day of the:
               a 12th month for 2nd class activities
               b 60th month for 3rd class activities
            - 40 or older on the date of the examination - Expires at the end of the last day of the:
               a 12th month for 2nd class activities
               b 24th month for 3rd class activities
         c. Third Class
            - Under 40 on the date of the examination - Expires at the end of the last day of the:
               a 60th month
            - 40 or older on the date of the examination - Expires at the end of the last day of the:
               a 24th month
   B. BasicMed / Using a Driver's License – FAR 61.23(c)
      i. A way to fly without a holding a medical certificate
         a. FAA BasicMed Info; FAA BasicMed FAQ
      ii. Applicable when operating under FAR 61.113(i), and exercising the privileges of:
         a. A student, recreational or private pilot certificate

b. A flight instructor certificate and acting as PIC or a required crewmember

iii. A person using their driver's license must:

a. Comply with all medical requirements associated with the license
b. Have held a medical certificate after July 14, 2006
c. Have completed the medical education course in the last 24 months
d. Have received a medical exam in the past 48 months using the directed exam checklist
e. Have not had the most recently held medical certificate revoked, suspended, or withdrawn
f. Be under the care of a physician if diagnosed with a condition that may affect flight abilities

iv. FAR 61.113(i) requires:

a. Aircraft: Authorized for no more than 6 occupants, Max takeoff weight ≤ 6,000 lbs.
b. Flight: In the US, less than 18,000' and 250 knots, not for compensation/hire
c. Pilot: Has medical exam checklist and certificate of course completion in logbook

4. Recent Flight Experience Requirements

A. Pilot in Command

a. FAR 61.57(a) – To carry passengers: 3 takeoffs and landings in the last 90 days
- Sole manipulator of the flight controls in the same category, class, type aircraft
- Tailwheel landings must be to a full stop

ii. FAR 61.57(b) – To carry passengers 1 hour after sunset to 1 hour before sunrise:

a. 3 takeoffs and landings in the last 90 days to a full stop (1 hour after to 1 hour before)
b. Sole manipulator of the flight controls in the same category, class, type aircraft

ii. FAR 61.57(c) & (d) - To act as PIC under IFR within the preceding 6 months:

a. 6 instrument approaches, holding procedures, and intercepting/tracking courses
b. If the pilot has failed to meet the experience requirements (above) for more than 6 calendar months, currency may only be reestablished through an instrument proficiency check (IPC)

B. Flight Reviews (FAR 61.56)

i. To act as PIC, a flight review/logbook endorsement are required within the last 24 months

ii. FAR 61.56(d) – Not necessary if any of the following have been passed (last 24 months):

a. Proficiency check or practical test for a pilot certificate, rating, or operating privilege
b. A practical test for a flight instructor certificate, an additional rating on a flight instructor certificate, renewal or reinstatement of a flight instructor certificate

iii. Not required if one or more phases of a pilot proficiency award program has been completed

iv. A student pilot in training, with a current solo flight endorsement does not need a flight review

5. Required Logbook Entries (FAR 61.51)

A. Must document training/experience used to meet the requirements for a certificate, rating, or review

i. Logbook must show:

a. Date, Total flight/lesson time; location of departure/arrival (location for a simulator); type and identification of aircraft/simulator/training device; name of the safety pilot (if necessary)
b. Type of pilot experience or training
- Solo, PIC, SIC, Flight/ground training received, training in a simulator/flight training device

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

Conclusion:

Brief review of the main points

Each certificate and medical has different rules. It is therefore important to know what is required to obtain and maintain the desired certificate as well as the privileges and limitations associated with it. It is also necessary to know how medical certificates work and what training must be logged.

III.B. Weather Information

References: 14 CFR Part 91, Aviation Weather (AC 00-6), Aviation Weather Services (AC 00-45), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), AIM

Objectives	The student should develop knowledge of the elements related to weather information with the ability to interpret several weather sources and make a well-educated Go/No Go decision.
Key Elements	1. Information Sources 2. EFAS: now part of FSS on 122.2 3. Go/No Go Decision

Elements	1. Importance of a Thorough Weather Briefing
	2. Weather Information Sources
	3. Weather Reports and Charts
	    a. METAR, TAF, and GFA
	    b. Surface Analysis Chart
	    c. Radar Summary Chart
	    d. Winds and Temperature Aloft Chart
	    e. Significant Weather Prognostic Charts
	    f. Convective Outlook Chart
	    g. AWOS, ASOS, and ATIS
	4. In-Flight Weather Advisories
	5. Recognizing Weather Hazards
	6. Go/No Go Decision

Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can effectively interpret the necessary weather information and has the ability to make a competent Go/No Go decision based on the information.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Instead of getting ourselves stuck, in the air, in a thunderstorm or some sort of extreme weather we should have a good understanding of weather information in order to know when to and not to fly.

Overview

Review Objectives and Elements/Key ideas

What

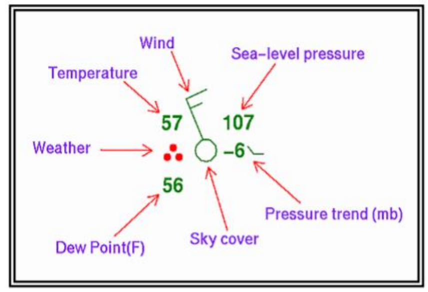
Through a complex system of weather services, government agencies, and independent weather observers, pilots are given vast information regarding weather patterns, trends, and characteristics in the form of up-to-date weather reports and forecasts

Why

These reports and forecasts enable pilots to make informed decisions regarding weather and flight safety.

How:

1. **Importance of a Thorough Weather Briefing**
   - A. FAR 91.103 – As PIC, you are required to become familiar with the weather reports and forecasts
   - B. Know what to expect and can be alert to changing conditions en route
   - C. Go / No Go Decision
2. **Weather Information Sources**
   - A. General awareness of the overall weather – Internet, Weather Apps, TV, etc.
   - B. Detailed Briefing (Specific to the flight)
     - i. FSS (1-800-WX BRIEF or 1800wxbrief.com)
     - ii. NWS – National Weather Service - Aviationweather.gov
     - iii. ForeFlight - Briefings are timestamped and stored to comply with FAR 91.103
   - C. Inflight Weather Sources
     - i. FSS Frequencies - as published, or 122.2
     - ii. ForeFlight, or other apps (with data connection)
     - iii. Satellite Weather - Current weather available to appropriately equipped aircraft
     - iv. FIS-B (Flight Information Service Broadcast – Part of the ADS-B system)
3. **Weather Reports and Charts**
   - A. METAR, TAF, and GFA
     - i. METAR (Aviation Routine Weather Report)
       - a. An observation of current surface weather reported in a standard international format
     - ii. Terminal Aerodrome Forecast (TAF)
       - a. A terminal aerodrome forecast is a report established for the 5 s.m. radius around an airport
       - b. Valid for a 24-hour period, updated four times a day at 0000Z, 0600Z, 1200Z, and 1800Z.
     - iii. Graphical Forecasts for Aviation (GFA) – replaced the Area Forecast (FA)
       - a. GFA Tool – Aviationweather.gov/gfa
       - b. Complete picture of the weather for US, Gulf, Caribbean and portions of the Atlantic/Pacific
       - c. Observational data, forecasts, warnings, T-storms, clouds, precip, icing, turbulence, wind, more
       - d. Tools



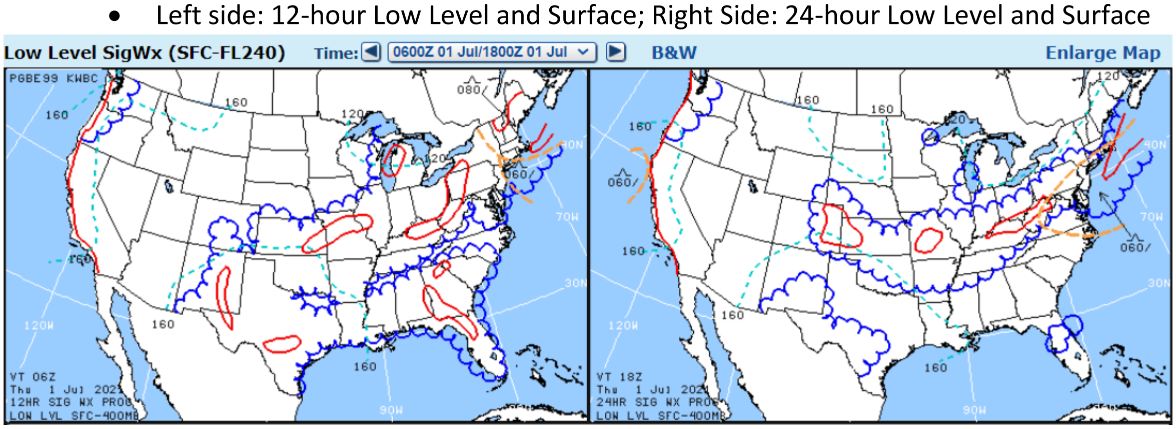
- [GFA User's Guide] - Weather.gov
- [GFA Tutorial Video] – Youtube.com
- [Product Description Doc] – National Weather Service

B. Surface Analysis Chart (surface station report pictured, right)
   i. Depicts surface weather covering contiguous 48 states
      a. Pressure, fronts, temps, dewpoints, wind direction/speed, local weather, visual obstructions

C. Radar Summary Chart
   i. Collection of radar weather reports showing areas and characteristics of precipitation
   ii. Published hourly at 35 min past the hour

D. Winds and Temperatures Aloft Chart (FD)
   i. Provide wind and temperature forecasts for specific locations twice a day (0Z/12Z)
   ii. Wind
      a. Direction = true north; Speed = knots
      b. No forecasts within 1,500' of station elevation
      c. First 2 numbers are direction; Second 2 are speed
   iii. Temperature (Celsius)
      a. No forecasts within 2,500 feet of station elevation
      b. Temperatures above 24,000 feet MSL are always negative

E. Significant Weather Prognostic Charts
   i. Portray forecasts of selected weather conditions over large areas at specified valid times
      a. Each chart depicts a "snapshot" of the weather elements expected at the chart's valid time
   ii. Surface Chart
      a. Used to obtain an overview of surface weather features over the next 2 ½ days
      b. Depicts: Pressure systems, fronts, precipitation, and squall lines
      c. Issued: 2x a day, based on the product
   iii. Low Level Chart (FL240 and below)
      a. Two charts: 12-hour and a 24-hour prog
      b. Big picture overview, more detailed and timely products should be used for flight planning
      c. Depicts:
         - Flying categories: IFR, MVFR, VFR
         - Turbulence intensities and altitudes
         - Freezing level in hundreds of feet MSL
      d. Issued: 4x per day
      e. Sometimes combined with surface prognostic charts for a four-panel display
         - Left side: 12-hour Low Level and Surface; Right Side: 24-hour Low Level and Surface



- iv. Mid/Medium Level Chart (10,000’ MSL to FL450)
    - a. Single 24-hour chart
    - b. Used by airline dispatchers for flight planning / weather briefings and flight crew during flight
    - c. Depicts: Thunderstorms / CB clouds, moderate or severe turbulence and icing, jet streams, tropopause heights, tropical cyclones, volcanic eruptions, sandstorms / dust storms
    - d. Issued 4x per day
- v. High Level Chart (FL250 to FL630)
    - a. Provided for enroute portion of international flights (used by airline dispatchers / flight crew)
    - b. Depicts: Same as mid, minus non-convective clouds with moderate or severe icing / turbulence
    - c. Issued: 4x a day
- vi. See Chapter 5 of Aviation Weather Services (AC 00-45) for all chart symbols

F. Convective Outlook Chart
- i. Depicts areas forecast to have severe and non-severe (general) convection over 8 days
    - a. 4 Charts: Day 1, Day 2, Day 3, and Days 4-8
    - b. Aviation Weather Convective Outlook Chart
- ii. Day 1-3 Charts
    - a. 5 levels of risk + general thunderstorm depict coverage and intensity of severe weather
        - General (TSTM)
        - Marginal (MRGL), Slight (SLGT), Enhanced (ENH), Moderate (MDT), High (HIGH)
    - b. Days 1 & 2: Also contain individual severe probabilities for tornadoes, wind, and/or hail
    - c. Day 3: Combined probability of all three types of severe weather
        - Graphic Probability Requirements
- iii. Day 4-8 Chart
    - a. Two thresholds of 15% and 30% can be forecast (equivalent to slight and enhanced)
    - b. If no 15% areas forecast, you’ll see:
        - Predictability too low, or
        - Potential too low

G. ASOS, AWOS, and ATIS
- i. ASOS (Automated Surface Observing System)
    - a. Continuous min-by-min airport area weather observations to generate a METAR
    - b. Levels of service
        - LEVEL A – Highest level; typically available at major airports like those in or near Class B
        - LEVEL B – Has human observers available 24 hours a day
        - LEVEL C – At airports with part-time towers (Human augmentation ends when tower closes)
        - LEVEL D – At smaller, nontowered airports meeting the FAA or NWS criteria for the ASOS
- ii. AWOS (Automated Weather Observing System)
    - a. Levels of service:
        - AWOS-A: Only reports the altimeter setting
        - AWOS-1: Also reports wind speed, direction, gusts, temperature, and dew point
        - AWOS-2: Adds visibility information
        - AWOS-3: Most capable – also includes cloud/ceiling data (essentially equivalent to ASOS)
    - b. Difference between ASOS / AWOS is ability to identify significant changes in surface weather
        - AWOS transmits 3 reports per hour at fixed intervals; cannot issue a special report
- iii. ATIS (Automatic Terminal Information Service)
    - a. A continuous broadcast of recorded non-control information in busier terminal areas
    - b. Updated when there is a significant change in the information; it is given a letter designation

4. In-Flight Weather Advisories

A. Forecasts that detail potentially hazardous weather
B. AIRMET (WA)
   i. Issued every 6 hours with intermediate updates as needed
   ii. Information of interest to all, but the weather section is specifically dangerous to light aircraft
   iii. 3 Types
      a. SIERRA: Denotes IFR and mountain obscurement
      b. TANGO: Denotes turbulence, strong surface winds, and low-level wind shear
      c. ZULU: Denotes icing and freezing levels
C. SIGMET (WS)
   i. In flight advisory concerning non-convective weather that is potentially hazardous to all aircraft
   ii. Severe icing; extreme turbulence; Clear Air Turbulence (CAT); dust / sandstorms; volcanic ash
   iii. Unscheduled forecasts valid for 4 hours (hurricane SIGMET is valid for 6 hours)
D. Convective SIGMENT (WST)
   i. Weather advisory issued for hazardous convective weather that affects the safety of every flight
   ii. Issued for: Embedded thunderstorms, line of thunderstorms, as well as:
      a. Severe Thunderstorms with
         - Surface winds greater than 50 knots
         - Hail at the surface ≥ ¾ inch in diameter
         - Tornadoes
      b. Thunderstorms with heavy or greater precip affecting 40% or more of a 3,000 ft^2 or greater area
E. PIREPS – Pilot generated report concerning meteorological phenomena encountered in flight

5. Recognizing Weather Hazards

A. Most hazards can be recognized through proper interpretation of aviation weather charts, reports, etc.
   i. Use resources in flight to maintain situation awareness (ATC, FSS, PIREPs, onboard weather, etc.)
B. Wind Shear
   i. Sudden, drastic change in wind speed and / or direction over a very small area
      a. Violent updrafts / downdrafts can be extremely dangerous to all aircraft
      b. Microbursts – The most severe type of wind shear; downdrafts up to 6,000 fpm
   ii. Indications
      a. Visual
         - Intense rain shaft at the surface, but virga at cloud base
         - Ring of blowing dust
      b. Alerting Systems
         - LLWAS-NE, TDWR, and ASR-9 WSP systems installed at major airports
         - Many airports, especially smaller airports, have no wind shear systems
            a AC 00-54 – FAA Pilot Wind Shear Guide
   iii. If possible, avoid it
      a. Never conduct low level (traffic pattern) operations near an active thunderstorm
      b. LLWAS (Low Level Wind Shear Alerting System)
      c. PIREPS
      d. If unable to avoid, follow manufacturer's procedures
         - General procedures include: Max power, pitch aggressively for max climb (DO NOT STALL)

6. Go/No Go Decision

A. Consider weather factors, aircraft and equipment to be used, as well as yourself
B. Set limits and don't bend them
C. Physical / Mental condition - IMSAFE checklist
D. Continual process of decision making – Don't be afraid to discontinue the flight or divert, if necessary

Conclusion:
Brief review of the main points
It is very important to be able to interpret and make a Go/No Go decision based on the information attained. A safe flight begins with a thorough weather briefing to ensure the pilot understands the meteorological factors that may affect the flight.

III.C. Operation of Systems

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25)

Objectives

The student should develop knowledge of the elements related to the aircraft systems and their operation as required in the ACS/PTS.

Key Elements

1. Intake, Compression, Power, Exhaust
2. Magneto Operation
3. Wet Sump vs Dry Sump Oil Sys

Elements

1. Primary Flight Controls and Trim
2. Flaps
3. Powerplants
4. Ignition Systems
5. Induction Systems
6. Oil Systems
7. Cooling Systems
8. Exhaust Systems
9. FADEC
10. Propellers
11. Landing Gear & Brakes (Hydro)
12. Fuel Systems
13. Electrical Systems
14. Avionics
15. Pitot Static, Vacuum Pressure, and Associated Flight Instruments
16. Environmental Systems
17. Deicing and Anti-Icing Systems

Schedule

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

Equipment

1. White board and markers
2. References

IP's Actions

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

SP's Actions

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

Completion Standards

The student understands the operation of the aircraft systems.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

The inner workings of the airplane; to develop a better understanding of what is what, and what is where.

Overview

Review Objectives and Elements/Key ideas

What

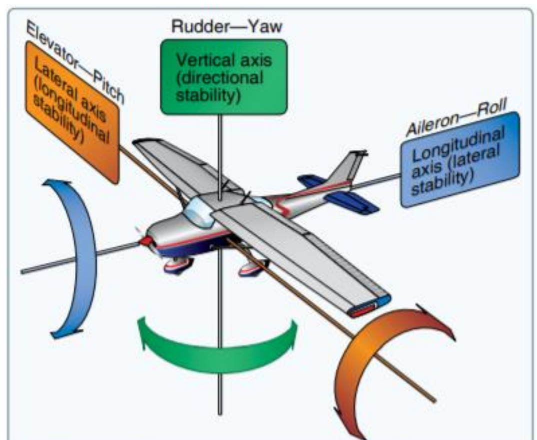
The primary systems found on most aircraft. This includes the engine, propeller, induction, ignition, as well as the fuel, lubrication, cooling, electrical, landing gear, and environmental systems.

Why

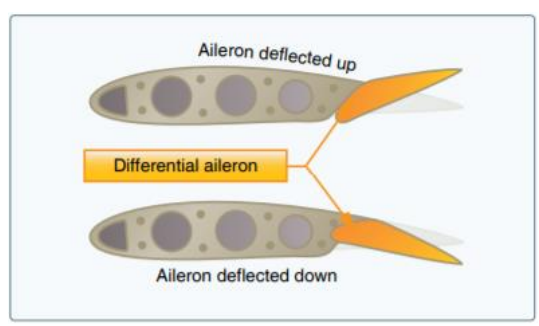
Understanding how the airplane works internally will allow for better troubleshooting and problem identification. The pilot will have a better understanding of the airplane as a whole.

How:

1. **Primary Flight Controls and Trim**
    A. Ailerons
        i. General
            a. Control roll about the longitudinal axis
            b. Outboard trailing edge of each wing
            c. Connected by cables, bell cranks, pulleys, and/or push-pull tubes
            d. Move opposite direction of each other
                - Up aileron decreases camber decreasing lift and lowering the wing
                - Down does opposite
        ii. Adverse Yaw
            a. Lowered aileron increases lift
            b. Increased lift = increased induced drag
            c. Drag causes yaw opposite the turn direction
            d. Rudder counters yaw / maintains coordination
        iii. Differential Ailerons (pictured, right)
            a. Up aileron raises higher than down aileron lowers
            b. Higher drag on low wing reduces adverse yaw
        iv. Frise-Type Ailerons (pictured below)
            a. Leading edge of the raised aileron projects into the airflow creating drag / reducing yaw



Primary Control Surface	Airplane Movement	Axes of Rotation	Type of Stability
Aileron	Roll	Longitudinal	Lateral
Elevator/ Stabilator	Pitch	Lateral	Longitudinal
Rudder	Yaw	Vertical	Directional



b. Forms a slot – air flows smoothly over the lowered aileron (more effective at high AOAs)

v. Coupled Ailerons and Rudder
  a. Ailerons and rudder are linked
  b. Rudder automatically applied with aileron input

vi. Flaperons (combined flaps and ailerons)
  a. Control the bank of the aircraft but can be lowered to function like flaps
  b. Separate controls for ailerons and flaps

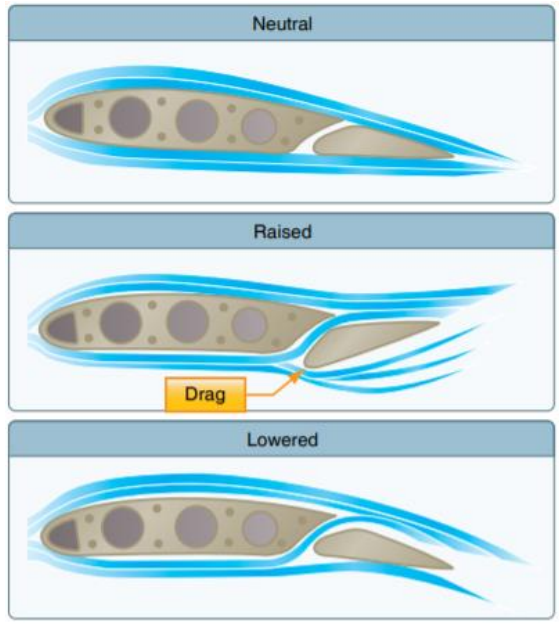
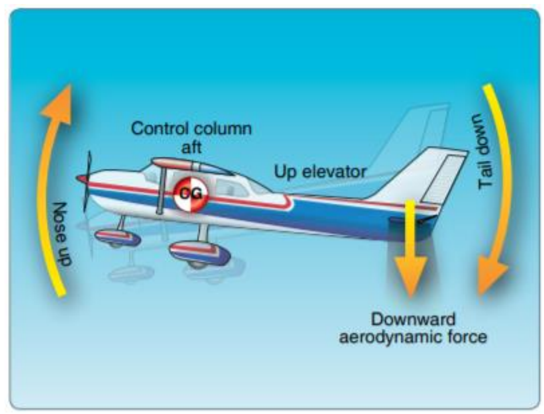


Figure 6-7. *Frise-type ailerons.*

Figure 6-9. *Flaperons on a Skystar Kitfox MK 7.*

B. Elevator

i. General
  a. Controls pitch about the lateral axis
  b. Aft movement of the controls deflects the trailing edge of the elevator up
    - Decreases camber creating a downward force moving the tail down / nose up
    - Rotation is around the CG
  c. Forward control movement does the opposite
  d. Conventional tail – attached near bottom of vertical stabilizer



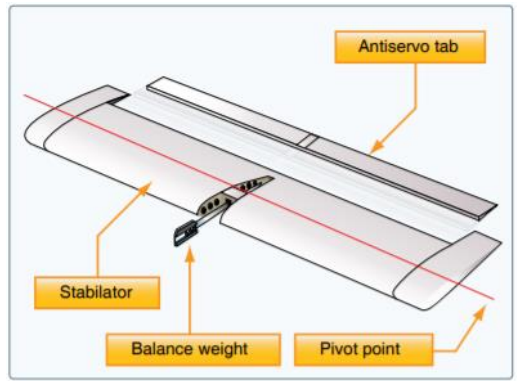
ii. T-Tail
  a. Mounted at the top of the vertical stabilizer, above most of the effects of downwash from the propeller, and airflow from around the fuselage and/or wings
    - Undisturbed air results in consistent control movements throughout most flight regimes
  b. Control Differences
    - Elevator must be moved a greater distance to raise the nose when at slow speeds
      a Conventional tail: propeller downwash pushes the tail down and helps raise the nose
    - Controls are rigged so that increased control force is required the farther the controls move
      a Progressively more difficult to move a T-tail elevator
  c. Design Considerations
    - Weight is at the top of the vertical stabilizer resulting in larger moment arms / higher loads
      a Vertical stabilizer must be designed stronger, resulting in additional weight

- At a very high angle of attack, low airspeed, and aft center of gravity, the T-tail can be more susceptible to a deep stall (pictured above, right)
    - a Airflow from the wing can blanket the T-tail
    - b Elevator control is reduced, or eliminated

iii. Stabilator

a. Stabilator – "All-moving tail"

- One-piece stabilizer pivoting on a central hinge
    - a Smaller forces required to move stabilator
    - b Anti-servo tabs oppose pilot input and counter the light control forces
- Back pressure moves the stabilator and anti-servo tab up, raising the nose of the plane
- Forward pressure does the opposite



iv. Safety Systems

a. Since flight at high AOAs can be dangerous, many aircraft have systems to prevent it

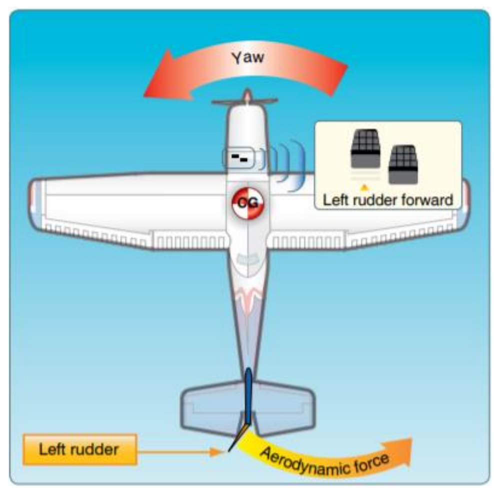
- Control stop – limits movement of the elevator control
- Elevator down spring – puts a mechanical load on the elevator, moving it toward the nose down position
- Stick pushers – commonly used on transport category jets
    - a In the case of an approaching stall, the stick is pushed forward to prevent a critical AOA

C. Rudder

i. General

a. Controls movement about the vertical axis (yaw)

b. When deflected into the airflow, a horizontal force is exerted in the opposite direction



ii. V-Tail

a. Two slanted tail surfaces perform the same functions as a conventional elevator and rudder

- Act as horizontal and vertical stabilizers
- Movable portion of the V-tail: "Ruddervators"

b. Control linkage can move both surfaces together

- Moving the rudder pedals moves the surfaces differentially, providing directional control
- When the rudder / elevator are moved together, a mixing mechanism blends the control inputs

c. Drawbacks

- More complex than for a conventional tail
- More susceptible to Dutch roll
- Total reduction in drag is minimal

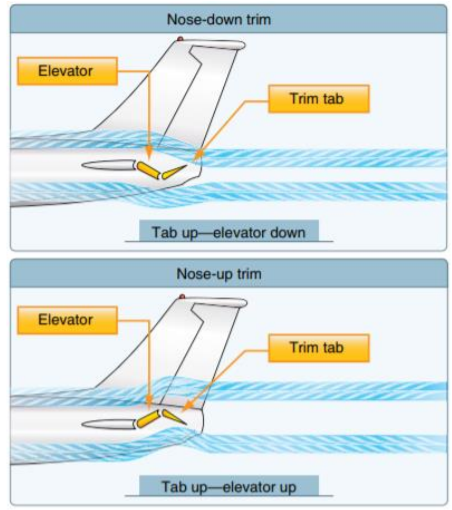
Figure 6-16. *Beechcraft Bonanza V35.*

D. Trim

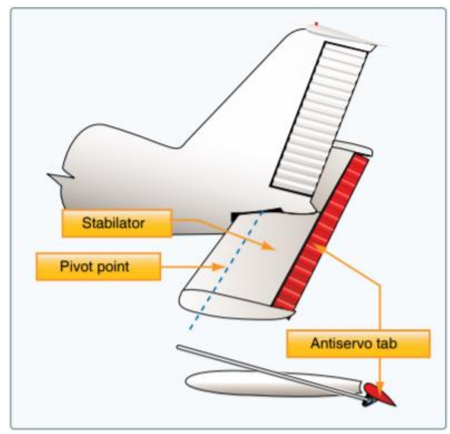
i. General

a. Relieves the pilot of the need to maintain constant pressure on the flight controls

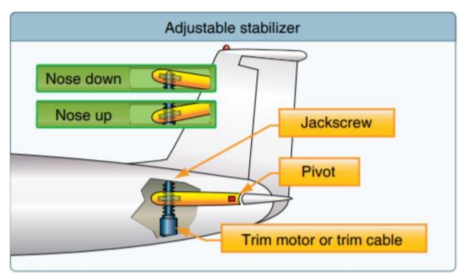
b. Small, hinged devices attached to the trailing edge of flight controls – usually controlled from cockpit



- ii. Trim Tabs
  - a. Most common installation is a single trim tab attached to the trailing edge of the elevator
  - b. How it works (pictured right)
    - Trimming nose down moves the tab up
      - a Trim Tab Up forces the elevator down
      - b Causes the tail to move up / nose down
    - Trimming nose up does the opposite
- iii. Balance Tabs
  - a. Balance tabs are used to decrease excessive control forces (enable easier control movement)
    - Moves opposite the flight control
    - Airflow striking the tab counterbalances air pressure against the control surface
  - b. If adjustable, balance tabs can also act as trim tabs to relieve control pressures
- iv. Servo Tabs – Similar to trim and balance tabs (primarily used on large aircraft)
  - a. A small portion of a flight control that moves the entire flight control surface
  - b. Only the servo tab moves in response to control inputs
    - Force of the air on the tab moves the control surface



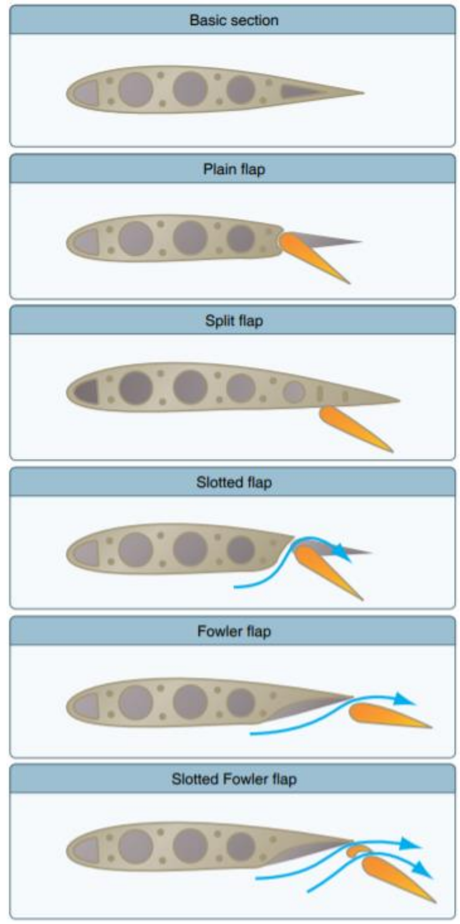
- v. Antiservo Tabs
  - a. Like balance tabs, except they move in the same direction as the trailing edge of the stabilator
  - b. Decrease the sensitivity of the control surface and function as a trim device to relieve control pressures
  - c. When the trailing edge of the stabilator moves up, the trailing edge of the tab moves up, vice versa
- vi. Ground Adjustable Tabs
  - a. Metal trim tabs that can be bent/positioned on the ground to apply a trim force in flight
    - Common on the rudder of small aircraft
  - b. Position is determined by trial and error



- vii. Adjustable Stabilizer
  - a. Rather than a movable tab, the entire stabilizer moves
  - b. Jackscrew is used to adjust the stabilizer
    - Small aircraft: Cable operated; Large: Motor driven

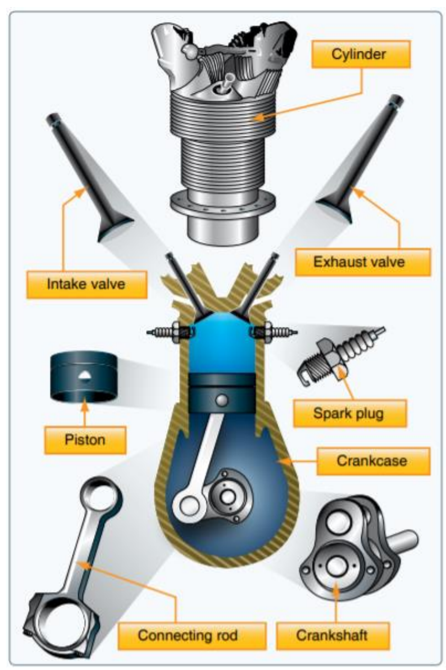
2. Flaps

- A. General
  - i. The most common high lift devices used on aircraft
  - ii. Increase lift and drag; allowing a compromise between high cruise speed / low landing speed
- B. Plain Flap
  - i. Most simple of the four types
  - ii. Increases the camber of the wing, resulting in a significant increase in lift at a given angle of attack
  - iii. Greatly increases drag and moves the airfoil center of pressure aft resulting in nose-down pitch

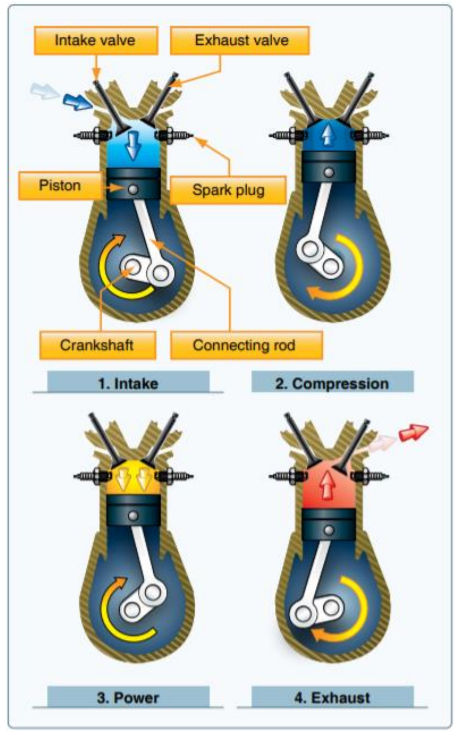


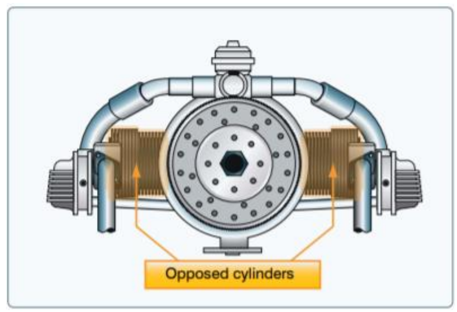
- C. Split Flap
  - i. Deflected from the lower surface
  - ii. Slightly greater increase in lift than the plain flap
  - iii. More drag because of turbulent airflow behind the airfoil
- D. Slotted Flap
  - i. Most popular flap on aircraft today
  - ii. Significantly more lift than plain/split flaps
  - iii. When the flap is lowered, a duct forms between the flap well in the wing and the leading edge of the flap
    - a. High energy air accelerates the upper boundary layer and delays separation (higher coefficient of lift)
  - iv. Large aircraft have double- or even triple-slotted flaps
- E. Fowler Flap (type of slotted flap)
  - i. Instead of rotating down, it slides backwards
    - a. Changes the camber, and increases the area of the wing
  - ii. Initial extension increases lift greatly, drag very little
  - iii. Last portion, increases drag greatly, lift very little

3. **Powerplant** – four-stroke, reciprocating engines
   - A. General
     - i. Converts chemical energy (fuel) into mechanical energy
       - a. Occurs in the cylinders through combustion
       - b. Pistons produce mechanical energy to accomplish work
   - B. Basic Components and Operation
     - i. Cylinders
       - a. Contain intake / exhaust valves, sparks plugs, pistons
         - Intake / exhaust valves allow the fuel-air mixture to enter / exit the combustion chamber
         - Spark plugs ignite the fuel air mixture
         - Pistons move up and down in the cylinder and drive the crankshaft which drives the propeller



     - ii. Crankcase
       - a. Contains crankshaft, and connecting rods
         - Pistons connect to the crankshaft via connecting rods
         - Crankshaft is connected to the propeller
     - iii. Accessory Housing
       - a. Contains magnetos
         - Power source for the spark plugs
         - More information in 4. Ignition System
     - iv. Four-stroke Operating Cycle
       - a. Intake Stroke
         - Piston moves to the bottom
         - Fuel-air mixture enters combustion chamber
       - b. Compression Stroke
         - Intake valve closes
         - Piston moves up, compressing mixture
         - Spark plug ignites mixture





c. Power Stroke
   - Mixture is ignited, increasing pressure
   - Pressure increases, forcing the piston back down
   - Turns the crankshaft which drives the propeller

d. Exhaust Stroke
   - Exhaust valve opens as piston reaches bottom
   - As piston moves back up, exhaust gas is pushed out

C. Two Primary Engine Designs
   i. Spark ignition – most popular for many years
   ii. Compression ignition is becoming more popular – Reduced costs, simpler designs, more reliable
      a. Compression systems can run on diesel or jet fuel (Diamond DA42, for example)
   iii. Components
      a. Main mechanical components of spark and compression systems are essentially the same
      b. Primary difference is the process of igniting the fuel
         - Spark Ignition – uses spark plug to ignite mixture
         - Compression Ignition – compression of the air raises its temperature to allow for automatic ignition when fuel is injected into the cylinder

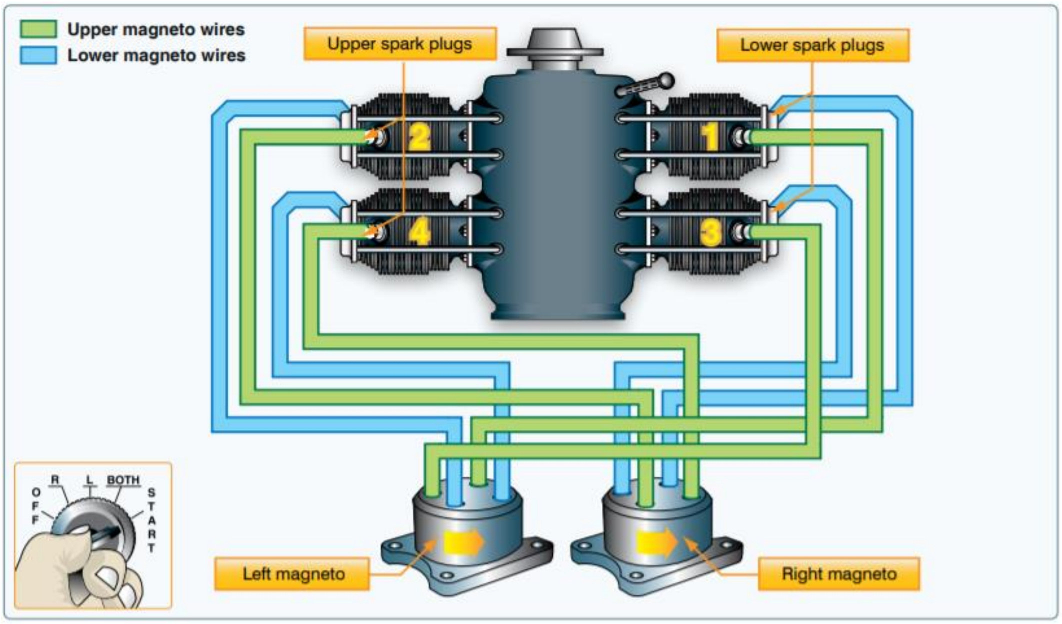
D. Horizontally Opposed Cylinder Arrangement
   i. Most popular reciprocating engine for smaller aircraft
   ii. Cylinder on one side "opposes" a cylinder on the other
   iii. Generally air cooled / mounted in a horizontal position
   iv. Compact arrangement allows for a more streamlined installation, minimizing aerodynamic drag
   v. High power-to-weight ratios

4. Ignition System

A. Provides the spark that ignites the fuel-air mixture in the cylinders

B. Components
   i. Magnetos
      a. Self-contained, engine driven unit that supplies electrical current to the spark plugs
         - A permanent magnet generates the electrical current
         - Completely independent of the airplane's electrical system
      b. Normally two magnetos per engine (left and right)
   ii. Spark Plugs
      a. Deliver electric current from the magnetos to the combustion chamber to ignite the mixture
   iii. High-Tension Leads – The wires that connect the magnetos to the spark plugs
   iv. Ignition Switch
      a. Controls the operation of the magnetos
      b. 5 position switch:
         - Off, R - Only runs R magneto, L - Only runs L magneto, Both - Runs both magnetos, and Start - Engages the starter using battery power. The starter rotates the crankshaft

a The ignition system begins to fire when the crankshaft begins to turn



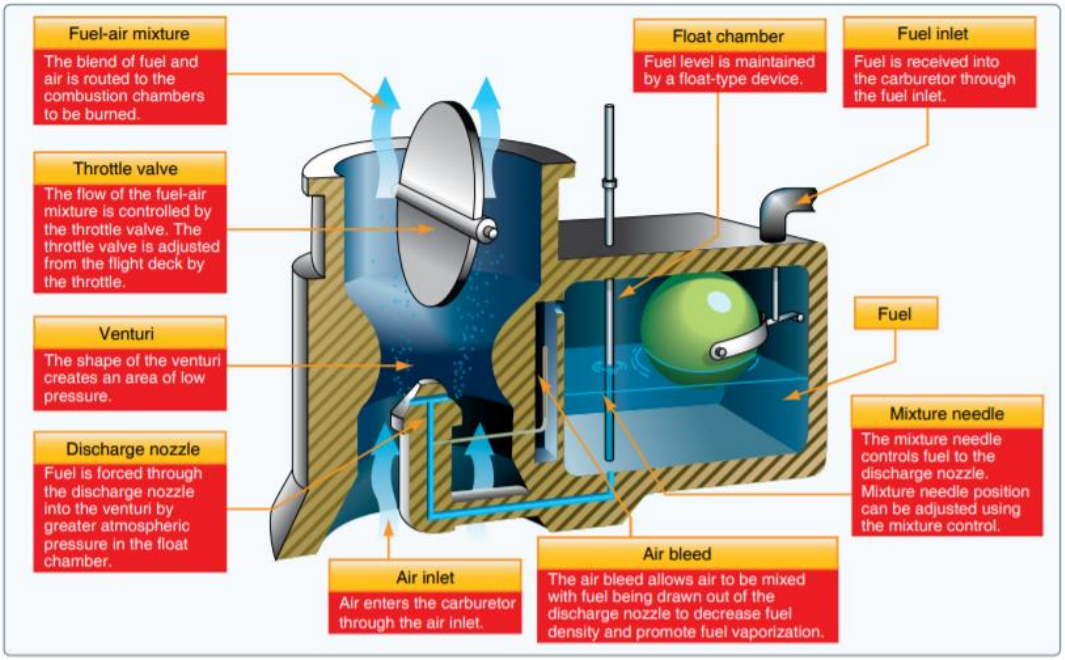
C. Operation
  i. Normal Operation
    a. The system begins to fire when the starter is engaged and the crankshaft begins to turn
      - Initially powered by the battery
    b. Crankshaft rotation activates the magnetos which send power to the spark plugs, producing a spark in the combustion chamber
      - Combustion in the chamber produces piston movement which rotates the crankshaft
    c. Once the engine can move the pistons on its own the starter is no longer necessary
      - As long as the crankshaft is rotating, the magnetos/ignition system continue to operate
      - As long as the magnetos/ignition system are operating, the crankshaft continues rotating
  ii. Dual Ignition System
    a. Two individual magnetos, separate sets of wires, and two separate spark plugs in each cylinder
    b. Each magneto operates independently to fire one of the two spark plugs in each cylinder
      - Firing two spark plugs improves combustion and provides slightly higher power output
      - If one magneto fails, the other is unaffected
        a The engine will continue to run but with a slight decrease in power
        b The same is true if one of the two spark plugs in a cylinder fails

5. Induction Systems

A. General
  i. Air enters through an intake, is filtered, mixed with fuel and delivered to the cylinders
  ii. Two types of induction systems
    a. Fuel Injection – Mixes fuel/air before entry into cylinders, or injects fuel directly into cylinders
    b. Carburetor System – Mixes the fuel and air in the carburetor before it enters the intake manifold

B. Carburetor System (older system)
  i. General
    a. Mixes the fuel and air in the carburetor before entering the intake manifold
    b. Two categories of carburetors – Float-type (most common) and pressure-type (rare)
      - Basic difference is delivery of fuel – pressure type delivers fuel under pressure by a pump
  ii. Float-type Carburetors

a. Operation
- Fuel is sent from the fuel tank(s) to the carburetor float chamber
- Float chamber stores / meters the fuel that will be mixed with the air and sent to the engine
- At the same time, outside air enters through an air filter
- The filtered air flows into the carburetor and through a venturi
  - a A low-pressure area is created forcing fuel to flow through the discharge nozzle
- The fuel / air mix and flow to the combustion chambers based on the throttle valve position
  - a Increasing power opens the valve, decreasing closes the valve



b. Disadvantages
- Do not function well with abrupt maneuvers
- Discharge of fuel at low pressure leads to incomplete vaporization and difficulty in discharging fuel into some supercharged systems
- Chief Disadvantage – Icing tendencies

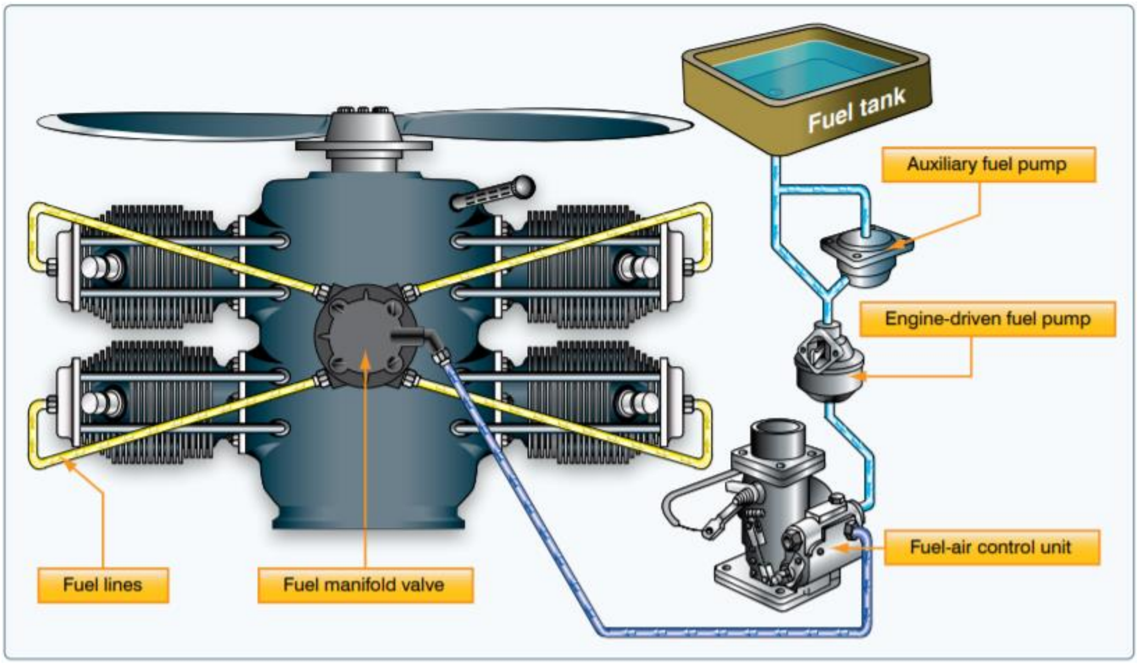
c. Carburetor Icing
- Fuel vaporization / decreased pressure in the venturi can cause a sharp drop in temperature
  - a If water vapor in the air condenses with temperatures at / below freezing, ice can form
- Carburetor icing restricts the flow of fuel-air mixture and reduces power
  - a If enough ice builds up, the engine can stop operating
- Most likely to occur at temperatures below 70° F with relative humidity greater than 80%
- Fixed Pitch Propellers: First indication is a decrease in rpm, then possibly engine roughness
- Constant speed propeller: First indication is a decrease in manifold pressure, but not RPM
- Carburetor heat is used to combat carburetor icing

d. Carburetor Heat
- Preheats the air before it reaches the carburetor
- Primarily prevents formation of ice, but can be used to melt ice that has already formed
- Decreases engine power, sometimes up to 15%

C. Fuel Injection System (newer, more popular system)

i. General

a. Fuel is injected directly into the cylinders, or just ahead of the intake valve
b. Advantages of Fuel Injection
   - Reduction in evaporation icing, better fuel flow, faster throttle response, precise control of mixture, better fuel distribution, easier cold weather starts
c. Disadvantages of Fuel Injection
   - Difficulty in starting a hot engine, vapor locks during ground operation on hot days, problems associated with restarting an engine that quits because of fuel starvation

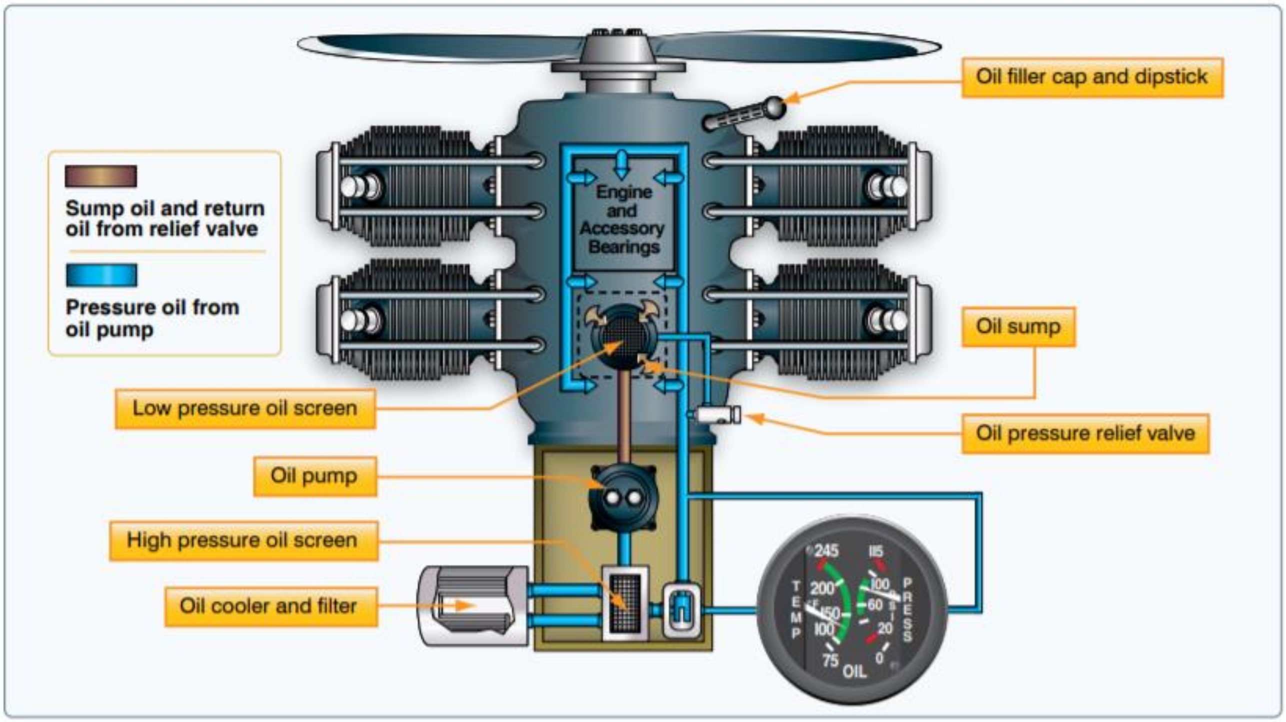


ii. Components and Operation
   a. Engine-driven fuel pump – Provides fuel to the fuel-air control unit after the engine is started
   b. Auxiliary fuel pump – Provides fuel to the fuel-air control unit for engine start / emergency use
   c. Fuel-air control unit – Meters fuel based on the mixture / throttle settings
   d. Fuel manifold (distributor) – Distributes the fuel to the individual fuel discharge nozzles
   e. Discharge nozzles – Inject the fuel-air mixture directly into each cylinder intake port
   f. Fuel pressure / flow indicators – Provide the pilot information in regards to the fuel system

6. Oil Systems

A. Functions of the Oil System
   i. Lubricates the engine's moving parts
   ii. Cools the engine by reducing friction / Removes heat from cylinders
   iii. Provides a seal between the cylinder walls and pistons
   iv. Carries away contaminants

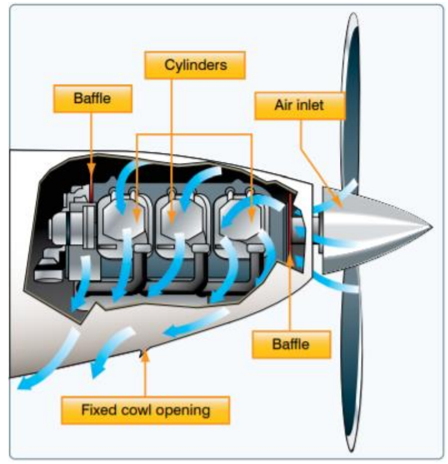
B. Types of Oil Systems
   i. Wet-Sump System
      a. Oil is located in a sump that is part of the engine (usually at the base of the engine)
      b. Operation
         - Oil pump draws oil from the sump and routes it to the engine
         - In some engines the rotating crankshaft splashes oil onto portions of the engine
         - After oil passes through the engine, it returns to the sump (generally returned by gravity)



- ii. Dry-Sump System
  - a. Oil is stored in a tank, outside of the engine, and circulated through the engine by pumps
  - b. A greater volume of oil can be supplied to the engine (suitable for large reciprocating engines)
  - c. Operation
    - Oil pump supplies pressure to pump oil from the external tank through the engine
    - Scavenge pumps return oil from various locations in the engine to the oil tank
- C. Indications
  - i. Oil Pressure Gauge – Provides a direct indication of the oil system operation
  - ii. Oil Temperature Gauge – Measures the temperature of the oil
    - a. High oil temperatures may signal:
      - A plugged oil line, Low oil quantity, A blocked oil cooler, A defective temperature gauge
    - b. Low oil temperatures may signal improper oil viscosity during cold weather operations

7. Cooling Systems

- A. General
  - i. Types of engine cooling
    - a. Air Cooling (most small aircraft are air cooled)
      - Air flows into the engine compartment, is routed over the hottest parts of the engine and expelled through the lower, aft portion of the cowling
    - b. Liquid Cooling
      - Cooling liquid (usually water, ethylene glycol, or a combination of the two) is pumped around the engine to cool the hot components
      - Benefits: Less chance of shock cooling, ability to direct coolant to specific, critical areas
      - Negatives: Added weight, increased complexity and increased cost
- B. Air Cooling
  - i. Operation



a. Outside air enters the engine compartment where baffles direct it to the hottest parts of the engine
b. Dependent on air flow, so it is less effective at low speeds
    - Conversely, high-speed descents provide excess air and can shock cool the engine

ii. Monitoring and Controlling Engine Temperature
a. Monitoring Temperature
    - Oil temperature gauge gives an indirect and delayed indication of rising engine temperature
    - Cylinder head temperature (CHT) indicates a direct / immediate cylinder temperature change

b. Controlling Temperature
    - Increase airspeed, Enrich the fuel air mixture, Reduce power, and/or Open cowl flaps

8. Exhaust Systems

A. Operation and Uses
i. Vent burned combustion gases overboard, provide heat for the cabin, defrost the wind screen
ii. Operation
a. Engine Exhaust
    - After combustion, exhaust gases are pushed out of the cylinder through the exhaust valve and travel through the exhaust manifold/piping, and muffler to the atmosphere

b. Cabin Heat
    - Outside air is ducted through a shroud around the muffler
        a Exiting exhaust gases heat the muffler, which in turn heats the air around the muffler
    - Heated air is ducted to the cabin for heat and defrost
    - Exhaust must be in good condition / free of cracks to ensure gases don't enter the cabin

B. EGT (Exhaust Gas Temperature) Probe
i. Measures the temperature of the gases at the exhaust manifold
ii. Temperature varies based on the ratio of fuel and air entering the cylinders and can be used for regulating the fuel-air mixture (highly accurate in indicating the proper mixture setting)

9. FADEC (Full Authority Digital Engine Control)

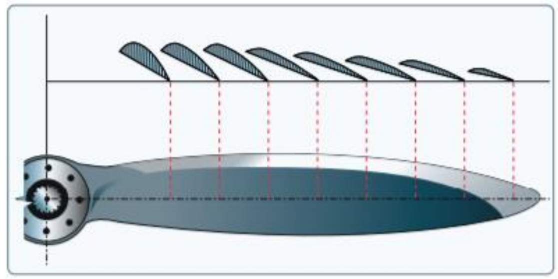
A. System consisting of a digital computer and ancillary components that control the engine and propeller
B. What it does
i. Optimizes Performance
a. Uses speed, temperature and pressure sensors to monitor the status of each cylinder
b. Calculates ideal pulse for each injector, and adjusts ignition timing / fuel flow as necessary
ii. Simplifies Systems
a. Eliminates pilot controls for magnetos, carburetor heat, mixture, propeller, and engine priming
b. A single throttle is characteristic of FADEC aircraft (pilot sets throttle, computer does the rest)

C. Safety
i. Two separate and identical digital channels are incorporated for redundancy
ii. Losing FADEC could result in loss of engine power
iii. To prevent a failure from resulting in engine failure a backup electrical source must be available
a. In many aircraft, the FADEC uses power from a separate generator connected to the engine

10. Propeller

A. General
i. Rotating airfoil – Subject to induced drag, stalls, and other aerodynamic principles

- ii. Engine power rotates the propeller
  - a. Rotation generates thrust similar to the manner in which a wing produces lift
  - b. Amount of thrust depends on the shape of the airfoil, the angle of attack, and RPM
- iii. Prop is twisted – the blade angle changes from hub to tip to provide uniform lift from hub to tip
  - a. The greatest angle of incidence (highest pitch) is at the hub, smallest (lowest pitch) is at the tip
  - b. A prop that wasn't twisted would be inefficient
    - As airspeed increased, the hub would have a negative AOA and the tip would be stalled



- iv. Installation
  - a. Mounted on a shaft connected to the engine
    - If it directly connected to the crankshaft, the propeller rpm matches crankshaft rpm
    - On some engines, the propeller is geared to the engine crankshaft
      - a In this case, the propeller RPM is different than that of the engine
      - b For example, the Diamond DA42 is geared at a ratio of 1.69:1 (engine to prop ratio)

B. Fixed Pitch Propellers

- i. General
  - a. Fixed blade angle
    - Pitch is set by the manufacturer and cannot be changed
    - Achieve best efficiency only at a given combination of airspeed and RPM
      - a Not ideal for cruise or climb; performance suffers a bit in each category
  - b. Used when low weight, simplicity, and low cost are needed
  - c. Two types of fixed-pitch propellers: Climb and Cruise
- ii. Climb Propeller
  - a. Lower pitch, and therefore less drag
    - Less drag results in higher RPM and more horsepower capability
  - b. Increases performance during takeoffs and climbs, decreases performance during cruise
- iii. Cruise Propeller
  - a. Higher pitch, and therefore more drag
    - More drag results in lower RPM and less horsepower capability
  - b. Decreases performance during takeoff and climbs, increases performance during cruise
- iv. Control and Indications
  - a. Tachometer – Indicator of power
    - Direct indication of the engine / propeller rpm
  - b. Controlling RPM
    - RPM is regulated by the throttle which controls the amount of fuel-air to the engine
    - At a given altitude, the higher the tachometer reading, the higher the power output of the engine

C. Adjustable Pitch Propellers (Constant-speed propellers)

- i. General
  - a. A governor adjusts propeller pitch to maintain a specific RPM
  - b. More efficient because it allows selection of the best RPM for the given phase of flight
- ii. How it Works
  - a. Once an RPM is selected, the governor adjusts the propeller blade to maintain the selected RPM

- An increase in airspeed or decrease in propeller load causes the governor to increase the propeller blade angle to maintain RPM
- A reduction in airspeed or increase in load causes the propeller blade to decrease

b. As long as the propeller blade angle is within its rpm range, a constant rpm is maintained
- If it reaches a pitch stop, rpm will increase / decrease (like a fixed pitch prop)

iii. Controls and Indications

a. 2 controls - Throttle and Propeller control
- Throttle controls power output
- Propeller control regulates rpm through the governor (rpm is shown on the tachometer)

b. Manifold Pressure Gauge
- Indicates power, and controlled by the throttle
- At a constant RPM / altitude, power is directly related to the fuel-air mixture
  - a Increased throttle = increased fuel/air = increased manifold pressure (and vice versa)

c. Adjusting power and rpm
- Decreasing: Reduce manifold pressure, then RPM (**L**ower = **L**eft to right; throttle then prop)
  - a If rpm is reduced first, manifold pressure increases and could exceed engine tolerances
- Increasing: Increase RPM, then manifold pressure (**R**aise = **R**ight to left; RPM then throttle)

11. Landing Gear and Brakes (Hydraulics)

A. Landing Gear

i. General

a. Two main wheels, one on either side of the fuselage, and a third wheel at the front or rear
- Conventional (tailwheel) – When the third wheel is positioned at the rear
- Tricycle – When the third wheel is positioned at the nose

b. Fixed and Retractable Landing Gear
- Fixed – Always remains extended. Advantages: Simplicity and low maintenance
- Retractable – Streamlines the airplane / reduces drag by stowing the landing gear

ii. Tricycle Landing Gear

a. Three advantages:
- Allows more forceful brake application without causing the aircraft to nose over
- Permits better forward visibility during takeoff, landing, and taxiing
- Tends to prevent ground loop since the center of gravity is forward of the main wheels
  - a Forward center of gravity keeps the plane moving forward in a straight line

b. Nosewheel
- Steerable or castering
  - a Steerable nosewheels are linked to the rudders by cables or rods
  - b Castering nosewheels are free to swivel
- In either case, steering is done with rudder pedals (and brake application, if needed)

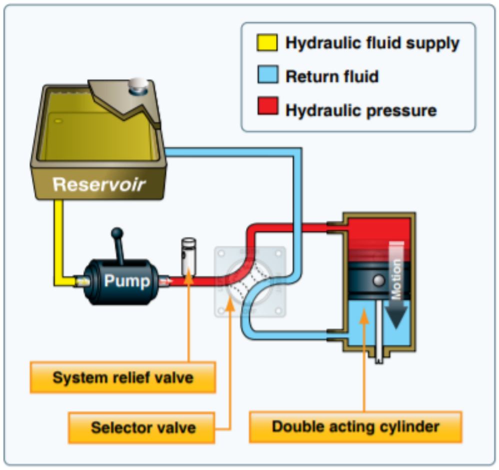
iii. Tailwheel Landing Gear

a. Two main wheels attached to the airframe, ahead of the center of gravity
- Support most of the weight of the structure
- Tailwheel at the very back of the fuselage provides a third point of support

b. Advantages:
- Ground clearance for a larger propeller
- More desirable for operations on unimproved fields

c. Disadvantages:
- Directional control is more difficult on the ground with the CG behind the main gear
- Diminished forward visibility when the tailwheel is on or near the ground

B. Hydraulics
i. Standard Hydraulic Components:
a. Reservoir
b. Pump
c. Filter
d. Selector Valve and Relief Valve
e. Actuator or servo



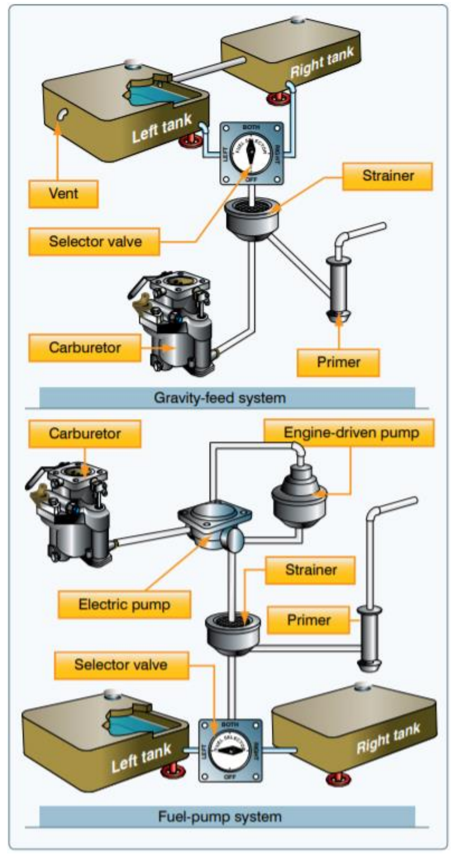
ii. Operation
a. Hydraulic fluid is pumped from the reservoir through a filter to an actuator or servo
- Servo – cylinder with a piston inside used to move a system or flight control
- Servos can be single- or double-acting
  a Fluid can be applied to one or both sides

b. Selector valve allows the fluid direction to be controlled
c. Relief valve provides an outlet for the system in case of excessive fluid pressure

C. Brakes
i. Located on the main wheels
ii. Applied by either a hand control or foot pedal (most common)
a. Foot pedals operate independently and allow for differential braking
b. Differential braking can supplement steering

12. Fuel Systems

A. General
i. Designed to provide uninterrupted, clean fuel from the tanks to the engine
ii. Fuel must be available under all conditions (power, altitude, attitude, approved maneuvers)



- iii. Two common types of fuel systems
  - a. Gravity Feed
    - Gravity transfers fuel from the tank(s) to the engine(s) (many high wing aircraft)
  - b. Fuel-Pump System
    - Fuel pumps transfer the fuel (low wing)
    - Two fuel pumps per engine
      - a Engine driven pump – Primary fuel pump
        - 1. Operates when the engine is operating
      - b Electrically-driven auxiliary pump – For engine start and backup to the main pump

B. Fuel Tank and Strainer
- i. Fuel Tank(s)
  - a. Normally located in the wings
  - b. Vented to maintain atmospheric pressure in tank
  - c. Include an overflow drain
    - Fuel can expand and not damage the tank
- ii. Strainer
  - a. After leaving the fuel tank, fuel passes through a strainer that removes moisture / sediment
    - Contaminants are heavier than aviation fuel and settle at the bottom of the strainer
  - b. Strainer should be drained before each flight
  - c. Water is the principal fuel contaminant
    - In cold weather it can freeze and block fuel lines
    - In warm weather it can flow into the carburetor and stop the engine
    - If water is present, drain until there is no evidence of water
    - Indicated by cloudy fuel, or by the clear separation of water from the fuel

C. Fuel Selectors

- i. Allows selection of fuel from various tanks, if installed
  - a. Common settings include, Left, Right, Both, Off
- ii. Both is not an option on all aircraft (swap between L / R)

D. Fuel Primer (assists with engine start)
- i. Draws fuel from the tanks to vaporize directly into the cylinders prior to starting the engine

E. Fuel Gauges
- i. Quantity Gauge(s) - Indicate amount of fuel in each tank
  - a. Certification rules only require accuracy in fuel gauges when they read "empty"
    - Always visually check the fuel level and compare it to the tank quantity indications
- ii. Pressure Gauge
  - a. If a fuel pump is installed, a fuel pressure gauge is included with it
  - b. Indicates the pressure in the fuel lines

13. Electrical Systems

A. General
- i. Most aircraft are equipped with either a 14 or 28-volt direct current (DC) electrical system
- ii. A basic electrical system consists of the following:

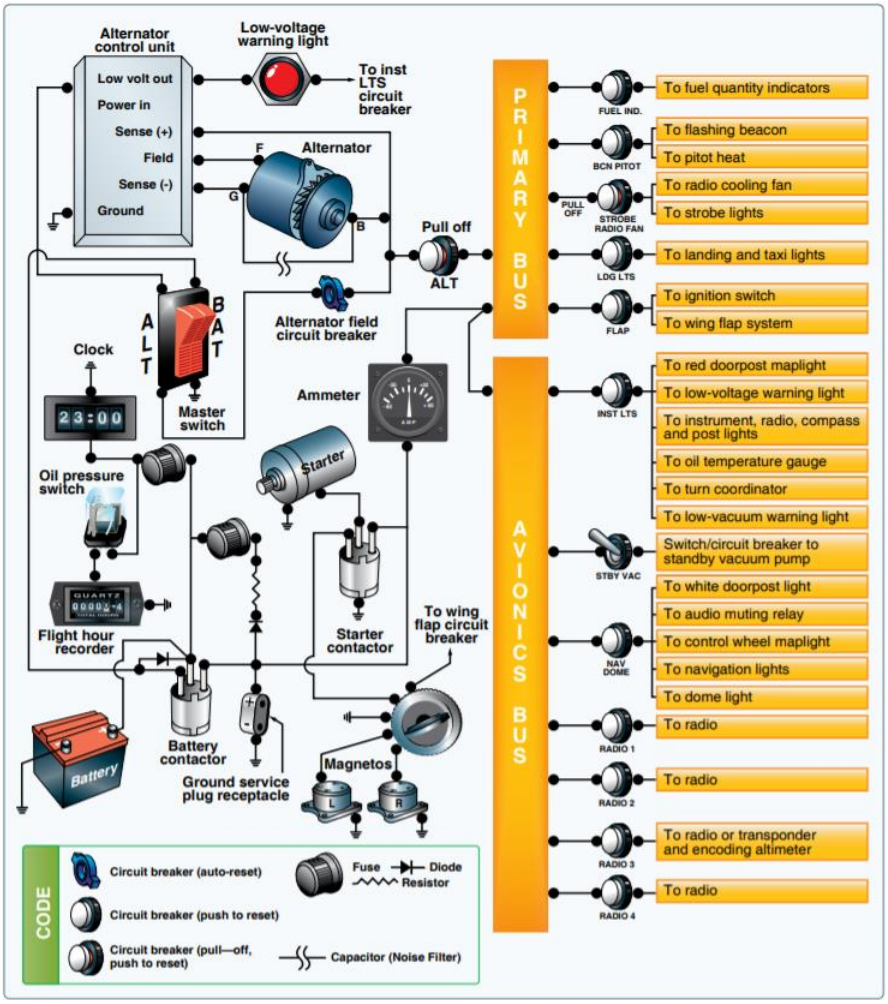
  a. Alternator/generator
  b. Battery
  c. Master/battery switch
  d. Alternator/generator switch
  e. Bus bar, fuses, and/or circuit breakers
  f. Voltage regulator
  g. Ammeter/loadmeter
  h. Electrical wiring

B. Power Generation (Alternators / Generators)
  i. Supply electric current to the electrical system and maintain a sufficient charge in the battery
  ii. Alternators have several advantages over generators
    a. Can operate entire electrical system, even at low engine RPM
    b. Electrical output is more constant through a wide range of engine speeds
  iii. Voltage Regulator (contained in most systems)
    a. Controls the rate of charge to the battery by stabilizing generator / alternator output
    b. The generator / alternator voltage should be higher than the battery voltage
      - The difference in voltage keeps the battery charged

C. Power Storage
  i. Power is stored in batteries, primarily the main battery
    a. Electrical power for engine start, and limited power in case of alternator / generator failure

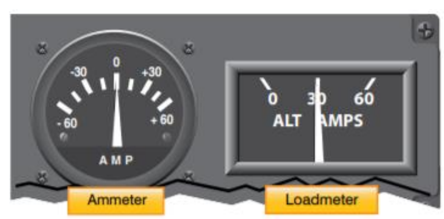
D. Power Distribution (bus bars)
  i. A bus bar is used to connect the main electrical system to the equipment using electricity

a. Distributes power from the alternator / generator / battery to the electrical components



E. Protection
  i. Fuses or circuit breakers protect the circuits and equipment from electrical overload
    a. Circuit breakers can be manually reset, rather than replaced (like a fuse), if an overload occurs

F. Indications
  i. Ammeter
    a. Monitors the performance of the aircraft electrical system
    b. Indications
      - Zero in the center, negative to L, positive to R
        a Positive: shows battery charge rate
        b Negative: shows battery discharge rate
      - Full scale deflection (+ or -) indicates a malfunction



    c. Not all aircraft have an ammeter, may just have a warning light to indicate a malfunction
  ii. Loadmeter
    a. Shows the load on the alternator/generator (% of load on the system)
    b. With all components off it reflects on the amount of charge demanded by the battery

14. Avionics

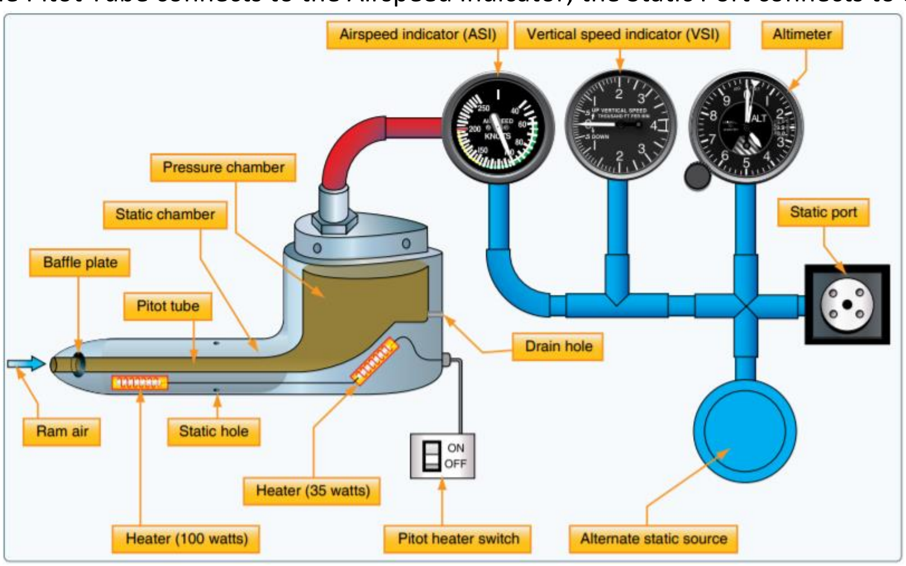
A. Avionics can vary greatly, especially with the advent and large-scale acceptance of glass displays
  i. Electronic instrument displays, GPS's, autopilots, radios, traditional instruments (vacuum, gyro, etc.)

a. G1000, Avidyne, etc.
ii. Be familiar with the avionics displays and instruments associated with your aircraft and their use
a. Manage automation
b. Do not become distracted with the seemingly unlimited functionality of glass cockpits
c. Reference the avionics user manual(s)
B. Autopilot
i. Automatic flight control system that keeps an aircraft in level flight or on a set course
ii. Reduces physical and mental demands on a pilot and increases safety
iii. Autopilots vary greatly in complexity
a. The simplest systems use gyroscopic attitude indicators and magnetic compasses to control servos connected to the flight control system
b. The number and location of the servos depends on the complexity of the system
- A single-axis autopilot controls the aircraft about one axis, a servo actuates the flight control
- A 3-axis autopilot controls the aircraft about the longitudinal, lateral, and vertical axes
  a Three different servos actuate ailerons, elevator, and rudder
- More advanced systems include a vertical speed and / or indicated airspeed hold mode
- Advanced autopilot systems are coupled to navigational aids through a flight director

iv. Most systems incorporate a disconnect safety feature to disengage the system in case of a problem
C. Because systems differ widely in their operation, refer to the manufacturer's operating instructions

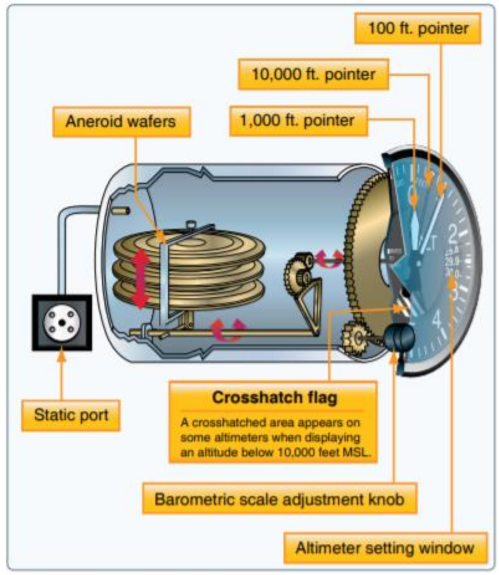
15. Pitot-static, Vacuum Pressure, and Associated Flight Instruments

A. Pitot-Static Flight Instruments
i. System that utilizes the static and impact pressure from the motion of the aircraft through the air
a. Airspeed indicator, altimeter, and vertical speed indicator
ii. How it Works
a. Static Pressure (still pressure) is measured at a flush static port where air is not disturbed
b. Pitot Pressure (impact pressure) is measured through a pitot tube pointed into the relative wind
c. The Pitot Tube connects to the Airspeed Indicator; the Static Port connects to all 3 instruments



iii. Sensitive Altimeter
a. Measures absolute pressure of the ambient air, displays it as feet above selected pressure level
b. Principle of Operation
- Air pressure tries to compress aneroid wafers while natural springiness tries to expand them
  a Compression and expansion move gears/linkages to change the altitude displayed

- Adjustable barometric scale (Kollsman window)
    - a Allows you to set the reference pressure from which the altitude is measured
    - b 1” Hg is equal to 1,000’
    - c Pressure Alt = 29.92” Hg
    - d Indicated Alt = local altimeter setting

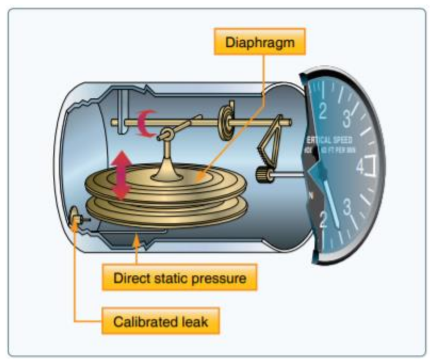


c. Errors (Mechanical and Inherent)
- Nonstandard Temperature
    - a Warmer than standard air is less dense, pressure levels are farther apart
        1. True altitude > Indicated altitude
    - b Colder than standard air is denser, pressure levels are closer together
        1. True altitude < Indicated altitude
- Nonstandard Pressure
    - a High pressure to Low pressure
        1. As pressure decreases, the altimeter registers it as a climb
        2. Pilot descends to maintain altitude
        3. True altitude < Indicated altitude
    - b The opposite applies from Low pressure to High pressure – True alt > Indicated alt
- REMEMBER: From hot to cold, or from high to low, look out below!

iv. Vertical Speed Indicator

a. Differential pressure instrument

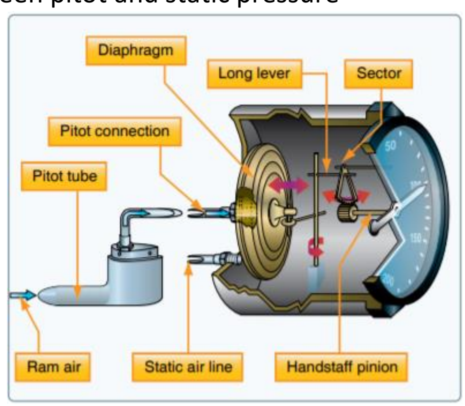
b. Operation
- Diaphragm and casing are connected to static pressure
    - a Diaphragm is directly connected
    - b Case has a delayed connection
- During a climb / descent, the diaphragm expands / contracts immediately, while pressure in the case remains the same for a short period
- The difference in pressure is displayed as rate of climb



v. Airspeed Indicator

a. Differential pressure gauge indicating the difference between pitot and static pressure

b. Operation
- Diaphragm receives pressure from the pitot tube
- Instrument case receives pressure from static port
- Increasing pitot pressure / decreasing static pressure expands the diaphragm and vice versa
- Gearing indicates changes in airspeed

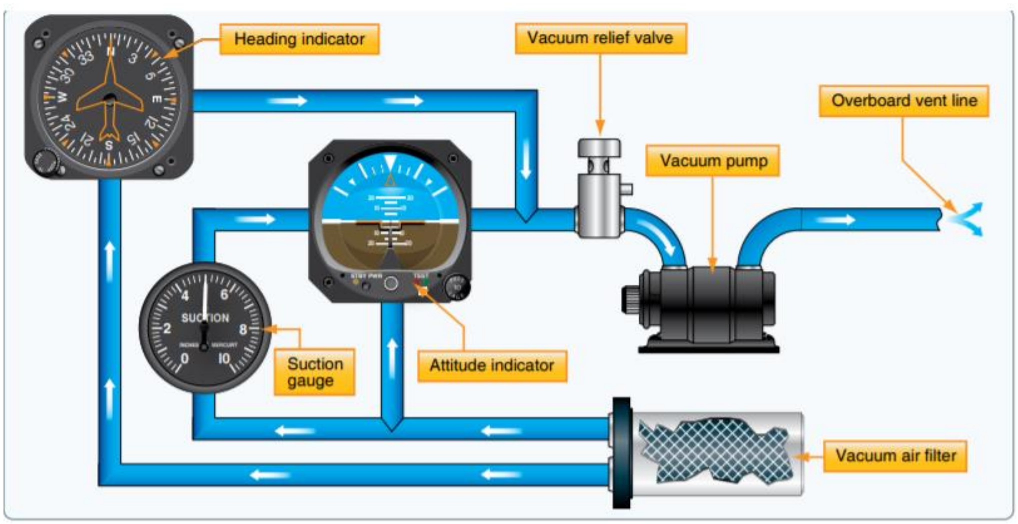


vi. Electronic Flight Display

a. General
- Same information (airspeed, altitude, VSI) is displayed, but via new methods

b. Air Data Computer (ADC)
- Information is still received from pitot / static inputs, but the processing is different
- ADC takes the pitot / static inputs and displays airspeed, altitude, VSI
    - a No diaphragms, gearing, linkages

B. Gyroscopic System (Attitude Indicator, Heading Indicator, Turn Coordinator)
  i. How it Works
    a. Heavy, fast spinning wheel/rotor mounted to utilize characteristics of spin
    b. The 2 characteristics of gyroscopes: Rigidity and Precession
      - Rigidity: Gyro remains in a fixed position in the plane in which it is spinning
        a Attitude/Heading instruments operate on the principle of rigidity
      - Precession: Any applied force is felt 90º from that point in the direction of rotation
        a Turn indicators/coordinators (rate instruments) operate on the principle of precession
    c. Power Sources
      - Electrical Systems
      - Pneumatic (vacuum) – Driven by jet of air impinging on buckets in the outside of the wheel
      - Venturi Tube Systems
        a Air flows through venturi tubes mounted on the outside of the aircraft
          1. The constricted part of the tube (low pressure) creates a suction for the instruments
      - Wet-Type Vacuum Systems
        a Steel vane air pumps are used to evacuate the instrument cases
        b The vanes in the pumps are lubricated with oil which is discharged with the air
      - Dry-Air Pump Systems
        a At high altitudes, more air is needed in the instruments as the air is less dense
          1. Air pumps that do not mix oil with the discharge air are used in high flying
        b Vanes are made of a special formulation of carbon which do not need lubricating
      - Pressure Systems
        a 2 dry pumps (one per engine) with a regulator to maintain desired pressure
        b Inline filters remove contamination, from there into a manifold check valve
        c If either engine / pump fails, the check valve isolates the bad side / uses the good side
        d After driving the gyros, air is exhausted from the case
        e Gyro pressure gauge measures the pressure drop across the instruments



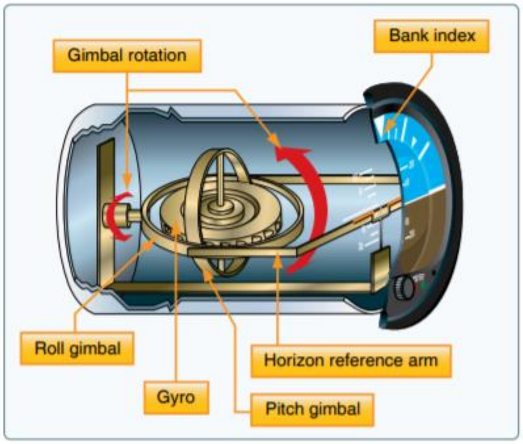
ii. Attitude Indicator

a. Operation

- Mounted in a horizontal plane
- Double gimbal - allows display of pitch and roll
- Horizon disk is attached to the gimbals
    a Remains in the same plane as the gyro and the plane pitches / rolls about it
- Adjustable mini aircraft appears to be flying relative to the horizon

b. Errors

- Free from most errors, but…
    a May be a slight nose-up indication during a rapid acceleration and vice versa
    b Possibility of a small bank angle and pitch error after a 180° turn
    c Tiny amounts of friction over time can cause precession / tilting – erection mechanism (pull the knob) returns the gyro to the proper position



iii. Heading Indicator

a. Gyro turns in a vertical plane

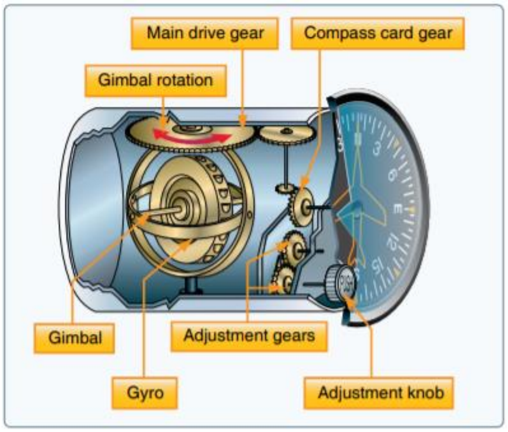
- Senses rotation about the plane's vertical axis

b. Compass is used to set the appropriate heading

- Rigidity causes it to maintain this heading

c. Precession causes heading to drift, and Earth rotates at 15° per hour

- Precession + rotation means heading should be checked / reset approximately every 15 min



iv. Turn-and-Slip Indicator

a. Shows rate of turn in degrees per second

b. Gyro rotates in the vertical plane showing movement around the longitudinal axis

c. Due to precession, a yawing force causes the gyro to tilt left or right

d. Turn needle displays direction and rate of turn

v. Turn Coordinator

a. Like Turn-and-Slip Indicator, but mounted at an angle – initially shows roll rate, then rate of turn

b. Rapid roll rate causes the miniature aircraft to bank more steeply than a slow roll rate

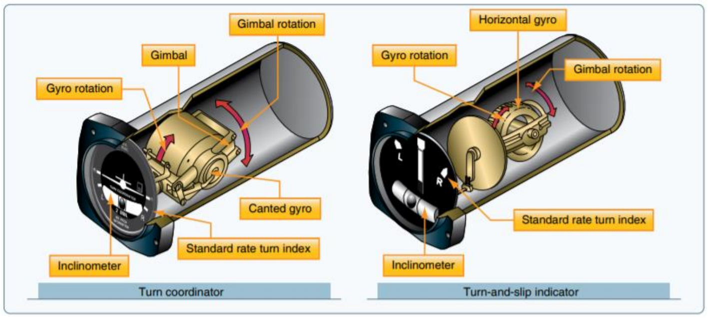
c. Align the wing of the miniature aircraft with the turn index for standard rate (3° per second)

vi. Electronic Flight Display

a. Gyroscopic instruments replaced with AHRS (attitude and heading reference system)

b. AHRS

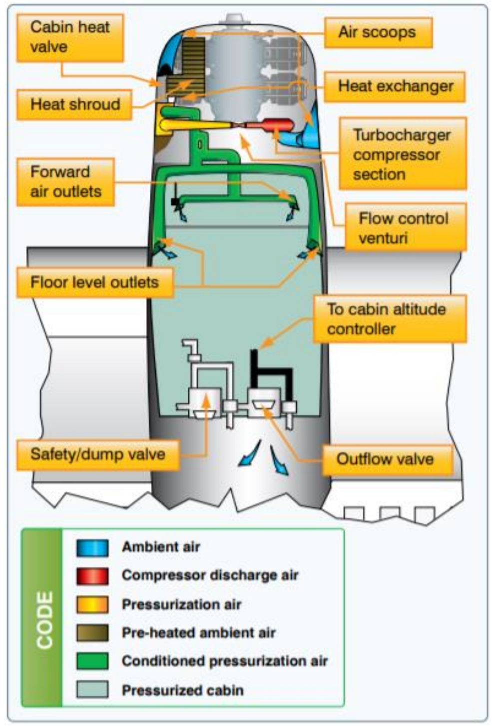
- Spinning gyros are replaced with solid-state laser systems that do not tumble
- Heading information comes from a magnetometer that senses earth's lines of magnetic flux
- All the information is processed and then sent to the PFD to be displayed



16. Environmental Systems

A. Heating
   i. Many different types of heating systems (Exhaust, Fuel Fired, Combustion, Bleed Air)
   ii. Exhaust Heating Systems – Simplest type of heating system, used on most light aircraft
      a. Outside air is ducted through a shroud around the muffler
         - Muffler is heated by exiting exhaust gases, and in turn heats the air around the muffler
         - Heated air is ducted to the cabin for heat and defrost
      b. Exhaust must be in good condition / free of cracks to ensure gases don't enter the cabin
   iii. Fuel Fired Heaters – A small mounted or portable space-heating device
      a. Fuel is brough to the heater's combustion chamber
      b. A fan blows air into the chamber, and an ignition device ignites the fuel-air mixture
      c. Air is ducted around the combustion chamber's outer surface
      d. A second fan blows the warm air into tubing which takes it to the cabin
   iv. Combustion Heater Systems – Often used to heat larger, more expensive aircraft
      a. Operation
         - Burns the aircraft's fuel in a combustion chamber or tube to develop heat
         - Air flowing around the tube is heated and ducted to the cabin
         - Exhaust exits through the heater's exhaust pipe
         - System is activated by the thermostat (fuel is turned on/off based on cabin temperature)
      b. Very Safe
         - Overheat switch – shuts off fuel in the case of a malfunction
         - Unlikely for carbon monoxide poisoning to occur
            a Low pressure in the combustion tube, high pressure outside the combustion tube
            b If there were a leak, high-pressure air would flow into the chamber / exit the exhaust
   v. Bleed Air Heating Systems – Used on turbine-engine aircraft
      a. Extremely hot, compressed engine bleed air is ducted into a chamber where it is mixed with ambient / re-circulated air to cool it to a useable temperature, and then is ducted into the cabin
      b. Safety Features
         - Temperature sensors prevent excessive heat from entering the cabin
         - Check valves prevent losing bleed air during engine start and when full power is required
         - Engine sensors eliminate the bleed system if the engine becomes inoperative

B. Pressurization
   i. General
      a. Aircraft are flown at high altitudes for two reasons:
         - More efficient - Less fuel consumed for a given airspeed
         - Bad weather and turbulence may be avoided by flying above the storms
      b. Pressurization is necessary to protect occupants from threats of high altitudes
   ii. How it Works
      a. The cabin, flight and baggage compartments are a sealed unit capable of containing air under a higher pressure than the outside atmospheric pressure (Differential Pressure)
         - Differential Pressure – the difference between the pressure acting on one side of a wall and the pressure acting on the other side of the wall (cabin pressure vs atmospheric pressure)
      b. Atmospheric air is compressed. Different aircraft compress the air in in different ways:
         - Turbine aircraft – bleed air from the engine compressor is used to pressurize the cabin
         - Older turbine aircraft – superchargers are used to pump air into the sealed fuselage
         - Piston aircraft – Air from the turbocharger through a sonic venturi (flow limiter)



c. Compressed air is conditioned / sent to the cabin
d. Air exits the fuselage through an outflow valve

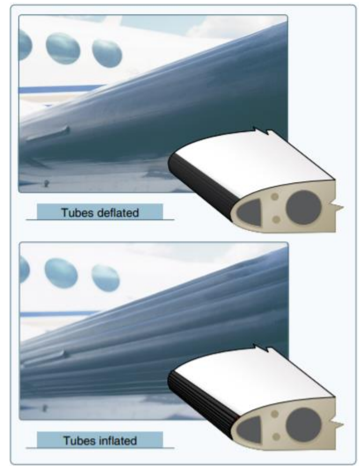
iii. Cabin Pressure Control System
   a. Cabin Pressure Regulator – controls cabin pressure
   b. Outflow Valve
      - Air exits the fuselage through the outflow valve
      - Allows for a constant inflow of air, while maintaining the proper differential pressure
   c. Cabin Air Pressure Safety Valve
      - Combination of a pressure relief, vacuum relief, and dump valve
      - Pressure relief valve prevents cabin pressure from exceeding maximum differential pressure
      - Vacuum relief valve prevents ambient pressure from exceeding cabin pressure
      - Dump valve dumps the cabin air into the atmosphere (emergency situations)

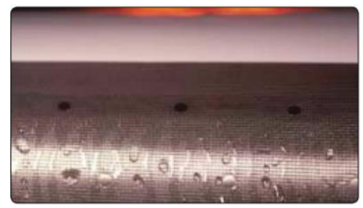
iv. Instruments
   a. Cabin differential pressure gauge – Indicates the difference between inside and outside pressure
   b. Cabin Altimeter – Shows the altitude inside the airplane
      - Differential pressure gauge and cabin altimeter can be combined into one instrument
   c. Cabin Rate of Climb/Descent – Shows rate the cabin altitude is changing during climb / descent

17. Deice and Anti-Ice Systems

A. General
   i. Anti-ice equipment is designed to prevent the formation of ice
   ii. Deice equipment is designed to remove ice once it has formed
   iii. Protect numerous parts of the aircraft – leading edge of wing and tail, pitot / static ports, fuel tank vents, stall warning devices, windshields, propeller blades

B. Airfoil
   i. Deicing Boots – Inflatable boots consisting of a rubber sheet bonded to the leading edge of the wing
      a. Operation
         - Engine-driven pump, or engine bleed air, inflates the rubber boots breaking up the ice
         - Single cycle operation, or at automatic, timed intervals
      b. Instruments – Suction and pneumatic pressure gauges
   ii. Thermal Anti-Ice System – Heat driven system
      a. Hot air is directed from the engine compressor to the leading-edge surfaces to prevent ice
      b. Should be activated prior to entering icing conditions





- iii. Weeping Wing (pictured, bottom right)
    - a. Antifreeze solution is pumped to the leading edge of the wings and weeps through small holes
    - b. Capable of deice and anti-ice
    - c. Antifreeze chemically breaks down the bond between the ice and airframe, allowing aerodynamic forces to remove the ice
- C. Windscreen
    - i. Alcohol - Flow of alcohol is directed to the windscreen
        - a. Used early enough, prevents ice buildup on the windscreen
    - ii. Electric Heat
        - a. Wires or other conductive material imbedded in the windscreen
        - b. Operated by a switch in the cockpit
- D. Propeller
    - i. Alcohol - Used to prevent ice forming on the propeller's leading edge
        - a. Released from nozzles, centrifugal force distributes it on props
        - b. Grooves in propeller boots to help direct the flow of alcohol
    - ii. Electric Heat – Anti-ice boots with electrical wires to heat the props

Conclusion:
Brief review of the main points
A thorough understanding of the airplane's systems makes a safer, smarter pilot.

III.D. Performance and Limitations

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), POH/AFM

Objectives	The student should develop knowledge of the elements related to airplane performance and limitations as required in the necessary ACS/PTS.
Key Elements	1. Density 2. Density Altitude 3. Airplane Performance
Elements	1. Determining Weight and Balance 2. Atmospheric Conditions and Performance 3. Performance Charts 4. Determining the Required Performance is Attainable 5. Exceeding Airplane Limitations
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to calculate the airplane's performance based on the current or expected conditions of a flight and decide whether or not the performance will suffice.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

How exciting would it be to find out firsthand, that the airplane actually doesn't have the ability to takeoff from a certain runway and that it also doesn't have the ability to clear the obstacle at the departure end?

Overview

Review Objectives and Elements/Key ideas

What

The Performance and Limitations section of the POH contains the operating data for the airplane; that is, the data pertaining to takeoff, climb, range, endurance, descent, and landing.

Why

The use of the operating data for the airplane is mandatory for safe and efficient operations

How:

1. **Determining Weight and Balance**
    - A. CG = Total Moment divided by Total Weight
    - B. Begin with the empty weight and make a list of everything that will be loaded in the airplane
        - i. Be sure the weight of what you want to load is within the maximum weight limits
    - C. Calculate the Moments of each item
        - i. The weight and moment of the airplane can be found in the weight and balance documents
        - ii. For the other items, use the tools available in the POH (graphs, and / or arms)
    - D. Calculate the total CG – Total Moment ÷ Total Weight
2. **Atmospheric Conditions and Performance**
    - A. Atmospheric Pressure
        - i. Under standard conditions at sea level, the average pressure is approx. 14.7 lbs. per sq. in
        - ii. Since air is a gas, it can be compressed or expanded
        - iii. Air density effects performance: As density increases, performance increases and vice versa
    - B. What Changes Air Density (DA)?
        - i. Barometric Pressure, Temperature, Altitude, and Humidity
            - a. Density varies directly with pressure - As pressure increases, density increases and vice versa
            - b. Density varies inversely with temperature – As temp increases, density decreases and vice versa
            - c. Density varies inversely with altitude - As altitude increases, density decreases and vice versa
            - d. Density varies inversely with humidity – As humidity increases, density decreases and vice versa
    - C. Density and Performance
        - i. As the air becomes less dense, it reduces:
            - a. Power, since the engine takes in less air
            - b. Thrust, since the propeller is less efficient in thin air (less air is being moved for every rotation)
            - c. Lift, because the thin air exerts less force on the airfoils
3. **Performance Charts**
    - A. Airplane performance is found in Section 5 of the POH (Performance and Limitations)
    - B. Using the performance charts, and the accompanying instructions, we can calculate
        - i. Cruise Performance
        - ii. Stall Speeds based on airplane configuration

    iii. Wind Components (Crosswind and Headwind)
    iv. Takeoff Distance and Landing Distance
    v. Climb Performance (In cruise and takeoff configurations as well as Balked Landing)
    vi. True Airspeed
    vii. Maximum Flight Duration (Chart in which the Pressure Altitude is combined with RPM to find % bhp, KTAS, GPH)
  C. In order to make use of these charts we need to know the Pressure Altitude (PA)
    i. PA – The altitude indicated when the altimeter setting window is set to 29.92
      a. PA = 1,000(29.92-Current Altimeter Setting) + Elevation
        - EX: Altimeter = 30.42 and Elevation = 808, so PA = 308’
    ii. From Pressure Altitude we can compute Density Altitude (DA)
      a. DA: PA corrected for non-standard temperature (Directly related to airplane performance)
      b. DA = 120(Current Temperature – ISA temperature) + PA (estimate of DA, it’s not exact)
        - EX: Temp = 23°C and PA = 308’, so DA = 1,268’
  D. With pressure altitude and density altitude, we can use the charts in the POH to calculate performance

4. Determining the Required Performance is Attainable
  A. Use the performance charts and relate them to the airport information (runway lengths, etc.)
    i. The charts will provide performance for all phases of flight
  B. Remember, the charts don’t make allowance for pilot proficiency or mechanical deterioration
  C. If conditions change, recalculate performance

5. Exceeding Airplane Limitations
  A. Operating Limitations are in Chapter 2 of the POH
  B. Limitations establish the boundaries for which the airplane can be safely operated
  C. Adverse Effects
    i. Attempting to takeoff or land without enough runway
    ii. Attempting to clear an obstacle that the airplane performance will not support
    iii. Not having enough fuel to reach the airport of intended landing
    iv. Using the wrong type of fuel
    v. Exceeding the structural/aerodynamic limits (overweight or outside CG limits)
    vi. Exceeding the maximum crosswind component

Conclusion:
Brief review of the main points
It is very important that before every flight, the pilot ensures the airplane can produce the required performance depending on the airport and atmospheric conditions.

III.E. Airworthiness Requirements - General Overview

References: 14 CFR part 23, 39, 43, 91, Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), Min Equipment Requirements for GA Ops under Part 91 (AC 91-67), Sample Type Certificate, Sample MEL

Objectives	The student should exhibit knowledge of the elements regarding airworthiness requirements as necessary based on their respective ACS/PTS.
Key Elements	1. CFR 91.205 – Required Instruments 2. CFR 91.213(d) – Deferral without MEL 3. Required Inspections
Elements	1. Airworthiness without a MEL 2. Airworthiness with a MEL 3. Obtaining a Special Flight Permit 4. Appropriate Record Keeping
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The lesson is complete when the student can explain, and when necessary, locate the elements and documents related to airworthiness requirements.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Just as you would never scuba dive without your regulator operating properly or sky dive without the rip cord functioning, you should never fly an airplane without essential equipment working properly.

Overview

Review Objectives and Elements/Key ideas

What

Airworthiness requirements are the basis for deciding whether an aircraft is worthy of safe flight. They are what must be met to ensure an aircraft is safe and therefore legal to fly.

Why:

For an airplane to be airworthy specific documents must be on board and current, inspections must be completed, and instruments must be functioning, otherwise the airplane is unfit for flight and therefore un-airworthy or illegal to fly.

How:

1. **Airworthiness without a MEL** (Required Instruments and Equipment)
   - A. Widely used due to the simplicity and minimal paperwork
   - B. When inoperative equipment is found prior to flight, decide whether to:
     - i. Cancel the flight, have the inoperative equipment fixed prior to flight, or
     - ii. Continue the flight by deferring the inoperative equipment (FAR 91.213(d))
       - a. In order to defer, the item must not be required for flight (broken down below, in part C)
       - b. The inoperative equipment must be deactivated (or removed) and placarded INOPERATIVE
   - C. Required Equipment - 91.213(d) – Is the equipment required by any of the following:
     - i. 14 CFR 91.205: Required Instruments and Equipment for Day and Night VFR Flight
       - a. Visual-Flight Rules (Day), The following instruments and equipment are required:
         - Remember: TOMATO FFLAAMES
         - **T**achometer for each engine
         - **O**il pressure gauge for each engine
         - **M**anifold pressure gauge for each altitude engine
         - **A**irspeed Indicator
         - **T**emperature gauge for each liquid-cooled engine
         - **O**il temperature gauge for each air-cooled engine
         - **F**uel gauge indicating the quantity of fuel in each tank
         - **F**lotation gear (if operated for hire over water beyond power-off glide distance from shore)
         - **L**anding gear position indicator
         - **A**ltimeter
         - **A**nti-Collision Lights (if certified after March 11, 1996)
         - **M**agnetic compass
         - **E**mergency Locator Transmitter
         - **S**afety belts/Shoulder Harnesses
       - b. Visual-Flight Rules (Night), The following instruments and equipment are required:

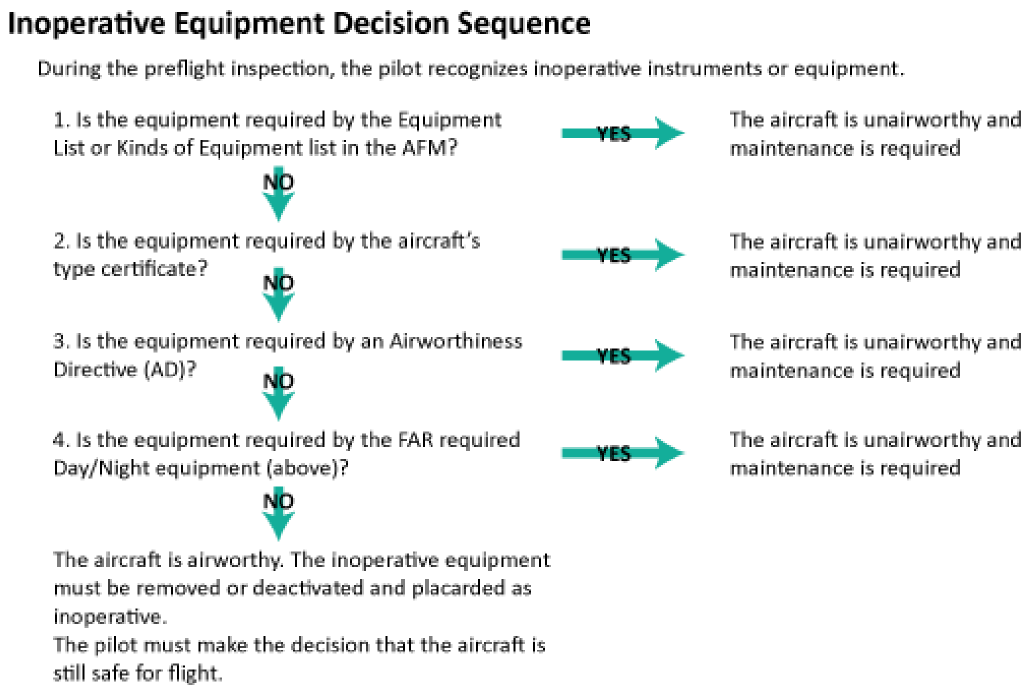
- All Instruments and equipment needed for VFR day flight are required, as well as:
- Remember: FLAPS
- **F**uses (if required)
- **L**anding Light (Electric)
- **A**nti-Collision Lights
- **P**osition Lights
- **S**ource of electricity for all installed electrical and radio equipment

ii. Kinds of Equipment List and Equipment List
   a. Kinds of Equipment List (chapter 2 of the POH)
      - Lists the manufacturer required equipment based on the type of flight (Day VFR, IFR, etc.)
   b. Equipment List (usually found in the weight and balance data, and / or the POH)
      - Specifies the required equipment and all equipment approved for installation in the aircraft

iii. Type Certificate
   a. A formal description of the aircraft, engine, or propeller. Lists limitations and information required for type certification including airspeed limits, weight limits, thrust limitations, etc.
   b. Can be found on the FAA TCDS Website
   c. The type certificate will specify things like the type of engine, propeller, number of seats, etc.
      - Things on the TC cannot be changed without a supplemental type certificate

iv. Airworthiness Directives (AD)
   a. Like a recall on a car – Used to notify pilots of unsafe conditions and specify the actions that must be taken to continue operating the aircraft (i.e., must fix / replace by a certain date)
   b. Two Categories of ADs:
      - Those of an emergency nature requiring immediate compliance prior to further flight
      - Those of a less urgent nature requiring compliance within a specific time period
   c. Regulatory in nature unless a specific exemption is granted
   d. If not complied with by the designated date and time, the aircraft is no longer airworthy
   e. Aircraft owner / operator's (PIC) responsibility to ensure compliance with ADs
   f. Compliance Records

- 14 CFR part 91.417 requires a record to be maintained showing the status of applicable ADs.



D. Required Inspections
   i. 14 CFR part 91 places responsibility on the owner/operator for maintaining airworthiness
      a. After inspections / repairs, the PIC is responsible for determining if in condition for safe flight
   ii. Inspections: Remember AV1ATE
      a. **A**nnual Inspection
         - Any reciprocating-engine powered or single-engine-turbojet/turbo-propeller powered small aircraft (less than 12,500 pounds) flown for business or pleasure and not flown for compensation or hire is required to be inspected at least annually
         - Requires an airframe and powerplant mechanic (A&P) with an Inspection Authorization (IA)
         - Special Flight Permit available for overdue aircraft – allows for flight to the inspection only
         - All applicable ADs must be complied with
         - Annual inspection may be substituted for a required 100-hour inspection
      b. **V**OR
         - Must have been checked in the preceding 30 days. A record must be kept (IFR Requirement)
      c. **1**00 Hour Inspection
         - All aircraft under 12,500 lbs. (except for turbo powered), used to carry passengers for hire or used for flight instruction for hire, must have received a 100-hour inspection
         - Accomplished by an A&P mechanic at an FAA certified repair station, or by the manufacturer
         - Annual inspection may be substituted for a required 100-hour inspection
         - Can exceed 100-hours by no more than 10 hours if enroute to the inspection location
            a Excess time used must be included in computing the next 100 hours of time in service
      d. **A**ltimeter/Pitot Static Inspection
         - FAR 91.411 – Altimeter and related system must be inspected in the last 24 months (IFR)
         - FAR 91.411 - The pitot / static system must be checked in the last 24 calendar months (IFR)
      e. **T**ransponder Inspection
         - FAR 91.413 – Tested and inspected in the last 24 months

        f. **E**LT Inspection
            - FAR 91.207(d) – If operations require an ELT, it must be inspected every 12 calendar months
    E. Required Documents
        i. Remember ARROW
            a. Airworthiness
            b. Registration
            c. Radio Operators License (if international)
            d. Operating Limitations (POH)
            e. Weight and Balance (specific to the aircraft tail number)

2. Airworthiness with a MEL
    A. Precise listing of required equipment based on the type of flight (less common in general aviation)
        i. Basically, combines FAR 91.205, Kinds of Equipment List, ADs, Type Certificate into one document
        ii. Considered to be a supplemental type certificate and is the authority to operate in a condition other than originally certificated
        iii. Must be requested from the FAA
    B. Required Equipment
        i. If equipment is broken, refer to the MEL to determine whether it is required for the type of flight
        ii. If the failed component is not listed as deferrable it must be repaired prior to flight
        iii. A special flight permit can be obtained if necessary to make the repairs
    C. Required Inspections – Same as above
    D. Required Documents – Same as above

3. Obtaining a Special Flight Permit
    A. FAR 21.197: Special Flight Permit - authorization that may be issued for an aircraft that may not currently meet applicable airworthiness requirements, but is safe for a specific flight
    B. Examples:
        i. Flying an aircraft to a base where repairs, alterations or maintenance are to be performed
        ii. Delivering or exporting an aircraft
        iii. Conducting customer demonstration flights
    C. Obtaining a Special Flight Permit
        i. Contact the local FSDO or Designated Airworthiness Representative (DAR)
        ii. FAR 21.199: Must submit a statement as prescribed by the FAA, indicating:
            a. Purpose of the flight and proposed itinerary
            b. Crew required to operate the aircraft / equipment
            c. The ways the aircraft does not comply with the applicable airworthiness requirement
            d. Restrictions necessary for safe operation of the aircraft
            e. Any other information considered necessary by the FAA
        iii. FAA Special Flight Permit Instructions (Allentown District Office instructions. Adjust as necessary)
        iv. Form 8130-6; FAA Special Flight Permit Regs & Policies

4. Appropriate Record Keeping (FAR 91.417)
    A. The 100-Hour / Annual inspection as well as the inspections required for instruments and equipment necessary for IFR / VFR flight are located in the aircraft and engine logbooks
    B. Removing/Installing equipment not on the Equipment List
        i. The AMT must change the weight and balance record to indicate the new empty weight and center of gravity; the equipment list is revised to reflect the equipment installed
    C. Repairs and Alterations
        i. Major

   a. 14 CFR part 43, Appendix A: Major alterations shall be approved for return to service on FAA Form 337, Major Repairs and Major Alterations, by a certificated repair station, an FAA certificated A&P mechanic holding an IA, or a representative of the Administrator

ii. Minor
   a. May be approved for return to service with a proper entry in the maintenance records by an FAA certificated A&P mechanic or an appropriately certificated repair station

Conclusion:
Brief review of each main point
The requirements and precautions mandated by the FAA are necessary to ensure the aircraft is in a safe condition for flight not only for legal reasons, but also for the safety of those onboard.

III.E. Airworthiness Requirements - FARS

References: 14 CFR Part 91

Objectives: The student should exhibit knowledge of the elements regarding airworthiness requirements as necessary based on their respective ACS/PTS.

Elements:
1. FAR 91.3 - Responsibility and Authority of the PIC
2. FAR 91.7 - Civil Aircraft Airworthiness
3. FAR 91.9 - Civil Aircraft Flight Manual, Marking, and Placard Requirements
4. FAR 91.203 - Civil Aircraft: Certifications Required
5. FAR 91.205 - Instrument and Equipment Requirements
6. FAR 91.213(d) - Inoperative Instruments and Equipment
7. FAR 91.400's - Maintenance, Preventative Maintenance, and Alterations (Subpart E)
8. FAR 91.207 - Emergency Locator Transmitters (ELT)

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

Equipment:
1. White board and markers
2. References

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

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

Completion Standards: The lesson is complete when the student can explain, and when necessary, locate the elements and documents related to airworthiness requirements.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Just as you would never sky dive without a properly functioning parachute, you should never fly an airplane without essential equipment working properly.

Overview

Review Objectives and Elements/Key ideas

What

Airworthiness requirements are the basis for deciding whether an aircraft is worthy of safe and legal flight.

Why:

For an airplane to be airworthy certain documents must be on board and current, inspections must be completed, and instruments must be functioning, otherwise the airplane is unfit for flight and therefore un-airworthy or illegal to fly. This lesson provides guidance as to whether the airplane is airworthy or not.

How:

1. **FAR 91.3 - Responsibility and Authority of the PIC**
    A. *The PIC is directly responsible for, and is the final authority as to, the operation of the plane*
    B. In an in-flight emergency, the PIC may deviate from any rule of this part to the extent required
2. **FAR 91.7 - Civil Aircraft Airworthiness**
    A. No person may operate a civil aircraft unless it is in an airworthy condition
        i. Airworthiness: Read the Airworthiness Certificate (Best definition of airworthiness)
            a. Authority and Basis for Issuance
                - States the aircraft must conform to the type certificate
                    a Cannot be changed from type certificate; must be in the condition it left the factory in
                - Only way the airplane can be changed is with a supplemental type certificate
            b. Terms and Conditions
                - States that the aircraft must be maintained in accordance with the FARS
    B. The PIC of a civil aircraft is responsible for determining whether that aircraft is in condition for safe flight and shall discontinue the flight when un-airworthy mechanical, electrical, or structural conditions occur
        i. This is the only FAR which mentions a visual inspection, i.e., in condition for safe flight
3. **FAR 91.9 - Civil Aircraft Flight Manual, Marking, and Placard Requirements**
    A. No person may operate a U.S.-registered civil aircraft:
        i. For which an Airplane Flight Manual (AFM) is required by FAR 21.5 unless there is available in the aircraft a current, approved Flight Manual or the manual provided for in FAR 121.141(b)
            a. Weight and Balance is included in the AFM, but is part of the type certificate and thus required
        ii. For which an AFM is not required by FAR 21.5 of this chapter, unless there is a current approved AFM, approved manual material, markings, and placards, or any combination thereof
    B. FAR 91.9 also states that without the AFM, all placards, markings, etc. must be in the aircraft
    C. Reference FAR 21.5 for aircraft not certificated with an AFM and with no flight time prior to March 1979
4. **FAR 91.203 - Civil Aircraft: Certifications Required**
    A. Except as provided in FAR 91.715, no person may operate a civil aircraft unless it has the following:
        i. An appropriate and current airworthiness certificate…

a. Must be displayed at the cabin or cockpit entrance so that it is legible to passengers or crew

ii. An effective U.S. registration certificate issued to its owner…

5. **FAR 91.205 - Instrument and Equipment Requirements**
   - A. The bare minimum instruments and equipment required for day/night VFR flight and IFR flight
     - i. VFR – TOMATOFFLAAMES (day) and FLAPS (night)
     - ii. IFR - GRABCARD
6. **FAR 91.213(d) - Inoperative Instruments and Equipment**
   - A. With an MEL – follow the MEL guidance
     - i. An FAA approved listing of instruments/equipment that may be inoperable and remain airworthy
   - B. Without an MEL – FAR 91.213(d)
     - i. Follow the flow provided in AC 91-67 (Caution: AC 91-67 has been cancelled)
       - a. Is it required by the aircraft's equipment list or the kinds of equipment list?
       - b. Is it required by the VFR type certificate requirements prescribed in the airworthiness certification requirements?
       - c. Is it required by an AD?
       - d. Is it required by FAR 91.205, 91.207, etc.?
       - e. If no, the inoperative equipment must be removed or deactivated and placarded as inoperative
         - FAR 91.405 - Repair, replace, or remove inop equipment at the next required inspection
       - f. Finally, the PIC decides whether the equipment creates a hazard for the anticipated flight
7. **FAR 91.400's - Maintenance, Preventative Maintenance, and Alterations (Subpart E)**
   - A. FAR 91.401 – Applicability: Rules governing maintenance, preventative maintenance, alterations
   - B. FAR 91.405 - Maintenance Required
     - i. Each owner or operator of an aircraft:
       - a. Shall have the aircraft inspected… and between inspections, have discrepancies repaired
       - b. Shall ensure maintenance personnel make appropriate entries in the maintenance records…
       - c. Shall have any inoperative instrument/equipment, permitted to be inoperative by FAR 91.213(d)(2), repaired, replaced, removed, or inspected at the next required inspection
       - d. When listed discrepancies include inoperative instruments or equipment, shall ensure that a placard has been installed as required by FAR 43.11 of this chapter
   - C. FAR 91.409 - Inspections
     - i. Annual Inspection requirement
     - ii. 100-hour inspection requirement, if for rent or for hire
   - D. FAR 91.411 - Altimeter system and Altitude Reporting Equipment Tests and Inspections
     - i. Static Pressure System and Altimeter tests required for IFR flight (every 24 calendar months)
   - E. FAR 91.413 - ATC Transponder Tests and Inspections
     - i. Transponder tests and inspections required (every 24 calendar months)
8. **FAR 91.207 - Emergency Locator Transmitters (ELT)**
   - A. Inspection requirements: Every 12 calendar months
   - B. The batteries must be replaced (or recharged)
     - i. When transmitter has been in use more than 1 cumulative hour, or 50% of useful life has expired

Conclusion:

Through the FARS mentioned here, we find that the PIC is the final authority as to the safety of the flight. Airworthiness requires conforming to the type certificate, as well as the required maintenance and inspections. To be airworthy, the documents required onboard are the airworthiness certificate, the registration, operating limitations (AFM), as well as the weight and balance (part of the type certificate). We have found the required equipment as well as the process for determining whether the airplane is airworthy in the case of inoperative equipment. Finally, the FARs provided the necessary inspections needed to maintain airworthiness.

PREFLIGHT LESSON ON A MANEUVER TO BE PERFORMED IN FLIGHT

IV.A. Maneuver Lesson

The examiner must select at least one maneuver Task from Areas of Operation VII through XIII and ask the applicant to present a preflight lesson on the selected maneuver as the lesson would be taught to a student.

All information necessary for this lesson is found in sections VII through XIII

PREFLIGHT PROCEDURES

V.A. Preflight Inspection

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to a comprehensive preflight inspection. The student will understand what to look for during each part of the inspection and have the ability to perform the preflight inspection as required by the checklist and the ACS/PTS.
Key Elements	1. Aircraft Specific Checklist 2. Airworthy and Safe 3. Fuel Grade and Contamination 4. *Oil Level (4-6 Quarts)
Elements	1. Reasons for the Preflight Inspection 2. Checklist 3. Preflight Overview 4. What to Inspect 5. Detecting Problems 6. Ice and Frost 7. Loading and Securing 8. Determining the Airplane is Safe
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can perform a comprehensive preflight inspection, understanding what to look for at each part of the inspection. The student will be able to determine whether or not the airplane is airworthy and in a condition for safe flight.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Interesting fact or attention-grabbing story

We don't want to find a problem with the airplane while we're in the air. For that reason, we perform a thorough preflight on the ground, allowing us to find and fix any problems before getting airborne, where issues are considerably more difficult to deal with.

Overview

Review Objectives and Elements/Key ideas

What

A thorough check of the airplane to ensure airworthiness and safety prior to flight.

Why

The accomplishment of safe flight begins with a careful preflight inspection. The preflight inspection determines the airplane is legally airworthy, and that it is in a condition for safe flight.

How:

1. **Reasons for the Preflight Inspection**
   A. Ensures the airplane meets airworthiness standards and is in a safe condition prior to flight
2. **Checklist**
   A. The POH must be the reference for the preflight inspection (Chapter 4)
   B. Always have the checklist on hand as a reference to ensure everything is checked
   C. Common Errors – Failure to use, or the improper use, of a checklist
   D. Common Error – Hazards which may result from distractions interrupting an inspection
3. **Preflight Overview**
   A. The preflight logically moves around the airplane to ensure it is in a condition for safe flight
   B. Begins while approaching the airplane on the ramp – Note the overall appearance / any issues
4. **What to Inspect**
   A. Inside the Cockpit
      i. Airworthiness - Required Documents (AROW)
      ii. Logbooks – Ensure tests / inspections complied with (may not be kept in the cockpit)
      iii. Items located inside the airplane / items controlled inside the plane (lights, pitot heat, etc.)
   B. Exterior of the Airplane
      i. Follow the checklist and inspect all exterior portions of the airplane
      ii. Common Error - Inability to recognize discrepancies to determine airworthiness
5. **Detecting Problems**
   A. Visible Structural Damage (follow the POH procedures and inspection requirements)
      i. Check for dents, cracks, bending, separating, etc.
      ii. Check for leaks / stains as they are signs of potential problems
      iii. Look for missing rivets, bolts, etc.
      iv. Inspect the propeller for damage including nicks and cracking
   B. Flight Controls
      i. Move freely / correctly and are properly attached
      ii. Check the flap movement and connections

C. Fuel Quantity and Contamination
   i. Confirm the fuel quantity indicated on the gauge
   ii. Contamination
      a. Type, Grade of Fuel – Critical to safe flight
         - Looking for 100LL (AVGAS) – Blue with a familiar gasoline scent
      b. Supervise fueling to ensure the right fuel type / grade and ensure the caps are in place
         - 80 is Red; 100LL is Blue; 100 is Green; Jet Fuel is Clear (kerosene scent)
      c. Water and Other Sediment
         - Water is heavier than fuel and therefore accumulates in the low points
         - Sediment can come from dust / dirt entering the tanks
      d. Check the Grade and Remove Water and Other Contamination
         - Drain fuel from the sumps. Check for color, smell, water / contamination
            a Water is usually in bubbles, a different in color, and at the bottom of the sample
         - If water or contaminants are found, drain until they have been removed

D. Oil Quantity and Contamination
   i. Verify the oil is at an acceptable amount
      a. The plane uses a small amount each flight, large changes in oil could indicate a problem
      b. Check the oil when the engine is cold (proper reading, oil is settled at the bottom)
   ii. Contamination can be detected by discoloration
      a. Oil darkens as operating hours increase; rapidly dark oil may point to cylinder problems

E. Common Error - Failure to ensure servicing with the proper fuel and oil

F. Leaks (Fuel, Oil, Hydraulic) – verify no leaks under the plane, in the cowling, on the struts, etc.

6. Ice and Frost

A. Small amounts of ice / frost can disrupt airflow over the wing, increase stall speed, reduce lift

B. Do not fly unless the ice / frost is removed in accordance with the requirements in the POH

7. Loading and Securing (Baggage, Equipment, Cargo)

A. Ensure everything is properly loaded and secured prior to flight (verify the CG matches)

B. Secure everything properly to prevent movement during flight (possible damage, or CG change)

C. Common Error - Failure to ensure proper loading / securing of baggage, cargo, and equipment

8. Determining the Airplane is Safe

A. During the preflight, note any issues and make an educated go / no go decision
   i. If there are questions as to whether the airplane is safe, ask for help (CFI, maintenance, etc.)

B. Follow the recommendations in the POH, as well as those learned from experience
   i. Do not let emotion, outside pressure, or any undue influence sway you from safety

C. Remember, FAR 91.3: The PIC is the final authority to the operation of the aircraft

Common Errors:

- Failure to use or the improper use of a checklist
- Hazards which may result from allowing distractions to interrupt a visual inspection
- Inability to recognize discrepancies to determine airworthiness
- Failure to ensure servicing with the proper fuel and oil
- Failure to ensure proper loading and securing of baggage, cargo, and equipment

Conclusion:

Brief review of the main points

A safe flight begins with a thorough preflight as prescribed in the airplane's POH. This preflight inspection ensures the airplane is both airworthy and safe for flight.

V.B. Cockpit Management

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to cockpit management. The student should maintain an organized cockpit and properly position all controls for correct use. All equipment should be fully understood in order to assist in utilizing all possible resources.
Key Elements	1. Good Housekeeper 2. Passenger Briefings 3. Internal and External Resources
Elements	1. Arranging and Securing Materials and Equipment 2. Use and Adjustment of Cockpit Items 3. Occupant Briefing 4. Resource Utilization
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can efficiently and safely complete a flight as described in cockpit management.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

All pilots need to learn to be good housekeepers. The airplane is your house, and you need to be sure it stays clean and organized.

Overview

Review Objectives and Elements/Key ideas

What

Cockpit management (single pilot resource management) is a process that combines you, the airplane, and the environment for safer and more efficient operations.

Why

Understanding the elements behind cockpit management provides for a more efficient and safer flight.

How:

1. **Arranging and Securing Materials and Equipment**
    - A. Arranging
        - i. Ensure that all the necessary equipment, documents, checklists, and charts are on board
        - ii. Materials should be organized in a manner that makes them readily available for use
    - B. Securing
        - i. Check for loose items which might be tossed about during flight, or if turbulence is encountered
    - C. Form the habit of "good housekeeping;" in the long run, it will pay off in safer and more efficient flying
    - D. Common Error - Failure to place / secure essential materials and equipment for easy access during flight
2. **Use and Adjustment of Cockpit Items**
    - A. Seats
        - i. On each flight, the pilot should be seated in the same position. Verify the seat is locked in position
            - a. Adjust for the proper viewing height as directed in the POH
    - B. Seat Belt/Harnesses
        - i. When seated, the seat belt/harness should be adjusted to a comfortable, snug fit
            - a. Shoulder harness must be worn at least for taxi, takeoff, and landing
            - b. The safety belt must be worn all times at the controls
    - C. Rudder Pedals
        - i. Adjust the rudder pedals forward or backward
            - a. Ensure full, comfortable range of motion of the rudders and brakes
    - D. Common Error - Failure to properly adjust cockpit items, like safety belts, harnesses, rudder pedals, seat
        - i. Improperly adjusted items can result in difficulty flying and / or controlling the airplane
    - E. Common Error - Failure to provide proper adjustment of equipment and controls
        - i. Same as above
3. **Occupant Briefing**
    - A. Safety Belts
        - i. FAR 91.107 - Each person must be briefed on operation of their seat belt and shoulder harness
            - a. Ensure each person has fastened their safety belt/shoulder harness for taxi, takeoff, landing
    - C. FAASafety passenger briefing discussion and briefing card – Passenger Briefing
    - D. Common Error - Failure to provide occupant briefing on emergency procedures and use of safety belts

4. Resource Utilization

A. Resources can be found both inside and outside the cockpit. Think outside the box if necessary
B. Internal Resources
    i. POH, checklists (normal and emergency), charts
    ii. Satellite and / or app data, if equipped; documents loaded on a tablet
    iii. Equipment - A thorough understanding of the equipment is necessary to fully utilize all resources
    iv. Passengers can look for traffic, provide helpful information (strange sound / scent, checklist help)
    v. Ingenuity, knowledge and skill
C. External Resources
    i. Maintenance technicians, and flight service personnel, 1800 WX Brief
    ii. Internet research (before flight – weather, NOTAMs, TFRs, airport procedures, etc.)
    iii. ATC – traffic advisories, vectors, emergency assistance, may even be able to contact someone
    iv. FSS can provide weather, airport conditions
    v. Other airplanes can provide PIREPs as well as radio communications
    vi. ASOS/AWOS can also provide weather conditions in flight
D. Common Error - Failure to utilize all resources required to operate a flight safely

Common Errors:

- Failure to place and secure essential materials and equipment for easy access during flight
- Failure to properly adjust cockpit items, such as safety belts, shoulder harnesses, rudder pedals, seats
- Failure to provide proper adjustment of equipment and controls
- Failure to provide occupant briefing on emergency procedures and use of safety belts
- Failure to utilize all resources required to operate a flight safely

Conclusion:

Brief review of the main points

By combining all the elements of cockpit management (single pilot resource management), the pilot will have a safer and more efficient flight due to a reduced workload and reduced mental stress and fatigue.

V.C. Engine Starting

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), Reduction of Electrical System Failures Following Aircraft Engine Starting (AC 91-55), Cold Weather Operation of Aircraft - Cancelled (AC 91-13), POH/AFM

Objectives	The student should develop knowledge of the elements related to engine starting as required in the ACS/PTS.
Key Elements	1. Checklist 2. Safety 3. Hand on the Throttle
Elements	1. Safety Precautions 2. Atmospheric Conditions 3. Checklists 4. Engine Controls During Start 5. Preventing Aircraft Movement 6. Starting with External Power 7. Hand Propping Safety
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student shows the ability to safely start the engine using the appropriate checklist and understands different conditions and their effect on starting.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Starting the engine of an airplane is not as simple as starting the engine of your car. A plane can't just be turned on anywhere at any time, the proper precautions and procedures must be followed for safety.

Overview

Review Objectives and Elements/Key ideas

What

Engine Starting discusses the safety precautions necessary when starting an airplane, the different conditions which affect starting the engine, as well as different ways to start the engine.

Why

Proper engine starting is necessary for the safety of people and property, as well as to prevent engine damage. There are certain situations which require special procedures, and some procedures can be dangerous. It is very important to know the proper engine starting procedures and precautions.

How:

1. **Safety Precautions**
   - A. Ensure the ramp area surrounding the airplane is clear of persons, equipment, and other hazards
     - i. Be aware of what is in front of, to the side, and behind the airplane
   - B. Anti-collision lights should be turned on prior to any start, at night use position lights too
   - C. Always call "CLEAR" out of the side window and wait for a response from someone who may be nearby
   - D. When activating the starter, the wheel brakes must be depressed and / or parking bake set (check POH)
   - E. Keep one hand on the throttle to allow prompt response if necessary
   - F. Common Error - Failure to use safety precautions related to starting, and ensure clearance of the prop
2. **Atmospheric Conditions**
   - A. Cold Weather
     - i. May result in congealed engine oil, less effective batteries, and stuck instruments
       - a. Preheat of the engine(s) (and cabin) before start is desirable (hangar, cowl heaters, etc.)
     - ii. Cold Engine Start Problems
       - a. Congealed oil can make the prop more difficult to move (both with the starter and by hand)
       - b. Tendency to over prime – washes down cylinder walls and may result in scoring of the walls
         - Results in poor compression / hard starting; fires have been started by over priming
       - c. Iced sparkplug
         - The engine only fires a few revolutions and then quits. The only remedy is heat
     - iii. Starting – Follow the POH procedures for a cold start
       - a. Prime the engine with fuel first (over-priming can result in fire – AC 91-13. Cancelled but useful)
       - b. After start, follow the POH procedures to allow the engine and oil to warm and circulate
   - B. Hot Weather – Follow the POH procedures
     - i. Unless very hot, normal start procedures will generally work (use hot start procedures, if needed)
       - a. Generally, little to no priming is needed. If the engine doesn't catch, use minimal priming
         - In the case of an over primed engine, follow the flooded start checklist
     - ii. Vapor lock (fuel injected engines)

a. Fuel delivery lines tend to be on the top of the engine, directly over the cylinder fins
b. Engine + outside heat can boil the fuel out of the lines creating vapor which can prevent starting
- Hot start procedures should be used to purge the lines of vapor

3. **Checklists**
   A. Because of different situations (Flooded, Cold, Normal, Hot, etc.) the correct checklist must be used
   B. Common Error - Failure to use the appropriate checklist
4. **Engine Controls During Start**
   A. Always keep one hand on the throttle to manage the initial engine starting speed
      i. After the engine is started, set the throttle to the RPM setting specified in the POH
      ii. Other controls (mixture, prop, carb heat, boost pump, etc.) should be set as specified in the checklist
   B. Monitor oil pressure after engine start
      i. In most conditions, oil pressure should reach at least the lower limit within 30 seconds
      ii. If oil pressure does not rise to the POH values in the specified time, shutdown the engine
   C. Avoid excessive engine RPM and temperatures
      i. Adjust the engine controls to maintain the POH recommended RPM, fuel, propeller, etc. settings
      ii. Monitor the instruments and use the checklist if engine temperature begins to rise abnormally
   D. Common Error - Improper adjustment of engine controls during start
5. **Preventing Aircraft Movement**
   A. Set the parking brake and hold the brakes
      i. Look outside, excessive heads down time (checklists, etc.) can lead to unnoticed movement
6. **Starting with External Power**
   A. Follow the procedures prescribed in the POH
   B. Be extremely cautious of people and equipment near the propeller during engine start (have a plan)
7. **Hand Propping Safety**
   A. Basic requirements BEFORE attempting a hand prop
      i. Do not hand prop unless two people, both familiar with hand propping techniques are available
      ii. The person pulling the propeller blades through directs all activity and is in charge of the procedure
      iii. The 2nd person is in the plane with brakes set, operating the controls, and following instructions
      iv. The ground surface near the prop should be stable and free of debris
      v. Both participants should discuss the procedure and agree on voice commands and expected action
   B. Engine Starting Set-up
      i. Unless otherwise specified, the descending prop blade should be slightly above horizontal
      ii. Person doing the propping should face the blade squarely and stand less than an arm's length away
         a. Too far away results in leaning forward into the prop in an unbalanced condition
   C. Procedures and Commands for Hand Propping
      i. Follow the procedures specified in the POH. Have a plan
   D. Common Error - Failure to use safety precautions related to starting
   E. Common Error - Failure to ensure proper clearance of the propeller

Common Errors:

- Failure to use the appropriate checklist
- Failure to use safety precautions related to starting
- Improper adjustment of engine controls during start
- Failure to ensure proper clearance of the propeller

Conclusion:
Brief review of the main points
Always ensure safety when starting the engine.

V.D. Taxiing

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to taxiing an airplane as required in the ACS/PTS.
Key Elements	1. Fast Walk 2. Crosswind Corrections 3. Taxi Diagram
Elements	1. Taxiway Markings 2. Taxi Clearance 3. How it Works 4. Wind Correction 5. Brake Check 6. Taxi Check 7. Avoiding Other Aircraft/Hazards 8. Avoiding Incursions 9. Light Gun Signals
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can safely maintain positive control of the airplane with the proper crosswind corrections. The student understands the elements related to safely and effectively taxiing.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Taxiing is one of the basic skills required anywhere you fly. At airports with many taxiways it can be intimidating and therefore is very important to understand how to safely and efficiently taxi an airplane.

Overview

Review Objectives and Elements/Key ideas

What

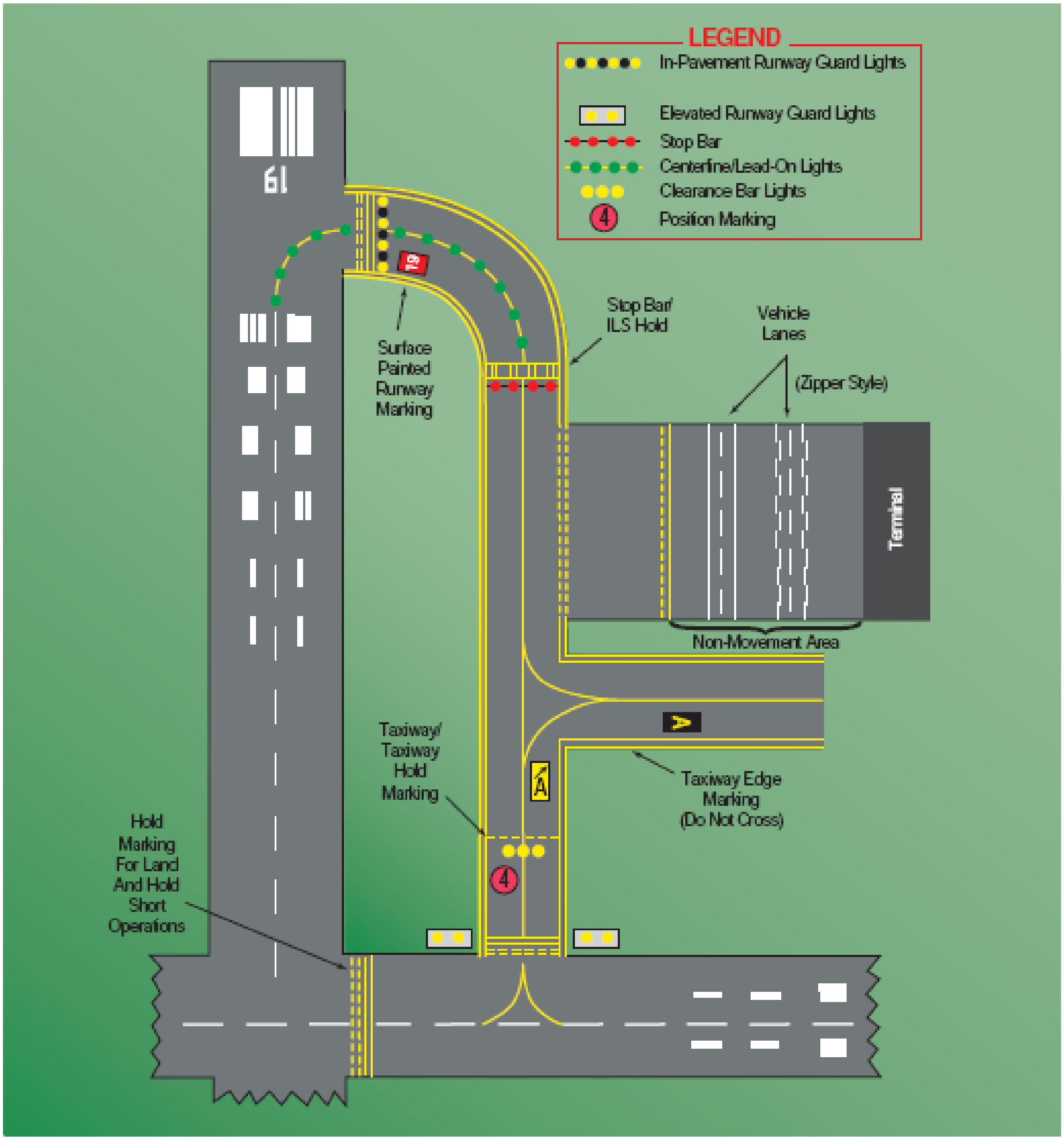
Taxiing is the controlled movement of the airplane under its own power while on the ground.

Why

Since the airplane is moved by its own power between the parking area and runway, the pilot must thoroughly understand and be proficient in taxi procedures.

How:

1. **Taxiway Markings**
    - A. Used to transition from parking areas to the runway
    - B. Taxiway Markings:
        - i. Continuous Yellow Centerline stripe
        - ii. Edge Markings
            - a. If an edge marking is a continuous line, the shoulder is not intended for use by an airplane
            - b. If it is a dashed marking, an airplane may use that portion of the pavement
        - iii. Holding Position Marker (Hold Short Lines – Do Not cross until cleared to)
            - a. Four yellow lines (two solid and two dashed), the solid lines are where the airplane is to hold
            - b. When approaching the hold short lines from the dashed line side, you may cross without clearance
                - Clearance must be obtained to cross from the solid line side


LEGEND
In-Pavement Runway Guard Lights
Elevated Runway Guard Lights
Stop Bar
Centerline/Lead-On Lights
Clearance Bar Lights
4
Position Marking
19
19
Surface
Painted
Runway
Marking
Stop Bar/
ILS Hold
Vehicle
Lanes
(Zipper Style)
Terminal
Non-Movement Area
A
A
Taxiway/
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For Land
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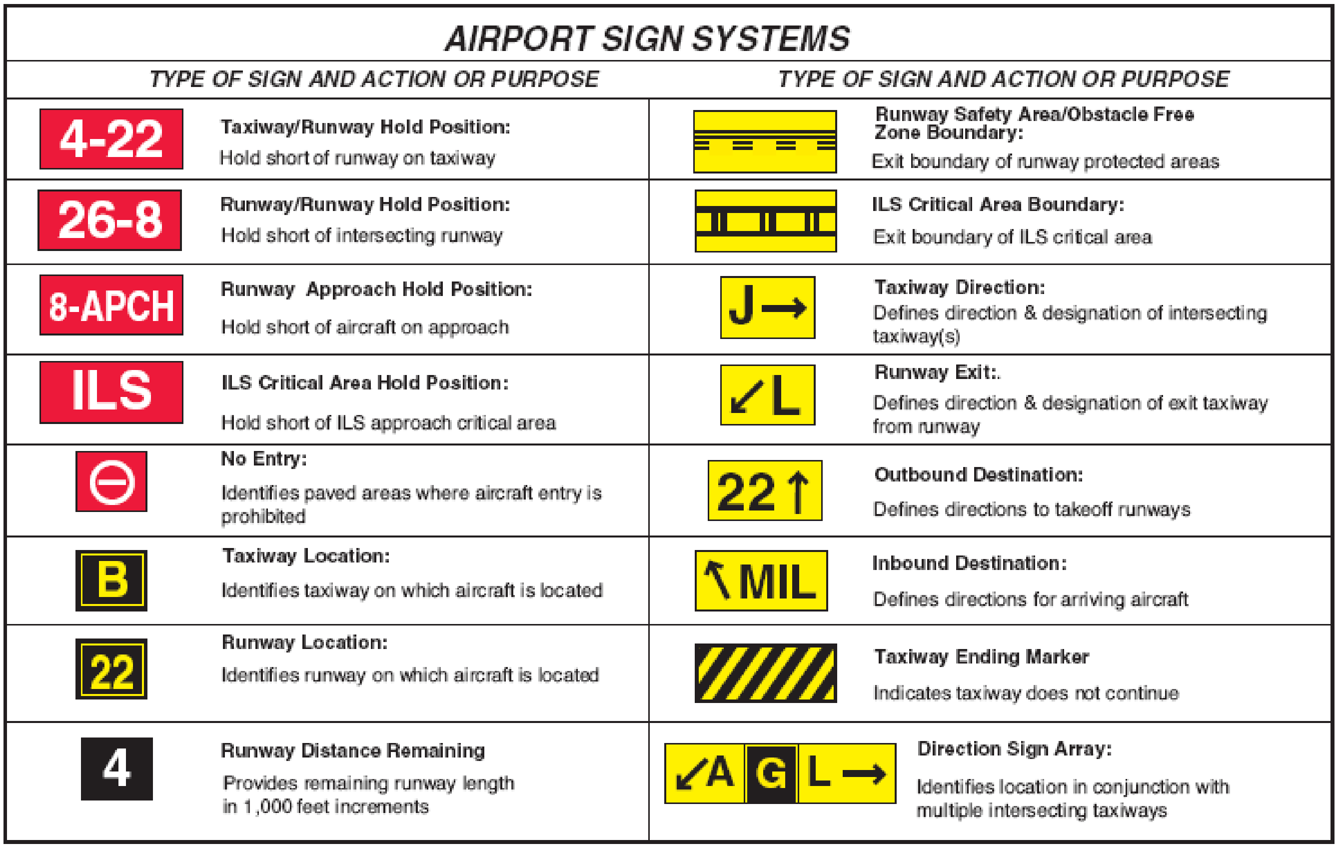
Short
Operations



AIRPORT SIGN SYSTEMS			
TYPE OF SIGN AND ACTION OR PURPOSE		TYPE OF SIGN AND ACTION OR PURPOSE	
4-22	**Taxiway/Runway Hold Position:** Hold short of runway on taxiway		**Runway Safety Area/Obstacle Free Zone Boundary:** Exit boundary of runway protected areas
26-8	**Runway/Runway Hold Position:** Hold short of intersecting runway		**ILS Critical Area Boundary:** Exit boundary of ILS critical area
8-APCH	**Runway Approach Hold Position:** Hold short of aircraft on approach	J→	**Taxiway Direction:** Defines direction & designation of intersecting taxiway(s)
ILS	**ILS Critical Area Hold Position:** Hold short of ILS approach critical area	↙L	**Runway Exit:.** Defines direction & designation of exit taxiway from runway
⊖	**No Entry:** Identifies paved areas where aircraft entry is prohibited	22↑	**Outbound Destination:** Defines directions to takeoff runways
B	**Taxiway Location:** Identifies taxiway on which aircraft is located	↖MIL	**Inbound Destination:** Defines directions for arriving aircraft
22	**Runway Location:** Identifies runway on which aircraft is located		**Taxiway Ending Marker** Indicates taxiway does not continue
4	**Runway Distance Remaining** Provides remaining runway length in 1,000 feet increments	↙A G L→	**Direction Sign Array:** Identifies location in conjunction with multiple intersecting taxiways

2. **Taxi Clearance (**AIM 4-3-18)
   - A. Approval must be obtained prior to moving onto the movement area while tower is in operation
   - B. A clearance must be obtained prior to crossing ***any runway***; ATC will issue an explicit clearance for ***all*** runway crossings
     - i. Any runway means ***any runway***: active, inactive, open, closed, etc.
   - C. When assigned taxi instructions, ATC will specify:
     - i. The runway or the point to taxi to
     - ii. Taxi instructions
     - iii. Hold short instructions or runway crossing clearances if the route will cross a runway
       - a. This does not authorize the aircraft to enter or cross the assigned departure runway at any point
   - D. When instructions are received from the controller, always read back:
     - i. The runway assignment
     - ii. Any clearance to enter a specific runway
     - iii. Any instruction to hold short of a specific runway
   - E. Common Error – Hazards associated with the failure to comply with airport/taxiway surface marking, signals, and ATC clearances or instructions
     - i. Failure to comply can lead to incursions and accidents
     - ii. Always read all clearances back, and ensure understanding of airport signs and markings
       - a. Ask for clarification if instructions unclear
       - b. Stop the airplane, if necessary and await proper clearance
     - iii. Have an airport diagram on hand. Always know where you are and where you're going
   - F. Uncontrolled Field
     - i. Since a taxi clearance is not given by ground, the pilot should announce their intentions on CTAF

ii. Always have a taxi diagram
    a. Plan and announce your taxi route prior to moving
iii. Monitor the CTAF frequency to be aware of other aircraft on or around the airport, and to build a mental picture of their location in relation to you
    a. Departing or Arriving? Will they be crossing your planned taxi route?
iv. Apply the right-of-way rules, and give way when appropriate, or when safety dictates
v. Keep in mind that radio communication is not required at uncontrolled fields, and therefore a visual scan is very important

3. How it works

A. Steering is accomplished with the rudder pedals and brakes
    i. To turn, apply rudder toward the desired turn and use power/brake to control the taxi speed
        a. Brakes may be used as necessary to assist in turning
        b. Add brake pressure to the brake on the inside of the turn to decrease turn radius
    ii. Rudder should be held until just short of the point where the turn is to be stopped
        a. Pressure is then released or opposite pressure is applied to maintain centerline track
    iii. Brakes are used to stop, slow, or aid in making a turn and should be applied smoothly and evenly
        a. Rather than continuously riding the brakes, it is appropriate to apply brakes only occasionally
    iv. Common Error - Improper use of brakes
        a. Don't ride the brakes while taxiing, slow the plane with the throttle first
            - If still too fast, rather than riding the brakes, allow the aircraft to accelerate, then use the brakes to slow it below a normal taxi speed, allow it to accelerate again, and repeat
            - This prevents overuse and excessive wear on the brakes
B. Speed is controlled 1st with power and 2nd with brake pressure (use the toes to apply brakes evenly)
    i. Taxi as though the brakes are inoperative – At the speed of a fast walk
        a. Primary speed requirement is safe, and under positive control (be able to stop, turn when desired)
    ii. More power may be necessary to get the airplane moving than to keep it moving (reduce after start)
C. Maintaining Centerline
    i. Keep the centerline between your outside leg and the stick, this should keep the nose of the aircraft on the centerline
        a. Adjust the sight picture as necessary if this sight picture does not work for you or the specific aircraft
D. When stopping, stop with the nose wheel straight to prevent side loading and to make moving again easier
E. Common Error - Hazards of taxiing too fast
    i. Taxiing too fast can be dangerous – Ground Loop, Accident, Obstruction, Loss of Control, etc.
    ii. Use minimal power to maintain taxi speed and reduce the use of brakes while taxiing

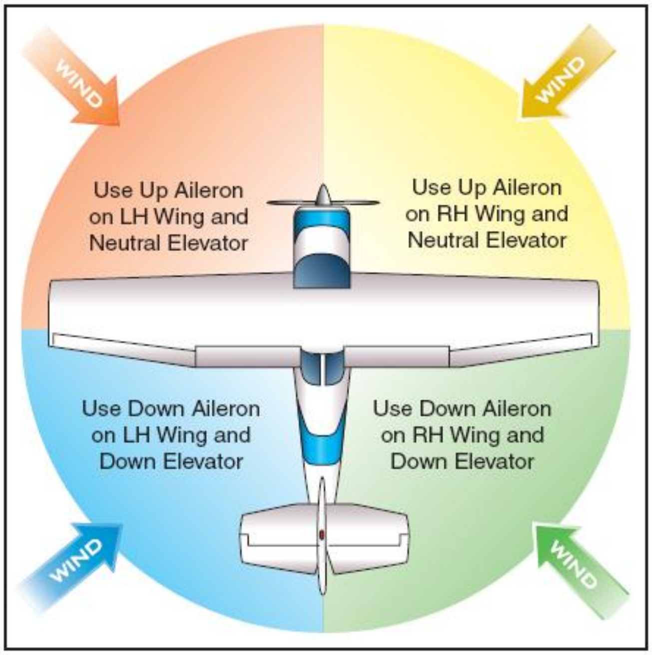
4. Wind Correction

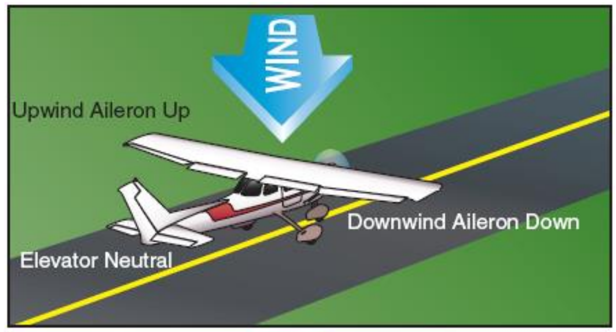
A. Downwind Taxiing
    i. Usually will require less engine power after the initial ground roll is begun
    ii. To avoid overheating the brakes, keep engine power at a minimum and only apply them occasionally
B. Taxiing with a quartering headwind
    i. Ailerons are turned into the wind and the elevator is held neutral
        a. To prevent the wind from lifting the upwind wing, aileron should be held into the wind
            - Upwind aileron is UP, reducing the effect of the lifting action
        b. The downwind aileron will be DOWN
            - A small amount of lift/drag is put on this wing keeping the upwind wing down
C. Taxiing with a Quartering Tailwind

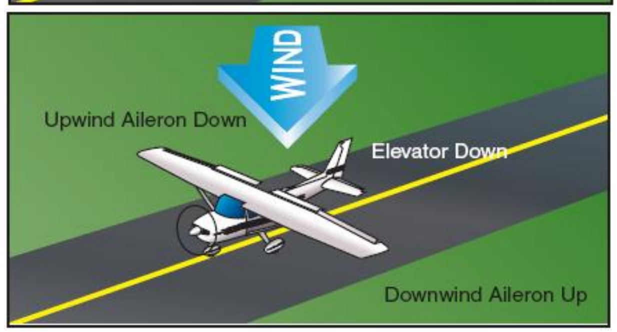
i. Flight controls are positioned to dive with the wind
   a. Ailerons are turned with the wind, and the elevator is DOWN
   b. The upwind aileron is DOWN in this case (opposite of a head wind)
   c. These control positions reduce the tendency of the wind to nose the plane over

D. These corrections help minimize weathervaning and make the airplane easier to steer

E. Common Error - Improper positioning of flight controls for various wind conditions
   i. Improperly positioned flight controls in strong winds can lead to hazardous conditions
      a. Wing lifting, nose over, etc.
   ii. Use the heading indicator/heading bug (if available) to visualize the wind in relation to the airplane and position the controls accordingly







5. **Brake Check**
   A. The brakes should be tested for proper operation as soon as the airplane is put in motion
   B. Apply power to start the airplane moving forward slowly, then retard the throttle and simultaneously apply just enough pressure to one side, then the other to confirm proper function/reaction
      i. Ensure the brakes are operating normally
      ii. If braking performance is unsatisfactory, the engine should be shut down immediately

6. **Taxi Check**
   A. Attitude Indicator - No more than 5° of pitch or bank indicated
   B. Turn and Slip Indicator - Wings with the turn/Ball movies opposite the turn/Inclinometer is full of fluid
   C. Magnetic compass and heading indicator are moving toward known headings, and the magnetic compass has no cracks, leaks, or bubbles

7. **Avoiding Other Aircraft / Hazards**
   A. Keep your eyes outside
      i. If a checklist needs to be completed, or attention needs to be diverted from taxiing, wait until the aircraft is stopped
         a. In the case of an emergency, stop the aircraft immediately and proceed as required
   B. Maintain situational awareness
      i. Know where you are and where you're going – have a taxi diagram
   C. Taxi at a safe speed (fast walk)

D. Build a mental picture of other traffic on the airport
    i. Listen to the ground / CTAF frequency and be alert to other traffic taxiing
E. Turn on aircraft lights and the rotating beacon or strobe lights when taxiing
    i. Be cautious with the strobe lights around other aircraft, they can be blinding
F. Apply the Right-of-Way rules (right-of-way is the same as in the air)
G. Be aware of your wingspan, and avoid taxiways, aprons, etc. that will not allow adequate taxi room
H. When yellow taxiway center lines are provided, they should be observed
I. Slow down before making a turn
    i. Sharp, high-speed turns place adverse loads on the gear and may result in a swerve or ground loop
J. Maintain a sterile cockpit
    i. Refrain from all nonessential activities during taxi
        a. There should be no checklists, conversations, phone calls/texting, etc.
K. Common Error - Hazards associated with failing to adhere to sterile cockpit procedures
    i. Distractions can be hazardous to yourself and other aircraft, wait until you are safely and fully stopped
L. Common Error – Hazards of becoming distracted while taxiing
    i. Distractions can be hazardous to yourself and other aircraft
    ii. Taxi first, accomplish checklists, etc. once fully stopped and in a safe place

8. Avoiding Incursions

A. Always have a taxi diagram
B. Read back all runway/taxiway crossing and hold instructions using proper phraseology/good discipline
C. Know airport signage
D. Review NOTAMS for information on runway/taxiway closures and construction areas
E. Request a progressive taxi from ATC when unsure of the route
    i. Write down complex instructions, especially at unfamiliar airports
F. When landing, clear the runway as soon as possible, then wait for taxi instructions before further taxiing
G. Common Error – Hazards associated with the failure to comply with airport/taxiway surface marking, signals, and ATC clearances or instructions
    i. Before taxiing, ask yourself whether the instructions make sense – Contact ground if they don't
    ii. Repeat all clearances back and understand airport signs and markings

9. Light Gun Signals

A. If a radio malfunctions, a phone call should be made for authorization to depart without two-way radios

i. If authorized, the pilot will be told to monitor a frequency and/or watch for light gun signals

LIGHT GUN SIGNALS			
COLOR AND TYPE OF SIGNAL	MOVEMENT OF VEHICLES, EQUIPMENT AND PERSONNEL	AIRCRAFT ON THE GROUND	AIRCRAFT IN FLIGHT
STEADY GREEN	Cleared to cross, proceed or go	Cleared for takeoff	Cleared to land
FLASHING GREEN	Not applicable	Cleared for taxi	Return for landing (to be followed by steady green at the proper time)
STEADY RED	STOP	STOP	Give way to other aircraft and continue circling
FLASHING RED	Clear the taxiway/runway	Taxi clear of the runway in use	Airport unsafe, do not land
FLASHING WHITE	Return to starting point on airport	Return to starting point on airport	Not applicable
ALTERNATING RED AND GREEN	Exercise Extreme Caution!!!!	Exercise Extreme Caution!!!!	Exercise Extreme Caution!!!!

Common Errors:

- Improper use of brakes
- Improper positioning of flight controls for various wind conditions
- Hazards of taxiing too fast
- Hazards associated with the failure to comply with airport/taxiway surface marking, signals, and ATC clearances or instructions
- Hazards of becoming distracted while taxiing
- Hazards associated with failing to adhere to sterile cockpit procedures

Conclusion:
Brief review of the main points
Requirements for safe taxiing include positive control of the aircraft, the ability to recognize potential hazards in time to avoid them, and the ability to stop or turn where and when desired without undue reliance on the brakes. Also, be aware of other traffic and its movement, write down and read back all clearances, and maintain the proper crosswind correction.

V.G. Before Takeoff Check

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to the before takeoff check. The student should perform the check as required in the manufacturer's POH and as required in the ACS/PTS.
Key Elements	1. Read and Do 2. Departure Brief 3. Incursions and Hazards
Elements	1. Required Temperatures and Pressures 2. Positioning the Aircraft 3. Division of Attention 4. Checklist 5. Go/No Go Decision 6. Departure Brief 7. Assuring the Takeoff Area is Free of Hazards 8. Avoiding Incursions
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the elements involved in a proper, thorough, and safe before takeoff check. The student can make a competent decision as to whether the airplane is safe to fly and is vigilant in maintaining hazard and incursion avoidance.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Which situation would you rather be in? Discovering there is a problem with the airplane after takeoff and having to make an emergency landing, or discovering the problem before taxiing onto the runway?

Overview

Review Objectives and Elements/Key ideas

What

The systematic procedure for checking the engine, controls, systems, instruments, and avionics prior to flight.

Why

This final check ensures the airplane is ready for safe flight before taking off.

How:

1. **Required Temperatures and Pressures**
   A. Usually performed after taxiing to a position near the takeoff runway (usually a designated run-up area)
      i. Allows time to for the engine to warm up to minimum operating temperatures
   B. Scan all the engine instruments periodically to ensure they are suitable for the run-up and takeoff
2. **Positioning the Aircraft**
   A. A suitable location should be firm and free of debris (smooth, paved, or turf surface if possible)
   B. There should not be anything behind the aircraft that might be damaged by the airflow
   C. Point the airplane as closely as possible into the wind**,** and move forward slightly to straighten the nose
   D. Common Error - Improper positioning of the airplane
3. **Division of Attention**
   A. Attention must be divided inside and outside the aircraft
      i. Excessive time with your head down (checklists, etc.) can result in unmonitored movement
4. **Checklist**
   A. The before takeoff checklist provided by the manufacturer should be used to ensure a proper check
      i. Never go solely off memory. It's very easy to unintentionally miss something
   B. Common Error - An improper check of flight controls
   C. Common Error - Failure to properly use the appropriate checklist
      i. The manufacturer's checklist ensures every item is completed and checked in a logical order
5. **Go/No Go Decision**
   A. The PIC is responsible for determining whether the airplane is in a condition for safe flight
      i. Use the criteria in the POH, as well as pilot judgement, to measure airplane performance
   B. This is your chance to catch a problem while safely on the ground rather than in flight
      i. If there is a problem, ask yourself, Are we still legal? Can the problem be fixed? Is this safe?
   C. If there are any doubts, return to the ramp for further investigation
   D. Common Error - Improper acceptance of marginal engine performance
6. **Departure Brief**
   A. Before takeoff, review the performance speeds, expected takeoff distance, and emergency procedures
      i. V_R, V_X, V_Y - Announce the speeds
      ii. Takeoff on runway XX, we have X,XXX' of runway, performance shows we need X,XXX' today
      iii. In the case of an emergency:

a. Lose engine on roll, close the throttle, stop straight ahead, maintain control with rudder / brakes
b. Lose engine after rotation with runway available, land on the remaining runway
c. Lose engine above XXX' AGL, attempt to turn back to the runway, otherwise land straight ahead

B. Common Error - Hazards of failure to review takeoff and emergency procedures
   i. Don't try to come up with a plan during an emergency

7. **Assuring the Takeoff Area is Free of Hazards**
   A. Visually check the area to ensure it is clear of anything that could be a hazard
   B. Check the runway, as well as final approach
      i. Remember, radio communication is not required at uncontrolled airports
8. **Avoiding Incursions**
   A. Before moving, clear to the left, right and center
   B. Monitor the appropriate frequency
   C. Know where other aircraft are in relation to you
   D. Repeat all clearances, and do not cross hold short lines without a clearance
   E. If any doubt exists, stop and wait for the traffic to clear
   F. Clear final approach before taxiing into the takeoff position
   G. Common Error - Failure to avoid incursions and to ensure no conflict with traffic prior to taxiing into takeoff position

Common Errors:

- Failure to properly use the appropriate checklist
- Improper positioning of the airplane
- Improper acceptance of marginal engine performance
- An improper check of flight controls
- Hazards of failure to review takeoff and emergency procedures
- Failure to avoid runway incursions and to ensure no conflict with traffic prior to taxiing into takeoff position

Conclusion:
Brief review of the main points
The before takeoff check is essential to ensure there are no problems before taking off. It is extremely important to use the correct checklist and make a safe decision regarding whether to make the flight. During this check, runway incursion and hazard avoidance is extremely important and should not be ignored.

AIRPORT OPERATIONS

VI.A. Radio Communications and ATC Light Signals

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), AIM

Objectives	The student should develop knowledge of the elements related to radio communications and ATC light signals as described in the ACS/PTS.
Key Elements	1. Understanding 2. Who, Where, What 3. Plan Ahead
Elements	1. Procedure and Phraseology for Radio Communications 2. ATC Clearance and Instructions 3. Selection and Use of Appropriate Frequencies 4. ATC Light Signals
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can properly use the radios through a flight of any kind. The student understands proper procedures, phraseology, clearances, and light signals.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Everyone wants to sound like a real, professional pilot. This lesson will explain how we do that, while making you into a more professional pilot.

Overview

Review Objectives and Elements/Key ideas

What

Radio communication is the communication between the pilot and different ATC controllers throughout the phases of a flight.

Why

Radio communications is a critical link in the ATC system. Operating in and out of a controlled airport, as well as in a good portion of the airspace system, requires an aircraft have two-way radio communications. For this reason, a pilot should be knowledgeable of radio procedures. By understanding proper radio communication procedures, the link can be strong providing safer flying for everyone.

How:

1. **Procedure and Phraseology for Radio Communications**
   - A. Understanding is the single most important thought in pilot-controller communications
     - i. If you don't understand, clarify the instruction
     - ii. Acknowledge each radio call with your aircraft call sign
     - iii. Brevity is important but, if necessary, use whatever words will get your message across
     - iv. Good phraseology enhances safety and is the mark of a professional pilot – Pilot/Controller Glossary
   - B. Radio Technique
     - i. LISTEN and THINK before you transmit
       - a. Know what you want to say before you say it (write it down if needed)
     - ii. Be alert to the sound/lack of sounds in the receiver
       - a. Check your volume, frequency, and make sure the microphone isn't stuck on transmit
     - iii. Be sure you are within the performance range of your equipment and the ground station equipment
       - a. VHF is line of sight
   - C. Radio calls can be broken down into Who, Where, What:
     - i. Who you are calling, Who you are, Where you are, What you want
   - D. Radio calls at non-towered airports can be broken down into a similar format:
     - i. Who you are calling, Who you are, Where you are, What you are doing
   - E. Common Error - Improper procedure and phraseology when using radio communications
2. **ATC Clearances and Instructions**
   - A. ATC clearance: authorization for an aircraft to proceed under specified conditions in controlled airspace
     - i. Not authorization to deviate from any rule, regulation, minimum altitude, or conduct be unsafe
   - B. When given a clearance:
     - i. Record and read back the clearance
       - a. Always read back:
         - Taxi instructions (AIM 4-3-18-9)

a Runway assignment, Clearance to enter a runway, Hold short / line up and wait
- Clearances containing altitude assignments, vectors, or runway assignments (AIM 4-4-7)
- Land and hold short operation (LAHSO) clearances (AIM 4-3-11-7)

b. Read back altitudes, altitude restrictions, vectors in the same sequence as they are given
c. If uncertain of a clearance, immediately request clarification from ATC (FAR 91.123)

C. It is the responsibility of the pilot to accept or refuse any clearance issued (AIM 4-4-1(b))
i. FAR 91.3(a): The PIC is directly responsible for, and the final authority to, operation of the aircraft
a. If ATC issues a clearance that deviates from a rule / regulation, or would place the aircraft in jeopardy, it is the pilot's responsibility to request an amended clearance
b. If a pilot prefers to follow a different course of action than what is in the clearance, the pilot is expected to inform ATC (you are making a request, not telling the controller what you will do)

D. FAR 91.123: No PIC may deviate from a clearance unless an amended clearance is obtained, an emergency exists, or it is in response to a traffic alert and collision avoidance system resolution advisory
i. If deviating, notify ATC as soon as possible

E. Common Error - Failure to acknowledge or properly comply with, ATC clearances and instructions

3. Selection and Use of Appropriate Frequencies

A. Preflight Planning
i. Look up the primary frequencies you plan to use on the flight
a. Tower, ground, ATIS, clearance delivery, and any other applicable frequencies at the departure, and arrival airport, as well as any divert airports you may use
b. Can be found in the Chart Supplement, Sectional Charts, ForeFlight, etc.

B. In the case a frequency needs to be found in flight, use available resources
i. Autopilot, ATC, planning documents should be organized and accessible (always fly first!)
ii. Know where to find the information needed (Chart Supp, Sectional, etc.)

C. Common Error - Use of improper frequencies
i. Understand each frequency's purpose
ii. If you get no response:
a. Wait a moment, the controller may be busy, then re-try
b. Double check the frequency
c. Return to the last frequency and ask them to repeat

4. ATC Light Signals (AIM 4-3-13)

A. Light Gun Signals and their Meaning
i. In the case of a loss of radio communication, the tower can communicate through light signals:

Color and Type of Signal	Movement of Vehicles, Equipment and Personnel	Aircraft on the Ground	Aircraft in Flight
Steady green	Cleared to cross, proceed or go	Cleared for takeoff	Cleared to land
Flashing green	Not applicable	Cleared for taxi	Return for landing (to be followed by steady green at the proper time)
Steady red	Stop	Stop	Give way to other aircraft and continue circling
Flashing red	Clear the taxiway/runway	Taxi clear of the runway in use	Airport unsafe, do not land
Flashing white	Return to starting point on airport	Return to starting point on airport	Not applicable
Alternating red and green	Exercise extreme caution!!!!	Exercise extreme caution!!!!	Exercise extreme caution!!!!

ii. General Information (AIM 6-4-2, AIM 4-3-13)

a. Squawk 7600 to indicate a loss of two-way radio capability
b. During daylight, acknowledge transmissions / light signals by moving the ailerons or rudder
c. At night, acknowledge by blinking the landing or navigation lights
d. Between sunset and sunrise, to get the attention of the tower turn on a landing light and taxi into a position, clear of the active runway, so that the light is visible to the tower
- The landing light should remain on until appropriate signals are received from the tower

B. Lost Communication Procedures
i. Airborne Aircraft
a. Receiver Inoperative - Receiving no audio on tower/ATIS frequencies
- Remain outside the airspace until the direction and flow of traffic is determined
- Advise tower of the failure, aircraft type, position, altitude, intention to land
- Enter the pattern, report position as appropriate, watch for light gun signals from the tower

b. Transmitter Inoperative - Receive no response to calls, but can receive calls
- Follow the previous procedures
- If you can hear ATC, they may ask you to acknowledge their radio calls with an ident
  a In this case light gun signals may not be necessary
  b Otherwise, acknowledge signals as discussed
- Make all normal radio calls, just in case

c. Receiver and Transmitter Inoperative
- Remain outside of the airspace until the direction and flow of traffic is determined
- Enter the pattern, clearing aggressively, and watch for light gun signals
- Acknowledge the signals as appropriate

ii. Trouble Shoot the Situation
a. Check the connections, equipment, receiver/transmitter, volume, try different frequencies, is there an annunciation showing when you are transmitting (is it working?), etc.

iii. Once on the ground, it is prudent to call the tower and explain the situation

C. Aircraft on the Ground
i. Radio malfunctions should be repaired before flight
a. If this is not possible, call ATC and request VFR departure without two-way radio communication

ii. If radio failure occurs while taxiing, watch for light signals / monitor the tower frequency

D. Disadvantages of Light Signals (AIM 4-3-13)
i. May not be looking at the tower when the signal is directed toward their aircraft
ii. Information transmitted is very limited (no explanations or supplemental information)

E. Common Error - Failure to understand or properly comply with ATC light signals

Common Errors:
- Use of improper frequencies
- Improper procedure and phraseology for radio communications
- Failure to acknowledge or properly comply with, ATC clearances and instructions
- Failure to understand or properly comply with ATC light signals

Conclusion:
Brief review of the main points
Proper radio communications begin with understanding. As long as you, the pilot, and the controller understand what each other are saying radio communication is effective and clearances can be obeyed properly.

VI.B. Traffic Patterns

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), Non-Towered Airport Flight Operations (AC 90-66B), Traffic Advisory Practices at Airports without Operating Control Towers (AC 90-42 - cancelled), , AIM

Objectives	The student should develop knowledge of the elements related to the proper procedures, rules, and elements of the traffic pattern at both a controlled and uncontrolled field. The student will be able to demonstrate this knowledge as required in the ACS/PTS.
Key Elements	1. Entry Procedures 2. Communication 3. Orientation
Elements	1. The Pattern 2. Orientation to the Runway 3. Controlled Field 4. Uncontrolled Field 5. Maintaining Proper Spacing 6. Wind Shear and Wake Turbulence
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the rules and elements to a proper traffic pattern and is comfortable arriving and departing from a controlled or uncontrolled field.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

In order to depart or land at an airport we're going to have to use the traffic pattern, I guess it's important, huh?

Overview

Review Objectives and Elements/Key ideas

What

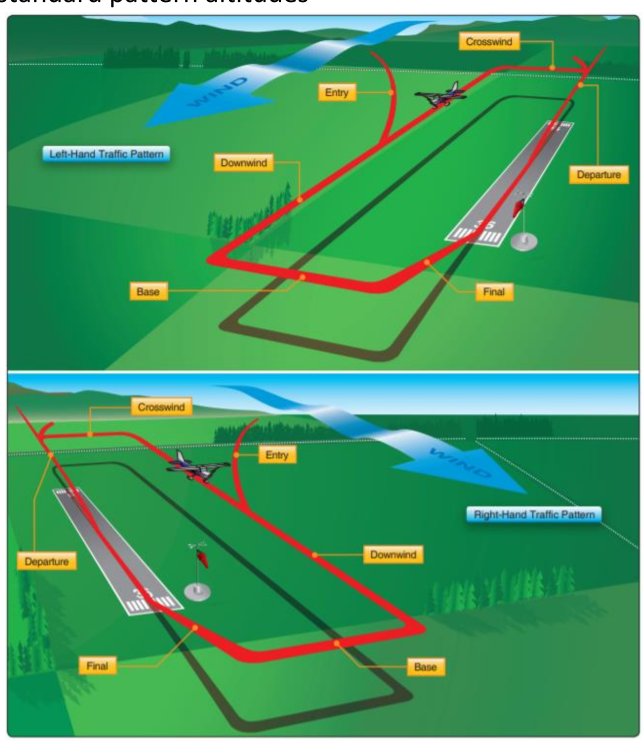
Traffic Patterns involve the rules and procedures involved with flying a proper traffic pattern at a controlled and uncontrolled airport.

Why

Every flight begins and ends at an airport or other suitable landing area. For that reason, it is essential that the pilot learn the traffic rules, procedures, and pattern layouts that may be in use at various airports.

How:

1. **The Pattern**
   A. Controlled - The pilot receives a clearance to approach / depart and pertinent pattern information
   B. Uncontrolled - It's up to the pilot to determine traffic direction, and comply with the appropriate rules
   C. Standard Traffic Pattern
      i. Pattern Altitude: Usually 1,000' AGL
         a. A common altitude is the key factor in minimizing collisions at uncontrolled airports
         b. Chart Supplement will usually specify nonstandard pattern altitudes
      ii. Standard Traffic Patterns: Left Turns
         a. Unless otherwise noted (Chart Supp, Controller, Airport Markings, etc.)
   D. Pattern Legs
      i. Upwind - Departure leg, flown parallel and in the same direction as runway heading
      ii. Crosswind –Transition from the upwind leg to the downwind leg
         a. Perpendicular to upwind leg**,** approx. ½ to 1-mile from runway
      iii. Downwind - Parallel to the landing runway
         a. Heading is opposite the landing runway, approx. ½ to 1 mile from the runway
         b. Before landing checks, and configuration are normally accomplished downwind
         c. Start descent abeam landing point
         d. Turn base 45° from the landing point
            - Adjust as necessary (winds, traffic, tower request, emergency, etc.)



- Stronger wind = closer base leg due to decreased groundspeed on final

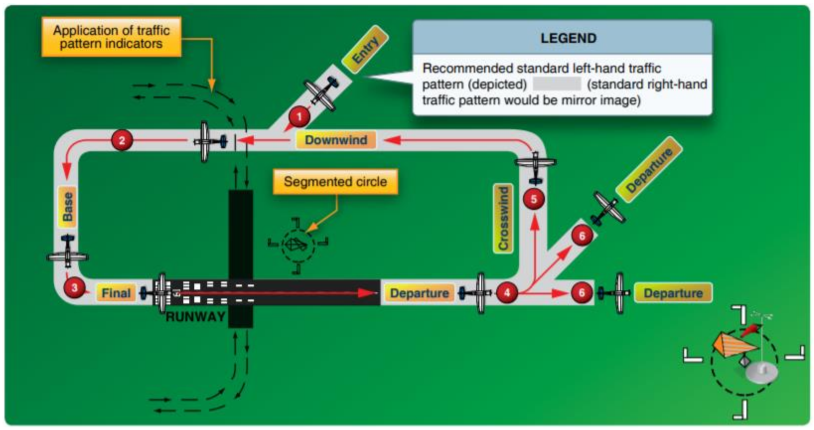
iv. Base - Perpendicular to the runway, the transition between downwind and final
   a. Airplane ground track should be perpendicular to the extended centerline
   b. Continue descent, adjusting pitch and power to maintain airspeed and glidepath

v. Turn to Final
   a. Lead the turn to final to be established on the extended centerline of the runway
   b. Turn to final should be no closer than ¼ mile, at the appropriate altitude (3° glide slope)

vi. Final - Final descent of the approach, aligned with the landing runway
   a. Crab into the wind to maintain runway centerline
   b. Adjust pitch and power to maintain airspeed, glidepath, and aim point
   c. Double check the Before Landing Checklist is complete and cleared to land

E. Departing the Pattern
   i. Climb out on the upwind leg
   ii. Remaining in the pattern: turn crosswind past the end of the runway, within 300’ of pattern alt
   iii. If departing, continue straight out, or exit with a 45° turn to the left (or right, for a right pattern)

F. Maintaining Ground Track



   i. The goal is to fly a rectangular pattern regardless of the wind direction or speed
      a. Crab into the wind to maintain a proper track
   ii. Visual references are helpful
      a. Upwind: Glance behind to ensure maintaining runway centerline
      b. Crosswind: Use the runway as a reference; note and correct for any drift to or from the runway
      c. Downwind: Intersect a point on the plane with the runway centerline (Ex. fuel cap / rivet line)
   iii. Common Error - Poor altitude or airspeed control
      a. Maintain a constant crosscheck (90% outside, 10% inside), stay ahead of the airplane
      b. Use small, controlled inputs to fly the airplane
   iv. Common Error - Improper correction for wind drift
      a. Use the heading bug, or make a mental note of the wind direction to help

2. Orientation to the Runway

A. Plan to enter visualizing your position in relation to the runway on the heading indicator
B. Confirm the runway number with the heading indicator during all pattern legs
   i. Downwind – reciprocal of the landing runway
   ii. Base - 90° off (in the direction of the pattern)
   iii. Final – Same as the runway number

3. Controlled Field

A. The pilot receives a clearance to approach / depart as well as pertinent information about the pattern
B. ATC will specify pattern entry and departure procedures (Where / how to enter and depart)
C. During the pattern the controller may make adjustments (speed, legs lengths, turns for spacing, etc.)
D. Common Error - Failure to comply with traffic pattern instructions, procedures, and rules

4. Uncontrolled Field

A. Communication – 2 ways depending on the airport
   i. Communicating with an FSS that provides advisories (are not air traffic controllers)

a. Provide wind info, runway in use, altimeter setting, known traffic, NOTAMs, etc.
b. Initiate contact approximately 10 miles out with altitude, aircraft type, location
c. Departing: transmit tail number, type of flight, destination, services desired, etc.

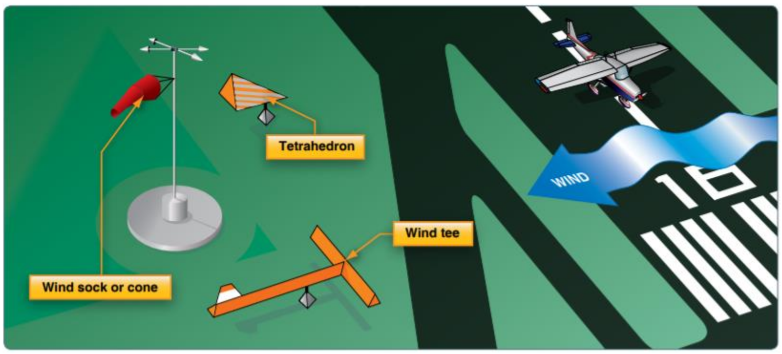
ii. Self-announced broadcast on CTAF

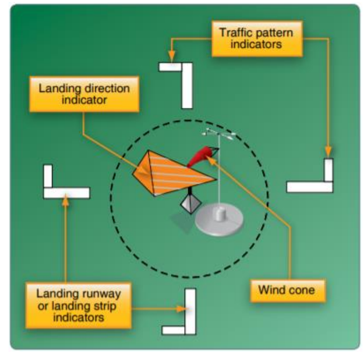
a. Announce your position and intentions on the CTAF frequency
b. Monitor other aircraft calls on CTAF and coordinate as necessary to avoid hazards

B. Arriving

i. Observe other aircraft already in the pattern and conform to the traffic pattern in use

a. If no other aircraft, use ground indicators and wind direction to determine the runway to use
- Check indicators 500’ – 1,000’ above pattern altitude
- Should also be researched before flight in the Chart Supplement / on sectional charts





b. Always enter the pattern at pattern altitude
- Descending into the pattern can be dangerous
- Avoids descending onto another aircraft and easier to visually acquire other traffic

ii. Downwind Entry

a. Enter at a 45° to midfield downwind

iii. Midfield Entry (pictured below, left)

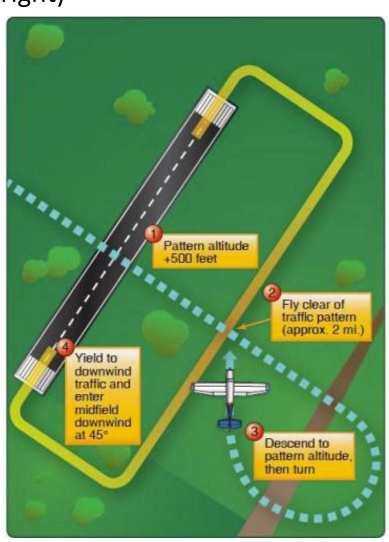
a. Cross midfield at least 500’ above pattern altitude
b. When well clear of the pattern (approximately 2 miles), descend to pattern altitude
c. Enter level, at pattern altitude, at a 45° angle to the downwind leg, abeam the runway midpoint
- Entry while descending creates collision hazards and should be avoided
- Another method of entry is a midfield entry from the upwind leg side

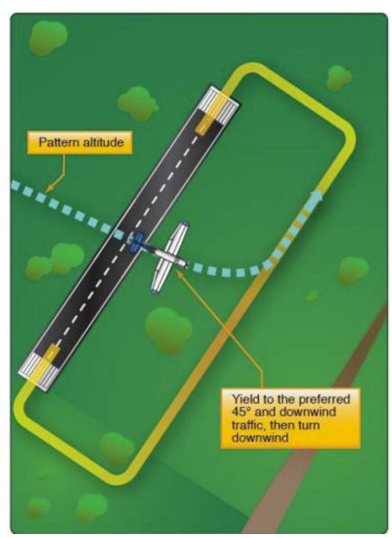
iv. Alternate Midfield Entry (pictured, right)

a. Enter at pattern altitude at midfield crosswind and turn downwind
b. Should not be used when the pattern is congested

C. Departing

i. Generally, depart on the upwind or a 45° off the upwind
ii. Monitor the radio for traffic in the local area, and announce your intentions
iii. Clear aggressively prior to takeoff and on departure (aircraft may not be using radios)





D. Common Error - Failure to comply with traffic pattern instructions, procedures, and rules

5. Maintaining Proper Spacing

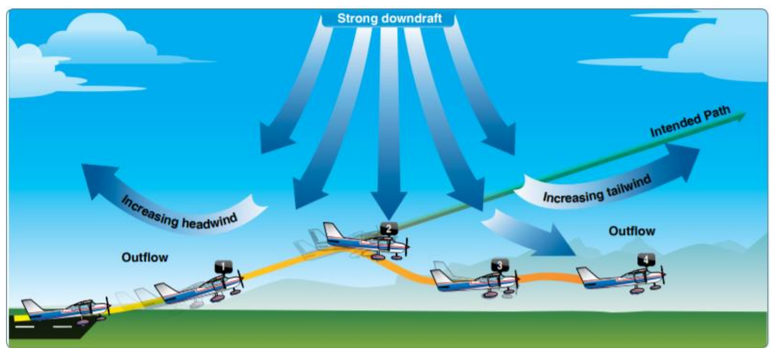
A. Be aware of other aircraft in the pattern, as well as aircraft entering and exiting the pattern
   i. Listen to radio calls to build a mental image of the traffic around you
      a. At an uncontrolled field, announce your intentions
      b. At a controlled field, follow the controller's instructions / request permission to make a change
   ii. On downwind with another aircraft on final, delay the base turn until abeam / past the other aircraft
   iii. Adjust upwind to accommodate aircraft on downwind

B. The pilot is always responsible for seeing and avoiding whether at a controlled or uncontrolled field

C. Common Error - Inadequate spacing from other traffic

6. Wind Shear and Wake Turbulence

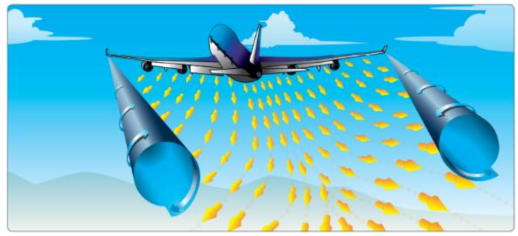
A. Wind Shear
   i. What is it?
      a. A sudden, drastic change in wind speed and/or direction over a very small area
      b. While wind shear can occur at any altitude, low-level wind shear is especially hazardous
   ii. Why is it dangerous?
      a. Violent updrafts and downdrafts (up to 6,000 fpm) / abrupt changes to horizontal movement
      b. Rapid changes in performance (tailwind shears to headwind, or headwind to tailwind)
      c. Microbursts
         - Most severe type of wind shear
         - Characteristics
            a 1-2 miles across
            b Lifespan of 5-15 mins.
            c Strong downdrafts (max of 6,000 fpm)
            d Strong turbulence
            e Headwind gains / losses of 30-90 knots



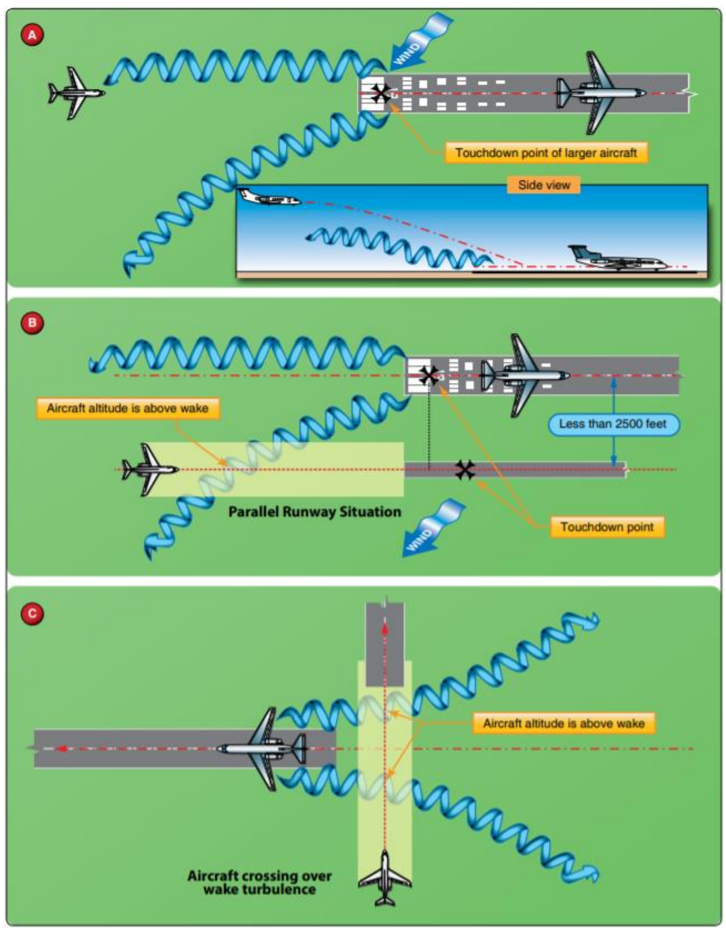
         - Indications
            a Visual – Intense rain shaft at the surface, but virga at cloud base; ring of blowing dust
            b Alerting Systems
               1. LLWAS-NE, TDWR, and ASR-9 WSP systems installed at major airports
               2. Many airports, especially smaller airports, have no wind shear systems
            c AC 00-54 – FAA Pilot Wind Shear Guide
   iii. Handling Wind Shear
      a. If possible, avoid it
         - Never conduct traffic pattern operations near an active thunderstorm
         - LLWAS (Low Level Wind Shear Alerting System) can warn of windshear
         - PIREPS
      b. Approach into Wind Shear
         - Follow the POH procedures. If none, general techniques include:
            a Higher power and faster approach speed (add ½ the gust factor to approach speed)
            b Stay as high as feasible until necessary to descend
            c Go around at the first sign of an unexpected pitch or airspeed change
               1. Important to get FULL power and get the airplane climbing

2. If the aircraft is descending toward the ground, ensure max power, increase pitch attitude as far as possible without stalling the airplane
   a. Intent is to keep the flying as long as possible in hope of exiting the shear

B. Wake Turbulence
   i. What is it?
      a. Difference between the high and low pressure below / above the wing causes the air to move outward, upward and around the wingtips, leading to counter rotating vortices



      b. All aircraft generate wake turbulence during flight
         - The larger the aircraft, the stronger the vortices
         - Vortices are strongest when the pressure differential is greatest (heavy, clean, slow)
   i. Why is it dangerous?
      a. Rolling moments can exceed control authority and / or damage the aircraft
      b. Wake turbulence can be encountered in any phase of flight (usually strongest at departure)
   ii. Vortex Behavior
      a. Vortices are generated when an aircraft leaves the ground until it touches down
      b. Remain about a wingspan apart, drift with wind, above ground effect altitudes (½ wingspan)
      c. Sink at a rate of several hundred FPM, slowing descent and diminishing in strength over time
      d. When close to the ground (100-200'), tend to move laterally at 2-3 knots
      e. A crosswind decreases lateral movement of upwind vortex, increases downwind vortex
      f. Light quartering tailwind can result in vortices along final approach centerline
   iii. Avoidance Procedures



      a. Maintain adequate separation
      b. Approach
         - Behind larger aircraft — stay at / above their flight path
         - Behind larger aircraft on parallel runway (closer than 2,500 feet) — consider possibility of drift, stay at / above their final approach path and note their touchdown point
      c. Landing
         - Behind a departing aircraft on same runway — land prior to their rotation point
         - Land beyond an arriving jet's touchdown point
         - Behind a larger aircraft on a crossing runway — cross above their flight path
         - Behind a larger aircraft on a crossing runway—note the aircraft's rotation point and, if

that point is past the intersection, continue and land prior to the intersection
  a. If the larger aircraft rotates prior to the intersection, avoid flight below its flight path
- After a large aircraft executing a missed approach or touch-and-go–wait at least 2 minutes

d. Departing
   - Behind larger aircraft – rotate before their rotation point, climb above their flight path until turning clear
   - Intersection takeoff on the same runway – be alert to adjacent larger aircraft operations, avoid headings that cross below a larger aircraft's path
   - After a large aircraft executing a missed approach or touch-and-go – wait at least 2 minutes

Common Errors:
- Failure to comply with traffic pattern instructions, procedures, and rules
- Improper correction for wind drift
- Inadequate spacing from other traffic
- Poor altitude or airspeed control

Conclusion:
Brief review of the main points
Every flight begins and ends at an airport or other suitable landing area, making patterns very important.

VI.C. Airport, Runway and Taxiway Signs, Markings, and Lighting

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), Procedures during Taxi Operations (AC 91-73), Standards for Airport Markings (AC 150/5340-1), Standards for Airport Sign Systems (AC 150/5340-18), AIM

Objectives	The student should develop knowledge of the elements related to airport, runway and taxiway signs, markings, and lighting as required in the ACS/PTS.
Key Elements	1. Runway Incursion Avoidance 2. If Unclear, Ask
Elements	1. Runway Incursion Avoidance 2. Runway Markings 3. Taxiway Markings 4. Holding Position Markings 5. Other Markings 6. Airport Signs 7. Airport Lighting and Other Airport Visual Aids
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the meaning of airport, runway and taxiway signs, markings, and lighting and can safely and properly utilize them, thus helping to avoid runway incursions.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Looking outside on the next flight, make note of the number of signs, markings and lights you see. How many of them do you understand? How many are unfamiliar?

Overview

Review Objectives and Elements/Key ideas

What

The markings, lights, and signs used at airports, which provide direction and assist pilots in airport operations.

Why

Understanding the markings, lights, and signs will greatly assist in avoiding runway incursions and provide the ability to more easily maneuver throughout any airport complex.

How:

1. **Runway Incursion Avoidance Basics**
   A. Know airport signage and use proper phraseology on the radio
   B. Be familiar with the airport taxi diagrams (common routes, closed taxiways, etc.)
   C. Review NOTAMs
   D. Notate your taxi instructions, read back the route and all runway crossing / hold short instructions
   E. Turn on taxi lights (rotating beacon should be on at engine start) when taxiing
   F. Be aware of your position on the airport and in relation to other aircraft
      i. Listen to other radio calls and build a mental picture of other traffic in relation to you
   G. Check for traffic before crossing any runway hold line and before entering a taxiway
   H. If lost / confused, stop and query ATC (request progressive taxi if required)
   I. When landing, clear the runway expeditiously, and obtain taxi instructions before continuing
   J. Common Error – Failure to use proper runway incursion avoidance procedures
2. **Runway Markings**
   A. General
      i. There are three types of markings for runways:
         a. Visual; Nonprecision Instrument; Precision Instrument

Marking	Visual	Nonprecision Instrument	Precision Instrument
Designation	X	X	X
Centerline	X	X	X
Threshold	X[1]	X	X
Aiming Point	X[2]	X	X
Touchdown Zone			X
Side Stripes			X

[1] On runways used, or intended to be used, by international commercial transports.
[2] On runways 4,000 feet (1200 m) or longer used by jet aircraft.

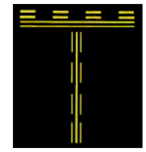
B. Runway Designators
   i. Purpose - To identify / differentiate runways from the approach end
      a. To Magnetic North; whole number to the nearest one-tenth of the runway course
      b. L, R, C differentiate multiple parallel runways
   ii. Markings - Large white numbers
C. Runway Centerline Marking
   i. Purpose - Identifies the center of the runway providing alignment guidance for takeoff and landing
   ii. Markings - A line of uniformly spaced stripes and gaps
D. Runway Aiming Point Markings
   i. Purpose - Serves as a visual aiming point for a landing aircraft
   ii. Markings - Broad white stripe on each side of the centerline, approximately 1,000' from threshold
E. Runway Touchdown Zone Markers
   i. Purpose - Identifies touchdown zone for landing; provide distance info in 500' increments
   ii. Markings - Groups of 1, 2, and 3 rectangular bars in pairs about the runway centerline
F. Runway Side Stripe Markings
   i. Purpose - Delineate edges of the runway providing a contrast between the runway and shoulder
   ii. Markings - Continuous white stripes located on each side of the runway
G. Runway Shoulder Markings
   i. Purpose - Identify pavement areas not intended for aircraft use
   ii. Markings - Yellow stripes
H. Runway Threshold Markings (stripes vary with width, chart to right)
   i. Purpose - Identifies beginning of the runway available for landing
   ii. Markings - Stripes about the centerline
   iii. Displaced Threshold (DT)
      a. Explanation
         - Landing threshold starts at a point other than the beginning of the runway
         - Used for taxiing, takeoff, landing rollout (not to be landed on, reduces landing distance)
      b. Markings
         - A 10' wide white threshold bar across the runway at the displaced threshold
         - White arrow heads are located across the runway just prior to the threshold bar
         - White arrows down the centerline between the start of the runway and displaced threshold
      c. Relocated Threshold
         - Explanation – Construction / other activities require the threshold to be relocated (NOTAM)
         - Markings – Normally a 10' wide white threshold bar across the runway, but can vary

Runway Width	Stripes
60 feet	4
75 feet	6
100 feet	8
150 feet	12
200 feet	16

I. Blast Pad / Stopway Area
   i. Blast Pad: Area where a propeller or jet blast can dissipate without creating a hazard
   ii. Stopway: Space to decelerate / stop in the event of an aborted takeoff (chevrons)

3. Taxiway Markings

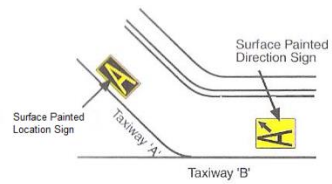
A. General
   i. Taxiways should have centerline/runway holding position markings whenever intersecting a runway
   ii. Edge markings separate the taxiway from areas not for aircraft use or define taxiway edges
B. Taxiway Centerline Markings
   i. Normal Centerline
      a. Purpose - Provide a visual cue to permit taxiing along a designated path
      b. Markings - A single continuous yellow line that is 6" - 12" wide
   ii. Enhanced Centerline



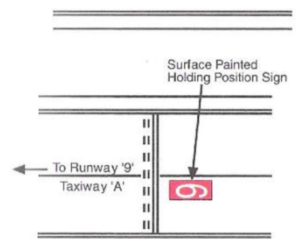
a. Purpose - Same as above but at larger commercial airports to warn that a runway hold position marking is being approached
b. Markings - Parallel line of yellow dashes on both sides of the taxiway centerline

C. Taxiway Edge Markings
  i. Purpose - Defines the edge of the taxiway (usually when edge doesn't match up with pavement)
  ii. Continuous Markings
    a. Purpose - Define the taxiway edge from the shoulder/paved surface not for use by aircraft
    b. Markings - Continuous double yellow line
  iii. Dashed Markings
    a. Purpose - Define the taxiway edge when adjoining pavement is intended for aircraft (apron)
    b. Markings - Broken double yellow line

D. Taxi Shoulder Markings
  i. Purpose - Shoulders prevent erosion but they may not support aircraft
  ii. Markings - Taxiway edge markings will usually define this area



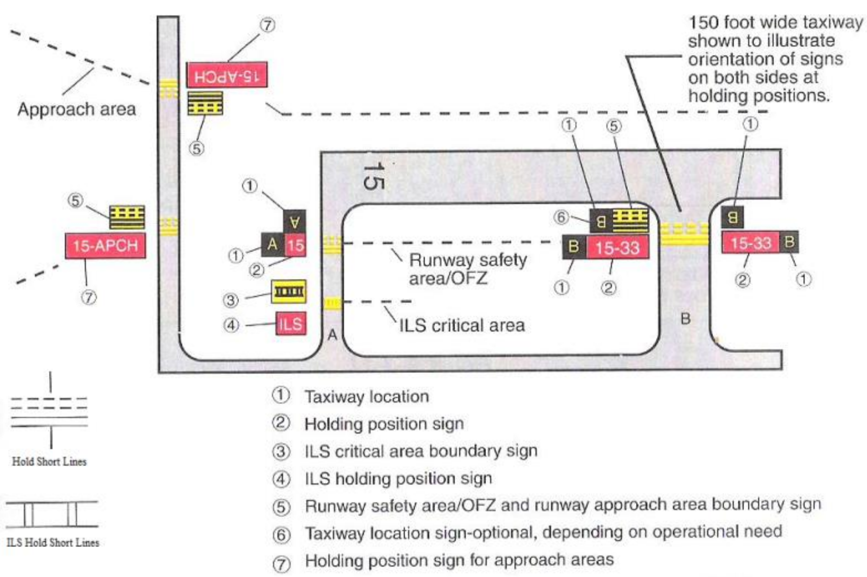
E. Surface Painted Taxiway Direction Signs
  i. Purpose - When it isn't possible to offer direction signs at intersections, or to supplement such signs
  ii. Markings - Surface painted location signs with a yellow background and black inscription



F. Surface Painted Location Signs
  i. Purpose - Location signs assisting in confirming the taxiway
  ii. Markings - Black background with a yellow inscription

G. Geographic Position Markings
  i. Purpose - Identifies aircraft location during low visibility operations
  ii. Markings - Left of the taxiway centerline in the direction of taxiing
    a. A circle with an outer black ring, inner white ring and a pink circle
      - When on dark pavements the white/black ring are reversed

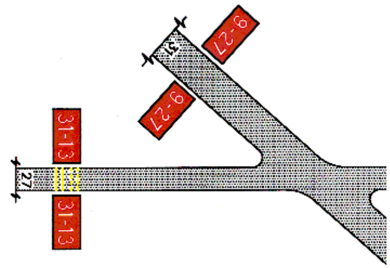
4. Holding Position Markings



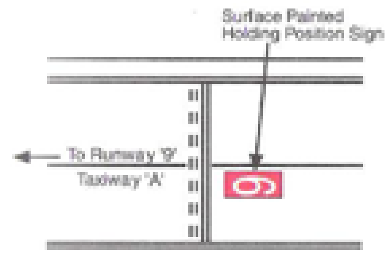
A. General
  i. Show where an aircraft is supposed to stop when approaching a runway (hold on the solid side)
  ii. 4 yellow lines (2 solid / 2 dashed) across the width of the taxiway / runway / approach area

B. Runway Holding Position Markings on Taxiways
   - i. Purpose - Identify where to stop without a clearance onto the runway

C. Runway Holding Position Markings on Runways (as shown to the right)
   - i. Purpose - Only installed if normally used for LAHSO or taxiing operations
     - Must stop before markings / exit prior to reaching the position
   - ii. Markings - White inscription / red background next to hold markings



D. Taxiways Located in Runway Approach Area
   - i. Holding Position Markings for Instrument Landing System (ILS)
     - a. Purpose - Hold aircraft when the ILS critical area is being protected
     - b. Markings - 2 yellow solid lines 2' apart joined by pairs of solid lines 10' apart across the taxiway
   - ii. Holding Position Markings for Taxiway / Taxiway Intersections
     - a. Purpose - Installed on taxiways where ATC normally holds aircraft short of an intersection
     - b. Markings - Single dashed line extending across the width of the taxiway
   - iii. Surface Painted Holding Position Signs (pictured, right)
     - a. Purpose - Supplements signs located at the holding position
     - b. Markings - Red background / white text, on hold side, before hold lines

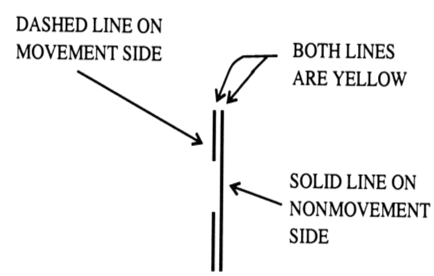


5. Other Markings

A. Vehicle Roadway Markings
   - i. Purpose - Defines a path for vehicle operations on the airport
   - ii. Markings - White solid line delineates each edge and a dashed line separates lanes

B. VOR Receiver Checkpoint Markings
   - i. Purpose - Allow the pilot to check aircraft instruments with navigational aid signals
   - ii. Markings - Painted circle with an arrow in the middle (arrow is aligned toward the facility)
     - a. Located with a sign on the apron / taxiway; Black text on a yellow background

C. Nonmovement Area Boundary Markings (pictured, right)
   - i. Purpose - Delineates movement area (area under control)
   - ii. Markings - 2 yellow lines (one solid and one dashed)



D. Marking and Lighting of Permanently Closed Runways
   - i. Purpose - For runways and taxiways which are permanently closed
   - ii. Markings - The lighting circuits will be disconnected
     - a. Yellow crosses at each end of the runway and at 1,000' intervals

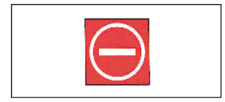
E. Temporarily Closed Runways and Taxiways
   - i. Purpose – Indication that a runway is temporarily closed
   - ii. Markings - Yellow crosses are placed on the runway at each end
     - a. A visual indication may not be present depending on the reason / duration of closure
       - Check NOTAMs / ATIS
     - b. Closed taxiways are blockaded (yellow cross may also be used)

6. Airport Signs

A. Six types of signs installed on airfields:
   - i. Mandatory Instruction; Location; Direction; Destination; Information; Runway Distance Remaining

B. Mandatory Instruction
   - i. Purpose - Denote entrance to runway or critical area / area where aircraft are prohibited
   - ii. Markings - Red background with a white text
   - iii. Typical Mandatory Signs and Applications
     - a. Runway Holding Position Sign

b. Runway Approach Area Holding Position Sign
c. ILS Critical Area Holding Position Sign
d. No Entry Sign

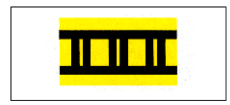


C. Location Signs
  i. Purpose - Identify either a taxiway or runway on which the aircraft is located
  ii. Taxiway Location Sign (pictured, right)
    a. Purpose - Along taxiways to indicate location
    b. Markings - Black background with yellow inscription and border

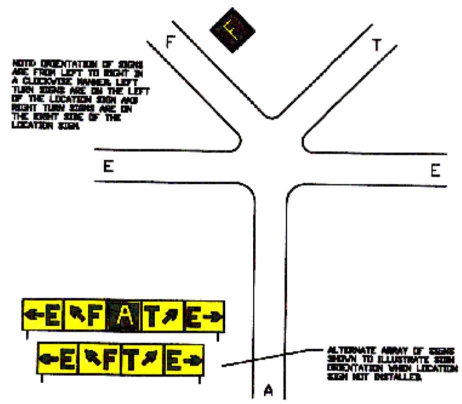
  iii. Runway Location Sign (pictured, right)
    a. Purpose - Complement compass / heading info; typically in areas with multiple runways
    b. Markings - Black background with yellow text

  iv. Runway Boundary Sign (pictured, right)
    a. Purpose - Visual cue depicting when "clear of the runway"
    b. Markings - Yellow background / black lines

  v. ILS Critical Area Boundary Sign (pictured, right)
    a. Purpose - Depicts where clear of the ILS critical area
    b. Markings - Yellow background / black lines



D. Direction Signs (pictured, right)
  i. Purpose - Identify taxiways out of an intersection
    - Designations / arrows are arranged clockwise from the 1st taxiway on the pilot's left
  ii. Markings - Yellow background / black text



E. Destination Signs
  i. Purpose - Indicates a destination on the airport
    b. Destinations commonly shown are

• Runways	• Civil Aviation Areas
• Aprons	• Cargo Areas
• Terminals	• International Areas
• Military Areas	• FBOs

  ii. Markings - Yellow background / black text
F. Information Signs
  i. Purpose - Provide information on things such as:
    a. Areas the tower can't see, radio frequencies, and noise abatement procedures
  ii. Markings - Yellow Background / black text
G. Runway Distance Remaining Signs (pictured, right)

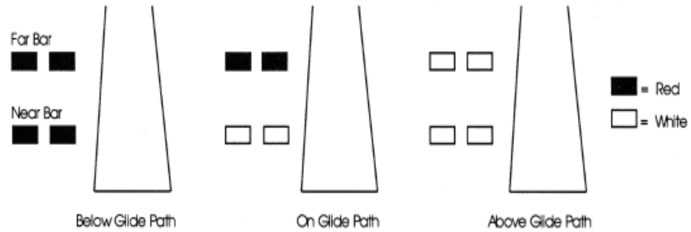
  i. Purpose – Informs the distance remaining on the runway
    a. Number indicates the thousands of feet of landing runway remaining
  ii. Markings - Black background / white number
H. Common Error - Failure to comply with airport, runway, taxiway sings and markings

7. Airport Lighting and Other Airport Visual Aids

A. Approach Light Systems (ALS)
  i. Purpose – Assists the transition from instrument conditions to visual conditions for landing
  ii. Explanation – A configuration of lights starting at the threshold, extending into the approach area
B. Visual Glideslope Indicators
  i. Visual Approach Slope Indicator (VASI)
    a. Purpose - Provides visual descent guidance during approach
    b. Explanation - The lights are visible from 3-5 miles during day and up to 20 or more at night
      - Safe obstruction clearance within ± 10° of the centerline and 4 NM from the threshold

c. Configurations
- 2, 4, 6, 12, or 16 light units arranged in bars
  a Arranged as near, middle, and far bars (Mid provide another glide path for high cockpits)
  b VASIs of 2, 4, or 6 light units are located on one side of the runway (usually left)
  c VASIs consisting of 12 or 16 light units are located on both sides of the runway

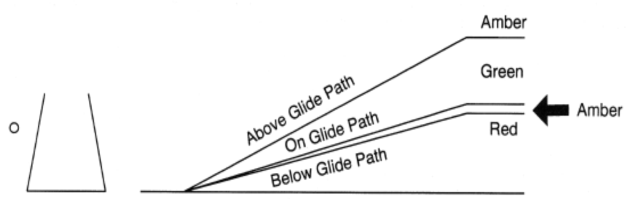
d. Two Bar VASI (most common) – Provide one visual glide path, normally set at 3°
- Each unit projects light with an upper white segment and a lower red segment



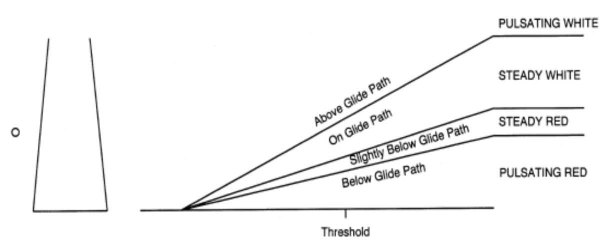
e. Three Bar VASIs – Provide two visual glide paths
- Lower glide path is provided by the near and middle bars - normally set to 3°
- Upper glide path is provided by the middle and far bars - normally ¼° higher

C. Precision Approach Path Indicator (PAPI)
i. General
a. Lights arranged to provide visual descent guidance during the approach to a runway
b. Uses light units similar to VASI but in a single row of either 2 or 4 light units

ii. Configuration
a. Tri-Color System
- Glide Path Indications
  a Above - Amber
  b On – Green
  c Below - Red
- Useful Range
  a Day - ½ to 1 mile; Night - Up to 5 miles



b. Pulsating System
- Glide Path Indications
  a Above - Fast pulsating white
  b Slightly Above - Pulsating white
  c On - Steady white
  d Slightly Below - Steady red
  e Below - Pulsating red
- Useful Range
  a Day, up to 4 miles; Night, up to 10 miles



D. Runway End Identifier Lights (REIL)
i. General - Installed to provide rapid / positive identification of the approach end of a runway
ii. Configuration - Pair of synchronized flashing lights on each side of the runway threshold

E. Runway Edge Light Systems (HIRL, MIRL, LIRL)
i. General - Outline the edges of runways during dark / restricted visibility conditions
a. Classified according to the intensity or brightness
- High Intensity (HIRL); Medium Intensity (MIRL); Low Intensity (LIRL)

ii. Configuration
a. Runway edge lights - White
- Instrument runways – Yellow for the last 2,000,' or half the runway, whichever is shorter

        b. Lights marking the end of the runway – Red / Green
            - Red indicates the end of the runway to a departing aircraft
            - Green indicates the threshold to landing aircraft

F. In-runway Lighting
    i. Runway Centerline Lighting System (RCLS)
        a. General - Installed on some precision runways to facilitate landing under adverse conditions
        b. Configuration
            - Along runway centerline at 50’ intervals
            - From the threshold, the lights are white until the last 3,000’ of the runway
                a White lights alternate with red for 2,000’, and the last 1,000’ all lights are red
    ii. Touchdown Zone Lights (TDZL)
        a. General - On some precision runways to indicate touchdown zone in low visibility conditions
        b. Configuration
            - Rows of (usually 3) lights on both sides of the runway centerline
            - Rows begin 100’ beyond the landing threshold and extend to 3,000’ beyond the landing threshold or he midpoint of the runway, whichever is less
    iii. Taxiway Centerline Lead-Off Lights
        a. General – Provide visual guidance to exit the runway
        b. Configuration
            - Alternate green / yellow lights, beginning with green, from the runway centerline to 1 light position beyond the runway hold position / ILS critical area hold position
    iv. Taxiway Centerline Lead-on Lights
        a. General – Provide visual guidance for entering the runway
        b. Configuration
            - Color coded with the same pattern as lead-off lights
            - Bidirectional (1 side emits light for the lead-on function the other for the lead-off)
    v. Land and Hold Short Lights
        a. General – Used to indicate the hold short point on certain runways approved for LAHSO
            - When installed, the lights will be on anytime LAHSO is in effect and off when not
        b. Configuration - A row of pulsing white lights installed across the runway

G. Control of Lighting Systems
    i. Operation of approach light systems and runway lighting is controlled by the tower / FSS
    ii. Pilots may request the lights be turned on or off

H. Pilot Control of Airport Lighting
    i. Radio control of lighting is available at some airports by keying the microphone
        a. Usually 3 clicks for low lights, 5 for medium, and 7 for high intensity (all clicks within 5 seconds)
    ii. The CTAF is used to activate the lights at most airports, but other frequencies may also be used
        a. Frequency is in Chart Supplement / standard instrument approach procedures publications

I. Airport Beacons
    i. Used to identify airports as well as differentiate different types of airports
    ii. Colors and Combinations of Beacons
        a. White and Green - Land Airport
        b. White and Yellow - Water Airport
        c. White, White, and Green – Military Airport
        d. Green, Yellow, and White - Lighted Heliport
    iii. Beacon operation during the day

        a. In Class B, C, D and E surface areas, operation of the airport beacon during the hours of daylight often indicates the ground visibility is less than 3 miles and / or the ceiling is less than 1,000'
            - No regulatory requirement for daylight beacon operation

J. Taxiway Lights
    i. Taxiway Edge Lights
        a. Purpose - Outline the edges of taxiways during periods of darkness or restricted visibility
        b. Configuration - Blue light
    ii. Taxiway Centerline Lights
        a. Purpose - Facilitate taxiing during low visibility conditions
        b. Configuration - Steady green lights along the centerline
    iii. Clearance Bar Lights
        a. Purpose - Installed to increase the visibility of a holding position in low visibility conditions
            - May also be installed to indicate the location of an intersecting taxiway during darkness
        b. Configuration - Three in pavement steady yellow lights
    iv. Runway Guard Lights
        a. Purpose - Enhance the visibility of taxiway and runway intersections
        b. Configuration - Either a pair of elevated flashing yellow lights on either side of the taxiway, or a row of in pavement yellow lights across the entire taxiway at the runway hold marking
    v. Stop Bar Lights
        a. Purpose - Confirm ATC clearances to enter / cross an active runway in low visibility conditions
        b. Configuration - Row of red, unidirectional, steady in pavement lights across the entire taxiway at the runway hold position, and elevated steady-burning red lights on either side
            - Following ATC clearance, the stop bar is turned off and the lead-on lights are turned on
        c. Never cross a red illuminated stop bar even if you have received ATC clearance
        d. If after crossing, the lead-on lights extinguish, hold position and contact ATC for instruction

K. Common Error - Failure to comply with airport, runway and taxiway lighting

Common Errors:

- Failure to comply with airport, runway, taxiway signs and markings
- Failure to comply with airport, runway and taxiway lighting
- Failure to use proper runway incursion avoidance procedures

Conclusion:

Brief review of the main points

It is important to understand the meaning of the airport, runway and taxiway signs, markings, and lighting for safety as well as to avoid runway incursions. If you are confused or have a question, do not proceed. Stop the aircraft and ask ATC.

TAKEOFFS, LANDINGS & GO AROUNDS

VII.A. Normal and Crosswind Takeoff and Climb

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	To understand the procedures and requirements for a normal and crosswind takeoff and climb. The student should be able to competently maintain control of the airplane and safely takeoff and climb with or without wind as described in the ACS/PTS.
Key Elements	1. Takeoff into the Wind 2. Left Turning Tendencies 3. *Rotation Speed (V_R - 44 knots)
Elements	1. Normal Takeoff 2. Crosswind Takeoff
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References 3. Model Airplane
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The lesson is complete when the student is able to walk through a normal or crosswind takeoff on the ground, providing knowledge of common errors regarding these procedures. The student also should be able to confidently demonstrate a takeoff and climb with or without a crosswind.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

The takeoff is one of the most basic and exciting parts of flying. Different situations regarding wind and weather, runway size and length, and the runway surface will provide different challenges for every flight.

Overview

Review Objectives and Elements/Key ideas

What

A normal takeoff is one in which the airplane is headed into the wind, or the wind is very light. Also, the takeoff surface is firm, and of sufficient length to permit the airplane to gradually accelerate to normal lift-off and climb-out speed, and there are no obstructions along the takeoff path.

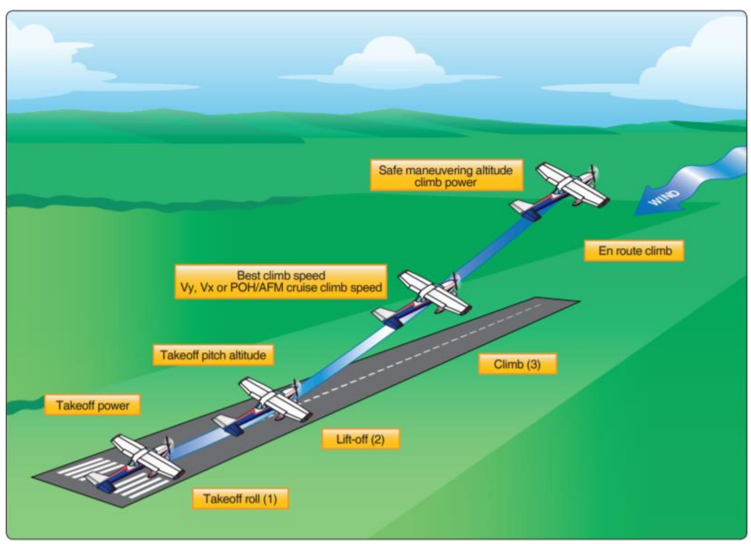
While it is preferable to takeoff into the wind, there will be instances when circumstances dictate otherwise. A crosswind takeoff is a normal takeoff with the exception being that the airplane is no longer headed directly into the wind.

Why

It is essential to every flight you will ever take! A smooth, safe takeoff is a key element of pilot proficiency. It is essential for the pilot to be able to perform a safe and smooth takeoff and have the ability to control the aircraft in varying conditions, starting with the basics. You need to be on your game while maneuvering close to the ground - takeoffs are, by definition, performed at and near the ground.

How:

1. **Normal Takeoff**
   A. General
      i. Normal = Headed into the wind, or very light wind, firm surface and sufficient length
      ii. Reasons for taking off into the wind
         a. Even motionless, a headwind will provide some airspeed due to wind moving over the wings
         b. Decreases speed necessary to achieve flying speed
            - Shorter ground roll, less runway required
            - Reduces wear / stress on the landing gear



   B. Takeoff Roll
      i. Taxi onto the Runway
         a. Before takeoff checklist prior to taxiing onto the runway
         b. Common Error - Improper use of checklist
         c. Controlled Airport
            - Never taxi onto a runway for takeoff without a specific clearance

- a In the case of confusion, stop and query the controller
- Clear the area prior to crossing the hold short lines

d. Uncontrolled Airport
- Announce intentions on the CTAF to alert other aircraft of your position and intentions
- Use other aircraft's radio calls to build a mental picture of the traffic in the area
- Check final approach
  - a 360° turn in the direction of the traffic pattern is recommended
- Check the runway
  - a Ensure the runway is clear of other aircraft, vehicles, persons, or other hazards

e. Verify the runway assigned matches the runway you are on
- Numerous accidents have been the result lining up on the wrong runway

f. Common Error – Improper runway incursion avoidance procedures

g. Aligning the aircraft
- Align with the intended takeoff direction, straighten the nosewheel
- Centerline site picture
- Note ground points aligned with the runway to help maintain runway centerline in the climb

ii. Release the brakes and advance power

a. After releasing brakes, smoothly and continuously advance to takeoff power
- Ensure both feet are on the rudder pedals, and not pressing on the brakes

b. Expect left yaw when power is added – maintain centerline with right rudder

c. Common Error - Improper use of controls during a normal or crosswind takeoff

iii. Gaining Speed

a. Check the engine instruments for proper operation, and verify airspeed indicator operation
- Announce "gauges green," "airspeed alive"
- If improper indications, abort the takeoff and stop straight ahead

b. Use rudder to keep the nose of the airplane tracking down the centerline of the runway
- Visual picture - Centerline between outer leg and control stick
- Don't use the brakes to steer

c. As speed increases, flight controls become more effective
- Progressively smaller rudder pressures are necessary to maintain direction

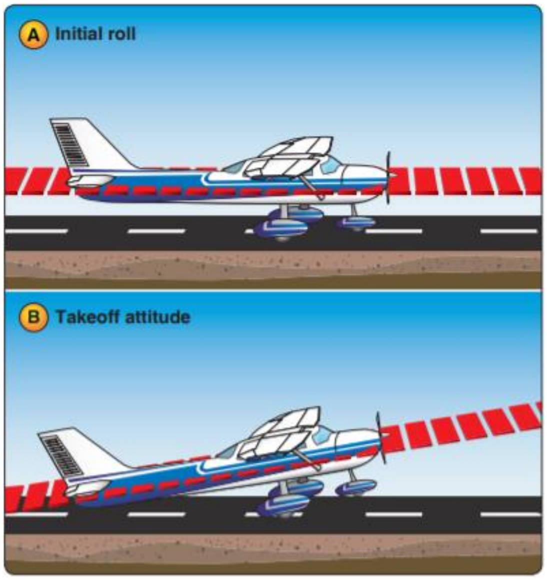
C. Lift-Off

i. Rotation (V_R)

a. As the aircraft reaches V_R, gently pull back to establish a climb at V_Y
- Varies with weight and density altitude
- Wings are kept level with aileron pressure
- Maintain rudder pressure to continue straight and coordinated

b. Visually
- Maintain centerline, pitch, bank with outside references / quick glances to instruments
  - a 90% outside, 10% inside

c. Common Error - Improper liftoff procedures
- Maintain the correct pitch attitude constant after rotation/lift-off
- Don't force the plane into the air with excessive back pressure



- Maintain right rudder pressure to keep the aircraft coordinated throughout

ii. Initial Climb

a. Pitch for V_Y – V_Y + takeoff power = maximum altitude in minimum time

- Provides the most altitude in the case of an emergency

b. Visually

- Adjust pitch and bank with reference to the natural horizon, verify with instruments
  - a Make slight adjustments in relation to the natural horizon
  - b Glance at the instruments to verify the new attitude is correct
  - c Adjust as required, check the instruments again to verify desired performance
- Maintain extended centerline to avoid drifting into obstructions / other aircraft
  - a Identify two points inline and ahead of the runway to use as a tracking reference
- Scan vigilantly

c. Common Error - Improper climb attitude, power setting, and airspeed (V_Y)

D. Climb Checklist

i. Perform the climb checklist when at a safe altitude and under control (technique: 500' AGL)

ii. Common Error - Improper use of checklists

a. Wait until the aircraft is at a safe altitude and under control to accomplish any checklists

b. The checklist can be delayed to continue flying the aircraft, always fly the aircraft first

2. Crosswind Takeoff

A. General

i. Basic steps are the same as a normal takeoff

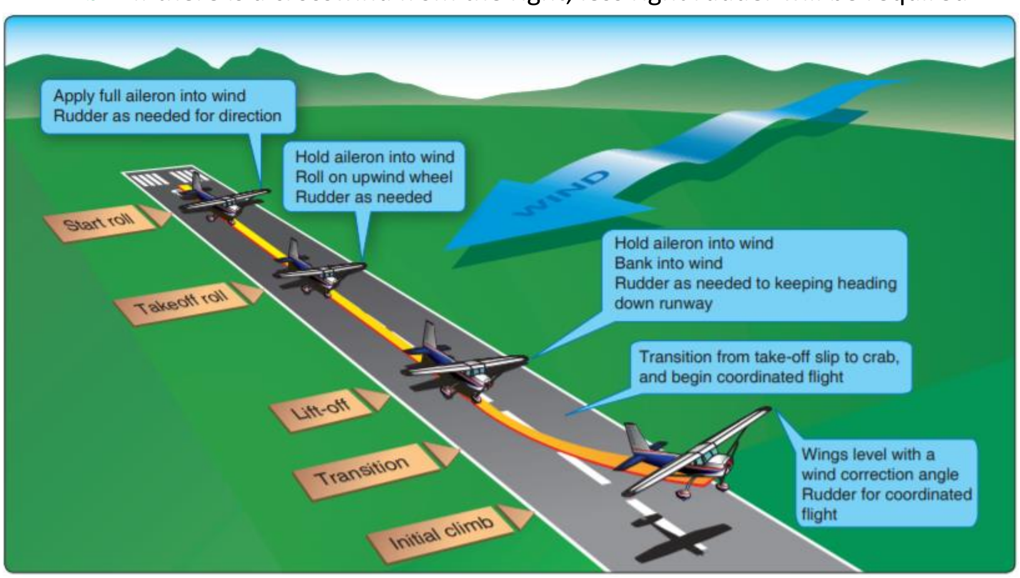
ii. Differences ensure centerline is maintained / smooth takeoff with wind pushing across the runway

iii. Aileron is applied into the wind, and rudder is used to maintain the centerline (sideslip)

a. Aileron keeps the wings level during the takeoff roll

b. Rudder keeps the nose tracking down the centerline

- Right rudder is used to counter left turning tendencies, but:
  - a If there is a crosswind from the left, additional right rudder will be required
  - b If there is a crosswind from the right, less right rudder will be required



c. Once established in the climb, transition from the sideslip to a crab

iv. Improper corrections can result in skipping, sideways movement, and side stress on the landing gear

B. Takeoff Roll

i. Taxi onto the Runway

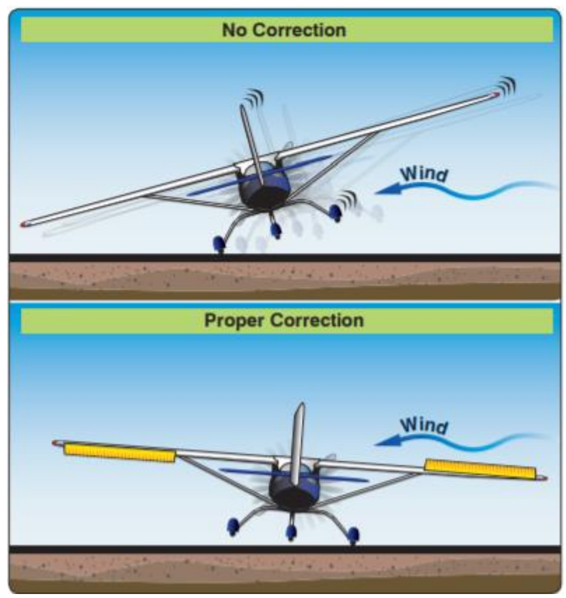
a. Complete the before takeoff checklist prior to taxiing onto the runway
- Common Error - Improper use of checklist

b. Align with the runway and straighten the nosewheel
- Common Error - Improper runway incursion avoidance procedures (same as Normal Takeoff)

ii. Visually
   a. Visual centerline reference
   b. Note visual points in line with the runway to assist in maintaining extended centerline in climb

iii. Full aileron should be held into the crosswind as the roll is started
   a. Puts a downward force on the upwind wing, prevents it from raising
   b. With the aileron into the wind, the rudder is used to keep the takeoff path straight

iv. Smoothly increase power and release the brakes
   a. Right rudder counteracts left turn tendencies and the weathervane due to crosswinds
   b. Common Error - Improper use of controls during a normal or crosswind takeoff
      - Ailerons should start the takeoff roll fully deflected into the wind
      - Rudder maintains centerline / keeps the longitudinal axis aligned with the centerline



v. Gaining Speed
   a. As forward speed increases, the ailerons become more effective and the crosswind becomes more of a relative headwind. Aileron pressure into the wind should gradually be reduced
      - Some aileron pressure will need to be maintained – keep the wings level
      - Adjust rudder pressure to continue straight down the centerline
   b. Common Error - Improper use of controls during a normal or crosswind takeoff

C. Lift-Off
   i. In a significant crosswind, stay on the ground slightly longer to ensure a smooth / definite takeoff
   ii. Maintain crosswind corrections during liftoff to prevent drifting / skipping
      a. As the nose is being raised, the aileron into the wind may result in the downwind wing rising first and the downwind main wheel lifting off first
         - This is preferred to side skipping
   iii. Once the plane leaves the ground, drift correction needs to be maintained
      a. Visually – Maintain centerline and pitch and bank (slip) with outside references and instruments
      b. Instrument Indications – Verify the pitch attitude to maintain V_Y
   iv. Common Error - Inappropriate lift off procedures
      a. Avoid removing crosswind corrections resulting in skipping and / or side loading gear

D. Initial Climb
   i. Maintain the sideslip until the climb is established, then crab into the wind

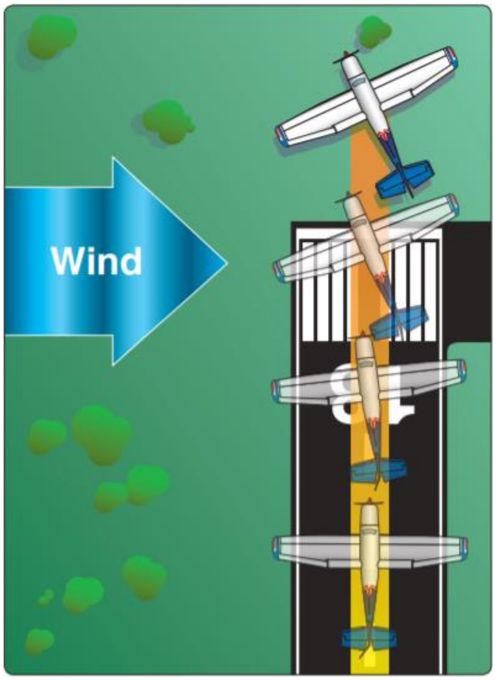
a. Sideslip creates excess drag / reduces performance
b. Nose should be turned into the wind to offset the crosswind with the wings level
c. Rudder should be centered for coordinated flight

ii. Visually
a. Use an outside scan to maintain the pitch and bank
b. Use two points ahead of, and in line with the runway to maintain extended runway centerline
c. 90% outside, 10% inside

iii. Continue the same as a normal climb

iv. Common Error - Improper climb attitude, power setting, and airspeed (V_Y)

E. *Climb Checklist
i. Climb to 500' AGL, and perform the 'Climb Check'
ii. Common Error - Improper use of checklists
a. Wait until the aircraft is at a safe altitude and under control to accomplish any checklists
b. The checklist can be delayed to continue flying the aircraft, if things are busy fly the aircraft first



Common Errors:
Normal Takeoff and Climb

- Improper runway incursion avoidance procedures
- Improper use of controls during a normal or crosswind takeoff
- Inappropriate lift off procedures
- Improper climb attitude, power setting, and airspeed (V_Y)
- Improper use of checklist

Conclusion:
Brief review of the main points
The lesson may have seemed technical or overbearing, but takeoffs are enjoyable. Not every takeoff will be the same and therefore adjustments will have to be made. A strong understanding of what is involved in a normal and crosswind takeoff is essential to every flight.

VII.B. Short-Field Takeoff and Maximum Performance Climb

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to short field takeoffs and maximum performance climbs. The student will have the ability to demonstrate a short field takeoff and climb as prescribed in the necessary ACS/PTS.
Key Elements	1. Use the Entire Runway 2. Maximum Performance Climb at V_X 3. Focus Outside the Airplane
Elements	1. V_X (Best Angle of Climb Airspeed) 2. Runway Incursion Avoidance 3. Pre-Takeoff 4. Takeoff Roll 5. Lift-Off 6. Maximum Performance Climb Common Errors, PTS/ACS Requirements
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student shows the ability to execute a proper short-field takeoff and climb by using the entire runway, pitching immediately for V_X until clear of obstacles, then pitching for V_Y.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

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

Overview

Review Objectives and Elements/Key ideas

What

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

Why

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

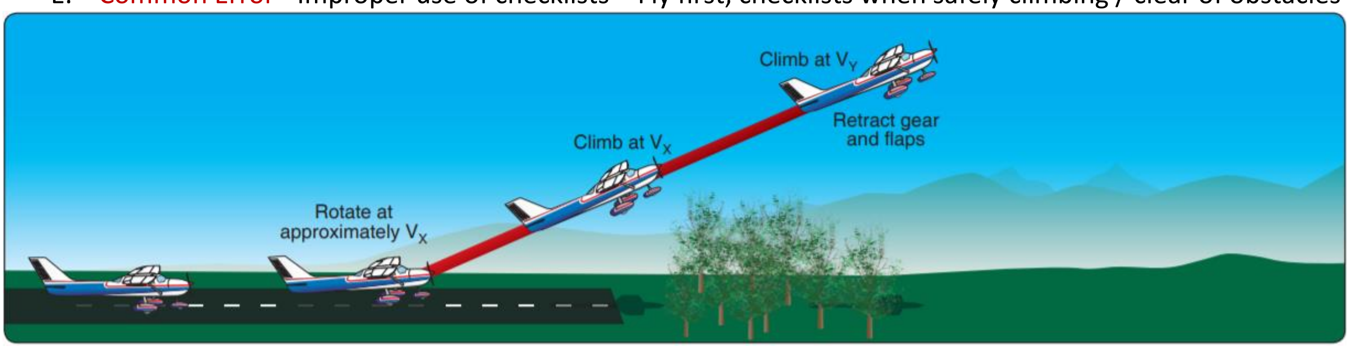
How:

1. **V_X (Best Angle-of-Climb Speed)**
   A. Provides the greatest gain in altitude for a given distance over the ground (usually slightly less than V_Y)
   B. Small deviations (5 knots) in some airplanes will result in a significant reduction in climb performance
      i. Precise control of airspeed is very important
2. **Runway Incursion Avoidance**
   A. Controlled Airport
      i. Taxi diagram
      ii. Ensure understanding of taxi clearance
      iii. Obtain clearance before crossing any runway
      iv. In the case of confusion, query the controller
      v. Stop the airplane if necessary to prevent an incursion
   B. Uncontrolled Airport
      i. Taxi diagram
      ii. Announce intentions on the CTAF
      iii. Be attentive to radio calls to build a mental picture of the traffic in the area
      iv. Check Final Approach, Check the runway (clear of aircraft, vehicles, persons animals, etc.)
         a. 360° in the direction of the traffic pattern is recommended to check for traffic
         b. Ensure you have time to takeoff before any aircraft make the turn onto final
   C. Common Error - Improper runway incursion avoidance
3. **Pre-Takeoff**
   A. Ensure the run-up is complete; configure as described in the POH
4. **Takeoff Roll**
   A. Start at the very beginning of the takeoff area. The field is short, don't waste runway
      i. Align the airplane with the runway centerline and come to a complete stop
      ii. Apply crosswind correction
   B. Smoothly and continuously advance the throttle to maximum power
      i. Follow the manufacturer's procedures (i.e., hold brakes and apply max power)
   C. Check the instruments, announce "airspeed alive," "engine gauges green"

        i. Do not hesitate to abort the takeoff if there is a problem
    D. Maintain directional control with the rudders
    E. The airplane should be allowed to roll with full weight on the main wheels and accelerate to liftoff speed
        i. Keep the elevator neutral to minimize drag / maximize acceleration
    F. Common Error - Improper use of controls during a short-field takeoff

5. **Lift-Off**
    A. Smoothly and firmly rotate at V_R to the pitch attitude that will result in a V_X climb
        i. Use outside references / attitude indicator to maintain the correct attitude
    B. In the case the airplane lifts off prior to V_R, allow the plane to accelerate in ground effect to V_X
        i. Preferable to forcing the airplane to remain on the ground with forward pressure
            a. Could result in "wheel barrowing," reducing acceleration and performance
        ii. Do not intentionally raise the nose prior to V_R – results in increased drag and prolonged roll
    C. Once airborne, a wings level climb should be maintained at V_X until obstacles have been cleared
        i. Since the airplane accelerates after liftoff, additional back pressure is required to maintain V_X
    D. Common Error - Improper liftoff procedures

6. **Maximum Performance Climb**
    A. Climb at V_X until clear of obstacles
        i. Maintain visual references, glance at the attitude / airspeed indicators to check pitch and V_X
    B. Configuration is not changed until clear of obstacles (unless recommended by the manufacturer)
    C. Once clear of obstacles pitch for V_Y
        i. Visually – Normal takeoff climb picture
        ii. Once stabilized at V_Y, configure the airplane per the POH, complete the climb checklist as normal
    D. Common Error - Improper initial climb attitude, power setting, and airspeed (V_X) to clear obstacle
    E. Common Error - Improper use of checklists – Fly first, checklists when safely climbing / clear of obstacles



Common Errors:

- Improper runway incursion avoidance
- Improper use of controls during a short-field takeoff
- Improper lift-off procedures
- Improper initial climb attitude, power setting, and airspeed (V_X) to clear obstacle
- Improper use of checklist

Conclusion:
Brief review of the main points
The short-field takeoff and maximum performance climb is based on rotating and pitching for V_X. This allows. for the greatest climb in the shortest distance, providing the most effective obstacle clearance.

VII.C. Soft-Field Takeoff and Climb

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	To develop the understanding of the soft-field takeoff as well as the skills needed to perform the takeoff from a soft-field. The student should be able to demonstrate the soft-field takeoff to ACS/PTS standards.
Key Elements	1. Constant back pressure 2. Transfer weight from the wheels to the wings 3. Stay in ground effect until reaching V_Y or V_X
Elements	1. Overview 2. Taxi 3. Takeoff Roll 4. Lift-Off 5. Initial Climb
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The lesson is complete when the student can demonstrate the knowledge of, and has shown proficiency in, soft field takeoffs and climbs, with and without an obstacle, and without the assistance of a flight instructor. The student must be able to maintain positive control of the airplane in ground effect until reaching the proper speed for climb out while demonstrating the proper use of checklists, traffic scan and safety procedures.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

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

Overview

Review Objectives and Elements/Key ideas

What

A takeoff from a “soft” field. Just like it says in the name, we are attempting to takeoff from a soft, often uneven surface which could produce enough drag to prevent the airplane from reaching normal takeoff speeds.

Why

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

How:

1. **Overview**
    - A. Differences from a Normal Takeoff:
        - i. Hazards
            - a. Reduced acceleration (sand, grass, snow, dirt, mud, etc.)
            - b. Gear and flap damage (uneven terrain, debris. Flap damage is more appliable to low wings)
            - c. Cartwheeling or flipping (nosewheel hits a hole during takeoff)
        - ii. To minimize hazards the goal is to get airborne ASAP and accelerate while in ground effect
    - B. The Basics
        - i. Maintain back pressure during the taxi and takeoff roll
            - a. Keep as much weight as possible off the nose to prevent it from getting stuck, or digging in
        - ii. Keep the aircraft moving – stopping may get the airplane stuck or require significant power to move
        - iii. Do a wheelie down the runway
            - a. Establish / maintain a nose-high pitch as early as possible; adjust back pressure to maintain
            - b. Transfer the weight as rapidly as possible from the wheels to the wings
        - iv. Accelerate in ground effect until reaching climb speed
            - a. The airplane will become airborne prior to normal rotation speed, and well before climb speed
            - b. Do not attempt to climb out of ground effect before reaching a safe climb speed (V_X or V_Y)
2. **Taxi**
    - A. Keep the elevator fully aft for the entire taxi
        - i. Keeps weight off the nose wheel keeping it from getting stuck or bogged down
    - B. More power is necessary due to the increased ground friction/drag
    - C. Keep turns shallow and don’t stop (helps prevent the plane getting stuck or bogged down)
    - D. Airport Procedures
        - i. Make normal traffic calls to alert other aircraft of your position and intentions
            - a. Use other aircraft’s radio calls to build a mental picture of the traffic in the area
        - ii. Before taxiing onto the runway visually clear the area

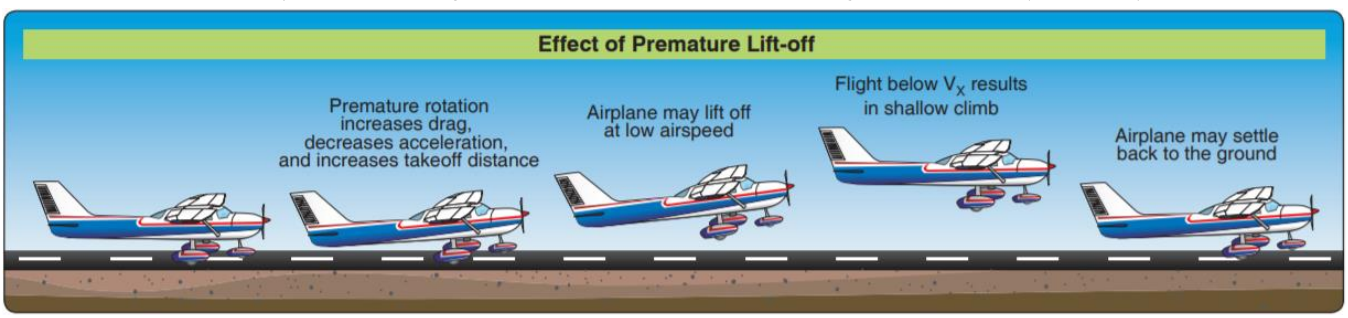
a. Check the final approach and the rest of runway for traffic, and obstructions
b. Be aware of any debris, animals, etc.
iii. Common Error - Improper runway incursion avoidance procedures

3. Takeoff Roll

A. Continue to maintain back elevator pressure and movement
   i. Apply crosswind corrections (same as a normal takeoff) in addition to the back pressure
B. While aligning with the takeoff path, takeoff power is established smoothly and rapidly
   i. Don't stop the plane. Add right rudder to counter left turning tendencies
   ii. Anticipate a slow acceleration due to the additional drag
   iii. Check "Gauges green," "Airspeed alive"
C. Back elevator pressure is initially held full aft
D. As the airplane accelerates and the nose lifts off the ground relax the back elevator pressure
   i. Full back pressure can result in a tail strike
E. The airplane will leave the ground below the normal rotation speed
F. Common Error – Improper use of controls during a soft-field takeoff
   i. As speed increases back pressure must be reduced to avoid an excessive angle of attack / tail strike
   ii. Use rudder and aileron to maintain the center of the runway and counteract any crosswind

4. Lift-Off

A. Once off the ground, gently lower the nose and accelerate to V_X or V_Y in ground effect
   i. Remain within ½ wing span of the ground (ground effect is most effective here)
      a. Increase forward pressure as airspeed (and lift) increases to stay in ground effect
      b. In some airplanes, to stay in ground effect the nose will have to point down toward the runway
         - Can be very uncomfortable
   ii. Accelerate to V_Y for a normal climb, V_X if an obstacle must be cleared
   iii. Common Error – Improper lift-off procedures
      a. Smoothly apply forward pressure to keep the aircraft in ground effect
      b. Abrupt / excessive control movements could easily put the aircraft back into the ground
      c. An early climb out of ground effect can result in settling on the runway, inability to climb, or stall



5. Initial Climb

A. Climb out as normal after the airplane has accelerated to V_X or V_Y
   i. Retract the gear and flaps as normal
B. Soft field runways are often short field runways (V_X may be necessary more often than not)
   i. If climbing to avoid an obstacle, the climb out is performed at V_X until the obstacle is cleared
   ii. After clearing the obstacle, pitch is set for V_Y and power is set to the normal climb setting
   iii. Retract gear and flaps as appropriate for obstacle clearance and performance
      a. If departing from a wet airstrip, gear should not be retracted immediately, allowing it to air dry
      b. If cold, cycle multiple times to avoid freezing
      c. If departing from a wet strip with an obstacle, retract the gear when a positive rate of climb is established to achieve the required performance

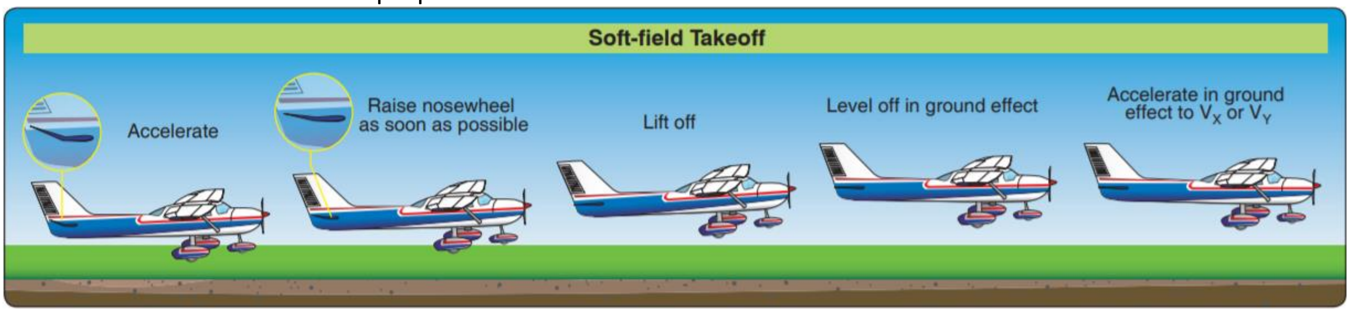
- If necessary to prevent freezing, lower and / or cycle the gear once clear of the obstacle
- Follow the manufacturer's guidelines

iv. Common Error - Improper climb attitude, power setting, and airspeed (V_X or V_Y)

C. Climb Checklist

i. Accomplish the climb checklist at a safe altitude, with the airplane under control

ii. Common Error - Improper use of checklists



Common Errors:
- Improper runway incursion avoidance procedures
- Improper use of controls during a soft-field takeoff
- Improper lift-off procedures
- Improper climb attitude, power setting, and airspeed (V_X or V_Y)
- Improper use of checklists

Conclusion:
Brief review of the main points
Anytime we are taking off from a soft field runway we need to get the weight off the wheels and onto the wings of the airplane as quickly as possible. This reduces the drag associated with a soft-field and allows the airplane to accelerate to a safe speed before climbing out. Without these procedures it is very possible the airplane would never reach the speed required for takeoff.

VII.F. Normal and Crosswind Approach and Landing

References: Airplane Flying Handbook (FAA-H-8083-3), Procedures during Taxi Operations (AC 91-73), Pilot Wind Shear Guide (AC 00-54), POH/AFM

Objectives	The student should be able to perform a normal approach and landing as prescribed in ACS/PTS. The approach and landing should be performed satisfactorily with or without a crosswind, and with the necessary corrections based on the situation.
Key Elements	1. Stabilized Approach 2. Smooth, Controlled Roundout 3. Hold the airplane inches above the ground before touching down 4. Don't Side Load the Aircraft
Elements	1. Determining Landing Performance and Limitations 2. Downwind Leg 3. Base Leg 4. Final Approach 5. Roundout 6. Touchdown 7. After-Landing Roll 8. Crosswind Approach 9. Go Around 10. Obstructions and Other Hazards to Consider 11. Wind Shear and Wake Turbulence
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can fly a coordinated, stabilized approach, transitioning into a smooth roundout and touchdown without side loading the airplane, with or without a crosswind.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

The landing is the most difficult, and most fun part of flying. It doesn't matter how good the flight was if the landing was bad.

Overview

Review Objectives and Elements/Key ideas

What

A normal approach and landing involves the use of procedures for what is considered a normal situation; that is, when engine power is available, the wind is light or the final approach is made directly into the wind, the final approach path has no obstacles, and the landing surface is firm and of ample length to gradually bring the airplane to a stop.

Why

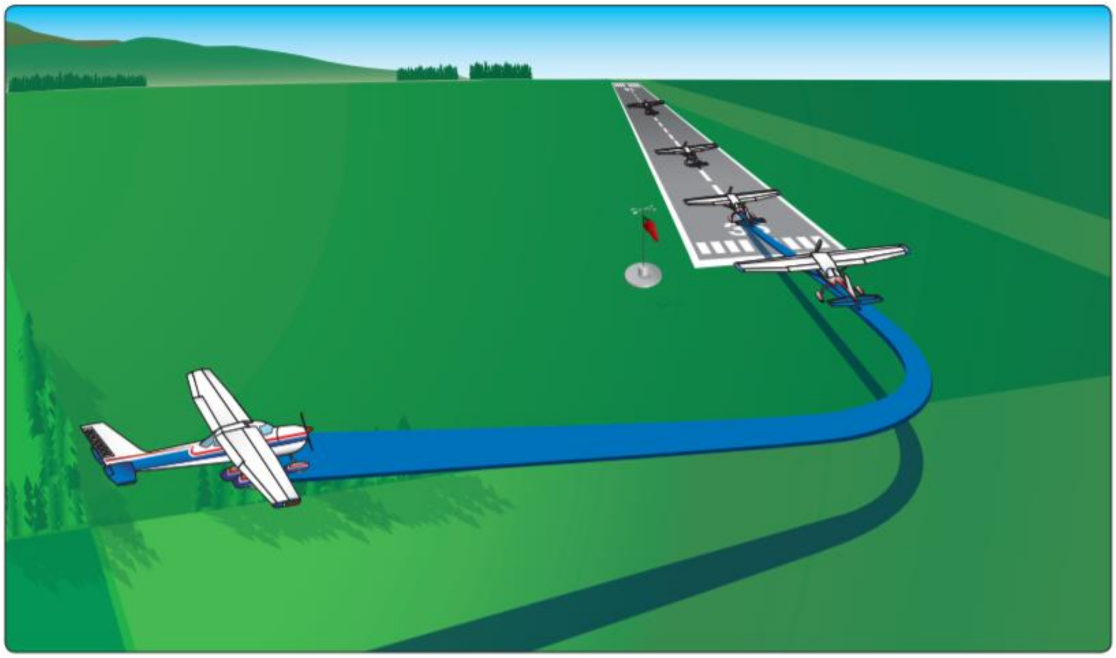
It's really a good skill to have when we decide we want to land the plane. Not only that, but the factors involved and procedures used also have applications to the other-than-normal approaches and landings.

How:

1. **Determining Landing Performance and Limitations**
    A. Performance is determined by using the appropriate charts in Chap 5 of the POH
    B. Limitations are found in Chap 2 of the POH
    C. Common Error - Improper use of landing performance data and limitations
2. **Downwind Leg**
    A. Parallel to the runway of intended landing, and normally at 1,000' AGL (pattern altitude can vary)
    B. Checklists – Complete the Before Landing Checklist at the midpoint of the downwind leg
    C. Abeam the landing threshold
        i. Begin descent
            a. Reduce power, extend flaps as appropriate, and establish the initial descent airspeed
            b. Maintain pattern altitude as the airplane slows to the descent speed
    D. Begin the turn to base when at a 45^{o} angle from the runway threshold
        i. Shallow to medium bank – recall Rectangular Course procedures to compensate for wind
        ii. At the 45^{o} point the airplane has descended approximately 200' (800' AGL) (varies with aircraft)
    E. Common Error - Failure to establish approach and landing configuration at appropriate time or in proper sequence
3. **Base Leg**
    A. Leg prior to turning final; perpendicular to approach end of the runway
    B. One of the more important judgements made by the pilot in any approach
        i. Must judge the altitude / distance from which a stable descent results in landing at the desired spot
        ii. The distance of the base leg from the runway depends on altitude, wind, and the flaps used
            a. Closer base leg if at a low altitude, flaps are used for a steeper descent, or a strong wind on final
    C. Configuration
        i. Establish the desired airspeed and configuration
    D. Drift Correction – Maintain a ground track perpendicular to the runway
        i. Common for a crosswind to push the airplane away from the runway

ii. Crab into the wind to maintain the course

E. Turn to Final
   i. Medium to shallow bank turn should align the airplane with the centerline of the runway
      a. Recall Rectangular Course and the effects of wind on the bank angle
      b. No more than 30^o of bank (stall speed increases rapidly above 30^o of bank)
      c. In the case a steep bank is necessary, a go-around is recommended
   ii. A descent of about 200' is also made on the base leg (600' AGL to start turn to final)
      a. Varies based on aircraft, and conditions (terrain, obstructions, flaps, etc.). Adjust as required
      b. On a 3^o glidepath (which is equal to 300' per nm), 600' AGL is a two-mile descent to the runway

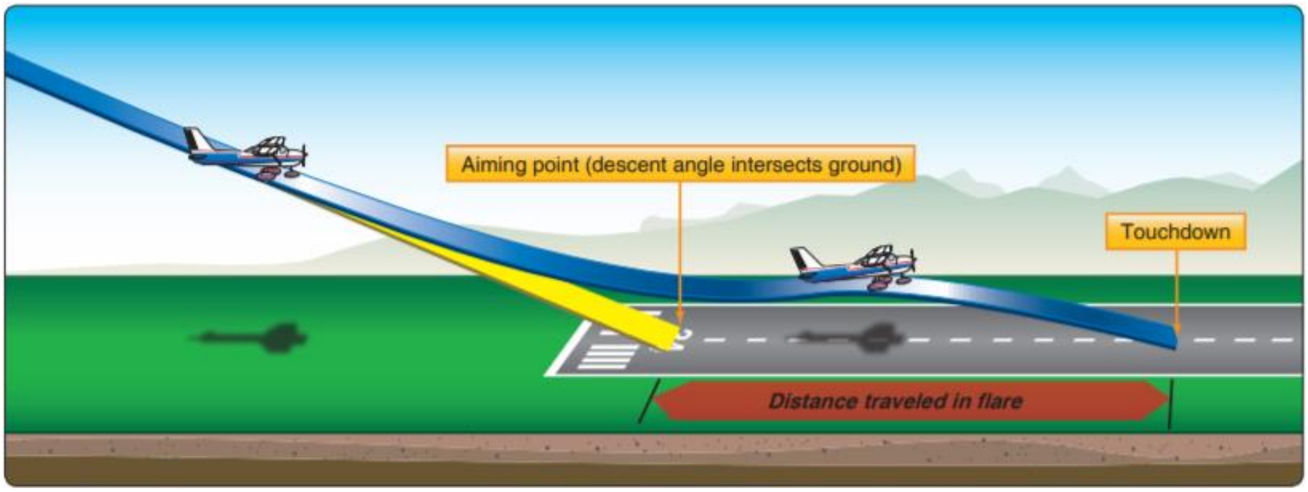


4. Final Approach

A. Longitudinal axis of is aligned with the center line and the final descent to the runway is made

B. Configuration – Generally, landing flaps and approach speed
   i. Accomplish the Landing Checklist

C. Stable Approach
   i. Stable approach: a constant glidepath towards a selected point on the landing runway
   ii. Common Error - Failure to establish and maintain a stabilized approach
      a. A stable approach is a safe approach
      b. Unstable increases the risk of excessive rates of descent or slow airspeed close to the ground
   iii. Controlling the Descent – Power and pitch are adjusted to maintain a stable approach
      a. The aircraft is below LD_{MAX} and in the Region of Reverse Command
         - Pitch is used to maintain airspeed (too fast, pitch up; too slow, pitch down)
         - Power is used to maintain altitude / glidepath (too low, add power; too high, reduce power)
      b. A change in either variable (pitch or power) requires a coordinated change in the other
         - If the approach is too high, reduce power and lower the nose to maintain airspeed
         - If the approach is too low, add power and raise the nose to maintain airspeed
   iv. Angle of Descent
      a. Aim Point



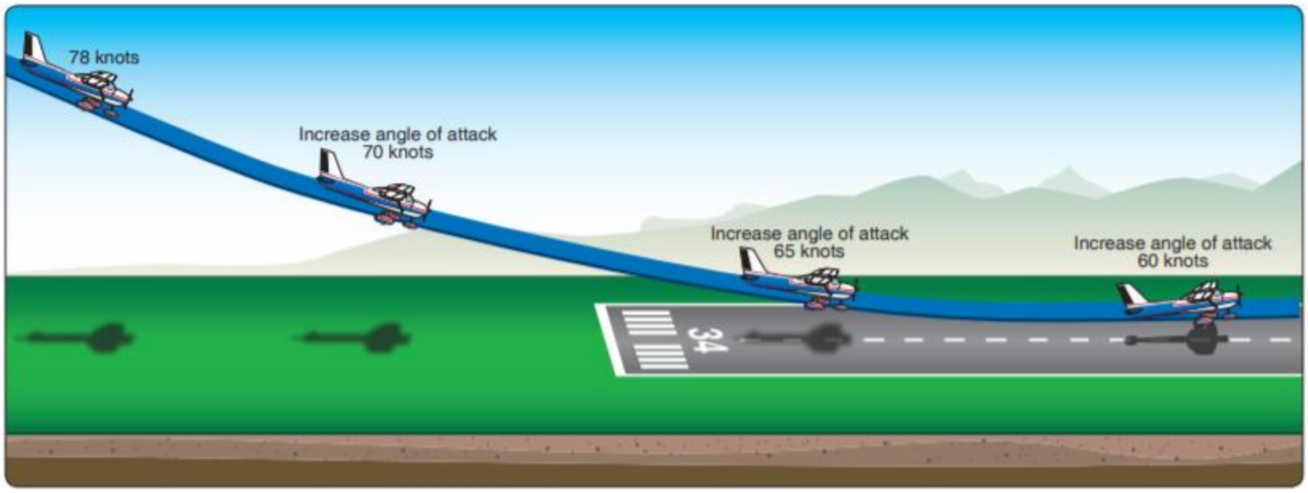
- Point the plane would strike the ground if a constant glidepath was maintained (no flare)
    - a The aim point should remain stationary in the windscreen
    - b Aim point is not the spot the airplane will touchdown due to flare / float
- Select an aiming point in front of the desired touchdown point (distance varies with aircraft)
- Keep the aim point steady on the windscreen
    - a If the aim point is not steady, the descent path has changed, and corrections are needed
    - b If the point moves up on the windscreen, the airplane is getting too low
        1. Add power and raise the nose to maintain airspeed
    - c If the point moves down on the windscreen, the airplane is getting too high
        1. Reduce power and lower the nose to maintain airspeed
    - d Small, proactive corrections will result in a steady, stable approach to the aim point

b. The Runway Image
- A normal glidepath is 3° (300' per nm descent)
- Too High – The runway will elongate and become narrower (overhead view of the runway)
- Too Low – The runway will shorten and become wider (flat view of the runway)
- On Path – Runway shape (between high and low) remains the same but grows in size

D. Common Error - Failure to ensure receipt and acknowledgement of landing clearance
   i. Ensure landing clearance was received, understood, and read back. Go around if not

5. Roundout

A. Smooth transition from a normal approach attitude to a landing attitude, gradually rounding out the flight path to one that is parallel with, and within a very few inches of the runway



B. Estimating Height and Movement
  i. Divide attention between a point just over the nose to the desired touchdown zone and back again
    a. Visual focus should not be fixed on any one side or to any one spot ahead
  ii. Speed and Vision
    a. Speed blurs objects at close range
    b. The distance at which vision is focused should be proportionate to the speed of the airplane
      - As speed is reduced, the distance that the pilot focuses should be brought closer
    c. Focusing too close will result in a blurred reference
      - Reactions will be too abrupt or too late (overcontrolling, high roundout / stalled landing)
    d. When focused too far, ability to judge the closeness of the ground is lost
      - Slow reactions (late or little to no flare, nose first landings)
    e. If focus is gradually brought closer as speed is reduced the landing process smoothed out

C. Starting the Roundout
  i. Started approximately 10’ to 20’ above the ground (varies between aircraft and rate of descent)
  ii. Power is reduced to idle and back elevator is applied gradually increasing pitch attitude
    a. Angle of attack is increased to allow the plane to settle slowly as airspeed decreases
    b. If angle of attack is increased too rapidly, the airplane will climb

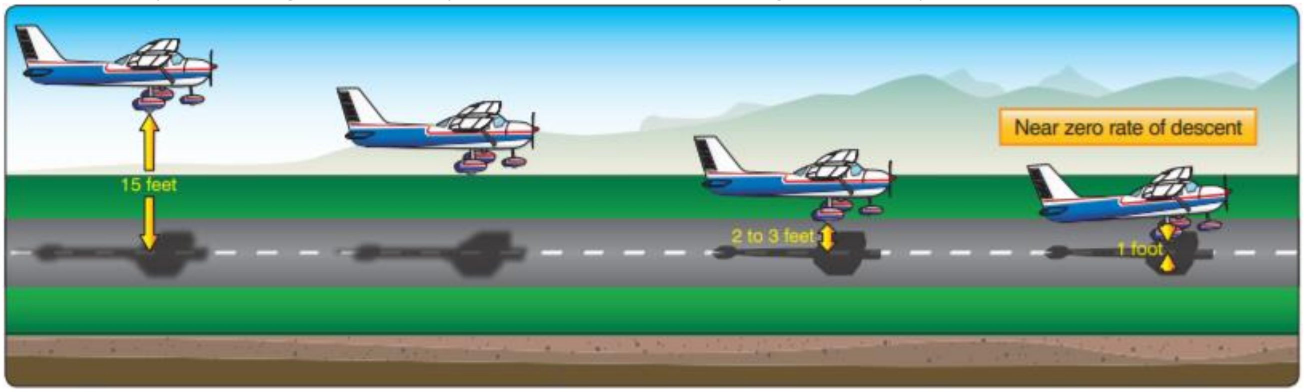
D. Decreasing Lift, Increasing Pitch Attitude
  i. With the power at idle, airspeed is decreasing. As airspeed decreases, the pilot increases the angle of attack which momentarily increases lift and decreases the rate of descent
  ii. Airspeed will continue to decrease causing lift to decrease again
    a. This must be controlled by raising the nose and further increasing the angle of attack
  iii. Airspeed is being decreased to touchdown speed, while lift is being controlled with back pressure so that the airplane will settle gently onto the runway

E. Rate of the Roundout
  i. Depends on the height above the ground, the rate of descent, and the pitch attitude
    a. High Roundout – Executed slower to allow the plane to descend
    b. Low Roundout – Execute faster to obtain the landing attitude before striking the runway
    c. High Rate of Descent – Similar to low roundout, pitch attitude must be changed at a higher rate
    d. Low Rate of Descent – Similar to high roundout, slow change in pitch is required
    e. High Pitch Attitude (ex: full flap landing) – Execute more slowly to prevent excessively high pitch
    f. Low Pitch Attitude (ex: no flap) – Execute faster to obtain attitude before striking runway
    g. Note: Once the roundout has been started, the elevator control should not be pushed forward
      - If necessary, relax back pressure or just hold it constant as the airspeed decreases

- ii. Common Error - Inappropriate removal of hand from throttles
  - a. Always be prepared to apply immediate power or initiate a go around

6. Touchdown

- A. The gentle settling of the airplane onto the landing surface at the minimum controllable airspeed with the airplane's longitudinal axis parallel to its direction along the runway



- B. Ideal Landing
  - i. Hold the airplane's wheels a few inches off the ground as long as possible with the elevators
  - ii. Increase back pressure to gently allow the main wheels to touchdown, followed by the nose
- C. Longitudinal Axis
  - i. The longitudinal axis should be parallel to the direction the airplane is moving along the runway
    - a. Failure to do this can impose severe side loads on the landing gear
- D. Rudder Control
  - i. Very little rudder is needed (no left turning tendencies with the engine at idle)
  - ii. During landing, rudder is primarily used in crosswinds (more below)
- E. After Touchdown
  - i. Maintain back-elevator pressure
    - a. Hold the nosewheel off the ground as the plane decelerates (assists with aerodynamic braking)
  - ii. As speed decreases relax elevator pressure to allow the nosewheel to gently settle onto the runway
- F. Common Error - Improper procedure during roundout and touchdown

7. After-Landing Roll

- A. The deceleration of the airplane to the normal taxi speed, or when the airplane has been brought to a complete stop when clear of the landing area
- B. Directional Control on the Ground
  - i. Rudder
    - a. With the nosewheel on the ground, use the rudder to steer the airplane on the ground
    - b. Rudder effectiveness is dependent on airflow which is dependent on the speed of the plane
  - ii. Aileron Control
    - a. During the after-landing roll ailerons are used to keep the wings level
    - b. As airspeed decreases during the landing roll the ailerons become less effective, therefore increasing aileron must be applied into a crosswind to keep the upwind wing from rising
  - iii. Be alert throughout the landing roll
    - a. Loss of Directional Control
      - May lead to an aggravated, uncontrolled, tight turn on the ground (ground loop)
      - Could impose a sideward force that could collapse the landing gear
    - b. Remain vigilant throughout the landing roll and keep positive control of the airplane
      - Don't assume that because the airplane is on the ground your work is done
  - iv. Common Error - Poor directional control after touchdown

C. Braking
   i. Slow the airplane, and can also be used to aid in directional control when the rudder is insufficient
   ii. Using the Brakes
      a. Toe brakes – Slide toes / feet up from the rudder pedals to the brake pedals
         - Be careful to maintain any necessary rudder pressure
      b. Brake pressure is applied by pushing forward on the toe pedals
      c. To turn with the brakes, apply pressure on one brake or uneven pressure on each brake
   iii. Effective Braking
      a. Put maximum weight on the main wheels after touchdown
      b. Nosewheel should be lowered to the runway to maintain directional control
      c. After the nose is down, apply back pressure without lifting the nosewheel off the ground
         - This enables directional control while keeping weight on the main wheels
      d. Firmly, smoothly, and evenly apply the brakes
         - Maximum brake effectiveness is just short of the point where skidding occurs
            a Maximum braking is not necessary in most landings
         - If the brakes are applied so hard that skidding takes place, braking becomes ineffective
         - Brake effectiveness is not enhanced by applying, releasing, and reapplying brake pressure
   iv. Common Error - Improper use of brakes
      a. Ensure feet are not on the brakes at touchdown, this could result in lost control and blown tires

D. Common Error - Failure to review airport diagram for runway exit situational awareness to avoid a runway incursion after landing

E. After Landing Checklist - Perform once safely clear of the runway

8. Crosswind Approach

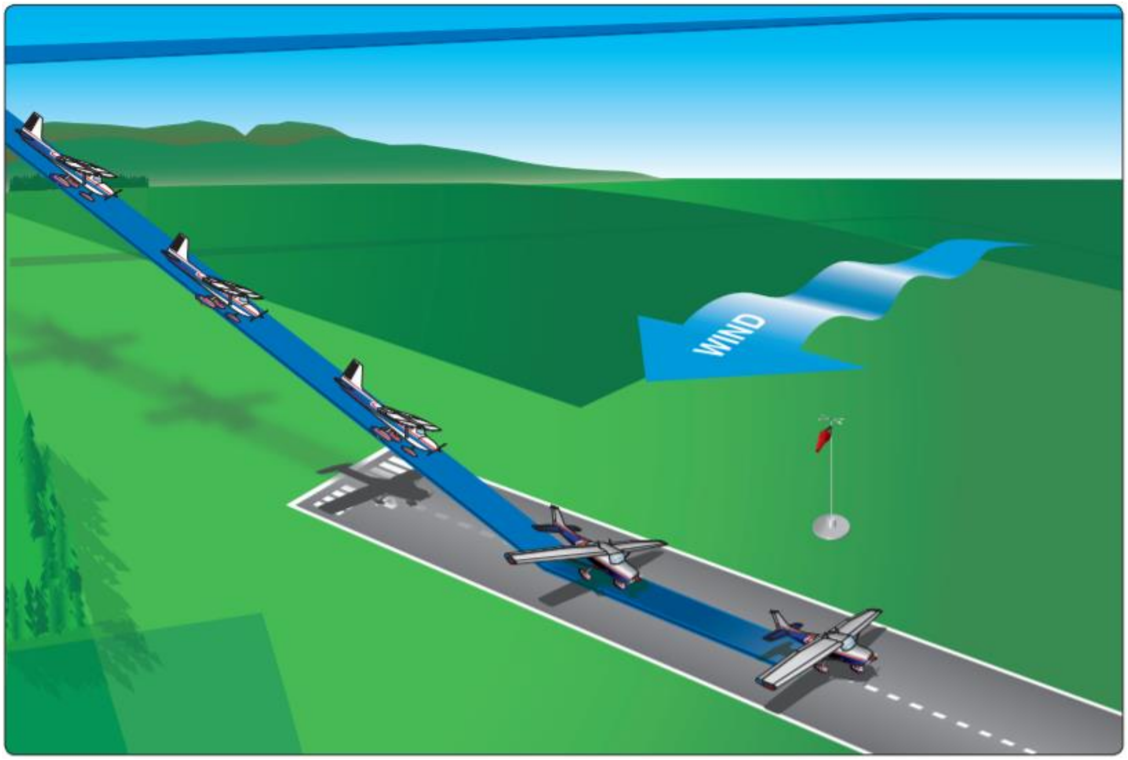
A. Landing in which the wind is blowing across, rather than parallel to the landing direction

B. The same basic principles apply to a crosswind approach and landing as a normal approach and landing

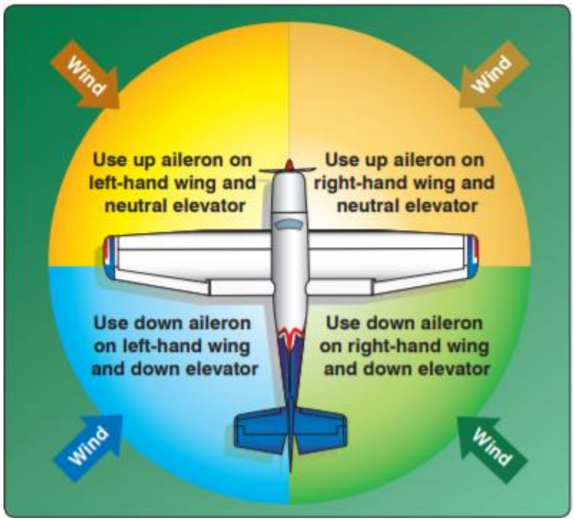
C. Two methods of accomplishing a crosswind approach and landing
   i. Crab Method
      a. Easier to maintain during final approach, but requires a high degree of judgment and timing in removing the crab right before touchdown
      b. How it Works
         - The pilot establishes a crab into the wind so that the airplane's ground track remains aligned with the centerline of the runway
         - Crab is maintained until just prior to touchdown, when the longitudinal axis of airplane is aligned with the runway to avoid a sideward touchdown of the wheels/airplane

      c. Not recommended

- ii. Sideslip (wing-low) Method (shown to the right)
    - a. Recommended method
- D. Final Approach
    - i. Sideslip (Wing-Low)
        - a. Align the airplane's heading with the centerline of the runway, noting the rate and direction of drift
        - b. Promptly apply drift correction
            - Lower the upwind wing
        - c. With wing lowered, the plane turns that direction
        - d. To compensate for the turn, opposite rudder pressure is used to keep the longitudinal axis of the airplane aligned with the runway
            - Side-slipping so that the flight path and ground track are aligned with the runway
        - e. Drift is controlled with aileron, and heading with rudder
            - Use ailerons to keep the airplane over the extended runway centerline
            - Use rudder to keep the longitudinal axis aligned with the runway centerline
        - f. Strong Crosswind
            - At some point, there will not be insufficient rudder available to overcome the turning tendency caused by the steepened bank
            - If full opposite rudder cannot prevent a turn, the wind is too strong (crosswind limit)
                - a Find another runway
                - b Always be aware of the airplane's crosswind limitations
        - g. Maintain a stabilized approach
            - Same as a normal approach, except with the added sideslip
            - Due to the slip, drag is increased and more power is necessary to maintain descent rate
                - a Pitch for airspeed; Power for altitude
    - ii. Roundout
        - a. Like a normal landing approach, but the crosswind correction is maintained to prevent drifting
            - Don't level the wings. Keep the upwind wing down throughout the roundout
                - a Leveling the wings will result in drifting, which will side loading the gear
        - b. Gradually increase the aileron and rudder pressure as the airplane slows
    - iii. Touchdown
        - a. The touchdown should be made on the upwind main wheel first
            - Continue to maintain the crosswind corrections to prevent drift
            - During gusty or high wind conditions, prompt adjustments must be made
        - b. As momentum decreases, the weight of the plane will cause the downwind main wheel to settle onto the runway, then the nosewheel
            - If your airplane has nose-wheel steering with the rudder, the nosewheel will not be aligned with the runway because opposite rudder is being held for the crosswind correction
                - a To prevent swerving, rudder pressure must be relaxed as the nose touches down



- iv. After Landing Roll
  - a. Special attention must be given to maintaining directional control using rudder / nose-wheel steering, while keeping the upwind wing from rising
  - b. Maintain directional control with rudders
  - c. Maintain crosswind control with ailerons
    - While decelerating, increasing aileron will help to keep the upwind wing from rising
    - When coming to a stop, aileron control should be fully into the wind



9. Go Around

- A. Used whenever landing conditions are not satisfactory
  - i. Can be executed for numerous reasons
- B. Go around anytime safety is compromised or the touchdown point is going to be missed
- C. Go Around Flow
  - i. Generally, apply full power, retract landing flaps, retract gear once a positive rate of climb is established, climb at V_X or V_Y, and retract the rest of the flaps at a safe altitude or with the climb checklist
- D. For more information, see VII.H. Go-Around/Rejected Landing

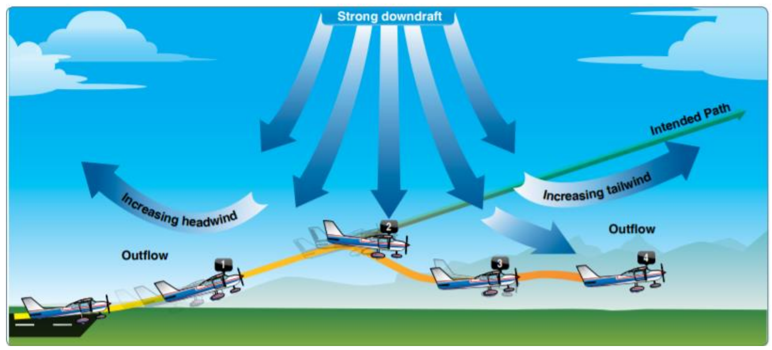
10. Obstructions and Other Hazards to Consider

- A. Strong/Gusty Winds
  - i. Increase speed on final approach per the manufacturer's guidelines
  - ii. Use flaps as recommended in the POH
- B. Obstacles
  - i. Trees, Towers, Construction equipment
  - ii. Be aware of any obstructions in the pattern / on the approach and / or takeoff path

    iii. Ensure the airplane performance can handle the obstructions
  C. Traffic
    i. Always be aware of, and looking for, other traffic
    ii. Use radio calls and any other available tools to build a mental picture of the traffic in your vicinity

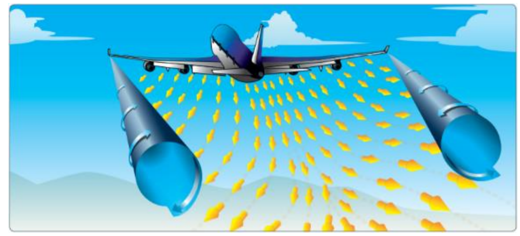
11. Wind Shear and Wake Turbulence

  A. Wind Shear
    i. What is it?
      a. A sudden, drastic change in wind speed and/or direction over a very small area
      b. While wind shear can occur at any altitude, low-level wind shear is especially hazardous
    ii. Why is it dangerous?
      a. Violent updrafts and downdrafts (up to 6,000 fpm) / abrupt changes to horizontal movement
      b. Rapid changes in performance (tailwind shears to headwind, or headwind to tailwind)
      c. Microbursts
        - Most severe type of wind shear
        - Characteristics



          a 1-2 miles across
          b Lifespan of 5-15 mins.
          c Strong downdrafts (max of 6,000 fpm)
          d Strong turbulence
          e Headwind gains / losses of 30-90 knots
        - Indications
          a Visual – Intense rain shaft at the surface, but virga at cloud base; ring of blowing dust
          b Alerting Systems
            1. LLWAS-NE, TDWR, and ASR-9 WSP systems installed at major airports
            2. Many airports, especially smaller airports, have no wind shear systems
          c AC 00-54 – FAA Pilot Wind Shear Guide
    iii. Handling Wind Shear
      a. If possible, avoid it
        - Never conduct traffic pattern operations near an active thunderstorm
        - LLWAS (Low Level Wind Shear Alerting System) can warn of windshear
        - PIREPS
      b. Approach into Wind Shear
        - Follow the POH procedures. If none, general techniques include:
          a Higher power and faster approach speed (add ½ the gust factor to approach speed)
          b Stay as high as feasible until necessary to descend
          c Go around at the first sign of an unexpected pitch or airspeed change
            1. Important to get FULL power and get the airplane climbing
            2. If the aircraft is descending toward the ground, ensure max power, increase pitch attitude as far as possible without stalling the airplane
              a. Intent is to keep the flying as long as possible in hope of exiting the shear
  B. Wake Turbulence
    i. What is it?

a. Difference between the high and low pressure below / above the wing causes the air to move outward, upward and around the wingtips, leading to counter rotating vortices



b. All aircraft generate wake turbulence during flight
- The larger the aircraft, the stronger the vortices
- Vortices are strongest when the pressure differential is greatest (heavy, clean, slow)

iv. Why is it dangerous?

a. Rolling moments can exceed control authority and / or damage the aircraft

b. Wake turbulence can be encountered in any phase of flight (usually strongest at departure)

v. Vortex Behavior

a. Vortices are generated when an aircraft leaves the ground until it touches down

b. Remain about a wingspan apart, drift with wind, above ground effect altitudes (½ wingspan)

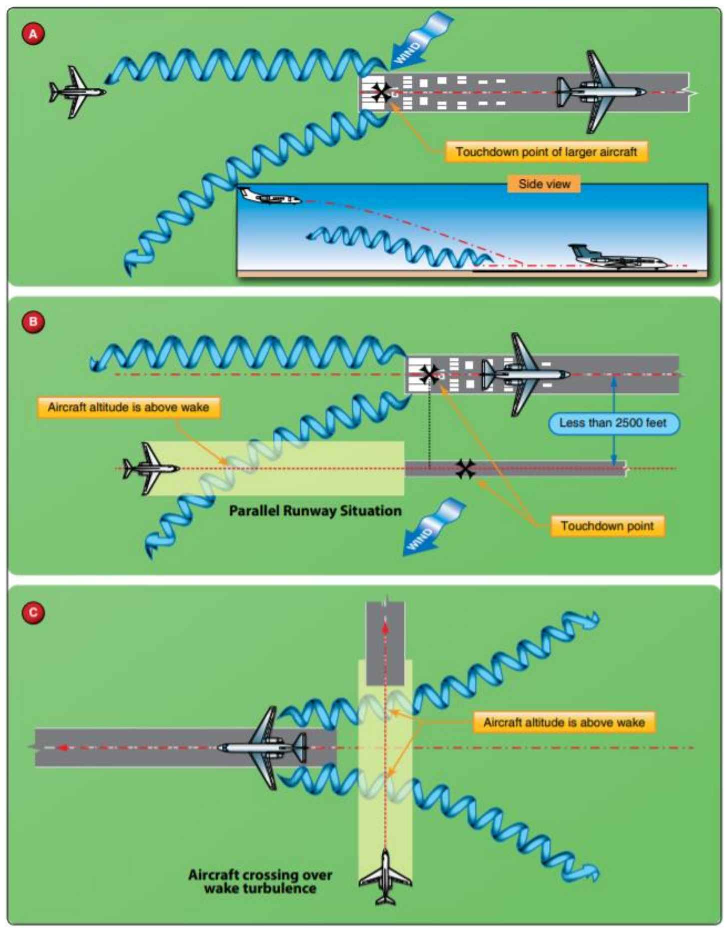
c. Sink at a rate of several hundred FPM, slowing descent and diminishing in strength over time

d. When close to the ground (100-200'), tend to move laterally at 2-3 knots

e. A crosswind decreases lateral movement of upwind vortex, increases downwind vortex

f. Light quartering tailwind can result in vortices along final approach centerline

vi. Avoidance Procedures



a. Maintain adequate separation

b. Approach
- Behind larger aircraft — stay at / above their flight path
- Behind larger aircraft on parallel runway (closer than 2,500 feet) — consider possibility of drift, stay at / above their final approach path and note their touchdown point

c. Landing
- Behind a departing aircraft on same runway — land prior to their rotation point
- Land beyond an arriving jet's touchdown point
- Behind a larger aircraft on a crossing runway — cross above their flight path
- Behind a larger aircraft on a crossing runway—note the aircraft's rotation point and, if that point is past the intersection, continue and land prior to the intersection
  - a If the larger aircraft rotates prior to the intersection, avoid flight below its flight path
- After a large aircraft executing a missed approach or touch-and-go–wait at least 2 minutes

d. Departing

- Behind larger aircraft – rotate before their rotation point, climb above their flight path until turning clear
- Intersection takeoff on the same runway – be alert to adjacent larger aircraft operations, avoid headings that cross below a larger aircraft's path
- After a large aircraft executing a missed approach or touch-and-go – wait at least 2 minutes

Common Errors:
- Improper use of landing performance data and limitations
- Failure to establish approach and landing configuration at appropriate time or in proper sequence
- Failure to establish and maintain a stabilized approach
- Inappropriate removal of hand from throttles
- Improper procedure during roundout and touchdown
- Poor directional control after touchdown
- Improper use of brakes
- Failure to ensure receipt and acknowledgement of landing clearance
- Failure to review airport diagram for runway exit situational awareness to avoid a runway incursion after landing

Conclusion:
Brief review of the main points
As simple and basic a procedure as this seems to be, a lot goes into a well-executed approach. Putting all of these parts together over time will result in a much more confident, safe, and skilled pilot. The fine nuances of a stabilized, well-planned approach are well worth the end result the first time you 'grease' a landing.

VII.G. Slip to a Landing

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), Pilot Wind Shear Guide (AC 00-54), POH/AFM

Objectives	The student should develop knowledge of the elements related to forward slips, as well as sideslips and have the ability to perform either one. The private pilot student should have the ability to perform the forward slip to a landing as required in the ACS/PTS.
Key Elements	1. Maintain Ground Track 2. Steeper the bank angle, Steeper the descent 3. Smooth recovery
Elements	1. What is a Slip? 2. Practical Slip Limit 3. Airspeed Indicator Errors 4. Stalls in a Slip 5. Performing the Forward Slip 6. Performing the Sideslip 7. Wind Shear and Wake Turbulence
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References 3. Model Airplane
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to perform a slip to a landing, maintaining ground track, and adjusting as necessary to establish and maintain a stabilized approach.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Today we get to learn how to make the plane drop out of the sky - in a controlled way.

Overview

Review Objectives and Elements/Key ideas

What

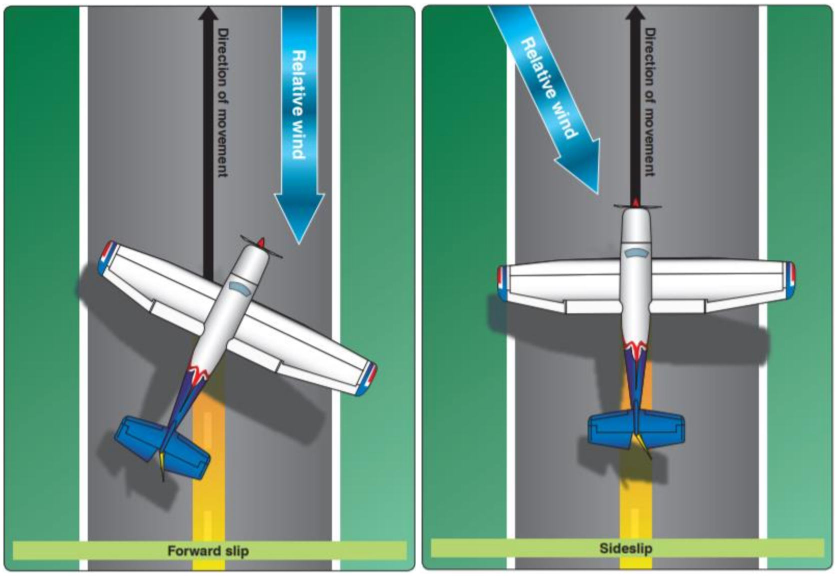
A slip occurs when the bank angle of an airplane is too steep for the rate of turn. The airplane is in essence flying sideways which increases drag as well as the rate of descent, without increasing the airspeed.

Why

Intentional slips are used to dissipate altitude without increasing airspeed, and/or adjust airplane ground track during a crosswind. Intentional slips are especially useful in forced landings and in situations where obstacles must be cleared during approaches to confined areas. A slip can also be used as an emergency means of rapidly reducing airspeed in situations where wing flaps are inoperative or not installed.

How:

1. **What is a Slip?**
   A. A slip is a combination of forward movement and sideward movement
      i. The plane is flying sideways resulting in a change in the direction the relative wind strikes the plane
   B. Characterized by an increase in drag, along with a decrease in climb, cruise, and glide performance
   C. Positive Static Stability
      i. Most planes have positive static directional stability (innate tendency to compensate for slips)
      ii. Requires deliberate cross-controlled ailerons and rudder throughout the maneuver
   D. Two Types of Slips
      i. Forward Slip - used to steepen the descent angle without excessively increasing airspeed
         a. Especially useful in forced landings and when obstacles must be cleared during the approach
         b. One wing is lowered, while yawing the opposite direction (angled in relation to original flight path)
         c. The amount of slip (and sink rate) is determined by the amount of bank
      ii. Sideslip – used in crosswind landings to keep aligned with the runway centerline / prevent drift
         a. Longitudinal axis of the plane remains parallel to the original flight path



b. One wing is lowered into the wind, and just enough opposite rudder is applied to keep the longitudinal axis of the airplane aligned with the centerline
   - Aileron corrects for the wind; rudder keeps the plane aligned with the centerline

c. Touchdown will occur on the upwind wheel, then the downwind wheel, then the nose wheel

2. Practical Slip Limit

A. The amount of slip is limited by the amount of rudder available

B. There's a point where full rudder is needed to maintain heading even though ailerons can steepen bank
   i. Practical Slip Limit: Any additional bank results in a turn even though full opposite rudder is applied

C. If there is a need to descend more rapidly, lowering the nose will increase the descent, and airspeed
   i. Increased airspeed increases rudder effectiveness, permitting a steeper slip
   ii. Conversely, when the nose is raised, rudder effectiveness decreases and bank must be reduced

3. Airspeed Indicator Errors

A. Airspeed indicators may have considerable error when in a slip

B. A change in either the static or ram pressure will result in a change in the airspeed
   i. Static Error Example – Static port on the left side, and pilot enters a slip to the left
      a. Static port now receives some amount of ram air pressure
      b. Static pressure increases, and for arguments sake, the ram (pitot) pressure remains the same
      c. Results in a lower indicated airspeed than what is actually being flown
   ii. Pitot Error Example
      a. Pitot tube is no longer directly into the relative wind; ram air pressure accuracy may be reduced

C. Reference the POH, be aware of any airspeed indicator errors / limitations

D. The pilot must be aware of the potential for errors and recognize a properly performed slip by the:
   i. Airplane attitude, sound of the airflow, and feel of the flight controls

4. Stalls in a Slip

A. If improperly flown, a cross-controlled stall can be entered in a slip
   i. Can be extremely hazardous close to the ground – some aircraft have a tendency to roll over

B. Displays little of the yawing tendency that causes a skidding stall to develop into a spin
   i. Stall characteristics may be improved, the airplane may even tend to roll into a wings level attitude
   ii. In a slip, the raised wing has a higher angle of attack than the low wing and will stall first
      a. Often the stall of the high wing first will reduce the bank angle, preventing a further stall

5. Performing the Forward Slip

A. Setup & Configuration
   i. Checklists should be used as normal
   ii. The airplane will have to be established higher on final
   iii. Reduce power to idle (there is no logic in slipping to lose altitude with power)
      a. Common Error - Inappropriate removal of hand from throttle
   iv. Extend the flaps as necessary
   v. Common Error - Failure to establish approach and landing configuration at the appropriate time or in proper sequence
      a. A slip is not the first option to lose altitude. Reduce power, lower flaps and gear, use spoilers, and if still necessary to increase the rate of descent, then slip

B. Entry
   i. The wing on the side toward which the slip is to be made should be lowered with the ailerons
      a. Slip into the wind, if a crosswind exists
   ii. Simultaneously, yaw the nose in the opposite direction so that the longitudinal axis is at an angle to the original flight path. The amount of yaw is such that the ground track is maintained
   iii. The nose of should be raised to prevent the airspeed from increasing

C. Stabilized Approach

- i. Precise Ground Track
  - a. Yaw the nose to the extent required to maintain ground track
  - b. If rudder is constant, the pilot can also adjust bank to maintain desired ground track
- ii. Rate of Descent
  - a. The amount of slip, and therefore sink rate, is determined by bank (more bank = more sink)
    - For maximum descent, use full rudder and adjust the aileron to maintain ground track
  - b. Pitch Attitude – smoothly adjust pitch to maintain the desired approach speed
- iii. Crosscheck should increase during a slip
- iv. Common Error - Failure to maintain a stabilized slip
  - a. Stable is safe. Excessive swings in descent rates, airspeed, or ground track is unsafe
  - b. Remove the slip and go around if unstable

D. Discontinuing a Forward Slip
- i. Level the wings and simultaneously release rudder pressure while readjusting the pitch attitude
  - a. Recovery should be smooth and controlled; no abrupt movements
- ii. Never land in a forward slip. Can impose severe side loads on the gear
- iii. Common Error - Improper procedure during transition from the slip to touchdown
  - a. Be smooth and controlled, establish a normal landing picture. Go around if unstable
- iv. Common Error - Poor directional control after touchdown
  - a. Ensure the slip has been removed with time to reestablish a safe landing picture
- v. Common Error - Improper use of brakes
- vi. Common Error - Improper use of landing performance data and limitations

6. Performing the Sideslip

A. Setup and Configuration
- i. Checklists should be used as normal
- ii. Configuration – normal landing configuration, unless specified otherwise
  - a. Maintain power setting
    - Not intended to increase sink as in a forward slip, therefore power is maintained
    - Common Error - Inappropriate removal of hand from throttle
  - b. Extend the flaps as necessary
    - Common Error - Failure to establish approach and landing configuration at the appropriate time or in proper sequence
- iii. Entry
  - a. Lower the upwind wing into the wind and apply just enough opposite rudder to prevent a turn
    - Aileron is used to keep the aircraft centered on the runway centerline
    - Rudder is used to keep the nose of the aircraft aligned with the runway
  - b. The amount of slip is determined by the strength of the crosswind
    - The stronger the crosswind, steeper the bank angle required to stay centered
    - As bank increases, additional opposite rudder is required to stay aligned with the centerline
  - c. The nose of the airplane should be raised slightly to prevent airspeed from increasing
  - d. Crosswind Limits
    - At some amount of crosswind, full rudder is required to maintain centerline alignment
    - Any additional crosswind will exceed the airplane’s ability to safely land
    - This is why there are crosswind limits in the aircraft POH
- iv. Forward Slip to a Sideslip
  - a. The pilot will have to transition from a forward slip to a sideslip
    - A high rate of descent is required, and the landing will be performed with a crosswind
  - b. The forward slip should be performed into the wind

        c. Once established on a normal glidepath smoothly remove the forward slip, maintain airspeed and glidepath, and then establish a sideslip for landing
- B. Stabilized Approach
    - i. Select an aim point; use pitch and power to maintain a stable approach to the aim point
    - ii. Precise Ground Track (while maintaining aim point / glidepath)
        - a. Establish bank to counter the crosswind (centerline control)
        - b. Establish rudder to align the airplane with the runway centerline
        - c. As conditions vary (gusts, etc.) adjust aileron and rudder
    - iii. Common Error - Failure to maintain a stabilized slip
        - a. Excessive swings in descent, airspeed, and ground track can be hazardous; go around if unstable
- C. Landing in a Sideslip
    - i. Maintain the slip during landing
        - a. Removing the sideslip over the runway will result in drifting
            - Can result in a severe side load, or even being pushed off the runway entirely
    - ii. The plane will touchdown on the upwind main first, then the downwind wheel, then the nosewheel
    - iii. Common Error - Improper procedure during transition from the slip to touchdown
        - a. Unlike the forward slip, it is essential to maintain the sideslip during landing
    - iv. Common Error - Poor directional control after touchdown
        - a. Directional control must be maintained to counter the crosswind after landing
        - b. Keep the aileron into the wind. As airspeed decreases, increase aileron deflection into the wind until reaching full deflection at a normal taxi speed
    - v. Common Error - Improper use of brakes
        - a. Brake evenly – when landing with more pressure on one rudder, uneven pressure is common
    - vi. Common Error - Improper use of landing performance data and limitations

7. Wind Shear and Wake Turbulence Avoidance
- A. See Wind Shear and Wake Turbulence in VII.F. Normal and Crosswind Approach and Landing

Common Errors:
- Improper use of landing performance data and limitations
- Failure to establish approach and landing configuration at the appropriate time or in proper sequence
- Failure to maintain a stabilized slip
- Inappropriate removal of hand from throttle
- Improper procedure during transition from the slip to touchdown
- Poor directional control after touchdown
- Improper use of brakes

Conclusion:
Brief review of the main points
A slip to landing can increase the rate of descent, helping in many different situations. It is important to ensure the airplane maintains the desired ground track. In order to adjust the rate of descent we increase or decrease bank angle and make the necessary rudder inputs to maintain ground track. We can reach a point where we can no longer maintain the ground track; this is the Practical Slip Limit. Ensure a smooth, gentle transition to landing to avoid sideloading and abrupt, violent maneuvering near the ground. To some extent, a sideslip can be used on almost every landing since the wind is rarely perfectly aligned with the runway. Use aileron to keep the aircraft over the runway, and rudder to align the longitudinal axis of the aircraft with the centerline.

VII.H. Go-Around/Rejected Landing

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to a Go-Around/Rejected Landing. The student will understand the importance of a prompt decision and have the ability to quickly and safely configure the airplane and adjust its attitude to accomplish a go-around. The student will perform the maneuver to the standards prescribed in the ACS/PTS.
Key Elements	1. Power 2. Attitude 3. Configuration
Elements	1. Situations When a Go-Around may be Necessary 2. Promptly Deciding to Go-Around 3. Cardinal Principles 4. Climb Out 5. Communication
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student shows the ability to recognize when a go-around is needed and promptly configures the airplane and adjusts its attitude to safely execute the rejected landing.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

There will be times when we have to discontinue a landing and set up for another one. This may be a result of a dangerous situation or may just be necessary to re-establish an approach. Either way, we definitely want to know what we're doing as we're getting closer and closer to the ground.

Overview

Review Objectives and Elements/Key ideas

What

A go-around is the discontinuance of a landing approach in order to make another attempt to land under more favorable conditions (it is an alternative to any approach or landing). The go-around is a normal maneuver that may at times be used in an emergency situation. It is warranted whenever landing conditions are not satisfactory and the landing should be abandoned or re-setup.

Why

The need to discontinue a landing may arise at any point in the landing process and the ability to safely discontinue the landing is essential, especially due to the close proximity of the ground.

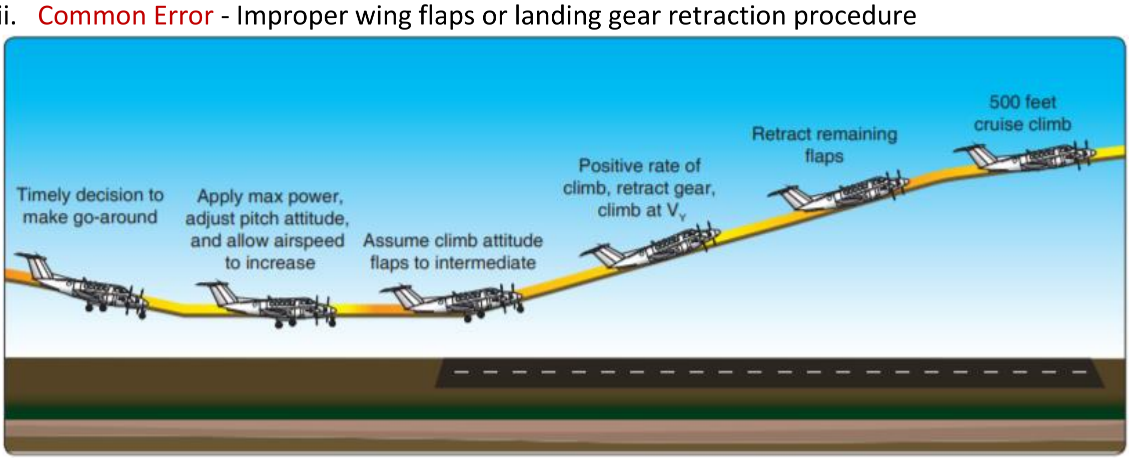
How:

1. **Situations When a Go-Around may be Necessary**
    - A. Unstable Approach
    - B. Air traffic control requirements / requests
    - C. Hazards on the runway (other aircraft, vehicles, animals, etc.)
    - D. Wind Shear / Wake Turbulence
    - E. Mechanical Failure
    - F. Whenever safety dictates a go-around
    - G. Common Error - Failure to recognize a situation where a go-around/rejected landing is necessary
2. **Promptly Deciding to Go-Around**
    - A. Not inherently dangerous, but becomes dangerous when unnecessarily delayed or executed improperly
    - B. Delaying a go-around tends to stem from two sources:
        - i. Landing Expectancy – belief that conditions are not as threatening as they are and it will end safely
        - ii. Pride –Mistaken belief that the act of going around is an admission of failure
    - C. Important to make a prompt decision
        - i. The earlier a situation that warrants a go-around is recognized, the safer the maneuver will be
        - ii. If there's a question as to go-around or not, it's usually safer / smarter to execute the go around
        - iii. Don't allow a situation to magnify. Don't hesitate, and stick to your decision. Safety first, always!
    - D. Common Error - Hazards of delaying a decision to perform a go-around/rejected landing
3. **Cardinal Principles – Power, Attitude, Configuration**
    - A. Power – the pilot's first concern
        - i. The instant the pilot decides to go-around, apply max takeoff power smoothly / without hesitation
            - a. Common Error - Improper power application
        - ii. Inertia – it takes considerable power, as well as time, to redirect an airplane's inertia
            - a. The downward inertia of the airplane must be slowed, stopped, then reversed
            - b. Newton's 1st Law - A body in motion wants to stay in motion

iii. Controlling Power – When takeoff power is applied:
  a. The nose may rise rapidly (especially if trimmed up for landing)
    - Hold forward pressure to maintain a safe attitude
    - Trim roughly to relieve some of the control pressures (fine tune later)
    - Common Error - Failure to control pitch attitude
  b. The nose will veer left
    - Right rudder pressure is necessary to counteract the left turning tendencies
    - Common Error - Failure to compensate for torque effect

B. Attitude
  i. An attitude must be established to allow the plane to gain sufficient speed before climbing / turning
  ii. Establish power, stop the descent, and when able, pitch to climb at V_Y (V_X, if obstacles)
    a. Common Error - Failure to maintain recommended airspeeds
  iii. "Rough trim" the airplane
    a. Quick relieving of the control pressures. Trim more precisely once stable
    b. Common Error - Improper trim procedure
  iv. Common Error - Failure to control pitch attitude
    a. Raising the nose too early / aggressively could result in stall
    b. If slow, it may be necessary to lower the nose briefly to gain airspeed

C. Configuration
  i. Cleaning Up the Airplane
    a. 1st Concern: Landing Flaps
      - Reduce drag to assist the airplane in climbing and accelerating
      - Retracting the flaps increments allows time for the airplane to accelerate
        a A sudden / complete flap retraction could result in a significant loss of lift
    b. 2nd Concern: Gear (if retractable)
      - After a controlled, positive rate of climb is established, the gear can be retracted
    c. 3rd Concern: Takeoff Flaps
      - At this point, treat the situation like a normal takeoff
      - Retract the flaps as you normally would (safe airspeed and altitude)
  ii. Flaps Before Gear
    a. Reduces the most drag immediately – full flaps tend to produce more drag than landing gear
    b. If the airplane inadvertently touches down it is desirable to still have the gear down and locked
  iii. Common Error - Improper wing flaps or landing gear retraction procedure



4. Climb Out

A. The majority of go-around climb outs will be identical to a normal takeoff climb out

    i. Adjust for wind and maintain the runway centerline
  B. Maneuver to the side of the runway or landing area when necessary to clear and avoid conflicting traffic
    i. Ex: Go around was due to another airplane taking off. Unable to see them if directly overhead
  C. Remain clear of obstacles / obstructions / other traffic
  D. Common Error - Failure to maintain proper track during climb-out
  E. Common Error - Failure to remain well clear of obstructions and other traffic

5. Communication

  A. Once the airplane is under control, then communicate with the tower or other facility / aircraft
    i. Let them know you're "Going Around"
    ii. Aviate, Navigate, then Communicate

Common Errors:

- Failure to recognize a situation where a go-around/rejected landing is necessary
- Hazards of delaying a decision to perform a go-around/rejected landing
- Improper power application
- Failure to control pitch attitude
- Failure to compensate for torque effect
- Improper trim procedure
- Failure to maintain recommended airspeeds
- Improper wing flaps or landing gear retraction procedure
- Failure to maintain proper track during climb-out
- Failure to remain well clear of obstructions and other traffic

Conclusion:

Brief review of the main points

The go-around is a very important maneuver that is essential in an emergency situation. Knowing the procedure to properly perform the maneuver will provide a considerably safer situation. The pilot's first concern is power, followed by the establishing the correct attitude, and configuration.

VII.I. Short-Field Approach and Landing

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to a short-field approach and landing. The student will understand the procedures involved and will have the ability to properly execute them as prescribed in the ACS/PTS.
Key Elements	1. 4° Stabilized Approach 2. Region of Reverse Command 3. Minimal Float/Max Effective Braking
Elements	1. Short Field Considerations 2. Configuration and Trim 3. Short Field Approach
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to perform a well-coordinated and stabilized short-field approach and landing as required in the ACS/PTS.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

The short-field landing requires the airplane to be flown precisely while close to the ground in order to safely land in a confined area.

Overview

Review Objectives and Elements/Key ideas

What

Short-field approaches and landings require the use of procedures for approaches and landings at fields with a relatively short landing area or where an approach is made over obstacles limiting the available landing area. This low-speed type of power-on approach is closely related to flight at minimum controllable airspeeds.

Why

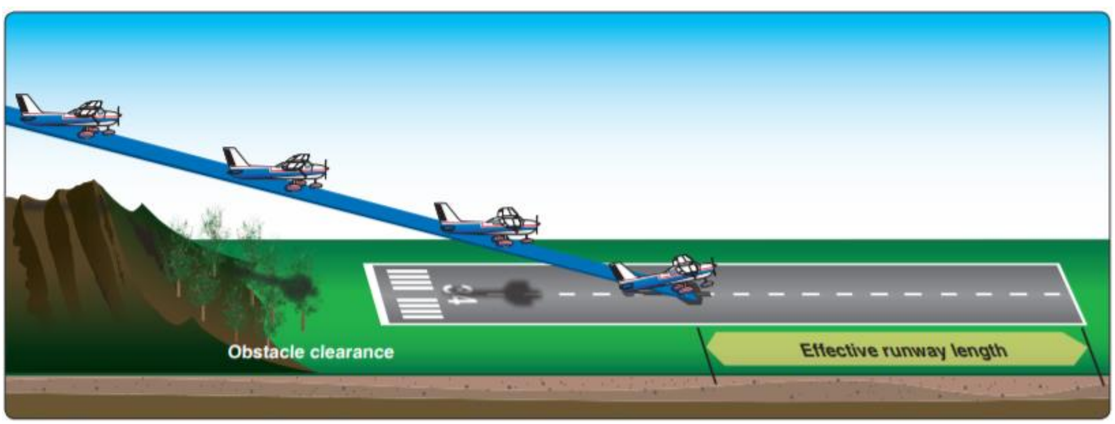
As in short-field takeoffs, a short field approach and landing is one of the most critical of the maximum performance operations. It requires that the pilot fly the airplane at one of its crucial performance capabilities while close to the ground in order to safely land within confined areas. To land within a short-field, the pilot must have precise, positive control of the rate of descent and airspeed.

How:

1. Short-Field Considerations

A. Airplane Landing Performance and Limitations
   i. Performance Section of the POH (Section 5)
      a. Do not attempt to land if the landing performance is not adequate
      b. Plan Ahead - Do not attempt to land on a short-field from which a takeoff cannot be made
   ii. Be aware of applicable limitations (Section 2 of the POH)
   iii. Common Error - Improper use of landing performance data and limitations

B. Obstructions and Other Hazards



   i. Obstacles
      a. What obstacles are there and how high? What descent angle / landing distance is required?
      b. What obstacles could be a concern in the case of a go around
      c. Be aware of how the wind will affect the takeoff and landing performance

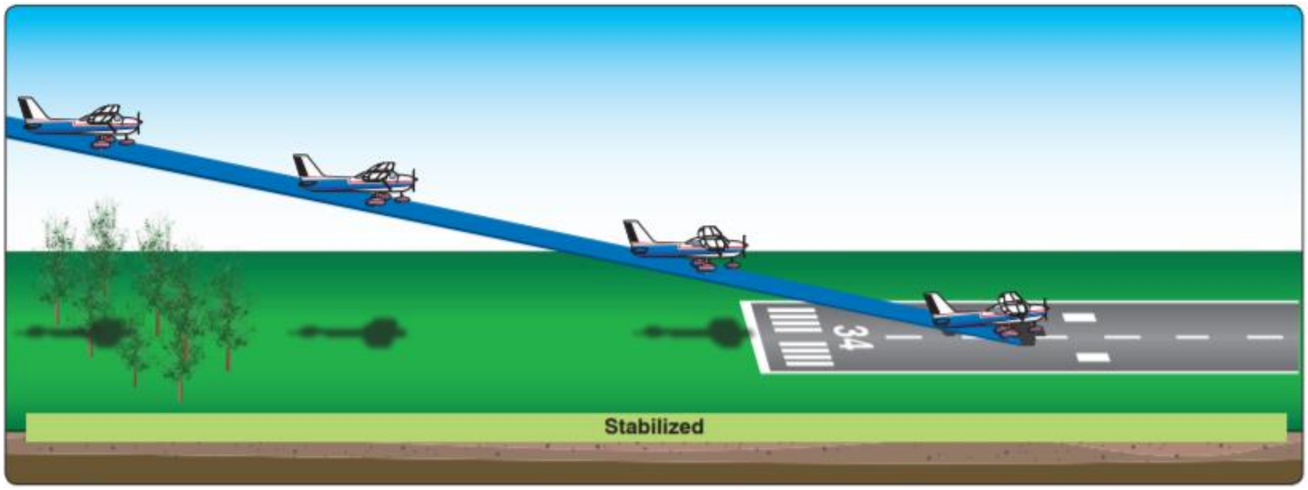
- ii. Wind
  - a. Tailwind? Crosswind? Varying winds due to the wind patterns over/around the obstruction?
  - b. Often time there is only one direction to takeoff and land
- iii. Performance Capabilities: Approach, descent, climb out / go-around performance

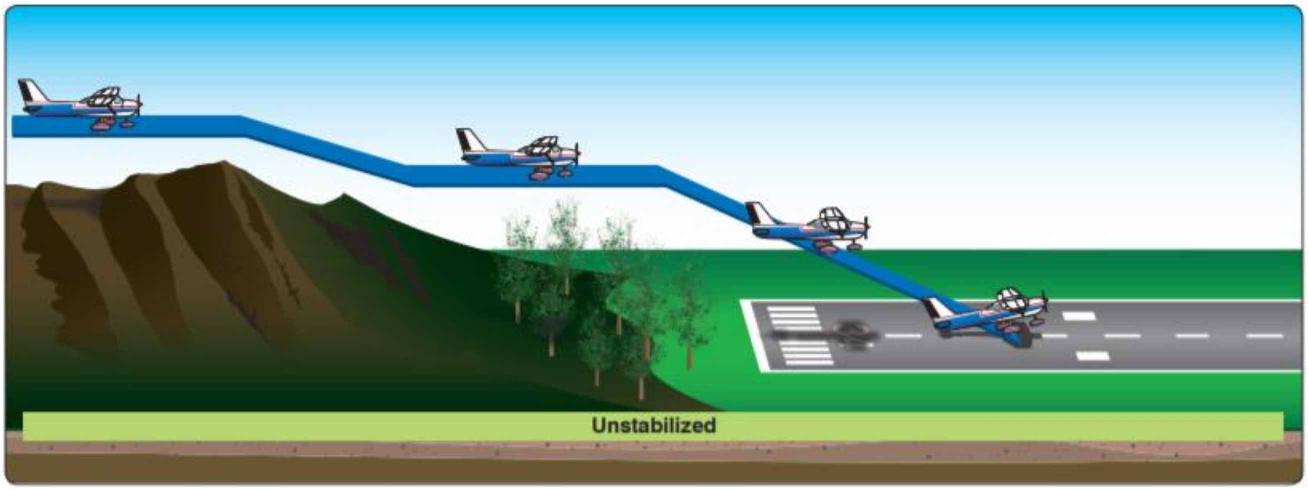
2. Configuration and Trim

- A. Unless the POH recommends otherwise, configure for a normal landing (landing flaps)
- B. Final Approach is often slower than normal to establish a steeper glide path (follow POH speeds)
  - i. As the airplane slows below L/D_{MAX}, increased drag increases the rate of descent
- C. Coordinated Flight Controls
  - i. When turning in the pattern, use no more than 30° of bank and keep the turn coordinated
  - ii. Maintain coordination throughout the approach and landing
- D. Trim to maintain approach speed (assists in more stable approach)

3. Short-Field Approach

- A. Downwind Leg
  - i. At the midpoint of the downwind leg, complete the landing checklist
  - ii. Select the Touchdown and Aim Point
    - a. The aim point will be closer to the touchdown point than normal
    - b. Adjust the aim point based on winds (ex. Strong headwind = lower groundspeed and less float)
  - iii. Establish Go Around Points and Criteria
    - a. Hazards and obstructions may dictate go around points
      - Ex. In a valley surrounded by mountains, the pilot may have to decide to go around at 500' AGL, any lower and the pilot is committed to landing since a go around is no longer possible
    - b. Pilots should set go around criteria that apply to all approaches (short, normal, soft, etc.)
      - Examples will vary by aircraft, but could include:
        - a 1,000' – configured for landing, on speed, and trimmed
        - b 500' – Airspeed ±5 knots, bank less than 15°, established on the desired approach path
        - c 250' – Same as 500' but with crosswind corrections established
        - d If at / below these altitudes the criteria is not met, go around
  - iv. Abeam the landing point or slightly beyond (due to the high rate of descent) configure as required and establish descent
- B. Base Leg
  - i. Configure for the landing
    - a. Configuring on the base leg is technique only, but allows more time to get stabilized
      - Another option is to configure on final
    - b. Adjust the turn to final to roll out on the centerline (use a shallow, coordinated turn)
- C. Final Approach
  - i. Usually started at least 500' AGL (can vary based on obstacles / other requirements)
  - ii. Establish and maintain a 4° glide path
    - a. If you haven't already, extend the landing flaps and trim for approach speed
      - Common Error - Failure to establish approach and landing configuration at appropriate time or in proper sequence
      - Common Error - Improper procedure in use of power, wing flaps, and trim
    - b. VASIs/PAPIs will indicate a high glide path
      - VASIs – Both bars White; PAPIs –4 White lights (Indicates above a 3.5° glide slope)
    - c. When practicing the approach / landing, an obstacle will be simulated at the approach end
      - The airplane should be approximately 100' AGL at the approach end to ensure clearance
  - iii. Maintaining a Stabilized Approach





a. The landing is an accuracy approach to a spot landing – a stabilized approach is essential
b. Pitch for Airspeed, Power for Altitude – Like a normal approach, but steeper and more precise
   - Below L/D_{MAX} – In the Region of Reverse Command
   - Aim Point Adjustments
     a A coordinated combination of both pitch and power is required
     b If high, reduce power and lower the nose to regain the 4° glidepath
     c If low, add power and raise the nose to regain the glidepath
   - Common Error - Failure to establish and maintain a stabilized approach
   - Common Error - Improper procedure in use of power, wing flaps, and trim
   - Common Error - Inappropriate removal of hand from throttle

iv. Wind Correction
a. Headwind
   - Lower groundspeed and therefore takes more time to fly the final approach
     a More power and a lower rate of descent will be required
   - Landing distance is decreased
b. Tailwind
   - Higher groundspeed and therefore less time on final approach
     a Use less power and increase the rate of descent
   - Landing distance will be increased

c. Ground Track
 - Use crosswind landing techniques to maintain a ground track in line with the landing area

D. Roundout & Flare
 i. Must be judged accurately to avoid flying into the ground or stalling and sinking rapidly
 ii. Minimum floating should occur. The airplane should settle quickly onto the aiming point
 iii. Common Error - Improper procedure during roundout and touchdown
  a. Do not try to hold the airplane off the ground and "grease" the landing

E. Touchdown
 i. Touchdown should occur at the minimum controllable airspeed with the airplane in the approximate pitch attitude that will result in a power off stall when the throttle is closed
 ii. Upon touchdown / closing the throttle:
  a. Apply max effective braking (braking to the point just prior to skidding the tires)
   - Common Error - Improper use of brakes
  b. In many aircraft, immediately retract the flaps to decrease lift and transfer weight to the wheels
   - Follow the POH
 iii. Hold the pitch attitude as long as the elevators remain effective to provide aerodynamic braking
 iv. Directional Control
  a. Maintain required crosswind corrections on landing, rollout, and taxi
  b. Use rudder to maintain the centerline as well as directional control
  c. Brake evenly
  d. Common Error - Poor directional control after touchdown
 v. Common Error - Improper procedure during roundout and touchdown

Common Errors:

- Improper use of landing performance data and limitations
- Failure to establish approach and landing configuration at appropriate time or in proper sequence
- Failure to establish and maintain a stabilized approach
- Improper procedure in use of power, wing flaps, and trim
- Inappropriate removal of hand from throttle
- Improper procedure during roundout and touchdown
- Poor directional control after touchdown
- Improper use of brakes

Conclusion:

Brief review of the main points

A short-field approach and landing requires the airplane be flown at one of its critical performance capabilities while close to the ground in order to land safely in a confined area. You must have precise positive control of the airplane's rate of descent to produce an approach that will clear any obstacles, result in little or no floating during the roundout, and permit the airplane to be stopped in the shortest possible distance.

VII.J. Soft-Field Approach and Landing

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student has the knowledge and ability to perform a soft field approach and landing as necessary based on the ACS/PTS with and without a crosswind.
Key Elements	1. Extend the approach in ground effect 2. Transfer weight from wings to wheels 3. Maintain Back Pressure
Elements	1. Objective 2. Determining Landing Performance and Limitations 3. Approach 4. Landing 5. After Landing Roll/Taxi
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References 3. Model Airplane
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can demonstrate knowledge of, and has shown proficiency in Soft Field approaches and landings, without the assistance of a flight instructor. The student can judge when to begin the flare, when to add power to the flare and can correct for any misjudgments. Finally, the student understands when to go-around and demonstrates the proper use of checklists, traffic scan and pertinent safety procedures.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

How awesome would it be, once you get your private pilot license, to take a flying adventure and land in the wilderness or on a remote island, in the middle of nowhere using a dirt or sand strip?

Overview

Review Objectives and Elements/Key ideas

What

Landing on fields that are rough or have soft surfaces, such as snow, sand, mud, or tall grass

Why

It is important to learn to land on soft field runways in order to ensure a safe landing. A normal landing on a runway like this could result in damage to the gear or the entire plane. By learning to safely set a plane down on different surfaces the pilot has many more available landing fields at his or her disposal. And, in the case of an emergency landing, this maneuver will be very important in making a safe landing.

How:

1. **Objective**
   A. Touchdown as smoothly as possible at the slowest possible landing speed
      i. Control the airplane so the wings support the weight of the plane as long as practical, minimizing drag and the stresses imposed on the gear by the landing surface
2. **Determining Landing Performance and Limitations**
   A. Chapter 5 of the POH: Landing distance, Crosswind components
   B. Effect of Wind and Landing Surface on Performance
      i. A headwind decreases landing distance, while a tailwind increases landing distance
      ii. The type of surface will affect the performance data (Ex. Hard packed surface vs soft, grassy field)
      iii. Common Error - Failure to consider the effect of wind and landing surface
   C. Common Error - Improper use of landing performance data and limitations
3. **Approach**
   A. Procedures
      i. Perform the before landing checklist and configure on downwind
         a. As in a normal approach, continue to use the appropriate checklists throughout the approach
      ii. Select a touchdown and aim point
         a. Due to the extended flare / float, aim further in front of the landing point than normal
      iii. Plan the turn to base and final based on wind and other applicable factors
      iv. Configure as directed by the POH – generally with landing flaps
         a. Flaps will aid in touching down at minimum speed and are recommended whenever practical
         b. In low-wing airplanes the flaps may suffer damage from mud, stones, slush, etc.
      v. Common Error - Failure to establish approach and landing configuration at appropriate time or in proper sequence
   B. Maintain a Stabilized Approach
      i. Establish the final approach speed (if it's a soft and short field, use the short field approach speed)
      ii. Establish a glidepath to your aim point, and trim to maintain the approach speed
      iii. Like a normal approach, use coordinated changes in pitch and power to remain stabilized

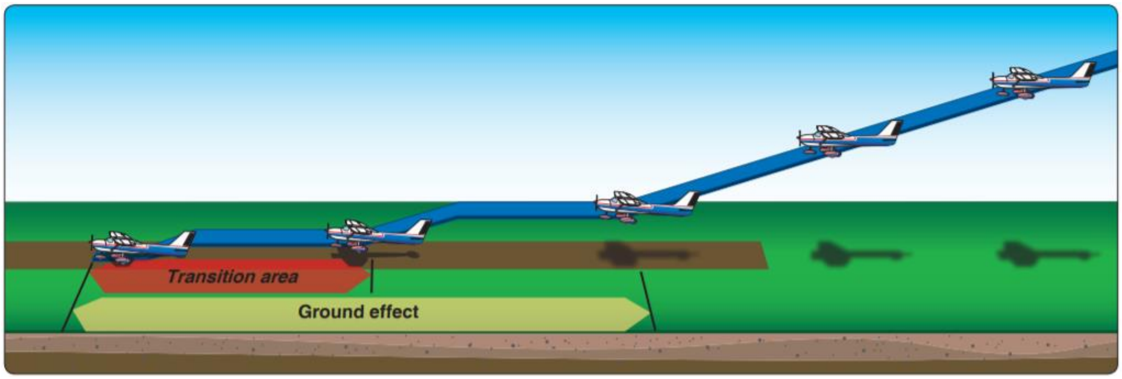
a. Common Error - Inappropriate removal of hand from throttle

iv. Common Error - Failure to establish and maintain a stabilized approach

C. Maintain Coordination – All turns should be coordinated and no more than 30° of bank

D. Maintain a Precise Ground Track
- i. Crab as necessary to maintain a proper downwind leg, base leg, and final approach
- ii. Sideslip into the wind to maintain the extended centerline

E. Common Error - Improper procedure in use of power, wing flaps, or trim



4. Landing

A. Always maintain one hand on the throttle lever
- i. Any time before the weight of the plane is being supported by the wheels, the pilot should be able to apply full power and perform a safe takeoff

B. The airplane should be flown onto the ground with the weight fully supported by the wings
- i. Hold the plane 1 to 2’ above the ground, in ground effect as long as possible
- ii. A small amount of power is used during touchdown in order to cushion the landing
  - a. Amount of power will vary with type of aircraft and the terrain
    - Ex: tall thick grass (more drag, therefore more power) vs packed dirt (less drag, less power)
  - b. Common Error - Closing the throttle too soon after touchdown

C. Touchdown should be made at the lowest possible airspeed in a nose-high pitch attitude
- i. Increase back pressure as the airplane slows to touchdown as gently as possible with power
- ii. A firm touchdown is not desired and could be hazardous

D. After main wheel touchdown, hold back pressure to keep the nose wheel off the surface (wheelie)
- i. Increase back pressure as the plane slows, use power as necessary to assist
- ii. Prevents the nosewheel digging into the soft surface, and getting stuck / cartwheeling

E. Maintain directional control with the rudder, while maintaining crosswind correction with the ailerons
- i. Common Error - Poor directional control after touchdown

F. Braking should be avoided to prevent the nose gear from striking the landing surface / digging in
- i. Common Error - Improper use of brakes

G. Common Error - Improper procedure during roundout and touchdown

H. Landing in a Crosswind (like a normal approach)
- i. Touchdown in a sideslip, with the upwind wheel first, and the airplane aligned with the centerline
- ii. Be cautious with one wheel touching down at a time on a soft field; Go-around if control is in doubt

I. Retract flaps after the plane is under control and the landing roll is complete
- i. Concentrate on landing and keeping the weight off the wheels
- ii. Retracting the flaps puts more weight onto the wheels

5. Taxi

A. Maintain full aft elevator pressure, as well as wind correction

B. Maintain enough speed to prevent becoming bogged down (too fast is also unsafe)

C. Steer with rudders (no differential braking)
D. Perform the After-Landing Checklist once parked

Common Errors:
- Improper use of landing performance data and limitations
- Failure to establish approach and landing configuration at appropriate time or in proper sequence
- Failure to establish and maintain a stabilized approach
- Failure to consider the effect of wind and landing surface
- Improper procedure in use of power, wing flaps, or trim
- Inappropriate removal of hand from throttle
- Improper procedure during roundout and touchdown
- Failure to hold back elevator pressure after touchdown
- Closing the throttle too soon after touchdown
- Poor directional control after touchdown
- Improper use of brakes

Conclusion:
Brief review of the main points
A soft field landing is very similar to a normal landing except that our main goal is to transfer the weight from the wings to wheels as gently as possible. When doing this it is also important to hold the nose wheel off the ground, and then slowly and gently bring it to the surface.

VII.K. Power-Off 180º Accuracy Approach and Landing

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The student should develop knowledge of the elements related to the power-off 180º accuracy approach and landing as required in the ACS/PTS.
Key Elements	1. Best Glide Airspeed 2. Wind Correction 3. Stabilized Approach
Elements	1. General 2. Selecting a Touchdown Point 3. The Maneuver
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can perform a power-off 180º accuracy approach and landing, landing within 200' beyond the selected landing point. The student will understand when corrections should be made, and will have the ability to make the necessary corrections in order to maintain a stabilized approach to landing.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

The power-off 180 is a challenging and very fun maneuver. Personally, it's one of my favorites…

Overview

Review Objectives and Elements/Key ideas

What

An approach and landing made by gliding with the engine idling through a 180° pattern, begun abeam a specified touchdown point on the runway, to a touchdown at or within 200' beyond that point.

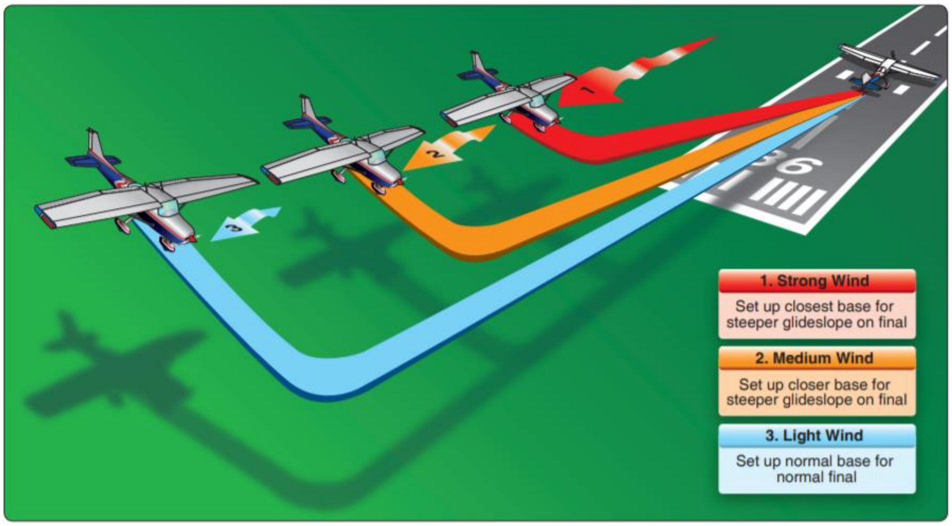
Why

It instills judgment and procedures necessary for accurately flying the plane, without power, to a safe landing.

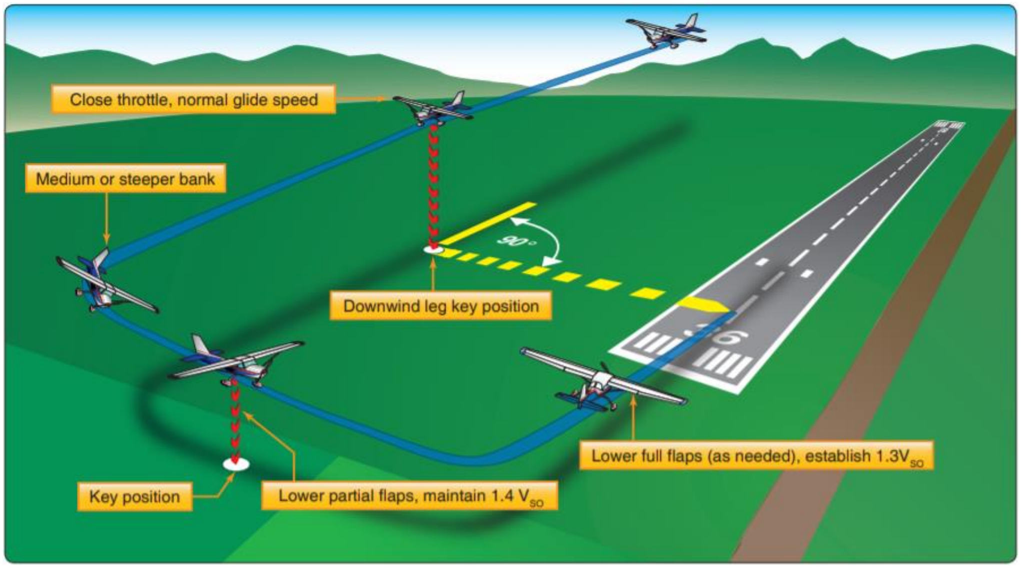
How:

1. **General**
   A. Executed by gliding at idle power from a given point on the downwind leg to a preselected landing spot
      i. The glide path is constantly assessed in order to land on the selected spot
         a. Key positions (points where one can judge whether the glide will safely reach the desired point)
            - Downwind key position: Abeam intended point of landing, where power is reduced to idle
            - Base key position: On base, 45° from landing point
   B. Flying the Power Off Descent
      i. Pitch is used to maintain the best glide airspeed
      ii. Speeds higher than best glide result in a steeper descent angle
      iii. Lower speeds result in rapid settling
   C. Attempt to fly a normal pattern, but keep in mind that:
      i. Various factors will change the pattern size (wind, altitude, approach speed, etc.)
      ii. Not a mechanical maneuver - altitudes, pattern size, when to configure, etc. will need to be adjusted
      iii. Tools at the pilot's disposal:
         a. Drag – Flaps, forward slips, drag devices (if available)
         b. Airspeed – Faster or slower than best glide increases the rate of descent
         c. Size of the pattern – Turning base early / late, dog-leg to final, S-turns
2. **Selecting a Touchdown Point**
   A. Select an easily recognizable point (Ex. specific centerline marking, the 500' or 1,000' markers, etc.)
      i. Ensure there is ample space before and after the point
   B. Choose an aiming point prior to the landing spot based on expected flare / float distance
   C. Common Error - Failure to consider the effect of wind and landing surface
3. **The Maneuver**
   A. Downwind Leg - 1,000' AGL
      i. Complete the before landing checklist as normal (midpoint)
      ii. Abeam the selected touchdown point (downwind key), reduce the throttle to idle
         a. Maintain altitude until reaching best glide speed; pitch for best glide speed, trim to maintain
      iii. Be aware of, and anticipate how wind will affect the pattern
      iv. Turn to the Base Leg

a. Base is positioned as needed based on altitude and wind
   - If the headwind on final is strong or the plane is low, base will need to be started early
   - If the wind is calm or the plane is high, downwind may need to be extended
b. Turn to base should be a uniform turn with a medium or slightly steeper bank
   - Bank and amount of turn will depend on glide angle and the wind speed
c. Common Error - Failure to consider the effect of wind



B. Base Leg
   i. Crab to maintain the base leg (amount of crab can indicate wind on final)
   ii. Base Key Position – 45º to the landing point
      a. Use this position to further evaluate the descent and make adjustments
         - Ex: if very low, turn directly / dogleg to final
      b. Flaps are often used at this position (approach flaps; landing flaps only when landing is assured)
         - Varies based on the aircraft, and the current situation
         - Remember, once flaps are lowered, they should not be raised
      c. Common Error - Failure to identify the key points in the pattern
   iii. Tailwind on the base leg
      a. Tailwind on base (crosswind on final), tends to result in being higher than desired, and vice versa
         - High groundspeed = less time to descend and vice versa
      b. Common Error - Failure to consider the effect of wind
   iv. Aim Point
      a. Watch the position of the aim point in relation to the window / windscreen
         - Steady position = maintaining glide path
         - Moving up = moving below glidepath; Moving down = moving above glidepath
            a Moving up: maintain glide, delay configuring; Down: consider drag, s-turns, etc.



C. Turn to Final
  i. Intent is to roll out aligned with the runway centerline (adjust for wind)
  ii. Keep coordinated, do not use rudder to increase rate of turn to align with the runway

D. Final Approach
  i. Verify the landing checklist is complete
  ii. Configuration
    a. Unless low, lower the approach flaps if not accomplished on the base leg
    b. Lower the landing flaps only when landing is assured
  iii. Maintain a Stabilized Approach
    a. Be proactive in maintaining the aim point
    b. Adjustments will vary based on the approach – gauge the situation
      - If high (aim point moving down) use flaps, s-turns, slips, airspeed changes, etc.
      - If low (aim point moving up), go directly to the runway, delay configuration
    c. Consistent, slight adjustments help to maintain a stable approach and lead to on-target landings
      - Large, abrupt changes lead to inconsistent descents, airspeeds, unstable approaches
    d. Common Error - Failure to establish and maintain a stabilized approach
  iv. Common Error - Improper use of power, wing flaps, or trim

E. Roundout and Touchdown
  i. Although accuracy is important, a safe / properly executed approach and landing is vital
  ii. Commercial ACS requires touchdown at proper pitch attitude, on or within 200' beyond the specified point with no side drift and the longitudinal axis aligned / over the centerline
  iii. Make a safe, normal, power-off landing
    a. Don't force the plane down or stretch the glide as it may result in a hard landing or stall
    b. Correct for crosswinds
    c. Common Error - Failure to hold back elevator pressure after touchdown
    d. Common Error - Improper procedure during roundout and touchdown
  iv. Flap Technique: If low, flaps can be delayed and used when approaching the runway for added float

F. Directional Control
  i. Maintain directional control with rudder; while slowing increase crosswind corrections
  ii. Common Error - Poor directional control after touchdown and Improper use of brakes
    a. Use minimum braking, and don't apply the brakes until firmly on the ground / under control
    b. Use equal pressure on both brakes to prevent swerving or loss of control

Common Errors:

- Failure to establish approach and landing configuration at proper time or in proper sequence
- Failure to identify the key points in the pattern
- Failure to establish and maintain a stabilized approach
- Failure to consider the effect of wind and landing surface
- Improper use of power, wing flaps, or trim
- Improper procedure during roundout and touchdown
- Failure to hold back elevator pressure after touchdown
- Poor directional control after touchdown
- Improper use of brakes

Conclusion:
Brief review of the main points
The power-off 180º accuracy approach and landing consists of constantly evaluating and adjusting the approach as necessary based on the wind, altitude, groundspeed, and other factors.

FUNDAMENTALS OF FLIGHT

VIII.A. Straight and Level Flight

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25)

Objectives	The student should develop the ability to maintain straight-and-level flight primarily through the use of outside visual references. The student should be able to reference the instruments inside the airplane to ensure straight-and-level flight is continued. The ability to effectively trim the airplane for straight-and-level flight should also be developed.
Key Elements	1. Control *Pressures* 2. Outside 90%, Inside 10% 3. Trim the airplane
Elements	1. Flight Controls 2. Control Pressures and Over-Controlling 3. Trim Technique 4. Integrated Flight Instruction 5. Straight and Level Flight
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands how to make adjustments to keep the aircraft in straight-and-level flight. He or she can also relieve the control pressures by trimming the aircraft and provides light, positive, proactive control pressures when aircraft attitude needs to be corrected.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Straight and level flight is the basis of *everything* dealing with flying. Every maneuver is based off a competent ability to maintain straight and level flight. It is the ground work for your flying abilities, and as simple and boring as it sounds, it is extremely important.

Overview

Review Objectives and Elements/Key ideas

What

Straight and level flight is flight in which a constant heading and altitude are maintained. It is accomplished by making immediate and measured corrections for deviations in direction and altitude from unintentional slight turns, descents, and climbs

Why

It is impossible to emphasize too strongly the necessity for forming correct habits in flying straight and level. All other flight maneuvers are in essence a deviation from this flight maneuver. It is not uncommon to find a pilot whose basic abilities consistently fall just short of minimum expected standards, and upon analyzing the reasons for the shortcomings we discover that the cause is the inability to fly straight and level properly.

How:

1. **Flight Controls**
    - A. Pitch – Controlled by the elevators
        - i. Back pressure deflects the trailing edge of the elevator surface up
            - a. Decreases camber creating a downward force. Tail down, nose up. Pitch occurs about CG
        - ii. Forward pressure deflects the trailing edge of the elevator surface down
            - a. Increases camber, creating more lift. Tail moves up, nose moves down
    - B. Roll – Controlled by the ailerons
        - i. Controls to the right
            - a. Right aileron deflects up decreasing lift and lowering the right wing
            - b. Left aileron deflects down increasing lift and raising the left wing
        - ii. Controls to the left does the opposite
    - C. Yaw – Controlled by the rudder
        - i. When rudder is deflected in one direction, a horizontal force is produced in the opposite direction
            - a. Left rudder pressure deflects the rudder to the left; the tail moves right yawing the nose left
            - b. Right rudder pressure deflects the rudder to the right; tail moves left yawing the nose right
2. **Control Pressures and Over-Controlling**
    - A. Control pressures should be light and just enough to produce the desired result
        - i. Common Error - Application of control movements rather than pressures
            - a. Use smooth, light *pressure*, not jerky movements
    - B. Overcoming Tenseness / Over-controlling
        - i. Signs of over-controlling
            - a. Jolty, large movements of the flight controls
            - b. White knuckles (look for the death grip)
            - c. Overall nervousness

ii. Prevention
   a. Point out over-controlling, help the student stay calm, and demonstrate the pressures desired
   b. Technique: put a pencil on top of the middle & ring finger, and under the index & pointer finger
      - Less fingers on the controls
      - If overcontrolling, the pressure on the middle and ring finger reminds them to relax

3. **Trim Technique**
   A. Most plane are designed to streamline the flight controls with the rest of the plane in straight-and-level flight at cruise speed, and standard weight and loading
      i. Outside of this condition (faster, slower, heavier, lighter, change in balance, etc.) one or more of the control surfaces will have to be held out of its streamlined position
      ii. Trim tabs offset the constant flight control pressure inputs needed from the pilot
   B. Trimming the Airplane
      i. Establish, Trim, Crosscheck, Adjust, and repeat
      ii. Set pitch and power, and let the airspeed stabilize
      iii. Trim to relieve control pressures (with multiple tabs, trim rudder, then elevator, then aileron)
      iv. Changes in pitch and power will require the plane to be trimmed again
         a. On a longer flight, as CG changes with decreasing fuel trim will slowly have to be adjusted
      v. Common Error - Faulty trim technique
         a. Trying to fly the airplane with trim is a common fault
         b. With changing conditions, gusts, fuel burn, etc. it is necessary to trim often

4. **Integrated Flight Instruction**
   A. Using outside references + flight instruments to establish and maintain flight attitudes and performance
   B. The Basic Elements
      i. 90% outside, 10% inside
      ii. Use outside references to fly, validate the airplane's attitude on the flight instruments
         a. If the instruments indicate a correction is necessary, apply it in reference to the natural horizon
         b. Verify the new attitude and performance on the flight instruments
   C. Common Error - Failure to crosscheck and correctly interpret outside and instrument references

5. **Straight and Level Flight**
   A. Level Flight
      i. Outside
         a. Select a visual reference (glareshield, etc.) and keep it in a fixed position relative to the horizon
      ii. Inside
         a. Check the outside reference against the Attitude Indicator, Altimeter, VSI and Airspeed

      iii. Corrections
         a. Elevators are the control
         b. Adjust pitch in relation to the horizon, then verify with the instruments
   B. Straight Flight
      i. Outside
         a. Wingtips should be level and equidistant from the horizon

b. Select two or more outside reference points directly ahead
    - Form an imaginary line between them and keep the plane headed along the line

ii. Inside
  a. Verify the outside references against the Heading Indicator, Attitude Indicator, Turn Coordinator, Magnetic Compass
  b. Common Error - Uncoordinated use of flight controls

iii. Corrections (Control Procedure)
  a. Ailerons are the control
  b. Adjust bank to put both wings an equal distance from the horizon

C. Power
  i. In straight-and-level flight, airspeed remains constant if power is constant
  ii. Outside
    a. Changes in power and airspeed will require changes in pitch attitude to maintain altitude
  iii. Inside
    a. Cross check changes in airspeed with the engine RPM and manifold pressure gauges
      - Increased power will result in a climb if no changes are made to the pitch attitude
      - Decreased power will result in a descent if no pitch changes are made to the pitch attitude
  iv. Corrections (Control Procedure)
    a. As power is changed, pitch attitude must be adjusted
      - Increased power: As airspeed increases, progressively decrease pitch to maintain altitude
        a Once stable and level, maintain the new visual reference in relation to the horizon
      - Decreased power: As airspeed decreases, progressively increase pitch to maintain altitude
        a Once stable and level, maintain the new visual reference in relation to the horizon

Common Errors:

- Failure to crosscheck and correctly interpret outside and instrument references
- Application of control movements rather than pressures
- Uncoordinated use of flight controls
- Faulty trim technique

Conclusion:

Brief review of the main points

Level flight is maintained through pitch. We monitor pitch by keeping the reference point off the nose in the same place on the horizon, and referencing the altimeter and attitude indicator. Level flight is controlled with elevator pressure. Straight flight is maintained through roll. We monitor bank by keeping an equal distance above (or below) each wing and the horizon, as well as maintaining a straight line between two points directly in front of the airplane. These visual references are cross checked with the heading indicator as well as the attitude indicator. Trim is essential in relieving the pilot of the control pressures necessary to maintain level flight. We should trim frequently and in small amounts in order to maintain straight and level flight.

VIII.B. Level Turns

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The student should develop knowledge of the elements related to establishing and maintaining a level turn.
Key Elements	1. Increased Back Pressure (HCL/VCL) 2. Coordination (Adverse Yaw) 3. Control *Pressures*
Elements	1. Flight Controls 2. How the Turn Works 3. Control Pressures and Over Controlling 4. Trim Technique 5. Integrated Flight Instruction 6. Level Turns
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References 3. Model Airplane
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to turn at varying degrees of bank, maintaining altitude and airspeed.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Level turns sound boring and simple, but there is a lot more to turning than you might think, and a strong grasp on this will make many other maneuvers considerably easier.

Overview

Review Objectives and Elements/Key ideas

What

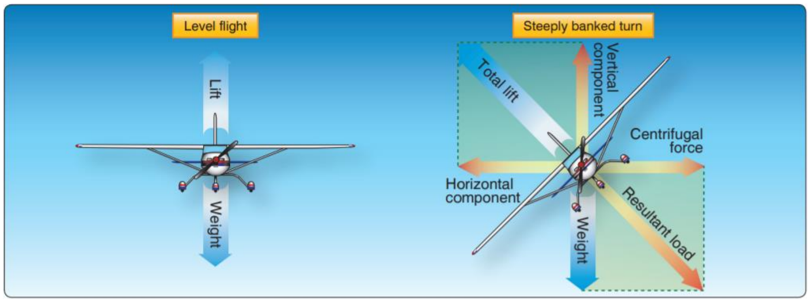
A level turn is a turn at a specified angle of bank in which altitude and airspeed are maintained.

Why

The ability to understand and fly a level turn is essential to the building of every pilot's skill set. Level turns are the building blocks to many more difficult maneuvers and will help the pilot in his or her control of the airplane.

How:

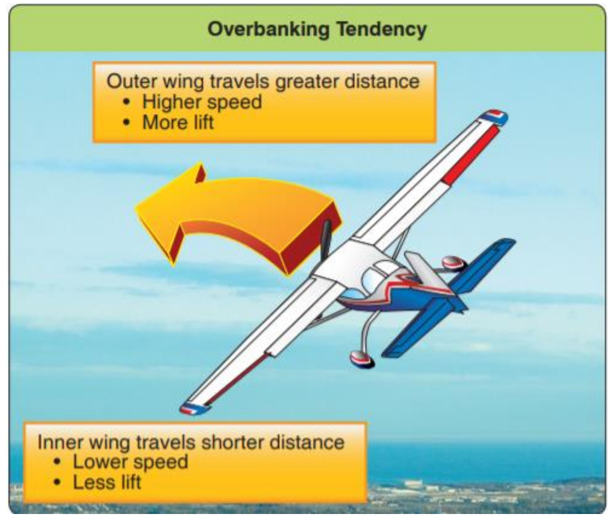
1. **Flight Controls**
    A. All four primary controls are used in coordination when making turns
        i. Ailerons - Bank the wings and determine the rate of turn at a given airspeed
        ii. Elevator - Moves the nose up or down in relation to the pilot, and perpendicular to the wings
            a. It sets the pitch attitude in the turn and "pulls" the nose around the turn
        iii. Rudder - Offsets yaw effects developed by the other controls (is not used to turn the airplane)
        iv. Throttle - Provides thrust which is used to maintain airspeed during a turn
2. **How the Turn Works**
    A. Changing the direction of the wing's lift to either side causes the airplane to be pulled that direction
        i. This is done by applying coordinated aileron and rudder to bank the airplane
    B. Lift
        i. In straight and level flight, total lift is acting perpendicular to the wings and the Earth
        ii. As the plane is banked, lift becomes the resultant of two components:
            a. Vertical Component (VC) - Acts perpendicular to Earth, opposes gravity (weight of the plane)
            b. Horizontal Component (HC) - Acts parallel to Earth's surface, opposes inertia (Centrifugal Force)
            c. The vertical and horizontal components act at right angles to each other, and total lift acts perpendicular to the banked wings (shown below)
                - The horizontal component of lift is what turns the airplane
        iii. Because some vertical lift has been transferred to horizontal lift, the AOA must be increased to maintain altitude



    C. Adverse Yaw
        i. When banking, both lift and drag are increased on the raised wing, and decreased on the lowered wing

ii. The difference in drag between the wings results in yaw in the opposite the direction of the turn
iii. To counter adverse yaw, rudder is applied with aileron in the direction of the turn

D. Overbanking Tendency
   i. As turn radius becomes smaller, a difference develops between the speed of the inside wing and outside wing
      a. Outside wing travels a longer path, but in the same amount of time as the inside wing
         - Outside wing generates more lift
         - Difference in lift can increase bank
      b. Shallow bank: the difference in lift is overcome by lateral stability
      c. Medium bank: the lift differential matches lateral stability
      d. High bank: the difference in lift outweighs lateral stability
         - Aircraft continues to bank even with neutral flight controls
         - Aileron pressure is required in the direction opposite the turn to maintain bank angle



E. Rate of Turn
   i. Dependent on airspeed and the horizontal component of lift
      a. Horizontal Component of Lift (directly related to the bank angle)
         - As bank angle increases, the horizontal component of lift increases
         - Therefore, the steeper the angle of bank, the higher the rate of turn
      b. As airspeed increases, the aircraft's rate of turn decreases due to inertia
         - The greater the inertia, the more the aircraft desires to continue straight ahead and therefore the slower the rate of turn
         - At a given angle of bank, higher airspeeds = reduced rate of turn, and a larger turn radius

F. Coordination
   i. Coordinated rudder and aileron should be used in all turns (counter adverse yaw)
   ii. Step on the ball to center it and maintain coordinated flight
   iii. Uncoordinated flight results in decreased performance (excess drag)

3. Control Pressures and Over-Controlling

A. Control pressures should be light and just enough to produce the desired result
   i. Common Error - Application of control movements rather than pressures
      a. Use smooth, light *pressure*, not jerky movements

B. Overcoming Tenseness / Over-controlling
   i. Signs of over-controlling: Jolty, large movements; white knuckles, overall nervousness
   ii. Prevention
      a. Point out over-controlling, help the student stay calm, demonstrate the pressures desired
      b. Technique: put a pencil on top of the middle & ring finger / under the index & pointer finger
         - Less fingers on the controls
         - If overcontrolling, the pressure on the middle and ring finger reminds them to relax

4. Trim Technique

A. Most plane are designed to streamline the flight controls with the rest of the plane in straight-and-level flight at cruise speed, and standard weight and loading

- i. Outside of this condition (faster, slower, heavier, lighter, change in balance, etc.) one or more of the control surfaces will have to be held out of its streamlined position
- ii. Trim tabs offset the constant flight control pressure inputs needed from the pilot

B. Trimming the Airplane
- i. Set pitch and power, and let the airspeed stabilize
- ii. Trim to relieve control pressures (with multiple tabs, trim rudder, then elevator, then aileron)
- iii. Changes in pitch and power will require the plane to be trimmed again
  - a. On a longer flight, as CG changes with decreasing fuel trim will slowly have to be adjusted
- iv. Common Error - Faulty trim technique
  - a. Trying to fly the airplane with trim is a common fault
  - b. With changing conditions, gusts, fuel burn, etc. it is necessary to trim often

5. Integrated Flight Instruction

A. Using outside references + flight instruments to establish and maintain flight attitudes and performance

B. The Basic Elements
- i. 90% outside, 10% inside
- ii. Use outside references to fly, validate the airplane's attitude on the flight instruments
  - a. If the instruments indicate a correction is necessary, apply it in reference to the natural horizon
  - b. Verify the new attitude and performance on the flight instruments

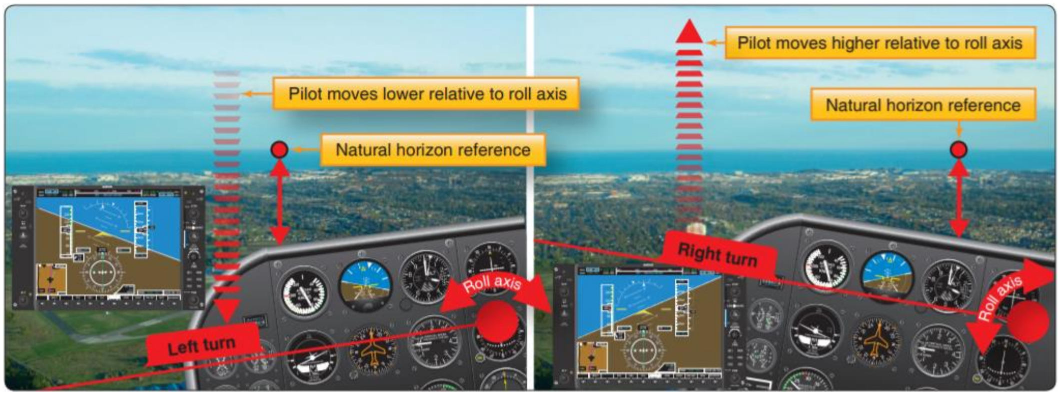
C. Common Error - Failure to crosscheck and correctly interpret outside and instrument references

6. Level Turns

A. Before turning, clear the area in the direction of the turn and complete the pre maneuver checklist

B. Entering the Turn, Establishing the Bank Angle
- i. Outside References
  - a. Use the top of the engine cowling or glareshield to set bank and pitch attitude
    - Crosscheck the turn with the instruments

  - b. Parallax Error
    - The airplane rolls on the longitudinal axis
    - With side-by-side seating, each pilot sits to one side of the longitudinal axis
    - Left seat: Nose appears to rise in a left turn (pilot lowers) and appears to descend in a right turn (pilot raises). Vice-versa for the pilot in the right seat



c. Leaning – The pilot may lean away from the turn to remain upright in relation to the horizon
    - Should be avoided and corrected immediately in order to properly use visual references

ii. Control Inputs
  a. Use small, smooth flight control inputs
    - Common Error - Application of control movements rather than pressures
  b. Aileron
    - The faster and firmer aileron is applied, the faster the roll
    - The longer the aileron pressure, the greater the bank
  c. Maintain coordination – Aileron and rudder should be input together
    - The nose should rotate on the horizon without leading or lagging the bank
    - If the nose starts to move before the bank starts, rudder is being applied too soon
    - If bank starts before the nose, or the nose moves in the opposite direction, the rudder is late
    - Common Error - Uncoordinated use of the flight controls
  d. Elevator Pressure
    - As bank is established, gently increase back pressure to maintain altitude
      - a The smaller the bank, the less back pressure required, and vice-versa
  e. Power
    - As lift is increased to maintain altitude, drag is also increased, reducing airspeed
    - Increase power to maintain airspeed (generally necessary above 30° of bank)

iii. Crosscheck – 90% outside, 10% inside
  a. Establish the turn with outside references
    - Bank – Angle of the engine cowling / glareshield and / or wings relative to the horizon
    - Pitch – Height of the engine cowling or another point on the aircraft relative to the horizon
  b. Crosscheck with the instruments

C. In the Turn
  i. Reference the natural horizon, scan for traffic, and occasionally crosscheck the flight instruments
  ii. Control Inputs
    a. Aileron and Rudder (Maintaining Bank)
      - Rudder and aileron pressure should be relaxed or adjusted, depending on the bank angle
      - Common Error - Uncoordinated use of the flight controls
    b. Elevator Pressure (Maintaining Altitude)
      - Back pressure on the elevator should not be relaxed in order to maintain altitude
      - Adjust trim as desired to maintain hands free level flight
    c. Power (Maintaining Airspeed)
      - Once set, power should remain the same through the turn
      - If the airspeed changes ± 5 knots, adjust to return to the desired speed

iii. Crosscheck and Adjust (90% outside, 10% inside)
  a. Backup the outside references with the instruments
  b. Adjustments
    - If bank angle is too high or low, reestablish the desired bank using the ailerons and rudder
    - If climbing / descending, adjust pitch in relation to the horizon, and crosscheck instruments
    - Once the necessary adjustments have been made re-trim the airplane
  c. Common Error - Faulty attitude and bank control
    - Understand the relationship between bank and pitch
      a Increased bank necessitates increased pitch to maintain altitude, and vice versa
  d. Common Error - Failure to cross-check / correctly interpret outside and instrument references

D. Roll Out
  i. Similar to a roll in except control pressures are used in the opposite direction
  ii. Since the plane continues to turn with any bank, rollout is started prior to the desired heading
    a. General rule: lead the rollout by approximately ½ the bank angle (this is a very slow roll out)
  iii. As bank decreases, elevator pressure should be gently relaxed to maintain altitude
    a. Horizontal component of lift is decreasing and the vertical component of lift is increasing
  iv. Power should be reduced to maintain the desired airspeed in straight flight
  v. Establish straight-and-level with visual references and verify with the instruments
  vi. Trim the airplane for level flight

Common Errors:

- Failure to cross-check and correctly interpret outside and instrument references
- Application of control movements rather than pressures
- Uncoordinated use of the flight controls
- Faulty attitude and bank control

Conclusion:

Brief review of the main points

In a level turn, we establish and maintain our bank angle and pitch attitude in relation to the horizon. The airplane's attitude is confirmed by referring to flight instruments and its performance. If the airplane performance, as indicated by flight instruments, indicates a need for correction, a specified amount of correction should be applied with reference to the horizon. Then the airplane's attitude and performance are rechecked by referring to the flight instruments.

VIII.C. Straight Climbs and Climbing Turns

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The student should develop knowledge of the elements related to straight and turning climbs. The student will demonstrate the ability to perform a constant airspeed climb during straight flight as well as in a turn. The student will learn the effects of climbs and be able to keep the airplane coordinated throughout.
Key Elements	1. Increased Thrust 2. Coordination 3. Crosschecking
Elements	1. Flight Controls 2. Forces in the Climb 3. Types of Climbs 4. Control Pressures and Overcontrolling 5. Trim Technique 6. Integrated Flight Instruction 7. Straight Climb 8. Climbing Turn
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to maintain a constant airspeed climb while maintaining coordination and making any necessary adjustments. The student has the ability to notice changes and properly correct for them by using outside references and crosschecking them with the instruments.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

As simple and boring as a climb sounds, it is part of the basis for your flying future. By understanding and having the ability to properly and effectively put the airplane into a straight or turning climb you will be able to perform many future maneuvers much easier.

Overview

Review Objectives and Elements/Key ideas

What

In straight and climbing turns the airplane is put into a climb attitude in order to gain altitude. The pitch and airspeed of the airplane are maintained together to accomplish the climb.

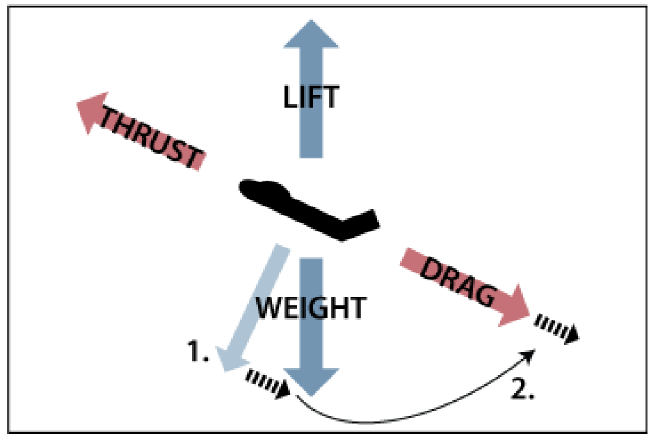
Why

Climbs and climbing turns are part of the fundamentals / basis for all flying. By developing the skills necessary for basic climbs and climbing turns the pilot will lay the groundwork for many future maneuvers.

How:

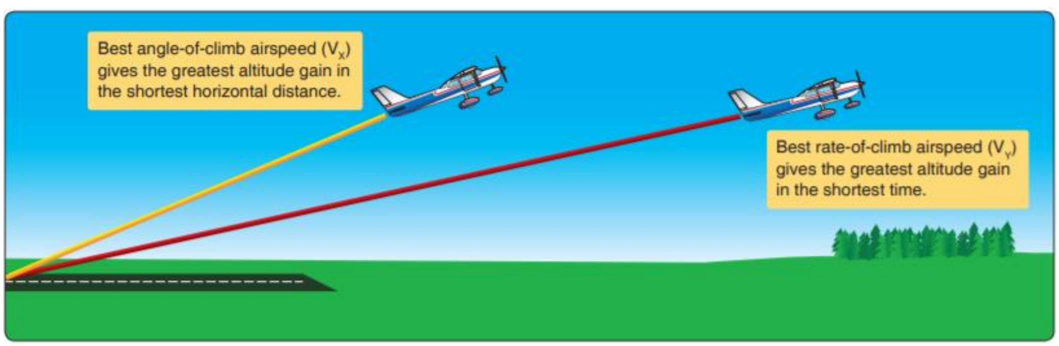
1. **Flight Controls**
    - A. All four primary controls are used in coordination when making climbs and climbing turns
        - i. Ailerons - Bank the wings and determine the rate of turn at a given airspeed
        - ii. Elevator - Moves the nose up or down in relation to the pilot, and perpendicular to the wings
            - a. Establishes the climb
            - b. Sets the pitch attitude in the turn and “pulls” the nose around the turn
        - iii. Rudder - Offsets yaw effects developed by the other controls (is not used to turn the airplane)
        - iv. Throttle - Provides thrust which may be used to maintain airspeed during climbs and turn
2. **Forces in the Climb**
    - A. Forces of Flight
        - i. Summary
            - a. In a climb weight isn’t perpendicular to the flightpath, it acts in a rearward direction (1. below)
                - This causes an increase in total drag requiring an increase in thrust (2. below)
            - b. An airplane can only sustain a climb angle when there is sufficient thrust to offset increased drag
                - Therefore, climb is limited by available, or excess, thrust

- B. Propeller Effects
    - i. Propeller speed is significantly lower and the AOA is significantly greater than in cruise
        - a. Torque / asymmetrical loading of the propeller results in left roll and yaw
            - Right rudder is necessary



3. Types of Climbs

- A. Normal Climb (Cruise Climb)
    - i. Performed at an airspeed recommended by the airplane manufacturer
        - a. Usually faster than the best rate of climb, but provides better cooling, control, and visibility
- B. Best Rate of Climb (V_Y)
    - i. Airspeed that produces the most altitude gain in the least time (maximum feet per minute)
        - a. The airspeed where the most excess *power* is available over that required for level flight
            - Power is the energy the engine produces
            - As altitude increases, the airspeed for the best rate of climb decreases
- C. Best Angle of Climb (V_X)
    - i. Performed at an airspeed that will produce the most altitude gain in a given distance
        - a. Slower than V_Y
        - b. The airspeed where the most excess t*hrust* is available over that required for level flight
            - Thrust is what propels the airplane (the displaced air as a result of the spinning propeller)
            - As altitude increases, the airspeed for the best angle of climb increases
        - c. V_X will result in a steeper climb path, but will take longer to reach altitude than a climb at V_Y



4. Control Pressures and Over-Controlling

- A. Control pressures should be light and just enough to produce the desired result
    - i. Common Error - Application of control movements rather than pressures
        - a. Use smooth, light *pressure*, not jerky movements
- B. Overcoming Tenseness / Over-controlling
    - i. Signs of over-controlling: Jolty, large movements; white knuckles, overall nervousness
    - ii. Prevention
        - a. Point out over-controlling, help the student stay calm, demonstrate the pressures desired
        - b. Technique: put a pencil on top of the middle & ring finger / under the index & pointer finger
            - Less fingers on the controls
            - If overcontrolling, the pressure on the middle and ring finger reminds them to relax

5. Trim Technique

A. Most plane are designed to streamline the flight controls with the rest of the plane in straight-and-level flight at cruise speed, and standard weight and loading
   i. Outside of this condition (faster, slower, heavier, lighter, change in balance, etc.) one or more of the control surfaces will have to be held out of its streamlined position
   ii. Trim tabs offset the constant flight control pressure inputs needed from the pilot
B. Trimming the Airplane
   i. Set pitch and power, and let the airspeed stabilize
   ii. Trim to relieve control pressures (with multiple tabs, trim rudder, then elevator, then aileron)
   iii. Changes in pitch and power will require the plane to be trimmed again
      a. On a longer flight, as CG changes with decreasing fuel trim will slowly have to be adjusted
   iv. Common Error - Faulty trim technique
      a. Trying to fly the airplane with trim is a common fault
      b. With changing conditions, gusts, fuel burn, etc. it is necessary to trim often

6. Integrated Flight Instruction

A. Using outside references + flight instruments to establish and maintain flight attitudes and performance
B. The Basic Elements
   i. 90% outside, 10% inside
   ii. Use outside references to fly, validate the airplane's attitude on the flight instruments
      a. If the instruments indicate a correction is necessary, apply it in reference to the natural horizon
      b. Verify the new attitude and performance on the flight instruments
C. Common Error - Failure to crosscheck and correctly interpret outside and instrument references

7. Straight Climb

A. Entering the Straight Climb
   i. Simultaneously establish the pitch attitude (visual references) / power setting for the desired climb
      a. Verify performance with the instruments
      b. In many airplanes, as power is increased, an increase in slipstream over the horizontal stabilizer will cause the nose to rise (creates a greater tail down force, lifting the nose)
         - Anticipate it and maintain pitch in relation to the horizon
      c. As power is increased, increase right rudder pressure to maintain coordination
         - Common Error - Improper correction for torque effect
   ii. Trim to maintain the climb pitch attitude
B. Maintaining the Straight Climb
   i. Airspeed is controlled with elevator pressure
      a. If the aircraft is too fast, raise the nose, let the airspeed stabilize, and trim. Opposite for slow
      b. Make small adjustments relative to the known pitch attitude
         - Crosscheck the change for the desired results on the instruments
      c. Common Error - Failure to cross-check / correctly interpret outside and instrument references
   ii. Keep the wings level to maintain heading
      a. Use the same procedures as discussed in Straight-and-Level flight to visually maintain a heading
      b. If off heading, use a bank angle equal to the degrees off to correct back
C. Returning to Straight-and-Level Flight
   i. Initiate the level off at approximately 10% the rate of climb (500 fpm = 50' before desired altitude)
   ii. Smoothly and slowly lower the nose to the level flight attitude to allow the airspeed to increase
      a. A loss of altitude will result if the pitch is changed too rapidly
      b. Crosscheck the pitch attitude with the instruments
   iii. Once in level flight, maintain the climb power setting temporarily to accelerate to cruise speed
      a. Reduce rudder as power is reduced to maintain the desired speed
   iv. Trim for level flight

8. Climbing Turn

A. Factors to Consider in a Climbing Turn vs a Straight Climb:
   i. Turning reduces vertical lift, therefore more back pressure is necessary during a turning climb
   ii. Bank Angle
      a. Shallower bank angles provide for a more efficient rate of climb
      b. In medium / steep banked turns climb performance is degraded, or possibly non-existent
   iii. Adverse Yaw
      a. Common Error - Improper correction for torque effect
         - Left turn: Less right rudder pressure is required than in a straight climb
         - Right turn: More right rudder pressure is required than in a straight climb

B. Entering the Climbing Turn
   i. Climbing turns may be established in one of two ways:
      a. Enter the climb first and then bank into the turn
      b. Enter the climb and turn simultaneously
   ii. The procedure
      a. In both cases, establish pitch and bank in relation to the natural horizon while increasing power
         - Anticipate and add the required right rudder pressure to maintain coordination
      b. Crosscheck the attitude with the instruments and correct as required
      c. Trim to maintain the pitch attitude / climb airspeed

C. Maintaining the Climbing Turn
   i. Maintain a constant bank angle and pitch attitude
   ii. To maintain a climbing turn we combine the level turns and straight climb references
      a. Pitch is maintained in relation to the horizon as in a straight climb
      b. Bank is maintained in relation to the angle of the cowling / glareshield / wings and the horizon
      c. Crosscheck with the instruments and make the necessary adjustments
         - A change in pitch or bank may require a change in the other
      d. Common Error - Failure to cross-check / correctly interpret outside and instrument references
   iii. Trim often to reduce pilot workload

D. Returning to Straight-and-Level Flight
   i. Initiate the level off at approximately 10% the rate of climb (500 fpm = 50' before desired altitude)
   ii. Smoothly lower the nose and level the wings to return to the straight-and-level flight site picture
      a. Attempt to level the nose and wings simultaneously
      b. A loss of altitude will result if the pitch is changed too rapidly
   iii. Maintain the climb power setting to accelerate to the cruise airspeed, then reduce the throttle
      a. Reduce rudder as power is reduced
   iv. Once stable, trim for straight-and-level flight

Common Errors:

- Failure to cross-check and correctly interpret outside and instrument references
- Application of control movements rather than pressures
- Improper correction for torque effect
- Faulty trim technique

Conclusion:

Brief review of the main points

In a climb thrust must be increased because weight is acting backward relative to the flight path, resulting in an increase in drag. To maintain the proper pitch attitude the nose of the airplane must be held in the same place relative to the horizon, adjustments are made by crosschecking the attitude indicator as well as Altimeter and VSI. During a climbing turn, due to the decreased vertical component of lift, the climb rate will be lower than in a straight climb. It is very important to keep any climb coordinated through the use of rudder.

VIII.D. Straight Descents and Descending Turns

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The student should develop knowledge of the elements related to straight and turning descents and have the ability to maintain a constant airspeed descent in both situations.
Key Elements	1. Decreased Drag 2. Coordination 3. Crosschecking
Elements	1. Flight Controls 2. Forces in the Descent 3. Types of Descents 4. Control Pressures and Overcontrolling 5. Trim Technique 6. Integrated Flight Instruction 7. Straight Descents 8. Turning Descents
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the factors related to descents and can properly perform a descent while in straight or turning flight.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

The final chapter of the fundamentals of flying. This, along with the other fundamentals, is what everything else in flying builds upon. Getting these maneuvers right will improve all future maneuvers.

Overview

Review Objectives and Elements/Key ideas

What

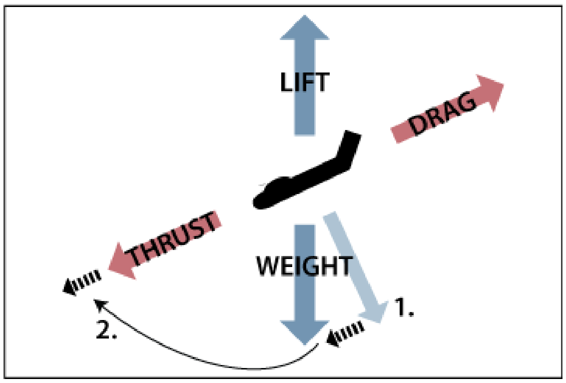
A descent is made when the aircraft is put in a configuration which will result in a loss of altitude.

Why

Descents are a fundamental part of flight, and a building block to many future maneuvers. Understanding and properly performing a descent will result in other maneuvers becoming easier.

How:

1. **Flight Controls**
   - A. All four primary controls are used in coordination when making climbs and climbing turns
     - i. Ailerons - Bank the wings and determine the rate of turn at a given airspeed
     - ii. Elevator - Moves the nose up or down in relation to the pilot, and perpendicular to the wings
       - a. Establishes the descent
       - b. It sets the pitch attitude in the turn and "pulls" the nose around the turn
     - iii. Rudder - Offsets yaw effects developed by the other controls (is not used to turn the airplane)
     - iv. Throttle - Provides thrust which may be used to maintain airspeed during a turn
2. **Forces in the Descent**
   - A. In a descent, weight isn't perpendicular to the flightpath (light blue line in the picture)
     - i. It acts in a forward direction (#1 in picture)
     - ii. Effectively adds to thrust (#2 in picture) which means a decrease in thrust (or increase in drag) is required to maintain airspeed in the descent
     - iii. Ignoring drag devices, airspeed will increase if thrust is not decreased in a descent



3. **Types of Descents**
   - A. Partial Power Descent – normal method of descending
     - i. The airspeed / power setting recommended by the manufacturer should be used
   - B. Descent at Minimum Safe Airspeed
     - i. Nose-high, power assisted descent (often used for clearing obstacles in a short field approach)
     - ii. Steeper than normal descent angle
     - iii. Excessive power is necessary to accelerate from the low airspeed should it become necessary
   - C. Emergency Descent
     - i. Some airplanes have a specific procedure for rapidly losing altitude in the POH
     - ii. In general, high drag / airspeed procedure requiring a specific configuration / speed, and often turns
   - D. Glide
     - i. A basic maneuver in which the airplane loses altitude in a controlled descent with little or no power

   ii. Common Error - Failure to clear engine and use carburetor heat, as appropriate

4. Control Pressures and Over-Controlling

- A. Control pressures should be light and just enough to produce the desired result
  - i. Common Error - Application of control movements rather than pressures
    - a. Use smooth, light *pressure*, not jerky movements
- B. Overcoming Tenseness / Over-controlling
  - i. Signs of over-controlling: Jolty, large movements; white knuckles, overall nervousness
  - ii. Prevention
    - a. Point out over-controlling, help the student stay calm, demonstrate the pressures desired
    - b. Technique: put a pencil on top of the middle & ring finger / under the index & pointer finger
      - Less fingers on the controls
      - If overcontrolling, the pressure on the middle and ring finger reminds them to relax

5. Trim Technique

- A. Most plane are designed to streamline the flight controls with the rest of the plane in straight-and-level flight at cruise speed, and standard weight and loading
  - i. Outside of this condition (faster, slower, heavier, lighter, change in balance, etc.) one or more of the control surfaces will have to be held out of its streamlined position
  - ii. Trim tabs offset the constant flight control pressure inputs needed from the pilot
- B. Trimming the Airplane
  - i. Set pitch and power, and let the airspeed stabilize
  - ii. Trim to relieve control pressures (with multiple tabs, trim rudder, then elevator, then aileron)
  - iii. Changes in pitch and power will require the plane to be trimmed again
    - a. On a longer flight, as CG changes with decreasing fuel trim will slowly have to be adjusted
  - iv. Common Error - Faulty trim technique
    - a. Trying to fly the airplane with trim is a common fault
    - b. With changing conditions, gusts, fuel burn, etc. it is necessary to trim often

6. Integrated Flight Instruction

- A. Using outside references + flight instruments to establish and maintain flight attitudes and performance
- B. The Basic Elements
  - i. 90% outside, 10% inside
  - ii. Use outside references to fly, validate the airplane's attitude on the flight instruments
    - a. If the instruments indicate a correction is necessary, apply it in reference to the natural horizon
    - b. Verify the new attitude and performance on the flight instruments
- C. Common Error - Failure to crosscheck and correctly interpret outside and instrument references

7. Straight Descent

- A. Entering the Straight Descent
  - i. Gently decrease power to the desired setting and maintain altitude to slow to descent speed
    - a. As power is reduced, the nose often has a tendency to fall
      - The decrease in the slipstream over the horizontal stabilizer reduces the tail down force
    - b. Slowly and gently increase back pressure to maintain altitude as speed reduces
  - ii. Establish the descent
    - a. Just prior to the descent airspeed, lower the nose to the descent pitch attitude on the horizon
    - b. Crosscheck the instruments and adjust pitch as necessary
  - iii. Once stable in the descent, trim to relieve the control pressures
    - a. Common Error - Faulty trim procedure
- B. Maintaining the Descent
  - i. Since the power is fixed, airspeed is controlled by pitch
    - a. If the aircraft is too fast, raise the nose, let the airspeed stabilize, and trim. Opposite for slow

            b. Common Error - Application of control movements rather than pressures
        ii. Keep the wings level to maintain the straight descent
            a. Use the same procedures as discussed in Straight-and-Level flight to visually maintain a heading
            b. If off heading, use a bank angle equal to the degrees off to correct back
        iii. Maintain Coordination
            a. Little, if any, rudder pressure will be required with reduced or idle power
            b. Adverse yaw still exists - Maintain coordination during any turns with the turn coordinator
            c. Common Error - Uncoordinated use of the flight controls
        iv. Crosscheck for the desired results on the instruments and adjust as necessary
            a. Common Error - Failure to cross-check / correctly interpret outside and instrument references
    C. Returning to Straight-and-Level flight
        i. A general rule is to lead the level off by 10% of the descent rate
        i. Smoothly increase power to the cruise power setting, and slowly raise the nose
            a. Adding power at the lead point will allow for a smooth acceleration back to cruise speed
            b. The airplane's nose tends to rise as airspeed and power increase
                - Monitor the horizon, and crosscheck the instruments adjusting pitch as necessary
        ii. Use smooth and slow control pressure to establish the level flight site picture at the desired altitude, and allow the aircraft to continue to accelerate to cruise speed
        iii. Set cruise power at cruise speed and trim for straight-and-level flight

8. Turning Descents

    A. Entering the Turning Descent
        i. Descending turns can be established one of two ways:
            a. Enter the descent first and then bank into the turn
            b. Enter the descent and turn simultaneously
        ii. The procedure
            a. Reduce the power and maintain altitude as airspeed slows
            b. Just prior to reaching the descent airspeed, establish pitch and bank in relation to the horizon
                - Crosscheck the instruments and fine tune airplane attitude
            c. Trim to relieve control pressures
    B. Maintaining the Turning Descent
        i. Pitch adjustments are made in the same way as in a straight descent
        ii. Bank Adjustments
            a. Increase or decrease the bank to maintain the desired bank angle
            b. Adjusting bank can have an effect on the airspeed and pitch may need to be readjusted
                - Increasing bank will require a lower pitch attitude to maintain airspeed
                - Decreasing bank will require an increase in pitch attitude to maintain airspeed
                - Trim to relieve the control pressures
            c. Common Error - Application of control movements rather than pressures
        iii. Maintain Coordination
            a. Without power, the left turning tendencies are greatly reduced
            b. Adverse yaw still exists - Maintain coordination during the turn using the turn coordinator
            c. Common Error - Uncoordinated use of the flight controls
        iv. Crosscheck for the desired results on the instruments
            a. Common Error - Failure to cross-check / correctly interpret outside and instrument references
    C. Returning to Straight-and-Level Flight
        i. Very similar to the straight descent, except with the addition of rolling the wings level
        ii. Lead the level off by 10% of the descent rate
        iii. Smoothly increase to the cruise power setting, and begin to raise the nose / level the wings

a. Establish the straight-and-level site picture
b. Ensure attention is divide between pitch, bank, and coordination
    - Attempt to level the nose and the wings simultaneously at the level off altitude

iv. Upon reaching cruise airspeed, set cruise power
i. Once stable, trim for straight-and-level flight

Common Errors:

- Failure to cross-check and correctly interpret outside and instrument references
- Application of control movements rather than pressures
- Uncoordinated use of the flight controls
- Faulty trim technique
- Failure to clear engine and use carburetor heat, as appropriate

Conclusion:

Brief review of the main points

Descents are part of the foundation of flying and as simple as they sound, they are extremely important. As in all of the fundamentals of flight it is important to learn to fly the airplane by visual references and back those references up with the instrument indications.

PERFORMANCE MANEUVERS

IX.A. Steep Turns

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The student should develop knowledge of the elements related to steep turns (load factors, torque, adverse yaw, and the overbanking tendency). The student should have the ability to perform a steep turn as required in the ACS/PTS.
Key Elements	1. Overbanking Tendency 2. Coordination 3. Increased back pressure and thrust 4. Maintain altitude with elevators and/or bank angle
Elements	1. Maximum Performance Turn 2. The Science Behind It 3. Performing the Steep Turn
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the characteristics behind the factors involved in the steep turn and can properly perform them in both directions maintaining altitude and airspeed.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Steep turns - the first really fun maneuver! Steep banks, you feel some G's and you're staring at the ground out the side window!

Overview

Review Objectives and Elements/Key ideas

What

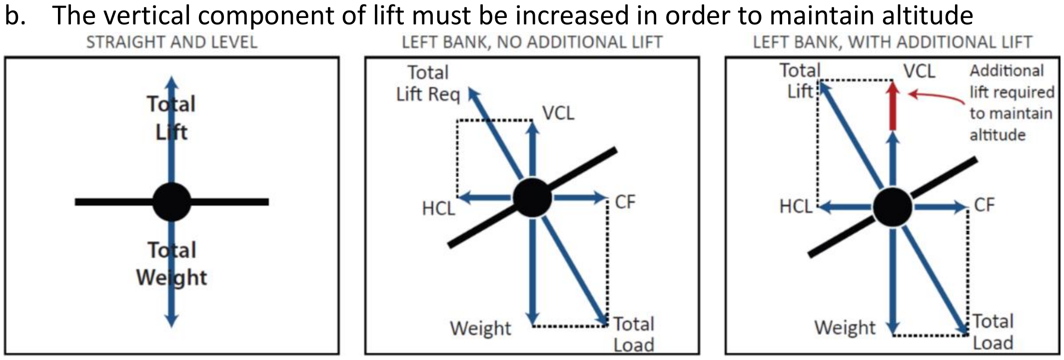
The steep turn maneuver consists of a constant altitude turn in either direction, using a bank angle between 45° to 60° (45° - Private, 50° - Commercial). This will cause an overbanking tendency during which maximum turning performance is attained and relatively high load factors are imposed.

Why

Steep turns develop smoothness, coordination, orientation, division of attention, and control techniques necessary for the execution of maximum performance turns. The pilot also understands the effects of the over banking tendency and how to counteract it.

How:

1. **Maximum Performance Turn**
    A. Fastest rate of turn and smallest radius of turn
        i. Radius changes with airspeed and angle of bank
            a. The higher the airspeed, the bigger the radius
            b. The higher the bank angle, the smaller the radius
    B. In addition to other factors, maximum bank angle is determined by the limiting load factor which can be maintained without stalling or exceeding structural limitations
        i. In most small airplanes the maximum bank is approximately 50° to 60°
2. **The Science Behind It**
    A. What makes an airplane turn?
        i. As an aircraft banks lift is divided into a horizontal and a vertical component
            a. The horizontal component of lift pulls the aircraft through the turn
            b. The vertical component of lift must be increased in order to maintain altitude



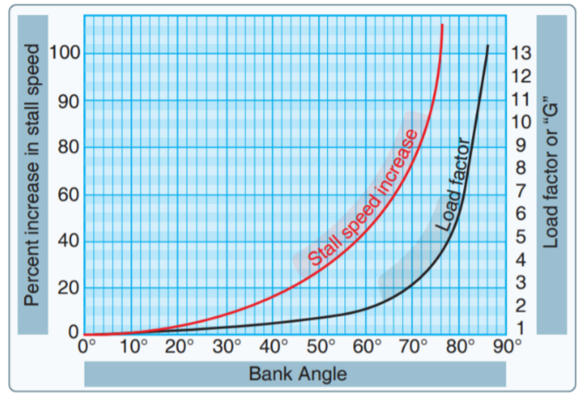
    B. Bank Angle, Load Factor and Stall Speed
        i. Basics
            a. Assuming level flight, as bank increases, load factor and stall speed also increase

b. The opposite also applies – decreasing bank decreases load factor and stall speed

ii. Load Factor

a. As bank increases beyond 45°, the loads on the aircraft increase rapidly (shown below)

- 60° bank = load factor of 2 Gs
- 70° bank = approximately 3 Gs



iii. Stall Speed

a. Stall speed increases in proportion to the square root of the load factor

b. Ex. In a 3G turn, a plane that normally stalls at 50 KIAS will stall at about 85 knots

C. Adverse Yaw

i. When banking, lift and drag are increased on the raised wing, and decreased on the lowered wing

ii. The difference in drag between the wings results in yaw in the opposite the direction of the turn

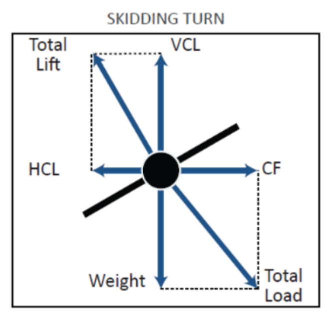
iii. To counter adverse yaw, rudder is applied with aileron in the direction of the turn

D. Torque Effect (left rolling tendency)

i. Newton's 3rd Law – every action has an equal and opposite reaction

a. The internal engine parts and propeller are revolving in one direction (clockwise / right), an equal force is trying to rotate the airplane in the opposite direction (counterclockwise / left)

b. Acts around the longitudinal axis, resulting in a roll to the left



ii. Torque Effect in Turns

a. Torque is based on the speed the engine / propeller are rotating

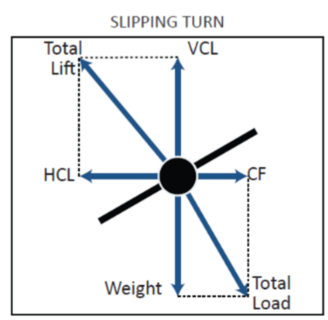
- The higher the power setting, the greater the turning tendency

b. Trim tabs combat torque effect in cruise in most small planes

- Thus, torque effect is generally negligible in a steep turn
- Large power changes could require bank adjustments though

c. Left Turn

- Torque, as a left rolling tendency, encourages a left turn
- Combined with other left turning tendencies can result in a skid
- Increase right rudder / reduce left rudder to counter the skid



d. Right Turn

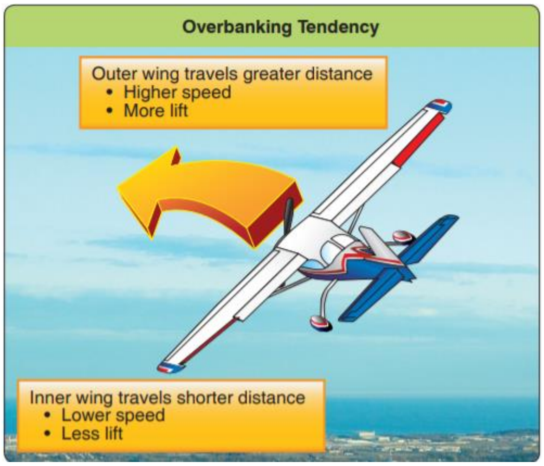
- Torque, as a left rolling tendency, discourages a right turn
- Combined with other left turning tendencies can result in a slip
- Increase right rudder / reduce left rudder to counter the slip

E. Overbanking Tendency

i. As turn radius becomes smaller, a difference develops between the speed of the inside wing and outside wing

a. Outside wing travels a longer path, but in the same amount of time as the inside wing

- Outside wing generates more lift
- Difference in lift can increase bank



b. Shallow bank: the difference in lift is overcome by lateral stability
c. Medium bank: the lift differential matches lateral stability
d. High bank: the difference in lift outweighs lateral stability
   - Aircraft continues to bank even with neutral flight controls
   - Aileron pressure is required in the direction opposite the turn to maintain bank angle

3. Performing the Steep Turn

A. Before Starting
   i. Select an altitude – No lower than 1,500' AGL
   ii. Pre-maneuver checklist, clear the area of traffic
   iii. Establish the recommended entry airspeed, or a speed that does not exceed V_A
   iv. Ensure the aircraft is in straight-and-level flight, and trimmed

B. Entering the Turn
   i. Note the entry heading and a visual reference to roll out on
   ii. Smoothly roll into the desired bank angle – 45° (Private); 50° (Commercial)
      a. Simultaneously apply rudder to maintain coordination
      b. Passing about 30° of bank, add back pressure to maintain altitude, and power for airspeed
         - Establish pitch / bank with visual references, crosscheck on the instruments
      c. Establish opposite aileron as necessary
      d. Trim as necessary
   iii. Common Error - Improper pitch, bank, and power coordination during entry

C. During the Turn
   i. Divide attention between the visual references, quick glances to the instruments, and clearing
      a. 90% outside, 10% inside
      b. Maintain the visual site picture, verify with the instruments, make adjustments, reassess
   ii. Adjustments
      a. Altitude ±
         - Relax or increase elevator pressure as appropriate
            a Small changes. Large changes lead to fast movement and a yo-yo effect
            b Power should be adjusted to maintain airspeed
         - Changes in bank may also be used to control altitude deviations
            a 1° to 3° of bank stays within PTS / ACS bank tolerances
            b Increasing bank decreases lift; Decreasing bank increases lift
         - If descending and bank is excessive, reducing bank angle may slow / stop the descent
         - If ascending and bank is shallow, increasing bank angle may correct the deviation
            a In either case, a combination of bank and pitch may be necessary
         - Common Error - Improper procedure in correcting altitude deviations
      b. Bank
         - Adjust bank to maintain the required bank angle, pitch will likely need adjusted as well
            a Increasing bank decreases lift
               1. If bank is shallow, increase bank and add back pressure to maintain altitude
            b Opposite applies for overbanking (decrease bank, reduce back pressure)
   iii. Common Error - Uncoordinated use of flight controls

D. Rolling out of the Turn
   i. Complete the rollout (roll wings level) on the heading the maneuver was started on
      a. General rule: Begin the rollout approximately ½ the bank angle from the desired heading
   ii. In the rollout, back pressure is gradually released / power reduced to maintain altitude and airspeed
      a. Use coordinated rudder and aileron to rollout of the turn
      b. If the elevator was trimmed up for the turn ensure the trim is removed on the rollout
   iii. Common Error - Loss of orientation
      a. Note the entry heading and find a visual reference to use
      b. Occasionally glance at the heading indicator / orient yourself with the visual reference
   iv. Common Error - Improper pitch, bank, and power coordination during entry and rollout

Common Errors:

- Improper pitch, bank, and power coordination during entry and rollout
- Uncoordinated use of flight controls
- Improper procedure in correcting altitude deviations
- Loss of orientation

Conclusion:
Brief review of the main points
In maintaining a properly coordinated steep turn, the pilot must use opposite aileron to maintain bank. Pitch should be controlled by adjusting elevator back pressure and bank angle. A smaller bank angle will result in more lift while an increased bank angle will reduce the lift. Maintaining coordination is very important and should be watched carefully throughout the maneuver.

IX.B. Steep Spirals

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The student should be able to perform the steep spiral maneuver to ACS/PTS standards adjusting for varying wind speed and direction as well as changing bank angles.
Key Elements	1. Similar to Turns Around a Point 2. Increased Groundspeed = Increased Bank 3. Decreased Groundspeed = Decreased Bank 4. Keep the reference between the wing root and fuselage
Elements	1. Rules 2. Performing a Steep Spiral
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the elements involved in a properly flown steep spiral. The student can apply those elements to a well flown, coordinated steep spiral.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

This can be a really cool maneuver, especially when combined with a power off 180º landing. The ability to maintain a position over the ground, while descending (as in an emergency landing) makes for a much more confident pilot.

Overview

Review Objectives and Elements/Key ideas

What

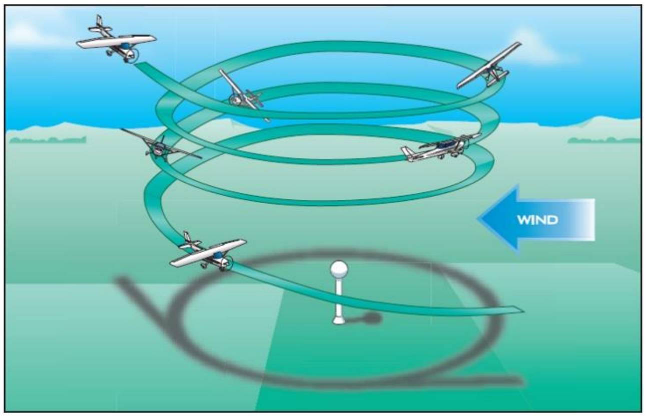
A steep spiral is a constant gliding turn, during which a constant radius around a point on the ground is maintained similar to the turn around a point maneuver.

Why

The steep spiral improves pilot techniques for airspeed control, wind drift control, planning, orientation, and division of attention. The steep spiral is not only a valuable flight training maneuver, but it has practical application in providing a procedure for dissipating altitude while remaining over a selected spot in preparation for landing, especially for emergency forced landings.

How:

1. **Rules**
   - A. Maintain an equal radius turn around a point – Approximately ¼ mile is a good reference
     - i. The radius should be such that the steepest bank will not exceed 60º
     - ii. Bank angle is increased as groundspeed increases, and decreased as groundspeed decreases
   - B. Enter on the downwind (groundspeed is the highest – Establishes the steepest bank at the start)
   - C. The spiral should be continued through three 360º spirals
     - i. Should not continue below 1,500’ AGL unless performing an emergency landing in conjunction
     - ii. Triple the approximate altitude lost per turn and add 1,500’ to it to plan a minimum entry altitude
   - D. Clear the engine headed into the wind
     - i. Minimizes variation in groundspeed / radius



2. **Performing a Steep Spiral**
   - A. Before Starting
     - i. Establish the required altitude
     - ii. Select a ground reference point
       - a. Small reference point (house, silo, etc.)
       - b. Should be in a sparsely populated area that permits an emergency landing
     - iii. Pre-maneuver checklist / clear the area
     - iv. Enter on the downwind, ¼ mile off the point
   - B. Entering the Spiral
     - i. Close the throttle and establish the recommended airspeed, trim the aircraft
       - a. When passing next to / over the point the aircraft will block the pilot’s view of the point
         - Once the point disappears, a good technique is to wait a few seconds and start the turn when past the reference point, establishing the ¼ radius (early turn puts you over the point)

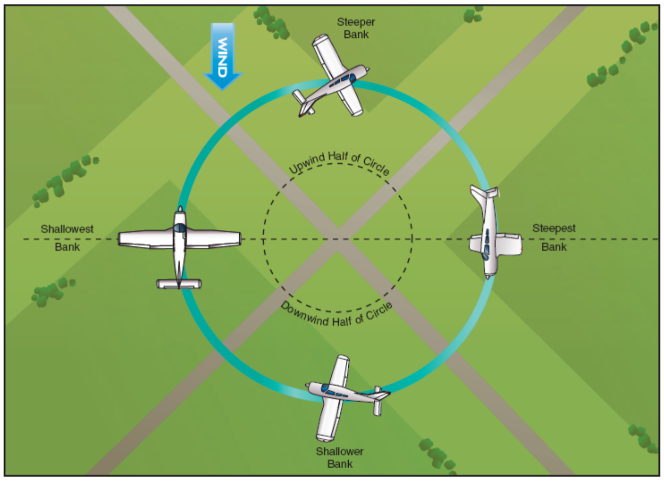
b. Establish the initial bank angle and establish the proper site picture with the reference point
- 45° is a good starting point

c. Common Error - Improper pitch, bank, and power coordination during entry or completion

C. During the Spiral
i. Divide attention between the ground reference point, other references, and the instruments
a. Monitor the altitude lost during each turn to establish the final 360 and plan a pattern entry
ii. Adjust bank based on changing winds during the descent to maintain a uniform radius
iii. Wind Correction
a. The higher the groundspeed, the steeper the bank required, and vice versa
- Higher speeds = bigger radius, therefore bank must be increased with a tailwind

b. As the airplane transitions into a headwind, bank must be decreased
c. Wind direction and speed may change during the descent
d. Adjust for winds to maintain the ground reference point / ¼ mile radius site picture
iv. Airspeed Correction
a. Inconsistent airspeeds vary the turn radius and therefore the bank required
b. Adjust pitch to maintain speed
- Small, smooth, proactive changes

c. Large speed changes may require a change in bank to maintain the radius
d. Common Error - Improper planning and lack of maintenance of constant airspeed and radius
v. Common Error - Uncoordinated use of flight controls



D. Rolling out of the Turn
i. After completing three complete rotations, roll out within 10° of the entry heading
a. Common Error - Failure to stay orientated to the number of turns and the rollout heading
- Techniques: Count the turns out loud, bug the entry heading

ii. There should be no increase or decrease of airspeed transitioning to the straight glide
a. Be smooth, controlled, and coordinated
b. Common Error - Improper pitch, bank, and power coordination during completion

Common Errors:
- Improper pitch, bank, and power coordination during entry or completion
- Uncoordinated use of flight controls
- Improper planning and lack of maintenance of constant airspeed and radius
- Failure to stay orientated to the number of turns and the rollout heading

Conclusion:
Brief review of the main points
The steep spiral is just like a turn around a point with the addition of a constant speed descent. The same procedures apply with the addition of making adjustments to the pitch attitude to maintain airspeed. It is important to stay oriented in relation to the number of turns and the entry and rollout heading.

IX.C. Chandelles

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The student should be able to complete a Chandelle taking into account the changing airspeed and maneuver as prescribed in the ACS/PTS.
Key Elements	1. Maximum Performance 2. 1st 90° - Constant Bank, Changing Pitch 3. 2nd 90° - Constant Pitch, Changing Bank 4. Coordination
Elements	1. Maximum Performance 2. Performing the Chandelle
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can perform a smooth, well-coordinated chandelle without the instructor's guidance. The student also understands the factors influencing control and coordination throughout the maneuver.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

The Chandelle is a *Maximum Performance* climbing 180º turn. We're going to get the airplane to climb as much as we possibly can, going from V_A down to just above the stalling speed.

Overview

Review Objectives and Elements/Key ideas

What

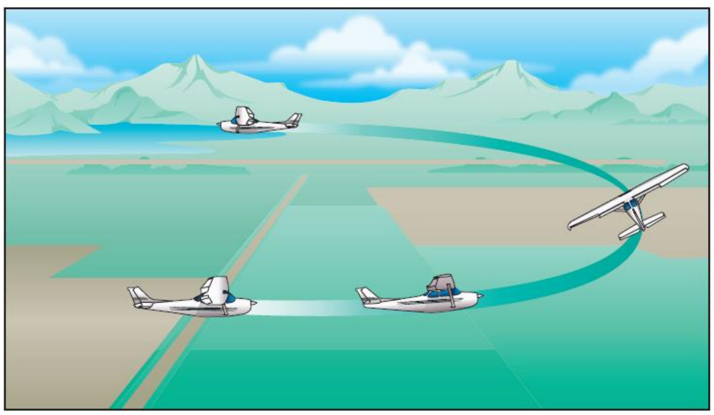
A maximum performance climbing turn beginning from straight and level flight, and ending at the completion of a precise 180º turn in a wings level, nose high attitude at the minimum controllable airspeed. The plane should gain the most altitude possible for a given degree of bank and power setting without stalling.

Why

This maneuver greatly develops the pilot's coordination, orientation, planning, and accuracy of control during maximum performance flight.

How:

1. **Maximum Performance**
   - A. The plane should gain the most altitude possible for a degree of bank and power setting without stalling
     - i. Altitude gained varies based on numerous factors and therefore isn't part of the grading criteria
2. **Performing the Chandelle**
   - A. Before Starting
     - i. Select an altitude – no lower than 1,500' AGL
     - ii. Pre-maneuver checklist; clear the area of traffic
     - iii. Straight-and-level flight at V_A, with flaps and gear (if retractable) in the UP position
     - iv. Note / bug the heading (rollout will be on the reciprocal heading)
     - v. Choose a visual reference point 90º off the wing in the direction of the turn



   - B. First 90º – Constant bank, Changing pitch
     - i. Smoothly enter a coordinated 30º turn
       - a. Maintain bank until 90º point
       - b. Correct for any variations / overbanking tendency
     - ii. With bank established, apply max power and initiate a climbing turn
       - a. No other power adjustments are made during the maneuver
       - b. Smoothly apply back pressure to reach the highest pitch attitude as 90º of the turn is completed
         - Intent is to be half way between entry speed and min controllable airspeed at 90º point
         - Divide attention between visual references, the 90º reference point, and instruments
       - c. Common Error - Improper pitch, bank, and power coordination during entry or completion
         - If the pitch is increased too quickly the aircraft will stall before reaching 180º
         - If the pitch is increased too slowly, the aircraft will not come close to the stall speed

        - Common Error - A stall during the maneuver
    iii. Maintain Coordination
        a. As speed decreases, torque effect becomes more pronounced / controls become less effective
            - Right rudder should be gradually increased to control yaw and keep coordinated
        b. In a left turn, less right rudder will be necessary than in a right turn
        c. Common Error - Uncoordinated use of flight controls
    iv. 90° Point: Airspeed should be about midway between entry speed and minimum controllable speed
        a. Bank is at 30°, pitch is at the highest pitch attitude

C. 2nd 90° of the Turn – Constant pitch, Changing bank
    i. Begin rolling out of the bank at a constant rate while maintaining a constant-pitch attitude
        a. Roll out approximately 10° of bank for every 30° of heading change
    ii. As airspeed decreases, increased back pressure is required to maintain a constant pitch attitude
        a. Left turning tendencies become more prevalent; right rudder is necessary to remain coordinated
        b. Common Error - Uncoordinated use of flight controls
    iii. 180° Point: Airspeed is just reaching minimum controllable airspeed
        a. Bank has been reduced to wings level, pitch is at the highest pitch attitude
        b. Common Error - Improper planning and timing of pitch and bank attitude changes

D. Rollout
    i. Time the rollout so that wings are level at the 180° point
    ii. Pitch attitude should be held momentarily while at the minimum controllable airspeed
    iii. Left Chandelle Rollout – Considerable right rudder is required (adverse yaw / left turning tendencies)
    iv. Right Chandelle Rollout – Less right rudder correction is needed
        a. Right rudder should be gradually released, use left rudder if necessary
    v. In either case once the wings are level, torque / p-factor are acting alone again
    vi. Common Error - Uncoordinated use of flight controls
    vii. Common Error - Improper pitch, bank, and power coordination during entry or completion

E. Finishing the maneuver
    i. Gradually reduce pitch to level flight, and accelerate while maintaining altitude
        a. Increase right rudder as pitch decreases to counter gyroscopic precession of the propeller
        b. Adjust pitch, power, and trim for cruise flight

F. Common Error - Factors related to failure in achieving maximum performance
    i. Maximum performance is degraded if pitch, bank, power or coordination is not established correctly

Common Errors:

- Improper pitch, bank, and power coordination during entry or completion
- Uncoordinated use of flight controls
- Improper planning and timing of pitch and bank attitude changes
- Factors related to failure in achieving maximum performance
- A stall during the maneuver

Conclusion:
Brief review of the main points
The chandelle is a maximum performance climbing 180° turn. During the first half of the turn bank is held constant while pitch is constantly increased. Through the second half of the turn, pitch is held constant and bank is constantly decreased. Throughout the maneuver it is important to keep the airplane coordinated, especially as the speed of the airplane decreases.

IX.D. Lazy Eights

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The student should understand the elements and necessary control inputs to perform the lazy eight maneuver. The student should show the ability to perform a coordinated, well planned and oriented lazy eight as prescribed in the ACS/PTS.
Key Elements	1. Transfer of Energy 2. Constantly changing control pressures 3. Symmetry
Elements	1. Relating the Maneuver 2. Performing the Lazy Eight 3. Rudder Control 4. Summary
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the elements involved in performing a lazy eight and has the ability to perform the lazy eight on their own.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Who wants to be a crop duster when they grow up? This is the maneuver you have to know if you want to crop dust. And, although challenging, it's a pretty fun maneuver.

Overview

Review Objectives and Elements/Key ideas

What

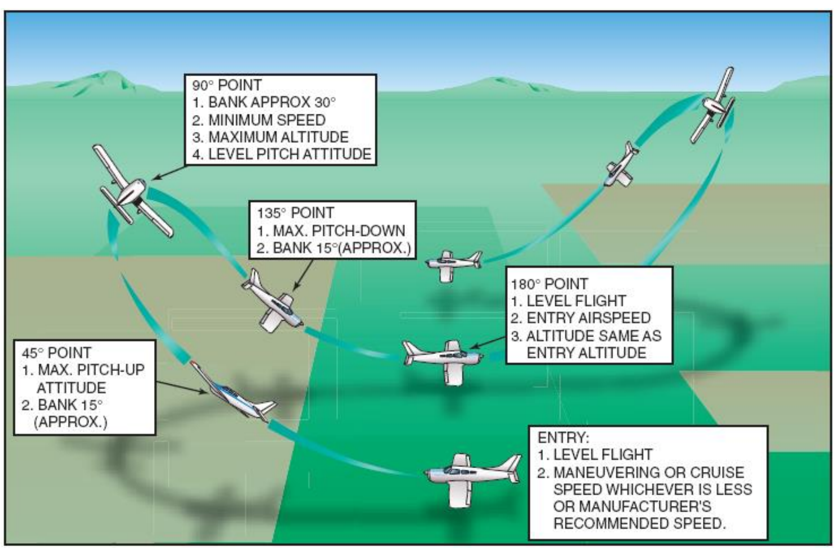
A maneuver consisting of two 180º turns in opposite directions, while making a climb and descent in a symmetrical pattern during each of the turns. It is designed to develop proper coordination of controls through a wide range of airspeeds and attitudes so that certain accuracy points are reached with planned attitude and airspeed. At no time do the forces on the controls remain constant.

Why

The lazy eight develops proper coordination of the controls through a wide range of airspeeds and attitudes. It is a great trainer because of the constantly varying forces and attitudes required. It also helps develop subconscious feel, planning, orientation, coordination, and speed sense.

How:

1. **Relating the Maneuver**
   - A. The maneuver can be compared to a half pipe and a transfer of energy
     - i. A transfer of energy as we climb the half pipe and then descend on the other side
       - a. The energy is used to get to the top, then we ride the 'pipe' back down
   - B. Crop-dusting maneuver
2. **Performing the Lazy Eight**
   - A. Before Starting
     - i. Select an altitude – No lower than 1,500' AGL
     - ii. Pre-maneuver checklist; Clear the area of traffic
     - iii. Straight-and-level flight, at or below V_A
     - iv. Choose visual reference points at 45º, 90º, and 135º in the direction of the turn
       - a. Should be easily identifiable
       - b. Don't use points that are too close, ensure that they are toward or on the horizon
       - c. Common Error - Poor selection of reference points



B. Starting the Lazy Eight
    i. Begin a *gradual* climbing turn toward the 45° reference point
        a. Intent is to reach maximum pitch / 15° of bank at the 45° point
        b. Pitch must be increased faster than bank
            - As pitch is increased airspeed decreases and therefore rate of turn increases
                a Since bank is also being increased, the rate of turn is further increasing
            - Decreasing airspeed means increased torque necessitating right rudder
C. 45° point: Pitch is at the maximum and bank is at 15°
D. 45° to 90°
    i. Bank should continue to increase at the same rate to reach 30° at the 90° point
        a. Opposite aileron may be required to maintain the bank angle (maintain coordination)
    ii. Pitch will decrease from maximum to pass through level flight at the 90° point
        a. Decrease at the same rate as the increase in the initial climbing turn
        b. As the aircraft continues to slow, additional right rudder pressure is necessary
            - Right rudder pressure will be highest at the slowest point (90° point of the turn)
E. At the 90° point
    i. Bank should be at the maximum angle (approximately 30°)
    ii. Airspeed should be at its minimum (5 to 10 knots above the stall speed)
    iii. Pitch should be passing through level flight
F. 90° to 135°
    i. Airplane should be flown into a descending turn
        a. Nose should describe the same size loop below the horizon as it did above
    ii. Bank is consistently decreased to reach 15° of bank at the 135° turn point
    iii. Pitch is decreased to reach the maximum pitch down at 135° of turn
        a. Guide the nose down, don't dive
        b. Max pitch down is less than max pitch
            - Gravity, thrust, and forward component of lift work together to descend the aircraft
    iv. As airspeed increases, right rudder pressure will need to be relaxed
G. 135° point: Pitch is at the minimum and bank is at 15°
H. 135° to 180°
    i. Continue to decrease bank to level the wings at the 180° point
    ii. Increase pitch to bring the nose back to the horizon
    iii. Bank and pitch should reach straight-and-level flight at the 180° point
        a. Note the amount of turn remaining and adjust the rate of rollout / pitch
        b. As airspeed continues to increase, reduce rudder and aileron pressure
    iv. Altitude should be where the maneuver was started
I. 180° point
    i. Upon returning to the starting altitude and the 180° point, a climbing turn should be started immediately in the opposite direction using the same visual references
    ii. The second turn should mimic the first as closely as possible
J. Common Error - Inconsistent airspeed and altitude at key points

3. Rudder Control

A. As airspeed decreases, considerable right rudder is gradually applied to counter left turning tendencies
    i. Pressure is the greatest at the point of lowest airspeed
B. More right rudder is needed in the right turn – compensates for adverse yaw + left turn tendencies
    i. In the left turn, adverse yaw counteracts some of the left turning tendencies
C. Climbing right turn: controls are slightly crossed due to overbanking tendency / left turning tendencies
    i. Remain coordinated, this is fine

D. Common Error - Uncoordinated use of flight controls

4. Summary

A. The maneuver requires constantly changing control pressures
   i. Not possible to perform it mechanically
B. Common Error - Loss of orientation / Excessive deviation from reference points
   i. Divide attention between visual references, pitch, bank, airspeed, coordination, reference points
   ii. Talk through the maneuver at each 45^o point. Know what you're going to do
C. Common Error - Unsymmetrical loops resulting from poorly planned pitch and bank attitude changes
   i. Use smooth, controlled inputs to obtain constant rate pitch and bank changes
   ii. Don't be aggressive

Common Errors:

- Poor selection of reference points
- Uncoordinated use of flight controls
- Unsymmetrical loops resulting from poorly planned pitch and bank attitude changes
- Inconsistent airspeed and altitude at key points
- Loss of orientation
- Excessive deviation from reference points

Conclusion:

Brief review of the main points

It is important that each part of the maneuver is performed at the same speed, or, increases and decreases in both pitch and bank should be made at the same rate during each part of the turn. Each part of the turn should be a mirror image of its opposite. It also is very important to keep the airplane coordinated throughout the varying attitudes and airspeeds in the maneuver.

GROUND REFERENCE MANEUVERS

X.A. Rectangular Course

References: Airplane Flying Handbook (FAA-H-8083-3)

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

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

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

Overview

Review Objectives and Elements/Key ideas

What

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

Why

This maneuver simulates conditions encountered in a traffic pattern preparing the student for pattern work.

How:

1. **Selecting a Suitable Altitude**
    - A. Entry altitude: 600' - 1,000' AGL (per the ACS)
        - i. ± 100' restrictions (800' AGL is a good balance with room above / below the altitude requirement)
2. **Selecting a Suitable Reference Point**
    - A. A square or rectangular field, or an area with suitable ground references on all four sides
        - i. Similar to a traffic pattern, sides should be 5,000 – 10,000' in length (one to two miles)
    - B. Wind direction must be estimated (METAR, smoke, water, trees, fields, a 360° turn noting ground track)
        - i. Per the ACS, the maneuver should be entered on a 45° angle to the downwind leg
    - C. Clear of populated areas, obstructions, hazards; Allows for an emergency landing, if necessary
    - D. Common Error - Selection of a ground reference without a suitable emergency landing area within gliding distance
3. **The Basics**
    - A. Rectangular course replicates a traffic pattern
    - B. Flown parallel to, and at a uniform distance (½ to ¾ mile) from the boundaries
    - C. All turns should be started and completed at the field boundaries (see maneuver picture)
        - i. The closer the aircraft is to the boundaries, the steeper the bank necessary at the turning points
            - a. Airplane Flying Handbook: Limit bank to 45° for all ground reference maneuvers
            - b. More sensible to practice at the traffic pattern limit of 30° of bank to establish good habits
    - D. Wind Correction
        - i. Crab – With any crosswind, the airplane will have to be crabbed into the wind
            - a. Use coordinated flight controls to point the aircraft into the wind; adjust crab for wind strength
        - ii. Roll Rate – Adjust roll rate to prevent drifting closer or farther from the desired course
            - a. If wind will push the plane to toward the course, the roll rate should be slow
            - b. If wind will push the airplane away from the course, the roll rate should he high
        - iii. Bank Angle –Amount of bank will vary with groundspeed
            - a. Higher groundspeed (tailwind) requires steeper bank to maintain the track
            - b. Slower groundspeed (headwind), requires a shallower bank to maintain the track
            - c. As groundspeed changes during a turn, bank will have to change with it
                - If groundspeed decreases through the turn, bank should decrease through the turn

- If groundspeed increases through the turn, bank should increase through the turn

iv. Common Error - Improper correction for wind drift

a. Stay ahead of the aircraft and know what is coming next

E. Airspeed (± 10 knots)

i. Keep airspeed in your crosscheck. Increase or decrease power as necessary

F. Coordination

i. The airplane must remain in coordinated flight at all times

a. Don't use the rudder to correct for wind drift, turn the plane with coordinated controls

b. Don't use the rudder to encourage a turn, this could result in a crossed-control situation

ii. Common Error - Uncoordinated flight control application

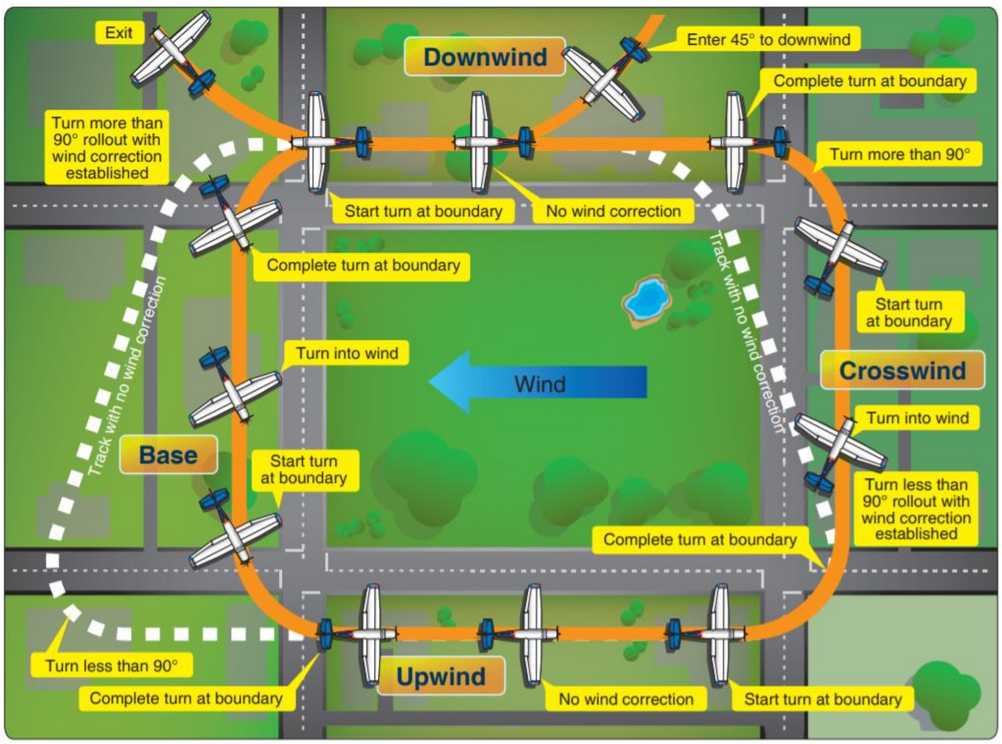
G. Common Error - Failure to maintain selected altitude or airspeed (± 100' / ± 10 knots)

i. Divide attention between visual references / instruments; be proactive in noticing / fixing deviations

H. Attention must be split between leg distance, turns, altitude, and airspeed

i. Plan ahead and divide attention between track, instruments, the next turn, etc.

ii. Common Error - Poor planning, orientation, or division of attention



4. Performing the Rectangular Course

A. Prior to Entry

i. Pre-Maneuver Checklist; Clearing turns

ii. Airspeed – Recommended speed, trimmed for hands off, level flight

iii. Orientation - Orient yourself in relation to the wind, plan to enter on a 45° entry to the downwind

B. The Maneuver

i. Enter at a 45° to the downwind

a. Upon reaching ½ to ¾ miles from the field, turn to a downwind heading, parallel to the field

ii. Downwind Leg – With a tailwind, no crab should be needed (crab as necessary for crosswinds)

iii. Turn to Base – High roll rate, Steepest bank transitions to Medium, > 90° turn

a. Roll Rate – High roll rate prevents the tailwind from pushing the aircraft outside the track

b. Bank – Groundspeed decreases through the turn so bank decreases through the turn

- Strongest tailwind / highest groundspeed at the start requires the steepest bank
- Bank decreases to medium as tailwind changes to crosswind / groundspeed decreases

c. Roll Out / Amount of Turn
- Crosswind on base leg will push the aircraft away from the field / outside the track
- To compensate, the turn to base will have to be > 90°; crab into the wind

iv. Base Leg – crab into the wind; divide attention between outside / instruments

v. Turn to Upwind – High roll rate, Medium bank transitions to Shallow, < 90° turn

a. Roll Rate – Wind will push the aircraft outside of the track so the roll rate should be high

b. Bank – Groundspeed decreases through the turn so bank decreases with it

a Average groundspeed (no head or tailwind) at the start requires medium bank

b Bank decreases to shallow as crosswind changes to headwind (lowest groundspeed)

c. Roll Out / Amount of Turn
- Roll out to parallel the upwind leg reference; Direct headwind will not affect drift
- < 90° of turn is required since the aircraft was already crabbed toward the field
- If the wind is not a perfect headwind, crab as necessary to maintain course

vi. Upwind Leg - Maintain track, divide attention between outside / instruments

vii. Turn to Crosswind – Low roll rate, Shallow bank transitions to Medium, < 90° turn

a. Roll Rate – A low roll rate prevents the wind from pushing the aircraft into the course

b. Bank – Groundspeed increases through the turn so bank increases through the turn
- Strongest headwind / slowest groundspeed at the start requires the shallowest bank
- Bank increases to medium as headwind changes to crosswind / groundspeed increases

c. Roll Out / Amount of Turn
- Roll out crabbed into the wind (pointed outside / away from the track); < 90° of turn

viii. Crosswind Leg - Adjust crab to maintain distance; divided attention – 90% outside, 10% inside

ix. Turn to Downwind – Low roll rate, Medium bank transitions to Steepest bank, > 90° turn

a. Roll Rate – Low roll rate prevents the wind from pushing the aircraft into the course

b. Bank – Groundspeed increases through the turn so bank increases through the turn
- Average groundspeed (no head or tailwind) at the start requires medium bank
- As the tailwind increases (highest groundspeed), increased bank is needed to maintain track

c. Roll Out/Amount of Turn
- Roll out to parallel the downwind leg reference; Direct headwind will not affect drift
- > 90° of turns is required since the aircraft was crabbed away from the field
- If the wind is not a perfect tailwind, crab as necessary to maintain course

x. Exit on the downwind leg

Common Errors:
- Poor planning, orientation, or division of attention
- Uncoordinated use of flight controls
- Improper correction for wind drift
- Failure to maintain selected altitude or airspeed
- Selection of a ground reference where there is no suitable emergency landing area within gliding distance

Conclusion:
Brief review of the main points
It is important to anticipate turns to correct for ground speed, drift, and turn radius. When wind is with the plane, turns must be steeper; if it's against, turns must be slow / shallow. Apply these techniques in the pattern.

X.B. S-Turns across a Road

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The student should develop knowledge of the elements related to S-turns as described in the ACS / PTS.
Key Elements	1. Wind Correction 2. Coordination 3. Emergency Landing Area
Elements	1. Purpose of S-turns 2. Selecting a Suitable Altitude 3. Selecting a Suitable Reference Line 4. The Basics 5. Performing S-Turns
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student will understand the effects of wind on maintaining equilateral radii on each side of a reference line. The student will be able to make the necessary adjustments throughout the turns due to the airplane's changing position in relation to the wind.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

This maneuver will provide a much better understanding of how the wind effects turning the airplane. And, it's considered to be easier than the rectangular course you already learned.

Overview

Review Objectives and Elements/Key ideas

What

A maneuver in which the airplane's ground track describes semicircles of equal radii on each side of a selected straight line on the ground

Why

S-turns develop the ability to:

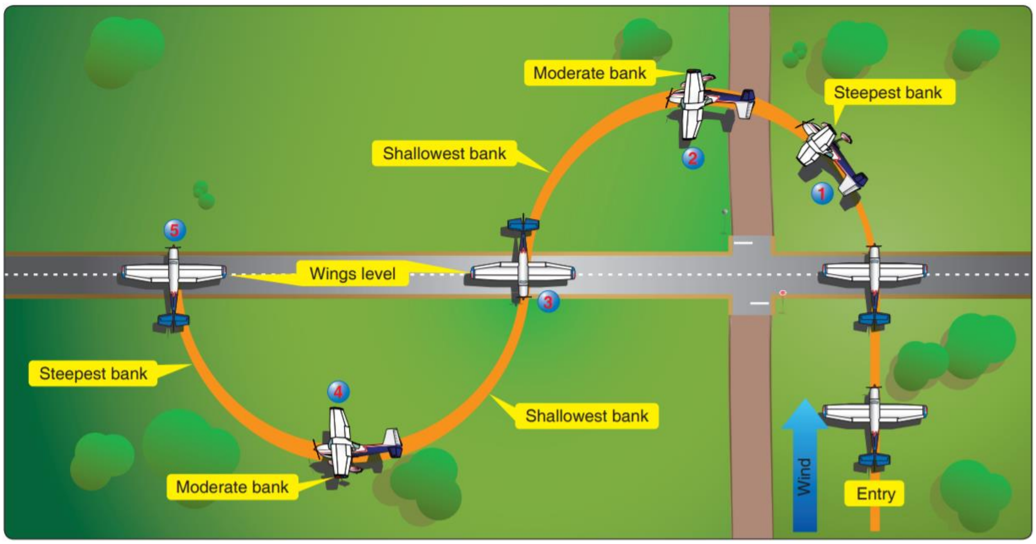
- Maintain a specific relationship between the airplane and the ground
- Divide attention between the flightpath, ground-based references, manipulating the flight controls, and scanning for outside hazards and instrument indications
- Adjust the bank angle during turns to correct for groundspeed changes in order to maintain constant radius turns
- Roll out from a turn with the required wind correction angle to compensate for any drift caused by wind
- Establish and correct the wind correction angle in order to maintain the track over the ground
- Compensate for drift in quickly changing orientations
- Arrive at specific points on required headings

How:

1. **Purpose of S-turns**
   A. As mentioned above, in Why
2. **Selecting a Suitable Altitude**
   A. Entry altitude should be 600' - 1,000' AGL per the ACS
      i. ± 100' restrictions (800' AGL is a good balance with room above / below the altitude requirement)
3. **Selecting a Suitable Reference Line**
   A. Estimate wind direction (METAR, smoke, water, trees, fields, or a 360° turn noting ground track)
   B. Select a ground based straight line reference perpendicular to the wind (Roads, train tracks, fences, etc.)
   C. Clear of populated areas, obstructions, hazards; Allows for an emergency landing, if necessary
   D. Common Error - Selection of a ground reference without a suitable emergency landing area within gliding distance
4. **The Basics**
   A. The Maneuver
      i. Enter on the downwind, perpendicular to the ground reference line
      ii. Cross perpendicular to the reference line, and begin a 180° constant radius turn
      iii. Adjust the turn to cross wings level, perpendicular to the reference point on an upwind
      iv. Begin an identical constant radius turn in the opposite direction
   B. Maintaining a Constant Radius – Bank, roll, and crab are adjusted for wind and changing groundspeed

i. Roll Rate is adjusted to prevent drifting in or out of the constant radius course
  a. High rate of roll: When wind will push you away from the reference / at a high groundspeed
  b. Low rate of roll: When wind will push you toward the reference / at a low groundspeed
ii. Bank Angle
  a. Higher groundspeeds require higher bank; lower groundspeeds require lower bank
iii. Wind Correction Angle
  a. The aircraft will have to be crabbed into any crosswind to maintain a constant radius
  b. Increases from start of the turn to 90° point (strongest crosswind), then decreases to the rollout
    - First turn: crab into the turn; Second turn: crab out of the turn
  c. The stronger the crosswind, the greater the wind correction angle

C. Common Error - Poor planning, orientation, or division of attention
  i. Plan ahead, know what's coming next. Stay ahead of the aircraft!



5. Performing S-Turns

A. Prior to Entry
  i. Pre-Maneuver Checklist; Clear the area
  ii. Airspeed – Recommended airspeed, and trimmed for hands off, level flight
  iii. Pick a reference line perpendicular to the wind, plan to enter on the downwind

B. The Maneuver
  i. Entry
    a. The reference line should be approached on the downwind (perpendicular to the line), 800' AGL
      - Minimize your workload – enter on airspeed and altitude, and trimmed for level flight
    b. Common Error - Faulty entry procedure
      - Ensure entry on the downwind (with a tailwind), perpendicular to the reference line
      - Set yourself up for success. Give yourself the time and distance necessary
  ii. Downwind Side of the Turn (1st Half) - The first turn establishes the radius for the second turn
    a. Bank Angle and Roll Rate
      - High groundspeed: Roll into the turn must be rapid, and the angle of bank the steepest
        a A normal rate of roll will result in being pushed away from the reference line
      - As the turn progresses and airspeed decreases, bank angle must be decreased
        a Otherwise, the turn would get progressively tighter as groundspeed decreased
      - Wind correction angle increases through the first 90° of turn, decreases through the second
        a Max crosswind correction angle should occur at the 90° crosswind point

            b Correction angle varies with wind strength; crab into the turn
    b. Completing the Turn
        - Reference the nose / wingtips, and ground reference to adjust the rollout to cross the reference line wings level, opposite the entry heading, on altitude and airspeed
  iii. Upwind Side of the Turn (2nd Half)
    a. Crossing the reference line, a turn in the opposite direction should be started
    b. Bank Angle and Roll Rate
        - Low groundspeed: Roll into the turn must be slow, and the angle of bank the shallowest
            a Normal rate will keep you too close to the reference line; won't complete 180° turn
        - As the turn progresses and airspeed increases, bank angle must increase
        - Wind correction increases through the first 90° of turn, and decreases through the second
            a Max crosswind correction angle should occur at the 90° crosswind point
            b Correction angle varies with wind strength; crab out of the turn
    c. Completing the Turn
        - Time the rollout to reach straight-and-level flight over / perpendicular to the reference line
        - Judge the closure rate and increase bank to cross wings level
  iv. Common Error - An unsymmetrical ground track, and Improper correction for wind drift
    a. Stay ahead of the plane – Visualize the wind in relation to the aircraft, know what's coming next
C. Maintaining a Constant Altitude (± 100' per the ACS)
  i. Trim for level flight prior to starting the maneuver
  ii. As bank increases, back elevator pressure will need to be increased to maintain altitude
    a. Divide attention, don't fixate on any one thing
D. Maintaining a Constant Airspeed
  i. A constant power setting and a stable altitude go a long way in maintaining a constant airspeed
    a. Power may have to be added with increased bank / back pressure and vice versa
  ii. Common Error - Failure to maintain selected altitude or airspeed
    a. Divide attention, don't fixate. Be proactive in noticing and making corrections
E. Coordination
  i. As in all phases of flight, it is important to maintain proper coordination
  ii. Do not use uncoordinated rudder to fix the radius or rollout of the turn (cross-controlled situation)
  iii. Common Error - Uncoordinated use of flight controls

Common Errors:
- Faulty entry procedure
- Poor planning, orientation, or division of attention
- Uncoordinated use of flight controls
- Improper correction for wind drift
- An unsymmetrical ground track
- Failure to maintain selected altitude or airspeed
- Selection of a ground reference line without a suitable emergency landing area in gliding distance

Conclusion:
Brief review of the main points
Bank is constantly changing to track a constant radius turn on each side of the reference line as the airplane's position relative to the wind is changing.

X.C. Turns Around a Point

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives
The student should exhibit knowledge regarding the performance of a turn around a point. Knowledge will include the elements listed below. Performance of the maneuver should be to ACS/PTS standards.

Key Elements
1. Increased Groundspeed = Increased Bank
2. Decreased Groundspeed = Decreased Bank
3. Maintain Coordination

Elements
1. Purpose of Turns Around a Point
2. Selecting a Suitable Altitude
3. Selecting a Suitable Reference Point
4. The Basics
5. Performing Turns Around a Point
6. Recap

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

Equipment
1. White board and markers
2. References

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

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

Completion Standards
The lesson is complete when the student can demonstrate the knowledge of, and has shown proficiency in turns around a point. The student understands the effect of wind on an aircraft's course over the ground primarily during a turn.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

This exercise shows the difference between the aircraft's motion in the air, and its ground track. These are different because the aircraft is subject to the moving air mass in which it flies. If wind exists, a ground track with constant radius will require a constantly changing bank angle to correct for wind.

Overview

Review Objectives and Elements/Key ideas

What

Turns around a point, the airplane is flown in two or more complete circles of uniform radii or distance from a prominent ground reference point using a maximum bank of approximately 45° while maintaining a constant altitude.

Why

Turns around a point teach the pilot to:

- Maintain a specific relationship between the airplane and the ground
- Divide attention between the flightpath, ground-based references, manipulating the flight controls, and scanning for outside hazards and instrument indications
- Adjust the bank angle during turns to correct for groundspeed changes in order to maintain constant radius turns
- Improve competency in managing the quickly changing bank angles
- Establish and adjust the wind correction angle in order to maintain the track over the ground
- Compensate for drift in quickly changing orientations
- Develop further awareness that the radius of a turn is correlated to the bank angle

How:

1. **Purpose of Turns Around a Point**
   A. As mentioned above, in Why
2. **Selecting a Suitable Altitude**
   A. Entry altitude should be 600' - 1,000' AGL per the ACS
      i. ± 100' restrictions (800' AGL is a good balance with room above / below the altitude requirement)
3. **Selecting a Suitable Reference Point**
   A. Should be prominent and easily distinguishable / small enough for precise reference (Ex. crossroads)
      i. Technique: Pick out targets along the flight path at ¼ intervals along the circle
         a. Helps to orient with the wind / ensure the airplane is in the right place at the right time
   B. Clear of populated areas, obstructions, hazards; Allows for an emergency landing, if necessary
   C. Common Error - Selection of a ground reference without a suitable emergency landing area within gliding distance
4. **The Basics**
   A. The Maneuver
      i. Consecutive, constant radius 360° turns, where bank, rate of turn, and wind correction angle are constantly adjusted due to the wind's varying affect at different points in the turn

B. Wind Correction
   i. Roll Rate
      a. Adjusted to prevent drifting in / out of the desired radius
      b. High rate of roll: When wind will push you away from the reference / at a high groundspeed
      c. Low rate of roll: When wind will push you toward the reference / at a low groundspeed
   ii. Bank Angle
      a. High groundspeeds (tailwind) require high bank; low groundspeeds (headwind) require low bank
   iii. Wind Correction Angle
      a. The aircraft will have to be crabbed into any crosswind to maintain a constant radius
      b. The stronger the crosswind, the greater the wind correction angle
      c. Increases from start to 90° point, then decreases to 180° point, and repeats on the other side
         - First half of the 360: crab into the turn; Second half: crab out of the turn
   iv. If there were no wind, bank would be constant around the turn, with no need to crab
      a. The stronger the wind, the more bank will have to be varied throughout the maneuver

C. Division of Attention
   i. Divide attention between the reference point, aircraft, what's coming next, and the surroundings
      a. 90% outside, 10% inside; Always keep an eye out for other traffic or threats
   ii. Common Error - Poor planning, orientation, or division of attention

5. Performing Turns Around a Point

A. Prior to Entry
   i. Pre-Maneuver Checklist; Clear the area
   ii. Airspeed: At or below V_A - Trimmed for hands off level flight

B. Entry Procedure
   i. Enter on the downwind, abeam the point, approximately ¼ to ½ mile radius from the point
   ii. Note the entry heading to maintain orientation
   iii. Common Error - Faulty entry procedure

C. The Turn
   i. Abeam the Point
      a. Coordinated roll in to maintain the desired radius
         - Steepest bank angle and high roll rate – bank should not exceed 45°
      b. As bank is increases, increase back pressure to maintain altitude
   ii. First Half of the Turn (Downwind Half)
      a. Steepest bank transitioning to the shallowest bank
      b. Decreasing groundspeed – Begins with a tailwind transitioning to a crosswind then a headwind
         - Bank should be gradually reduced to maintain a constant radius
            a As bank is reduced, back pressure should be relaxed to maintain altitude
         - Common Error - Failure to maintain selected altitude or airspeed
      c. Progressively crab inside the turn to establish max wind correction angle at the 90° point
         - Decrease wind correction angle from the 90° point until completing the first half of the turn
         - Common Error - Improper correction for wind drift
      d. Always keep the turn coordinated
         - As the bank is reduced, rudder pressure will reduce
         - Common Error - Uncoordinated use of flight controls
      e. At the end of the first half of the turn, bank should be at its lowest, and crab should be removed
         - Direct headwind, therefore lowest groundspeed and lowest bank angle / no crab required
   iii. Second Half of the Turn (Upwind Half)
      a. Opposite of the first half - Slowly move from a shallow to steep bank

b. Increasing groundspeed – Begins with a headwind transitioning to a crosswind then a tailwind
   - Bank should be gradually increased to maintain a constant radius
     a As bank is increased, back pressure should be increased to maintain altitude
   - Common Error - Failure to maintain selected altitude or airspeed

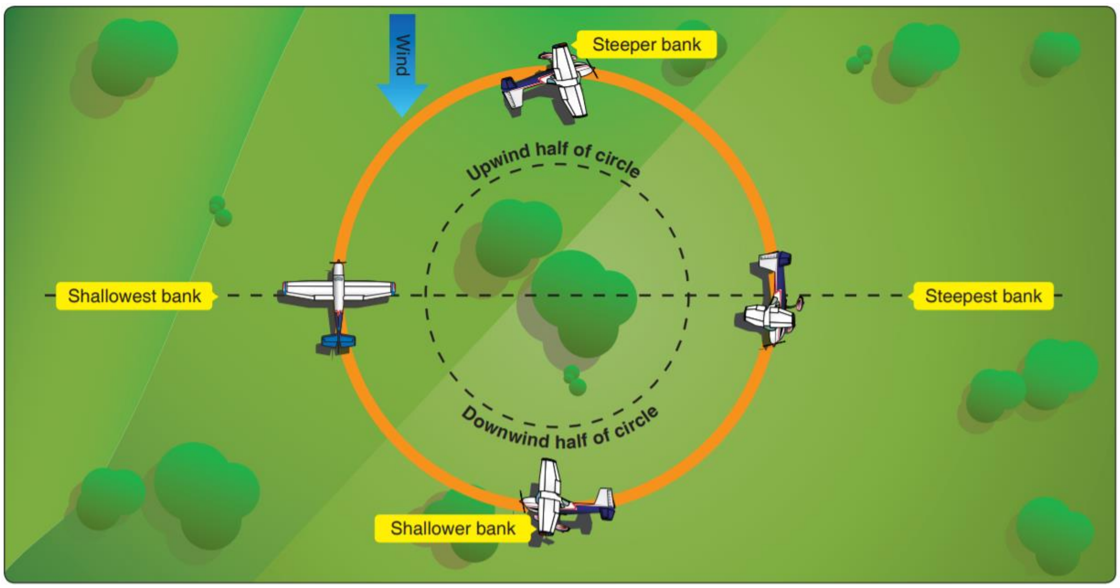
c. Progressively crab outside the turn to establish max wind correction angle at the 90º point
   - Decrease wind correction angle from the 90º point until completing the first half of the turn
   - Common Error - Improper correction of wind drift

d. Always keep the turn coordinated
   - As the bank is reduced, rudder pressure will reduce
   - Common Error - Uncoordinated use of flight controls

e. At the end of the second half of the turn, bank should be the highest (same as entry bank angle)
   - Direct tailwind, therefore highest groundspeed / bank angle and no crab required

D. Exit

i. Once at least 2 turns have been completed, initiate a smooth rollout on the initial entry heading



Common Errors:
- Faulty entry procedure
- Poor planning, orientation, or division of attention
- Uncoordinated use of flight controls
- Improper correction for wind drift
- Failure to maintain selected altitude or airspeed
- Selection of a ground reference point where there is no suitable emergency landing area within gliding distance

Conclusion:
Brief review of the main points
This maneuver works to establish a better understanding of the airplane's turning tendencies due to changing crosswinds while helping the pilot learn to divide attention between controlling the airplane and other traffic.

X.D. Eights on Pylons

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The student should develop knowledge of the elements behind the Eights on Pylons maneuver and have the ability to perform the maneuver to ACS/PTS standards.
Key Elements	1. Points moves forward: Forward Pressure 2. Point moves backward: Backward Pressure 3. Small, coordinated corrections
Elements	1. What is Pivotal Altitude? 2. The Basics 3. Calculating Pivotal Altitude 4. Performing Eights on Pylons
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The lesson is complete when the student understands Pivotal Altitude and the accompanying concepts to Eights on Pylons. The student also will have the ability to properly fly the maneuver.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

The eights on pylons maneuver started in WWI. This maneuver was developed in order to maintain a constant view of a target, allowing the gunner to destroy a target. A more practical application now, is keeping the wing out of the way for aerial photography.

Overview

Review Objectives and Elements/Key ideas

What

Eights on Pylons is an advanced maneuver in which the pilot's attention is directed at maintaining a pivotal position on a selected pylon, with minimum attention inside the cockpit.

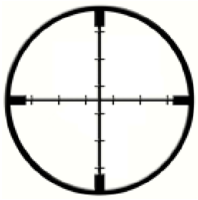
The maneuver itself involves flying the airplane in a figure eight path around two selected points, or pylons, on the ground. No attempt is made to maintain a uniform distance from the pylon. Instead, the goal is to have an imaginary line that extends from the pilot's eyes to the pylon. Along this line, the airplane appears to pivot as it turns around the pylon. In other words, if a taut string extended from the airplane to the pylon, the string would remain parallel to lateral axis as the airplane turned around the pylon.

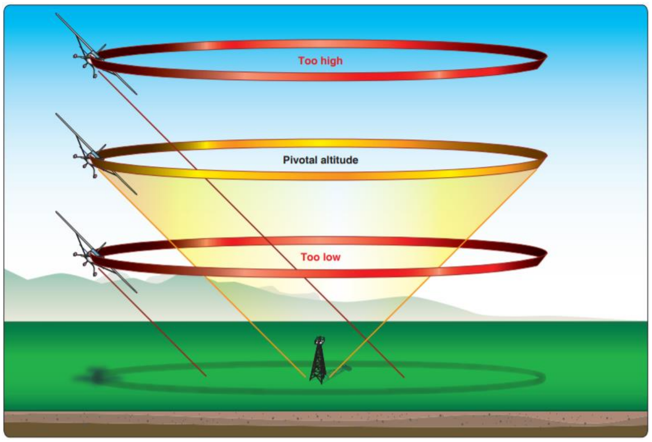
Why

The objective is to develop the ability to maneuver accurately while dividing attention between the flight path and the points on the ground. They are extremely helpful in teaching, developing, and testing subconscious control of the plane.

How:

1. **What is Pivotal Altitude**
    - A. General Description
        - i. Altitude which keeps a pylon in the same position relative to the aircraft as the plane turns around it
            - a. Varies with groundspeed
            - b. The reference line is parallel with the lateral axis (off wingtip or position on the window)
        - ii. When turning at the pivotal altitude, the wingtip appears to be fixed to a point on the landscape
            - a. Above the pivotal altitude, the wingtip appears to move backward
            - b. Below the pivotal altitude, the wingtip appears to move forward

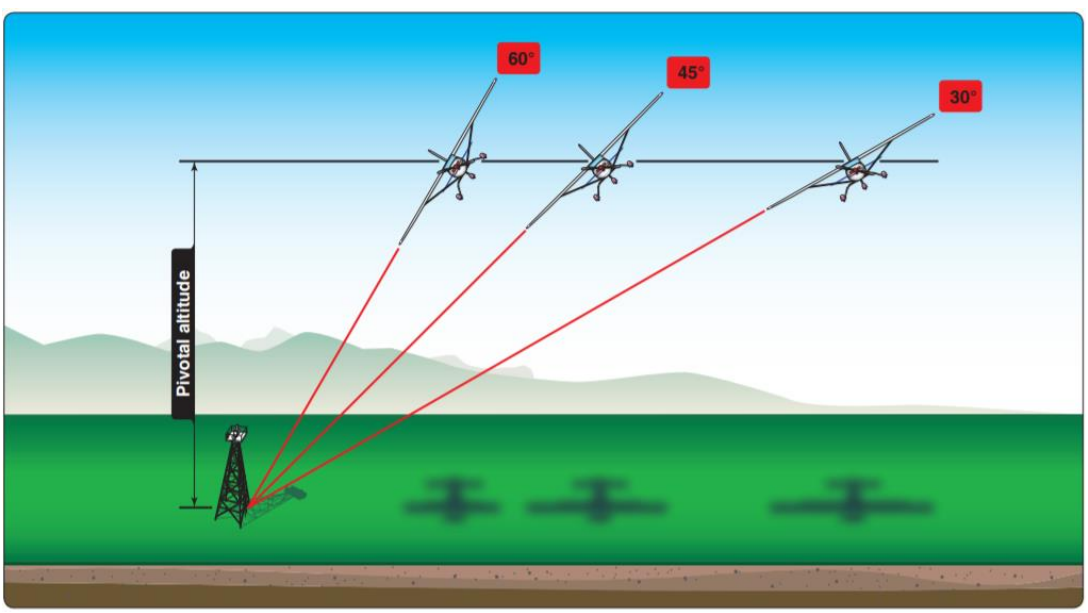




2. **The Basics**
    - A. Pivotal altitude is based on groundspeed
        - i. As groundspeed increases, pivotal altitude increases, and vice versa
            - a. Does not change with bank angle
            - b. Distance from pylon affects bank angle
        - ii. Circling the reference point, groundspeed / pivotal altitude will change with wind
        - iii. To adjust, the pilot climbs or descends to maintain the visual reference with the pylon

a. The change in altitude will depend on how much the wind affects groundspeed

B. Maintaining the Pivotal Altitude Reference
   i. Pitch
      a. As groundspeed decreases, the pivotal altitude decreases
         - Wing moves backward over the ground / point moves forward in relation to the wing
         - Descend to maintain the reference line to the pylon
            a We descend to lower pivotal altitude, increase in airspeed moves pivotal altitude up
         - General Rule: If the point moves FORWARD, apply FORWARD pressure
      b. As groundspeed increases, the pivotal altitude increases as well
         - Wing moves forward over the ground / point moves backward in relation to the wing
         - Climb to maintain the reference line to the pylon
            a We climb to higher pivotal altitude, decrease in airspeed moves pivotal altitude down
         - General Rule: If the point moves BACKWARD, apply BACK pressure
      c. Corrections and Wind Speed
         - Corrections are like tracking a VOR
            a Once the correction is made (intercept angle is established), remove the correction when the pylon is back on the line-of-sight reference (intercepting the radial)
         - Changes in pitch / altitude are based on wind speed
            a The stronger the wind, the greater the variation in max / min pivotal altitudes
         - Too strong of winds becomes unsafe
            a Get closer and closer to the ground; and can require very high bank angles
      d. Common Error - Uncoordinated use of flight controls, and Application of rudder alone to maintain "line-of-sight" on the pylon
         - Use altitude changes, rather than rudder pressure, to hold the reference point on the pylon
   ii. Bank – Performed at bank angles ranging from shallow to steep (no more than 40° per the ACS)
      a. Distance from the pylon affects bank
         - As wind pushes you to / from the pylons, bank is used to maintain the reference line
      b. If the pylon moves above the reference point, (i.e., above the wing tip) decrease bank
      c. If the pylon moves below the reference point (i.e., below the wing tip), increase bank
   iii. Common Error - Use of an improper "line-of-sight" reference



Groundspeed		Approximate Pivotal Altitude
Knots	MPH	
87	100	670
91	105	735
96	110	810
100	115	885
104	120	960
109	125	1050
113	130	1130

3. Calculating Pivotal Altitude

A. Equation to estimate pivotal altitude

i. For Knots – $(Groundspeed^2 \div 11.3)$ + MSL

ii. For MPH – $(Groundspeed^2 \div 15)$ + MSL

B. Calculate the highest and lowest pivotal altitudes

i. Highest = TAS + tailwind; Lowest = TAS - headwind

ii. If altitudes are unsafe, do not perform the maneuver

4. Performing Eights on Pylons

A. Selecting Pylons

i. Two ground points along a line perpendicular to the wind

a. Sufficiently prominent / easy to see in an open area away from hills / obstructions

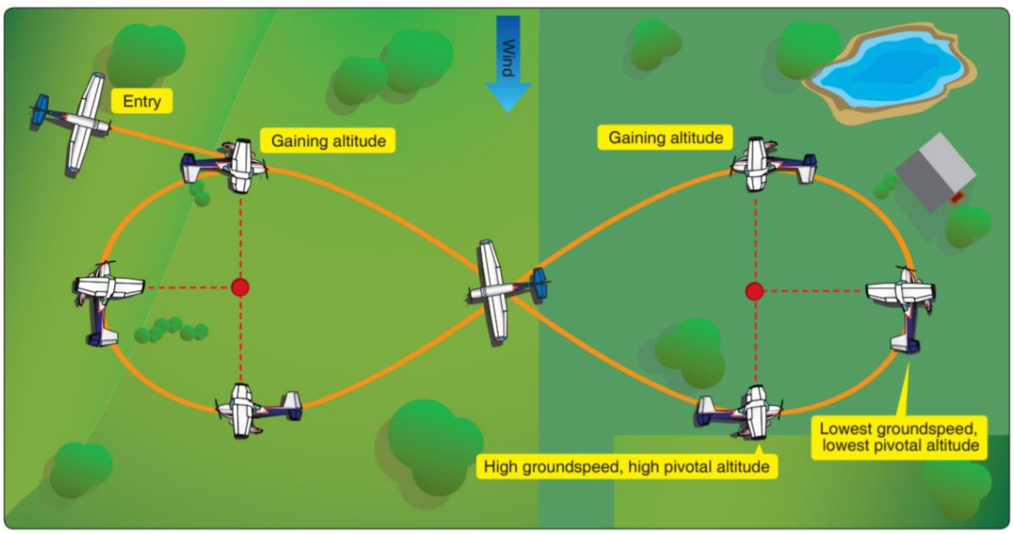
- Smaller pylons are easier to notice changes in movement

b. About ½ mile apart (3-5 second flight between pylons)

- Allows time for planning, but not unnecessary drone between the pylons

c. At the same elevation

ii. Common Error - Selection of pylons with no suitable emergency landing area within gliding distance



B. Before the Maneuver

i. Pre-maneuver checklist; Clear the area of traffic

ii. Trimmed for straight and level flight, at or below V_A

C. Entering the Maneuver

i. Fly to the midpoint of the pylons at a 45° angle to the downwind (note the entry heading)

a. Make the first turn to the left around the left pylon

b. Downwind entry starts at the highest groundspeed / highest pivotal altitude

ii. Roll into a 30° – 40° bank when the pylon is just ahead of the reference

iii. Place wingtip at the base of the pylon

iv. Common Error - Faulty entry procedure, and Improper planning for turn entries and rollouts

D. First Turn

i. Entry is at the highest groundspeed

a. As groundspeed decreases through the turn, pivotal altitude decreases

b. With no corrections, the pylon will move forward

c. Forward movement = forward pressure. Descend to maintain reference point

d. Decrease bank to maintain reference as wind pushes the airplane away from the point

ii. Continuing the turn

a. Continuing around, groundspeed and therefore pivotal altitude will begin to increase again
b. Climb to maintain pivotal altitude / visual reference. Backward movement = back pressure
c. Relative wind will push the airplane toward the pylon
  - Increase bank angle to maintain the visual reference

E. Transitioning between Pylons
  i. Start the rollout to proceed diagonally to a point on the downwind side of the 2nd pylon
  ii. Maintain straight and level flight for 3 to 5 seconds
  iii. Crab into the wind to correct for wind drift
    a. Common Error - Improper correction for wind drift between pylons
  iv. Initiate a turn in the opposite direction as the pylon aligns with the reference point
  v. Common Error - Improper planning for turn entries and rollouts

F. Second Turn
  i. Entry is at the highest groundspeed / highest pivotal altitude
    a. As the turn continues, groundspeed, and therefore pivotal altitude, decreases
      - With no correction, the pylon will move forward. Forward movement = forward pressure
      - Descend to correct for changing groundspeed
  ii. Continuing around the turn, groundspeed increases again, increasing pivotal altitude
    a. Pylon will move backward in relation to the wingtip; Backward movement = back pressure
    b. Increase bank as relative wind pushes the airplane closer to the pylon

G. Exit
  i. Roll wings level after completing one rotation around each pylon and exit on the entry heading

H. Common Error - Poor planning, orientation, and division of attention

Common Errors:

- Faulty entry procedure
- Poor planning, orientation, and division of attention
- Uncoordinated use of flight controls
- Use of an improper “line-of-sight” reference
- Application of rudder alone to maintain “line-of-sight” on the pylon
- Improper planning for turn entries and rollouts
- Improper correction for wind drift between pylons
- Selection of pylons where there is no suitable emergency landing area within gliding distance

Conclusion:

Brief review of the main points

If the point moves forward, apply forward pressure. If the point moves backward, apply back pressure.

The most advanced and most difficult of the low altitude flight training maneuvers. Because of the techniques involved, this maneuver is unsurpassed for teaching, developing, and testing subconscious control of the plane.

SLOW FLIGHT, STALLS & SPINS

XI.A. Maneuvering During Slow Flight

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), POH/AFM

Objectives	To develop an understanding and proficiency of the flight characteristics and degree of controllability of an aircraft in slow flight. A "feel" for the airplane at very low speeds should be developed to avoid inadvertent stalls and to operate the aircraft with precision. In flight, the student should perform the maneuver in varying configurations to ACS/PTS standards.
Key Elements	1. Pitch for Airspeed 2. Power for Altitude 3. Stay Coordinated
Elements	1. What is Slow Flight 2. Flight Characteristics and Controllability a. Power b. Maneuvering Loads & Turns c. Weight d. Center of Gravity 3. Slow Flight and Critical Flight Situations 4. Slow Flight and the Senses 5. Performing Slow Flight
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The lesson is complete when the student understands factors affecting flight characteristics and controllability and shows the ability to control the airplane effectively in different configurations of slow flight.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

When the aircraft is flying at just above the stall speed, there is little margin for error. This maneuver will greatly improve your piloting skills.

Overview

Review Objectives and Elements/Key ideas

What

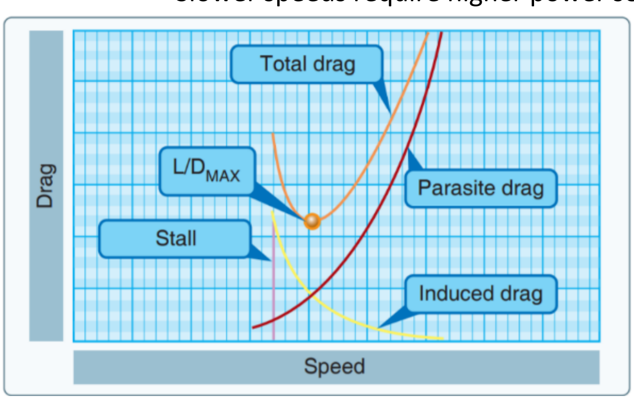
Flight at a speed which any further increase in AOA / load factor, or reduction in power will cause a stall.

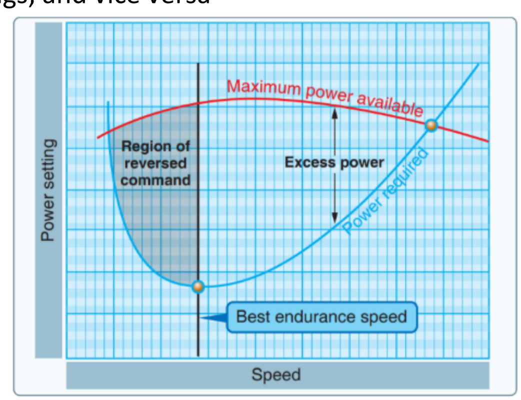
Why

The aircraft performs and is controlled differently at low airspeeds. Maneuvering during slow flight demonstrates the characteristics and degree of controllability of the aircraft near the critical angle of attack. The aircraft is flown at high angles of attack and slow airspeeds in many phases of flight (takeoff, landing, go-around), so understanding how the aircraft performs and is controlled at reduced speeds is essential.

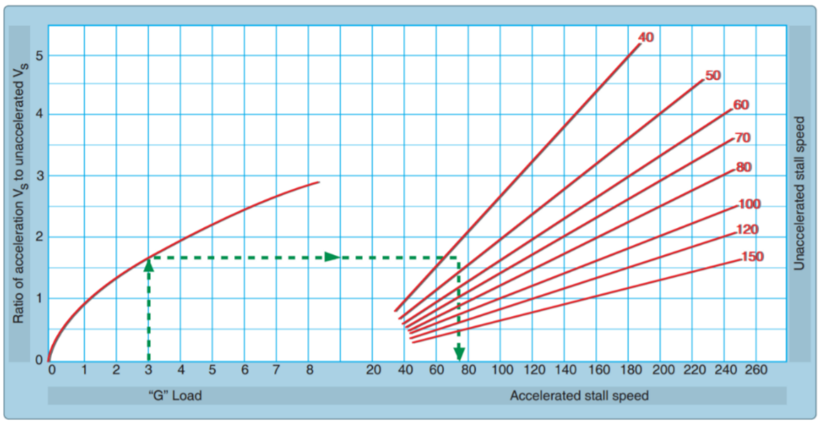
How:

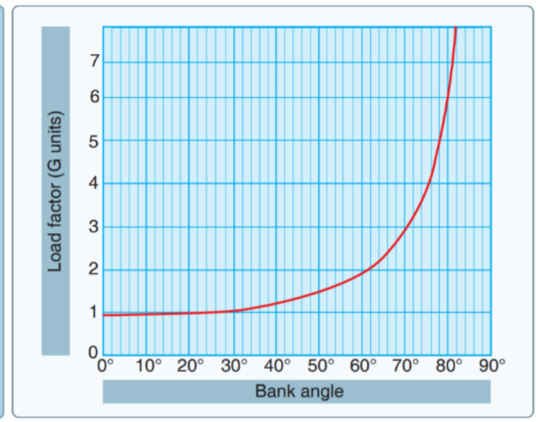
1. **What is Slow Flight**
   A. Any speed less than cruise speed, however, in training it can be broken down into two elements
      i. Establishment, maintenance of, and maneuvering at airspeeds and in configurations appropriate to takeoffs, climbs, descents, landing approaches and go-arounds (anything less than cruise speeds)
      ii. Flight at a speed which any increase in AOA / load factor, or power reduction will cause an immediate stall
         a. This description is used for the slow flight maneuver
2. **Flight Characteristics and Controllability**
   A. **Power**
      i. Region of Reversed Command
         a. Normal Command
            - As airspeed decreases, total drag decreases, until reaching a point (L/D_{MAX})
            - Higher speeds require higher power settings, and vice versa
         b. Region of Reversed Command
            - Airspeeds below L/D_{MAX}, where total drag begins to increase
            - Slower speeds require higher power settings, and vice versa



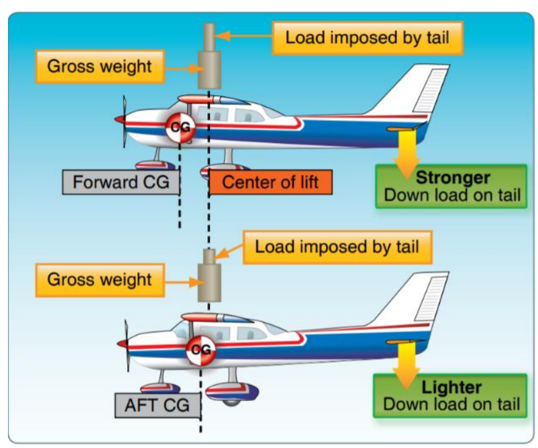


- ii. Controllability
  - a. Increased power at slow airspeeds / high AOAs results in increased left turning tendencies
- B. **Maneuvering Loads & Turns**
  - i. Load factor: Ratio of the total load acting on the plane to the gross weight of the plane
    - a. Expressed in terms of G's
    - b. Increased load factor increases stall speed
  - ii. Turns
    - a. Increased load factors are a part of all banked turns
    - b. Load factor increases rapidly after 45°-50° of bank
  - iii. Controllability
    - a. The increased load factor associated with a level turn in slow flight can quickly result in a stall
      - Use gentle, coordinated, low bank turns during slow flight to prevent a potential stall
      - Remain coordinated
        - a Right turn = more right rudder; Left turn = less right rudder (still requires right rudder)





- C. **Weight**
  - i. The heavier the aircraft, the more lift necessary to maintain altitude
    - a. As more lift is required, the angle of attack required to maintain level flight is increased
      - Brings the aircraft closer to the critical angle of attack
  - ii. Heavier aircraft is more stable – takes more force to move a heavier object than a lighter one
  - iii. The increased weight and stability can help in controlling the aircraft
- D. **Center of Gravity**
  - i. Forward Loaded Aircraft
    - a. Acts heavier, and consequently slower
      - More nose up elevator pressure is required to maintain altitude
      - Tail must produce a greater download resulting in greater wing loading
      - Added wing loading requires increased lift to maintain altitude
    - b. Higher AOA results in more induced drag and a higher stall speed (similar to heavy aircraft)
    - c. Controllability
      - More controllable than aft loaded aircraft
      - Due to the longer arm from elevator to CG



  - ii. Aft Loaded Aircraft

a. Acts lighter, and consequently faster
    - Less nose up pressure required
    - Lower nose requires less down load
    - Decreased down load reduces wing loading, decreasing lift required to maintain altitude
b. Lower AOA results in less induced drag allowing for a faster cruise speed and a lower stall speed
c. Controllability
    - Recovery from a stall becomes progressively more difficult as the CG moves aft
        a Shortens the arm from CG to the elevator

3. Slow Flight and Critical Flight Situations
A. In general, takeoffs, climbs, landings, and go-arounds
    i. Anything on the backside of the power curve and close to the ground
B. Specific examples:
    i. High sink rate during a short field landing
    ii. Climbing out of ground effect too early on a soft field takeoff

4. Slow Flight and the Senses
A. Sight: Nose high, more sky than normal, few, if any, ground references (clouds can be used)
B. Hearing: Decrease as airspeed slows, stall warning horn, engine noise as power established
C. Feel: Controls become progressively less responsive, increase in right rudder required, buffet

5. Performing Slow Flight
A. Basics
    i. Pitch for Airspeed, Power for Altitude (backside of the power curve)
    ii. Right rudder
    iii. Use visual references and instrument indications (90% outside, 10% inside)
B. Pre-Maneuver
    i. Pre-maneuver checklist; Clear the area
    ii. Select an altitude (no lower than 1,500' AGL)
    iii. Configuration
        a. Different configurations can be used to develop a feel for different situations
            - The 'dirtier' (more flaps), the slower we can get
        b. Common Error - Failure to establish specified gear and flap configuration
C. Establishing Slow Flight
    i. Gently reduce the throttle, maintaining altitude as airspeed is lost
        a. Common Error - Improper trim technique. Continually trim the aircraft
    ii. Lower flaps as airspeed limits are reached
    iii. Note the change in feel and sound
        a. Flight controls are less effective with the reduction in airspeed
        b. Sound is decreasing with airspeed
    iv. Approaching slow flight speed, gently introduce power to maintain altitude and airspeed
        a. Set the approximate pitch and power settings for your aircraft and adjust from there
        b. Maintain coordination with right rudder
    v. Common Error - Improper entry technique
D. Maneuvering During Slow Flight
    i. Pitch for airspeed
        a. If fast, pitch up; If slow, pitch down – use very small changes in pitch (1-2^{o} at a time)
        b. A change in pitch generally requires a change in power to maintain altitude
        c. Common Error – Failure to establish and maintain the specified airspeed
    ii. Power for Altitude
        a. If low, increase power; If high, decrease power

b. A change in power generally requires a change in pitch to maintain airspeed
c. Common Error – Inappropriate removal of hand from throttles

iii. Heading
  a. Maintain coordination, keep heading / coordination in crosscheck
iv. Level Turns
  a. Use smooth, controlled inputs to establish the desired bank (small bank angles)
    - Anticipate opposite aileron to maintain bank angle (counter overbanking tendencies)
  b. Adjust pitch and power to maintain altitude and airspeed
    - Additional power is often necessary; requires a change in pitch to maintain speed
  c. Keep coordinated with rudder (adverse yaw, power changes, etc.)
v. Climbing / Descending Turns
  a. Set power for the climb or descent and simultaneously adjust pitch to maintain airspeed
    - Adjust right rudder to maintain coordination
  b. Establish the desired bank as discussed above
    - Same process, but the power is higher / lower for the climb / descent
vi. Common Error - Excessive variations of altitude and heading when a constant altitude and heading are specified
vii. Common Error – Uncoordinated use of flight controls / Improper correction for torque effect

E. Returning to Cruise Flight (similar to stall recovery)
  i. Full power, lower the nose to maintain altitude (trim), clean up the flaps as airspeed increases
  ii. Approaching cruise airspeed, reduce power, maintain coordination and retrim the airplane
F. Common Error - Unintentional stalls
  i. Smooth, controlled, coordinated control movements are integral
  ii. A consistent crosscheck will help you catch deviations before they become an issue

Common Errors:
- Failure to establish specified gear and flap configuration
- Improper entry technique
- Failure to establish and maintain the specified airspeed
- Excessive variations of altitude and heading when a constant altitude and heading are specified
- Uncoordinated use of flight controls
- Improper correction for torque effect
- Improper trim technique
- Unintentional stalls
- Inappropriate removal of hand from throttles

Conclusion:
Brief review of the main points
Understanding the characteristics that affect slow flight and how to perform this maneuver is an extremely important part of a pilot's training. Slow flight develops the student's awareness of the characteristics, feel and control responses during flight at slow speed (takeoff, climb, landings and go-arounds) to maintain safe flight, and avoid unintentional stalls.

XI.B. Power-On Stalls

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), Stall and Spin Awareness Training (AC 61-67), POH/AFM

Objectives	The student should develop knowledge of stalls regarding aerodynamics, factors associated with stall speeds, as well as proper recovery techniques. The student will understand situations in which power on stalls are most common and most dangerous and will have the ability to perform a power-on stall as required in the ACS/PTS.
Key Elements	1. Critical Angle of Attack 2. A Stall Can Occur at any Airspeed, Attitude, Power Setting 3. Recovery (Reduce the Angle of Attack)
Elements	1. Aerodynamics 2. Various Factors and their Effect on Stall Speed 3. Possible Situations for a Power-On Stall 4. Entering the Maneuver 5. Recognizing the Stall 6. Recovery
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student will become familiar with the conditions that produce power-on stalls and will develop the habit of taking prompt preventative and/or corrective action when in a situation resulting in a stall.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Stalls can be intimidating and frightening but understanding how they work and practicing them will make you more comfortable with them and a much safer pilot.

Overview

Review Objectives and Elements/Key ideas

What

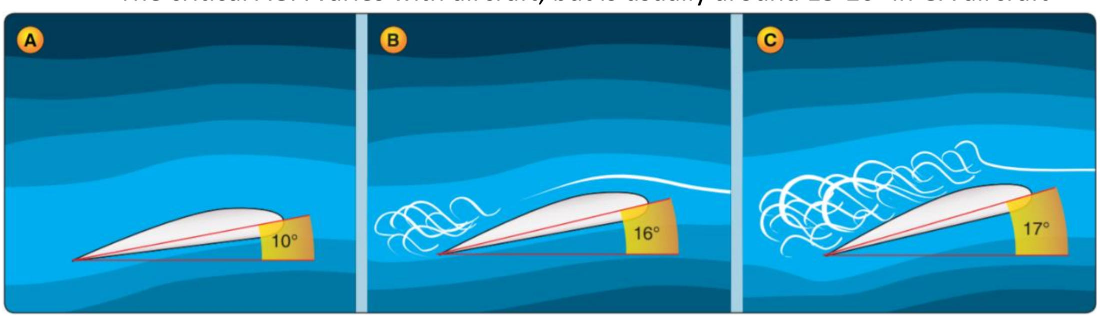
A stall occurs when the critical angle of attack is exceeded. When this happens, the smooth airflow over the wing is disrupted resulting in a loss of lift and increased drag. Power on stalls (also known as departure stalls) are practiced to simulate stalls in the takeoff and climb-out conditions and configuration.

Why

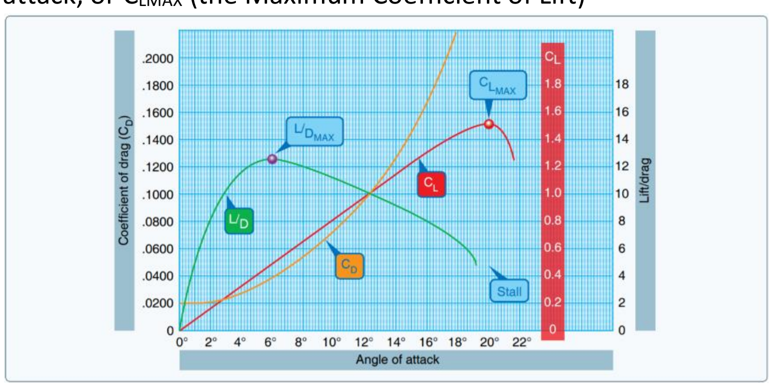
Stalls are practiced to become familiar with stall characteristics. It is important to understand how power on stalls happen, how to avoid them, and how to recover from them to avoid a potentially dangerous situation.

How:

1. **Aerodynamics**
   A. Why an Aircraft Stalls
      i. A stall occurs when the smooth airflow over the wing is disrupted and lift decreases rapidly
         a. This happens when the wing exceeds its critical angle of attack (AOA)
            - The critical AOA varies with aircraft, but is usually around 15-20° in GA aircraft



      ii. The Critical Angle of Attack/C_{LMAX}
         a. The point at which the airflow separates and there is a rapid reduction in lift is the stalling angle of attack, or the critical angle of attack, or C_{LMAX} (the Maximum Coefficient of Lift)
            - C_L = Coefficient of Lift – Measurement of lift as it relates to AOA
               a Determined by wind tunnel tests; based on airfoil design / AOA
            - Any AOA beyond C_{LMAX} results in a stall and lift drops off rapidly



   B. Stall Characteristics

- i. Most general aviation aircraft are designed to stall at the wing root and progress out to the wing tips
  - a. Aileron effectiveness is maintained at the wing tips, maintaining control
- ii. Various designs can be used to accomplish this:
  - a. Twisting the wing to create a lower angle of attack at the wing tip compared to the wing root
  - b. Adding strips to the first 20-25% of the leading edge to induce a stall earlier than otherwise

C. There's More than One Way to Exceed the Critical AOA

- i. If at *ANY* time the AOA becomes excessive, the aircraft will stall
- ii. Low Speed
  - a. As airspeed decreases, the AOA must be increased to maintain altitude
  - b. At a slow enough speed, the critical AOA is exceeded
- iii. High Speed
  - a. If an aircraft is in a high-speed dive and the pilot pulls back sharply on the elevator
    - Although the nose is raised, the aircraft continues downward for some amount of time
  - b. AOA changes from low to very high while the flight path remains the same
  - c. The aircraft reaches the critical AOA at a speed much higher than the published stall speed
- iv. Turns
  - a. The stall speed of an aircraft is higher in a level turn than in straight-and-level flight
  - b. In a turn, AOA must be increased to maintain altitude
  - c. If during the turn the AOA becomes excessive, the aircraft will stall

2. Various Factors and their Effect on Stall Speed

A. A stall can occur at any airspeed, attitude, or power setting, depending on the factors affecting the plane

B. Airspeed & Power Settings (Not part of the CFI PTS – Private and Commercial ACS Requirement)

- i. Low Speed and / or Low Power Setting (same as above)
- ii. High Speed and / or High-Power Setting (same as above)
  - a. Additionally, in low wing planes, high power settings may reduce stall speed and increase lift
    - Propeller airflow over the wing roots can provide some lift even if the wing is stalled

C. Configuration (Gear and Flaps)

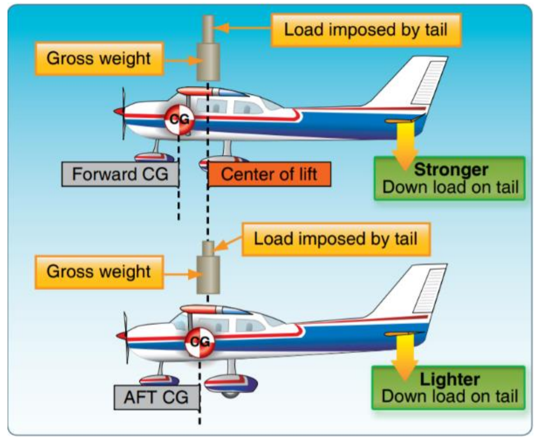
- i. Flaps - Reduce the stall speed of an aircraft
  - a. Most flaps increase the camber of the wing and change the chord line, producing more lift
  - b. Note the differing speeds on the airspeed indicator (green arc vs white arc)
- ii. Gear
  - a. The effects of gear can vary based on the aircraft design and characteristics
  - b. Gear extension increases drag and if not properly compensated for could lead to a stall

D. Weight - As the weight of the aircraft is increased, the stall speed increases

- i. The greater the weight, the greater the lift required, and therefore the higher AOA
  - a. Closer to the critical angle of attack
- ii. A lighter aircraft will stall at a slower airspeed (opposite of a heavy aircraft)

E. Center of Gravity

- i. Forward Center of Gravity (CG)
  - a. Increases stall speed (same effect as a heavier aircraft)
  - b. The farther forward the CG moves, the higher the AOA has to be to compensate for the extra load imposed by the tail (see picture)
    - Aircraft is closer to the critical AOA
  - c. More controllable due to the longer arm from CG to elevator, improving stall recovery ability

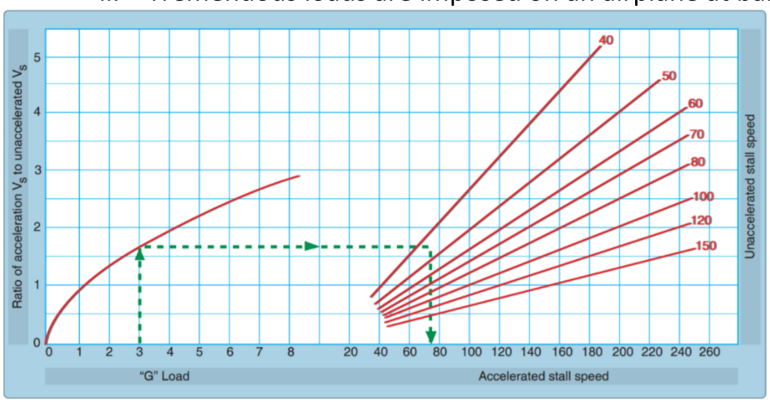


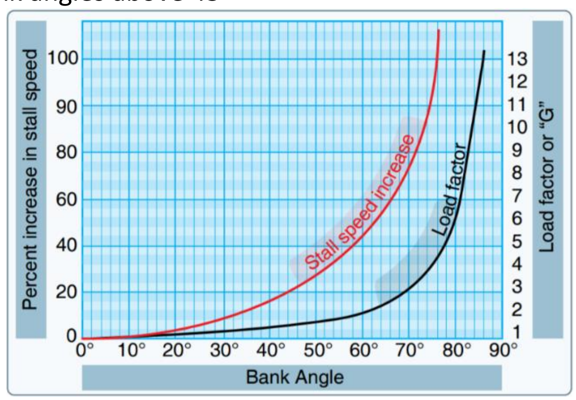
d. Additionally, the farther forward the CG, the greater the tendency for the nose to pitch down

ii. Aft CG
   a. Decreases stall speed
   b. The farther aft the CG moves, the lower the AOA needed to compensate for the tail down load
      - Aircraft is farther from the critical AOA
   c. Aircraft is less controllable due to the shorter arm from the CG to the elevator
      - Recovery from a stall becomes progressively more difficult as the CG moves aft
      - Additionally, the farther aft the CG, the less tendency the nose has to pitch down on its own

F. Load Factor
   i. Any increase in the load factor increases the stall speed
      a. Stall speed increases in proportion to the square root of the load factor
   ii. Pulling out of a steep descent, steep turns, aggressive control inputs, etc.

G. Bank Angle
   i. Increased load factors are a characteristic of all banked turns
   ii. Tremendous loads are imposed on an airplane at bank angles above 45°





H. Snow, Ice, and Frost
   i. Increase the stall speed
   ii. Disrupt smooth airflow over the wing causing the boundary layer to separate at an AOA lower than the critical AOA
      a. To make matters worse, as ice accumulates weight is increased
         - More lift is required due to the added weight, but less lift is available due to the ice
      b. As little as .8 millimeters of ice on the upper wing increases drag and reduces lift by 25%

I. Turbulence
   i. Can increase the stall speed
   ii. Sudden changes in the relative wind / aggressive control inputs can exceed the critical AOA

3. Possible Situations for an Unintentional Power-On Stall

A. High power, high pitch situations
   i. Takeoff, climb, and go arounds. Most hazardous of these situations are likely:
      a. Short field takeoff – high pitch, V_X climb – closer to the stall speed
      b. Go Around – changing configuration, pitch, power. Significant nose up trim, and distractions

4. Entering the Maneuver

A. Differences - Considerably louder and steeper than a power-off stall

B. Entry
   i. Pre-Maneuver Checklist; Clear the area
   ii. Select an altitude - Must recover prior to 1,500' AGL
   iii. Takeoff configuration (can be practiced clean as well)
   iv. Note the heading (bug the heading)
   v. Common Error - Failure to establish the specified landing gear and flap configuration prior to entry
C. Getting into the Straight-Ahead Stall
   i. Reduce power to slow to normal lift off speed while maintaining altitude
      a. Visually - Nose pitches above the horizon; use a cloud, or other high visual reference
   ii. At V_R, increase to takeoff power and maintain the specified climb attitude
      a. Common Error - Improper torque correction. Counter left turning tendencies with right rudder
      b. As speed decreases / controls lose effectiveness, increase back pressure and right rudder
      c. Visual references are primary, but back them up with the instruments
   iii. Common Error - Improper pitch, heading, yaw, bank control during straight ahead / turning stalls
   iv. Common Error - Rough and / or uncoordinated control procedure
      a. Just like in slow flight, use smooth movements to control the aircraft, nothing jerky
D. Getting into the Turning Stall
   i. Procedure
      a. Same as a straight stall, except a specific bank is maintained (15-20° - Airplane Flying Handbook)
      b. Apply power / pitch for the climb, and then establish the desired bank angle
      c. Continually adjust aileron pressure to maintain bank
         - Reduced airspeed / control effectiveness
         - Overbanking tendency requires opposite aileron
      d. Maintain coordination
         - Especially important in a turning, power on stall due to the increased chance of a spin
   ii. Common Error - Improper pitch, yaw, and bank control during turning stalls

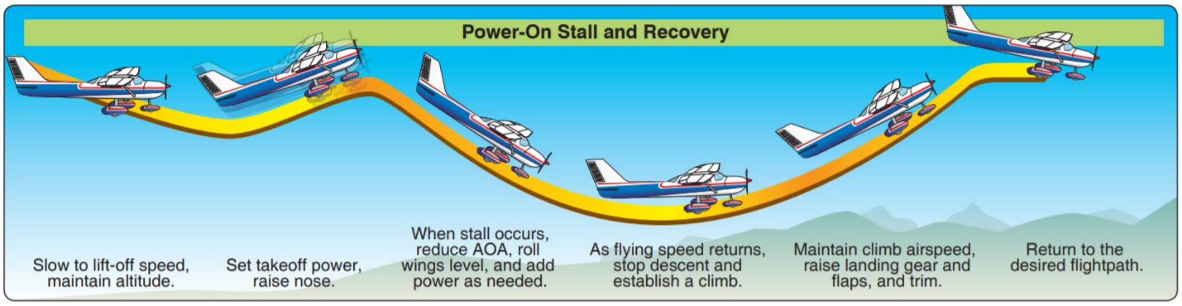
5. Recognizing the Stall

A. Announce the stages of the stall: Stall Warning Horn, Reduced Control Effectiveness, Buffet, Stall
B. Sight: Nose high attitude (especially high in a power on stall)
C. Sound: Stall warning horn, reduced RPM due to propeller load, slowing airspeed / airflow
D. Feel: Mushy / less effective controls, leaning back, buffeting and vibrations just before stall
E. Kinesthesia (sensing of movements by feel, "seat of the pants," your "spidey sense")
   i. Experience based. When properly developed you can recognize when something doesn't feel right
F. Common Error - Failure to recognize the first indications of a stall
G. Common Error - Poor stall recognition and delayed recovery
H. Common Error - Failure to achieve a stall

6. Recovery

A. Recovery - Disconnect, Pitch, Roll, Thrust, Stabilize, Configure (perform each step as appropriate)
   i. Disconnect the autopilot
   ii. Pitch nose down – Pitch attitude must be decreased immediately
   iii. Roll wings level – Regain / maintain directional control with coordinated aileron and rudder
   iv. Thrust/power as necessary – Stalls can occur at high/low power & airspeeds, adjust as required
      a. In general, in a power-on stall, verify maximum power is set
   v. Stabilize/establish the desired flight path – Establish a climb at the desired airspeed V_Y (or V_X)
   vi. Common Error – Poor stall recognition and delayed recovery
   vii. Common Error - Excessive altitude loss or excessive airspeed during recovery
   viii. Common Error - Secondary stall during recovery
      a. Once the stall is broken, do not aggressively lift the nose to reestablish a climb

b. Use smooth, controlled inputs and monitor the performance to ensure it is ready to climb



B. Ailerons and Recovery
   i. Most general aviation aircraft are designed to stall progressively outward from the wing root
      a. Aileron control is maintained at high AOAs, providing more stable stall characteristics
      b. During recovery, the return of lift begins at the tips and progresses towards the roots
         - Ailerons can be used to level the wings
   ii. If the wing is fully stalled (ailerons included), using ailerons can aggravate the stall
      a. Attempting to raise the low (stalled) wing increases its AOA, further stalling the wing

C. Rudder and Recovery
   i. Primary cause of spins is exceeding the critical AOA with improper rudder (uncoordinated flight)
   ii. Maintaining directional control / coordinated flight with rudder is vital in avoiding a spin

Common Errors:
- Failure to establish the specified landing gear and flap configuration prior to entry
- Improper pitch, heading, yaw, and bank control during straight ahead and turning stalls
- Improper pitch, yaw, and bank control during turning stalls
- Rough and/or uncoordinated use of flight controls
- Failure to recognize the first indications of a stall
- Failure to achieve a stall
- Improper torque correction
- Poor stall recognition and delayed recovery
- Excessive altitude loss or excessive airspeed during recovery
- Secondary stall during recovery

Conclusion:
Brief review of the main points
Exceeding the critical angle of attack causes a stall. A stall can occur at any airspeed, in any attitude, or ay any power setting, depending on the total number of factors affecting the particular airplane.

XI.C. Power-Off Stalls

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), Stall and Spin Awareness Training (AC 61-67), POH/AFM

Objectives	The student should develop knowledge of power-off stalls regarding aerodynamics, factors associated with stall speeds, as well as proper recovery techniques. The student will understand situations in which power off stalls are most common and most dangerous and will have the ability to perform a power-off stall as required in the ACS/PTS.
Key Elements	1. Critical Angle of Attack 2. A Stall Can Occur at any Airspeed, Attitude, Power Setting 3. Recovery (Reduce the Angle of Attack)
Elements	1. Aerodynamics 2. Various Factors and their Effect on Stall Speed 3. Possible Situations 4. Entering the Maneuver 5. Recognizing the Stall 6. Recovery
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student will become familiar with the conditions that produce power-off stalls and will develop the habit of taking prompt preventative and/or corrective action when in a power-off stall.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Stalls can be intimidating / frightening but understanding how they work and practicing them will make you more comfortable with them, and a safer pilot.

Overview

Review Objectives and Elements/Key ideas

What

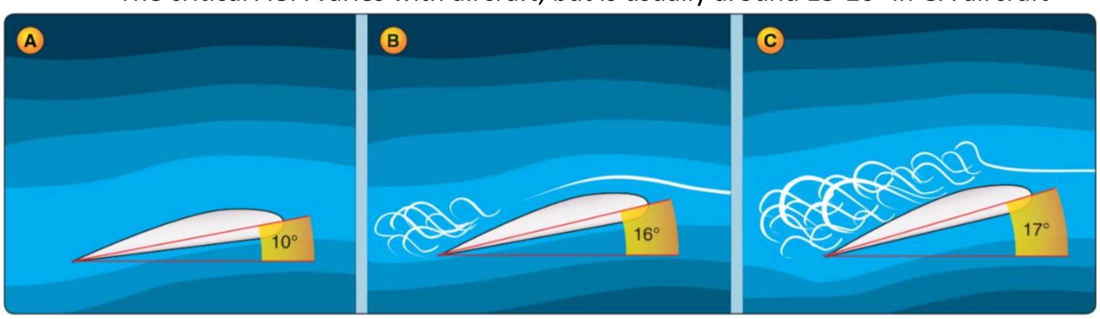
A stall occurs when the critical angle of attack is exceeded. When this happens, the smooth airflow over the wing is disrupted resulting in a loss of lift and increased drag. Power off stalls are practiced to simulate stalls in the landing and approach conditions and configuration.

Why

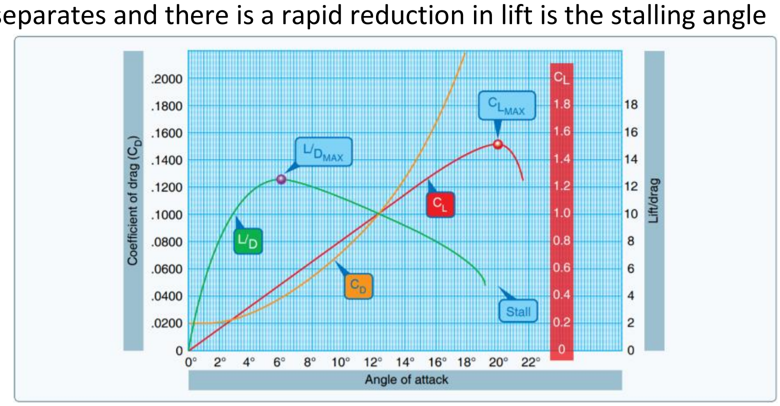
Stalls in general are practiced to become familiar with an aircraft's particular stall characteristics and to avoid putting the aircraft into a potentially dangerous situation. Power-off stalls are essential to safety in the aircraft. It is important to understand how they happen, how to avoid them, and how to recover from them.

How:

1. **Aerodynamics**
   D. Why an Aircraft Stalls
      i. A stall occurs when the smooth airflow over the wing is disrupted and lift decreases rapidly
         a. This happens when the wing exceeds its critical angle of attack (AOA)
            - The critical AOA varies with aircraft, but is usually around 15-20º in GA aircraft



      ii. The Critical Angle of Attack/C_{LMAX}
         a. The point at which the airflow separates and there is a rapid reduction in lift is the stalling angle of attack, or the critical angle of attack, or C_{LMAX} (the Maximum Coefficient of Lift)
            - C_L = Coefficient of Lift – Measurement of lift as it relates to AOA
               a Determined by wind tunnel tests; based on airfoil design / AOA



- Any AOA beyond C_{LMAX} results in a stall and lift drops off rapidly

E. Stall Characteristics
   i. Most general aviation aircraft are designed to stall at the wing root and progress out to the wing tips
      a. Aileron effectiveness is maintained at the wingtips, maintaining control
   ii. Various design can be used to accomplish this:
      a. Twisting the wing to create a lower angle of attack at the wing tip compared to the wing root
      b. Adding strips to the first 20-25% of the leading edge to induce a stall earlier than otherwise

F. There's More than One Way to Exceed the Critical AOA
   i. If at *ANY* time the AOA becomes excessive, the aircraft will stall
   ii. Low Speed
      a. As airspeed decreases, the AOA must be increased to maintain altitude
      b. At a slow enough speed, the critical AOA is exceeded
   iii. High Speed
      a. If an aircraft is in a high-speed dive and the pilot pulls back sharply on the elevator
         - Although the nose is raised, the aircraft continues downward for some amount of time
      b. AOA changes from low to very high while the flight path remains the same
      c. The aircraft reaches the critical AOA at a speed much higher than the published stall speed
   iv. Turns
      a. The stall speed of an aircraft is higher in a level turn than in straight-and-level flight
      b. In a turn, AOA must be increased to maintain altitude
      c. If during the turn the AOA becomes excessive, the aircraft will stall

2. Various Factors and their Effect on Stall Speed

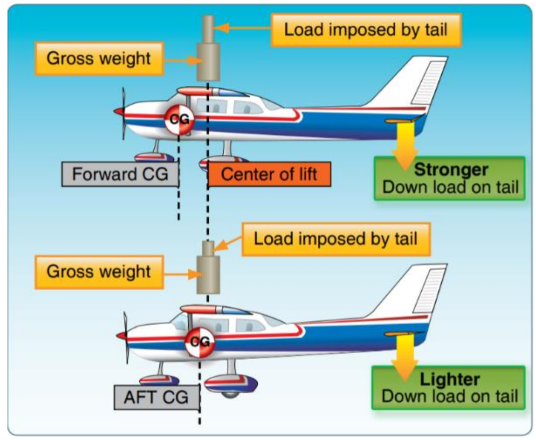
A. A stall can occur at any airspeed, attitude, or power setting, depending on the factors affecting the plane

B. Airspeed & Power Settings (Not part of the CFI PTS – Private and Commercial ACS Requirement)
   i. Low Speed and / or Low Power Setting (same as above)
   ii. High Speed and / or High-Power Setting (same as above)
      a. Additionally, in low wing planes, high power settings may reduce stall speed and increase lift
         - Propeller airflow over the wing roots can provide some lift even if the wing is stalled

C. Configuration (Gear and Flaps)
   i. Flaps - Reduce the stall speed of an aircraft
      a. Most flaps increase the camber of the wing and change the chord line, producing more lift
      b. Note the differing speeds on the airspeed indicator (green arc vs white arc)
   ii. Gear
      a. The effects of gear can vary based on the aircraft design and characteristics
      b. Gear extension increases drag and if not properly compensated for could lead to a stall

D. Weight - As the weight of the aircraft is increased, the stall speed increases
   i. The greater the weight, the greater the lift required, and therefore the higher AOA
      a. Closer to the critical angle of attack
   ii. A lighter aircraft will stall at a slower airspeed (opposite of a heavy aircraft)

E. Center of Gravity
   i. Forward Center of Gravity (CG)
      a. Increases stall speed (same effect as a heavier aircraft)
      b. The farther forward the CG moves, the higher the AOA has to be to compensate for the extra load imposed by the tail (see picture)
         - Aircraft is closer to the critical AOA
      c. More controllable due to the longer arm from CG to elevator, improving stall recovery ability



d. Additionally, the farther forward the CG, the greater the tendency for the nose to pitch down

ii. Aft CG

a. Decreases stall speed

b. The farther aft the CG moves, the lower the AOA needed to compensate for the tail down load

- Aircraft is farther from the critical AOA

c. Aircraft is less controllable due to the shorter arm from the CG to the elevator

- Recovery from a stall becomes progressively more difficult as the CG moves aft
- Additionally, the farther aft the CG, the less tendency the nose has to pitch down on its own

F. Load Factor

i. Any increase in the load factor increases the stall speed

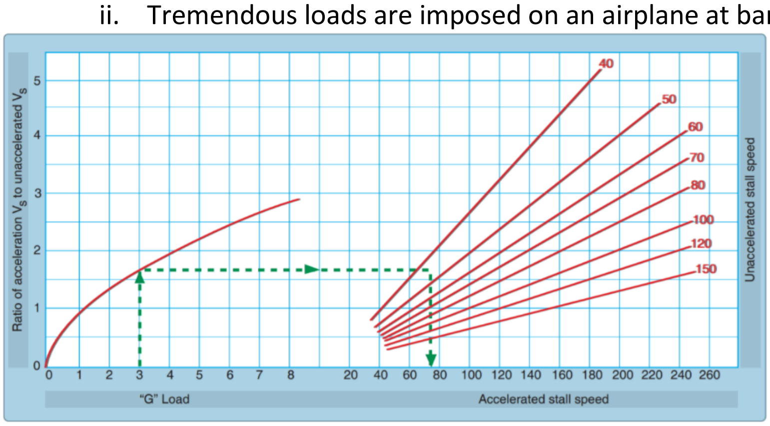
a. Stall speed increases in proportion to the square root of the load factor

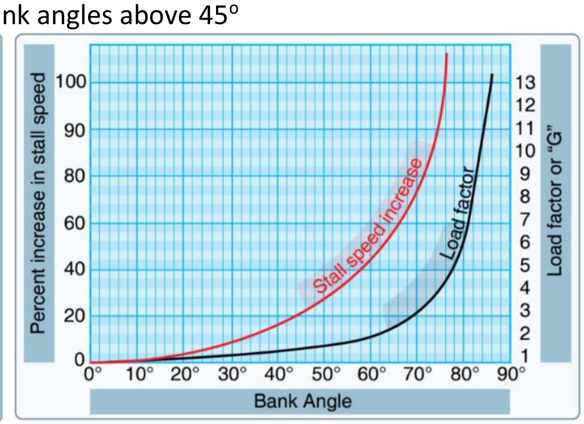
ii. Pulling out of a steep descent, steep turns, aggressive control inputs, etc.

G. Bank Angle

i. Increased load factors are a characteristic of all banked turns

ii. Tremendous loads are imposed on an airplane at bank angles above 45°





H. Snow, Ice, and Frost

i. Increase the stall speed

ii. Disrupt smooth airflow over the wing causing the boundary layer to separate at an AOA lower than the critical AOA

a. To make matters worse, as ice accumulates weight is increased

- More lift is required due to the added weight, but less lift is available due to the ice

b. As little as .8 millimeters of ice on the upper wing increases drag and reduces lift by 25%

I. Turbulence

i. Can increase the stall speed

ii. Sudden changes in the relative wind / aggressive control inputs can exceed the critical AOA

3. Possible Situations

A. Approach to landing conditions and configurations

i. Crossed-control turns from base to final

ii. Attempting to recover from a high sink rate on final approach using only an increased pitch attitude

iii. Improper airspeed control on final approach and other segments of the traffic pattern

4. Entering the Maneuver

A. Entry

i. Pre-Maneuver Checklist; Clear the area
ii. Select an altitude - Must recover prior to 1,500’ AGL
iii. Landing configuration
   a. Common Error - Failure to establish the specified configuration prior to entry
iv. Note the heading (bug the heading)

B. Getting into the Straight Stall (very similar to slow flight entry)
   i. Slow to normal approach speed while maintaining altitude
      a. Extend the flaps (landing flaps)
      b. Visually - Find a reference off the nose to maintain direction and to assist with pitch attitude
   ii. Smoothly lower the nose to the normal approach attitude and maintain approach speed
   iii. Once stable, reduce power to idle and smoothly raise the nose to an attitude that will induce a stall
      a. Simulate a flare to landing
   iv. Common Error - Improper pitch, heading, yaw, and bank control during straight-ahead stalls
   v. Common Error - Rough and/or uncoordinated use of the flight controls
      a. Just like in slow flight, use smooth movements in controlling the airplane, nothing jerky

C. Getting into the Turning Stall
   i. Same procedures as a straight-ahead stall, except a specific bank angle is maintained
      a. When the power is set and the descent established, establish the desired bank angle
      b. Aileron pressure must be continually adjusted to keep the bank constant
         - Overbanking tendency
      c. Maintain coordination
   ii. Common Error - Improper pitch, yaw, and bank control during turning stalls
      a. Increase control pressure as the aircraft slows and controls become less effective

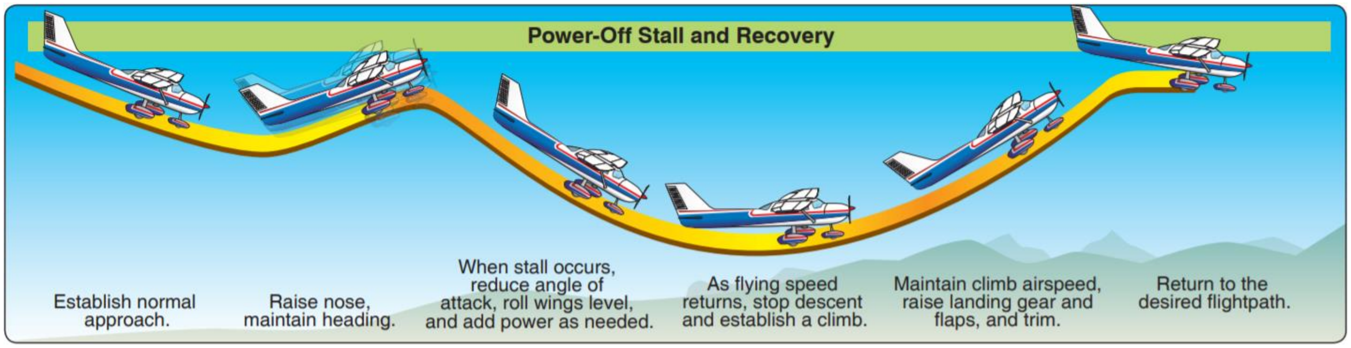
5. Recognizing the Stall

A. Announce the stages of the stall: Stall Warning Horn, Reduced Control Effectiveness, Buffet, Stall
B. Sight: Attitude of the plane
C. Sound: Stall warning horn, reduced RPM, slowing airspeed / airflow
D. Feel – Mushy / less effective controls, leaning back, buffeting and vibrations just before stall
E. Kinesthesia (sensing of movements by feel, “seat of the pants,” your “spidey sense”)
   i. Experience based. When properly developed you can recognize when something doesn’t feel right
   ii. Sinking feeling
F. Common Error - Failure to recognize the first indications of a stall
G. Common Error - Poor stall recognition and delayed recovery
H. Common Error - Failure to achieve a stall

6. Recovery

A. Basics: Disconnect, Pitch, Roll, Thrust, Stabilize, Configure (perform each step as appropriate)
   i. Disconnect the autopilot (if applicable)
   ii. Pitch nose down – AOA must be decreased positively and immediately
   iii. Roll wings level – Regain / maintain directional control with coordinated aileron and rudder
      a. Reorients the lift vector vertical for a more effective recovery and climb
      b. Do not attempt to level the wings prior to reducing angle of attack (can aggravate stall)
   v. Thrust/power as necessary - Stalls can occur at high/low power & airspeeds, adjust as required
      c. Generally, in a power-off stall, maximum allowable power should be applied
      d. Right rudder will be required to maintain coordination/heading
   iv. Stabilize/establish the desired flight path - Go around and climb at the desired airspeed V_Y (V_X)
   v. Configure – Once in a climb, configure as required (same flap and gear retraction as a go around)
   vi. Common Error – Poor stall recognition and delayed recovery
   vii. Common Error - Excessive altitude loss or excessive airspeed during recovery

viii. Common Error - Secondary stall during recovery
   a. Once the stall is broken, do not aggressively lift the nose to reestablish a climb
   b. Use smooth, controlled inputs and monitor the performance to ensure it is ready to climb



B. Ailerons and Recovery
   i. Most general aviation aircraft are designed to stall progressively outward from the wing root
      a. Aileron control is maintained at high AOAs, providing more stable stall characteristics
      b. During recovery, the return of lift begins at the tips and progresses towards the roots
         - Ailerons can be used to level the wings
   ii. If the wing is fully stalled (ailerons included), using ailerons can aggravate the stall
      a. Attempting to raise the low (stalled) wing increases its AOA, further stalling the wing
C. Rudder and Recovery
   i. Primary cause of spins is exceeding the critical AOA with improper rudder (uncoordinated flight)
   ii. Maintaining directional control / coordinated flight with rudder is vital in avoiding a spin

Common Errors:
- Failure to establish the specified configuration prior to entry
- Improper pitch, heading, yaw, and bank control during straight-ahead stalls
- Improper pitch, yaw, and bank control during turning stalls
- Rough and/or uncoordinated use of the flight controls
- Failure to recognize the first indications of a stall
- Failure to achieve a stall
- Improper torque correction
- Poor stall recognition and delayed recovery
- Excessive altitude loss or excessive airspeed during recovery
- Secondary stall during recovery

Conclusion:
Brief review of the main points
Exceeding the critical angle of attack causes a stall. A stall can occur at any airspeed, in any attitude, or ay any power setting, depending on the total number of factors affecting the particular airplane.

XI.D. Cross-Controlled Stalls

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should understand the dynamics of a cross-controlled stall and therefore be able to recognize situations which could lead to a cross-controlled stall. The student also should be able to safely and effectively demonstrate and properly recover from a cross-controlled stall.
Key Elements	1. Too much rudder can hurt us 2. Little or no warning of a stall 3. Intuitive reactions are dangerous
Elements	1. Aerodynamics of Cross-Controlled Stalls 2. Performing Cross-Controlled Stalls
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The lesson is complete when the student understands the unique requirements for a cross-controlled stall and can confidently recognize and recover from a cross-controlled situation.

Instructor Notes:

Introduction:

Attention
Interesting fact or attention-grabbing story
Situation intro below

Overview
Review Objectives and Elements/Key ideas

What
This type of stall occurs with the controls crossed - aileron pressure applied in one direction and rudder pressure in the opposite direction.

Why
It is imperative that this type of stall not occur during an actual approach to landing, since recovery may be impossible prior to ground contact due to the low altitude. During traffic pattern operations, any conditions that result in overshooting the turn from base leg to final approach, dramatically increase the possibility of an unintentional accelerated stall while the airplane is in a cross-controlled condition.

How:
Awesome, very interesting read on cross-controlled stalls from APS (Aviation Performance Solutions)

1. **Aerodynamics of a Cross-Controlled Stall**
   A. Situation
      i. 30° bank left turn to final with overshooting wind pushing you past the runway centerline
      ii. To avoid the overshoot, you add left rudder – aircraft rolls left, and the nose drops
         a. Compensate with right aileron (cross controlling the plane), and raising the nose
      iii. Still overshooting so you add more left rudder (more right aileron and back pressure to counter)
      iv. Suddenly, the aircraft rolls sharply left, inverted (or even into a spin)
      v. Instinct is to recover with more right aileron and back elevator pressure
      vi. Aircraft rolls further left and accelerates the descent to the ground
   B. Why did this happen?
      i. A cross control stall occurs when the critical AOA is exceeded with aileron pressure applied in one direction and rudder pressure in the opposite direction
      ii. Using rudder to turn requires opposite (right) aileron and back pressure to maintain bank / altitude
         a. Opposite Aileron
            - As the right wing accelerates, right aileron is necessary to maintain the bank angle
            - Right aileron increases the AOA on the left wing, and decreases it on the right
               a The inside, low wing, has a higher AOA than the outside, high wing
         b. Back Elevator Pressure (leads to the stall)
            - The nose drop, due to increasing drag, leads to increased back pressure to maintain altitude
            - Increased back pressure to maintain the same flight path leads to increased AOA
         c. Overall
            - AOA of the left, inside wing, is increased with right aileron
            - AOA of both wings is increased with the added back pressure
      iii. The Stall and the Reaction to the Stall

a. At the point of the stall, the inside wing has a higher AOA and therefore stalls first
- The plane rolls in the direction of the low wing (often inverted if not corrected quickly)

b. If you attempt to roll wings level (more right aileron), it further increases AOA on the inside wing
c. With the ground approaching rapidly, instinct is to pull up, making the stall even deeper
d. Stall + Yaw = Spin. You could very easily end up in a low altitude spin

C. The Moral of the Story
i. Stay coordinated, especially low to the ground
ii. In the case of an overshoot, or a cross controlled situation, go around and avoid the risk

2. Performing Cross-Controlled Stalls

A. Safe Altitude
i. Before demonstrating the stall, it is extremely important to be at a safe altitude
a. This is because of the extreme nose down attitude and loss of altitude that could occur
b. Plan for the worst-case scenario, a spin – 3,500’ AGL would allow for 3 rotations (at 500’ per rotation) and a recovery above 1,500’ AGL (these numbers can vary by aircraft)
ii. Single engine stalls should be recovered by 1,500’ AGL

B. Pre-Maneuver Checklist; Clear the Area

C. Set Up
i. Close the throttle
ii. Gear down (if retractable)
iii. Do not extend flaps to avoid exceeding airplane limitations
iv. Maintain altitude as the airplane slows, then establish a descent at normal glide speed
v. Common Error - Failure to establish selected configuration prior to entry

D. Performing
i. Roll into a medium-bank turn (simulate an overshooting turn to final)
ii. Apply excessive rudder in the direction of the turn and maintain 30° of bank with opposite aileron
iii. At the same time, increase back pressure to keep the nose from lowering
iv. Increase control pressures until the airplane stalls
a. Due to the sideslip / abnormal airflow, the plane may stall without warning
- Depending on stall horn location, it may or may not warn the pilot of the stall
- Due to the sideslip, the buffet may not be felt until very late (right before the stall), if at all

v. Common Error - Failure to establish a cross-controlled turn and stall condition that will adequately demonstrate the hazards of a cross-controlled stall

E. Recovery - Disconnect, Pitch, Roll, Thrust, Stabilize, Configure (perform each step as appropriate)
i. Recovery must be made before the airplane enters an abnormal attitude
ii. When the stall occurs:
a. Disconnect: Likely not applicable in this situation
b. Pitch: Apply nose down pressure to reduce AOA and eliminate the stall warning
c. Roll: Remove the excessive rudder, and level the wings
d. Thrust: Add power as necessary
e. Stabilize: Return to the desired flight path
iii. Configure: Likely not applicable, but establish the configuration required
iv. Common Error - Improper or inadequate demonstration of the recognition and recovery from a cross-controlled stall
v. Common Error - Failure to present simulated student instruction that emphasizes the hazards of a cross-controlled condition in a gliding or reduced airspeed condition

F. Spin Recovery – if the cross controlled stall develops into a spin:
i. Recovery
a. Power - Idle

b. Ailerons - Neutral
c. Rudder - Opposite
d. Elevator - Briskly forward
   - Break the stall
e. Rudder - Relaxed
f. Elevator – To recover

G. Bottom Line: Stay coordinated to avoid a cross-controlled stall!

Common Errors:
- Failure to establish selected configuration prior to entry
- Failure to establish a cross-controlled turn and stall condition that will adequately demonstrate the hazards of a cross-controlled stall
- Improper or inadequate demonstration of the recognition and recovery from a cross-controlled stall
- Failure to present simulated student instruction that emphasizes the hazards of a cross-controlled condition in a gliding or reduced airspeed condition

Conclusion:
Brief review of the main points
It is imperative that this type of stall not occur during an actual approach to landing, since recovery may be impossible due to the low altitude. During traffic pattern operations, any conditions that result in overshooting dramatically increases the possibility of an unintentional accelerated stall while the airplane is in a cross-control condition. If overshooting, do not try to correct with rudder, instead initiate a go-around and try again.

XI.E. Elevator Trim Stalls

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to elevator trim stalls and their application in executing a safe go-around. The student understands the inherent danger involved when positive control of the airplane is not maintained, especially close to the ground.
Key Elements	1. Maintain Positive Control 2. Anticipate Attitude Changes 3. Do Not Stall in a Go-Around
Elements	1. Aerodynamics 2. Possible Situations 3. The Maneuver
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to properly and safely perform a go-around procedure, correcting for any unintentional changes in airplane attitude, and without stalling the aircraft.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Applying full power with too much nose up trim (as in an approach to land) can have dire results if we don't know how to deal with it.

Overview

Review Objectives and Elements/Key ideas

What

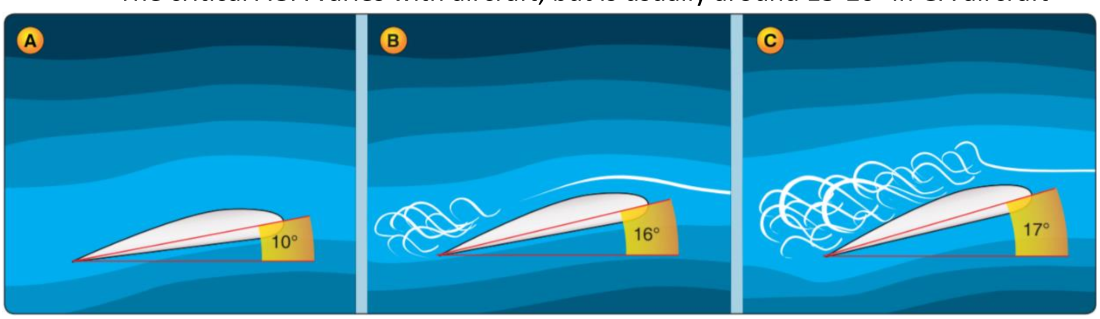
The elevator trim stall maneuver shows what can happen when full power is applied for a go around and positive control of the airplane is not maintained.

Why

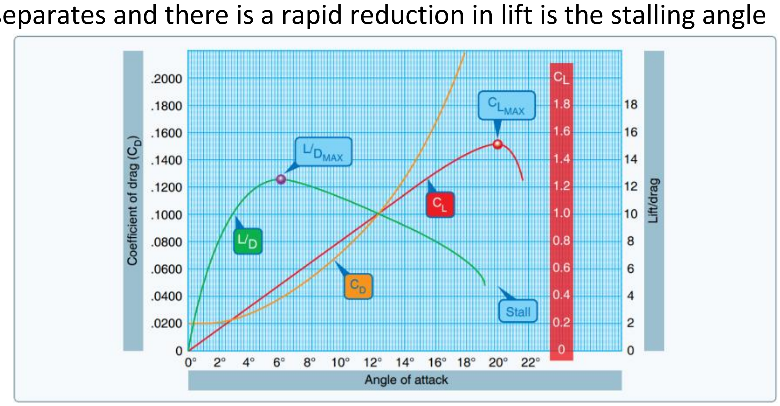
A situation like this could occur during a go-around procedure from a normal approach or immediately after takeoff. The objective is to show the importance of making smooth power applications, overcoming strong trim forces, maintaining positive control of the airplane to hold safe flight attitudes, and using proper and timely trim techniques. It is imperative that a stall not occur during an actual go-around.

How:

1. **Aerodynamics**
   - A. Why an Aircraft Stalls
     - i. A stall occurs when the smooth airflow over the wing is disrupted and lift decreases rapidly
       - a. This happens when the wing exceeds its critical angle of attack (AOA)
         - The critical AOA varies with aircraft, but is usually around 15-20º in GA aircraft



     - ii. The Critical Angle of Attack/C_{LMAX}
       - a. The point at which the airflow separates and there is a rapid reduction in lift is the stalling angle of attack, or the critical angle of attack, or C_{LMAX} (the Maximum Coefficient of Lift)
         - C_L = Coefficient of Lift – Measurement of lift as it relates to AOA
           - a Determined by wind tunnel tests; based on airfoil design / AOA



- Any AOA beyond C_{LMAX} results in a stall and lift drops off rapidly

B. Stall Characteristics
   i. Most general aviation aircraft are designed to stall at the wing root and progress out to the wing tips
      a. Aileron effectiveness is maintained at the wingtips, maintaining control
   ii. Various design can be used to accomplish this:
      a. Twisting the wing to create a lower angle of attack at the wing tip compared to the wing root
      b. Adding strips to the first 20-25% of the leading edge to induce a stall earlier than otherwise

C. Specific too the Elevator Trim Stall
   i. In the event of a go around, as maximum power is applied, the nose will rise sharply and turn left
      a. Nose high trim and increased prop wash over the tail / elevator make the nose rise sharply
      b. Torque and the left turning tendencies make the aircraft turn to the left
   ii. If uncontrolled, the excessive nose-up pitch can result in a stall
   iii. If uncorrected, the uncoordinated left turn / yaw can lead to a spin

2. Possible Situations

A. Primarily used to demonstrate a go-around without maintaining control (namely pitch and yaw)
   i. Basically, any situation where the aircraft is trimmed nose high and considerable power is added

B. Situations include:
   i. Normal landing approach followed by a go around / Simulated forced landing followed by a climb
   ii. Immediately after takeoff with the trim still set for the landing approach (nose high trim)

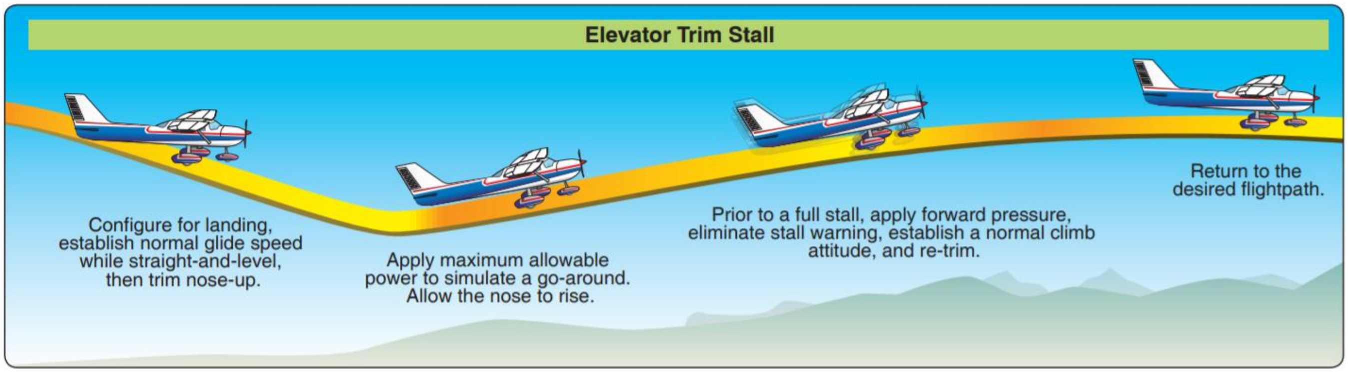
3. The Maneuver

A. Entry
   i. Pre-Maneuver
      a. Pre-Maneuver Checklist; Clear the area
      b. Select an altitude - Must be able to recover prior to 1,500' AGL
      c. Note / bug the heading
   ii. Setup
      a. Slowly retard the throttle while maintaining altitude
      b. As airspeed decreases, configure for landing (gear and landing flaps)
      c. Once configured, close the throttle and maintain altitude until approaching normal glide speed
      d. Establish a glide and trim to maintain glide speed
      e. Common Error - Failure to establish selected configuration prior to entry

B. Performing the Elevator Trim Stall
   i. Smoothly advance the power to the maximum allowable (as would be done in a go-around)
      a. The nose will rise sharply and turn to the left
         - Allow time for the student to see the hazards without compromising safety
   ii. Recognizing the stall is imminent
      a. Rapid pitch up combined with rapid loss of airspeed
      b. Stall warning horn and buffeting

C. Recovery – Disconnect, Pitch, Roll, Thrust, Stabilize, Configure (perform each step as appropriate)
   i. Disconnect the autopilot (this may be the reason for the excessive trim)
   ii. Pitch: Sufficient forward pressure must be applied to return to normal climbing attitude
   iii. Roll: Coordinated roll as necessary to establish wings level
   iv. Thrust: As required (likely max power, if it's not already there)
   v. Stabilize: Trim should be relieved and the normal go-around and level-off procedures completed
   vi. Configure: As you would for a normal go-around
   vii. If a full stall occurs, recovery will require significant nose-down pitch and altitude loss
      a. Do not allow a full stall to occur as there may not be enough altitude to recover

viii. Common Error - Improper or inadequate demonstration of the recognition of and the recovery from an elevator trim stall
ix. Common Error - Failure to present simulated student instruction that adequately emphasizes the hazards of poor correction for torque and up-elevator trim during go-around and other maneuvers



D. Additional Concerns
   i. If a full stall occurs significant nose down pitch is required which can lead to significant altitude loss
      a. It is important that a full stall not occur during an actual go-around
   ii. Often times instinct is to undo the action that caused the problem
      a. In this case, adding power created the excessively nose high, left yaw situation
      b. Although it might be somewhat helpful, taking power to idle could lead to:
         - Significant loss of airspeed while close to the ground
         - Inability to climb while close to the ground

Common Errors:
- Failure to present simulated student instruction that adequately emphasizes the hazards of poor correction for torque and up-elevator trim during go-around and other maneuvers
- Failure to establish selected configuration prior to entry
- Improper / inadequate demonstration of the recognition of and the recovery from an elevator trim stall

Conclusion:
Brief review of the main points
It is very important that a pilot understands the elevator trim stall hazard associated with go-arounds. By understanding the risk involved if positive control is not maintained, future flights will be considerably safer.

XI.F. Secondary Stalls

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), Stall and Spin Awareness Training (AC 61-67), POH/AFM

Objectives	The student should develop knowledge of the elements related to secondary stalls and the importance of an initial proper stall recovery.
Key Elements	1. Airspeed! 2. Increased Load Factor 3. More Pronounced Stall the 2nd Time
Elements	1. Aerodynamics 2. Possible Situations 3. Performing the Maneuver
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the importance of a properly performed stall recovery.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Fool me once shame on you. Fool me twice, shame on me. Stalling once isn't good. Stalling twice *really* isn't good.

Overview

Review Objectives and Elements/Key ideas

What

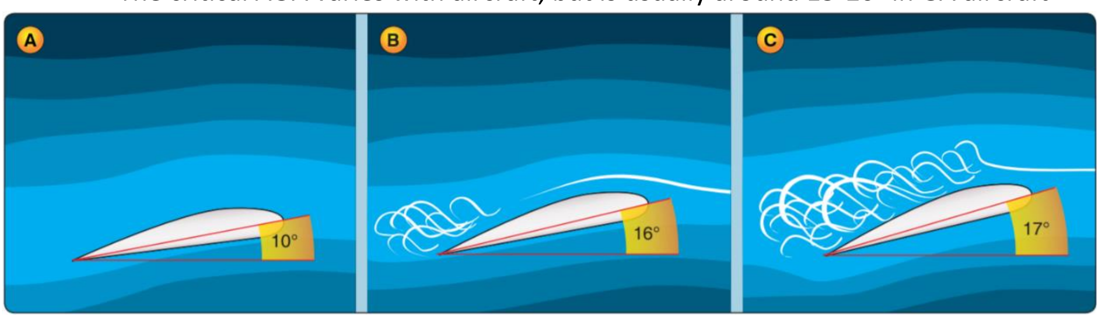
A secondary stall is a stall that occurs after a recovery from a preceding stall.

Why

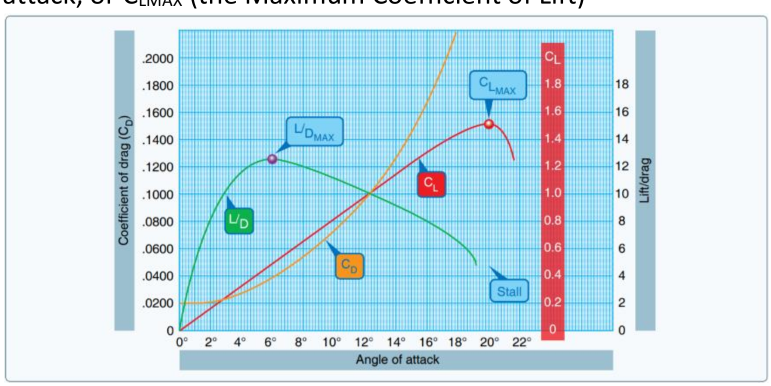
The loss of altitude associated with a single stall can be potentially hazardous. By stalling the aircraft a second time while recovering from the first stall, the altitude loss is amplified and the second stall may be more aggressive. Learning the proper stall recognition and recovery procedures and seeing/demonstrating a secondary stall will allow the pilot to safely recover the first time and not aggravate the situation.

How:

1. **Aerodynamics**
   A. Why an Aircraft Stalls
      i. A stall occurs when the smooth airflow over the wing is disrupted and lift decreases rapidly
         a. This happens when the wing exceeds its critical angle of attack (AOA)
            - The critical AOA varies with aircraft, but is usually around 15-20° in GA aircraft



      ii. The Critical Angle of Attack/C_{LMAX}
         a. The point at which the airflow separates and there is a rapid reduction in lift is the stalling angle of attack, or the critical angle of attack, or C_{LMAX} (the Maximum Coefficient of Lift)
            - Any AOA beyond C_{LMAX} results in a stall and lift drops off rapidly



   B. Stall Characteristics
      i. Most general aviation aircraft are designed to stall at the wing root and progress out to the wing tips
         a. Aileron effectiveness is maintained at the wingtips, maintaining control

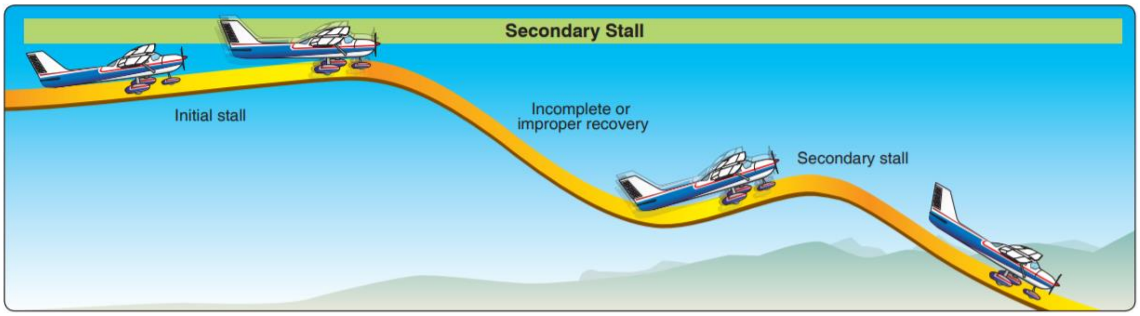
        ii. Various design can be used to accomplish this:
            a. Twisting the wing to create a lower angle of attack at the wing tip compared to the wing root
            b. Adding strips to the first 20-25% of the leading edge to induce a stall earlier than otherwise
    C. Specific to a Secondary Stall
        i. Causes: Aggressive recovery, recovery with only power, recovering before breaking the stall
        i. Secondary stall is often deeper / more aggressive than the first
        ii. Hazards Associated with a Secondary Stall
            a. Prolonged Recovery – Takes longer to recover from 2 stalls than 1 (hazardous near the ground)
                - Startle Factor – can lead to even longer recovery delays
            b. Additional loads on the aircraft due to aggressive control inputs
            c. Spin / Loss of Control – Deeper, unexpected stall means a greater chance of loss of control / spin

2. Possible Situations

    A. Stall recovery close to the ground – To avoid the ground, the pilot may try to raise the nose too early
    B. Unexpected stall scaring the pilot – Can lead to abrupt, overaggressive control movements
    C. Attempting to recover using power only – Pitch must be used to recover, the AOA must be reduced

3. Performing the Maneuver

    A. Pre-Maneuver
        i. Pre-maneuver checklist; Clear the area
        ii. Select a safe altitude – Recover no lower than 1,500’ AGL
        iii. Setup and configure for a power on or power off stall, as required
        iv. Common Error - Failure to establish selected configuration prior to entry
    B. Stall
        i. Initial Stall: Once configured, perform the initial stall (normal power on, or power off stall)
        ii. Secondary Stall: Reaching the first stall, reduce AOA, then abruptly pull back on the controls
            a. Do not exceed V_A
    C. The Secondary Stall
        i. Similar to a normal stall, but more aggressive / pronounced
            a. Stall warning horn will sound again, and buffeting rapidly returns
            b. Excessive back pressure / Controls are “mushy,” loss of control effectiveness
            c. Nose down pitch, high sink rate
            d. Yaw (depending on the stall characteristics, power on or power off stall, coordination)
    D. Recovery – Disconnect, Pitch, Roll, Thrust, Stabilize, Configure (perform each step as appropriate)
        i. Disconnect: Autopilot is likely already disconnected
        ii. Pitch: Apply nose down elevator pressure to reduce AOA and break the second stall
            a. Because the stall is more aggressive, greater nose down pitch may be required to break it
        iii. Roll: Coordinated roll to return to wings level
        iv. Thrust: Apply maximum power and maintain coordination with right rudder
        v. Stabilize: With sufficient airspeed, return to straight-and-level or establish a climb at (V_X or V_Y)
        vi. Configure: Once stabilized, establish the desired configuration based on the phase of flight
        vii. Common Error - Improper or inadequate demonstration of the recognition of and recovery from a secondary stall



Common Errors:

- Failure to establish selected configuration prior to entry
- Improper or inadequate demonstration of the recognition of and recovery from a secondary stall
- Failure to present simulated student instruction that adequately emphasizes the hazards of poor procedure in recovering from a primary stall

Conclusion:

Brief review of the main points

Properly recover from the stall the first time. The second stall likely will be more aggressive / pronounced.

XI.G. Spins

References: 14 CFR Part 23, Type Certificate Data Sheet; Stall and Spin Awareness Training (AC 61-67), Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to spins. The student will learn how to recognize a spin and the proper recovery techniques.
Key Elements	1. Stall + Yaw = Spin 2. Brisk and Positive Recovery 3. Ensure Spins are Approved
Elements	1. Spins and Anxiety 2. Aerodynamics of a Spin 3. Relationship of Various Factors to Spins 4. Not all Aircraft are Approved for Spins 5. Possible Spin Situations 6. Recognizing Potential Spins 7. Spin Procedures
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the factors involved in creating and maintaining a spin and knows the process to recover from a spin.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Who WANTS to do a spin? Most people are scared of them, but understanding them will help in avoiding them and remove some of the fear.

Overview

Review Objectives and Elements/Key ideas

What

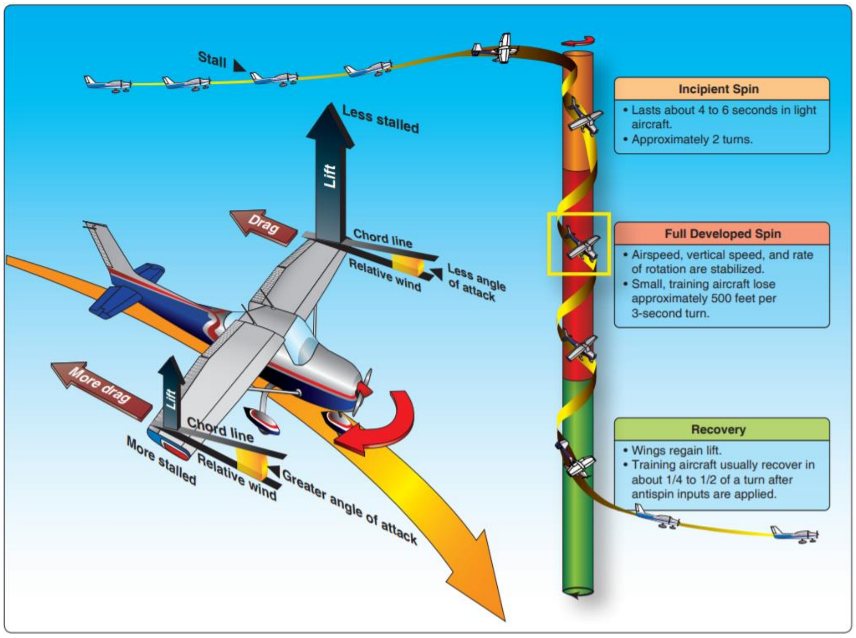
A spin is an aggravated stall that results in what is termed "autorotation," wherein the airplane follows a downward corkscrew path.

Why

Without an understanding of spins and the proper procedures to recover from them the pilot could be put in an impossible situation. Understanding spins, and their recovery procedures will also increase confidence and reduce the anxiety associated with spins.

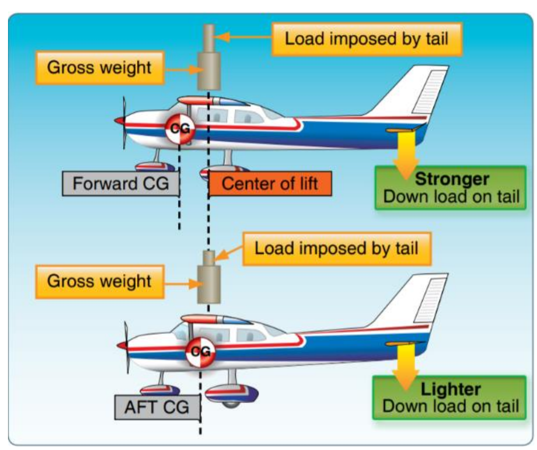
How:

1. **Spins and Anxiety**
    - A. A common perception to those unfamiliar with aviation is that a spin is a death sentence
    - B. Knowledge and training can remove the anxiety and make you a far safer and competent pilot
        - i. You're trained to avoid a stall, and if you do stall, you're trained to recover safely, preventing a spin
        - ii. In the unlikely case you stall and spin, you'll also be trained to recover from a spin
2. **Aerodynamics of a Spin**
    - A. Requirements for a Spin: Stall + Yaw
    - B. Basically, the inboard, lower wing is more stalled than the outboard wing, which creates an autorotation, or rolling, yawing, and pitching motion around the vertical axis of the aircraft
    - C. More specifically…
        - i. When the aircraft stalls, one wing drops (the wing will drop in the direction of the yaw)
            - a. Although both wings are stalled…
                - The wing that drops has an increasing AOA (more stalled) – decreased lift / increased drag
                - And, the rising wing has a decreasing AOA (less stalled) – increased lift / decreased drag
        - ii. The autorotation results from the unequal angle of attack on the airplane's wings
            - a. The difference in lift results in the rolling action and the drag difference results in the yawing
        - iii. Load factor during a spin varies with aircraft, but is usually slightly above 1G. Two reasons for this:
            - a. Airspeed in a spin is very low, usually within 2 knots of the unaccelerated stall speed
            - b. An aircraft pivots, rather than turns, while it is in a spin



D. 4 Phases of a Spin
   i. Entry Phase – Elements for a spin are provided (stall + yaw)
   ii. Incipient Phase – From start of the stall / rotation to the time the spin has fully developed
      a. 2 - 4 turns for most aircraft; Aerodynamic / inertial forces have not balanced
      b. Airspeed generally stabilizes at a low and constant airspeed
      c. Airplane in the turn indicator will indicate the direction of the spin
   iii. Developed Phase – Rotation, airspeed, and vertical speed are stabilized in a nearly vertical flightpath
      a. Spin is in equilibrium – attitude, angles, self-sustaining motions are constant, or nearly so
   iv. Recovery Phase – Rotation ceases and AOA is decreased below the critical AOA

3. **Relationship of Various Factors to Spins** (very similar to stall lessons)
   A. Configuration
      i. Flaps –generally increase the lifting ability of the wings and therefore decrease stall speed
      ii. Gear – the effects of gear can vary based on the aircraft design and characteristics
   B. Weight
      i. Heavier plane = higher stall speed (more lift / higher AOA to maintain altitude)
      ii. Lighter plane = lower stall speed (opposite of above)
   C. Center of Gravity (CG)
      i. Forward CG
         a. Increases stall speed (same as a heavier aircraft)
         b. The farther forward the CG, the higher the AOA to compensate for the extra load imposed by the tail
         c. More controllable due to the longer arm from CG to elevator, improving stall recovery ability
         d. Additionally, the farther forward the CG, the greater the tendency for the nose to pitch down
      ii. Aft CG
         a. Decreases stall speed (same as lighter aircraft)
         b. The farther aft the CG moves, the lower the AOA needed to compensate for the tail down load



        c. Aircraft is less controllable due to the shorter arm from the CG to the elevator
            - Stall recovery becomes progressively more difficult as CG moves aft
            - Additionally, the farther aft the CG, the less tendency the nose has to pitch down on its own
    D. Coordination – Maintaining coordination is key to preventing spins
        i. Uncoordinated flight is what results in a spin (Stall + Yaw = Spin)

4. Not all Aircraft are Approved for Spins
    A. DO NOT intentionally spin an aircraft that is not authorized for spins
    B. To determine if spins are approved, check:
        i. Airworthiness Category, Type Certificate and Data Sheets, AFM/POH – Limitations section
        ii. Placard in the airplane stating, "No acrobatic maneuvers including spins approved"
    C. In the case spins are approved, also check:
        i. Weight and Balance limitations, as well as recommended entry and recovery procedures
        ii. Even minor weight and balance changes can affect spin recovery characteristics
        iii. Utility category plane approved for spins but loaded for the normal category may not be recoverable
    D. Common Error - Hazards of attempting to spin an airplane not approved for spins

5. Possible Spin Situations
    A. Any situation in which you have both a stall and yaw
    B. Uncoordinated Go-around / Short field takeoff – High pitch attitude, high power, low airspeed situations
    C. Turn from base to final – Cross controlled to avoid overshooting the runway without excessive bank
    D. Sloppy stall recovery

6. Recognizing Potential Spins
    A. Understand what causes a spin, and be aware of situations where spins are likely to occur
    B. Continued stall / spin practice makes the pilot more competent in recognizing / avoiding potential spins
    C. Common Error - Failure to recognize the indications of an imminent, unintentional spin

7. Spin Procedures
    A. Preflight – Special emphasis on loose items that may affect weight, CG, and controllability of the plane
    B. Pre-Maneuver
        i. Pre-maneuver checklist; Clear the Area
        ii. Altitude – Recovery must be completed at or above 1,500' AGL
            a. 3,500' AGL is a good minimum altitude, assuming 500' is lost per turn (varies with aircraft)
        iii. Common Error - Failure to establish proper configuration prior to spin entry
    C. Maneuver
        i. Entry Phase
            a. Procedure (similar to a power off stall)
                - Reduce power to idle while raising the nose to a stalling pitch attitude
                    a Common Error - Failure to close throttle when a spin entry is achieved
                - Approaching stall, apply full rudder in the direction of desired spin with full back pressure
                - Keep ailerons neutral
            b. Maintaining a Stabilized Spin – Keep full back pressure / rudder, with neutral ailerons
                - Common Error - Failure to achieve and maintain a full stall during spin entry
            c. Maintaining Orientation During a Spin
                - Select an outside reference point and use the turn coordinator
                    a Turn coordinator deflects in the direction of the spin and is reliable
                    b Gyroscopic Instruments may tumble and be misleading (heading / attitude indicator)
                - Common Error - Disorientation during a spin
        ii. Incipient Phase – The aerodynamic and inertial forces have not reached a balance
            a. Airspeed is near / below stall speed and the turn coordinator indicates direction of the spin

iii. Developed Phase – Aerodynamic forces and inertial forces are in balance, the spin is in equilibrium
   a. Note: Some planes will transition from the incipient phase to a spiral dive (no developed phase)
      - Airplane will be accelerating and as a result G load can rapidly increase
      - In a spin, the airspeed does not accelerate
   b. Common Error - Failure to distinguish between a high-speed spiral and a spin

iv. Recovery Phase (PARE – Power, Ailerons, Rudder, Elevator) – Can last ¼ of a turn to several turns
   a. General procedures (follow manufacturer's procedures, if published):
   b. Step 1 – POWER IDLE
      - Power aggravates spin characteristics, resulting in a flatter spin and increased rotation
   c. Step 2 – AILERONS NEUTRAL
      - Aileron in the direction of spin can speed rotation, steepen spin attitude, delay recovery
      - Opposite direction: flattens spin attitude delaying recovery, or making recovery impossible
   d. Step 3 – RUDDER OPPOSITE THE ROTATION
      - Briskly apply and hold FULL rudder opposite the direction of rotation until rotation stops
   e. Step 4 - ELEVATOR FORWARD
      - To break the stall, apply a positive / brisk, straight forward movement of the elevator
         a Apply immediately after full rudder application. Do not wait for the rotation to stop
         b Hold the controls firmly in this position (decreases AOA, breaks stall)
            1. If airspeed is increasing, the airplane is no longer in a spin
   f. Step 5 – RUDDER NEUTRAL (after rotation stops)
      - If not neutral, increased airspeed will cause a yawing or skidding effect
      - Also, if the stall is not broken a spin can quickly start in the direction of the rudder pressure
   g. Step 6 – ELEVATOR BACK PRESSURE
      - Once broken, raise the nose to level flight. Avoid secondary stall / exceeding load limits
      - Common Error - Excessive speed or accelerated stall during recovery
   h. Common Error - Improper use of flight controls during spin entry, rotation, or recovery
   i. Common Error - Failure to recover with minimum loss of altitude

Common Errors:
- Failure to establish proper configuration prior to spin entry
- Failure to achieve and maintain a full stall during spin entry
- Failure to close throttle when a spin entry is achieved
- Failure to recognize the indications of an imminent, unintentional spin
- Improper use of flight controls during spin entry, rotation, or recovery
- Disorientation during a spin
- Failure to distinguish between a high-speed spiral and a spin
- Excessive speed or accelerated stall during recovery
- Failure to recover with minimum loss of altitude
- Hazards of attempting to spin an airplane not approved for spins

Conclusion:
Brief review of the main points
Spins can be dangerous, especially when close to the ground. Understanding the reasons for a spin and how to prevent them is extremely important. As long as coordination is maintained during a stall, a spin will not occur. Once in a spin, recovery is accomplished by PARE - Power idle, Ailerons neutral, Rudder opposite, and Elevator forward. The recovery should be performed with brisk, positive pressure.

XI.H. Accelerated Maneuver Stalls

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to accelerated stalls and develop the ability to recognize such stalls immediately, with the capability to take prompt, effective recovery action.
Key Elements	1. Excessive Maneuvering Loads 2. Unusual Stall Attitudes 3. Normal Recovery
Elements	1. Aerodynamics of an Accelerated Maneuver Stall 2. When Could an Accelerated Stall Occur? 3. The Maneuver
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands situations in which an accelerated stall is possible and has the ability to recognize and effectively recover from the stall.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Stalling during a steep turn, or in a level, possibly even nose low attitude? Didn't think that could happen?

Overview

Review Objectives and Elements/Key ideas

What

Stalls entered from flight situations that impose excessive maneuvering loads on the airplane. Situations such as steeps turns, pull-ups, or other abrupt changes in flightpath.

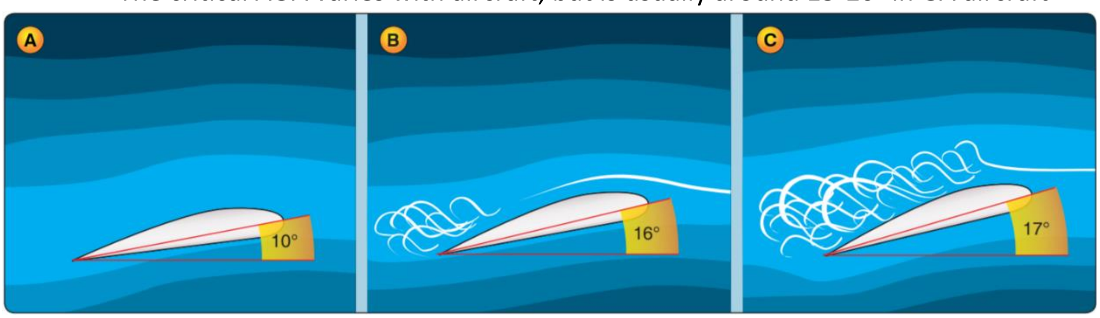
Why

The airplane doesn't have to be going slow to stall. Accelerated maneuver stalls demonstrate this principle and the recovery procedures. Stalls which result from abrupt maneuvers tend to be more rapid, or severe, than the unaccelerated stalls, and because they occur at higher-than-normal airspeeds, and may occur at lower than anticipated pitch attitudes, they may be unexpected.

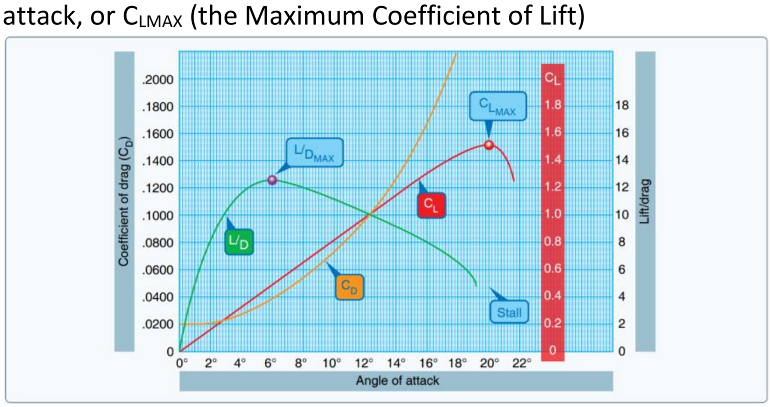
How:

1. Aerodynamics of an Accelerated Maneuver Stall

A. Why an Aircraft Stalls
  i. A stall occurs when the smooth airflow over the wing is disrupted and lift decreases rapidly
    a. This happens when the wing exceeds its critical angle of attack (AOA)
      - The critical AOA varies with aircraft, but is usually around 15-20° in GA aircraft



  ii. The Critical Angle of Attack/C_{LMAX}
    a. The point at which the airflow separates and there is a rapid reduction in lift is the stalling angle of attack, or the critical angle of attack, or C_{LMAX} (the Maximum Coefficient of Lift)
      - Any AOA beyond C_{LMAX} results in a stall and lift drops off rapidly



C. What is an Accelerated Stall?
  i. A plane will stall at speeds above the published stall speed when subject to load factors above 1G
    a. Turning, pulling up, abrupt changes to the flight path

ii. Stalls encountered anytime the load factor exceeds 1G are Accelerated Maneuver Stalls

D. Load Factor and Stall Speed

i. Load factor: Ratio of the total load acting on the plane to the gross weight of the plane (G's)

ii. Any increase in the load factor increases the stall speed

a. Stall speed increases in proportion to the square root of the load factor

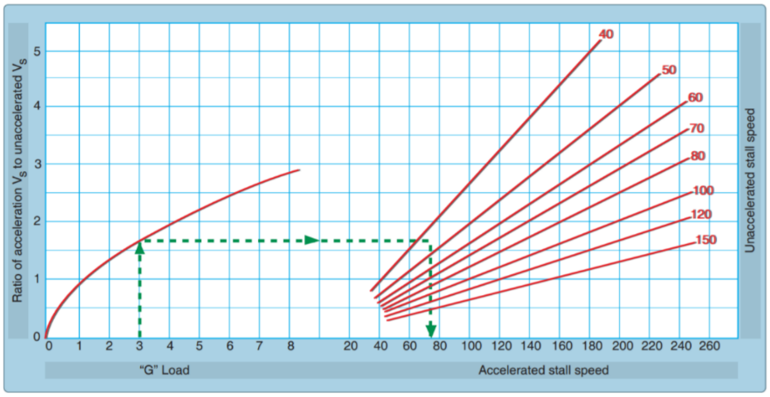
iii. Pulling out of a steep descent, steep turns, aggressive control inputs, etc.

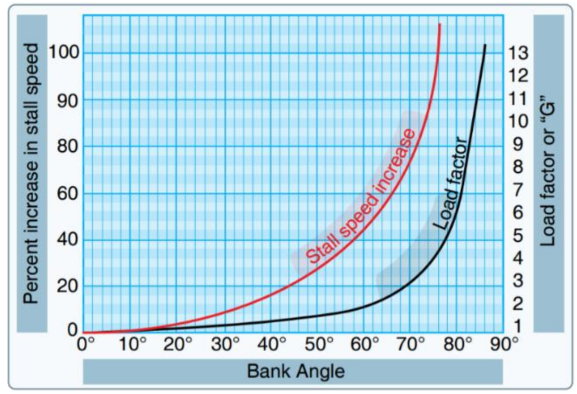
E. Bank Angle

i. Increased load factors are a characteristic of all banked turns

a. The wings must produce additional lift to maintain altitude (increased load factor)

ii. Tremendous loads are imposed on an airplane at bank angles above 45°





iii. Aggressive Pull ups and Load Factor

a. Can greatly increase G loading and quickly exceed the critical AOA

b. If an aircraft is in a high-speed dive and the pilot pulls back sharply on the elevator

- Although the nose is raised, the aircraft continues downward for some amount of time

c. AOA changes from low to very high while the flight path remains the same

d. The aircraft reaches the critical AOA at a speed much higher than the published stall speed

C. Hazards of Accelerated Stalls

i. Significant load factor increases can be imposed when pulling out of steep dives or in steep turns

a. Can result in structural damage at high airspeeds

b. Stay below V_A

ii. Tend to occur at relatively high airspeeds and to be more aggressive due to the higher airspeeds

a. The aggressive stall, higher stall speed, and low pitch attitude can catch a pilot off guard

b. A prolonged accelerated stall may result in a spin or departure from controlled flight

2. When Could an Accelerated Stall Occur?

A. Steep turns; Stall and spin recoveries (especially when close to the ground); Steep, aggressive pull ups, or other abrupt changes in the aircraft's flightpath

3. The Maneuver

A. Pre-Maneuver

i. Pre-maneuver checklist; Clear the area

ii. Select a safe altitude (recover no lower than 3,000' AGL)

iii. Configure as required

a. Never perform accelerated stalls with flaps extended due to lower design G-load limitations

iv. Common Error - Failure to establish selected configuration prior to entry

B. Performing

i. Establish the desired flight attitude

a. At or Below V_A

- The airplane will stall before the limit load factor can be exceeded

b. Roll into 45° of bank and smoothly increase back pressure
    - Above V_A, roll into a 45° bank and after the airspeed reaches V_A, increase back pressure

ii. Smoothly, firmly, and progressively increase AOA until a stall occurs (never above V_A)
    a. Increases wing loading, decreases airspeed, the centrifugal force will push the pilot into the seat

C. Recognizing the Stall
    i. Buffet, stall warning horn will indicate an impending stall
        a. The normal nose high attitude and reduction in noise as the aircraft slows does not occur
    ii. Same stall as straight-and-level flight, except buffet is sharper, and pitching / rolling is more sudden
        a. If coordinated - Both wings stall simultaneously, just like straight and level
        b. If slipping - Tends to roll rapidly toward the outside of the turn (outside wing stalls 1st)
        c. If skidding - Tends to roll rapidly toward the inside of the turn (inside wing stalls 1st)
    iii. High or increasing descent rate
    iv. Common Error - Improper or inadequate demonstration of the recognition and recovery

D. Recovery - Disconnect, Pitch, Roll, Thrust, Stabilize, Configure (perform each step as appropriate)
    i. Disconnect: Autopilot is likely already disconnected
    ii. Pitch: Release elevator pressure to reduce the AOA and eliminate the stall warning
    iii. Roll: Use coordinated aileron and rudder pressure to level the wings
    iv. Thrust: Adjust power as necessary (power may even have to be reduced)
    v. Stabilize: Return to the desired flight path
    vi. Configure: Likely no changes applicable, but establish the desired configuration
    vii. Common Error - Improper or inadequate demonstration of the recognition and recovery
    viii. Common Error - Failure to present simulated student instruction that adequately emphasizes the hazards of poor procedure in recovering from an accelerated stall

Common Errors:
- Failure to establish selected configuration prior to entry
- Improper or inadequate demonstration of the recognition and recovery
- Failure to present simulated student instruction that adequately emphasizes the hazards of poor procedure in recovering from an accelerated stall

Conclusion:
Brief review of the main points
It is important that the pilot be able to determine the stall characteristics of the airplane being flown and develop the ability to instinctively recover at the onset of a stall at other than normal stall speeds or flight attitudes.

BASIC INSTRUMENT MANEUVERS

XII.A-D. Basic Attitude Instrument Flight

References: Airplane Flying Handbook (FAA-H-8083-3), Instrument Flying Handbook (FAA-8083-15)

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

Instructor Notes:

Introduction:

Note: Basic Instrument Maneuver Lessons A-D are often taught together, and therefore have been combined into a single lesson.

Attention

Interesting fact or attention-grabbing story

As you're flying you can see that the weather ahead looks like it might be getting worse. You think you can 'scud run' the rest of the way but, lo and behold, you unexpectedly enter a cloud and need to get out safely.

Overview

Review Objectives and Elements/Key ideas

What

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

Why

In the instance that you mistakenly fly into adverse weather it is important to be comfortable flying without visual references.

How:

1. **Control and Performance**
   - A. Pitch + Power = Performance
   - B. 3 categories of instruments:
     - i. Control - Display immediate attitude and power indications and permit precise adjustments
       - a. Control is determined by reference to the attitude indicator and power indicators
       - b. Control covers the Pitch + Power portion of the equation
     - ii. Performance - Indicate the aircraft's actual performance
       - a. Altimeter, airspeed indicator, VSI, heading indicator, and turn coordinator
     - iii. Navigation - Indicate the position in relation to a selected navigation facility or fix
       - a. Determined by course / range indicators, glide-slope indicators, and bearing pointers
2. **Procedural Steps**
   - A. *Establish* - an attitude and power setting on the control instruments to obtain desired performance
   - B. *Trim* - until control pressures are neutralized
   - C. *Crosscheck* - the performance instruments to determine if the desired performance is being obtained
   - D. *Adjust* - the attitude or power setting on the control instruments as necessary, trim and repeat
3. **Establish**
   - A. Control instruments are used to set the pitch / bank attitude and power setting
     - i. Pitch (and bank) control is accomplished with the attitude indicator
     - ii. Power control is accomplished with the throttle
   - B. Set known / approximate pitch and power settings for the desired performance
   - C. Pitch Control
     - i. Changes are made by changing the pitch attitude by precise amounts in relation to the horizon
       - a. Measured in degrees or bar widths
   - D. Bank Control
     - i. Changes are made by changing the bank attitude by precise amounts in relation to the bank scale
   - E. Power Control

i. Made by throttle adjustments and reference to the power indicators
   a. Make changes with the throttle and then crosscheck the engine indicators
   b. Don't fixate on the engine indicators while setting the power

F. Common Error – Improper control applications

4. Trim

A. Trim for hands off flight. Don't fly with trim; set pitch / power and trim the control pressures away

B. Common Error – Faulty Trim Procedure

5. Crosscheck

A. The continuous / logical observation of instruments for attitude and performance information

B. Select Radial Crosscheck (most popular method – great for analog and digital displays)
   i. Commonly referred to as the Hub and Spoke method (based off the attitude indicator)
      a. Attitude indicator is the hub / primary reference, performance instruments are the spokes
      b. Move from the hub out to a spoke, back to the hub and repeat to another spoke, etc.

C. Crosscheck and Bank
   i. Establish, then check the heading indicator and turn coordinator for desired performance

D. Crosscheck and Pitch
   i. Establish, then check the altimeter, VSI, and airspeed indicator for desired performance

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

F. Instrument Interpretation
   i. For the crosscheck to be effective, you must understand the information being received
   ii. Understand each instrument's operation and the application of that knowledge to performance
   iii. Common Error – Improper instrument interpretation

6. Adjust

A. Make the necessary adjustments on the attitude indicator, then repeat the process again
   i. The amount of deviation from the desired performance will determine the magnitude of correction
      a. Restrict the attitude indicator's pitch displacement to 1 bar or ½ bar width up or down
      b. Use a bank angle that approximates the degrees to turn, not to exceed 30°
   ii. Smooth, small adjustments lead to smooth, steady control

B. Common Error – Failure to establish proper pitch, bank, and power adjustments during altitude, bank, and airspeed corrections

7. Straight-and-Level Flight

Pitch + Power = Desired Performance
Nose on Horizon + Cruise Power = Straight and Level

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

A. Establish - Establish wings level / nose on the horizon on the attitude indicator; adjust power for cruise

B. Trim - Trim to relieve the control pressures
C. Crosscheck – Monitor the instruments for any performance deviations from straight-and-level flight
D. Adjust – Re-establish pitch and / or power to correct for deviations, trim, and repeat

8. Constant Airspeed Climbs

Pitch + Power = Desired Performance
10° Nose Up + Full Power = Constant Airspeed Climb

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

A. Establish - Raise the nose to the approximate pitch attitude for the desired climb speed
  i. As the airspeed approaches the climb speed, set the power to the climb setting (full)
B. Trim -Trim to relieve the control pressures
C. Crosscheck – Monitor the instruments for any performance deviations from the climb
D. Adjust - Re-establish pitch and / or power to correct for deviations, trim, and repeat
  i. Adjust pitch to maintain the desired climb airspeed (1 bar or ½ bar width movements)
E. Level Off
  i. Lead the altitude by 10% of the vertical speed (Ex: 500 fpm climb is led by 50')
    a. Establish - Reduce power, apply elevator pressure toward level flight on the attitude indicator
    b. Crosscheck - VSI, Altimeter and attitude indicator should show level flight
    c. Trim the airplane, maintain straight-and-level flight, and continue to repeat the process
F. Turning Climbs
  i. Apply the climb procedures above, and establish the desired bank angle on the attitude indicator
  ii. Monitor turn performance on the heading indicator and turn coordinator
  iii. Small adjustments to pitch and power may be necessary to maintain airspeed in the turn
  iv. The instrument crosscheck will have to be accelerated as there is more information to take in
G. Common Error – Improper entry or level-off procedure
  i. The four-step process works for any change in flight attitude - Establish, trim, crosscheck, adjust

9. Constant Airspeed Descents

Pitch + Power = Desired Performance
3° Nose Down + Descent Power = Constant Airspeed Descent

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

A. Establish - Reduce power for the descent and maintain straight-and-level flight as airspeed decreases
  i. Approaching descent speed, lower the nose with the attitude indicator to maintain descent speed
B. Trim - Trim to relieve the control pressures
C. Crosscheck – Monitor the instruments for any performance deviations from the desired descent
D. Adjust – Re-establish pitch and / or power to correct for deviations, trim, and repeat
  i. Adjust the pitch attitude to maintain the desired climb airspeed
E. Level Off
  i. Lead the altitude by 10% of the vertical speed (EX: 500 fpm descent is led by 50')
  ii. Establish - Introduce power and apply smooth steady elevator pressure toward a level attitude
  iii. Crosscheck - VSI, Altimeter and attitude indicator should show level flight
  iv. Trim the airplane to maintain straight-and-level flight, repeat the process

F. Turning Descents
    i. Apply the same procedures as above, and establish the desired bank angle on the attitude indicator
    ii. Monitor turn performance on the heading indicator and turn coordinator
    iii. Small adjustments to pitch and power may be necessary to maintain airspeed in the turn
    iv. The instrument crosscheck will have to be accelerated as there is more information to take in
G. Common Error – Improper entry or level-off procedure
    i. The four-step process works for any change in flight attitude - Establish, trim, crosscheck, adjust

10. Turns to Headings

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

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

A. Prior to entering, determine turn direction and the angle of bank required
B. Establish – Use coordinated aileron and rudder to establish the desired bank on the attitude indicator
    i. If standard rate, use the turn coordinator
    ii. Adjust pitch as necessary (increase back pressure) to maintain level flight
C. Trim - Trim the airplane
D. Crosscheck – Monitor the instruments for any performance deviations from the turn
E. Adjust – Re-establish pitch and / or power to correct for deviations, trim, and repeat
F. Roll Out
    i. Apply coordinated rudder and aileron pressure to level the wings on the attitude indicator
        a. Depending on the rate of turn, rollout 5-10º before the desired heading
            - Or use ½ the bank angle or less as a reference for small turns
    ii. Adjust pitch and power for straight-and-level flight at cruise, crosscheck, adjust, and repeat
G. Common Error – Improper entry or rollout procedure
    i. The four-step process works for any change in flight attitude - Establish, trim, crosscheck, adjust

Common Errors:
- "Fixation," "Omission," and "Emphasis" errors during instrument cross-check
- Improper instrument interpretation
- Improper control applications
- Failure to establish proper pitch, bank, or power adjustments during altitude, heading, or airspeed corrections
- Improper entry or level-off procedure (specific to Constant Airspeed Climbs and Descents)
- Improper entry or roll-out procedure (specific to Turns to Headings)
- Faulty trim procedure

Conclusion:
Brief review of the main points
In visual flight, you control aircraft attitude in relation to the natural horizon using reference points on the aircraft. In instrument flight, you control attitude by reference to the flight instruments. A proper interpretation of the instruments provides essentially the same information that outside references provide in visual flight.

XII.E. Recovery from Unusual Flight Attitudes

References: Airplane Flying Handbook (FAA-H-8083-3), Instrument Flying Handbook (FAA-8083-15)

Objectives	The student should develop knowledge of the elements related to recovering from unusual flight attitudes as required in the ACS/PTS.
Key Elements	1. Crosscheck 2. Recovery 3. Coordination
Elements	1. General 2. Unusual Attitude Situations and Conditions 3. Recognizing Unusual Attitudes 4. Recovery Basics 5. Nose High (Climbing Turn) Recovery 6. Nose Low (Diving Spiral) Recovery 7. Coordination During Recovery 8. Common Recovery Errors
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student will understand the reasons unusual flight attitudes may occur, and the proper recovery procedure for a nose low or nose high unusual flight attitude.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

On July 16, 1999, JFK Jr. was killed along with his wife and sister-in-law, when the aircraft he was piloting crashed into the Atlantic Ocean. Kennedy had 310 hours of flight experience, including 55 hours of night flying and 36 hours in the high-performance Piper Saratoga. He had completed about half of an instrument training course. The NTSB investigation found no evidence of mechanical malfunction and determined that the probable cause was the pilot's failure to maintain control of the airplane during a descent over water at night, which was a result of spatial disorientation (or, not recovering properly from an unusual attitude). Factors in the accident were haze, and the dark night.

Overview

Review Objectives and Elements/Key ideas

What

An unusual attitude is an airplane attitude not normally required for flight.

Why

Without proper training on instrument interpretation and aircraft control, a pilot can quickly aggravate an abnormal flight attitude into a potentially fatal accident.

How:

1. **General**
   A. Since unusual attitudes (UAs) are not intentional maneuvers, they are often unexpected
      i. Reactions are therefore instinctive and often times dangerous, rather than intelligent and deliberate
   B. In a UA, the immediate problem is not how it got there, but what is the aircraft doing and how to get back to straight and level flight as quickly and safely as possible
2. **Unusual Attitude Situations and Conditions**
   - Turbulence
   - Disorientation / Confusion
   - Instrument Failure
   - Preoccupation with cockpit duties
   - Careless crosscheck / Errors in instrument interpretation
   - Lack of proficiency in aircraft control
3. **Recognizing Unusual Attitudes**
   A. General Rule: If you note an instrument rate of movement / indication other than those associated with basic instrument flight maneuvers, assume a UA and increase the crosscheck to confirm the situation
   B. Two Categories: Nose high, and Nose low attitudes
   C. Nose High Attitudes (Climbing Turn)
      i. Airspeed Indicator: Decreasing airspeed
      ii. Altimeter / VSI: Increasing altitude / Positive rate of climb
      iii. Turn Coordinator: May indicate a bank
      iv. Attitude Indicator: Nose high, a lot of blue
   D. Nose Low Attitudes (Diving Spiral)
      i. Shown by the same instruments but in the opposite directions
   E. Common Error - Failure to recognize an unusual flight attitude
4. **Recovery Basics**
   A. When using analog instruments, recovery is performed without the attitude indicator

i. If the attitude indicator is spillable its upset limits may have been exceeded and is unreliable
ii. Even if operating properly, errors of up to 5° pitch and bank can result
iii. May be inoperative due to mechanical malfunction, and is a reason for the UA
iv. Indications are difficult to interpret in extreme attitudes

B. Recovery, instead, is performed with the airspeed indicator, altimeter, VSI, and turn coordinator
i. Follow the POH recommended recovery procedures if they differ from the information here
ii. With a glass cockpit, the attitude indicator is very helpful and can be used for recovery

C. The basic intent of the nose high recovery is to prevent a stall

D. The basic intent of the nose low recovery is to prevent over stressing the airplane

5. Nose High (Climbing Turn) Recovery

A. Nose High Attitudes (Main Point: Avoid a stall) - If the airspeed is decreasing, or below that desired:

i. Procedure – the steps listed are made in the sequence below, but occur almost simultaneously
a. Power – Increase as necessary (in proportion to the deceleration)
b. Pitch – Apply forward elevator pressure to lower the nose (reduces AOA preventing stall)
c. Bank – Use coordinated aileron / rudder to level the wings (reference turn coordinator)

ii. After the initial correction, accelerate the cross-check to verify performance
a. As the altimeter and airspeed needles slow, attitude is approaching level flight
b. When the needles stop and reverse direction, the aircraft is passing through level flight

iii. Return to the desired altitude, and establish / verify straight-and-level, coordinated cruise flight
a. Level flight is indicated by reversal and stabilization of the altimeter and airspeed indicator
b. Straight, coordinated flight is indicated on the turn coordinator by a level aircraft / centered ball
c. Set power for the desired airspeed once the airspeed is under control

6. Nose Low (Diving Spiral) Recovery

A. Nose Low Attitudes (Main Point: Avoid over G-ing) - If the airspeed is increasing, or above that desired:

i. Procedure

      a. Power – Reduce power to prevent excessive airspeed and loss of altitude
      b. Bank – Use coordinate aileron / rudder to level the wings using the turn coordinator
         - Leveling the wings prior to raising the nose reduces load factors in the recovery
      c. Pitch – Raise the nose to level flight attitude with smooth back pressure
         - If ground contact is a concern, use whatever back pressure necessary to survive
      d. All components should be changed simultaneously for a smooth, proficient recovery
   ii. After the initial correction, accelerate the cross-check to verify performance
      a. As the altimeter and airspeed needles slow, attitude is approaching level flight
      b. When the needles stop and reverse direction, the aircraft is passing through level flight
   iii. Return to the desired altitude, and establish/verify straight-and-level, coordinated cruise flight
      a. Level flight is indicated by reversal and stabilization of the altimeter and airspeed indicator
      b. Straight, coordinated flight is indicated on the turn coordinator by a level aircraft / centered ball
      c. Set power for the desired airspeed once the airspeed is under control

7. Coordination During Recovery

A. Use the turn coordinator and attitude indicator, if available, to determine / maintain coordinated flight
   i. Skidding and slipping sensations can aggravate disorientation and retard recovery
   ii. A nose low recovery could result in excessive G's *and* uncoordinated flight
   iii. A nose high recovery could result in an uncoordinated stall, and potentially a spin

8. Common Recovery Errors

A. Common Error - Inappropriate control applications during recovery
   i. It is very important to properly recognize the type of UA and apply the proper procedures
B. Common Error - Consequences of attempting to recover from an unusual flight attitude by "feel" rather than by instrument indications
   i. Feel can be especially deceiving in IMC conditions; trust the instruments
C. Common Error - Failure to recognize from instrument indications when passing through level flight
   i. Level flight is indicated by the reversal/stabilization of the airspeed indicator and altimeter needles

Common Errors:

- Failure to recognize an unusual flight attitude
- Consequences of attempting to recover from an unusual flight attitude by "feel" rather than by instrument indications
- Inappropriate control applications during recovery
- Failure to recognize from instrument indications when passing through a level flight attitude

Conclusion:
Brief review of the main points
When recovering from an unusual attitude, it is essential to ignoring the attitude indicator and use the airspeed indicator, altimeter, turn coordinator, heading indicator and VSI to determine the attitude of the aircraft. Recovery should be made promptly in the proper order to avoid damaging the airplane or inducing a stall. Once level flight has been attained, the airplane should be reconfigured for straight-and-level flight.

EMERGENCY OPERATIONS

XIII.A. Emergency Approach and Landing

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to performing an emergency approach and landing. The student will be able to perform the maneuver as required in the ACS/PTS.
Key Elements	1. Best Glide Airspeed 2. Emergency Checklists 3. Soft Field Power Off Approach and Landing
Elements	1. ABC - Aviate, Best Landing Spot, Checklists 2. Approach 3. Contact ATC 4. Landing 5. Mental Attitude
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to simulate an emergency approach and landing, taking into account the landing area, and wind while accomplishing the necessary checklists and properly positioning the airplane to land safely on the desired landing spot.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Understanding the elements behind a properly executed emergency approach and landing could be the difference between a safe soft field landing and a dangerous, poorly performed crash.

Overview

Review Objectives and Elements/Key ideas

What

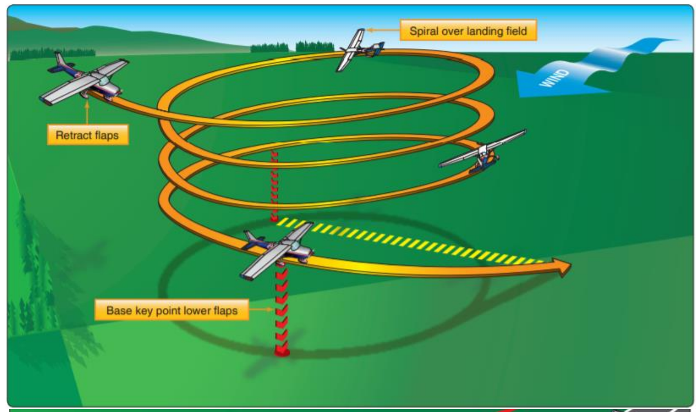
A simulated emergency landing occurs when the power is pulled, simulating a lost engine, and the pilot must attempt to restart the engine while properly configuring for an approach / landing, usually in a nearby field.

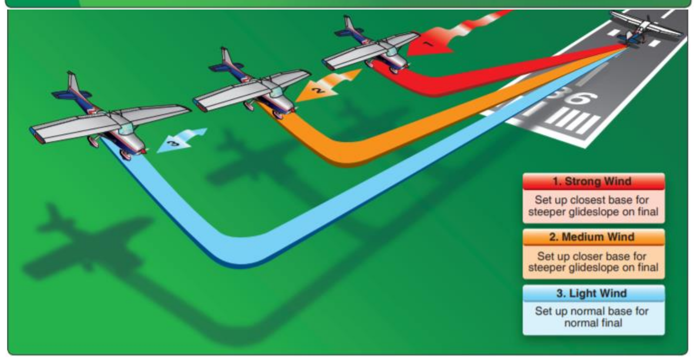
Why

To develop accuracy, judgment, planning, technique, and confidence when little or no power is available.

How:

1. **ABC - Aviate, Best Landing Spot, Checklists**
   A. **A**VIATE: The first reaction should be to immediately establish the best glide airspeed and fly the airplane
      i. Flying the airplane is the most important priority
      ii. Variations in speed nullify accuracy in judgment of gliding distance / landing spot
      iii. Eagerness to get down is one of the most common faults during simulated emergency landings
         a. Pilots neglect speed, arriving too fast for a safe landing – just as dangerous as too slow
      iv. Common Error - Improper airspeed control
   B. **B**EST Landing Spot: Select the best landing spot and immediately turn toward it
      i. Check in front, behind and to both sides of the airplane
      ii. Landing sites are restricted by the route of flight, height above the ground, and excess airspeed
      iii. An airport is ideal. If no airport, select a field within glide distance:
         a. Preferably hard packed, long, smooth, with no obstacles, especially at the approach end
         b. As a general rule, the pilot should not change their mind more than once
      iv. Note wind direction / speed; land into the wind, if able (altitude, obstacles, etc. may prevent this)
         a. Be aware of tailwind (longer landing distance) and crosswinds
         b. Common Error - Failure to estimate the approximate wind speed and direction
      v. Always continue to clear for traffic
      vi. Common Error - Poor judgment in selection of an emergency landing area
   C. Emergency **C**HECKLISTs
      i. Restart Checklist
      ii. Troubleshoot (if the reason for failure can be determined, a restart becomes more likely)
         a. Check the systems to decipher the problem
         b. Ex: Mixture: RICH, Alternate Air: OPEN, Fuel Valve: OPEN, Fuel Pump: ON, Ignition: CYCLE L/R
      iii. Common Error - Failure to accomplish the emergency checklist
2. **Approach**





- A. Planning the Approach
  - i. Governed by:
    - a. Wind direction / speed
    - b. Dimensions / slope of the field
    - c. Obstacles on final approach path
- B. Proceed directly to the landing area
  - i. Goal: Be on downwind, abeam the landing point at normal pattern altitude
  - ii. If above pattern altitude, circle over the approach end while descending
    - a. Turn in the same direction you intend to fly the pattern
- C. Divide attention between flying / checklists
  - i. Constantly assess the approach
- D. Adjust the pattern based on altitude, wind, etc. to safely reach the landing area
  - i. Make the approach as normal as possible
  - ii. Base / final turns are positioned based on altitude, wind, obstructions, etc.
    - a. Strong headwind = closer base
      Tailwind = farther out base
    - b. If high, delay base leg; if low, turn early, or go direct to landing area
  - iii. Corrections:

Too High	Too Low
• Extend the pattern	• Tighten the pattern
• S-turn	• Proceed direct to landing
• Configure early	• Delay configuration
• Slip	• Maintain best glide

  - iv. Common Error - Undershooting or overshooting selected emergency landing area
- E. Common Error - Failure to fly the most suitable pattern for existing situation
  - i. The pattern that works for one emergency approach and landing likely won't work for the next one

3. Contact ATC

- A. If on frequency with ATC, transmit "Mayday, mayday, mayday." If not on frequency, use guard 121.5
  - i. Let them know who you are, where you are, and what you're doing
  - ii. The radios will likely be kept on until just before landing. Keep ATC apprised of the situation / plan
- B. If time and conditions permit, squawk emergency - 7700

4. Landing

- A. If a restart is not an option, complete the Emergency Landing Checklist
  - i. Keep the electrical equipment on as long as practical to make radio calls, use the flaps, etc.
- B. Gear & Flaps
  - i. Gear and flaps should only be lowered after landing is assured
    - a. Gear can provide better protection in the case of stumps, rocks, or other obstacles
    - b. If the field is excessively soft, wet, short, or snow covered, a gear up landing may be safer
- C. If practical, hold the wheels off to allow for a gentle touchdown, like a soft field landing
  - i. At this point, the safety of the passengers is the only concern, the airplane does not matter

5. Mental Attitude

- A. Survival records favor pilots who maintain composure and can apply these concepts and procedures

B. Success is as much a matter of the mind as of skill

Common Errors:

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

Conclusion:

Brief review of the main points

During an emergency approach and landing, it is important that the pilot choose the most suitable landing area within gliding distance and properly configure the airplane to maintain the best glide airspeed and attempt to regain power. If regaining power is not possible, the airplane should be set up for an emergency landing and an emergency approach and landing should be executed into the wind as precisely as possible. The pilot should announce the emergency and squawk 7700 as practicable. Flying the aircraft is the number one priority.

XIII.B. Systems and Equipment Malfunctions

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives

The student should develop knowledge of the elements related to emergency procedures and be able to explain the proper procedures for certain situations based on the ACS/PTS.

Key Elements

1. Understand the Problem
2. Follow the Checklist
3. Safety of Those Onboard

Elements

1. Smoke, Fire, or both, during Ground or Flight Operations
2. Rough Running Engine or Partial Power Loss
3. Loss of Engine Oil Pressure
4. Fuel Starvation
5. Engine Overheat
6. Hydraulic Malfunction
7. Electrical Malfunction
8. Induction Icing
9. Door or Window Opening in Flight
10. Inoperative or “Runaway” Trim
11. Flap malfunction
12. Pressurization Malfunction

Schedule

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

Equipment

1. White board and markers
2. References

IP’s Actions

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

SP’s Actions

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

Completion Standards

The student has the ability to understand problems and why they may occur in the airplane. The student also can properly react to the emergency situations that have been discussed in a timely manner.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Wouldn't it be fun to be flying one day and experience a problem that you have no idea how to deal with? Of course not, that's why it's important to understand your equipment and the proper procedures associated.

Overview

Review Objectives and Elements/Key ideas

What

Systems and equipment malfunctions involve the knowledge and procedures to handle problems that may occur in the airplane.

Why

The key to successful management of an emergency situation, and/or preventing a non-normal situation from progressing into a true emergency, is a thorough knowledge of, and adherence to, the necessary procedures.

How:

Note: This lesson provides generic procedures for malfunctions. Always follow the POH procedures.

1. Smoke, Fire, or Both, During Ground or Flight Operations

A. In-Flight Smoke / Fire - In any fire, it is essential the source is discovered first
  i. Engine Fire
    a. Usually caused by a failure allowing a combustible substance to contact a hot surface
    b. Indicated by smoke / flames from cowling; and / or discoloration, bubbling, melting of cowling
    c. Unless the POH says otherwise, 1st step should be to shut off fuel
    d. If the flames are put out, do not attempt to restart the engine
    e. Perform an emergency landing
    f. Keep in mind:
      - There may be severe structural damage and control could be lost at any time
      - Airplane may still be on fire and susceptible to explosion
      - Airplane is expendable and the only thing that matters is the safety of those onboard
  ii. Electrical Fires
    a. First indication is usually the distinct odor of burning insulation
    b. Try to identify the problem by checking circuit breakers, lights, instruments, avionics
      - If it cannot be detected, the battery master and generator should be turned off
        a Any materials which have been ignited may continue to burn
    c. If power is essential for the flight, attempt to identify / isolate the faulty circuit:
      - Electrical master off, then all individual electrical switches off
      - Electrical master on
      - Turn on electrical switches one at a time, waiting after each switch to check for signs of fire
        a Turn off / do not use any equipment that restarts the fire. Other equipment can be used
  iii. Cabin Fires
    a. Usually result from smoking, electrical system malfunctions, and heating system malfunctions
    b. Two immediate demands:

- Attacking the fire, and getting the airplane safely on the ground as quickly as possible

c. In general, identify and shutdown the cause of the fire

d. Smoke can often be cleared by opening air vents – only after using the fire extinguisher

- If smoke increases, immediately close them

e. Windows can also be used to help clear smoke

f. Use oxygen if the smoke is severe; initiate an immediate descent

B. Ground Smoke / Fire

i. Engine Fire / Smoke - Shut down the engine, turn off the electrics and evacuate the airplane

ii. Electrical Fire / Smoke - Immediately turn off the master switch, and shutdown the engine

a. Use the fire extinguisher and evacuate as necessary

2. Rough Running Engine or Partial Power Loss

A. Follow the POH procedures

B. In general:

Possible Causes	Corrective Action
Improper mixture	Adjust mixture for smooth op
Defective ignition or valves	Consult maintenance personnel
Detonation / preignition	Reduce power, enrich mixture, open cowl flaps, land as soon as practical
Induction air leak	Reduce power. Consult maintenance
Plugged fuel nozzle	Reduce power. Consult maintenance
Excessive fuel pressure / fuel flow	Lean mixture

3. Loss of Engine Oil Pressure

A. High Oil Pressure

i. Possible Cause - Cold oil or possible internal plugging

ii. Corrective Action - If cold, allow the engine to warm, if not, reduce power and land ASAP

B. Low Oil Pressure

i. Possible Cause - Broken Pressure Relief Valve, Insufficient Oil, Burned Out Bearings

ii. Corrective Action - Land as soon as possible or feather the propeller and stop engine

C. Fluctuating Oil Pressure

i. Possible Cause - Low oil supply, loose oil lines, defective pressure relief valve

ii. Corrective Action - Land as soon as possible or feather propeller and stop engine

4. Fuel Starvation

A. Normally indicated by a rough running engine, and can be caused by blocked lines or empty tanks

B. In general, turn on boost pumps, switch tanks, verify fuel is on, adjust mixture

5. Engine Overheat

A. The oil temperature gauge is the primary instrument in determining if the engine is overheating

B. Causes and Corrective Action

Possible Causes	Corrective Action
Low Oil	Reduce Power. Land ASAP
Oil Congealed in Cooler	Reduce Power. Land. Preheat Engine
Inadequate Engine Cooling	Reduce Power, Increase airspeed
Detonation or Preignition	Check Cylinder Head Temps / Enrich Mixture / Reduce MP
Obstruction in the Oil Cooler	Reduce Power. Land ASAP
Damaged or Improper Baffle Seals	Reduce Power. Land ASAP
Defective Gauge	Reduce Power. Land ASAP

6. Hydraulic Malfunction

A. If the hydraulic pump were to fail, there are alternate means to raise / lower the gear

        i. Some airplanes will automatically lower the gear

7. **Electrical Malfunction**
    A. The generator / alternator is the cause of most electrical system failures (indicated on the ammeter)
        i. Once the generator goes offline, the only electrical source remaining is the battery (time limited)
    B. Electrically powered gear and flaps use up power at rates much greater than most other equipment
    C. General steps
        i. Turn off all but the most necessary electrical equipment (save as much power as possible)
        ii. Notify ATC immediately and request vectors for a landing at the nearest airport
        iii. Expect to make a no flap landing, and anticipate a manual gear extension
8. **Induction Icing**
    A. As air is ingested moisture can freeze in the induction system, reducing or stopping the air to the engine
        i. Ice can also form on the exterior and clog the air intake openings
    B. Corrective Action: Leave icing, use the alternate air source
9. **Door or Window Opening in Flight**
    A. Follow the POH procedures. In general, adhere to the following:
        i. Concentrate on flying the plane, an open door seldom compromises the ability of the plane to fly
        ii. Do not rush to land (climb to normal pattern altitude, fly a normal pattern, make a normal landing)
        iii. Don't release the seatbelt to attempt to reach the door, leave the door alone, land, then close it
        iv. Most doors will not stay open, they will usually bang open then settle partially closed
            a. A slip toward the door may open it wider, and a slip away may push it closed
10. **Inoperative or "Runaway" Trim**
    A. Grip the controls and maintain control of the plane while disengaging the electric trim system
        i. Disengage button, circuit breaker, etc.
    B. If the reason for the runaway trim is obvious and has been resolved, engage the breaker
11. **Flap Malfunction**
    A. Total Flap Failure (no flap approach and landing)
        i. Requires substantially more runway than normal (as much as 50% more)
        ii. Flown in a relatively nose-high attitude compared to flaps extended
        iii. A wider, longer pattern may be necessary
        iv. Tend to float during roundout (don't force the plane onto the ground)
    B. Asymmetric (Split) Flap
        i. A situation in which one flap deploys / retracts while the other remains in position
        ii. Indicated by a roll toward the wing with the least flap deflection
        iii. Countered with opposite aileron
            a. Yaw caused by the additional drag on the extended flap side requires opposite rudder
            b. Almost full aileron may be necessary at reduced airspeeds to maintain wings level
                - Do not attempt to land with a cross-wind from the side of the deployed flap
        iv. Be aware of the differing stall speeds of each wing
            a. The wing with the retracted flap will stall earlier - possible cross-controlled stall condition
        v. Approach and landing should be flown at a higher-than-normal airspeed
12. **Pressurization Malfunction**
    A. Descend or use supplemental oxygen
    B. Hypoxia is the primary danger of decompression

Conclusion:
Brief review of the main points
Understanding different emergencies and how to deal with them is obviously important as you will always be prepared and be able to react quickly in the event one of these emergencies occurs.

XIII.C. Emergency Equipment and Survival Gear

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to emergency equipment and survival gear, understanding that certain equipment should be taken on certain flights to aid in survival and rescue operations. The student will have knowledge in accordance with the ACS/PTS.
Key Elements	1. Equipment for the Situation 2. Equipment Care 3. Equipment Storage
Elements	1. Appropriate Equipment and Gear 2. Equipment Use and Care
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References 3. Basic Survival Kit
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands that flights over different terrain, and during different seasons require different emergency equipment and survival gear. The student also knows that the gear must be properly cared for and stored to ensure it functions correctly upon use.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Would you want to crash land in the desert with a life raft, life preserver, warm clothes and an average water supply as your survival equipment? Or, wouldn't you rather have survival gear tailored to the flight you are taking? We want to be properly prepared for an emergency landing.

Overview

Review Objectives and Elements/Key ideas

What

Emergency equipment and survival gear refers to the equipment carried onboard an airplane to aid in survival and rescue operations. Equipment can and should vary by flight (terrain, climate, season, etc.).

Why

By carrying and understanding the use of survival equipment tailored to your flight you will greatly increase chances of rescue and survival.

How:

1. **Appropriate Equipment and Gear**
   A. For flight over uninhabited areas, it is wise to take survival equipment for the type of climate and terrain
   B. A survival kit should provide sustenance, shelter, medical care and a means to summon help
   C. General Items to consider
      i. First Aid Kit and Field Medical Guide
      ii. Flashlight and batteries
      iii. Food and Water
      iv. Multi-tool or Knife
      v. Rope
      vi. Matches
      vii. Shelter
      viii. Signaling Device
      ix. Compass
      x. GPS, satellite phone, etc.
   D. More specific items should be considered based on the type of terrain and climate
2. **Equipment Use and Care**
   A. Onboard equipment often consists of an ELT, a fire extinguisher, emergency axe, and any survival gear
   B. ELT
      i. Purpose - transmit a downed aircraft's location for search and rescue personnel
         a. Broadcasts on 121.5 and 243.0 (no longer monitored by satellite), and 406 MHz
      ii. Operation / Use – Emits a signal for rescue crews. Designed to automatically activate in a crash
         a. Operates continuously for at least 48 hours over a wide temperature range
         b. Know how to activate the ELT and ensure transmitting
      iii. Servicing - Must be checked every 12 calendar months
         a. FAR 91.207 – The battery must be replaced after 1-hour cumulative use or ½ its useful life
         b. ELT Testing
            - Analog 121.5/243 MHz ELTs – Test only during the first 5 minutes after any hour
            - Digital 406 MHz ELTs – Test in accordance with the unit's manufacturer's instructions
            - Airborne tests are not permitted
      iv. Storage – Usually installed by the manufacturer in order to prevent damage to the device in a crash
   C. Fire Extinguisher

i. Purpose - Used to fight / extinguish fires
ii. Operation – Generally, pull the pin, point and squeeze the handle (verify operating instructions)
    a. Aim at the base of the fire
iii. Servicing – Verify the extinguisher isn't expired, has been inspected, and contains the proper charge
iv. Storage – Ensure it is attached / secured where it is supposed to be, securely in its mount

D. Emergency Axe
    i. Purpose – To provide a means to exit in case the doors cannot be opened
    ii. Operation – If door(s) can't be opened, use the axe to escape as described by the manufacturer
    iii. Servicing – Ensure the axe is onboard and properly mounted, and inspected as required
    iv. Storage – The axe should be stored in its mount as the manufacturer intends

E. Survival Gear
    i. Purpose – Used for survival (food, water, shelter, warmth, etc.)
    ii. Operation / Use – The operation / use will vary with equipment. Use based on the instructions
    iii. Servicing – Verify the equipment is in good working order and does not need replaced, cleaned, etc.
        a. Ensure electronic equipment is in good working order and properly charged/ for use
        b. Adjust the contents of the survival gear based on the trip, weather, terrain, etc.
    iv. Storage – Store the gear safely and accessibly on the airplane

Conclusion:
Brief review of the main points
Emergency equipment should be tailored to the type of flight that will be taken. Gear should be stored and serviced properly to ensure it functions properly during an emergency. Survival manuals can be obtained to help in planning.

XIII.D. Emergency Descent

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to an emergency descent, when the descent is required, and the proper procedure to perform the maneuver. The student will have the ability to perform the maneuver as required in the ACS/PTS.
Key Elements	1. Configuration 2. Airspeed and Load 3. Recovery
Elements	1. General 2. The Maneuver
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the situations which necessitate an emergency descent and can properly perform the maneuver with a smooth, controlled recovery.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

This maneuver is a lot of fun to practice, partly because there is not a lot too it, but also because the airplane is put in a very nose low attitude and is descending very fast. You're dive bombing the ground.

Overview

Review Objectives and Elements/Key ideas

What

An emergency descent is a maneuver for descending as rapidly as possible to a lower altitude, or to the ground for an emergency landing.

Why

The need for this maneuver may result from an uncontrollable fire, a sudden loss of cabin pressurization, or any other situation demanding an immediate and rapid descent.

How:

1. **General**
   A. Objective: Descend as soon and as rapidly as possible, within the structural limitations of the airplane
   B. Situations
      i. Fire, smoke, loss of cabin pressurization, or any other demanding situation (medical, injury, etc.)
      ii. Common Error - The consequences of failing to identify reason for executing an emergency descent
         a. Situation can become very dangerous and unrecoverable
2. **The Maneuver**
   A. Prior to the Maneuver
      i. Pre-maneuver checklist; Clear the area
      ii. Common Error - Improper use of clearing procedures for initiating the emergency descent
   B. Procedure
      i. Reduce power to idle
      ii. Extend the flaps and gear as specified by the manufacturer
         a. Provides maximum drag to increase the rate of descent, without excessive airspeed
         b. Common Error - Improper use of the prescribed emergency checklist to verify accomplishment of procedures for initiating the emergency descent
      iii. Put the nose down to maintain maximum allowable airspeed based on the procedure
         a. Speed may vary based on flaps, nature of the emergency, and turbulent conditions
            - Never exceed V_{NE} or V_{FE}, and in the case of turbulence, do not exceed V_A
      iv. As the nose is lowered, begin a 90° left turn at 30-45° of bank
         a. Puts positive load on the aircraft (countering the negative load from the descent)
         b. Acts as a clearing turn (below and to each side) and gets the plane off an airway
         c. Left turn because faster traffic passes on the right (right of way rules)
   C. Level Off
      i. The recovery should be smooth to prevent overstressing the airplane
      ii. These recommendations generally work well, but in the case of a real-life emergency descent (i.e., a fire in the cabin), do what is necessary to land safely / stay alive

a. Initiate the level off at an altitude that will ensure a safe recovery or precautionary landing
    - 10% rule works well (lead the level off by 10% of the VSI)

iii. Increase power to the cruise setting, or as required
iv. Once straight-and-level, return to a normal configuration (flaps, gear, etc. are retracted)
v. Trim the aircraft and adjust the mixture as necessary
vi. Common Error - Improper procedures for recovering from an emergency descent
    a. Follow the POH procedures, and avoid overstressing the airplane with an aggressive level off

Common Errors:

- The consequences of failing to identify reason for executing an emergency descent
- Improper use of the prescribed emergency checklist to verify accomplishment of procedures for initiating the emergency descent
- Improper use of clearing procedures for initiating the emergency descent
- Improper procedures for recovering from an emergency descent

Conclusion:
Brief review of the main points
An emergency descent is used in a situation where altitude must be lost quickly in order to make a landing as soon as possible. The airplane is put into a configuration which will allow for the maximum descent rate. Recovery should be smooth and controlled as straight-and-level cruise flight is reestablished.

POSTFLIGHT PROCEDURES

XIV.A. Postflight Procedures

References: Airplane Flying Handbook (FAA-H-8083-3), POH/AFM

Objectives	The student should develop knowledge of the elements related to postflight procedures and be able to perform them as required in the ACS/PTS.
Key Elements	1. Shutdown Checklist 2. Postflight Inspection 3. Securing the Airplane
Elements	1. Parking 2. Engine Shutdown and Securing the Cockpit 3. Deplaning passengers 4. Postflight Inspection 5. Securing the Aircraft 6. Refueling Procedures 7. Common Error
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can safely 'postflight' the airplane based on different situations and at different airports.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Have you ever forgotten to turn something off after a flight? Leaving certain things running can be dangerous or costly. Properly securing an airplane isn't important just to save on costs though, weather and other situations can cause damage and / or injuries.

Overview

Review Objectives and Elements/Key ideas

What

Postflight procedures are completed at the end of the flight when the airplane is parked, shutdown and properly secured.

Why

The postflight is just as important as preflight in maintaining the plane and keeping it safe for the next flight.

How:

1. **Parking**
   A. Select a parking location and heading that avoids the propeller / jet blast of other planes
      i. Also ensure you are not parked in a way that will blast other aircraft
   B. Park heading into the wind, if possible
   C. Hand signals may be used if ramp personnel are available – be familiar
   D. After stopping, roll forward slightly to straighten the nosewheel
2. **Engine Shutdown and Securing the Cockpit**
   A. A flight is not complete until the engine is shut down and the airplane is secured
   B. Once stopped, set the parking brake
   C. Common practice: With the engine running, move the ignition from BOTH to OFF and back to BOTH
      i. Ensures mags are properly grounded
   D. Follow the procedures outlined on the manufacturer's checklist for shutting down and securing
      i. Read each item aloud and perform the task (Read and Do)
      ii. Common Error - Hazards resulting from failure to follow recommended procedures
3. **Deplaning Passengers**
   A. Ensure passengers understand the safe procedures for exiting the airplane (after engine shutdown)
   B. Ensure passengers are aware of hazards nearby and know where to go once out of the plane
4. **Postflight Inspection**
   A. Check the general condition of the aircraft
      i. Inspect for any damage that may have occurred
      ii. Look for leaks, streaks, stains

        iii. Check oil, and other required fluids and replenish as necessary
        iv. Note discrepancies
    B. Consider fuel requirements for future use of the plane
        i. If another flight is planned, the tanks should be filled based on that flight's fuel requirements
        ii. If the aircraft is going to be inactive, fill the tanks to prevent water condensation from forming

5. **Securing the Aircraft**
    A. The aircraft should be hangered or tied down and chocked, flight controls secured, locked as required
        i. Verify the nosewheel is straight
        ii. Chains are not flexible and therefore should not be made taught to prevent structural damage
        iii. Ropes are flexible and may be reasonably cinched
        iv. Brakes should be set based on local procedures
    B. Cover the airplane as required (airframe, propeller, shades, cowling inlet covers, etc.)
    C. Close the windows, ensure you have everything, and lock the airplane
6. Common Error - **Poor planning, improper procedure, or faulty judgment in performance of postflight procedures**
    A. Be aware of the parking areas (ramps space, FBOs, etc.) at the destination
        i. Contact the FBO or parking management to verify the location and procedures
    B. Follow all checklist(s) step by step, and ensure the plane is left in a safe condition for the next flight
        i. Do not skip the postflight inspection, assuming the next pilot will catch any issues in their preflight
            a. They might not catch the issue
            b. The issue could have been found and possibly fixed prior to them showing up (be considerate)
        ii. If a discrepancy is noted, attempt to have the issue inspected / fixed prior to the next flight
    C. Leaving the airplane in an unsafe place, condition, or situation could result in damage

Common Errors:
- Hazards resulting from failure to follow recommended procedures
- Poor planning, improper procedure, or faulty judgment in performance of postflight procedures

Conclusion:
Brief review of the main points
When parking and shutting down the airplane it is very important, to follow the manufacturer's established guidelines to ensure everything is properly shut down and secured.

APPENDIX

A. Flight Review

References: Currency Requirements and Guidance for the Flight Review and Instrument Proficiency Check (AC 61-98), FAR 61.56 – Flight Review, Certificate: Pilots and Flight and Ground Instructors (AC 61-65), WINGS – Pilot Proficiency Programs (AC 61-91)

1. **Purpose**
   - A. A routine evaluation of a pilot's ability to conduct safe flight
   - B. Not a test or checkride, rather a training event in which proficiency is evaluated
2. **Role of the Instructor**
   - A. Provide an evaluation, however instruction is also encouraged (they should leave a better pilot)
   - B. As long as deficiencies are corrected, providing instruction does not prevent a successful review
3. **FAR 61.56**
   - A. Flight Review Requirements – Minimum of 1 hour ground and 1 hour flight training, covering:
     - i. Current operating/flight rules (part 61/91)
     - ii. Maneuvers/procedures that, at the discretion of the CFI, demonstrate safe operation
   - B. Aircraft –Must be accomplished in an aircraft for which the pilot (and CFI) is rated (FAR 61.56(c)(1))
     - i. If a pilot holds multiple ratings, a flight review in any one counts for all
   - C. Exceptions to the Flight Review:
     - i. 61.56(d) – Passed a proficiency check, or practical test in the last 24 months
     - ii. 61.56(e) – Completed one or more phases of WINGS in the last 24 months (more info: AC 61-91)
     - iii. 61.56(f) – CFI who has completed a renewal of a flight certificate in the last 24 months (61.197)
4. **Planning the Flight Review**
   - A. Tailor the Review to the Pilot's Needs (talk to the pilot to create a plan)
     - i. Type of aircraft, and type of flying usually done by the pilot
     - ii. Amount and recency of flight experience
     - iii. Specific topics/weaknesses they would like to focus on or review
   - B. AC 61-98 Focus Areas
     - i. Pilot Deviation Avoidance
       - a. Review airspace types/ground operating procedures/best practices to avoid deviations
     - ii. Automation Competency
       - a. Numerous accidents/incidents have been attributed to a lack of proficiency in automation
     - iii. AOA Systems (Safety initiative aimed at reducing the GA accident rate/loss of control accidents)
       - a. If equipped with AOA indicator, evaluate proper use. If not, review AOA aerodynamic principles
   - C. Build the Plan Based on the Individual - See sample Topics/Maneuvers below
   - D. Agreement on the review
     - i. Review the plan with the pilot to reach an understanding of how the flight review will be conducted
     - ii. Review the criteria for satisfactory completion of the flight review (ex. ACS/PTS standards)
5. **Post Flight Review**
   - A. Debrief the pilot
     - i. Satisfactory or not, provide a comprehensive analysis of performance, including ways to improve
   - B. If unsatisfactory, log the flight as dual instruction given, not as a failure (not a checkride)
     - i. Offer a practical course of action to regain proficiency
6. **Endorsement**
   - A. AC 61-65: I certify that [First name, MI, Last Name], [grade of pilot certificate], [certificate number], has satisfactorily completed a flight review of § 61.56(a) on [date].

Ground Review Topics (AC 61-98)

Pilot

- Experience
  - Recent Flight Experience (61.57)
- Responsibility
  - Authority (91.3)
  - ATC Instructions (91.123)
  - Preflight Action (91.103)
  - Safety Belts (91.107)
  - Flight Crew at Station (91.105)
- Cautions
  - Careless or Reckless Operation (91.13)
  - Dropping Objects (91.15)
  - Alcohol or Drugs (91.17)
  - Supplemental Oxygen (91.211)
  - Fitness for Flight (AIM 8-1)

Aircraft

- Airworthiness
  - Basic (91.7)
  - Flight Manual, Markings, Placards (91.9)
  - Certification Required (91.203)
  - Instruments/Equipment Requirements (91.205)
    - ELT (91.207)
    - Aircraft Lights (91.209)
    - Transponder Requirements (91.215)
    - Inoperative Instrument/Equip (91.213)
- Maintenance
  - Responsibility (91.403)
  - Maintenance Required (91.405)
  - Maintenance Records (91.417)
  - Operation after Maintenance (91.407)
- Inspections
  - Annual, ADs, 100-hour (91.409)
  - Altimeter & Pitot Static (91.411)
  - VOR Check (91.171)
  - Transponder (91.413)
  - ELT (91.207)

Environment

- Airports
  - Markings (AIM 2-3)
  - Operations (AIM 4-3, 91.125, 91.126)
  - Traffic Patterns (91.126)
- Airspace
  - Altimeter Settings (91.121, AIM 7-2)
  - Min Safe Alts (91.119, 91.177)
  - Cruising Alts (91.159, 91.179, AIM 3-1-5)
  - Speed Limits (91.117)
  - Right-of-Way (91.113)
  - Formation (91.111)
  - Cntrld Airspace (AIM 3-2, 91.129, 130, 131, 135)
  - Class G (Aim 3-3)
  - Special Use (AIM 3-4, 91.133, 137, 141, 143, 145)
  - Emergency Rules (91.139, AIM 5-6)
- ATC
  - Services (AIM 4-1)
  - Radio Comms (AIM 4-2, Pilot Controller Glossary)
  - Clearances (AIM 4-4)
  - Procedures (AIM 5)
- Weather
  - Meteorology (AIM 7-1)
  - Wake Turbulence (AIM 7-4)

Flight Activities (AC 61-98)

- Preflight Preparation
  - Weather Information
  - Cross-Country Flight Planning
  - Performance and Limitations
  - Operation of Systems
- Preflight Procedures
  - Inspection(s)
  - Cockpit Management
  - Before Takeoff Check
- Airport Operations
  - Radio Communications
  - Airport, Runway, Taxiway Signs/Markings/Lights
- Takeoffs, Landings, Go-Arounds
  - Normal/Crosswind Takeoff/Climb and Landing*
  - Soft Field Takeoff/Climb and Landing
  - Short Field Takeoff/Climb and Approach
  - Go-Around / Rejected Landing*
- Performance Maneuvers
  - Steep Turns
- Navigation
  - Pilotage / Dead Reckoning
  - Nav Systems and Radar Services
  - Diversion
  - Lost Procedures
- Slow Flight and Stalls*
  - Slow Flight
  - Power Off Stalls
  - Power On Stalls
  - Spin Awareness
- Basic Instrument Maneuvers
  - Straight and Level / Turns to Headings*
  - Recovery from Unusual Attitudes*
  - Radio Comm/Navigation Systems
- Emergency Operations
  - Emergency Approach and Landing
  - Systems and Equipment Malfunctions
  - Automation Failure
- Postflight Procedures
  - After Landing, Parking, and Securing

NOTES

Possible Structure: Out-and-back. One leg focuses on XC procedures, and one leg focuses on air work. Remember, some ground review can be gauged and/or accomplished in flight.

Structure activities and review based on pilot's normal flying. For example, a different plan for someone who flies local/single airport flights vs long-distance XCs in busy terminal areas.

*Maneuvers critical to flight – recommended to be reviewed

B. Plan of Action

The intent is to use time and altitude as efficiently as possible during your student's training flights. Below are two sample plans designed to conserve energy and minimize drone time while incorporating all maneuvers. The instructor should tailor the individual plan based on airfield, airspace, maneuver and training requirements, etc.

HIGH TO LOW

PRIVATE PILOT	COMMERCIAL PILOT
"High" Alt	Climb
1. SLOW FLIGHT & STALLS ○ Maneuvering during Slow Flight ○ Power-Off Stalls ○ Power-On Stalls	**1. PERFORMANCE MANEUVER** ○ Chandelles (Up to altitude)
2. PERFORMANCE MANEUVER ○ Steep Turns	"High" Alt **2. SLOW FLIGHT & STALLS** ○ Maneuvering During Slow Flight ○ Power-On Stalls ○ Power-Off Stalls
3. BAI FLIGHT ○ Straight-and-Level ○ Constant Airspeed Descent ○ Constant Airspeed Climb ○ Turns to Heading ○ Unusual Attitudes	**3. PERFORMANCE MANEUVERS (CONT)** ○ Steep Turns ○ Lazy Eights
Descent **4. EMERGENCY OPERATIONS** ○ Systems & Equipment Malfunctions ○ Emergency Approach / Go-Around	Descent **4. EMERGENCY OPERATIONS** ○ Systems & Equipment Malfunctions ○ Steep Spiral / Emergency Approach
Low Alt **5. GROUND REFERENCE MANEUVERS** ○ Rectangular Course ○ S-Turns ○ Turns Around a Point	Low Alt **5. GROUND REFERENCE MANEUVERS** ○ Eights on Pylons
6. TAKEOFFS & LANDINGS ○ Normal / Crosswind ○ Soft-Field ○ Short-Field ○ Slip to a Landing ○ Go-Around	**6. TAKEOFFS & LANDINGS** ○ Normal / Crosswind ○ Soft-Field ○ Short-Field ○ Power-Off 180 ○ Go-Around

The student climbs to training altitude, transitions from the climb into slow flight and stalls, completes the maneuvers, and attitude instrument flight (if applicable), and then uses a simulated engine failure to descend to ground reference maneuver altitudes before returning to the airfield for landings.

LOW TO HIGH

PRIVATE PILOT

1. **TAKEOFFS & LANDINGS**
   - Normal / Crosswind
   - Soft-Field
   - Short-Field
   - Slip to a Landing
   - Go-Around
2. **GROUND REFERENCE MANEUVERS**
   - Rectangular Course*
   - S-Turns
   - Turns Around a Point
3. **BAI FLIGHT**
   - Straight-and-Level
   - Constant Airspeed Climb
   - Constant Airspeed Descent
   - Turns to Heading
   - Unusual Attitudes
4. **SLOW FLIGHT & STALLS**
   - Maneuvering during Slow Flight
   - Power-Off Stalls
   - Power-On Stalls
5. **PERFORMANCE MANEUVER**
   - Steep Turns
6. **EMERGENCY OPERATIONS**
   - Systems & Equipment Malfunctions
   - Emergency Approach & Landing

COMMERCIAL PILOT

Low Alt

1. **TAKEOFFS & LANDINGS**
   - Normal / Crosswind
   - Soft-Field
   - Short-Field
   - Power-Off 180
   - Go-Around
2. **GROUND REFERENCE MANEUVERS**
   - Eights on Pylons

Climb

3. **PERFORMANCE MANEUVERS**
   - Chandelles (Up to altitude)

"High" Alt

4. **SLOW FLIGHT & STALLS**
   - Maneuvering During Slow Flight
   - Power-On Stalls
   - Power-Off Stalls
5. **PERFORMANCE MANEUVERS (CONT)**
   - Steep Turns
   - Lazy Eights

Descent

6. **EMERGENCY OPERATIONS**
   - Systems & Equipment Malfunctions
   - Steep Spiral / Power-Off 180

The student begins in the pattern, and transitions to the applicable ground reference maneuvers. BAI or Chandelles can be accomplished during the climb to an altitude where slow flight, stalls, and maneuvers can be practiced. Finally, a simulated engine failure descends back to the airfield.

*Rectangular course doesn't make a lot of sense after patterns