CFI LESSON PLANS

THE BACKSEAT PILOT

The CFI Condensed lesson plans are the CFI lesson plans with less detail, aircraft specific information, and examples.

USING THE CFI CONTENT

EBOOK NAVIGATION (immensely helpful)

- Word: **Open the View Tab & check Navigation Pane in the box labeled 'Show'**
- Adobe: Open the Bookmarks bar

ACS KNOWLEDGE & RISK MANAGEMENT ELEMENTS

- Every single task is annotated (Ex: AI.II.G.K1, AI.VII.N.R2). Search for anything you need

RISK MANAGEMENT CONTENT

- Many sections contain numerous repetitive risk management elements
- Rather than repeating the information over and over, you'll find the RM concepts at the end of the applicable section (VII – XII)
- In the eBooks, the lessons that reference these topics are linked to the RM section

IMPORTING THE PDF TO AN IPAD

- Login to your account, tap the My Digital Content button, open the PDF & tap the screen
- In the box that appears at the bottom center of the screen, tap Download
- When the download is complete, tap Open In and choose the desired app
- ForeFlight provides multiple different ways to import a document

LEGEND / ABBREVIATIONS

- CE: Common Error
- RM: ACS Risk Management concept

QUESTIONS OR ISSUES

- info@thebackseatpilot.com – More than happy to help!

RECENT UPDATES

Most of the recent updates are indicated with a Red bar in the left margin (not shown in the PDF)
To View/Remove the Red Bar in Word, select the Review tab, Track Changes drop down, then Track Changes

DATE	LESSON(S)	CHANGES
Aug 2024	Numerous Lessons	Very minor updates to streamline RM content
July 2024	All Lessons Sections VI-XII	Added ACS annotations for all Knowledge & Risk Management tasks Updated to include the latest AFH Common Errors & moved Common Errors into the lesson plan (ACS required task now)
May 2024	All Lessons	Various updates to clean up/expand on RM concepts Various updates to match the ACS updated PowerPoints
April 2024	All Lessons	Updated to the new Instructor ACS standards

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FUNDAMENTALS OF INSTRUCTING

I.A. Effects of Behavior & Communication on the Learning Process

References: Aviation Instructor's Handbook (FAA-H-8083-9) Chapters 2 & 4

Objectives	The learner should develop knowledge of the elements related to human behavior and effective communication as required in the Instructor ACS.
Elements	1. Elements of Human Behavior 2. Learner Emotional Reactions 3. Teaching the Adult Learner 4. Effective Communication 5. Recognizing & Accommodating Human Behavior
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 human behavior and its relation to teaching in addition to the 3 basic elements of the communicative process. They recognize the various barriers to communication and develop communication skills to convey the desired information to 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

How human behavior (needs, personalities, motivations, emotions, age, communication, etc.) affect the learning process.

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. **Elements of Human Behavior** (Aviation Instructor's Handbook, Chapter 2) FI.I.A.K1
   - A. Definitions of Human Behavior FI.I.A.K1a
     - i. The study of human behavior is an attempt to explain how and why human functions the way they do
     - ii. Scientific World Definition
       - a. Product of factors that cause people to act in predictable ways
         - Ex: how people handle fear is a product of individual experiences
     - iii. Satisfying Needs Definition
       - a. Human behavior is the result of attempts to satisfy certain needs
         - Behavior is driven by simple (food, water) and complex needs (respect and acceptance)
     - iv. Life Course of Humans Definition
       - a. As humans grow, behavior changes
         - As an individual matures, their mode of actions moves from dependency to self-direction
         - Therefore, the age of the learner impacts how the curriculum is designed
     - v. Personality Types
       - a. Myers Briggs Type Indicator
         - Seeming random variation in human behavior is quite structured due to differences in way individuals prefer to use their perception & judgment
       - b. Now used to discover future careers
     - vi. Big Picture: A working knowledge of behavior can help an instructor better understand a learner
   - B. Instructor and Learner Relationship FI.I.A.K1b
     - i. Instructor must understand their style of teaching and as much as possible adapt to learners
   - C. Motivation FI.I.A.K1c
     - i. The reason one acts or behaves in a certain way and lies at the heart of goals
       - a. Probably the dominant force governing progress and ability to learn
     - ii. Positive Motivation
       - a. Promise or achievement of awards (personal, social, financial, satisfaction of self, recognition)
       - b. Examples
         - Secure, pleasant conditions, a safe environment

- Tangible return for efforts
- Group approval/belonging
- Favorable self-image

iii. Maintaining Motivation
  a. Reward Success: Praise incremental successes and relate accomplishments to lesson objectives
  b. Present New Challenges

iv. Drops in Motivation
  a. Natural, especially after the initial excitement wears off
  b. Remind learners of their goals and reasons for training and that plateaus are normal

D. Human Needs FI.I.A.K1d

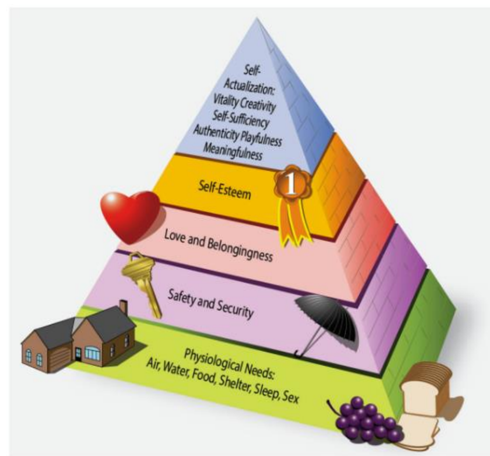
i. Hierarchy of Human Needs – An organization of human needs into levels of importance
  a. Until the needs are satisfied, one can't focus fully on learning, self-expression, or any other task
    - Once a need is satisfied, it no longer provides motivation

ii. **Physiological -** Biological needs: Food, rest, and protection from the elements

iii. **Security -** Protection against danger, threats, deprivation affect learner behavior

iv. **Belonging -** Belong, to associate, and to give and receive friendship and love

v. **Esteem -** Two types:
  a. Internal - Relating to self-esteem: confidence, independence, achievement, competence, knowledge
  b. External - Relating to reputation: status, recognition, appreciation, and respect of associates



vi. **Cognitive and Aesthetic**
  a. This was added years after the initial theory development
  b. Cognitive: Need to know and understand
    - If a person understands, they can control the situation / make informed decisions
  c. Aesthetic: Emotional needs
    - If an instructor does not like a learner, this feeling may affect the instructor's ability to teach

vii. **Self-Actualization**
  a. When all other needs are satisfied, only then can self-actualization be attained
  b. Realizing one's own potential for continued development / Reaching personal goals and potential

viii. Help learners satisfy their own needs in a manner that will create a healthy learning environment

E. Defense Mechanisms FI.I.A.K1e

i. Subconscious, almost automatic, ego-protecting reactions to unpleasant situations
  a. Used to soften feelings of failure, to alleviate feelings of guilt, and to protect personal worth

ii. **Repression -** Uncomfortable thoughts are placed in inaccessible areas of the unconscious mind

iii. **Denial -** Refusal to accept a reality because it is too threatening

iv. **Compensation -** Disguising the presence of a weak quality by emphasizing a more positive one
  a. May develop a less preferred / more attainable goal instead of one more preferred / less attainable

v. **Projection -** Blame is relegated to others for their own shortcomings, mistakes, and transgressions

vi. **Rationalization -** Subconscious technique for justifying actions that otherwise would be unacceptable
  a. When true rationalization takes place, individuals sincerely believe in their excuses

vii. **Reaction Formation** - Protect from dangerous desires by developing opposite attitudes / behaviors

viii. **Fantasy -** Daydreaming about how things should be rather than doing something about how they are

ix. **Displacement -** Unconscious shift in emotion from the original object to a less threatening substitute

2. Learner Emotional Reactions (Aviation Instructor's Handbook, Chapter 2) FI.I.A.K2

A. Anxiety – "A state of mental uneasiness arising from fear…" FI.I.A.K2a
   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
B. Impatience FI.I.A.K2b
   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 FI.I.A.K2c
   i. Those worried or emotionally upset are not ready to learn and derive little benefit from instruction
   ii. 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 FI.I.A.K2d
   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 FI.I.A.K2e
   i. Provide well-planned, appropriate, and accurate instruction
   ii. Instruction should be meaningful. Teach to the level of the learner
   iii. Once the instructor loses confidence, it is difficult to regain, and learning is diminished
F. Stress FI.I.A.K2a
   i. Normal Reactions to Stress
      a. People respond rapidly and exactly, within the limits of their experience and training
         - This is desired, stress should not overwhelm and cause abnormal reactions (below)
   ii. Abnormal Reactions to Stress
      a. Response may be random, illogical, completely absent, or at least inadequate
      b. Abnormal Reactions:
         - Over-cooperation, extreme self-control, inappropriate laughter or singing, rapid emotion changes
   iii. Flight Instructors Actions Regarding Seriously Abnormal Learners
      a. Refrain from instructing the learner and assure they don't continue training or become certificated
      b. 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

3. Teaching the Adult Learner (Aviation Instructor's Handbook, Chapter 2) FI.I.A.K3

A. Adult Learner Characteristics
   i. Learning is a means to an end (generally have a use for the knowledge/skill)
   ii. Seek out learning experiences to cope with specific life changing events (marriage, new job, etc.)
   iii. Autonomous & self-directed; need to be independent & exercise control
   iv. Draw from foundation of life experience and knowledge for learning
   v. Goal & relevancy oriented
   vi. Practical, focusing on aspects of a lesson most useful to them in their work
   vii. Need to be shown respect
   viii. Need to increase or maintain a sense of self-esteem is a strong secondary motivator
   ix. Want to solve problems & apply new knowledge immediately
B. Instructors Should
   i. Clarify and articulate learner expectations early

ii. Provide an organized training syllabus with clearly defined objectives
iii. Recognize the learner's need to control pace and start/stop time
iv. Use scenario-based training (takes advantage of preference to self-direct)
v. Help learners integrate new ideas with what they already know
vi. Provide self-directed learning involving other people as resources, guides, etc. (don't isolate)
vii. Use books, programmed instruction and computers which are popular with adults
viii. Refrain from "spoon-feeding"
ix. Set a cooperative learning climate
x. Create opportunities for mutual planning

4. Effective Communication (Aviation Instructor's Handbook, Chapter 4) FI.I.A.K4

A. Doesn't occur automatically, a communication style must be developed that can convey info to learners

B. Basic Elements FI.I.A.K4a
   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 – 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. Not all learners learn in the same way, using multiple approaches is most effective

C. RM: Barriers to Effective Communication FI.I.A.K4b, FI.I.A.R.2
   i. Lack of Common Experience
      a. Greatest single barrier to effective communication
      b. It is essential that instructors speak the same language as the learners
      c. When specific terminology is needed, ensure understanding
   ii. Confusion Between the Symbol and the Symbolized Object
      a. This results when the meaning or intent of words and / or the context isn't clear (ex. Sarcasm)
   iii. Overuse of Abstractions (Abstractions are words that are general rather than specific)
      a. Abstractions may not evoke the same items of experience in the learner's minds
   iv. External Factors
      a. Factors outside the instructor's control that prevent an activity from being carried out properly
      b. Physiological interference - physical problem inhibiting understanding (injury, hearing loss, etc.)
      c. Environmental interference - caused by external physical conditions (like noise)
      d. Psychological interference - product of how the learner / instructor feel
   v. Interference
      a. Occurs when the message gets disrupted or truncated. Ensure the learner understands the message

D. Developing Communication Skills FI.I.A.K4c
   i. Role Playing
      a. Practice instructing to develop communication skills, techniques, etc.

ii. Instructional Communication
    a. Know the topic well; Do not be afraid to use examples of past experience to illustrate points
    b. Determine the level of understanding by some sort of evaluation
iii. Listening
    a. Listen to understand rather than refute
iv. Questioning
    a. Good questioning can determine how well a learner understands
    b. Ask open ended and focused questions
    c. Paraphrasing and perception checking can confirm understanding
v. Instructional Enhancement
    a. The deeper the knowledge about an area, the better the instructor is at conveying it

5. **RM: Recognizing & Accommodating Human Behavior** FI.I.A.R1
   A. Working knowledge of behavior can help an instructor better understand a learner
      i. Leads to successful instruction
   B. Understand and adjust for different personalities, motivators, learning styles, etc.

Conclusion:
Brief review of the main points

I.B. Learning Process

References: Aviation Instructor's Handbook (FAA-H-8083-9) – Chapter 3

Objectives	The learner should develop knowledge of the elements related to the learning process as required in the Instructor ACS.
Elements	1. Definitions of Learning 2. Learning Theory 3. Perceptions and Insight 4. Acquiring Knowledge 5. Laws of Learning 6. Domains of Learning 7. Characteristics of Learning 8. Acquiring Skill Knowledge 9. Distractions & Interruptions, Fixation & Inattention 10. Errors 11. Memory & 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. **Definitions of Learning** FI.I.B.K1
    A. Numerous definitions
        i. Change in behavior of the learner as a result of experience
        ii. Process by which experience brings about a relatively permanent change in behavior
        iii. Change in behavior that results from expertise & practice
        iv. Gaining knowledge or skills, or developing a behavior, through study, instruction, or expertise
        v. Process of acquiring knowledge or skill through study, expertise, or teaching
            a. Depends on experience and leads to long-term changes in behavior potential
            b. Behavior potential: Possible behavior of an individual in a given situation in order to achieve a goal
        vi. Relatively permanent change in cognition, resulting from experience and directly influencing behavior
    B. Effective instructors
        i. Understand the subject material, the learner, and the learning process & the relationship between them
        ii. Realize learning is a complex process
        iii. Assist each learner in reaching their goals while building self-esteem & confidence
2. **Learning Theory** FI.I.B.K2
    A. A body of principles used to explain how people acquire skills, knowledge, and attitudes
        i. 2 concepts: Behaviorism and Cognitive Theory
    B. Behaviorism (Positive Reinforcement, rather than no reinforcement or punishment) FI.I.B.K2a
        i. Encourage progress and learning with rewards
        ii. Popularity of behaviorism has waned – learning is much more complex than simple rewards
    C. Cognitive Theory (Focuses on what is going on inside the learner's mind) FI.I.B.K2b
        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 and retrieve it, use it to produce behavior, and receive and process feedback on the results
            b. Constructivism
                - Learning is the result of matching new information against preexisting information and integrating it into meaningful connections

- 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:
       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) FI.I.B.K8
    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

D. 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

3. Perceptions & Insight FI.I.B.K3

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

4. Acquiring Knowledge FI.I.B.K4

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 and schemas, we create manageable categories

5. Laws of Learning (REEPIR) FI.I.B.K5

A. 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

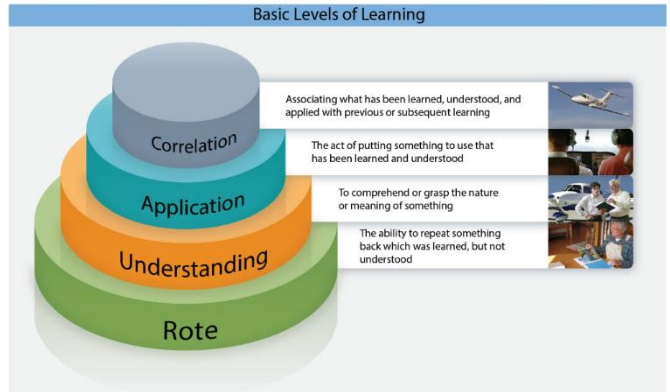
C. **E**xercise
   i. Connections are strengthened with practice and weakened without it
   ii. Most effective when a skill is learned in the context of real-world applications
D. **E**ffect
   i. Behaviors that lead to satisfying outcomes are likely to be repeated, and vice versa
   ii. Teaching should 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

6. **Domains of Learning** (What is to be learned: Knowledge, Attitude Change, and/or Physical Skill) FI.I.B.K6
   A. **C**ognitive Domain (Change in Knowledge) FI.I.B.K6a
      i. Includes ground school, reading a textbook, etc.
      ii. 6 major levels starting from the simplest to the most complex
      iii. Highest level may be shown by learning to evaluate a maneuver

	Competence	Skills Demonstrated	Example
I	Knowledge: remembering information	Define, identify, label, state, list, match, select	1. State the standard temperature at sea level. 2. Define a logbook entry.
II	Comprehension: explaining the meaning of information	Describe, generalize, paraphrase, summarize, estimate, discuss	1. In one sentence explain why aviation uses a standard temperature. 2. Describe why a log entry is required by the FAA.
III	Application: using abstractions in concrete situation	Determine, chart, implement, prepare, solve, use, develop, explain, apply, relate, instruct, show, teaches	1. Using a standard lapse rate, determine what the temperature would be at a pressure altitude of 4000'. 2. Determine when a logbook entry is required.
IV	Analysis: breaking down a whole into component parts	Points out, differentiate distinguish, examine discriminate, compare, outline, prioritize, recognize, subdivide	1. Compare what the different temperatures would be at certain pressure altitudes based on the standard lapse rate. 2. Determine information required for logbook entry.
V	Synthesis: putting parts together to form a new and integrated whole	Create, design, plan, organize, generate, write, adapt, compare, formulate, devise, model, revise, incorporate	1. Generate a chart depicting temperatures for altitudes up to 12,000'. 2. Write a logbook entry for an oil change.
VI	Evaluation: making judgments about the merits of ideas, materials, or phenomena	Appraise, critique, judge, weigh, evaluate, select, compare and contrast, defend, interpret, support	1. Evaluate the importance of this information for a pilot. 2. Evaluate the necessity of keeping logbook entries.

	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

   B. **A**ffective Domain (Change in Attitude) FI.I.B.K6b
      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) FI.I.B.K6c
      i. Skill based and includes physical movement, coordination, and use of the motor-skill areas
         a. Ex. flying a precision approach, programming a GPS
   D. Four Practical Levels of Learning
      i. Often categorized in the Cognitive Domain
      ii. Rote – Ability to repeat without understanding or application
         a. Define, identify, label
      iii. Understanding – Insight into what has been taught
         a. Learner consolidates old and new perceptions into an insight on a subject/maneuver
         b. Describe, estimate, explain



- iv. Application – Skill for applying what has been learned
    - a. Understands, has had demonstrations, and has practiced until consistent
    - b. Determine, develop, solve
- v. Correlation – Correlation of what has been learned with things previously learned and subsequently encountered
    - a. Primary objective in aviation instruction

7. Characteristics of Learning (PRMA) FI.I.B.K7

- 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

8. Acquiring Skill Knowledge FI.I.B.K9

- A. Skill knowledge: Skills that manifests themselves in the doing of something (Ex. riding a bike)
- B. Stages FI.I.B.K9a
    - 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. Knowledge of Results: The learner must be informed of their progress (both good and bad) FI.I.B.K9b
- D. How to develop skills: Consistent practice FI.I.B.K9c
- E. Learning Plateaus: Normal & temporary, ensure the learner understands this FI.I.B.K9d
    - i. Over-practice can bring on a learning plateau
- F. Types of Practice (3 types of practice which yield results in acquiring skills) FI.I.B.K10
    - i. Deliberate Practice: Practice specific areas for improvement and receive specific feedback after practice
    - ii. Blocked Practice: Practicing the same drill until it becomes automatic (enhances short-term performance)
    - iii. Random Practice: Mixes up the skills to be acquired throughout the practice session
        - a. Leads to better retention
- G. Evaluation vs. Critique FI.I.B.K11
    - i. Overview
        - a. Practical suggestions are more valuable than a grade in the initial stages of skill acquisition
        - b. Instructor monitors learner practice and provides feedback
        - c. Allowing the learner to critique themselves enhances learner-centered training
    - ii. Overlearning of Knowledge
        - a. The continued study of a skill after initial proficiency is established
        - b. Advantage: Application of knowledge is more streamlined and efficient
        - c. Disadvantage:
            - Reduces critical thinking

- Can impedes further learning or lead to forgetting general knowledge

iii. Application of Skill
   a. Final and critical question is "Can the learner use the information received?"
      - Learner needs to understand the skill so well it becomes easy/habitual
      - Learner needs to be able to recognize the situations where the skill is appropriate to use

H. Summary of Instructor's Actions
   i. Explain that the key to acquiring & improving skill is continued practice
   ii. Monitor practice and provide immediate feedback
   iii. Avoid conversation & other distractions when learners are practicing individual skills
   iv. Explain that learning plateaus are common and continued practiced = continued improvement

9. Distraction & Interruptions, Fixation & Inattention FI.I.B.K12

A. Distraction: Unexpected event that causes the learner's attention to be momentarily diverted
   i. Learners need to decide whether a distraction warrants further attention/action
B. Interruption: Unexpected event where the learner voluntarily suspends one task to complete a different one
   i. Significant source of errors - Learners need to develop procedures for dealing with interruptions
C. Fixation: Occurs when the learner becomes absorbed in one task to the exclusion of other tasks
   i. Generally, a sign that the task has not been mastered well enough to be performed with other tasks
D. Inattention: Occurs when a learner fails to pay attention to a task that is important
   i. Can be a natural byproduct of fixation
   ii. Can occur when learners are not busy, or don't find a task important/are bored
   iii. Alert the learner to the problem and develop habits to keep their attention
E. Identifying Fixation & Inattention Problems
   i. Follow where learners look
      a. Extended time on one instrument could be fixation
      b. Extended time neglecting engine instruments could be inattention

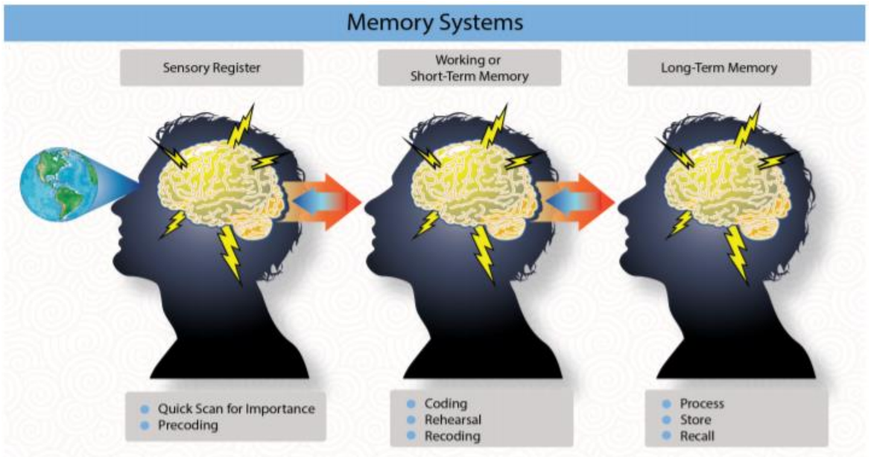
10. RM: Errors (RM: Recognizing & correcting learner errors) FI.I.B.K13, FI.I.B.R3

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. Take time, work at a comfortable pace
   iii. Check for errors
   iv. Use reminders (checklists, bugs, notebook, etc.)
   v. Develop routines
   vi. Raise awareness of conditions and 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 & Forgetting FI.I.B.K14

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) FI.I.B.K14a
  i. Receives stimuli from environment, quickly processes it based on personal idea of what is important
    a. If it is dramatic or impacts more than one sense it is more likely to make an impression
  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) FI.I.B.K14b
  i. Resembles a control tower; responsible for coordinating all incoming and outgoing information
  ii. Info is stored for about 30 seconds, then it may rapidly fade or be sent into long-term memory
    a. Repetition 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) FI.I.B.K14b
  i. Relatively permanent storage of unlimited information (Information typically has some significance to it)
  ii. For it to be useful, special effort must have been expended during the coding process
    a. The more effective the coding, the easier the recall
  iii. Affects a person's perceptions of the world
  iv. Make training relevant and meaningful to transfer new information to long-term memory

E. Memory and Usage FI.I.B.K14c
  i. Retrieving knowledge or skills is primarily related to how often and how recently the knowledge was used

F. Theories of Forgetting FI.I.B.K14d
  i. **F**ading: Suggests that information that is not used for a period of time is forgotten
  ii. **I**nterference: Another experience has overshadowed the info, or learning of similar things has intervened
    a. Material not well learned suffers most from interference

iii. Retrieval Failure: Inability to retrieve the information
iv. Repression or Suppression: Don't want to remember feelings associated with a memory

12. Retention of Learning FI.I.B.K15

A. Teach thoroughly and with meaning to make certain that learning is readily available for recall
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 FI.I.B.K16

A. Ability to apply knowledge or procedures learned in one context into new contexts
B. 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. 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)
C. Habit Formation - Insist on correct techniques/procedures to provide proper habit patterns
   i. Training traditionally has followed the building block concept - Start with the basics and build from there
D. Understanding: Ability to remember is greatly affected by the depth of understanding
E. 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
      a. Combine repetition of knowledge with efforts to increase understanding
F. Remembering after Training: Continued practice is the only means to retaining what was learned
G. Sources of Knowledge
   i. Instructor is primary, but also recommend other sources
   ii. Books, photographs, videos, diagrams, charts, etc.
   iii. Encourage the learner to gain experience in the real-world
H. 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

14. Risk Management Concepts

A. Lack of Learner Motivation FI.I.B.R2
   i. See lesson I.A. Effects of Behavior & Communication on the Learning Process section 1.B & C
      a. 1.B. Motivation & 1.C. Human Needs
B. Inadequate or Incomplete Instruction FI.I.B.R1
   i. Inadequate preparation or teaching leads to apathy in learners
   ii. Poor instruction also comes from distracting mannerisms, untidiness, or appearing irritated with the learner
   iii. Talking down to the learner is one of the fastest ways to lose their confidence and attention

iv. Provide well-planned, appropriate, and accurate instruction
    a. Teach to the level of the learner – teaching needs to be meaningful to the person for whom it's intended

Conclusion

Brief review of the main points

I.C. Course Development, Lesson Plans, & Classroom Training Techniques

References: Aviation Instructor's Handbook (FAA-H-8083-9) Chapter 5 & 7

Objectives	The learner should develop knowledge of the elements related to course & lesson development as required in the Instructor ACS.
Elements	1. Teaching 2. Course of Training 3. Preparation of a Lesson 4. Organization of Material 5. Training Delivery Methods 6. Electronic Learning 7. Instruction Aids and Training Technologies 8. Problem Based Instruction 9. Integrated Flight Instruction 10. Planning Instructional Activity
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 how to prepare a lesson, and effectively organize and present the material, integrating training aids, problem-based instruction, & other tools based on the specific learner(s) and the situation.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

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

Overview

Review Objectives and Elements/Key ideas

What

The teaching process can be divided into 4 steps - preparation, presentation, application, and review and evaluation. This lesson focuses on the preparation, organization, presentation, and instructional tools and techniques.

Why

Effective planning, organization and presentation is essential to providing a proper learning experience.

How:

1. **Teaching** FI.I.C.K1
   - A. Process FI.I.C.K1a
     - i. Organizes material to teach in a way the learner can understand
     - ii. Four steps: Preparation, Presentation, Application, Review/Evaluation
   - B. 4 Essential Teaching Skills FI.I.C.K1b
     - i. People skills
       - a. Effective instructors relate well to people
       - b. Effective communication requires actively listening to the learner
     - ii. Subject matter expertise
       - a. Effective instructors have a sincere interesting in learning & professional growth
     - iii. Management skills
       - a. Ability to plan, organize, lead, and supervise (plan, organize & carry out a lesson)
       - b. Effective time management to achieve goals without over planning
       - c. Supervision of learners when necessary (i.e., preflight procedures)
     - iv. Assessment skills (more details in Task D.)
       - a. Used to verify the learner's progress
2. **Training Course** FI.I.C.K2
   - A. Complete series of studies leading to a specific goal
   - B. Includes
     - i. Curriculum: Courses for various pilot certificates and ratings
     - ii. Syllabus: Summary/outline of an individual course of study containing multiple lessons
     - iii. Lesson plan: Detailed plan for how a specific lesson is conducted
       - a. Objective, organization, teaching aids, instructor/learner actions, evaluation criteria, standards
3. **Preparation of a Lesson** FI.I.C.K3
   - A. Lesson must be planned – Objectives, procedures and facilities, goals to be attained, review/evaluation
   - B. Training Objectives & Completion Standards FI.I.C.K3a
     - i. Objectives: Performance & Decision Based
       - a. Performance: Define exactly what needs to be done and how it is done
       - b. As training progresses, shift toward decision-based objectives

- Scenario based training to teach critical thinking skills

c. Clearly defined objectives are critical and should include the desired level of learning from the domain(s)

ii. Completion Standards

a. Description of the desired knowledge, behavior, or skill in specific terms, along with conditions & criteria

b. Should contain comprehensive examples of desired learning outcomes or behaviors

C. Performance Based Objectives FI.I.C.K3b

i. Set measurable, reasonable standards describing desired performance

a. Must be clear, measurable, and repeatable

ii. Elements:

a. Description - Desired outcome as a change in knowledge, skill, or attitude (concrete & measurable terms)

b. Conditions - Explain the rules for skills demonstration

- Equipment, tools, material, limiting parameters, etc.

c. Criteria - Standards measuring objective accomplishment

- Should be no question whether the objective is met

D. Importance of the ACS FI.I.C.K3c

i. Supply specific performance objectives based on the standards for issuance of a certificate/rating

ii. Use the maneuver-based approach of the ACS but present the objectives as scenario-based training

E. Decision Based Objectives FI.I.C.K3d

i. Scenario based training to develop judgement/ADM - Facilitates a higher level of learning and application

4. Organization of Material FI.I.C.K4

A. Intro – Sets the stage for everything to come. 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

5. Training Delivery Methods (Presentation) FI.I.C.K5

A. Lecture FI.I.C.K5a

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. Discussion FI.I.C.K5b

i. Short lecture followed by instructor-learner & learner-learner discussion

ii. Requires participation & develops higher order thinking skills (HOTS)

C. Guided Discussion FI.I.C.K5c

i. Goal is to draw out learner knowledge (encourages active participation)

ii. Instructor acts as a facilitator

iii. Useful in areas where learners can use initiative and imagination in addressing problems

D. Cooperative or Group Learning FI.I.C.K5d
   i. Organizes learners into small groups who work together to maximize understanding
   ii. Instructor
      a. Plan what the group is expected to learn and be able to do on their own
      b. Use clear & specific objectives to describe the knowledge/abilities to be acquired
   iii. Conditions & Controls
      a. Small, heterogeneous groups
      b. Clear, complete instructions (what to do, in what order, materials)
      c. Learner perception of targeted objectives as their own, personal objectives
      d. Opportunity for learner success
      e. Learner access to and comprehension of required info
      f. Sufficient time for learning
      g. Individual accountability
      h. Recognition & reward for group success
      i. Time to reflect on how they worked together as a team
E. Demonstration-Performance Method FI.I.C.K5e
   i. Best used for the mastery of mental or physical skills that require practice
   ii. Many aviation lessons can combine the lecture and demonstration-performance methods
   iii. Five Phases: Explanation, Demonstration, Learner Performance, Instructor Supervision, Evaluation
F. Drill and Practice Method FI.I.C.K5f
   i. Connections are strengthened with practice
   ii. Learn by practicing and applying what they have been told and shown
G. Be familiar with as many methods as possible
H. RM: Selection of Teaching Method - Choose the best method(s) based on the situation FI.I.C.R1

6. Electronic Learning FI.I.C.K6

A. General
   i. Any type of education involving an electronic component
   ii. Advantages: Time flexible, cost effective, easily updated, accessible from anywhere, self-paced
   iii. Limitations: Lack of interaction and personal feedback, limited instruction on certain subjects, cost, system operation training, not a replacement for the real thing
B. Computer Assisted Learning (CAL) 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
C. Simulation, Role-Playing, Video Gaming
   i. Allows the learner to learn/practice in a defined environment
   ii. Can practice things that would otherwise be dangerous in the plane, like emergency procedures

7. Instruction Aids and Training Technologies FI.I.C.K7

A. Effective instruction aids: FI.I.C.K7a
   i. Cover key points & concepts
   ii. Straightforward & factual
   iii. Relatively simple
B. Reasons for instructional aids: FI.I.C.K7b
   i. Assist in the teaching-learning process
   ii. Clarify relationships between objects & concepts
   iii. Help learners understand & retain knowledge
   iv. Hold learner's attention

v. Utilize multiple senses
vi. Help solve language barriers

C. Guidelines for Use of Instructional Aids FI.I.C.K7c
   i. Clearly establish the lesson objective
   ii. Gather necessary data
   iii. Organize the material into a lesson plan
   iv. Select the ideas to be supported with aids

D. Types of Aids FI.I.C.K7d
   i. Chalk/Marker Board
   ii. Print Material
   iii. Enhanced Training Materials (training syllabi/records, maneuvers guide, etc.)
   iv. Projected Material & Video
   v. Computer learning and Interactive Systems
   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.

8. Problem Based Instruction FI.I.C.K9

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 - Instructor helps 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

9. Integrated Flight Instruction (Aviation Instructor's Handbook, Chapter 9) FI.I.C.K8

A. Learners are taught to perform flight maneuvers both by visual & instrument references
   i. Leads to improved airspeed control, navigation, coordination, landings, safety, and overall competency
B. From the first brief, each maneuver is introduced with outside references & expected instrument indications
C. See & Avoid: Don't allow the focus on instrument indications to preclude scanning & collision avoidance

10. Planning Instructional Activity (Aviation Instructor's Handbook, Chapter 7) FI.I.C.K10

A. Blocks of Learning FI.I.C.K10a
   i. Constitute the necessary parts of the total objective
   ii. By developing blocks, a learner can master the segments (blocks) individually
      a. Blocks should represent units of learning which can be measured and evaluated
      b. Blocks should be truly integral – extraneous blocks waste money and detract from objectives
   iii. Any problems can be divided into blocks of learning

B. Training Syllabus FI.I.C.K10b
   i. Road map showing how to accomplish the overall objective of a course
   ii. Format & Content
      a. The syllabus should always be in the form of an abstract or digest of the course training
         - Include blocks of learning to be completed in the most efficient order
         - Well defined objectives and standards for
            a The overall course
            b Each stage of training
            c The separate flight and ground segments
   iii. Using a Training Syllabus
      a. Must be flexible, and should be used as a guide
         - Consider the effects on the learning blocks if departing from the syllabus
      b. Ground Lessons
         - Concentrate on the cognitive domain of learning
         - Many areas concern safety/ADM/judgment which are related to the affective domain
      c. Flight Lessons
         - Generally, emphasize the psychomotor domain, but affective is also important
         - Should include risk management instruction
   iv. Include special emphasis areas that are causal factors in accidents or incidents

C. Lesson Plans FI.I.C.K10c
   i. Purpose
      a. Designed to assure each learner receives the best possible instruction under existing conditions
      b. An adequate lesson plan, when properly used, should:
         - Assure a wise selection of material and the elimination of unimportant details
         - Make certain that due consideration is given to each part of the lesson
         - Aid the instructor in presenting the material in a suitable sequence for efficient learning
         - Provide an outline for the teaching procedure to be used
         - Serve as a means of relating the lesson to the objectives of the course of training
         - Give the inexperienced instructor confidence
         - Promote uniformity of instruction regardless of the instructor or date on which the less is given

ii. Characteristics
  a. Working document that should be revised as changes occur or are needed
  b. Unity – should be a unified segment of instruction
  c. Content – Each lesson should contain new material, but it should be related to previous lessons
  d. Scope – Each lesson should be reasonable in scope (reasonable objectives)
  e. Practicality – Plan each lesson in terms of the conditions under which training is to be done
  f. Flexibility – A degree of flexibility should be incorporate even though there is an outline
  g. Relation to a Course of Training – Plan and teach each lesson so the relation to objectives is clear
  h. Instructional Steps – Every lesson falls logically into the four steps of the teaching process

Conclusion
Brief review of the main points

I.D. Student Evaluation, Assessment, and Testing

References: Aviation Instructor's Handbook (FAA-H-8083-9) Chapter 6 & 9

Objectives	The learner should develop knowledge of the elements related to evaluation, assessment & testing as required in the Instructor ACS.
Elements	1. Assessment 2. Critique 3. Assessment of Piloting Ability
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 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 in assessing levels of learning, including the different methods of assessment, and how to conduct effective assessments, critiques, and tests.

Why

The instructor must be able to appraise the learner's performance and convey this information back to the learner to maximize learning and progress. This is not only an essential part of testing, but occurs after every flight, at stage checks, and in preparation for the checkride to measure and document whether course objectives have been met.

How:

1. **Assessment** FI.I.D.K1
   - 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 FI.I.D.K2
     - 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 FI.I.D.K3
     - i. Perform real-world tasks, and demonstrate a meaningful application of skills and competencies
       - a. Uses open ended questions and established performance criteria
       - b. Learners must generate responses from skills and concepts they have learned

c. Enhances real-world skills, encourages high order thinking, and self-assessment of work/performance

ii. Learner Centered Assessment FI.I.D.K3a
   a. Open ended questions and set criteria are important characteristics
      - Four-step series of open-ended questions to guide the learner through a self-assessment
         a Replay: Verbally replay the flight or procedure
         b Reconstruct: Identify the things that could have been done differently
         c Reflect: Reflect on the events to find insight
         d Redirect: Relate the lessons learned to other experiences
      - Can then compare the instructor's assessment with the learner's self-assessment
      - Post assessment, progress is recorded on a rubric. Two broad rubrics are used:
         a One that assesses proficiency on skill-focused maneuvers/procedures (Maneuver Grades)
         b One that assesses proficiency on single-pilot resource management (Risk Management Skills)

iii. Maneuver or Procedure Grades FI.I.D.K3b
   a. Describe: Learner can describe characteristics and elements but needs help executing the maneuver
   b. Explain: Learner can describe the activity, its concepts, principles & procedures but needs help executing
   c. Practice: Learner can plan and execute the scenario. Assistance corrects deviation and errors
   d. Perform: Learner identifies/corrects errors & can perform the activity without instructor assistance
   e. Not Observed: Not accomplished/required

iv. Assessing Risk Management Skills FI.I.D.K3c
   a. Explain: Can identify, describe & understand risks, but needs prompted to identify risks/make decisions
   b. Practice: Can identify, understand, and apply SRM principles; assistance corrects deviation & errors
   c. Manage-Decide: Can gather the most important data, identify courses of action, evaluate risk in each course of action, and make the appropriate decision; instructor intervention not required

E. Choosing an Assessment Method FI.I.D.K4
   i. Determine level-of-learning objectives
      a. Should measure one of the learning levels of the cognitive, affective, or psychomotor domains
   ii. List indicators of desired behaviors
      a. Samples of measurable behavior that give the best indication the objective has been achieved
   iii. Establish criterion (performance-based) objectives
      a. State the behavior expected, conditions under which it is to be performed, and criteria that must be met
   iv. Develop criterion-reference test items
      a. Written Test Questions should attempt to measure the behavior described in the criterion objectives
      b. Performance Tests for Maneuvers
         - Desirable for evaluating training based on ACS standards
         - Instructor's job is to prepare the learner for the practical tests

F. Oral Assessment FI.I.D.K6
   i. Overview
      a. Most common means of assessment
      b. Questions are generally classified as fact questions (memory or recall) and HOT questions (analyze situations, solve problems, arrive at conclusions)
      c. Desirable results when done properly:
         - Reveals the effectiveness of the training methods
         - Reviews material already presented to the learner
         - Checks learner retention of what has been learned
         - Checks comprehension of what has been learned
         - Can be used to retain learner interest and stimulate thinking
         - Emphasizes the important points of training

- Identifies points that need more emphasis
- Promotes active learner participation, which is important to effective learning

ii. Effective Questions: FI.I.D.K6a
   a. Apply to the subject of instruction
   b. Brief and concise, but also clear and definite
   c. Adapted to the ability, experience, and stage of training of the learners
   d. Center on only one idea (limited to who, what, where, when, why, or how and not a combination)
   e. Present a challenge to the learner

iii. Questions to Avoid FI.I.D.K6b
   a. Yes/No questions, Puzzle, Oversize, Toss-up, Bewilderment, Trick, Irrelevant Questions

iv. Answering Learner Questions FI.I.D.K6c
   a. Understand the questions before you answer
   b. Display interest in the question, and frame an answer that is as direct and accurate as possible
   c. After responding, determine if the learner is satisfied with the answer
   d. If overly advanced for the stage of training, explain that, and reintroduce the question later
   e. If you cannot answer the question, freely admit not knowing, but promise to get the answer or reintroduce the question later at the appropriate point in training

2. Critique FI.I.D.K5

A. Purpose
   i. An instructor-to-learner assessment
      a. Used in conjunction with a traditional or authentic assessment
   ii. Covers good/bad performance, the individual parts, relationships of individual parts & overall performance
   iii. Oral, written, or both

B. Types
   i. Instructor / Learner Critique - Instructor leads discussion where learners offer criticism of a performance
      a. This should be controlled carefully and directed with a firm purpose (not a free-for-all)
   ii. Learner Led Critique - A learner is asked to lead the assessment; Can generate interest and learning
   iii. Small Group Critique - Small groups are assigned a specific area to analyze and present their findings on
      a. The combined reports can result in a comprehensive critique
   iv. Critique by another Learner - Another learner is requested to present the entire assessment
      a. The instructor must maintain firm control over the process
   v. Self-Critique - A learner critiques their own personal performance
      a. Do not leave controversial issues unresolved, or erroneous impressions uncorrected
   vi. Written Critique
      a. Instructor can devote more time and thought to it
      b. Learners can keep written assessments and refer to them whenever they wish
      c. The learner has a record of suggestions, recommendations, and opinions of all other learners
      d. Disadvantage is that other members of the class do not benefit

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

3. Assessment of Piloting Ability (Aviation Instructor's Handbook, Chapter 9) FI.I.D.K7

A. Overview

   i. Essential part of the teaching process to determine how, what, and how well learning is occurring
   ii. Provides learner something constructive to work or build on
   iii. Learners must understand the purpose of the assessment

B. Demonstrated Ability
   i. Assessment must be based on established standards of performance adjusted for the learner's experience
   ii. Evaluation considers the mastery of maneuver/procedure elements rather than just the overall performance
   iii. Ex: Qualification of learners for solo & solo xc privileges depends upon demonstrated performance

C. Postflight Evaluation
   i. Keep the learner informed of progress
   ii. Should be written
   iii. With SBT, collaborative assessment is used when a scenario is completed

D. Practice Landings
   i. Aircraft speed & control take precedence during takeoff & landing
   ii. Stress touching down in the first third of the runway
   iii. Go around if not in the first third, not within standards, or unsafe
   iv. Full stop landings are beneficial to aircraft control, checklist use, and time for detailed instruction

E. Solo Flight (& Pilot Supervision)
   i. Responsibility to provide guidance and restraint with respect to solo operations
      a. By far the most important instructor responsibility
   ii. Ensure a positive, confidence building experience
      a. Be available to answer questions or resolve issues
      b. Have access to a portable radio, if possible, to monitor and, terminate the solo if a situation arises
   iii. Debrief
      a. Answer questions
   iv. Be involved in all aspects of the flight to ensure correct flight procedures

F. Correction of Errors
   i. Safety permitting, it's often better to let learners progress part way into a mistake and find a way out
   ii. Learners may perform a procedure correctly but not fully understand the principles/objectives
      a. Vary the procedure slightly, combine it with another operation, or apply the elements to the performance of another procedure

G. Visualization
   i. Scenario-Based Training is very useful
   ii. Have the learner visualize/describe a normal flight, and then add unforeseen circumstances

H. Dealing with Normal Challenges
   i. Teach learners to solve ordinary problems encountered during flight
      a. Pattern congestion, runway change, unexpected crosswinds, etc. must be mastered individually before collectively

I. Practical Test Recommendations
   i. Serious flight instructor responsibility
   ii. Require learner to thoroughly demonstrate the knowledge & skill required for the certificate/rating
      a. Failure to ensure the learner meets the requirements is a serious deficiency in instructor performance

RM: Delivering an Assessment FI.I.D.R1

The lesson as a whole is a discussion of mitigating risk associated with delivering assessments

Conclusion

Brief review of the main points

I.E. Elements of Effective Teaching in a Professional Environment

References: Aviation Instructor's Handbook (FAA-H-8083-9) Chapter 8

Objectives	The learner should develop knowledge of the elements related to flight instructor characteristics, responsibilities, & professionalism as necessary in the Instructor ACS.
Elements	1. Aviation Instructor Responsibilities 2. Flight Instructor Responsibilities 3. Qualifications & Professionalism 4. Professional Development 5. Ethics & Conduct
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** FI.I.E.K1
   - A. Helping Learners FI.I.E.K1a
     - i. Learning should be enjoyable and interesting
     - ii. Standards, and measurement against standards, are key to helping learners
   - B. Providing Adequate Instruction FI.I.E.K1b
     - 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 FI.I.E.K1c
     - 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 FI.I.E.K1d
   - E. Minimizing Learner Frustration (Encourage, rather than discourage) FI.I.E.K1e
     - 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. **RM: Flight Instructor Responsibilities** (RM: Fulfilling Instructor Responsibilities) FI.I.E.K2, FI.I.E.R1
   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
      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, 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
   C. Pilot Supervision & Surveillance
      i. Instructors have the responsibility to provide guidance & restraint with respect to solo operations
      ii. Does not stop at solo
         a. Responsibility to train competent, safe, and smart pilots who will be an asset to the aviation community
3. **Qualifications & Professionalism** FI.I.E.K3
   A. Qualifications
      i. Be thoroughly familiar with the functions, characteristics, and use of all flight instruments/avionics/systems
      ii. Maintain familiarity with current pilot training techniques and certification requirements
   B. RM: Professionalism FI.I.E.R2
      (RM: Exhibiting Professionalism)
      i. The instructor is the central figure in aviation training and bear responsibility for all phases of training
   C. Sincerity – Always be straight forward and honest
      i. Do not attempt to hide inadequacy – can lead to loss of confidence and adversely affect learning
   D. 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
   E. 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)
   F. 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
   G. Proper Language - Speak normally, without inhibitions; positively and descriptively, without profanity
4. **Professional Development** FI.I.E.K4
   A. Be alert for ways to improve your qualifications,

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.

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

5. Instructor Ethics & Conduct FI.I.E.K5

A. A formal code of conduct/ethics promotes safety, good judgement, ethical behavior, and personal responsibility
    i. Flight Instructors Model Code of Conduct (FIMCC)
B. Remember you are teaching a pilot who should:
    i. Make safety the #1 priority
    ii. Develop and exercise good judgment in making decisions
    iii. Recognize and manage risk effectively
    iv. Be accountable for their actions
    v. Act with responsibility and courtesy
    vi. Adhere to prudent operating practices and personal operating parameters
    vii. Adhere to applicable laws and regulations
    viii. Seek proficiency in control of the aircraft
    ix. Use flight deck technology in a safe and appropriate way
    x. Be confident in a wide variety of flight situations
    xi. Be respectful of the privilege of flight

Conclusion

Brief review of the main points

I.F. Elements of Effective Teaching (Risk Management & Accident Prevention)

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

Objectives	The learner should develop knowledge of the elements related to managing and mitigating risk and its application to effective teaching per the Instructor ACS.
Elements	1. Principles of Risk Management 2. Risk Management Process 3. Risk Management Tools 4. Teaching Risk Management 5. Obstacles to Maintaining SA 6. ADM, CRM, & SRM
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 not only recognize potentially hazardous situations and effectively mitigate risk but can teach practical risk management.

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

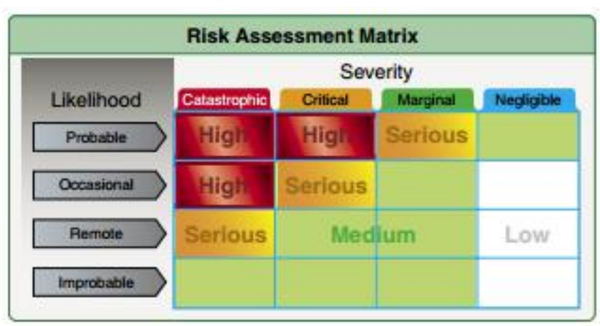
Risk management is a decision-making process designed to perceive hazards systematically, assess the degree of risk associated with a hazard, and determine the best course of action. Beyond understanding these principles, this lesson discusses effective techniques for teaching risk management.

Why

Flying is inherently dangerous, but there are ways to keep the danger to a minimum. Risk management skills are foundational to every flight, providing the learner the ability to recognize and mitigate the dangers associated with each flight, and make logical decisions regarding safety.

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** FI.I.F.K1
   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
      ii. Measured in terms of
         a. Probability or the likelihood that a hazard will cause a loss
         b. Severity, or the extent of the possible loss
      iii. Develop a method to tangibly measure risk
         a. Risk Assessment Matrix (pictured)
         b. Likelihood (probability of occurrence): Probable, Occasional, Remote, Improbable
         c. Severity: Catastrophic, Critical, Marginal, Negligible
   C. Step 3: Mitigate the Risk
      i. Look for ways to reduce, mitigate, or eliminate risk
      ii. Use the Cost/Benefit analysis to decide if it is worth



accepting the risk

iii. Delay or cancel the flight, change the route / destination, bring a CFI or more experienced pilot, etc.

3. Risk Management Tools FI.I.F.K2

A. PAVE Checklist FI.I.F.K2a

i. Another way to mitigate risk

ii. Risk is divided into 4 categories

a. Decide whether the risks can be managed safely. If not, the flight should be cancelled

iii. **P**ilot in Command: Am I ready? (IMSAFE Checklist, proficiency, recency, currency, etc.)

iv. **A**ircraft: Is the aircraft appropriate for the trip?

a. Maintenance, Landing Distance, Performance Capabilities, Equipment, Fuel load, Altitude, etc.

v. En**V**ironment: Weather, Terrain, Airports, Airspace, Day/Night, etc.

vi. **E**xternal Pressures: Influences outside of the flight that create pressure to complete the flight

a. This is the one risk factor that can cause a pilot to ignore all other risk factors

b. Follow your own personal operating procedures (don't bend the rules for anyone)

B. 5P Checklist

i. Used to evaluate the situation at key decision points during the flight, or when an emergency arises

a. Very helpful portion of Single Pilot Resource Management (SRM)

b. At least 5 times, review the 5 P's and make a decision for the current situation

- 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

ii. The 5 P's:

a. Plan - The mission. It contains planning, weather, route, fuel, publication currency, etc.

- Always changing, adjust with it

b. Plane - Condition, abilities (performance, automation, etc.), equipment, systems, etc.

c. Pilot - IMSAFE

d. Passengers - Passenger's desires can have an influence on decision making and risk management

- Ensure passengers understand the risk and are involved in decision making process
- Understand what passengers want to do (they may be more risk averse than you)

e. Programming - Plan when and where programming should (and should not) be accomplished

C. Flight Risk Assessment Tools (FRAT) FI.I.F.K2b

i. Formal process to remove personal desires and emotion from decision making (numerous FRATs available)

a. Determine an acceptable level of risk for flight based on type of operation, environment, aircraft, etc.

- Create realistic numerical thresholds (min of 3) that trigger additional levels of scrutiny, for example:
  - a Green (medium): Good to fly, mitigate risk as able
  - b Yellow (serious): Some risk needs to be reduced before departure
  - c Red (high): Do not fly until risk is reduced/mitigated
- Hazards are scored based on severity
- When risk exceeds the acceptable level, reevaluate hazards and reduce risk or don't fly

ii. National Business Aviation Association (NBAA) Flight Risk Assessment Tool

D. IMSAFE Checklist (can be incorporated into the Pilot portion of the PAVE checklist & the 5 Ps)

i. Mitigate risk by determining your own physical and mental readiness for flight

a. Illness – Symptoms?

b. Medication – Taking any?

c. Stress – Family, money, relationships, work, etc.

d. Alcohol – Been drinking?

e. Fatigue – Well rested?

f. Emotion – Emotionally upset?

4. Teaching Risk Management (RM)

A. When & How FI.I.F.K3
   i. Most beneficial if RM is taught first (lesson 1) and then integrated into the rest of training (ground & flight)
   ii. Should be included in all preflight and postflight briefings
   iii. Include in recurrent, transition, flight reviews, IPCs, etc.

B. Teaching Techniques by Phase of Instruction FI.I.F.K4
   i. Private Pilot
      a. Pre-Solo
         - Part of every preflight & postflight brief
         - Introduce a non-numerical FRAT and demo its use. Learner can conduct basic RM analysis by solo
      b. Post-Solo to XC
         - Perform risk analysis of planned flight with some help from instructor
         - Instructor reviews RM prior to solo flight, and learner debriefs instructor on RM aspects of the flight
      c. XC
         - Learner masters RM techniques
         - Learner completes a full risk analysis for every flight and reviews it with instructor
   ii. Instrument
      a. Emphasize broad risk management techniques to analyze/evaluate complex weather & other elements
   iii. Transition
      a. Employ scenarios emphasizing RM & SRM aspects of the new plane
   iv. Recurrent, Flight Reviews, IPCs
      a. Use RM scenarios that mirror the pilot's typical operating profile
   v. Operational Flights
      a. Encourage operational pilots to practice RM on all their flights
         - Goal is to provide guidance allowing pilots to think of RM intuitively as part of every flight
      b. Scale RM procedures to match the complexity of the flight
   vi. Professional Pilots
      a. Most professional pilots encounter RM and more (TEM, CRM, etc.) training at their jobs
      b. Emphasize RM factors specific to this training, outside of their job

C. RM: Managing Risk during Flight Instruction FI.I.F.K5, FI.I.F.R1
   i. Overview
      a. Same RM techniques as taught to learners apply to the instructor (maintain SA)
   ii. Common Risks FI.I.F.K5a
      a. Identify risks using the PAVE acronym (Pilot, Aircraft, Environment, External Pressures)
         - Generic examples below
      b. Pilot (includes learner & instructor pilot)
         - Qualification & aeromedical risks
         - Flight Risks: Be prepared for the learner to make mistakes
            a Mitigation: Proactive planning based on conditions, providing time & space to allow the learner to practice and allow the instructor to takeover if necessary
      c. Aircraft: Maintenance & payload/performance requirements based on the flight
      d. EnVironmental
         - Collision Hazards: Crowded airspace and/or restricted visibility due to haze, pollution, other factors
         - Complex airspace
      e. External
         - Scheduling problems, which can be aggravated by aircraft problems, weather, etc.
         - Learners are subject to work, family, finances, and other issues

iii. Best Practices FI.I.F.K5b
   a. Follow RM procedures discussed in this lesson
   b. Always include the learner in RM
   c. Pilot: Be familiar with aircraft & avionics before instructing, IMSAFE, etc.
   d. Aircraft: Determine airworthiness, resolve any concerns (include the learner in the process)
   e. Environment: Emphasize precise risk assessment & mitigation with learner (terrain, weather, etc.)
   f. External: Be conscious of learner's limitations, concerns & other factors that can affect performance

iv. Takeoff & Landing Considerations FI.I.F.K5c
   a. Takeoff
      - Majority of teaching should be done prior to contacting tower/advising CTAF of takeoff
      - Imperative that the instructor creates realistic training scenarios
   b. Landing
      - Don't teach landings mechanically
      - Teach when the learner can listen and absorb
      - Certain landings present unique risks, be aware and be ready

5. RM: Obstacles to Maintaining SA FI.I.F.R2

A. Distraction
   i. Minor problem can result in neglecting proper control of the aircraft
   ii. Divide attention – flying always comes first

B. Fatigue
   i. Two major phenomena: Sleep loss & circadian rhythm disruption
   ii. Fatigue is a normal response to many flight operation conditions (noise, vibration, low pressure)
   iii. Only effective treatment is sleep

C. Complacency
   i. Overconfidence from repeated experience
   ii. Reduces effectiveness in the flight deck
   iii. Difficult to recognize
      a. Be especially alert to complacency in learners with significant experience
      b. Advanced avionics can promote complacency and inattention
   iv. Exercises to recognize complacency and situational awareness
      a. Ask about positions of other aircraft, instrument indications, and location in relation to references
      b. Focus the learner's attention on an imaginary problem
         - Point out that SA is not being maintained if the learner diverts too much attention from other tasks

6. ADM, CRM, & SRM FI.I.F.K6

A. Aeronautical Decision Making (ADM)
   i. Systematic approach to the mental process used to determine the best course of action
      a. It is estimated that approximately 80% of all aviation accidents are a result of human factors
   ii. Decision Making Process
      a. Define the Problem
         - Recognize a change has occurred or an expected change did not occur
         - Critical error: Incorrectly defining the problem
      b. Choose a Course of Action
         - Evaluate the need to react, determine actions to resolve the situation in the time available
         - Consider the expected outcome of each action and associated risks
      c. Implement the Decision and Evaluate the Outcome

B. Factors Affecting Decision Making
   i. RM: Hazardous Attitudes (pictured below) FI.I.F.R3

    a. Attitude affects the quality of decisions
    b. Must spot hazardous attitudes & remove them
  ii. Stress Management
    a. A certain amount of stress is normal/good
    b. Too much can be very bad – stress is cumulative
    c. 3 types of stress that affect performance
      - Physical: Associated with the environment (temperature, noise, vibration, lack of oxygen)
      - Physiological: Physical conditions (fatigue, lack of physical fitness, missed meals)
      - Psychological: Social or emotional factors (divorce, death in the family, sick child)
    d. Recognize when stress is affecting a learner
      - Distracted or has a difficult time accomplishing tasks
      - Try to determine the cause (doesn't have to be specific, could be a private matter)
      - Have them self-assess then set realistic goals - Delay training, if necessary
      - Put the learner and their progress first

C. Single Pilot Resource Management (SRM)/Crew Resource Management (CRM)
  i. What is it?
    a. How to gather information, analyze it, & make decisions
    b. Includes all groups working with the flight crew involved in decisions to operate a flight safely
  ii. Use of Resources
    a. Use all available resources (think outside the box)
    b. Internal Resources
      - Equipment, systems, charts, books, ingenuity, knowledge, skill, other passengers
    c. External Resources
      - ATC, flight service specialists, guard, etc.
    d. Workload Management
      - Plan, prioritize, and sequence to prevent overload
      - Prepare for high workload situations
      - Be able to recognize high workloads
  iii. 5 P's Check, as discussed is a very helpful to (SRM)

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

TECHNICAL SUBJECT AREAS

II.A. Human Factors

References:

Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25); Chapter 17 pgs. 1-19
Airplane Flying Handbook (FAA-H-8083-3) Chapter5 pg. 3
AIM – Chapter 8

Objectives	The learner exhibits knowledge regarding human factors as required in the Instructor 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
Elements	1. Hypoxia 2. Hyperventilation 3. Middle Ear and Sinus Problems 4. Spatial Disorientation 5. Motion Sickness 6. Carbon Monoxide Poisoning 7. Fatigue and Stress 8. Dehydration & Nutrition 9. Hypothermia 10. Optical Illusions 11. Nitrogen and Scuba Diving 12. Alcohol and Other Drugs 13. ADM, CRM, & SRM
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 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 are 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

Human factors involve several 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. **Hypoxia** AI.II.A.K1a
   - 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. Delayed reactions
     - iv. Impaired judgment
     - v. Euphoria
     - vi. Visual Impairment

vii. Drowsiness
viii. Lightheaded or dizzy sensation
ix. Tingling in fingers or toes
x. Numbness

G. Useful Consciousness
   i. Max time to make and carry out rational decisions without supplemental oxygen

H. Treatment
   i. Lower altitude and supplemental oxygen

I. FAA Physiology Training – One day course in OK with altitude chamber and vertigo demonstrations

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

2. Hyperventilation AI.II.A.K1b

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. Common Symptoms (very similar to hypoxia):
   i. Visual Impairment
   ii. Lightheaded or dizzy sensation
   iii. Tingling sensations
   iv. Hot and cold sensations
   v. Muscle spasms
   vi. Unconsciousness

C. 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. If unsure, treat for hypoxia (more dangerous situation)

3. Middle Ear and Sinus Problems AI.II.A.K1c

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

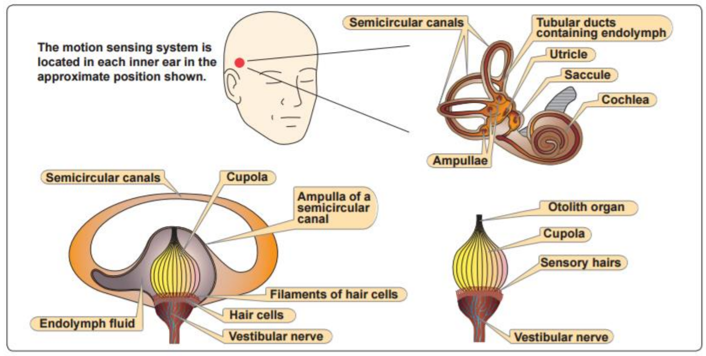
B. Sinus Problems
   i. Explanation
      a. Congestion prevents pressure in the sinuses equalizing with the pressure in the flight deck
   ii. Symptoms
      a. Sinus pain/Upper teeth ache
      b. Bloody mucus from the nasal passages
   iii. Treatment
      a. Slower descent rates can reduce the pain

b. Do not fly with sinus problems

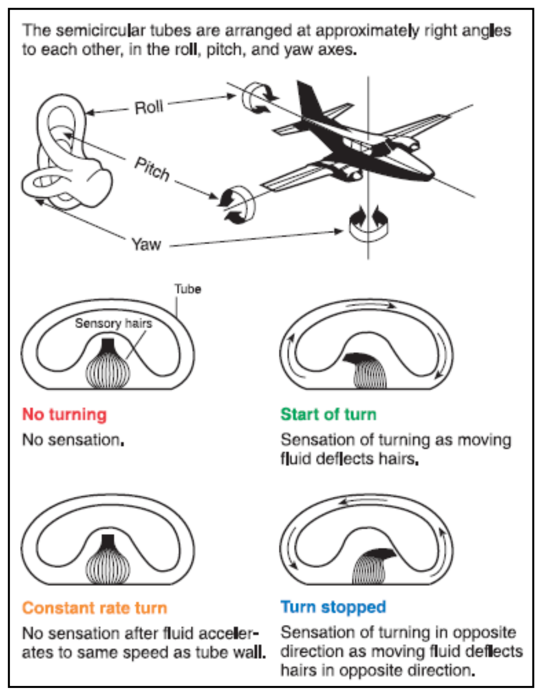
4. Spatial Disorientation AI.II.A.K1d

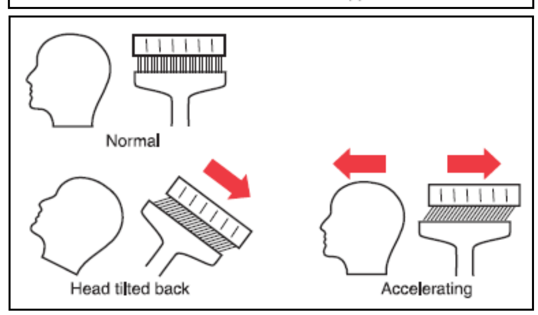
A. Overview
   i. Spatial Disorientation - lack of orientation of the position/attitude/movement of the plane in space
   ii. The body uses 3 systems for orientation:
      a. Visual: The eye, by far the largest source of information
      b. Somatosensory: Nerves that sense position based on gravity, feeling, and sound
      c. Vestibular System: Motion sensing system in inner ears
         - Reports head position, orientation, movement

B. Relation to Flight



   i. Flying can result in conflicting information between the systems leading to disorientation
   ii. Visual System (eyes)
      a. VMC - Eyes prevail over false sensations
      b. IMC - Eyes can't correct for false sensations
   iii. Vestibular System (inner ear)
      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

5. Motion Sickness AI.II.A.K1e

A. Causes
   i. Brain receiving conflicting messages about the body's state
   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

6. Carbon Monoxide Poisoning AI.II.A.K1f

- 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

7. Fatigue and Stress

- A. Fatigue AI.II.A.K1h
  - i. Acute Fatigue (short term)
    - a. 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. 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 AI.II.A.K1g
  - 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

8. Dehydration AI.II.A.K1i

A. Dehydration: Critical loss of water from the body
   i. Causes: Hot flight decks/flight lines, wind, humidity, diuretic drinks (coffee, tea, alcohol, soda)
   ii. Effects: Fatigue, inability to concentrate, headaches, cramps, tingling, sleepiness, and dizziness
   iii. Prevention: Primarily water
      a. Keep the flight deck well-ventilated and protect yourself from the sun
      b. Limit daily caffeine and alcohol intake
B. Nutrition
   i. Ensure properly fed and nourished
   ii. Causes: Missing/postponing meals and/or poor eating habits
   iii. Effects: Low energy and/or low blood sugar, stomach contractions, distraction, breakdown in habit patterns, and shortened attention span
      a. Insufficient vitamin A can impair night vision
   iv. Prevention: Eat healthy, regularly spaced & sized meals

9. Hypothermia AI.II.A.K1j

A. How it Happens
   i. The body loses heat faster than it can be produced (Normal: 98.6° F/37° C, Hypothermia: < 95° F/35° C)
   ii. Mechanisms of heat loss
      a. Radiated heat: Most heat loss is due to heat radiated from unprotected parts of the body
      b. Direct contact: In contact with something very cold, heat is conducted away from the body
         - Heat is lost much faster in cold water than cold air and if clothes are wet vs dry
      c. Wind: Carries away the thin layer of warm air at the surface of your skin
B. Causes
   i. Clothes that aren't warm enough for the weather, or unable to get out of wet clothes
   ii. Too much time in the cold or cold water
C. Symptoms
   i. Shivering, Slurred speech or mumbling, Slow, shallow breathing, Weak pulse, Clumsiness, Drowsiness, Confusion or memory loss, Bright red, cold skin
D. Prevention (COLD)
   i. Cover: Wear protective clothing
   ii. Overexertion: Avoid activities that result in a lot of sweat
   iii. Layers: Loose fitting, layered, lightweight clothing (wool, silk or polypropylene)
      a. Tightly woven, water repellent material is best for wind protection
   iv. Dry: Stay dry – get out of wet clothing as soon as possible

10. Optical Illusions AI.II.A.K1k

A. 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
B. 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
C. 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

D. 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
E. 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
F. Preventing landing Illusions
   i. Anticipate them during approaches; Use glide slope or VASI/PAPI systems whenever possible

11. Nitrogen and Scuba Diving AI.II.A.K1l

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. 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. Alcohol and Other Drugs AI.II.A.K2, AI.II.A.K3

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

13. ADM, CRM, & SRM AI.II.A.K4

A. RM: Distractions (Task Prioritization, Loss of SA, Disorientation) AI.II.A.R3
   i. Human factors can present significant, distractions, disorientation, and an inability to manage tasks
      a. IMSAFE:
         - Illness – Symptoms?
         - Medication – Taking any?
         - Stress – Family, money, relationships, work, etc.
         - Alcohol – Been drinking?
         - Fatigue – Well rested?
         - Emotion – Emotionally upset?
   ii. In flight, be alert to factors that can affect performance and lead to disorientation, etc.
B. RM: Combat expectation bias AI.II.A.R4
   i. Your expectations can influence behavior
   ii. Individuals are vulnerable to thinking they see (or hear) what they expect to see (or hear)
C. RM: Hazardous Attitudes AI.II.A.R2
   i. Attitude affects the quality of decisions

- ii. Spot hazardous attitudes and remove them
- D. Stress Management
  - i. A certain amount of stress is normal/good
  - ii. Too much can be very bad – stress is cumulative
  - iii. 3 types of stress that affect performance
    - a. Physical: Associated with the environment (temperature, noise, vibration, lack of oxygen)
    - b. Physiological: Physical conditions (fatigue, lack of physical fitness, missed meals)
    - c. Psychological: Social or emotional factors (divorce, death in the family, sick child)
  - iv. Recognize when stress is affecting a learner
    - a. Distracted or has a difficult time accomplishing the tasks
    - b. Try to determine the cause (doesn't have to be specific, could be a private matter)
    - c. Have them self-assess then set realistic goals - Delay training, if necessary
    - d. Put the learner and their progress first
- E. Use all Resources
  - iv. Use all available resources (think outside the box)
  - v. Internal Resources
    - a. Equipment, systems, charts, books, ingenuity, knowledge, skill, other passengers
  - vi. External Resources
    - a. ATC, flight service specialists, guard, etc.
  - vii. Workload Management
    - a. Plan, prioritize, and sequence to prevent overload
    - b. Prepare for high workload situations
    - c. Be able to recognize high workloads
    - d. "Attack the closest alligator" – Deal with the most pressing/threatening issue

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	I'm not helpless. I can make

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.

RM: Aeromedical & Physiological Issues AI.II.A.R2

The lesson as a whole is a discussion of managing risk associated with aeromedical issues

Conclusion:

Brief review of the main points

II.B. Visual Scanning & Collision Avoidance

References:
Airplane Flying Handbook (FAA-H-8083-3) (Chapter 1 pgs. 10-12)
Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25) (Chapter 14 pgs. 28-30, 17 pgs. 7-8
AIM Chapter 8-1-8
Pilot's Role in Collision Avoidance (AC 90-48)

Objectives	The learner should develop knowledge of the elements related to proper visual scanning and collision avoidance, as well as illusions and their effect on the pilot.
Key Elements	1. "See and Avoid" 2. Clearing Procedures 3. Trust Your Instruments
Elements	1. "See and Avoid" 2. Proper Visual Scanning 3. Collision Risks 4. Clearing Procedures 5. Recognizing Hazards 6. Collision Avoidance 7. Conditions that Degrade Vision 8. 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 learner understands the importance of maintaining a vigilant scan and applies these concepts during planning and in the airplane. In the onset of an illusion the learner can recognize the illusion and maintain safe flight.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

AC 90-48C 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

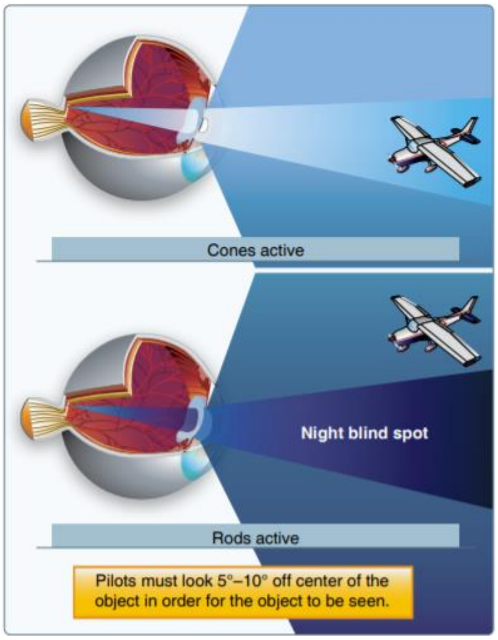
Visual scanning and collision avoidance is the knowledge and ability to recognize hazards and effectively scan the sky for potential collision threats.

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) AI.II.B.K3
   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) AI.II.B.K4
   A. Fovea vs Peripheral Viewing
      i. Fovea (center of vision) - sends a clear, sharp image to the brain
         a. Effective in daylight, but effectively a blind spot at night
      ii. Peripherals – outside of the center of vision, good for detecting motion/collision threats, and 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
   C. Poor visual scanning and/or a lack of visual scanning increases the risk of midair collisions
   D. RM: Distractions to Visual Scanning AI.II.B.R1
      i. Imperative to fly based on outside references with short glances inside (90% outside, 10% inside)
      ii. Remove distractions – if it's a person, explain the situation and ask them to stop



3. **Collision Risks** AI.II.B.K7
   A. RM: High Traffic Areas AI.II.B.R3

(RM: High volume operational environments)
   i. Class B, C, D & E surface areas, VORs, VFR waypoints, VFR corridors, training areas, airways, etc.
B. Distractions
   i. Overconcentration on instruments, maps, tablet, conversation, a problem, or anything other the scan
   ii. Poor visibility conditions such as rain, reduced visibility/haze, and the position of the sun
C. Division of Attention AI.II.B.K8
   i. 90% outside, 10% inside

4. Clearing Procedures AI.II.B.K5

A. Before Takeoff - Scan the approach/departure areas for traffic
B. Climbs & Descents - Use gentle banks left and right to permit scanning
C. Straight & 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

5. Visual Cues / Recognizing Hazards (AC 90-48, AIM 8-1-8) AI.II.B.K6

A. RM: Aircraft Speed and Collision Risk (RM: Collision reaction time) AI.II.B.R4
   i. *Minimum* time to spot traffic, identify it, realize it's a threat, and respond – 12.5 seconds
B. Determining Relative Altitude
   i. If the aircraft is above the horizon, it is probably on a higher flight path, and vice versa
C. Any aircraft that appears to have no relative motion is likely to be on a collision course
D. 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)

Table 1. Aircraft Identification and Reaction Time Chart

Event	Seconds
See Object	0.1
Recognize Aircraft	1.0
Become Aware of Collision Course	5.0
Decision to Turn Left or Right	4.0
Muscular Reaction	0.4
Aircraft Lag Time	2.0
TOTAL	12.5

6. Collision Avoidance (AIM 8-1-8)

A. Flight deck Management - Plan ahead/organize to minimize time spent with your eyes inside/head down
B. Visual obstructions in the Flight deck
   i. Adjust for blind spots, do not block windows, keep windscreens clean
   ii. Keep the windscreen clean
C. Be More Visible
   i. Use exterior lights & keep interior lights low at night to maintain night vision
D. ADS-B
   i. Other traffic is displayed on the MFD, often with visual and/or audio alerts
E. ATC Support - Use flight following for radar traffic advisories whenever possible
F. RM: Safety Pilot/Another set of Eyes (RM: Use of a safety pilot) AI.II.B.R5

7. Conditions that Degrade Vision (AIM 8-1-6) AI.II.B.K1

A. Physical Conditions
   i. Medicine/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. RM: Relaxed Intermediate Focal Distance AI.II.B.R2
   a. With nothing to focus on, the eyes focus on a point slightly ahead of the plane (10-30')
   b. 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

8. Vestibular / In Flight / Visual Illusions AI.II.B.K2

A. 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

B. 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

C. 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

D. 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

E. 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)

F. 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

G. 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)

H. 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

I. 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

J. Preventing Spatial Disorientation
   i. Prevented by reference to flight instruments or reliable, fixed points on the ground

Conclusion:
Brief review of the main points

II.C. Runway Incursion Avoidance

References:

Single Pilot Flight School Procedures During Taxi Operations (AC 91-73)
AIM – Chapter 4-3-18 Taxiing
Airplane Flying Handbook (FAA-H-8083-3) – Chapter 1 pgs. 12-13
Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25) – Chapter 14 pgs. 31-33
Risk Management Handbook (FAA-H-8083-2)

Objectives	The learner develops and understands techniques for effective 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. Runway Incursions 2. Taxi Instructions 3. Plan, Review, and Brief 4. Appropriate Flight Deck Activities 5. Airport Markings, Signs, & Lights 6. Airport Operations & Runway Incursions 7. Case Study: United 1448
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 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 have sometimes led to serious accidents with significant loss of aircraft as well as life. Although they are not a new problem, with increasing air traffic, runway incursions have been on the rise.

How:

1. **Runway Incursion** AI.II.C.K1
   A. Any occurrence at an airport involving an aircraft, vehicle, person, or object on the ground that creates a collision hazard or results in a loss of separation with an aircraft taking off, landing, or intending to land
   B. Approximately 3 runway incursions occur each day at towered airports in the US
      i. About 65% of all incursions are caused by pilots (about half of those are caused by GA pilots)
   C. Airport/Taxiing Challenges
      i. Situational Awareness: Complex layouts, increased traffic
      ii. Distractions: Checklists, radio calls, cell phone
   D. Causal Factors
      i. Failure to comply with ATC instructions
      ii. Lack of airport familiarity
      iii. Nonconformance with standard operating procedures (SOPs)
   E. Preventive Practices
      i. Maintain SA (your position & other aircraft)
      ii. Review airport layouts & know airport signage
      iii. Review NOTAMs
      iv. Study & use proper phraseology
      v. Write down complex taxi instructions
      vi. Readback all runway crossing and/or hold short instructions
      vii. Request progressive taxi instructions when necessary
      viii. Turn on lights and the rotating beacon or strobes when taxiing
      ix. Check for traffic before crossing any runway hold line or entering any taxiway
      x. When landing, clear the runway as soon as possible and wait for taxi instructions before moving
2. **Taxi Instructions & Clearances** AI.II.C.K2
   A. Approval must be obtained prior to moving onto the movement area while tower is in operation
   B. Clearance must be obtained prior to crossing ***any runway***
   C. When assigned taxi instructions, ATC will specify:

        i. The runway or point to taxi to
        ii. Taxi instructions
        iii. Hold short instructions or runway crossing clearances if the route will cross a runway
    D. When instructions are received from the controller, always read back:
        i. The runway assignment
        ii. RM: Any clearance to enter a specific runway (RM: Entering or crossing runways) AI.II.C.R3
        iii. Any instruction to hold short of a specific runway
    E. Uncontrolled Field AI.II.C.K6
        i. Announce intentions on CTAF
        ii. Always have a taxi diagram
        iii. Monitor CTAF and maintain SA (your position & other aircraft)
        iv. Apply the right-of-way rules, and give way when appropriate, or when safety dictates

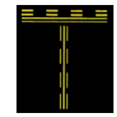
3. Plan, Brief, Review
    A. Route Planning
        i. Have a current copy of the Airport Diagram & review expected routes/closed taxiways
        ii. Check for pre-designated, or standard, taxi routes, review these for familiarity
    B. Taxi Briefing (AC 91-73)
        i. Ground Procedures
            a. Timing and execution of checklists/communications that will not interfere with taxiing
            b. Expected route/any abnormalities or unusual procedures
            c. Previous experience/unusual procedures or techniques
            d. Critical locations on the taxi route (hold short, hot spots, etc.)
            e. During low visibility operations, brief the requirements and considerations
        ii. Expectations of others (pilots of passengers) in the plane
            a. Sterile flight deck 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. Record & Review AI.II.C.K3
        i. Write down ATC taxi instructions to prevent mistakes
            a. RM: Combats expectation bias AI.II.C.R2
        ii. Review the route given by ATC, query ATC in case of confusion

4. RM: Appropriate Flightdeck Activities (RM: Distractions, Task Prioritization) AI.II.C.K5, AI.II.C.R1
    A. For safety reasons the pilot's workload should be at a minimum during taxi operations
        i. All heads down activities should be done only when the aircraft is stopped
        ii. RM: Task prioritization – taxiing comes first, handle all other tasks when safely stopped
    B. Sterile flight deck
    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. Use a "continuous loop" process to monitor and update other aircraft progress and location
        iii. Be especially vigilant if another aircraft with a similar call sign is on frequency

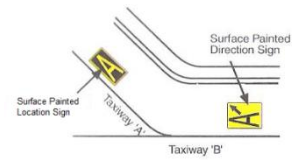
5. Airport Markings, Signs, & Lights AI.II.C.K4
    A. Airport Markings
        i. Overview
            a. Taxiways should have centerline/runway holding position markings whenever intersecting a runway
            b. Edge markings separate the taxiway from areas not for aircraft use or define taxiway edges
        ii. Taxiway Centerline Markings
            a. Normal Centerline
                - Purpose - Visual cue to permit taxiing along a designated path

- Markings - Single continuous yellow line, 6” - 12” wide

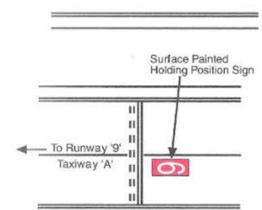
b. Enhanced Centerline
   - Purpose - Same as above but at larger commercial airports to warn that a runway hold position marking is being approached
   - Markings - Parallel line of yellow dashes on both sides of the taxiway centerline



iii. Taxiway Edge Markings
   a. Purpose - Defines the edge of the taxiway (usually when edge doesn’t match with pavement)
   b. Continuous Markings
      - Purpose - Define the taxiway edge from the shoulder/paved surface not for use by aircraft
      - Markings - Continuous double yellow line
   c. Dashed Markings
      - Purpose - Define the taxiway edge when adjoining pavement is intended for aircraft (apron)
      - Markings - Broken double yellow line



iv. Taxi Shoulder Markings
   a. Purpose - Shoulders prevent erosion but they may not support aircraft
   b. Markings - Taxiway edge markings will usually define this area

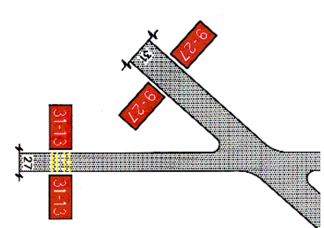


v. Surface Painted Taxiway Direction Signs
   a. Purpose - When it isn’t possible to offer direction signs at intersections, or to supplement such signs
   b. Markings - Surface painted location signs with a yellow background and black inscription

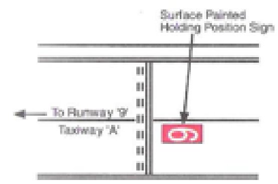
vi. Surface Painted Location Signs
   a. Purpose - Location signs assisting in confirming the taxiway
   b. Markings - Black background with a yellow inscription

vii. Geographic Position Markings
   a. Purpose - Identifies aircraft location during low visibility operations
   b. Markings - Left of the taxiway centerline in the direction of taxiing
      - A circle with an outer black ring, inner white ring, and a pink circle
         a On dark pavement, the white/black ring are reversed

viii. Holding Position Markings
   a. General
      - Show where an aircraft is supposed to stop when approaching a runway (hold on the solid side)
      - 4 yellow lines (2 solid / 2 dashed) across the width of the taxiway / runway / approach area
   b. Runway Holding Position Markings on Taxiways
      - Purpose - Identify where to stop without a clearance onto the runway
   c. Runway Holding Position Markings on Runways (as shown to the right)
      - Purpose - Installed if normally used for LAHSO or taxiing operations
      - Markings - White inscription/red background next to hold markings



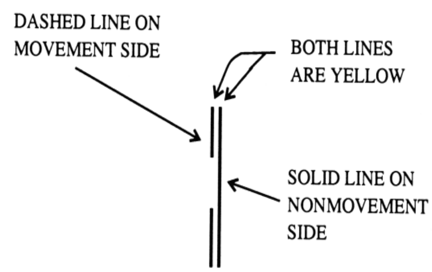
   d. Taxiways Located in Runway Approach Area
      - Holding Position Markings for Instrument Landing System (ILS)
         a Purpose - Hold aircraft when the ILS critical area is being protected
         b Markings - 2 yellow solid lines 2’ apart joined by pairs of solid lines 10’ apart across the taxiway
      - 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
    - 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

ix. Other Markings

- a. VOR Receiver Checkpoint Markings
    - Purpose - Allow the pilot to check aircraft instruments with navigational aid signals
    - 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
- b. Vehicle Roadway Markings
    - Purpose - Defines a path for vehicle operations on the airport
    - Markings - White solid line delineates each edge and a dashed line separates lanes
- c. Marking and Lighting of Permanently Closed Runways
    - Purpose – For permanently closed runways and taxiways
    - Markings - Lighting circuits will be disconnected
        - a Yellow crosses at each end and at 1,000' intervals
- d. Temporarily Closed Runways and Taxiways
    - Purpose – Indication that a runway is temporarily closed
    - Markings - Yellow crosses at each end
        - a A visual indication may not be present (check NOTAMs/ATIS)
        - b Closed taxiways are blockaded (yellow cross may also be used)
- e. Nonmovement Area Boundary Markings (pictured, right)
    - Purpose - Delineates movement area (area under control)
        - a Markings - 2 yellow lines (one solid and one dashed)

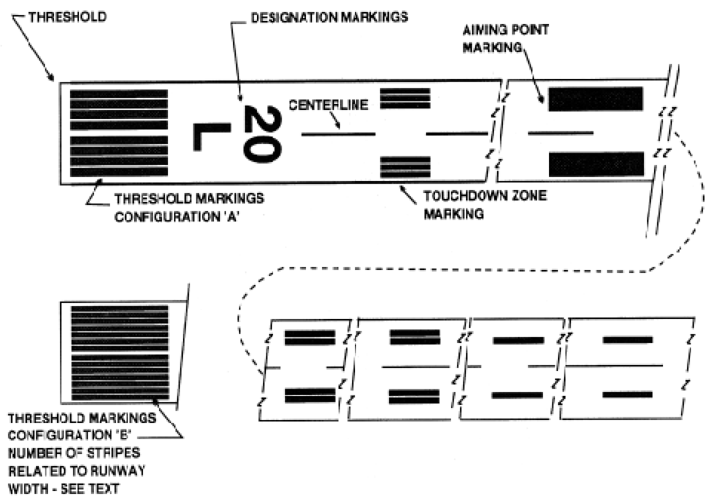


x. Runway Markings

- a. There are three types of markings for runways:
    - Visual; Nonprecision Instrument; Precision Instrument
    - Diagram Notes
        - a Note 1: Required on runways serving category C/D aircraft, & runways for international commercial transport
        - b Note 2: Required on 4,200' or longer runways serving categories C & D airplanes
        - c Note 3: Required on 4,200' or longer instrumented runways
        - d Note 4: Used when the full runway pavement width may not be available for use as a runway
- b. Runway Designators
    - Purpose - To identify / differentiate runways from the approach end
        - a To Magnetic North; whole number to the nearest one-tenth

Runway Surface Marking Scheme	Threshold Approach Category		
	Visual Approach	Non-precision Approach (Approaches with vertical guidance not lower than 0.75 statute mile visibility)	Precision Approach (Approaches with vertical guidance lower than 0.75 statute mile visibility)
Runway diagram	 20	 20	 20
Landing Designator	Required	Required	Required
Centerline	Required	Required	Required
Threshold	Note 1	Required	Required
Aiming Point	Note 2	Note 3	Required
Touchdown Zone	(not applicable)	(not applicable)	Required
Edge Markings	Note 4	Note 4	Required

Precision Instrument Runway Markings



of the runway course

b L, R, C differentiate multiple parallel runways

- Markings - Large white numbers

c. Runway Centerline Marking
- Purpose - Identifies the center of the runway providing alignment guidance
- Markings - A line of uniformly spaced stripes and gaps

d. Runway Aiming Point Markings
- Purpose - Serves as a visual aiming point for a landing aircraft
- Markings - Broad white stripe on each side of the centerline, approximately 1,000' from threshold

e. Runway Touchdown Zone Markers
- Purpose - Identifies touchdown zone for landing; provide distance info in 500' increments
- Markings - Groups of 1, 2, and 3 rectangular bars in pairs about the runway centerline

f. Runway Side Stripe Markings
- Purpose - Delineate edges of the runway providing a contrast between the runway and shoulder
- Markings - Continuous white stripes located on each side of the runway

g. Runway Shoulder Markings
- Purpose - Identify pavement areas not intended for aircraft use
- Markings - Yellow stripes

h. Runway Threshold Markings (stripes vary with width, chart to right)

Runway Width	Stripes
60 feet	4
75 feet	6
100 feet	8
150 feet	12
200 feet	16

- Purpose - Identifies beginning of the runway available for landing
- Markings - Stripes about the centerline
- Displaced Threshold (DT)

a Explanation
1. Landing threshold starts at a point other than the beginning of the runway
2. Used for taxiing, takeoff, landing rollout (not to be landed on, reduces landing distance)

b Markings
1. A 10' wide white threshold bar across the runway at the displaced threshold
2. White arrow heads are located across the runway just prior to the threshold bar
3. White arrows down the centerline between the start of the runway and displaced threshold

c Relocated Threshold
1. Explanation – Construction / other activities require the threshold to be relocated (NOTAM)
   a. Markings – Normally a 10' wide white threshold bar across the runway, but can vary

B. Airport Signs

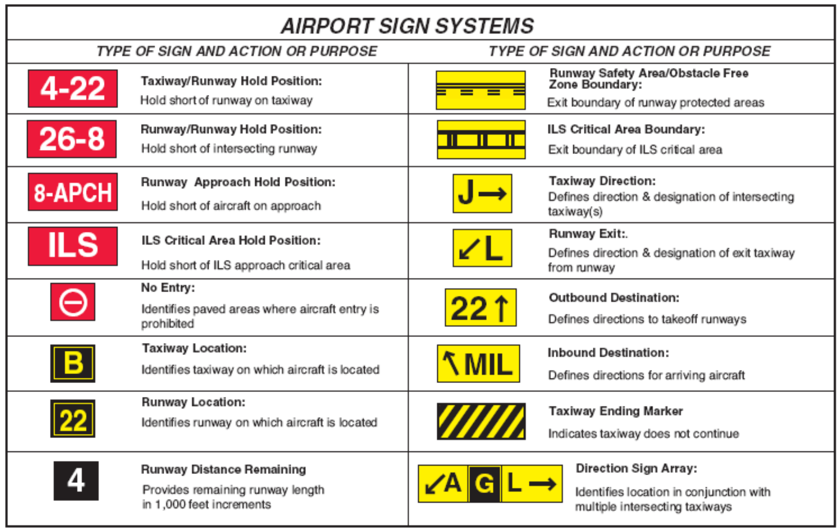
i. Mandatory Instruction Signs

a. Purpose - Denote entrance to runway or critical area / area where aircraft are prohibited

b. Markings - Red background with a white text

c. Typical Mandatory Signs and Applications
- Runway Holding Position Sign
- Runway Approach Area Holding Position Sign
- ILS Critical Area Holding Position Sign
- No Entry Sign

ii. Location Signs
   a. Purpose - Identify either a taxiway or runway on which the aircraft is located
   b. Taxiway Location Sign



      - Purpose - Along taxiways to indicate location
      - Markings - Black background with yellow inscription and border
   c. Runway Location Sign
      - Purpose - Complement compass/heading info; typically, in areas with multiple runways
      - Markings - Black background with yellow text
   d. Runway Boundary Sign (pictured, right)
      - Purpose - Visual cue depicting when "clear of the runway"
      - Markings - Yellow background / black lines
   e. ILS Critical Area Boundary Sign (pictured, right)
      - Purpose - Depicts where clear of the ILS critical area
      - Markings - Yellow background / black lines

iii. Direction Signs
   a. Purpose - Identify taxiways out of an intersection
      a Designations / arrows are arranged clockwise from the 1st taxiway on the pilot's left
   b. Markings - Yellow background / black text

iv. Destination Signs
   a. Purpose - Indicates a destination on the airport
   b. Markings - Yellow background/black text

• Runways	• Civil Aviation Areas
• Aprons	• Cargo Areas
• Terminals	• International Areas
• Military Areas	• FBOs

v. Information Signs
   a. Purpose - Provide information on things such as:
      - Areas the tower can't see, radio frequencies, noise procedures
   b. Markings - Yellow Background / black text

vi. Runway Distance Remaining Signs
   a. Purpose – Informs the distance remaining on the runway
      - Number indicates the thousands of feet of landing runway remaining
   b. Markings - Black background / white number

C. Airport Lighting
   i. Taxiway Lighting
      a. Taxiway Edge Lights
         - Steady blue lights outlining the edges of taxiways
      b. Taxiway Centerline lights
         - Steady green lights installed along the centerline of the taxiway

c. Clearance Bar Lights
- Three in-pavement steady-burning yellow lights
- Installed at holding positions on taxiways to increase visibility of the holding position

d. Runway Guard Lights
- 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 holding position marking
- Installed at taxiway/runway intersections
- Enhance conspicuity of taxiway/runway intersections

e. Stop Bar Lights
- A row of red, unidirectional, steady-burning in-pavement lights across the entire taxiway at the runway holding position, and elevated steady-burning red lights on each side
- A controlled stop bar operates in conjunction with the taxiway centerline lead-on lights
  - a Following ATC clearance, the stop bar is turned off and the lead-on lights are turned on
- Used to confirm the ATC clearance to enter or cross the active runway in low visibility

ii. Runway Lighting

a. Runway End Identifier Lights (REIL)
- Installed to provide rapid / positive identification of the approach end of a runway
- Configuration - Pair of synchronized flashing lights on each side of the runway threshold

b. Runway Edge Light Systems (HIRL, MIRL, LIRL)
- Outline the edges of runways during dark / restricted visibility conditions
  - a Classified according to the intensity or brightness: High (HIRL); Medium (MIRL); Low (LIRL)
- Configuration
  - a Runway edge lights - White
    1. 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
    1. Red indicates the end of the runway to a departing aircraft
    2. Green indicates the threshold to landing aircraft

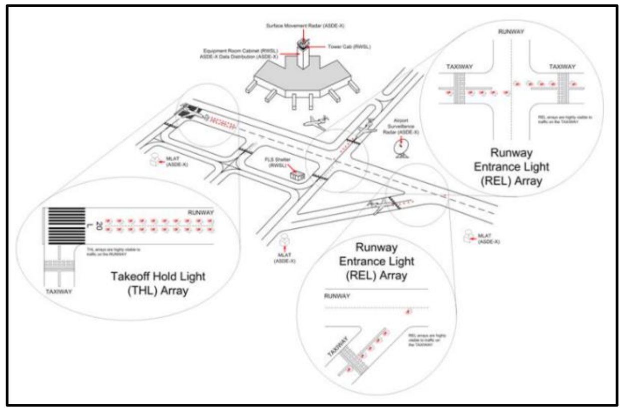
c. Runway Centerline Lighting System (RCLS)
- Installed on some precision runways to facilitate landing under adverse conditions
- Configuration
  - a Along runway centerline at 50' intervals
  - b From the threshold, the lights are white until the last 3,000' of the runway
    1. White lights alternate with red for 2,000', and the last 1,000' all lights are red

d. Touchdown Zone Lights (TDZL)
- On some precision runways to indicate touchdown zone in low visibility conditions
- Configuration
  - a Rows of (usually 3) lights on both sides of the runway centerline
  - b Rows begin 100' beyond the landing threshold and extend to 3,000' beyond the landing threshold or the midpoint of the runway, whichever is less

e. Taxiway Centerline Lead-Off Lights
- Provide visual guidance to exit the runway
- Configuration
  - a 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

f. Taxiway Centerline Lead-on Lights
- Provide visual guidance for entering the runway
- Configuration

        a Color coded with the same pattern as lead-off lights
        b Bidirectional (1 side emits light for the lead-on function the other for the lead-off)
    g. Land and Hold Short Lights
        - Used to indicate the hold short point on certain runways approved for LAHSO
            a When installed, the lights will be on anytime LAHSO is in effect and off when not
        - Configuration - A row of pulsing white lights installed across the runway
    h. Runway Status Lights (RWSL)
        - Fully automated system providing indication it's unsafe to enter, cross, takeoff, or land on a runway
            a Installed at several major US airports
            b Processes information from surveillance systems to turn red warning lights on/off
            c Used in conjunction with ATC – lights and ATC instructions must agree
        - Runway Entrance Lights (REL)
            a In-pavement red lights
            b Warns aircraft waiting to cross/enter a runway that there is conflicting traffic
        - Takeoff Hold Lights (THL)
            a In-pavement red lights
            b Warns aircraft in the takeoff position that the runway is occupied & takeoff is unsafe
        - More details: FAA Runway Status Lights



6. Airport Operations & Runway Incursions

A. Hold Lines
    i. Show where stop when approaching a runway. Cross the dashed side, stop on the solid side
    ii. Always have a clearance to cross any runway
    iii. RM: During taxi: (Entering or crossing runways) AI.II.C.R3
        a. Approaching from the dashed side, cross (no clearance necessary) and stop fully passed the solid lines
        b. If approaching hold lines from the solid side, do not cross without a clearance
        c. Always clear both directions and turn on all exterior lights when crossing

B. RM: Landing and Rollout AI.II.C.R6, AI.II.C.R7
    i. Brief the landing and runway exit/taxi plan (sterile flight deck during taxi)
    ii. Exit the runway entirely, do not cross another runway without clearance

C. RM: Night Operations AI.II.C.R4
    i. Exterior lights make an aircraft easier to see (use day and night)
        a. Starting engines/Engines Running: Rotating beacon on
        b. Taxiing: Prior to taxi, turn on navigation, position, and anti-collision lights
            - Strobes should not be used during taxi if they will adversely affect the vision of others
        c. Crossing a Runway: All exterior lights should be illuminated when crossing a runway
        d. Entering the runway for takeoff: Turn on all lights, except for landing lights
        e. At night: Line up 3' off centerline to allow landing aircraft to differentiate you from runway lights
        f. Takeoff: Turn on landing lights when cleared for takeoff/starting the takeoff roll if no control tower
    ii. Be more cautious at night
        a. Taxi slower, allow more time to stop
        b. Ensure you remain on the assigned route – lights and signs can be confusing

D. RM: Low Visibility AI.II.C.R5
    i. AIM 4-3-19 Taxi During Low Visibility
        a. Focus entire attention on the safe operation of the aircraft while it is moving

            - Taxi slowly with focus outside
        b. Sterile flight deck
        c. Notify the controller of difficulties or at the first indication of becoming disoriented
        d. Lack of visibility from the tower can prevent visual confirmation of adherence to taxi instructions
    E. RM: Loss of SA & Disorientation AI.II.C.R1
        i. Stop if disoriented or SA is lost and inform ATC (or CTAF)
            a. Regain orientation before proceeding
        ii. Ask for help from ATC - Request progressive, if necessary

7. Case Study: United 1448 (PVD Airport)
    A. YouTube Animation & Audio Transcript
    B. NTSB Safety Recommendation – July 6, 2000
        i. Page 6 has a short summary and diagram
    C. RM Concepts
        i. Low visibility taxi, night operations, loss of SA/disorientation, entering/crossing runways
        ii. Discuss options to mitigate these risks

Conclusion:
Brief review of the main points

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 learner develops an understanding of the principles of flight. They understand why airplanes are designed in certain ways, as well as the forces acting on airplanes, and how to apply that knowledge to the aircraft in flight.
Key Elements	1. Stability vs. Maneuverability 2. Left Turning Tendency 3. Load Factors
Elements	1. Forces of Flight 2. Airfoil Design 3. Wing Planform 4. Stability and Controllability 5. Turning Tendencies 6. Load Factors in Airplane Design 7. Wingtip Vortices
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 learner understands the principles to flight and can answer questions regarding lesson concepts.

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

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

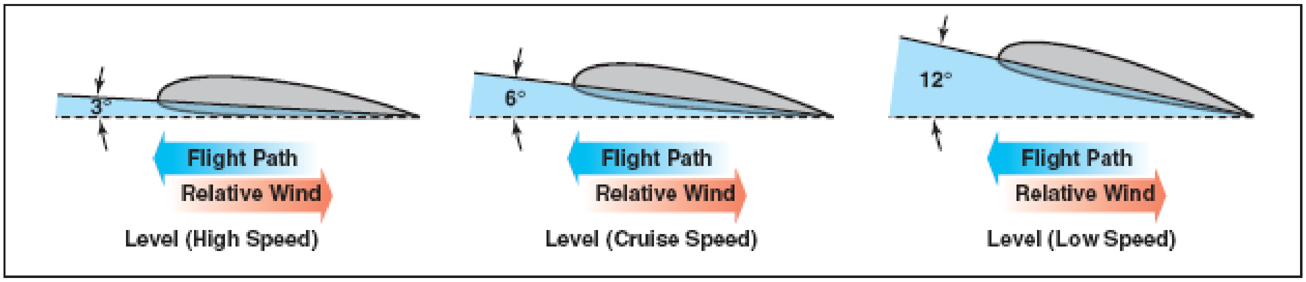
Why

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. **Forces of Flight** AI.II.D.K4
   - A. Overview
     - i. Lift – The upward force created by the effect of airflow as it passes over and under the wing
     - ii. Weight – Opposes lift, and is caused by the downward pull of gravity
     - iii. Thrust – The forward force which propels the airplane through the air
     - iv. Drag – Opposes thrust, and is the backward, or retarding force, which limits the speed of the airplane
     - v. Terminology:
       - a. Chord Line: The imaginary straight line joining the leading and trailing edges of an airfoil
       - b. Relative Wind: The direction of movement of the wind relative to the aircraft's flight path
       - c. Angle of Attack: The angle between the chord line and the relative wind
   - B. Lift
     - i. The force that opposes weight
     - ii. Principles of Lift
       - a. Newton's three laws of motion:
         - 1st Law: A body at rest tends to remain at rest, and a body in motion tends to remain in motion
         - 2nd Law: Force = Mass x Acceleration (F=ma)
         - 3rd Law: For every action, there is an equal and opposite reaction
       - b. Bernoulli's Principle: As the velocity of a fluid (air) increases, its internal pressure decreases
     - iii. Airfoils
       - a. Airfoil: Any surface which provides aerodynamic force when it interacts with a moving stream of air
       - b. The wing's shape is designed to take advantage of Newton's Laws and Bernoulli's Principle
         - Greater curvature on the upper portion causes air to accelerate as it passes over the wing (Bernoulli)
         - 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)
         - 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

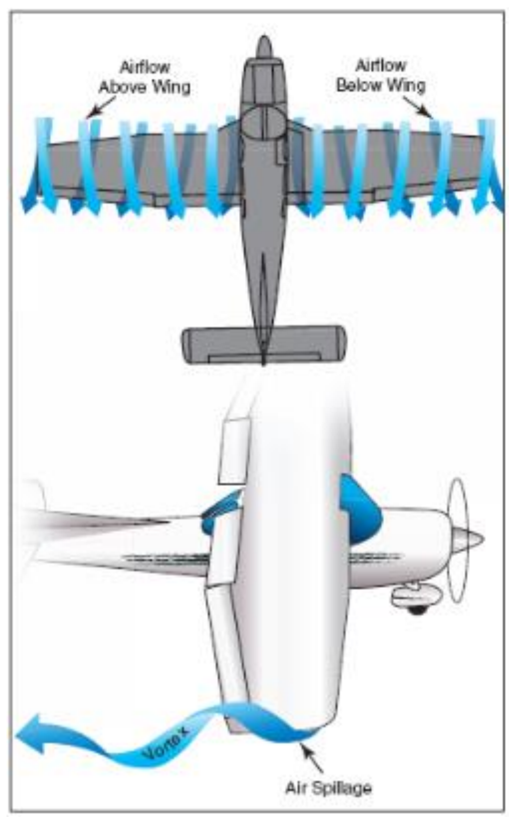
iv. Pilot Control of Lift
   a. Lift = ½ pC_Lv^2S (Memory Aid: **½ P**int, **C**hug a $_L$iter, **V**omit **twice**, **S**leep it off)
      - P = Rho or a pressure constant
      - C_L = Coefficient of Lift – A way to measure lift as it relates to the angle of attack
      - V = Velocity
      - S = Surface Area (Constant)
   b. The amount of lift generated is controlled by the pilot and determined by aircraft design factors
      - The pilot can change the Angle of Attack (AOA), the airspeed, and the shape of the wing (flaps)



C. Weight
   i. Force of gravity which acts vertically through the center of the plane toward the center of earth
   ii. When lift = weight, the plane is in equilibrium and doesn't gain or lose altitude

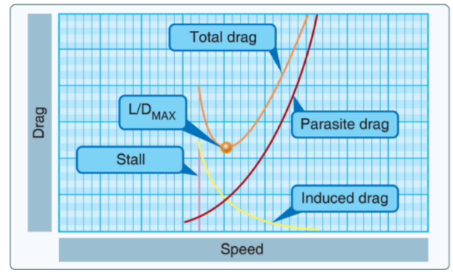
D. Thrust
   i. Forward-acting force which opposes drag and propels the airplane
      a. F=MA (Force comes from the engine, mass of air is accelerated opposite the direction of flight)
   ii. Thrust starts the airplane moving, it continues to move and gain speed until thrust and drag are equal

E. Drag
   i. Rearward, retarding force, caused by disruption of airflow by the wing, fuselage, or other objects
      a. Opposes thrust, and acts rearward and parallel to the relative wind
   ii. Two types of drag
      a. Parasite Drag - Caused by surfaces which deflect/interfere with the smooth airflow of the airplane
         - Three Types of Parasite Drag
            a Form Drag: Shape of the aircraft/separation of airflow from the surface of the structure
            b Interference Drag: Occurs when varied currents or air over an airplane meet and interact
            c Skin Friction Drag: Caused by the roughness of the airplane's surfaces
         - Parasite Drag and Airplane Speed – As airspeed increases, Parasite drag increases
            a Varies proportionately to the square of the airspeed
      b. Induced Drag – As lift increases, so does induced drag
         - Lift is produced at the expense of induced drag
         - How it Works
            a Vortices create upward flow of air beyond the wingtip/downwash behind the trailing edge
               1. This downwash = source of induced drag
            b Downwash – The source



1. Tilts the wing's vertical lift backward (induced drag)
2. The greater the vortices strength/downwash, the more the lift tilts back, and the greater induced drag

c. Total Drag

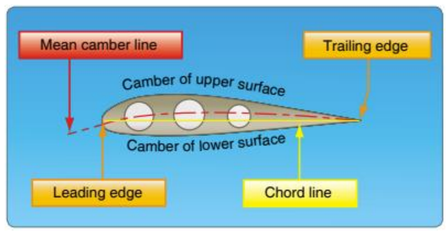


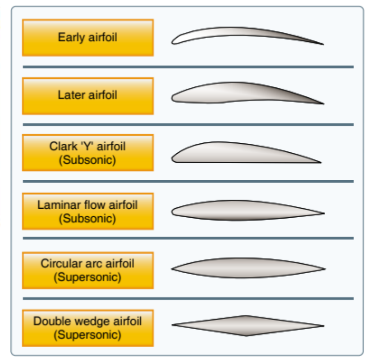
- The sum of induced and parasitic drag
- Region of Normal vs Reversed Command
  a Normal Command
    1. As airspeed decreases, total drag decreases, to a point (L/D_{MAX})
    2. Higher speeds require higher power
  b Region of Reversed Command
    1. As airspeed decreases below L/D_{MAX}, total drag increases

2. Airfoil Design AI.II.D.K1

A. Airfoil: Structure designed to obtain reaction upon its surface from the air

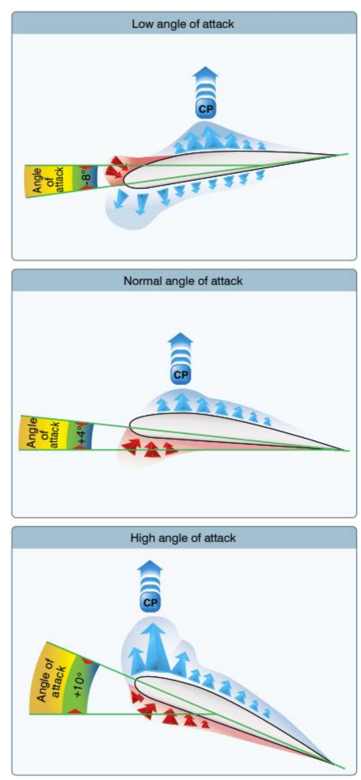
B. Terminology





   i. Camber
   ii. Leading edge / Trailing edge
   iii. Chord Line
   iv. Mean Camber Line

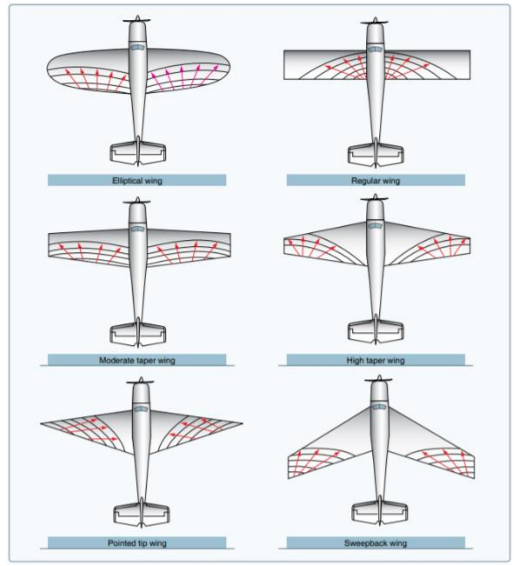
C. General Design Characteristics
   i. Air Pressure
      a. Negative pressure lifting action above the wing
      b. Positive pressure lifting action from below
      c. Aircraft weight, speed, purpose dictate shape
         - Examples pictured to the right
   ii. Low Pressure Above



      a. Faster moving air over the upper surface
         - Bernoulli's Principle
      b. Downward, backward flow of air creates downwash
         - Newton's 3rd Law
   iii. High Pressure Below
      a. Positive pressure from below the airfoil
         - Newton's 3rd Law
      b. Stagnation Point: Air is virtually stopped at the leading edge
         - Slower airflow = increased pressure (Bernoulli's principle)
   iv. Aircraft weight, speed & purpose dictate the airfoil shape (pictured, right)
   v. Pressure Distribution (pictured, right)
      a. At different AOAs, pressures vary between positive / negative
      b. Center of Pressure (CP): Average of the pressure variations at a given AOA
         - Aerodynamic forces act through the CP
         - Higher AOAs: CP moves forward
         - Lower AOAs: CP moves aft
      c. CP movement affects aerodynamic balance and controllability

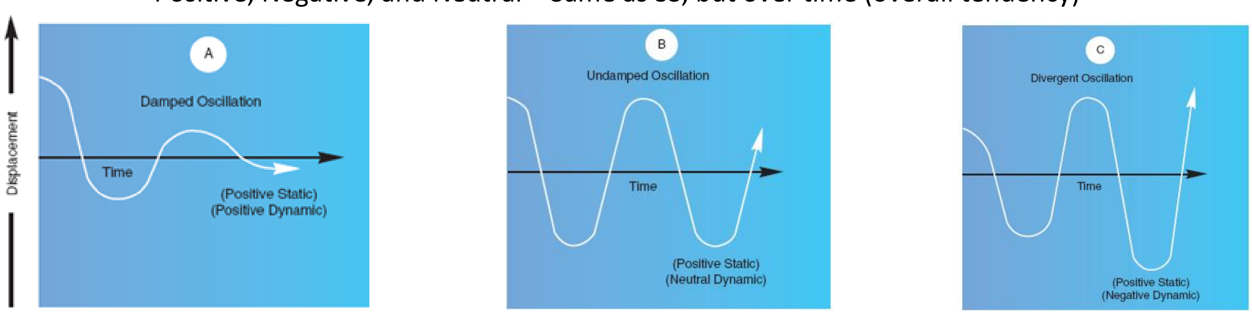
D. Note: Production of lift is much more complex than simple differential pressures between the upper / lower surfaces, but these concepts suffice for this discussion

3. **Wing Planform & Terminology**
   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/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

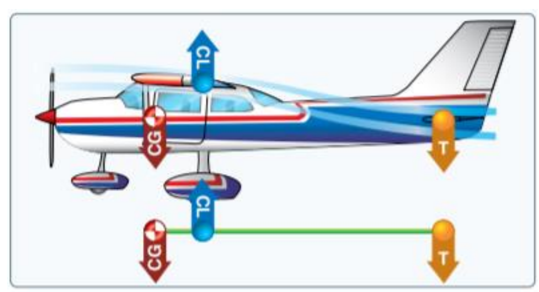


AI.II.D.K2

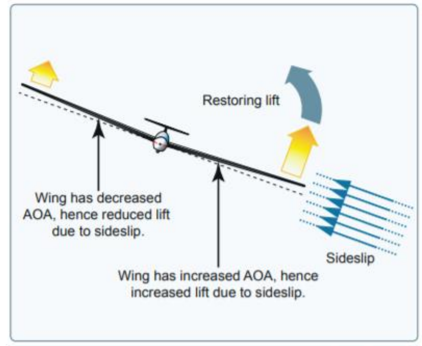
4. **Stability and Controllability**
   A. Stability (Static and Dynamic)
      i. Inherent quality of the airplane to correct for disturbances and return the original flight path
         a. Primarily a design characteristic
      ii. Static Stability (SS): The *initial tendency*; aircraft's initial 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)

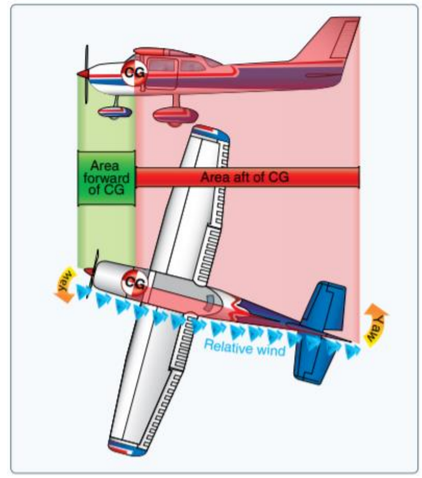


      iv. Must balance controllability and maneuverability
   B. Longitudinal Stability (LS) – About the lateral axis
      i. The wing and tail moments need to be balance
         a. Ex: If nosed up, the wing/tail moments will change to bring the nose back down
      ii. Static LS is dependent on 3 factors:
         a. Location of the wing in relation to the CG
         b. Location of the horizontal tail with the CG
         c. The area of the tail surfaces



   C. Lateral Stability - About the Longitudinal Axis (pictured below)
      i. Dihedral - Angle wings are slanted upward
         a. Stabilizing - Balances lift in a sideslip





ii. Sweepback - angle wings are slanted back
 a. Effectively increases dihedral (10° of sweepback = 1° of dihedral)
iii. Keel effect
 a. Fuselage acts like a keel, moving the plane 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 (pictured below)
 i. Affected by the area of the vertical fin and sides of the fuselage aft of the CG
 ii. Plane acts like a weathervane, nose points into relative wind

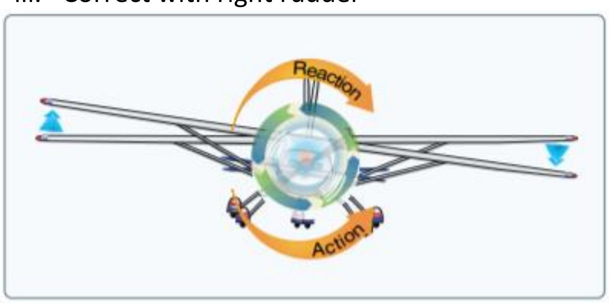
5. Turning Tendency AI.II.D.K3

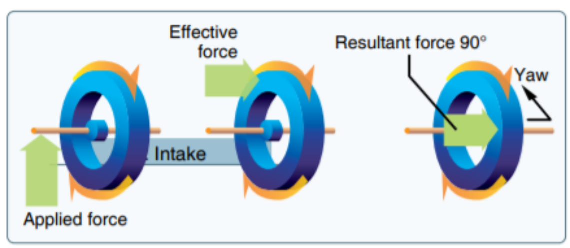
A. Torque Reaction – Based on Newton's 3rd Law
 i. The engine parts/propeller rotate right, an equal force attempts to rotate the plane left
 ii. In flight: left rolling tendency; On ground: left turning
 iii. Corrected by offsetting the engine, aileron trim tabs, and/or aileron and rudder use

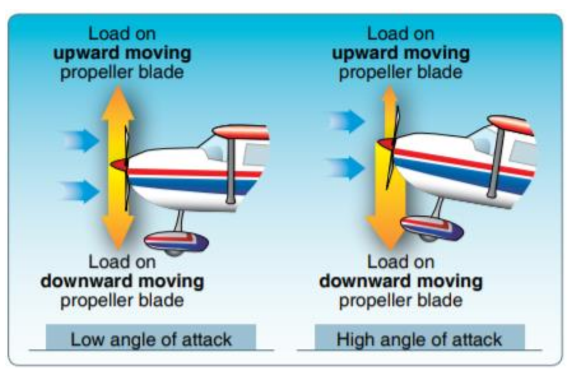
B. Corkscrew/Slipstream Effect
 i. Corkscrewing propeller air strikes the left side of the vertical stabilizer - pushes nose left (shown below)
 ii. Strongest at high prop speeds/low forward speeds

C. Gyroscopic Action
 i. Precession - Any force takes effect 90° ahead of, and in the direction of rotation
 ii. Pitch results in a yawing moment and vice versa
 iii. Correct with rudder/elevator

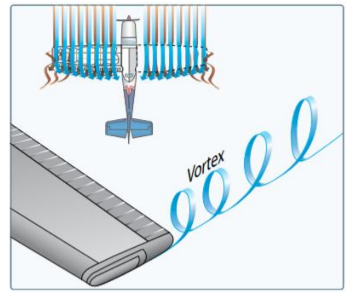
D. Asymmetric Loading (P Factor)
 i. At high AOAs, the bite of the down moving blade is greater than the up moving blade
 ii. Center of thrust moves to the right of the propeller disc, causing a yaw to the left
 iii. Correct with right rudder



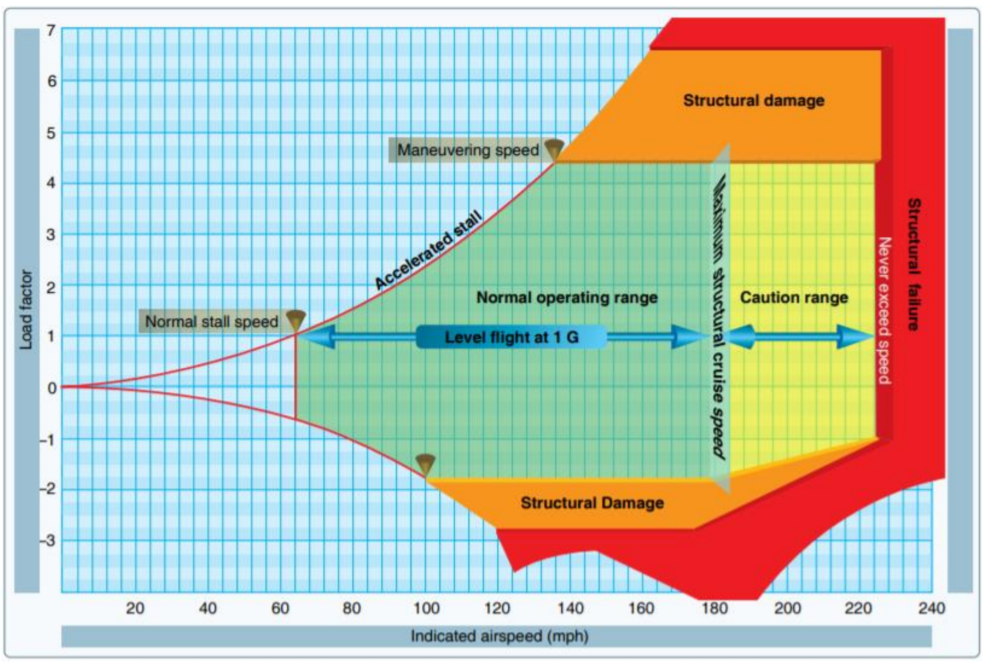




6. Load Factors (LF) in Airplane Design AI.II.D.K5



A. General
   i. Ratio of the total air load on the plane to the gross weight of the plane (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 to impose a dangerous overload on the aircraft structures
B. Airplane Design
   i. Aircraft strength is determined largely by the use it will be subjected to
   ii. 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)



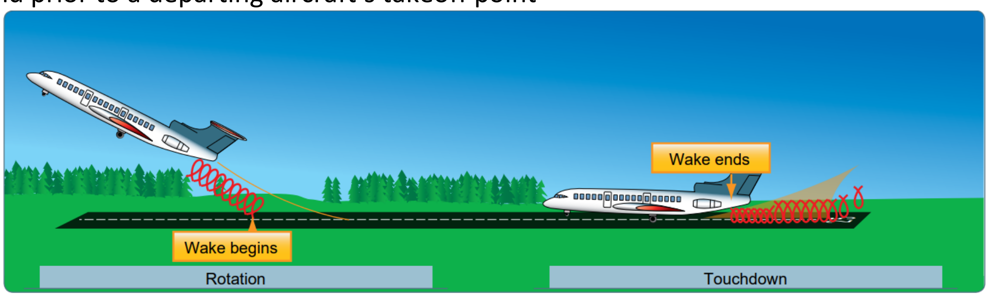
      b. Maneuvering Speed
      c. Intersection of the Negative Limit Load Factor and Line of Maximum Negative Lift Capability
      d. Limit Airspeed (red line)

7. Wingtip Vortices AI.II.D.K6

A. How They Work
   i. Why they Occur
      a. At positive AOA, pressure differential exists above/below the wing
      b. Air moves from higher to lower pressure, and the path of least resistance is the tips of the wings
      c. Air curls upward around the wingtip and combines with downwash to form vortices (increases drag)
   ii. Vortex Strength
      a. The greater the AOA, the stronger the vortices
      b. Heavy, clean, and slow = strongest vortices
   iii. Vortex Behavior

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

B. 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



C. For more details, see lesson VI.B. Traffic Patterns, Wake Turbulence

RM: Basic aerodynamic principles of flight AI.II.D.R1
   The lesson as a whole is a discussion of managing risk associated with aerdynamic principles

Conclusion:
Brief review of the main points

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

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

Objectives	The learner understands how the forces of flight affect the aircraft in different phases of flight.
Key Elements	1. Pilot Control of Lift 2. Parasite vs. Induced Drag 3. Ground Effect
Elements	1. Ground Effect 2. Climbs 3. Descents 4. Turns 5. 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 learner 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 better pilot.

Overview

Review Objectives and Elements/Key ideas

What:

How the forces of flight affect the airplane in different phases of flight.

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, and means of controlling them, the greater the pilot's skill.

How:

1. **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: Capable of lift off at lower-than-normal speed
     - ii. Landing: Airplane seems to float in ground effect
2. **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 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
3. **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
4. **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}

5. 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
        b.

Conclusion:
Brief review of each main point

II.E. Flight Controls & Operation of Systems

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

Objectives

The learner should develop knowledge of the primary and secondary flight controls, and trim, as well as the aircraft's various systems and their operation.

Key Elements

1. Primary Flight Controls – Airflow and Pressure Distribution
2. Trim relieves control pressures
3. Flaps increase lift and induced drag

Elements

1. Terms
2. Primary Flight Controls
3. Secondary Flight Controls
4. Trim Systems
5. Power Plant
6. Ignition Systems
7. Induction Systems
8. Oil Systems
9. Cooling Systems
10. Exhaust Systems
11. FADEC
12. Propeller
13. Landing Gear & Brakes
14. Fuel Systems
15. Electrical Systems
16. Avionics
17. Flight Instruments
18. Environmental Systems
19. Deicing & Anti-Icing Systems
20. Autopilot
21. Abnormalities & Failures
22. Flight Instruction

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 operation of the flight controls and systems and has a foundation of knowledge in how the aircraft works and how it applies in real-life scenarios.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

The inner workings of the flight controls and aircraft systems; to develop a better understanding of what is what, what is where, and why things work the way they do.

Overview

Review Objectives and Elements/Key ideas

What

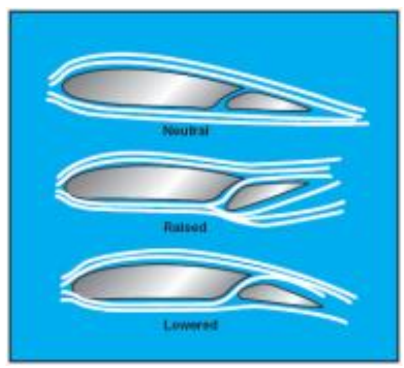
How the airplane's attitude is controlled using the primary flight controls. The effects and reasons for the secondary flight controls and trim, as well as the primary operating systems found on most aircraft.

Why

Understanding how the airplane functions results in an understanding of how to control the airplane, and a much more proficient pilot.

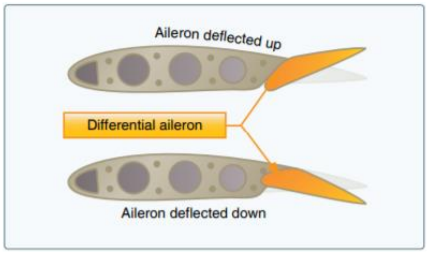
How:

1. **Terms**
   - 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** AI.II.E.K1a
   - 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



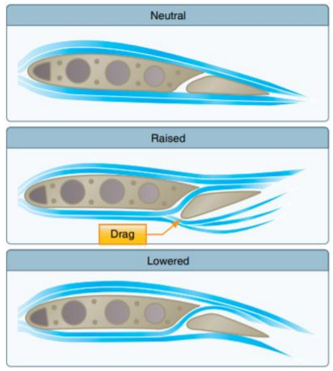
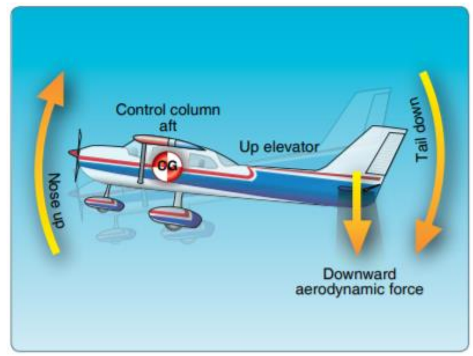
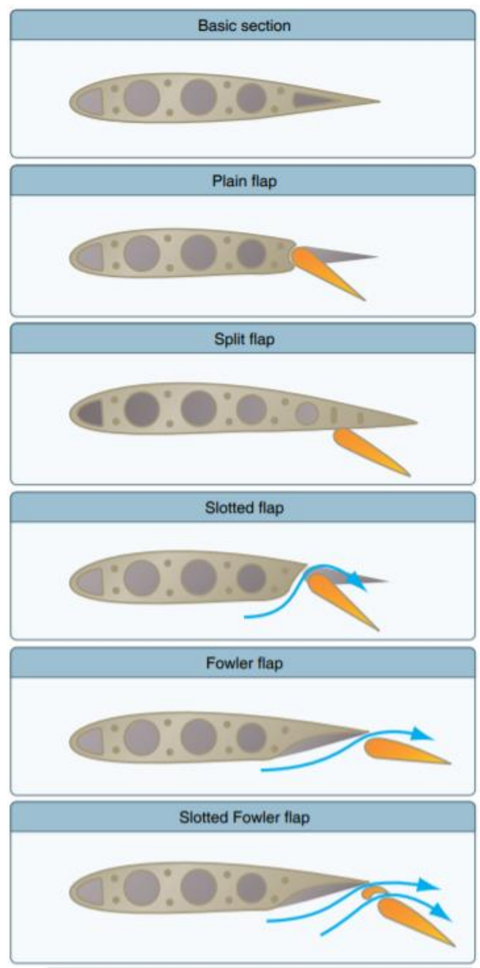


Figure 6-7. *Frise-type ailerons.*

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. Design Considerations
         - Designed stiffer and heavier than conventional
            a Longer moment arm creates high loads that can result in flutter
         - Susceptible to a deep stall when slow/high AOA (pictured)
            a The wing's airflow, when fully stalled, creates a wake of decelerated, turbulent air blanketing the horizontal tail
               1. Elevator control is reduced, or possibly eliminated
      c. 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

- iv. Safety Systems
  - a. Systems range from control stops to elevator down springs
    - Control stops limit the movement of the elevator control
    - Elevator down spring assists in lowering the nose to prevent a stall caused by an aft CG position
  - b. Stick pushers are commonly used on transport category jets
- 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
  - iv. V-Tail
    - a. Utilizes two slanted tail surfaces to perform the same functions as a conventional elevator and rudder
      - The fixed surfaces act as both horizontal and vertical stabilizers
    - b. 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.*

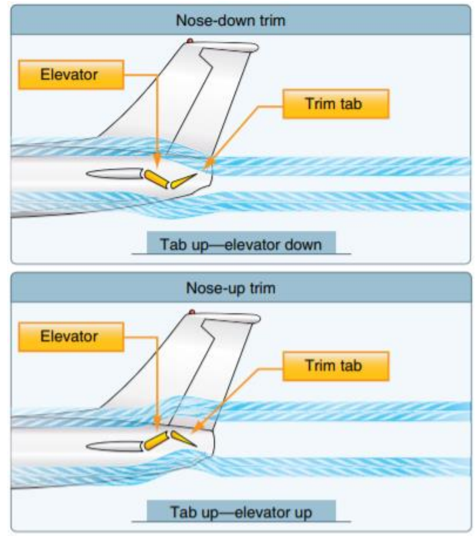
AI.II.E.K1b

3. Secondary Flight Controls

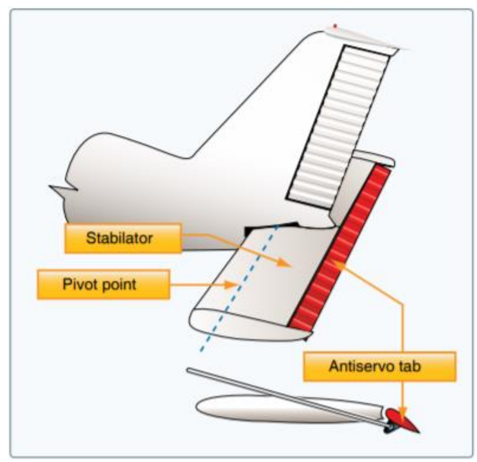
- A. Improve performance characteristics or relieve control forces
  - i. Wing Flaps, leading edge devices, spoilers, and trim systems
- B. Flaps
  - i. Increase induced drag and lift for any given AOA
  - ii. Functions
    - a. Get airborne at lower speeds, reduce takeoff runway required, improve climb 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 Systems



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. Note: Bottom pic should say "Tab Down – Elevator Up"
C. Flight deck Operation
   i. Establish desired power/pitch/configuration, then trim to relieve pressures
   ii. Re-trim any time power/pitch/configuration is changed
D. Types of Trim Tabs



   i. Balance Tabs
      a. Function like trim tabs, but coupled to the control rod
         - The tab moves opposite flight control deflection
      b. If adjustable by the pilot, it can be used as a trim tab too
   ii. Servo Tabs (primarily used in large aircraft)
      a. Small portion of a flight control that moves the entire flight control surface
      b. Only the servo tab moves in response the flight controls
      c. Airflow on the servo tab moves the control surface
   iii. Antiservo Tabs
      a. Decrease stabilator sensitivity/act as a trim device
      b. Operation
         - Like a balance tab, but moves in the same direction as the flight control
   iv. Ground Adjustable Tabs
      a. Metal trim tab on the rudder bent in either direction while on the ground to apply a trim force
   v. Adjustable Stabilizer
      a. Some aircraft can adjust the entire stabilizer
      b. Driven by a jackscrew
E. Using Trim Tabs
   i. Establish the desired power, pitch attitude, and configuration, then trim to relieve pressures
   ii. Any time power, pitch attitude, or configuration is changed, re-trim for the new condition

5. Power Plant – four stroke reciprocating engines AI.II.E.K1c

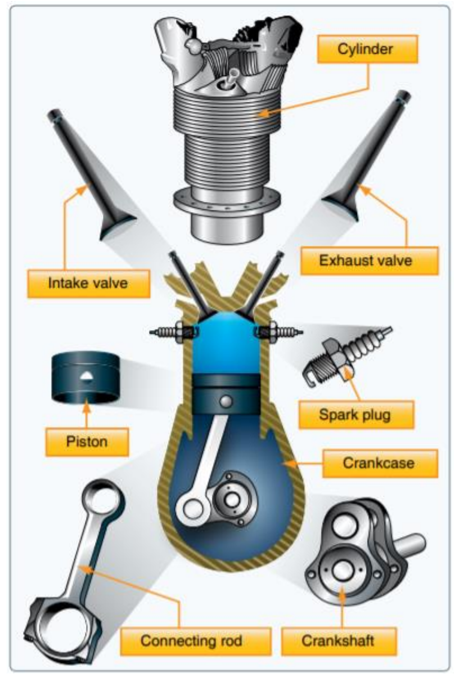
A. General
   i. Converts chemical energy (fuel) into mechanical energy
      a. Occurs in the cylinders through combustion
      b. Pistons produce mechanical energy to accomplish work
B. Basic Components and Operation

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

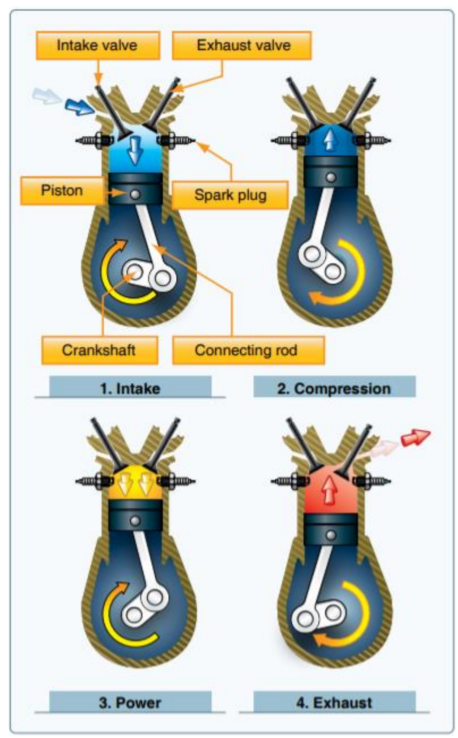
ii. Crankcase
  a. Contains crankshaft, and connecting rods
    - Pistons connect to the crankshaft via connecting rods
    - Crankshaft is connected to the propeller

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

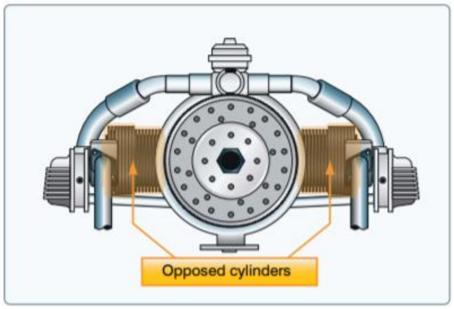


C. Two Primary Engine Designs
  i. Spark ignition – most popular for many years
  ii. Compression ignition is becoming more popular – Reduced costs, simpler designs, more reliable
    a. Compression systems can run on diesel or jet fuel (Diamond DA42, for example)
  iii. Components
    a. Main mechanical 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

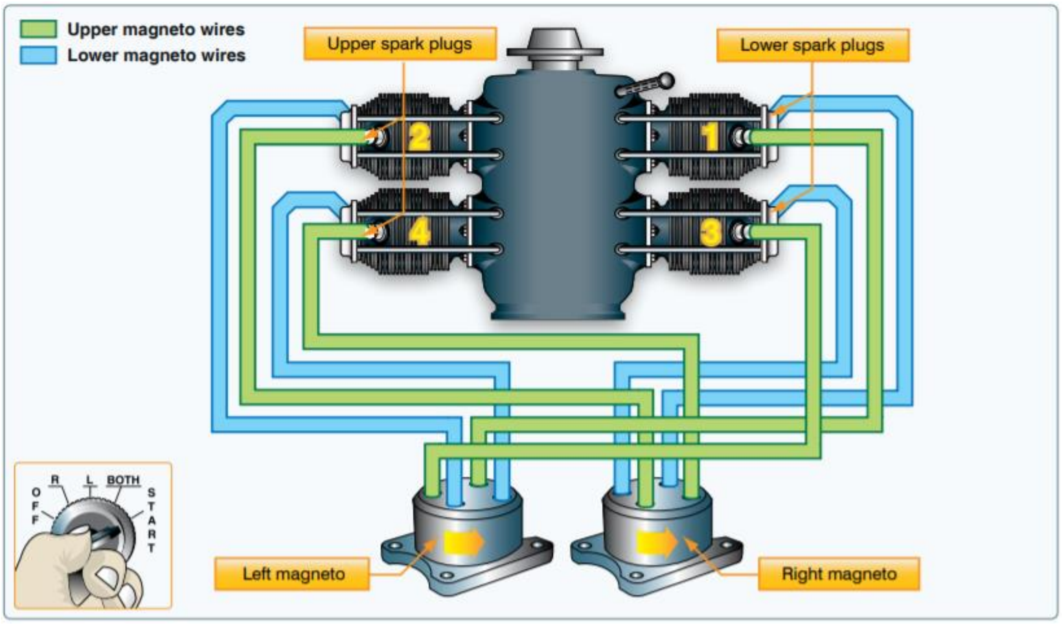
D. Horizontally Opposed Cylinder Arrangement
   i. Most popular reciprocating engine for smaller aircraft
   ii. Cylinder on one side "opposes" a cylinder on the other
   iii. Generally air cooled / mounted in a horizontal position
   iv. Compact arrangement allows for a more streamlined installation,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



6. 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

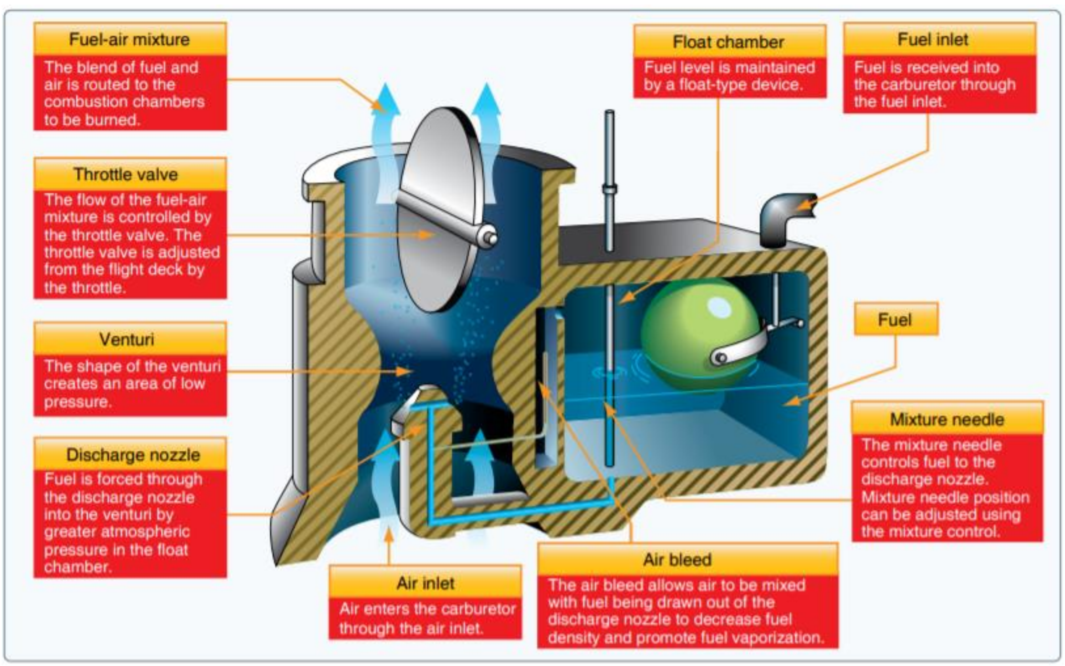
b. Crankshaft rotation activates the magnetos which send power to the spark plugs, producing a spark in the combustion chamber
   - Combustion in the chamber produces piston movement which rotates the crankshaft
c. Once the engine can move the pistons on its own the starter is no longer necessary
   - If 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

7. 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

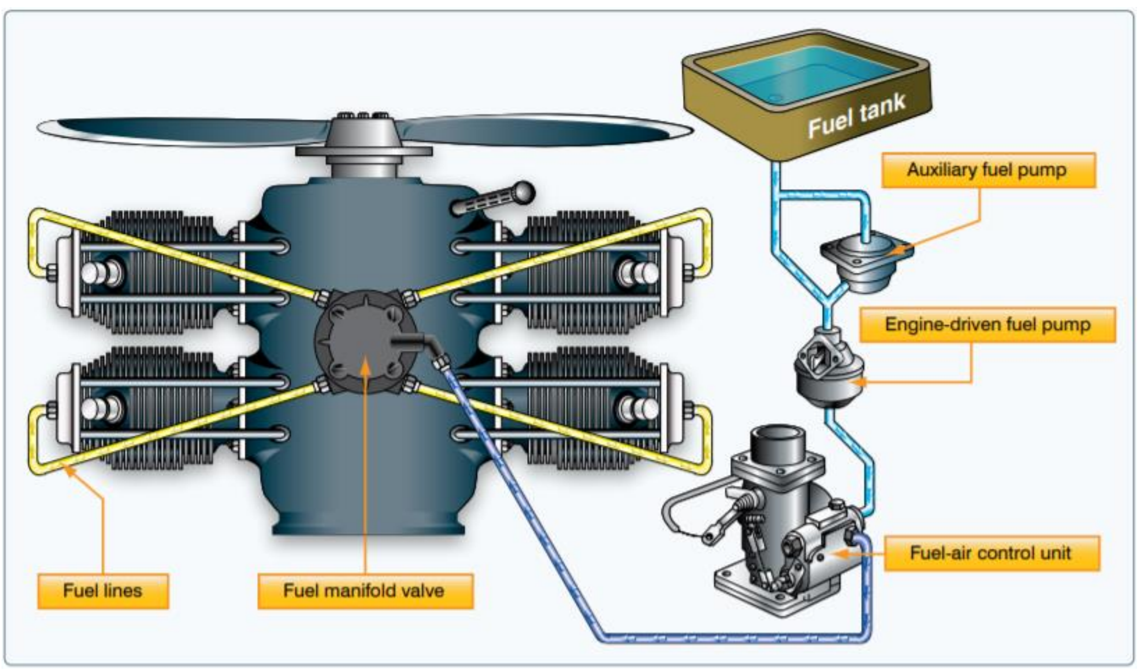
- The filtered air flows into the carburetor and through a venturi
    - a A low-pressure area is created forcing fuel to flow through the discharge nozzle
- The fuel / air mix and flow to the combustion chambers based on the throttle valve position
    - a Increasing power opens the valve, decreasing 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



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

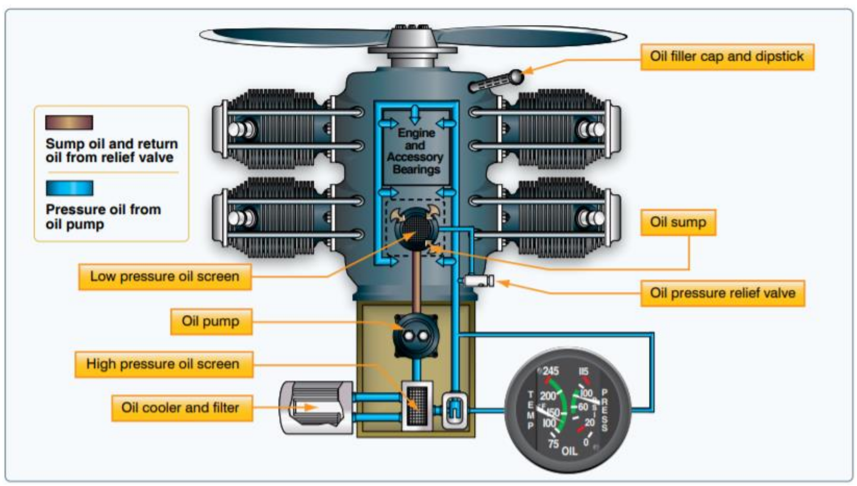
ii. Components and Operation
a. Engine-driven fuel pump – Provides fuel to the fuel-air control unit after the engine is started
b. Auxiliary fuel pump – Provides fuel to the fuel-air control unit for engine start / emergency use
c. Fuel-air control unit – Meters fuel based on the mixture / throttle 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 regard to the fuel system

8. Oil Systems AI.II.E.K1e

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 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

9. 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

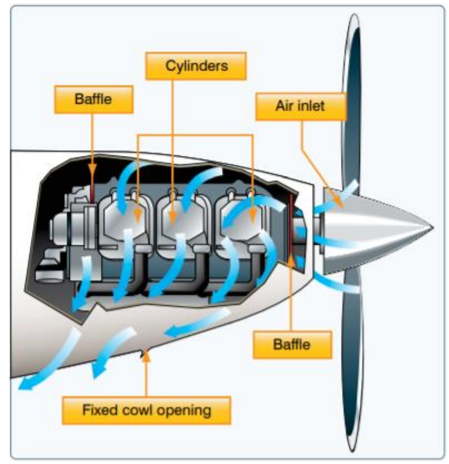
b. Liquid Cooling
   - Cooling liquid (usually water, ethylene glycol, or a combination of the two) is pumped around the engine to cool the hot components
   - Benefits: Less chance of shock cooling, ability to direct coolant to specific, critical areas
   - Negatives: Added weight, increased complexity 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

10. 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)

11. 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

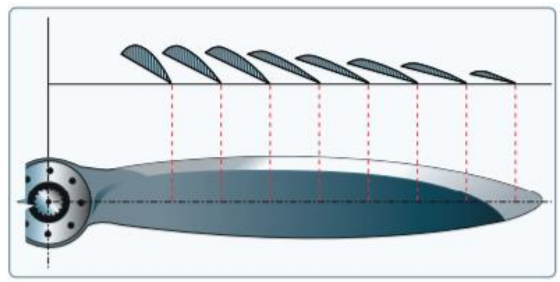
ii. Simplifies Systems

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

12. Propeller AI.II.E.K1c

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)

13. Landing Gear and Brakes (Hydraulics) AI.II.E.K1d, AI.II.E.K1e

A. Landing Gear

i. General

a. Principal support of the aircraft
- Types: Wheels, floats for water, skis for snow, etc.

b. Generally, 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

c. Fixed and Retractable Landing Gear
- Fixed – Always remains extended. Advantages: Simplicity and low maintenance
- Retractable – Streamlines the airplane / reduces drag

ii. Tricycle Landing Gear

a. 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

b. Nosewheel
- Steerable nosewheels are linked to the rudders by cables or rods
- 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

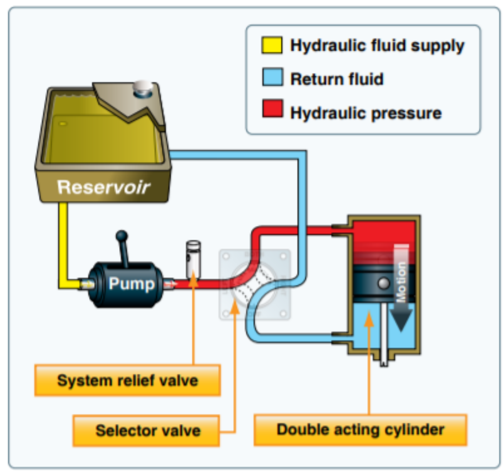
b. Advantages:
- Ground clearance for a larger propeller
- More desirable for operations on unimproved fields

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

14. Fuel Systems AI.II.E.K1e

A. General

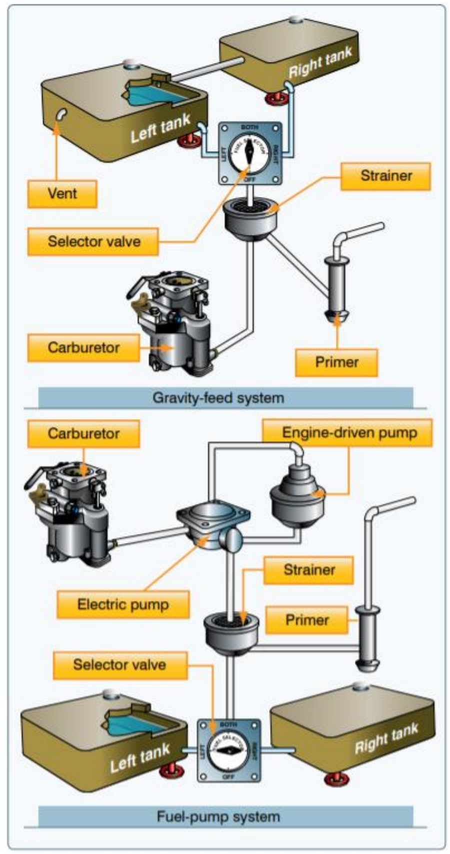
i. Provide uninterrupted, clean fuel from the tanks to the engine

ii. Fuel must be available under all conditions

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

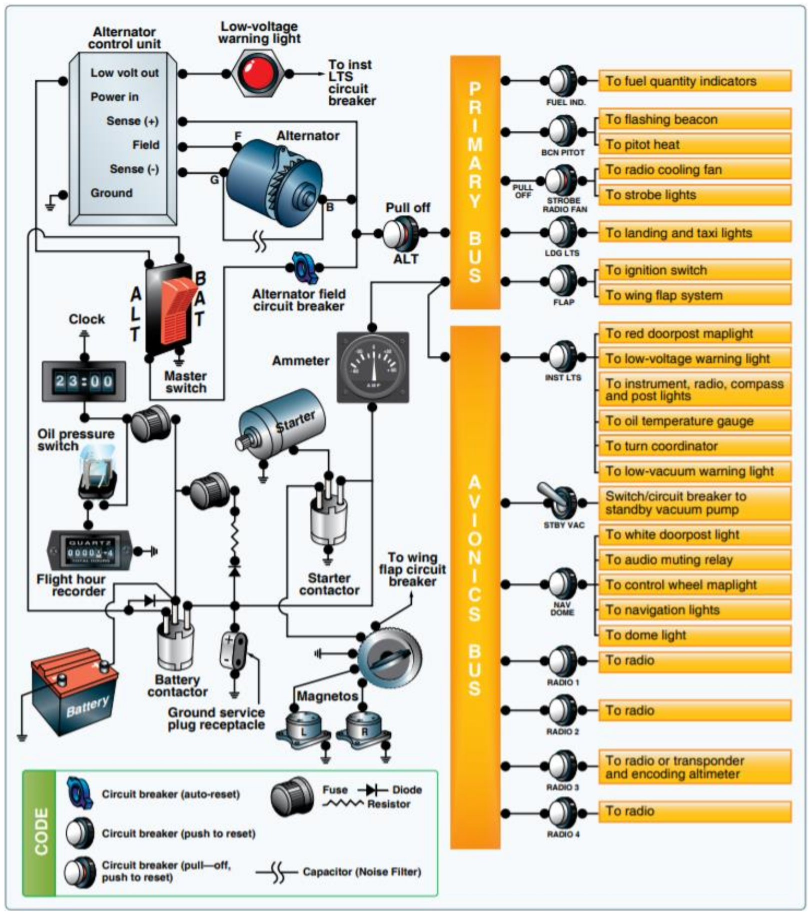
15. Electrical Systems AI.II.E.K1f

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

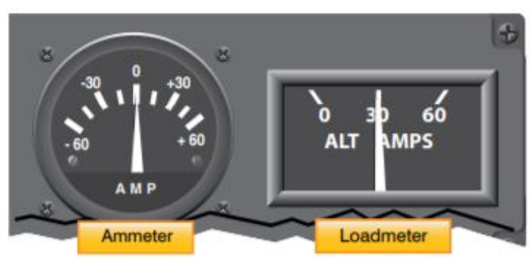
C. Power Storage
  i. Power is stored in batteries, primarily the main battery
    a. Electrical power for engine start, and limited power in case of alternator / generator failure



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 load on alternator/generator (% of load on the system)
    b. With all components off it reflects on the amount of charge demanded by the battery

16. Avionics AI.II.E.K1g

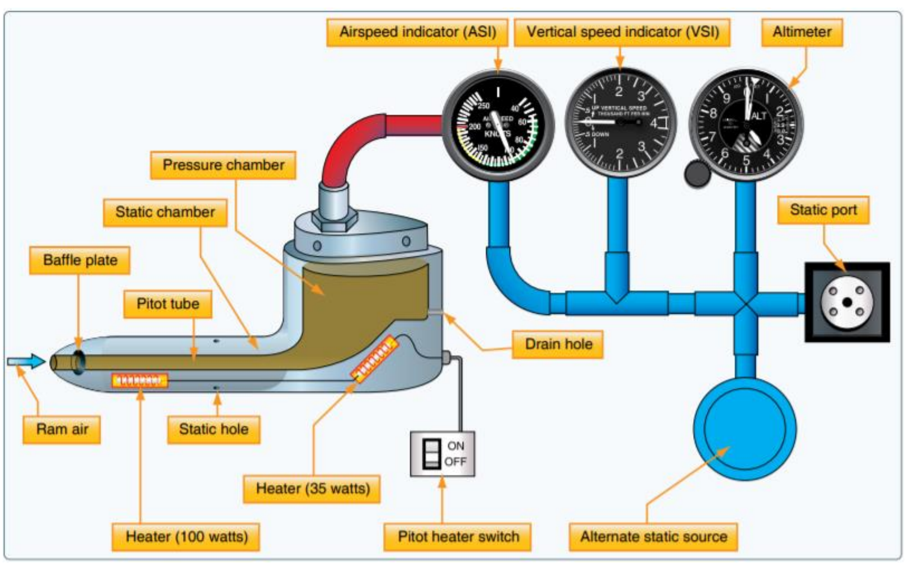
A. Avionics can vary greatly, especially with the advent and large-scale acceptance of glass displays
   i. Electronic instrument displays, GPS's, autopilots, radios, traditional instruments (vacuum, gyro, etc.)
      a. G1000, Avidyne, etc.
   ii. Be familiar with the avionics displays and instruments associated with your aircraft and their use
      a. Manage automation
      b. Do not become distracted with the seemingly unlimited functionality of glass flight decks
      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
      a. Can be directed by the pilot or coupled to a radio navigation signal
   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
         - Ex: A single-axis autopilot controls about the longitudinal axis and a servo actuates the ailerons
         - A three-axis autopilot controls the aircraft about the longitudinal, lateral, and vertical axes
            a Three different servos actuate ailerons, elevator, and rudder
         - More advanced systems often include a vertical speed and/or indicated airspeed hold mode
         - Advanced autopilot systems are coupled to navigational aids through a flight director
            a These autopilots work with inertial navigation systems, GPS, and flight computers to control the aircraft
   iv. Most autopilot systems also incorporate a disconnect to disengage the system automatically or manually
      a. Allows the pilot to override an autopilot malfunction

C. Because avionics systems differ widely in their operation, refer to the manufacturer's operating instructions

17. Flight Instruments AI.II.E.K1h

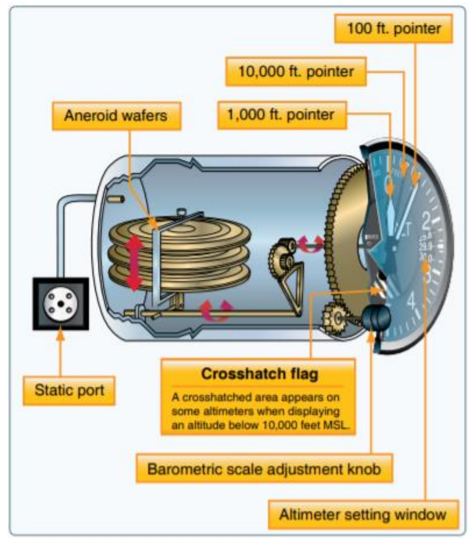
A. Pitot-Static Flight Instruments
   i. System that utilizes the static and impact pressure from the motion of the aircraft through the air
      a. Airspeed indicator, altimeter, and vertical speed indicator



   ii. How it Works
      a. Static Pressure (still pressure) is measured at a flush static port where air is not disturbed

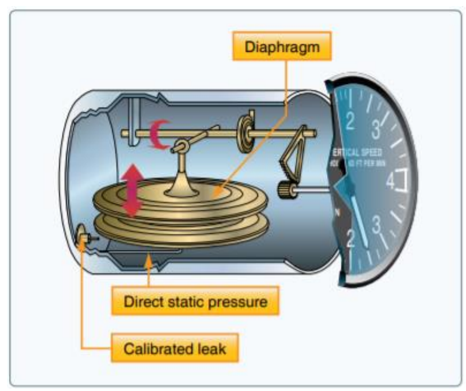
- b. Pitot Pressure (impact pressure) is measured through a pitot tube pointed into the relative wind
- c. The Pitot Tube connects to the Airspeed Indicator; the Static Port connects to all 3 instruments

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

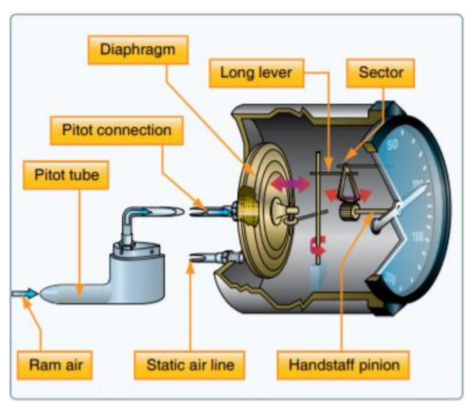


- c. Errors (Mechanical and Inherent)
  - Nonstandard Temperature
    - a Warmer than standard air is less dense, pressure levels are farther apart
      1. True altitude > Indicated altitude
    - b Colder than standard air is denser, pressure levels are closer together
      1. True altitude < Indicated 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

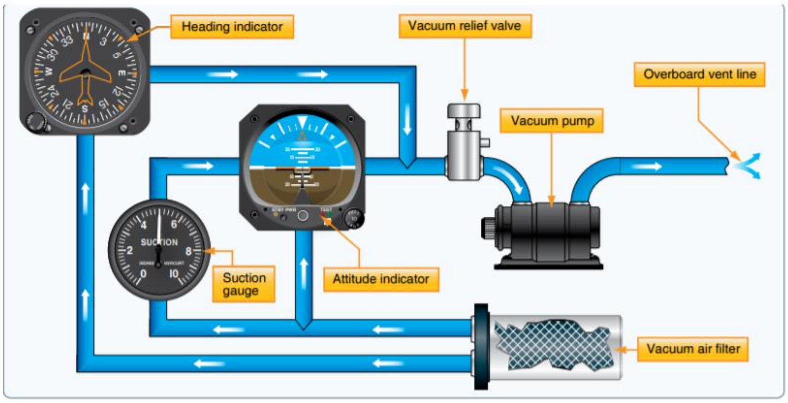
B. Gyroscopic System (Attitude Indicator, Heading Indicator, Turn Coordinator)

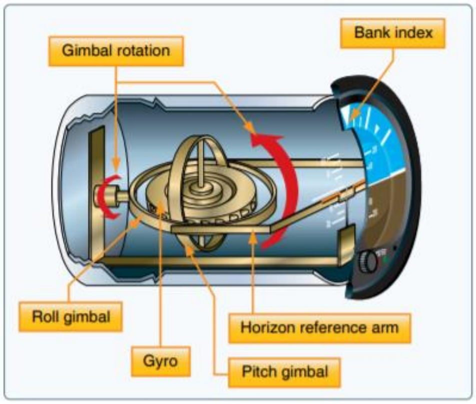
i. How it Works

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 90° from that point in the direction of rotation
  - a Turn indicators/coordinators (rate instruments) operate on the principle of precession

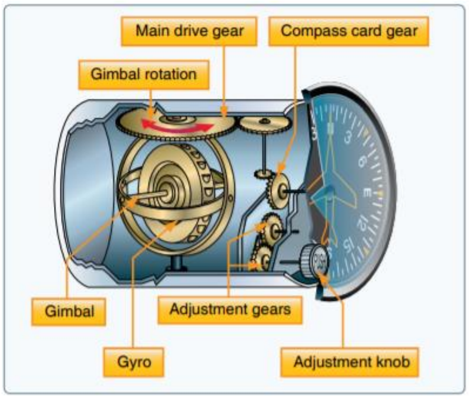
c. Power Sources
- Electrical Systems
- Pneumatic (vacuum) – Driven by jet of air impinging on buckets in the outside of the wheel
- Venturi Tube Systems
  - a Air flows through venturi tubes mounted on the outside of the aircraft
    1. The constricted part of the tube (low pressure) creates a suction 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





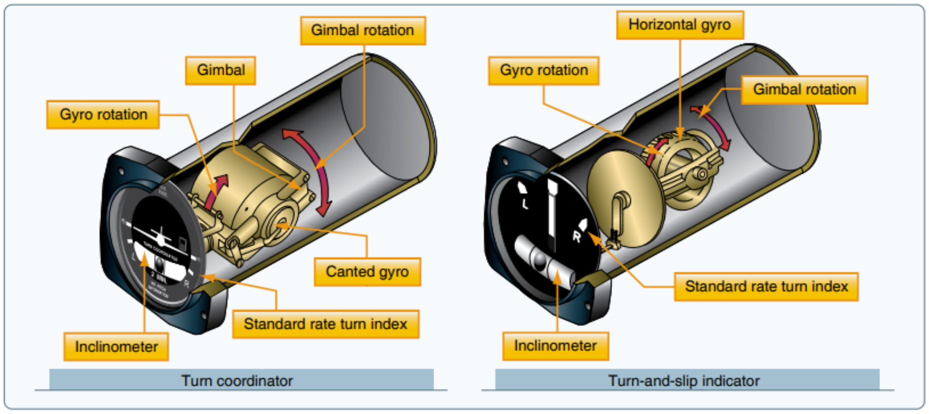
ii. Attitude Indicator (pictured above)
   a. Operation
      - Mounted in a horizontal plane
      - Double gimbal - allows display of pitch and roll
      - Horizon disk is attached to the gimbals
         a Remains in the same plane as the gyro and the plane pitches / rolls about it
      - Adjustable 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 & Earth rotates 15° per hour
      - Precession + rotation means heading should be checked / reset every 15 min

iv. Turn Indicators
   a. General
      - Two types: Turn-and-slip, and Turn coordinators
      - Both instruments indicate turn direction and quality of turn (coordination)
         a Turn-and-slip shows direction and rate of turn
         b Turn coordinator (canted gyro) shows direction and rate of turn and rate of roll
      - Backup source of bank information if the attitude indicator fails
   b. Operation
      - Gyro is powered by air or an electric motor
      - Small gyro mounted in a single gimbal
      - Yawing produces a force in the horizontal plane
         a Precession causes any yawing forces to tilt the gyro to the left or right
         b A spring works to maintain the center position
   c. Turn-and-Slip Indicator
      - Direction and rate of turn is displayed by the turn needle as yawing forces tilt the gyro
   d. Turn Coordinator (more common in GA aircraft)
      - Very similar to the turn-and-slip but gimbal is canted
         a Gyro can sense both rate of roll as well as rate of turn
         b A rapid roll rate causes the mini aircraft to bank more steeply than a slow roll rate
      - Used to establish and maintain a standard-rate turn (3° per second)
      - Align the wing of the mini aircraft with the turn index



v. 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

18. Environmental Systems AI.II.E.K1i

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

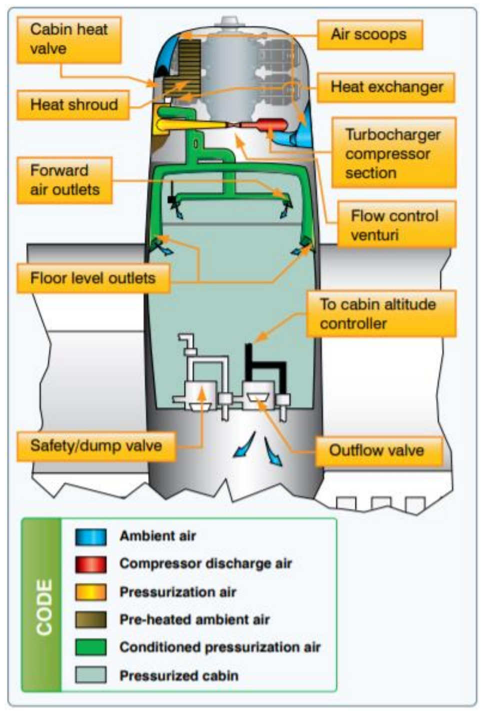
ii. How it Works

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

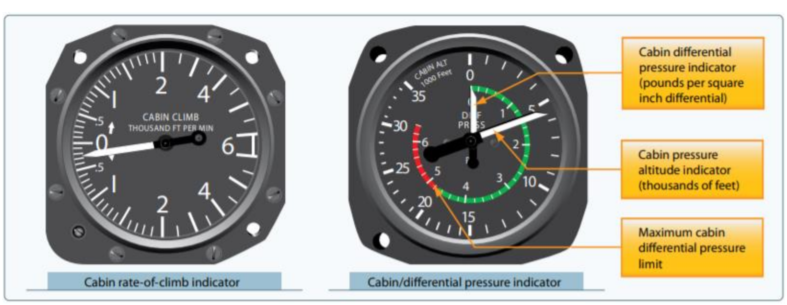
b. Outflow Valve
- Air exits the fuselage through the outflow valve
- Allows for a constant inflow of air, while maintaining the proper differential pressure

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

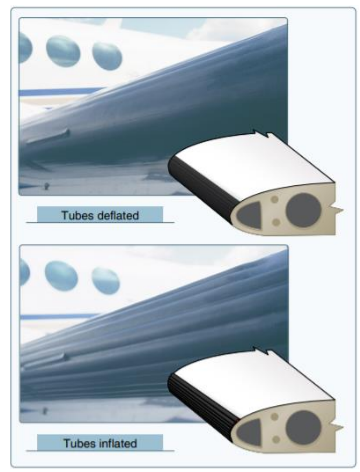
b. Cabin Altimeter – Shows the altitude inside the airplane
- Differential pressure gauge and cabin altimeter can be combined into one instrument
- Cabin Rate of Climb/Descent – Shows rate the cabin altitude is changing during

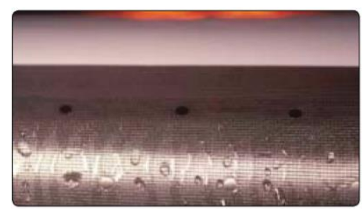


19. Deice and Anti-Ice Systems AI.II.E.K1j

A. Overview
   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 flight deck

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

20. Autopilot

A. Overview
   i. Automatic flight control system to keep an aircraft in level flight or on a set course
      a. Amount of automation varies based on the system – Reference POH/Operator's Manual
   ii. Reduces pilot physical and mental demands

B. RM: Managing & Monitoring Automation AI.II.E.R3
   i. Managing: Automation is only as good as the inputs it's given
      a. Understand the system's capabilities & ensure proper set up and programming
   ii. Monitoring: Follow along with the automation to ensure it's doing what you intend, when you intend it

21. RM: Abnormalities & Failures AI.II.E.K2, AI.II.E.R1

A. Automated Systems AI.II.E.R3
   i. Monitor indications and be familiar with expected operation, ranges & limitations, & warning annunciations
   ii. Reference the POH and/or take action if indications are out of range

B. Recognizing Malfunctions or Failures
   i. Specific to the aircraft and its systems (EFD warnings, caution/warning lights, gauge indications, etc.)

C. Managing a Failure (Airborne) AI.II.E.R2

- i. Maintain Aircraft Control
  - a. Fly the airplane - Get to a safe flight state (straight-and-level, etc.)
  - b. Trim and turn on automation, if possible
  - c. Maintain control throughout the malfunction
- ii. Analyze the Situation
  - a. Indications, lights, sounds, visual (i.e., smoke, leaks, fire, etc.), smells, etc.
  - b. Use all available information to determine the issue
- iii. Take the Proper Action
  - a. Apply any memory items
  - b. Use the appropriate checklist from the POH
- iv. Land, as conditions require/permit
  - a. Based on the emergency, decide on a landing area (divert, field, ditching, etc.)
  - b. This may have to occur in conjunction with the checklist(s)

D. Managing a Failure (On the Ground)
- i. Remain on the ground
- ii. Analyze the situation: Same as above
- iii. Take proper action: Run the appropriate checklist(s)
- iv. Decide whether to continue the flight, return to park, or evacuate

22. RM: Flight Instruction (Unfamiliar Aircraft, Systems & Avionics) AI.II.E.R4

A. Just because it's legal, doesn't mean it's safe

B. Ensure proficiency in any aircraft you're flying, let alone instructing in
- i. Important for safety as well as the learner's time, money, and education

Conclusion:

Brief review of the main points

II.F. Performance & Limitations

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

Objectives	The learner develops knowledge of the elements related to airplane performance and limitations.
Key Elements	1. Density 2. Density Altitude 3. Airplane Performance
Elements	1. Performance 2. Performance Factors 3. Aerodynamics 4. Performance Charts 5. Weight & Balance 6. Exceeding 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 learner can calculate weight & balance, and performance and properly apply the information to the specific aircraft and its limitations as well as the operating environment (runway, terrain, cruise altitude, airspeeds, etc.).

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 and determine the aircraft's performance based on current weather conditions and the operating environment, as it would not be fun to find out first-hand that based on the conditions we didn't have a strong enough headwind to takeoff.

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. Additionally, airplane weight and balance is basically balancing the airplane within approved limits (also in the aircraft's limitations)

Why

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

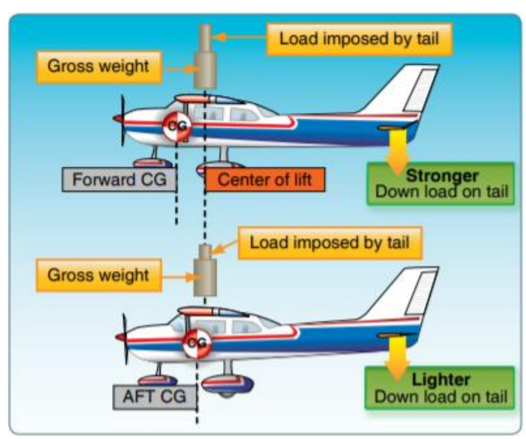
How:

1. **Performance**
   - A. Ability of an aircraft to accomplish certain things that make it useful for a certain purpose
   - B. Primary factors most affected by performance are:
     - i. Takeoff/landing distance, climb rate, ceiling, payload, range, speed, maneuverability, stability, fuel economy
   - C. Aircraft and powerplant design & characteristics dictate available performance
     - i. Manufacturer will match aerodynamic configuration with a powerplant for the specific design conditions
   - D. POH charts and information are used to measure performance based on the specific flight's conditions
2. **Performance Factors**
   - A. Atmospheric Conditions AI.II.F.K2a
     - i. Atmospheric Pressure
       - a. Under standard conditions at sea level, the average pressure is approx. 14.7 lbs. per sq. in
       - b. Since air is a gas, it can be compressed or expanded
       - c. Air density effects performance: As density increases, performance increases and vice versa
     - ii. What Changes Air Density (DA)?
       - a. Barometric Pressure, Temperature, Altitude, and Humidity
         - Density varies directly with pressure - As pressure increases, density increases and vice versa
         - Density varies inversely with temperature – As temp increases, density decreases and vice versa
         - Density varies inversely with altitude - As altitude increases, density decreases and vice versa
         - Density varies inversely with humidity – As humidity increases, density decreases and vice versa
     - iii. How it affects Performance
       - a. As the air becomes less dense, it reduces:
         - Power, since the engine takes in less air
         - Thrust, since the propeller is less efficient in thin air (less air is being moved for every rotation)
         - Lift, because the thin air exerts less force on the airfoils

B. RM: Pilot Technique & Airplane Configuration AI.II.F.K2b, AI.II.F.K2c, AI.II.F.R3
(RM: Difference between calculated & actual performance)
   i. Performance is based on specific aircraft configuration, procedures, airspeeds, etc.
   ii. Any technique or configuration that differs from POH criteria will change (likely reduce) performance

C. Airport Environment AI.II.F.K2d
   i. Airport Runways & Layout
      a. Runway Surface (paved, grass, dirt, gravel, etc.)
         - Any surface that is not hard and smooth increases ground roll
         - Braking Effectiveness
            a Soft surfaces slow an aircraft much faster than smooth and slick surfaces
            b Wet runways reduce braking effectiveness and can result in hydroplaning
      b. Runway Gradient: Amount of change in height over the length of the runway, expressed as a percentage
      c. Runways available based on wind conditions
   ii. Surrounding Terrain & Factors (Obstacles, towers, buildings, etc.)
      a. Can the aircraft clear the obstacles based on the specific conditions?
      b. Is a max angle versus max rate of climb required
      c. Are there specific noise abatement or climb rate procedures requiring specific performance

D. Loading and Weight & Balance AI.II.F.K2e
   i. Weight and Flight Performance
      a. Added weight reduces aircraft performance
      b. Manufacturer's limit maximum weights to ensure aircraft performance / structural abilities
      c. Effects of increased weight
         - Higher takeoff speed and longer takeoff run
         - Reduced rate and angle of climb & Lower maximum altitude
         - Slower cruise speed and reduced range, and increased fuel consumption
         - Reduced maneuverability
         - Higher stall speed
         - Higher approach speed and longer landing roll
         - Excessive weight on the nose / tail wheel
      d. RM: Effects of Overloading (RM: Exceeding weight limits) AI.II.F.R4
         - Degraded climb performance, may not even be able to takeoff, inability to reach max altitude
         - Overheating during climbs, added wear on engine parts
         - Overstressing the aircraft
   ii. RM: Weight and Structure (RM: Exceeding weight limits) AI.II.F.R4
      a. Structural failures from overloading are often affect progressive, making it difficult to detect or repair
      b. Airworthiness requirements prescribe the aircraft can withstand a specific load factor (3.8 Gs - normal)
         - Any overload is amplified in the case the aircraft is stressed to these G limits
            a For example, a 200 lb. overload imposes a potential structural overload of 740 lbs.
   iii. Stability and Controllability
      a. Forward Loading
         - Problems controlling and raising the nose, especially at slow airspeeds (takeoff and landing)
         - "Heavier" and consequently slower than the same airplane with a further aft CG



- Higher stall speed
- More controllable in a stall

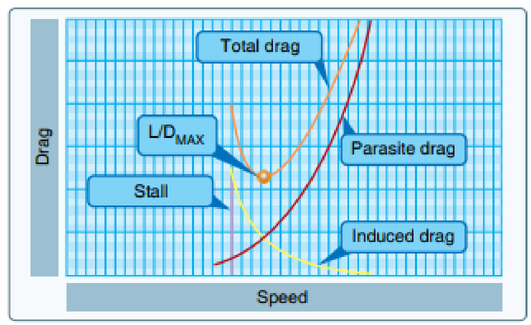
b. Aft loading
- Very light control forces (easier to overstress)
- "Lighter" and consequently faster than the same airplane with a more forward CG
- Lower stall speed
- Less controllable in a stall/spin
- Serious effect upon longitudinal stability

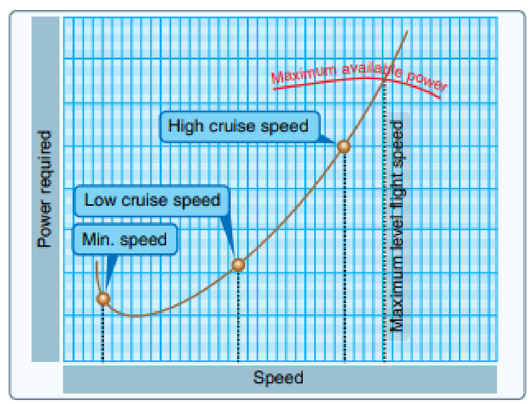
c. The CG and Lateral Loading
- Unbalanced loading can have adverse effects
- Trim, or maintain constant control pressure
  - a Increases drag, decreases efficiency

d. RM: Operating outside of CG limits can result in control difficulties AI.II.F.R5
- Extremely nose or tail heavy – may not have control authority

3. Aerodynamics AI.II.F.K5

A. Straight-and-Level





i. To maintain straight-and-level, lift must equal weight and thrust must equal drag

ii. Parasitic drag dominates at high speed, induced drag at low speed (pictured, top right)

iii. Max level flight speed is obtained when power required equals max power/thrust available (lower right picture)

iv. Min level flight speed is not defined by thrust/power requirements since stall occurs first (lower right picture)

B. Climb Performance

i. Kinetic Energy (KE): Energy of speed
a. Directly proportional to the square of airspeed
b. $KE = \frac{1}{2} \times m \times v^2$
- m = mass, v = velocity

ii. Potential Energy (PE): Stored energy, Altitude
a. Directly proportional to the altitude
b. $PE = m \times g \times h$
- m = mass, g = gravity, h = height

iii. Power & Thrust
a. Thrust: Force or pressure exerted on an object (pounds or newtons)
b. Power: Measurement of the rate of performing work or transferring energy (horsepower or kilowatts)
- The motion (KE and PE) a force (thrust) creates when exerted on an object over a period of time

iv. Positive climb performance occurs when an aircraft gains PE by increasing altitude
a. Two factors contribute to gaining altitude:
- Factor One: Aircraft uses excess power above what's required to maintain level flight
- Factor Two: Aircraft converts airspeed (KE) to altitude (PE)

C. Angle of Climb (AOC)

i. Comparison of altitude gained relative to distance traveled
a. V_X is used for max AOC performance

ii. Max AOC occurs at the airspeed and AOA combination resulting in maximum excess *thrust*
a. This combination differs amongst aircraft types

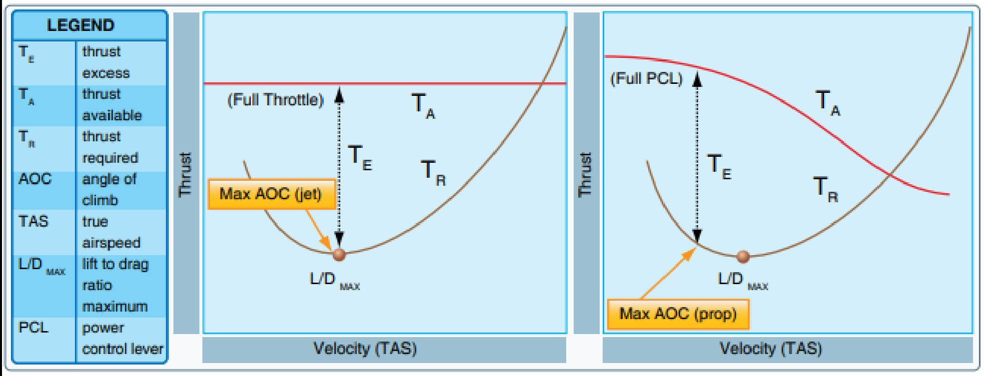


Figure 11-8. *Comparison of maximum AOC between jet and propeller airplanes.*

- Jet: Approximately L/D_{MAX}
- Propeller Plane: Below L/D_{MAX} and just above stall speed

D. Rate of Climb (ROC)

  a. Comparison of altitude gained relative to the time needed to reach that altitude (V_Y)

 ii. Max ROC occurs at the airspeed and AOA combination resulting in maximum excess *power*

  a. Combination differs amongst aircraft types

- Jet: Airspeed > L/D_{MAX} and AOA < L/D_{MAX} AOA
- Propeller Plane: Airspeed and AOA combination close to L/D_{MAX}

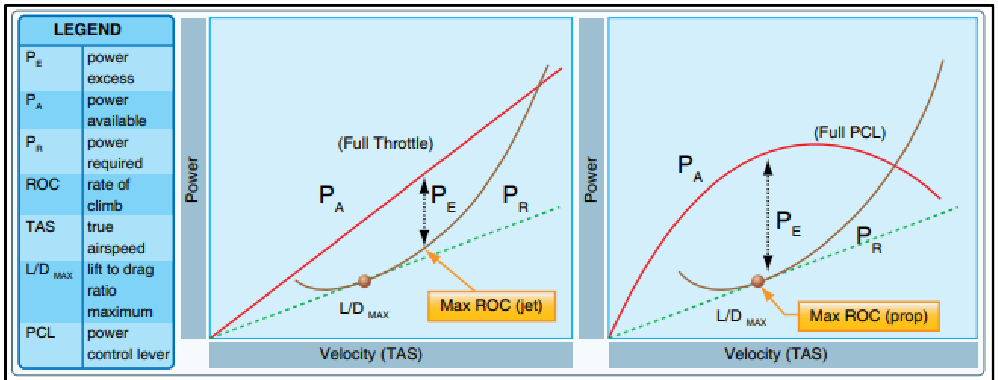


Figure 11-9. *Comparison of maximum ROC between jet and propeller airplanes.*

E. Climb Performance Factors

 i. Weight, altitude, and configuration affect excess thrust & power and therefore climb performance

  a. Increased weight/altitude and lowering the flaps/gear decrease excess thrust & power

 ii. Weight

  a. Added weight means the aircraft must fly at a higher AOA to maintain a given altitude & speed

- Increases drag requiring additional thrust
- Additional thrust = less reserve thrust to climb

 iii. Altitude (pictured, right)

  a. Climb performance diminishes with altitude

- Increases power required & decreases power available

  b. As altitudes increases, max AOC/ROC & min/max level flight speeds converge at the absolute ceiling

- At the absolute ceiling, there is no excess power and

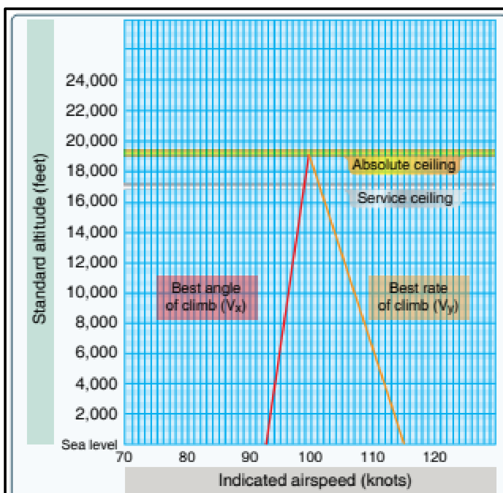
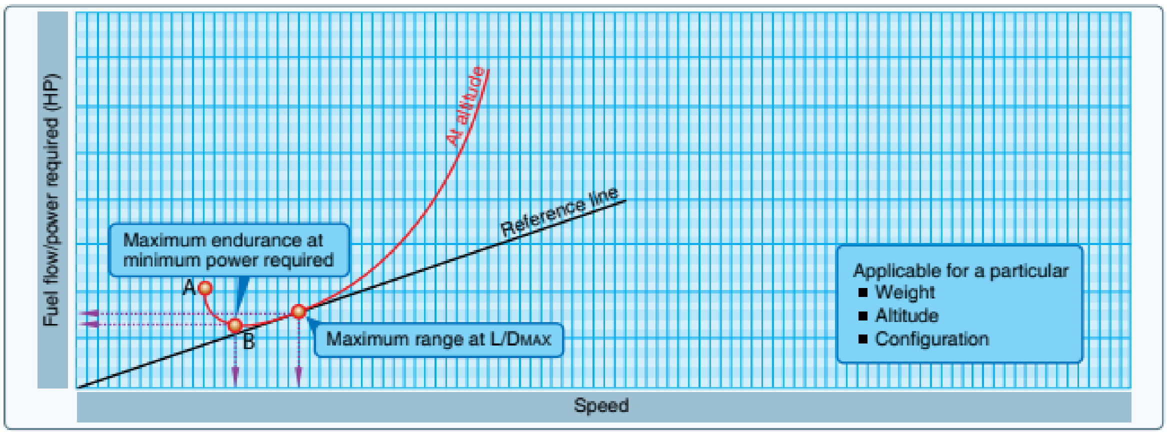


Figure 11-10. *Absolute and service ceiling.*

only one speed allows level flight

F. Range Performance



i. The ability to convert fuel into flying distance
ii. Range versus Endurance
  a. Range involves the consideration of flying distance
  b. Endurance involves the consideration of flying time
iii. Maximum Endurance (Time)
  a. If max endurance is desired, the flight condition must provide minimum fuel flow (point B in the chart)
  b. Point A (low speed, high fuel flow) is takeoff and climb
  c. As airspeed increases, power and fuel requirements decrease due to aerodynamic factors up to Point B
  d. Beyond Point B, you must pay to go faster (more airspeed requires more power at the cost of fuel)
iv. Maximum Range
  a. Costs aside, max range is the flight condition providing max NM per pound of fuel (or specific range)
    - Specific Range = NM / pounds of fuel
      a Ex: Specific range of 1.89 means for every pound of fuel, the aircraft could fly 1.89 miles
  b. Obtained at L/D_{MAX} and varies with gross weight, altitude, and configuration
    - As fuel is burned, gross weight changes, and therefore optimum altitude, airspeed, & power changes
    - L/D_{MAX} occurs at a specific AOA & lift coefficient, irrespective of weight
      a Changes in weight alter the specific airspeed and power required to attain L/D_{MAX}
    - To maintain maximum range, optimum conditions must be maintained
  c. Headwinds & Tailwinds
    - Theories say that speeding up in a headwind & slowing in a tailwind helps achieve max range
    - May be true in many cases, but there are many variables to every situation – no catch all rule
  d. Reciprocating engine aircraft experience little, if any, variation in specific range up to absolute altitude

4. Performance Charts AI.II.F.K1

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. 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 (Altimeter=30.42, 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. Determining the Required Performance is Attainable
   i. Use the performance charts and relate them to the airport information (runway lengths, etc.)
      a. The charts will provide performance for all phases of flight
   ii. Remember, the charts don't make allowance for pilot proficiency or mechanical deterioration
   iii. If conditions change, recalculate performance
E. RM: Inaccuracies (RM: Use of performance charts, tables, and data) AI.II.F.R1
   i. Ensure you are using the proper chart
   ii. Many charts are imprecise, requiring you follow numerous small, detailed lines through various charts
      a. Be as accurate as possible, double check work and verify if the performance information makes sense
F. RM: Calculated versus Actual Performance AI.II.F.R3
   i. Calculated performance is based on the POH chart assumptions (configuration, airspeeds, etc.)
      a. Anything different leads to different (generally, reduced) actual performance
   ii. Be conservative in performance calculations and precise in flying/operating procedures

5. Weight & Balance

A. Terms AI.II.F.K3
   i. Reference Datum (RD) - imaginary vertical plane or line from which all measurements of arm are taken
   ii. Center of Gravity (CG) – the point at which an airplane would balance if it were suspended at that point
   iii. Arm – the horizontal distance in inches from the reference datum line to the CG of an item
   iv. Basic Empty Weight –weight of the airplane, optional equipment, unusable fuel, full operating fluids
   v. CG Limits – the specified forward and aft points within which the CG must be located during the flight
   vi. Maximum Landing Weight – the greatest weight that an aircraft is normally allowed to have at landing
   vii. Maximum Ramp Weight – the total permitted weight of a loaded aircraft, including all fuel
   viii. Maximum Takeoff Weight – the maximum allowable weight for takeoff
   ix. Maximum Zero Fuel Weight – the maximum weight, exclusive of usable fuel
   x. Moment – the product of the weight of an item multiplied by its arm - expressed in pound-inches
   xi. Moment Index – a moment divided by a constant such as 100, 1,000 or 10,000 (simplifies calculations)
   xii. Payload – the weight of the occupants, cargo and baggage
   xiii. Standard Weights – established weights for numerous items in weight and balance computations
      a. Gas – 6lbs; Jet Fuel – 6.8 lbs.; Oil – 7.5 lbs.; Water – 8.35 lbs. (All per gallon)
   xiv. Station - a location in the aircraft identified by a number designating its distance from the datum
   xv. Unusable Fuel – the fuel in the tanks that cannot be safely used in flight or drained on the ground
   xvi. Usable Fuel – the fuel in the tanks that can be used for flight
   xvii. Useful Load – the basic empty weight subtracted from the maximum allowable gross weight
B. Weight & Balance Control
   i. The pilot is responsible
      a. 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
      b. Part 91.9 requires the PIC to comply with the operating limitations in the approved AFM
   ii. Aircraft owner/operator should ensure up to date information is available to the pilot
C. Determining Weight and Balance AI.II.F.K4
   i. CG = Total Moment divided by Total Weight

a. Begin with the empty weight and make a list of everything that will be loaded in the airplane
b. Calculate the Moment of each item, then calculate the CG – (Total Moment/Total Weight)

ii. RM: Weight Change and/or CG Shift (RM: Shifting, adding, and removing weight) AI.II.F.R6

a. Shifting Weight
- Formula: $\frac{Weight\ to\ be\ Shifted}{Total\ Weight} = \frac{\Delta\ CG}{Distance\ Weight\ is\ Shifted}$
  - a If you know 3 of the components, you can solve for the 4^{th}

b. Adding or Removing Weight
- Formula: $\frac{Weight\ Added\ or\ Removed}{New\ Total\ Weight} = \frac{\Delta CG}{Distance\ between\ the\ Weight\ and\ old\ CG}$
  - a Solve for the missing component

6. RM: Exceeding Limitations AI.II.F.R2

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

II.G. 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. Special VFR
3. Special Use Airspace
4. Other Airspace Areas
5. VFR Charts

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 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. 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** AI.II.G.K1
   (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. ADS-B Requirements (91.225(d))
            - ≥ 10,000' MSL excluding at and below 2,500' AGL
            - ≥ 3,000' MSL over Gulf of Mexico within 12 nm of the coast
         c. 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
         d. Pilot Qualifications: Student pilot
      iii. ATC Services

Class E	
VFR Minimum Visibility	Below 10,000' MSL - 3 sm Above 10,000' MSL - 5 sm
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	As specified: Mode C Transponder & ADS-B
ATC	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
a. For VFR Operations:
- At least a Private Pilot Certificate is required

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

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 ADS-B
ATC Services	IFR/IFR & VFR Separation VFR Traffic advisories (permitting)

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

- Or learner/recreational/sport pilot with endorsement
    - a AIM 3-2-3b: Solo learner, 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

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 Airspace	Entry Requirements	Equipment	Minimum Pilot Certificate
A	ATC Clearance	IFR Equipped	Instrument Rating
B	ATC Clearance	Two-way radio Transponder with altitude reporting capability ADS-B	Private – with exception
C	Two-way radio communications prior to entry	Two-way radio Transponder with altitude reporting capability ADS-B	No specific requirement
D	Two-way radio communications prior to entry	Two-way radio	No specific requirement
E	None for VFR	Transponder, as specified ADS-B, as specified	No specific requirement
G	None	No specific requirement	No specific requirement

VFR Weather Minimums Summary (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

2. Special VFR (FAR 91.157) AI.II.G.K5

A. Clearance to operate under VFR with less than VFR weather minimums
   i. Only in Class B, C, D, or E surface areas, below 10,000' MSL
   ii. Must be requested by the pilot
   iii. Special VFR is on the basis of weather conditions at the airport of intended landing/departure
   iv. Only approved if IFR traffic are not delayed

B. Special VFR may only be conducted
   i. With an ATC clearance
   ii. Clear of clouds
   iii. With at least 1 statute mile flight visibility
   iv. At night (sunset to sunrise):
      a. With an instrument rated pilot and aircraft

C. May not takeoff or land under special VFR unless ground visibility is at least 1 statute mile
   i. If not reported, flight visibility must be at least 1 statute mile

D. Prohibited at certain airports (mostly large class B airports) shown in Part 91 Appendix D Section 3

3. Special Use Airspace AI.II.G.K3

A. Special Flight Rules Area (SFRA) - Airspace governed by the rules described in Part 93
   i. Normal rules don't necessarily apply – special rules for operating in the boundaries of certain airspace
   ii. Ex: Washington DC National Security, LA VFR Corridor, Grand Canyon National Park

B. 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

C. 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

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

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

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

G. 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 AI.II.G.K3

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. VFR Charts

A. Chart Symbology AI.II.G.K2

i. Aeronautical Chart User's Guide (Pgs. 17-19: Airspace, Special Use & Other Airspace)

B. Chart Updates & Currency AI.II.G.K4

i. Terminal Area & Sectional Charts: Updated every 56 days

ii. Wall Planning Chart: Updated annually

iii. Information changes rapidly, it is important to check the effective dates on each chart/publication

iv. To confirm currency, refer to the next scheduled edition date printed on the cover

a. Use the FAAs Dates of Latest Editions to verify you have the most current edition

b. Prior to expiration, check NOTAMs and Safety Alerts and Charting Notices for any changes

RM: Various classes & types of airspace AI.II.G.R1

The lesson as a whole is a discussion on the risks and requirements for each class of airspace

Conclusion:

Brief review of each main point

II.H. Navigation Systems & Radar Services

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

Objectives

The learner should develop knowledge of the elements related to the navigation systems and radar services provided by ATC as required in the ACS.

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
7. Transponder
8. EFBs & Automation
9. Distractions

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 operation of different navigation systems as well as their use in the airplane. The learner 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

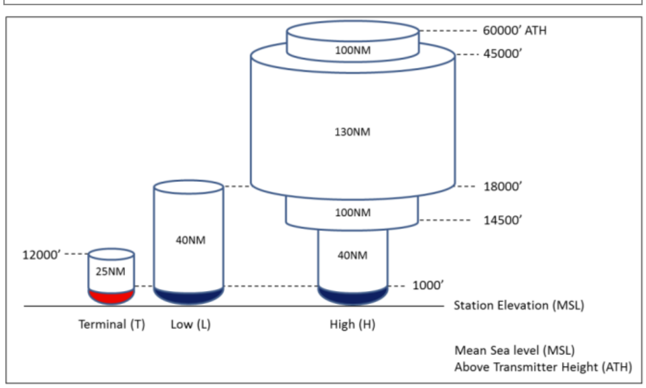
It is important to understand how the navigation systems function to properly use them. It also is important to know the services provided by ATC to pilots.

How:

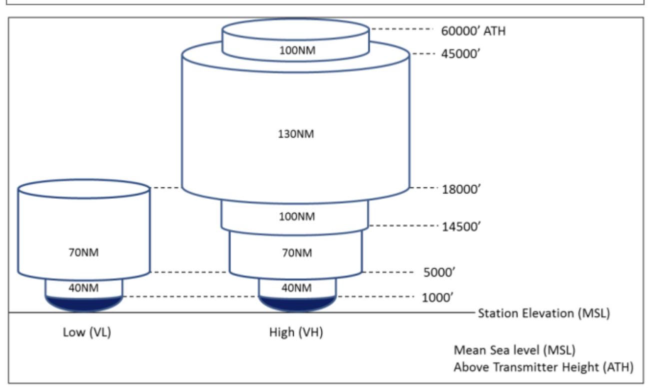
1. **VOR/VORTAC** (Very High Frequency Omnidirectional Range) AI.II.H.K1
   A. What is it?
      i. Omni means all **-** VHF radio projecting straight line courses (radials) in *all* directions
      ii. Referenced to magnetic north / 108.0 – 117.95 MHz
      iii. 3 classes: Terminal, Low, High
      iv. RM: Limitations AI.II.H.R3
         a. Radials projection depends on transmitter power
         b. VHF signals are subject to line-of-sight restrictions
   B. VOR MON (Minimum Operating Network)
      i. NAS is transitioning to Performance Based Nav (PBN)
         a. Number of VORs is being reduced (896 to 590 by 2030)
         b. Two new, larger service volumes will enable near continuous navigation above 5,000' AGL
      ii. Designed to enable aircraft, having lost GPS, to revert to conventional navigation procedures
      iii. New Service Volumes
         a. Low: 70 nm from 5,000' to 18,000'
         b. High: 70 nm from 5,000' to 14,500'

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

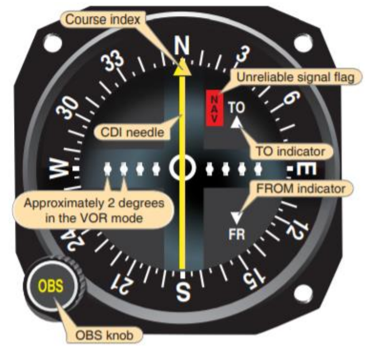
LEGACY SERVICE VOLUMES



NEW SERVICE VOLUMES



C. 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
D. VOR Components
    i. Ground - VOR station; transmits on assigned frequency
    ii. Aircraft - Antenna, Receiver, and VOR navigation instrument
        a. Antenna – Picks up the VOR signal
        b. Receiver – Processes the signal into navigation information
        c. VOR Instrument – Displays the navigation information



- OBS (Omnibearing Selector, or course selector)
    - a Dial used to select desired radial or determine the radial on
- CDI (Course Deviation Indicator) Needle
    - a Indicates position in relation to the selected course/radial
    - b Full scale deflection = ≥ 12° off selected course (2° per dot)
- To/From Indicator
    - a Shows whether the selected course takes the aircraft To or From the VOR
    - b Does not indicate whether the aircraft is currently heading To or From the VOR
- Flags
    - a OFF flag indicates an unusable/unreliable signal

E. VOR Basics
    i. RM: TIM (Tune, Identify, Monitor) (RM: Loss of a navigation signal) AI.II.H.R4
        a. Loss of signal: If the morse code/identifier stops operating, do not use for navigation
    ii. Orientation
        a. Rotate the OBS to center the CDI - note the course and the TO or FROM indication
            - TO indication displays the course to fly to the VOR
            - FROM indication displays the radial you're currently on
        b. Using a second VOR can provide an exact location at the intersection of the two radials
    iii. Tracking
        a. Tune the VOR frequency and check the identifier to verify the desired VOR is being received
        b. Rotate the OBS to center the CDI with a "TO" indication
        c. Turn to the heading indicated on the VOR azimuth dial or course selector
        d. Adjust for crosswind
        e. Upon arriving, and passing the VOR station, the TO indication will change to a FROM indication
        f. Reverse Sensing (not applicable to HSI)
            - If flying toward a VOR with a FROM indication, or away with TO, the CDI will indicate opposite
F. 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. ± 4° for ground checks, ± 6° for airborne checks
G. VOR Tips
    i. Positively identify the station by its code or voice identification
    ii. VOR signals are line-of-sight
    iii. Don't reset the course, correct for drift
    iv. When flying TO a station always fly the selected course with a TO indication
    v. When flying FROM a station always fly the selected course with a FROM indication

2. Distance Measuring Equipment (DME) AI.II.H.K1

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
      a. "Paired frequency" - auto selects the UHF DME frequency associated with the VORTAC
   ii. Airborne Equipment - Antenna and Receiver
D. RM: TIM (Tune, Identify, Monitor) the VOR (RM: Loss of a nav signal) AI.II.H.R4
   i. Do not use if the nav signal is lost
E. RM: Errors & Limitations AI.II.H.R3
   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. 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. Automatic Direction Finder (ADF) & Nondirectional Radio Beacon (NDB) AI.II.H.K1

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. RM: Limitations AI.II.H.R3
  i. Lighting, precipitation, static, etc. result in erroneous bearing information
  ii. At night, NDBs are vulnerable to interference from distant stations
  iii. Noisy identification usually occurs when the ADF needle is erratic
    a. Voice, music, or erroneous identification will usually be heard when a steady false bearing is displayed
  iv. ADF receivers do not have a flag to warn the pilot of erroneous bearing information

G. Using the NDB
  i. RM: TIM (Tube, Identify, Monitor) (RM: Loss of a navigation signal) AI.II.H.R4
    a. 3-letter ID – very important since there is no flag to warn of erroneous information
  ii. Orientation (Fixed Card ADF)
    a. The ADF needle points TO the station, showing Relative Bearing
    b. Magnetic Heading + Relative Bearing = Magnetic Bearing
  iii. 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 AI.II.H.K2

A. GPS (Global Positioning System)
  i. 3 major segments
    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
      - Updates/corrections are uplinked as satellites pass over ground antennas
    c. User Segment - All components associated with GPS receivers
  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
  iv. RM: RAIM (Receiver Autonomous Integrity Monitoring) AI.II.H.R4
  (RM: Loss of navigation signal & Limitations)
    a. How the GPS verifies the integrity of the signals received from the satellites
    b. Requires at least 5 satellites in view (or 4 satellites and a barometric altimeter)
      - Some receivers can use a 6th satellite to isolate and remove a corrupt satellite
    c. RAIM Messages (generally, two types)
      - Not enough satellites available to provide RAIM
      - RAIM has detected a potential error exceeding the limit for the phase of flight
  v. RM: GPS for VFR (RM: Limitations) AI.II.H.R3
    a. In VFR operations, GPS receivers can vary between full IFR installation to handheld receivers
      - Many have no RAIM capability & antenna location is based on convenience instead of performance
      - Limitations of the individual installation must be understood
    b. Database Currency
      - No requirements exist for VFR ops; however, it is always a good idea to keep a current database
      - Violations
        - a It is not FAA policy to initiate enforcement action against a pilot for having an expired database

- b However, if involved in an enforcement investigation and there is evidence an out-of-date database contributed to the situation, that information could be used in any enforcement action

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 (IFR)
      - 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. Like 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. ATC Radar Services and Procedures (AIM 4-1-17 & 18) AI.II.H.K3

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. RM: Limitations
   - i. Based on controller discretion
   - ii. Guidance information is advisory and responsibility for safe flying remains with the pilot
   - iii. Cannot determine if flight into IMC will results from their instructions

C. 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 AI.II.H.K4

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)
         - Like 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

7. **Transponder** AI.II.H.K4
   A. Modes
      i. A: Transmits 4-digit code that identifies an aircraft and its position
      ii. C: Mode A + ATC can see the aircraft's altitude
      iii. S: Transmits a variety of information to ATC & other aircraft
         a. Unique ICAO address (assigned to each aircraft)
         b. Heading, speed, other flight related data
         c. Integral to TCAS (Traffic Collision Avoidance System) and ADS-B
   B. See lesson II.G. National Airspace System for transponder requirements
8. **RM: EFBs & Automation** (Navigation & Flight Systems) AI.II.H.R1, AI.II.H.R5
   A. Pilots are responsible for proper use of an EFB and installed avionics
      i. Pilots may be evaluated on the use and interpretation of an EFB or installed avionics
   B. Although not required, always maintain current EFB charts and publications
   C. Understand the abilities and limitations of the system(s) on your aircraft
8. **RM: Distractions** (Task Prioritization, Loss of SA, Disorientation) AI.II.H.R2
   A. Distractions
      i. Distractions are dangerous
         a. Navigation systems, especially GPS/moving maps, can consume the pilot's attention
      ii. Fly first! Aviate, Navigate, Communicate
   B. Situational awareness (SA) & Disorientation
      i. Navigation systems and radar services can be huge for situational awareness
      ii. Don't be overdependent on a single system (like the GPS), if the GPS/VOR fails, have a backup
      iii. If SA is lost, admit it, and find a way to regain
   C. Task Management
      i. Divide attention between flying/navigating, scanning, and communicating
      ii. Recognize when you are getting behind and find a way to catch up

Conclusion:
Brief review of the main points

II.I. Navigation & Flight Planning

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

Objectives	The learner should develop knowledge of the elements related to navigation and flight planning as required in the applicable tasks in the ACS.
Key Elements	1. Time, Distance, and Fuel Calculations 2. Navigation 3. Lost Procedures
Elements	1. Terms 2. Charts & Chart Supplement 3. Navigation 4. Flight Planning 5. VFR Flight Plan 6. Weather Check & Decision Making 7. GPS Navigation 8. Planned Calculations versus Actual Results 9. Diversion to an Alternate 10. Lost Procedures 11. Flight Following & Intercept 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 learner can properly and confidently plan and execute a cross country flight to any chosen destination. The learner also understands the procedures for diversions and lost situations.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

This is what leads to 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 includes procedures for situations that may arise during flight (diversions, lost procedures, using flight following & intercepts)

Why

This information will make planning flights easier and more organized. Proper flight planning is integral to safe flying between airports.

How:

1. **Terms**
   A. Navigation Terminology
      i. True North – Points directly to the geographic north pol
      ii. Magnetic North – Aligns with Earth's magnetic field and points directly to the magnetic north pole
      iii. Variation – The angular difference between true north and magnetic north; isogonic lines on charts
      iv. True Course – The direction of flight as measured on a chart clockwise from true North
      v. True Heading – The direction the longitudinal axis of the airplane points with respect to true North
      vi. Magnetic Course – True course corrected for magnetic variation
      vii. Magnetic Heading – Magnetic Course corrected for wind (direction and speed)
      viii. Compass Heading – Aircraft heading read from the compass
      ix. Deviation – Compass error due to magnetic disturbances from electrical/metal parts in the plane
   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 - $120(°\mathrm{C} - 15°\mathrm{C}) + PA$
      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 & Chart Supplement**
   A. Charts AI.II.I.K15
      i. The roadmap for a pilot flying VFR

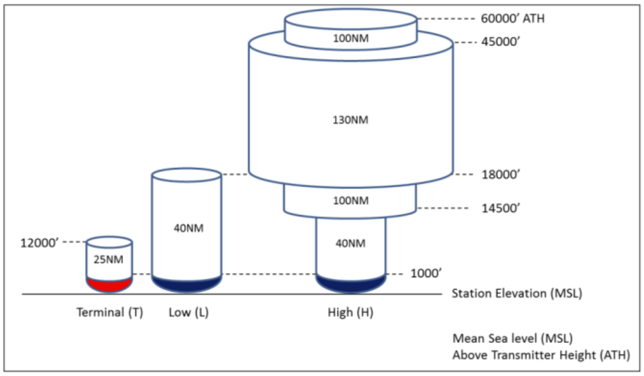
        a. FAA Aeronautical Chart User's Guide
    ii. Sectional Charts (Most commonly used by pilots) – revised every 56 days
        a. Information provided: Airport data, nav aids, airspace, and topography. Revised semiannually
        b. Scale is 1:500,000 (1" = 6.86 NM)
    iii. VFR Terminal Area Charts – revised every 56 days
        a. More detailed map/information. Helpful in busy airspace and flying in or near Class B airspace
        b. Scale is 1:250,000 (1" = 3.43 NM)
    iv. VFR Wall Planning Chart – revised annually
        a. Provides aeronautical and topographic information of the conterminous US
            - Airports, navaids, Class B airspace, Special use airspace
        b. Scale is 1:3,100,000 (1" = 43 NM)
    v. Proper and Current Aeronautical Charts
        a. Always use current editions and discard obsolete charts and publications
        b. Check Aeronautical Chart Bulletins and NOTAMs for important updates between publication cycles
B. Chart Supplement
    i. Essential to planning
        a. Digital Chart Supplements & FAA Chart Supplement description
    ii. Provides the most comprehensive information on a given airport
        a. Detailed runway information, procedures, frequencies, hours of operation, lighting, services, and more
        b. Also provides, VFR waypoints, VOR checkpoints, chart bulletins, LAHSO operations, parachute jump areas, special notices and FAA, NWS, and facility phone numbers
    iii. Reference all potential airports during planning (departure, arrival, alternates)

3. Navigation AI.II.I.K10

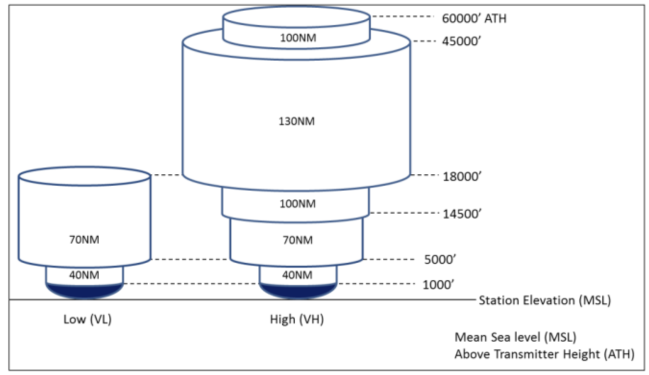
A. Pilotage – Navigation by reference to landmarks or checkpoints
    i. Checkpoints used should be prominent features common to the area of flight
        a. Easily recognizable and spaced at a comfortable frequency
        b. Use features that can create boundaries (rivers, roads, mountain ranges, 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. Radio Navigation – Navigation by which a predetermined course is followed
    i. There are three primary navigation systems available: VOR, NDB, and GPS
    ii. For more detailed information, see II.H. Navigation Systems and Radar Services
D. VOR Minimum Operating Network (VOR MON)
    i. NAS is transitioning to PBN
        a. Number of VORs is being reduced (896 to 590 by 2030)
        b. Two new, larger service volumes will still enable near continuous navigation above 5,000' AGL
    ii. Designed to enable aircraft, having lost GPS, to use conventional navigation procedures
        a. Can use VOR station to station nav to reach a MON airport and fly a conventional approach
        b. MON airport assured within 100 nm
    iii. New VOR Service Volumes
        a. Low: 70 nm from 5,000' to 18,000'

b. High: 70 nm from 5,000’ to 14,500’

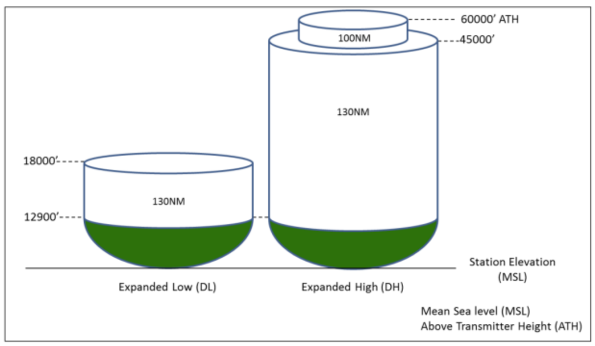
LEGACY SERVICE VOLUMES



NEW MON SERVICE VOLUMES



c. New DME Service Volumes



E. Ideally, pilotage, dead reckoning, and radio navigation should be used together

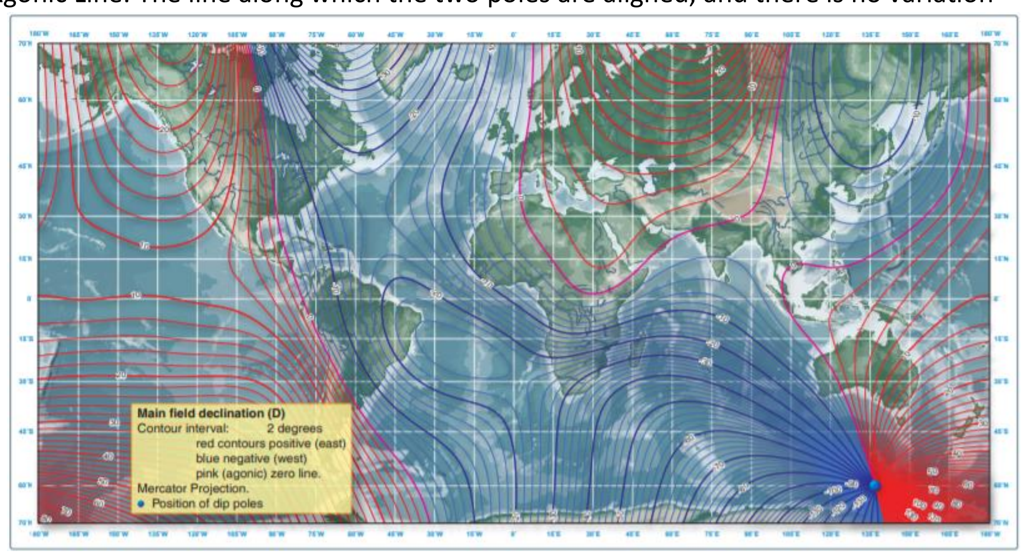
F. Magnetic Compass Errors AI.II.I.K9

i. Variation

a. Caused by the difference in the locations of the magnetic and geographic north pole

b. Isogonic Lines: Lines used to connect points with the same magnetic variation

c. Agonic Line: The line along which the two poles are aligned, and there is no variation



ii. Deviation

a. Caused by local magnetic fields within the aircraft

b. Degrees of deviation is shown on a compass correction card

iii. Finding the Compass Course – True Course corrected for Variation and Deviation

a. True Course ± Variation = Magnetic Course; Magnetic Course ± Deviation = Compass Course

b. Remember: East is Least, West is Best

- East: Subtract variation from true course; West: Add variation to true course

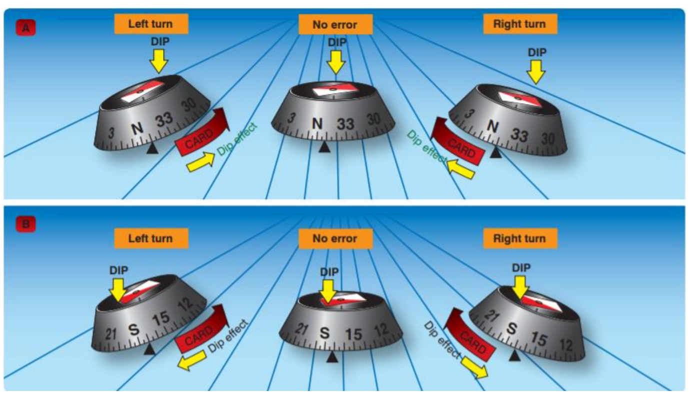
iv. Dip Errors (pictured below, left)

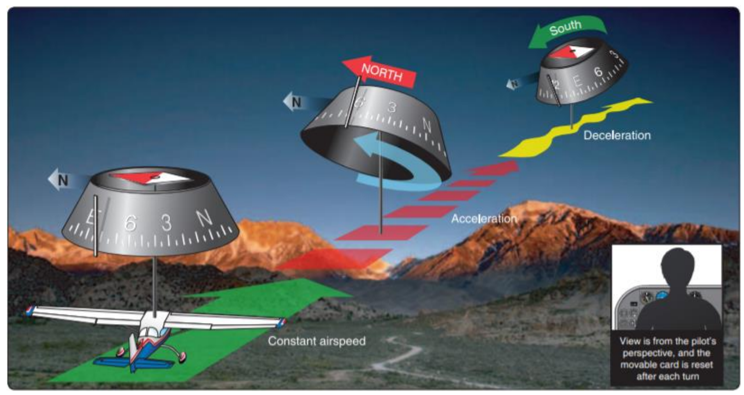
a. What's Going On

- Lines of magnetic flux leave the Earth at the magnetic N pole/enter at magnetic S pole
  - a At both poles the lines are perpendicular to the surface
  - b Over the equator the lines are parallel to the surface
- Magnets align with these fields and near the poles they dip/tilt the float and card

b. Northerly and Southerly Turning Errors (basically, the compass pulls toward the North)

- Starting a turn from a Southerly heading (turning to a Northerly direction):
  - a Compass Leads – initially shows a more aggressive turn in the same direction
  - b Undershoot Northerly headings to compensate (30°- N; 20°- 030/330; 10°- 060/300)
- Starting a turn from a Northerly heading (turning to a Southerly direction):
  - a Compass Lags – initially shows a turn in the opposite direction
  - b Overshoot Southerly headings to compensate (30°- S; 20°- 150/210; 10°- 120/240)
- *Remember*: Undershoot North, Overshoot South (no compensation needed for E/W)





c. Acceleration Error (only applicable on East and West headings) (pictured above, right)

- Aft end of the compass tilts up when accelerating and down when decelerating
- On an E or W heading, acceleration appears as a turn to the North, and deceleration a turn South
- *Remember*: ANDS – Accelerate North, Decelerate South

v. Oscillation Error

a. A combination of all the other errors as well as the movement of the plane

- It results in the compass card swinging back and forth around the heading being flown

b. Use the average indication

4. Flight Planning

Note: Per the ACS, preparation, presentation, and explanation of a computer-generated flight plan is acceptable

A. The flight log provides the pilot an organized, point by point plan of the flight and other useful info

B. Plotting a Course AI.II.I.K1

i. First, draw the route

a. Consider terrain, airspace, weather, winds, navaids, etc.

ii. Choose cruise altitude AI.II.I.K2

a. FAR 91.159

- Fly Odd Thousands + 500' when on a magnetic course between 0 & 179°

- Fly Even Thousands + 500' when on a magnetic course between 180 & 359º
- Applies above 3,000' AGL and up to 17,500' MSL

b. Consider terrain, airspace, performance, glide distance, weather & wind, unique factors, etc. - Combine all factors with the FAR requirements

C. Checkpoints – Recognizable points along your route of flight used to maintain course AI.II.I.K3
   i. Top of Climb (TOC) and Top of Descent (TOD) AI.II.I.K5a
   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

D. Fuel Stops AI.II.I.K5c
   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)

E. Completing the Nav Log AI.II.I.K5a, AI.II.I.K5b
   i. Chooser a power setting AI.II.I.K4
      a. Use the chart provided in the POH based on desired speed, fuel burn, altitude, etc.
   ii. Start by finding the True Airspeed for the trip and record it on your Nav Log
   iii. Find and input the distance between each of the checkpoints
   iv. Next, find the true course for each leg of the flight plan
   v. Adjust True Course for wind to get True Heading, and record ground speed
   vi. Adjust the True Heading to obtain Magnetic Heading
   vii. If necessary, get your Compass Heading by adjusting for Deviation with the correction card
   viii. Calculate the estimated time for each leg
      a. Based on expected departure time, you can calculate an expected arrival time
      b. Convert to UTC

UTC CONVERSION	Pacific Standard: 8 hrs	Mountain Standard: 7 hrs	Central Standard: 6 hrs	Eastern Standard: 5 hrs
Add to local time:	Pacific Daylight: 7 hrs	Mountain Daylight: 6 hrs	Central Daylight: 5 hrs	Eastern Daylight: 4 hrs

   ix. Use the time for each leg to find the fuel burn for each leg
      a. RM: Fuel Planning Considerations AI.II.I.R6
         - Ensure fuel required for the trip plus an adequate reserve is available
            a Adequate reserve is a minimum of the FAR requirements (personal mins may be higher)
            b Account for engine start & taxi
            c Ensure fuel will allow deviation to an alternate airport/landing with reserves
         - Rate of fuel burn depends on many factors
            a Engine condition, propeller pitch, rpm, mixture setting, % of horsepower used
            b Enroute, compare expected burn to the actual burn and adjust as required

F. Use of an EFB, if used AI.II.I.K14
   i. Apps such as ForeFlight can be great tools for flight planning, and cross-country flying
   ii. Ensure understanding and proficiency with the app used

5. VFR Flight Plan AI.II.I.K6, AI.II.I.K8, AI.II.I.K14

A. Not required but it is a good operating practice since the info can be used for search and rescue

B. ICAO Flight Plans
   i. ICAO Flight Plan Form
   ii. A great, short ICAO flight plan instructional video from AOPA
   iii. AIM ICAO Flight Plan instructions
   iv. FAA Aircraft Type Designators
   v. AIM 5-1-9 – International Flight Plan - IFR Flights

C. 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. Airborne: FSS
iii. Once filed, the flight plan will be held for an hour after the proposed departure time

D. Opening the Flight Plan
   i. After takeoff, contact the FSS by radio and give them the takeoff time to activate the flight plan
   ii. Can also be done through ForeFlight

E. Don't forget to close the flight plan
   i. Should be done via telephone to avoid radio congestion
   ii. Can be done through ForeFlight

6. Weather Check & Decision Making AI.II.I.K7

A. Obtaining a preflight weather briefing is the first step to determine if the flight can be conducted safely
   i. Often done in conjunction with filing the flight plan
   ii. See III.C. Weather Information for more details

B. FAR 91.103 requires familiarity with weather reports and forecasts for the flight

C. RM: Go/No Go
   i. Good judgment is necessary in deciding whether to take the flight
   ii. RM: Apply the PAVE risk management checklist to the flight AI.II.I.R1
      a. Pilot, Aircraft, enVironment, External Pressures
   iii. Continual process of decision making before and throughout the flight

7. Planned Calculations versus Actual Results AI.II.I.K11

A. Planned calculations are never perfect

B. Recognize deviations and adjust
   i. The more familiar with the route, flight planning, & waypoints, the easier to recognize deviations
   ii. If the time to waypoints is too fast or slow, power and airspeed may be adjusted
      a. If power/increased fuel burn is a concern, accept the speed and adjust the time to each waypoint

C. Use tools at your disposal (GPS, tablet, rules of thumb, etc.)

D. Ignoring the problem only makes it worse

8. Diversion to an Alternate AI.II.I.K12

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. Choose an altitude
   v. Use the winds aloft nearest the diversion point to calculate a heading and ground speed
   vi. Calculate a new arrival time and fuel consumption

9. Lost Procedures AI.II.I.K12

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)

10. **Flight Following & Intercept Procedures** (AIM 5-6-13 Interception Procedures) AI.II.I.K13
    A. Flight Following
        i. Radar equipped ATC facilities can provide radar assistance and navigation services to VFR aircraft by request
        ii. RM: Limitations AI.II.I.R5
            a. Based on controller discretion (workload permitting)
            b. Guidance information is advisory and responsibility for safe flying remains with the pilot
            c. Cannot determine if flight into IMC will results from their instructions
            d. Can only communicate with participating aircraft
    B. In conjunction with the FAA, Air Defense Sectors monitor air traffic and can order an intercept in the interest of national security or defense – reasons include to:
        i. Identify, track, inspect, divert, or establish communications with an aircraft
    C. AOPA Intercept Procedures Card

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.J. 14 CFR & Publications

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

Objectives	The learner 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 2. NTSB Part 830 3. Advisory Circulars, INFOs, & SAFOs 4. ACS & PTS 5. POH 6. AIM 7. Expired 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 learner understands 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

To provide a better understanding of these publications, their applicability to you, their use in relation to flying, and where to find specific information.

How:

1. **FARS (1, 61, 91, 21, 39, 43, 67)** AI.II.J.K1
   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. Part 21 – Certification Procedures
      i. Requirements for airworthiness certificates and airworthiness approvals
   E. Part 39 – Airworthiness Directives
      i. Provides a legal framework for the FAA's system of Airworthiness Directives
   F. Part 43 – Maintenance
      i. Rules governing maintenance, preventive maintenance, and rebuilding
   G. Part 67 – Medical Standards and Certification
      i. Medical standards and certification for issuing medical certificates
2. **NTSB (National Transportation Safety Board) Part 830** AI.II.J.K2
   A. Notification and reporting of aircraft incidents and accidents
      i. Immediately notify the nearest NTSB office for:
         a. Accident or serious incident (listed in 830.5a)
         b. Aircraft is overdue and believed to have been involved in an accident
      ii. Information to be provided described in 830.6
   B. Preservation of aircraft wreckage, mail, cargo, and records involving aircraft accidents
3. **Advisory Circulars, INFOs & SAFOs**
   A. FAA Advisory Circular (AC) AI.II.J.K3
      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
    iii. Commonly used ACs: The Backseat Pilot – Advisory Circulars
  B. InFOs & SAFOs AI.II.J.K3
    i. InFO (Information for Operators)
        a. Information to meet requirements with low urgency or impact on safety
            - Ex: Updates to Cold Temperature Airports Program
        b. InFO Database
    ii. SAFO (Safety Alert for Operators)
        a. Designed to share important safety information broadly and quickly, may include recommended actions
            - Especially valuable to air carriers and their duty to provide service with the highest degree of safety
            - Ex: Recognizing & Mitigating GPS/GNSS Disruptions
        b. Training center managers should pay attention to any SAFO bearing directly on their operation and consider immediate implementation of any applicable actions recommended
        c. SAFO Database

4. Airman Certification Standards (ACS) & Practical Test Standards (PTS) AI.II.J.K4
  A. PTS/ACS Concept
    i. Part 61 specifies the Areas of Operation (knowledge/skill) required to be issued a certificate
        a. The FARs provide the flexibility that permits the FAA to publish PTS/ACS containing specific Tasks in which competency must be demonstrated
  B. Current PTSs for Airplanes
    i. Sport, Flight Instructor Instrument
  C. Airman Certification Standards (ACS)
    i. Essentially an "enhanced" version of the PTS. Updated and modernized certification standards
    ii. So far, the FAA has released the Flight Instructor, Private, Instrument Rating, Commercial, and ATP ACS

5. Pilot's Operating Handbook (POH) AI.II.J.K5
  A. The POH is published by the manufacturer and describes the specific airplane and its operation

6. Aeronautical Information Manual (AIM) AI.II.J.K6
  A. Official guide to basic flight information and ATC procedures in the US
  B. Contains information such as health and medical facts, flight safety, a pilot/controller glossary, information on safety, accidents, and reporting of hazards

7. Expired Publications AI.II.J.R1
  A. FAR 91.103 requires each PIC to become familiar with all available information concerning that flight
    i. Although not specifically required, you should always carry current publications
    ii. Information changes rapidly, out of date publications may be missing crucial information
  B. It is not FAA policy to initiate enforcement action for expired publications, but if involved in an investigation and out-of-date publications contributed, that information could be used in any action
  C. To confirm currency, refer to the next scheduled edition date printed on the cover
    i. Use the FAAs Dates of Latest Editions
    ii. Prior to expiration, check NOTAMs and Safety Alerts and Charting Notices for any changes

Conclusion:
Brief review of the main points

II.K. Endorsements & Logbook Entries

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), Flight Instructor Refresher Course (AC 61-83), WINGS Pilot Proficiency Program (AC 61-91), FAA Order 8900.1 (FSIMS)

Objectives

The learner should develop knowledge of the elements related to logbook entries and endorsements as required by the appropriate ACS.

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. Additional Ratings
5. Reapplying for a Practical Test
6. Time Limits
7. Flight Review Endorsements
8. Flight Instructor Responsibilities
9. Maintaining your CFI Certificate

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 what is necessary in learner's logbooks, what is necessary for Student Pilot certificates and preparing a learner 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 learner 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

The necessary entries instructors must make in their learner's logbooks as well as the endorsements required for different practical tests, reviews, etc.

Why

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

How:

1. **Logbook Entries** (FAR 61.189) AI.II.K.K1
   - 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) AI.II.K.K2, AI.II.K.K3
   - A. Student Pilot Endorsements (Examples shown in AC 61-65)

Solo Flight Endorsements	XC Endorsements
• Pre-solo Aeronautical Knowledge: 61.87(b)	• Solo XC Training: 61.93(c)(1) and (2)
• Pre-solo Flight Training: 61.87(c)	• Solo XC Planning: 61.93(c)(3)
• Pre-solo Flight Training at Night: 61.87(c) & (o)	• Repeated Solo XCs not > 50 nm from the departure: 61.93(b)(2)
• Solo Flt (1st 90-days): 61.87(n) / Additional 90 days: 61.87(p)	**Class B Endorsements**
• Solo T/O & LDGs at an Airport within 25 nm: 61.93(b)(1)	• Solo Flight in Class B Airspace: 61.95(a)
• TSA US Citizenship: 49 CFR 1552.3(h)	• Solo Flight, to/from/at a Class B airport: 61.95(b) & 91.131(b)(1)

   - B. Special Federal Aviation Regulation (SFAR)
     - i. Mentioned in the ACS – Included here in case it comes up
     - ii. Temporary regulations issued by the FAA that apply to specific people and aircraft
       - a. Often issued with an expiration date that can be amended, extended or rescinded as needed
       - b. Ex: In 2020, the FAA issued an SFAR to provide regulatory relief to people/schools who were unable to comply with training, experience, testing, and checking requirements due to Covid

1. **Preparation of a Practical Test Recommendation** AI.II.K.K4
   - A. Endorsements AI.II.K.K4a
     - i. AC 61-65 A.1: Prerequisites for a Practical Test: 61.39(a)(6)(i) & (ii)
     - ii. AC61-65 A.2: Aeronautical Knowledge Test Deficiencies: 61.39(a)(6)(iii)
       - a. As required

b. Sometimes combined with the above endorsement (Ex. AC 61-65 A.40: Instrument rating)

iii. Other part 61 endorsement(s) for the category, class, rating, or privilege of certification sought

B. Example Endorsement – Single Engine Private Pilot

i. AC 61-65 A.1: Prerequisite for a Practical Test: § 61.39(a)(6)(i) & (ii)

ii. AC 61.-65 A.2: Aeronautical Knowledge Test Deficiencies: § 61.39(a)(6)(iii)

iii. AC 61-65 A.32: Aeronautical Knowledge Test: §§ 61.35(a)(1), 61.103(d), and 61.105

a. Part 61 required endorsement specific to the private pilot required knowledge training

iv. AC 61-65 A.33: Flight Proficiency/Practical Test: §§ 61.103(f), 61.107(b), and 61.109

a. Part 61 required endorsement specific to the private pilot certificate

C. Endorsement References

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 Category/Class Rating (Not ATP) - 61.63(b) or (c)
Commercial Pilot	Additional Type Rating Only (Not ATP) - 61.63(d)(2) & (3)
Knowledge Test - 61.35(a)(1), 61.123(c), 61.125	Type Rating & Category/Class Rating - 61.63(d)(2) & (3)
Practical Test - 61.123(e), 61.127, 61.129	Additional Aircraft Rating (ATP) - 61.157(b)(1)
-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 Only (ATP) - 61.157(b)(2) 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)

A. The instructor/learner must complete the IACRA rating application online (iacra.faa.gov)

i. Or the instructor/learner must complete/sign a Form 8710-1 (rarely used)

B. Except in certain instances, applicant must hold at least a current 3rd class medical: FAR 61.123 (a)(3)(iii)

4. Additional Ratings (FAR 61.63) AI.II.K.K4b, AI.II.K.K4c

A. Category and Class Ratings

i. Additional category and/or class (other than ATP), must have:

a. Instructor recommendations

b. Appropriate endorsements (vary by specific FAR 61 requirements)

ii. Applicant must:

a. Comply with the requirements of FAR 61.63 (described below)

b. Pass the practical test appropriate for the aircraft category, and if applicable, class rating sought

B. Additional Class Requirements – FAR 61.63(c)

i. Endorsement stating competence in knowledge areas and proficient in areas of operation

a. AC 61-65 A.74: Additional aircraft category or class rating (other than ATP)

b. AC 61-65 A.1: Practical test endorsement

c. Other endorsement(s) as required, see example

ii. Pass practical test

        iii. No need to meet the time requirements that apply to the class rating (see FAR for exception)
        iv. No knowledge test, provided applicant holds a rating at the certificate level
    C. Additional Category Requirements – FAR 61.63(b)
        i. Complete training and have the applicable aeronautical experience required by FAR part 61
        ii. Endorsement stating competence in knowledge areas and proficient in areas of operation
            a. AC 61-65 A.74: Additional aircraft category or class rating (other than ATP)
            b. AC 61-65 A.1: Practical Test Endorsement
            c. Other endorsement(s), as required
        iii. Pass practical test
        iv. No additional knowledge test, provided applicant holds a rating at the certificate level
    D. Solo Flight Requirements (without the appropriate category/class rating) – FAR 61.31(d)(2)
        i. Must have received the FAR required training for the aircraft
        ii. AC 61-65 A.72 – Solo PIC when the pilot doesn't hold appropriate category/class
    E. Additional Rating Example
        i. Single engine private pilot wants to add multiengine class rating
        ii. AC 61-65 A.1: Prerequisite for a Practical Test: 61.39(a)(6)(i) & (ii)
        iii. AC 61-65 A.74: Additional Aircraft Category or Class Rating (other than ATP): 61.63(c)
        iv. AC 61-65 A.68: To act as Pilot in Command in a Complex Aircraft: 61.31(e)

5. **Reapplying for a Practical Test**
    A. Following a Notice of Disapproval
        i. Must have another endorsement in accordance with FAR 61.43(f) & 61.49(a)(2)
            a. AC 61-65 A.73: Retesting after failure of a knowledge or practical test: 61.49
        ii. Instructor recommendation (8710/IACRA) is required for a retest
        iii. Get credit for areas of operation passed for 60 calendar-days from the date discontinued
    B. Following a Letter of Discontinuance
        i. No additional endorsements are required
        ii. Get credit for areas of operation passed for 60 calendar-days after the discontinuation date
6. **Time Limits** (Two Calendar Months vs 60 Calendar-Days)
    A. 60 Calendar-Day Time Limit
        i. FAR 61.43(e) – Practical test can be discontinued for 4 reasons:
            a. Fail one or more areas of operation, Inclement weather, Airworthiness, Safety of flight concern
        ii. FAR 61.43(f) – If discontinued per 61.43(e), applicant gets credit for the areas they passed, but
            a. FAR 61.43(f)(1) – the remainder of the test must be completed within 60 calendar days
    B. 2 Calendar Month Time Limit
        i. FAR 61.39(f) – If all increments of a practical test are not completed on the same date, all remaining increments must be completed within 2 calendar months
            a. Increment may be because the test was discontinued for reasons stated in 61.43(e), or because it was planned to be conducted in increments
        ii. Separate time limit from the 60 calendar-day limit
7. **Flight Review Endorsements** AI.II.K.K5
    A. After a satisfactory completion of a flight review, the instructor must endorse the pilot's logbook
        i. AC 61-65 A.65: Completion of a Flight Review: 61.56(a) & (c)
    B. Instrument Proficiency Checks (IPC)
        i. CFII is required
        ii. AC 61-65 A.67: Completion of an Instrument Proficiency Check: 61.57(d)
    C. No logbook entry reflecting unsatisfactory performance is necessary for either flight review
8. **Flight Instructor Responsibilities** AI.II.K.K6
    A. Records (FAR 61.189)

i. Must maintain a record that contains the following:
   a. Name of each person endorsed for solo flight privileges, and the date of the endorsement
   b. Name of each person endorsed for a knowledge or practical test, with the kind of test, date, results
ii. Must retain the records for at least 3 years

B. RM: Limitations & Expiration Dates AI.II.K.R1
   i. Failure to ensure proper endorsements is a serious deficiency in performance
      a. Depending on the situation, the FAA could hold the instructor accountable
   ii. Required limitations & expiration dates are implemented for safety
      a. Ensure proper endorsements and learner understanding of those endorsements

9. Maintaining your CFI Certificate AI.II.K.K7

A. Duration
   i. FAR 61.19(d): A flight instructor certificate expires 24 calendar months from the month in which it was issued, renewed, or reinstated, as appropriate (Except as specified in FAR 61.197(b))

B. Renewal (FAR 61.197)
   i. If the certificate has not expired:
      a. Pass a practical test for:
         - One of the ratings listed on your flight instructor certificate
         - An additional flight instructor rating
      b. Submit a signed application with the FAA for one of the following:
         - Endorsed 5 or more learners for a checkride in the past 24 calendar months with an 80% or better pass rate on their first attempt
            a Gold Seal Instructor Certificate (apply for renewal/gold seal together if desired)
         - Served as a company check pilot or check airman, chief flight instructor, Part 121 or 135 instructor, or in a position involving the regular eval of pilots in the past 24 calendar months
         - Completion of an approved instructor refresher course in the past 3 calendar months
            a AC 61-83: Flight Instructor Refresher Course
         - Passed a military instructor pilot or pilot examiner proficiency check in an aircraft in the past 24 calendar months (considerably more detail to this - reference FAR 61.197(4))
      c. WINGS Program
         - Requires evaluating/endorsing at least 15 WINGS-accredited flight activities (min of 5 pilots)
         - FAAST Team Notice – WINGS CFI Renewal Opportunity
         - AC 61-91: WINGS – Pilot Proficiency Programs. See page 5, paragraph 6(e)
   ii. Reinstatement of an expired certificate:
      a. Submit a signed application with the FAA for one of the following requirements
         - An instructor practical test for one of the ratings on the expired certificate per 61.183(h)
         - A practical test for an additional flight instructor rating
         - Passed a military instructor pilot or pilot examiner proficiency check
         - Completed a military instructor pilot/pilot examiner training course and received an additional rating appropriate to the flight instructor rating sought

Conclusion:
Brief review of the main points

II.M. Night Operations

References: Airplane Flying Handbook , Pilot's Handbook of Aeronautical Knowledge, AIM

Objectives	The learner 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. Lighting 3. Disorientation and Night Optical Illusions 4. Pilot & Plane 5. Engine Start, Taxi, & Run-up 6. Takeoff & Climb 7. In-Flight Orientation 8. Traffic Patterns 9. Approach and Landing 10. Go Around 11. Hazards & 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 learner 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

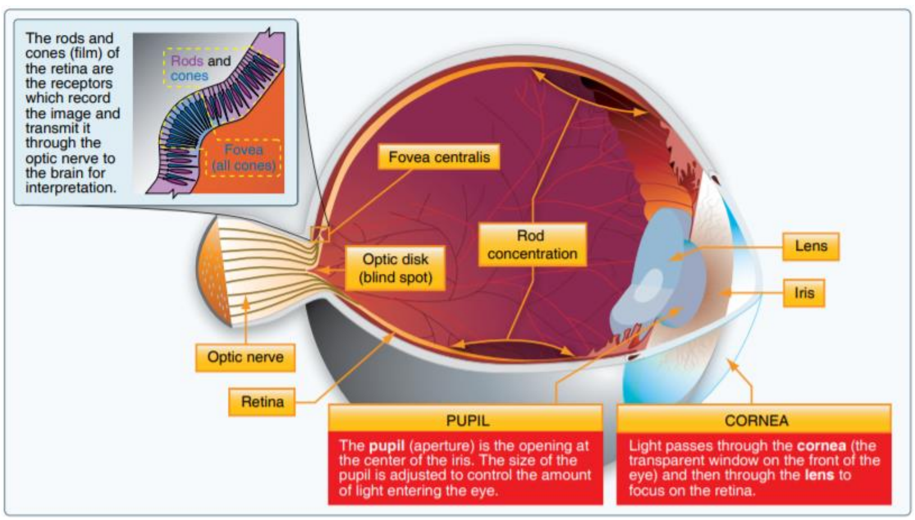
What

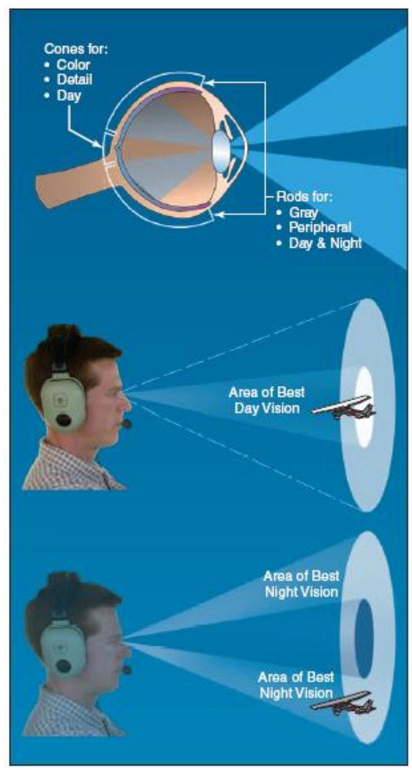
Night operations are the factors dealing with the operation of the airplane at night.

Why

Night flying is very different from 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** AI.II.M.K1
   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. Without normal light, the process of night vision is placed almost entirely on the rods
      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

c. Summary: Night vision is based on the rods and off-center viewing is necessary

B. RM: Collision Avoidance AI.II.M.R3

i. Use off center viewing, as looking directly at an object may result in not seeing it

ii. Avoid bright lights before and during a flight to maintain adequate night vision

a. Use red/green light in the flight deck

C. Flight deck lighting should be at a minimum

2. Lighting AI.II.M.K2

A. Taxiway Lighting

i. Taxiway Edge Lights: Steady blue lights outlining the edges of taxiways

ii. Taxiway Centerline lights: Steady green lights installed along the centerline of the taxiway

iii. Clearance Bar Lights: Three in-pavement steady-burning yellow lights

a. Installed at holding positions on taxiways to increase visibility of the holding position

iv. Runway Guard Lights

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 holding position marking

b. Installed at taxiway/runway intersections

c. Enhance conspicuity of taxiway/runway intersections

v. Stop Bar Lights

a. A row of red, unidirectional, steady-burning in-pavement lights across the entire taxiway at the runway holding position, and elevated steady-burning red lights on each side

b. A controlled stop bar operates in conjunction with the taxiway centerline lead-on lights

- Following ATC clearance, the stop bar is turned off and the lead-on lights are turned on

c. Used to confirm the ATC clearance to enter or cross the active runway in low visibility

B. Runway Lighting

i. Runway Edge Lights: White lights except on instrument runways they're yellow for the last 2,000' or half of the runway, whichever is less

a. Lights marking the end of the runway emit red toward the runway (takeoff) and green outward (landing)

b. Classified based on brightness: High Intensity Runway Lights (HIRL), Medium (MIRL), and Low (LIRL)

ii. Runway End Identifier Lights (REIL)

a. Installed to provide rapid/positive identification of the approach end of a runway

b. Pair of synchronized flashing lights on each side of the runway threshold

iii. Runway Centerline Lighting System (RCLS): If installed, white in-pavement lights every 50' until the last 3,000' of the runway at which point they alternate red and white for 2,000' and are red for the last 1,000'

iv. Touchdown Zone Lights (TDZL): If installed, two rows of light bars set symmetrically about the centerline

a. Steady burning white lights starting 100' beyond the landing threshold and extend to 3,000' beyond the threshold or the midpoint of the runway, whichever is less

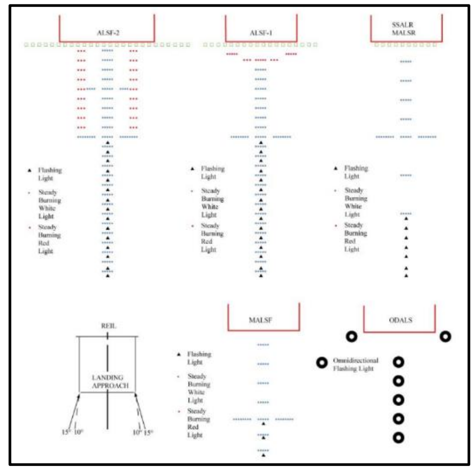
v. Taxiway Centerline Lead-Off Lights: Alternate green & yellow lights from the runway centerline to one light position beyond the holding position or ILS critical area holding position

vi. Taxiway Centerline Lead-On Lights: Same as lead-off lights but leading onto the runway

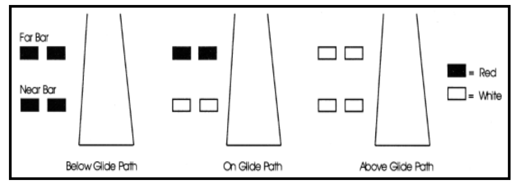
vii. Land and Hold Short Lights: Row of pulsing white lights across the runway at the hold short point

a. Off when LAHSO is not in effect

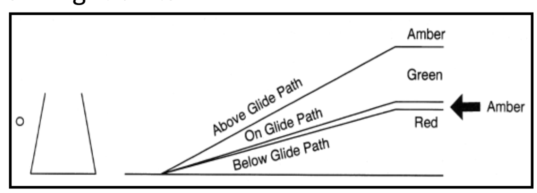
C. Approach Lighting



- i. Approach Light System
  - a. Basic means to transition from instrument conditions to visual conditions for landing
    - VFR pilots: Used to identify/recognize the runway
  - b. A configuration of lights starting at the threshold, extending into the approach area
- ii. Visual Glideslope Indicators
  - a. Visual Approach Slope Indicator (VASI)
    - Provides visual descent guidance during approach
    - Visible from 3-5 miles during day and ≥ 20 at night
      - a Safe obstruction clearance within ± 10° of the centerline and 4 NM from the threshold
    - Configurations
      - a 2, 4, 6, 12, or 16 light units arranged in bars
        1. Arranged as near, middle, and far bars (Mid provide another glide path for high flight decks)
        2. Usually on left side of the runway



    - Two Bar VASI (most common) – Normally, 3° glide path
      - a Each unit projects light with an upper white segment and a lower red segment
- iii. Precision Approach Path Indicator (PAPI)
  - a. Lights arranged to provide visual descent guidance during the approach to a runway
    - Uses light units like a VASI but in a single row of either 2 or 4 light units
  - b. Configuration
    - Tri-Color System
      - a Above – Amber, On – Green, Below - Red
      - b Range: Day - ½ to 1 mile; Night - Up to 5 miles



D. 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, White, and Green – Military Airport
  - c. White and Yellow - Water Airport
  - d. Green, Yellow, and White - Lighted Heliport
- iii. During the day, beacon operation often indicates ground visibility < 3 miles and/or ceiling < 1,000'
  - a. No regulatory requirement for daylight beacon operation

E. Pilot Control of Airport Lighting
- i. Controlled Airport
  - a. Operation of approach light systems and runway lighting is controlled by the tower/FSS
  - b. Pilots may request the lights be turned on, off, or dimmed
- ii. Pilot Control of Airport Lighting
  - a. Radio control of lighting is available at some airports by keying the microphone
    - 3 clicks for low lights, 5 for medium, and 7 for high (all clicks within 5 seconds – lasts 15 minutes)
  - b. Frequency is in Chart Supplement (usually CTAF)

F. Obstruction Lighting
- i. Aviation Red Obstruction Lights: Flashing red beacons and steady-burning red lights
- ii. Medium Intensity Flashing White Obstruction Lights: Flashing white obstruction lights
  - a. Not normally installed on structures less than 200' AGL

iii. High Intensity White Obstruction Lights: Flashing white lights
iv. Dual Lighting: Combination of flashing red beacons and steady burning red lights
v. Catenary Lighting: Light markers for high voltage transmission line catenary wires
vi. High intensity flashing white lights are being used to identify some supporting structures of overhead transmission lines located across rivers, chasms, gorges, etc. as well as tall structures (chimneys, towers)
   a. Beamed toward the companion structure and identify the area of the wire span

3. RM: Disorientation and Night Optical Illusions AI.II.M.K7, AI.II.M.R4, AI.II.M.R5

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. False Horizon
   i. The natural horizon is not readily apparent
   ii. Trust your instruments to maintain orientation
G. 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
H. 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
I. Disorientation at Night AI.II.M.K6
   i. Disregard false sensations and trust the instruments
   ii. Always verify aircraft attitude with the instruments at night

4. Pilot & Plane AI.II.M.K3, AI.II.M.K4

A. Night Currency (FAR 61.57(b))
   i. 3 takeoffs/landings (full stop) in the last 90 days to act as PIC from 1 hour after sunset-1 hour before sunrise
      a. Sole manipulator of the flight controls & in an aircraft of the same category, class, and type
   ii. RM: Current doesn't imply proficient – Ensure proficiency AI.II.M.R7
B. Equipment
   i. Flashlight - Red and white light (White light is used to preflight, red is used in the flight deck)
   ii. Aeronautical Charts, Nav Logs
      a. Be cautious of washout (red color on the chart is difficult to distinguish with a red light)
   iii. Regardless of equipment, organization eases the burden on the pilot

C. Preflight Inspection (FAR 91.205)
  i. Required equipment for VFR flight at night
    a. TOMATO FFLAMES (day VFR) and FLAPS (additional night VFR requirements)
      - Fuses (if applicable)
      - Landing Light
      - Anti-Collision Lights
      - Position Lights
      - Source of Power
    b. Instrument required equipment doesn't hurt (safer is smarter)
  ii. Walk Around – Just like a normal walk around but be more vigilant with night equipment
    a. Check all aircraft lights, and check the ramp for obstructions
  i. RM: Inoperative Equipment AI.II.M.R1
    a. If inoperative equipment is found, handle it the same as you would during the day, but with the additional night required equipment
      - Is it required by Kinds of Equipment List, Type Certificate, AD, FAR 91.205
      - And, of course, Personal Minimum requirements
    a. Reference III.B. Airworthiness Requirements for more details

5. Engine Start & Taxi

A. Engine Start
  i. Take extra precaution to be sure the propeller area is clear
    a. Turn on the beacon, announce "clear prop" and scan carefully
  ii. To avoid excessive battery drain, leave all unnecessary electrical equipment off until after engine start

B. Taxiing AI.II.M.K8
  i. Turn on the taxi and/or landing light (be sure not to blind other pilots)
  ii. Taxi slowly, particularly in congested areas

C. Orientation
  i. Airport diagram (always have one out)
  ii. Understand the taxiway markings, lights, and signs
  iii. RM: Orientation & Situational Awareness (RM: Runway incursion) AI.II.M.R6
    a. Airport diagram (always have one out)
    b. Understand the taxiway markings, lights, and signs
    c. Taxi slowly to allow time to maintain situational awareness
    d. If there is a loss of situational awareness, conflicting information, or doubt, stop and ask for clarification

D. 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

6. Takeoff & Climb

A. General AI.II.M.K6
  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 flight deck lighting so the instruments are readable, without hindering night vision

B. Clear final approach for approaching traffic

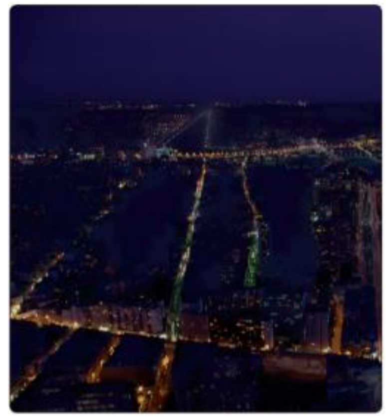
C. Entering the runway
  i. Turn on all lights, except the landing light
  ii. Recommended to align 3' off the centerline to prevent blending in with the runway lights
  iii. Verify correct runway

D. Turn on landing light after receiving takeoff clearance or starting the roll at an uncontrolled field

E. Same as a day takeoff except many visual cues aren't available (compensate with instruments)
F. 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

7. In-Flight Orientation AI.II.M.K5

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. RM: Nav Lights (Collision Hazards) AI.II.M.K9, AI.II.M.R3
   i. Red on Left Wing, Green on Right Wing, White on the Tail



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

8. Traffic Pattern at Night

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. RM: Ensure appropriate lights are on for collision avoidance AI.II.M.R3
D. Fly a normal traffic pattern

9. 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 any references 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

10. 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

11. RM: Hazards & Emergencies

A. Weather Considerations AI.II.M.R2

   i. Narrow temperature/dewpoint spread leading to fog

   ii. Fog and clouds are more difficult to see at night

   iii. The wind's effect on the airplane cannot be as easily detected at night as during the day

B. Night Emergencies

   i. General

      a. Don't panic, maintain control, attempt to fix the problem/accomplish emergency procedures

      b. As the checklist is completed, crosscheck the outside visual references (if any), and the instruments to ensure a safe flight attitude is maintained

   ii. Electrical Failure

      a. In the case of a suspected problem, follow the checklist in the POH
         - Generally, reduce the electrical load as much as possible

      b. If total electrical failure is expected, land at the nearest airport immediately
         - Transition to backup instruments if applicable

   iii. Engine Failure

      a. ABCD – Airspeed, Best landing area, Checklist, Distress call

      b. Don't Panic - Establish a normal glide and turn toward an airport or suitable landing area

      c. Check to determine the cause and correct it immediately, if possible (Engine restart checklist)

      d. Always maintain positive control of the airplane!

      e. Announce the emergency to ATC, UNICOM, and/or guard
         - If already on a frequency, talk to them, don't change unless instructed to

      f. Before landing checklist

      g. Touchdown at the slowest possible airspeed

      h. After landing, turn off all switches and evacuate as quickly as possible

C. Distractions, Situational Awareness & Task Prioritization AI.II.M.R4

   i. Distractions

      a. They're dangerous
         - Remove distractions from view – if it's a person, explain the situation and ask them to stop

      b. Sterile flight deck (taxi, takeoff, descent, and landing)

      c. Fly first! Aviate, Navigate, Communicate

   ii. Situational Awareness

      a. Plan thoroughly, have navigation backups, use flight following

   iii. Task Prioritization

      a. On the ground, clearing takes precedence – take care of all heads down activities while stopped

      b. Airborne, divide attention between the aircraft, scanning, and communicating (ATC or CTAF)

      c. No one responsibility should take your full attention full more than a short period

      d. Understand what tasks need to be accomplished and when

      e. Recognize when you are getting behind and find a way to catch up
         - "Attack the closest alligator" – Deal with the most pressing problem

D. Collision Hazards AI.II.M.R3

   i. Collision Avoidance

      a. Scanning with off-center viewing

      b. Clearing Procedures

- Before Takeoff: Scan the runway and final approach for other traffic
- Climbing: Execute gentle banks to allow scanning above/below the wings as well as other blind spots
- Uncontrolled Fields: Be conservative with spacing during takeoff, landing, and in the pattern

c. Clearly communicate intentions & location at uncontrolled fields

d. Operation Lights On
- Turn on landing lights during takeoff and when operating below 10,000', day or night

ii. Terrain

a. Be aware of terrain that could cause a hazard during the climb or descent into the airfield

b. Be extra vigilant at night, when terrain may be impossible to see until it is too late

c. Use Minimum Safe Altitudes (FAR 91.119)

iii. Obstacles and Wire Strike

a. Many structures can significantly affect safety when below 500' AGL and particularly below 200' AGL
- Become familiar with any obstacles nearby airports
- Obstacles can be found in the NOTAMs, and the Terminal Procedures (IFR document)

b. Antenna Towers
- Numerous antennas extend over 1,000'-2,000' AGL
  - a Most are supported by guy wires which are very difficult to see
  - b Avoid structures by at least 2,000' as guy wires can extend 1,500' horizontally from a structure

iv. Vehicles, Persons, Wildlife, etc.

a. Be alert for anyone/anything that may cause a hazard
- Often the ATIS/NOTAMs will inform of potential vehicles/persons working around the airport

b. Takeoff: Reject the takeoff or delay takeoff, if required

c. Landing: Go around

d. Taxiing: Stop until safe (taxi slowly to ensure the ability to stop if something suddenly appears)

Conclusion:
Brief review of the main points

II.N. Supplemental Oxygen

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

Objectives	The learner develops knowledge of the elements related to supplemental oxygen and be able to explain the necessary elements as required in the ACS.
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. Types of Oxygen Systems 5. Aviator's Breathing Oxygen 6. Care and Storage of High-Pressure Oxygen Bottles
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 and can explain the requirements, elements, and safety procedures involved with supplemental oxygen 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 supplemental oxygen.

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. Oxygen requirements, specifically, vary based on the altitude. Without proper adherence to the regulations and procedures, the pilot is endangering themself and anyone else on the airplane.

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) AI.II.N.K1
   - 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. **RM: Physiological Hazards** (RM: High altitude flight) AI.II.N.K2, AI.II.N.R1
   - 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 AI.II.N.K2a, AI.II.N.K2b, AI.II.N.K2c
     - 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
     - i. Symptoms: Cyanosis, headache, delayed reactions, impaired judgment, euphoria, visual Impairment, drowsiness, lightheaded or dizzy, tingling in the fingers or toes, numbness

Altitude	TUC
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 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

- iii. Time of Useful Consciousness (TUC)
  - a. Max time to make and carry out rational, lifesaving decisions at a given altitude
  - b. > 10,000', symptoms increase in severity, and TUC rapidly decreases
- iv. Treatment: Lower altitudes (emergency descent) and supplemental oxygen
- v. For more details, see II.A. Human Factors - Hypoxia

4. Types of Oxygen Systems AI.II.N.K3a

- 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'

5. Aviator's Breathing Oxygen (Introduction to Aviation Physiology document) AI.II.N.K3b

- 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

6. RM: Care and Storage of High-Pressure Oxygen Bottles AI.II.N.K3c, AI.II.N.R3

- 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. RM: Be aware of the danger of fire when using oxygen (RM: Combustion hazards) AI.II.N.R4
- D. Thoroughly inspect/test all oxygen equipment before flight. Accomplish periodic inspections/servicing

RM: Use of Supplemental Oxygen AI.II.N.R2

The lesson as a whole is a discussion on supplemental oxygen risk management

Conclusion:

Brief review of the main points

II.O. Pressurization

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

Objectives	The learner should develop knowledge of the elements related to high altitude operations and be able to explain the necessary elements as required in the ACS.
Key Elements	1. Regulations 2. Aviator's Oxygen 3. Decompression and Hypoxia
Elements	1. High-Altitude Flight Environment 2. Physiological Factors 3. Pressurization in Airplanes 4. Rapid Decompression
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 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, and the unique hazards associated with pressurized aircraft.

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 of pressurization.

How:

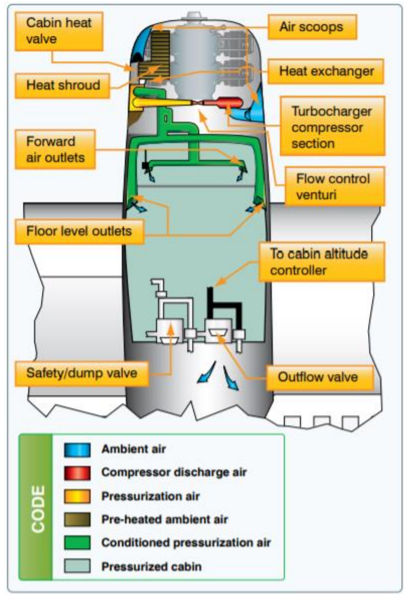
1. **High-Altitude Flight Environment**
   A. FAR 61.31(g) considers all flight operations conducted above 25,000' MSL to be high altitude, however many effects of higher altitudes can be felt well below 25,000'
2. **RM: Physiological Hazards** (RM: High altitude flight) AI.II.O.K2, AI.II.O.R1
   A. 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 AI.II.O.K2a, AI.II.O.K2b, AI.II.O.K2c
      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
      iii. Time of Useful Consciousness (TUC)
         a. Max time to make and carry out rational, lifesaving decisions at a given altitude
         b. > 10,000', symptoms increase in severity, and TUC rapidly decreases

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

      iv. Treatment: Lower altitudes (emergency descent) and supplemental oxygen
   C. Vision tends to deteriorate with altitude - Lack of oxygen to the rods significantly reduces their sensitivity
   D. 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
   E. Nitrogen Absorption (Decompression Sickness - DCS)
      i. If 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
3. **Pressurization in Airplanes** AI.II.O.K1
   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/outside pressure
   ii. Cabin Altimeter – shows altitude inside the airplane
   iii. Cabin Rate of Climb/Descent – cabin rate of change

Cabin rate-of-climb indicator
Cabin/differential pressure indicator



   iv. RM: Malfunctions/Failure Modes AI.II.O.R2
      a. Reference the POH checklist
      b. Be prepared for reduced pressurization or decompression (supplemental oxygen/emergency descent)

4. Rapid Decompression AI.II.O.K2d

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, and 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

PREFLIGHT PREPARATION

III.A. Pilot Qualifications

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 learner 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. Medical Certificates & Basic Med 2. Certification & Training Requirements 3. Logbook Entries & Records 4. Privileges and Limitations 5. Pilot Currency 6. Required Documents
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 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. **Medical Certificates** (FAR 61.23) **& Basic Med** AI.III.A.K3
   A. Medical Certificates
      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. 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
      iii. 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
      iv. 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

v. How to find an AME - FAA.gov AME Locator
  a. FAA Directory of AMEs can be found at FSDOs, FSSs, FAA Offices

vi. 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)

vii. 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)
  - With few exceptions, all disqualifying conditions may be considered for special issuance

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 learner, 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

2. Certification & Training Requirements AI.III.A.K1

A. Sport Pilot Certificate

i. Eligibility – FAR 61.305

ii. Aeronautical Knowledge – FAR 61.309

        iii. Flight Proficiency – FAR 61.311
        iv. Aeronautical Experience – FAR 61.313
    B. Recreational Certificate (FAR 61.99)
        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. 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
    D. Private Certificate (FAR 61.109)
        i. Eligibility Requirements – FAR 61.103
        ii. Aeronautical Knowledge – FAR 61.105
        iii. Flight Proficiency – FAR 61.107
        iv. Aeronautical Experience - FAR 61.109
    E. Commercial Certificate (FAR 61.129)
        i. Eligibility Requirements – FAR 61.123
        ii. Aeronautical Knowledge – FAR 61.125
        iii. Flight Proficiency – FAR 61.127
        iv. Aeronautical Experience – FAR 61.129
    F. Flight Instructors
        i. Eligibility Requirements – FAR 61.183
        ii. Aeronautical Knowledge – FAR 61.185
        iii. Flight Proficiency – FAR 61.187

3. Logbook Entries & Records AI.III.A.K1

    A. Required Logbook Entries (FAR 61.51 & 61.189)
        i. 61.189: A flight instructor must sign the logbook of each person they have given flight or ground training
        ii. 61.51: Must document training/experience used to meet the requirements for a certificate, rating, or review
        iii. 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 used)
            b. Type of Experience/Training: Solo, PIC, SIC, flight/ground training. simulator/flight training device)
            c. Conditions of Flight: Day/Night, Actual Instrument, Simulated Instrument in flight or a simulator/FTD)
    B. Flight Instructor Records (FAR 61.189)
        i. Must maintain the following records for at least 3 years:
            a. Name of each person endorsed for solo flight privileges, and the date of the endorsement
            b. Name of each person endorsed for a knowledge or practical test, with the kind of test, date, results

4. Privileges and Limitations AI.III.A.K2

    A. Sport Pilot - FAR 61. 89(c) & 61.315
    B. Recreational Pilot - FAR 61.101
    C. Student Pilot - FAR 61.89
    D. Private Pilot - FAR 61.113
    E. Commercial Pilot - FAR 61.133
    F. Flight Instructor Privileges - FAR 61.193
    G. Flight Instructor Limitations & Qualifications - FAR 61.195

5. Pilot Currency (FAR 61.57) AI.III.A.K1

A. Pilot in Command
   i. FAR 61.57(a) – To carry passengers: 3 takeoffs and landings in the last 90 days
      a. Sole manipulator of the flight controls in the same category, class, type aircraft
      b. 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
B. RM: Proficiency versus Currency — AI.III.A.R1
   i. Currency is the minimum required by law to legally fly
   ii. Proficiency is a level of understanding and ability that creates a safe and competent pilot
   iii. Just because you are current does not mean you are proficient
   iv. RM: Flying Unfamiliar Aircraft — AI.III.A.R2
      a. Ensure proficiency – Just because you can, doesn't mean you're proficient or safe

6. Required Documents — AI.III.A.K4

A. FAR 61.3 Requirement for Certificates, Ratings, and Authorizations
   i. Pilot Certificate (& Flight Instructor Certificate, if exercising privileges)
   ii. Government Issued Photo Identification
   iii. Medical Certificate
B. FAR 61.51(i) Presentation of Documents
   i. Must present pilot certificate, medical, logbook, or any other record required by part 61 upon request
   ii. Student Pilot on solo cross-country flights must carry:
      a. Pilot logbook with endorsements, Student Pilot certificate, and any other certificate required by Part 61
   iii. Sport pilot must carry their logbook or other evidence of required instructor endorsements on all flights
   iv. Recreational pilot must carry their logbook with the required instructor endorsements on all solo flights:
      a. > 50 nm from the airport at which the training was received
      b. Within airspace requiring communication with ATC
      c. Conducted between sunset & sunrise, or
      d. In an aircraft for which the pilot doesn't hold an appropriate category or class rating
   v. Instructor with a sport pilot rating must carry:
      a. Logbook or other evidence of required instructor endorsements when providing flight training

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. 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 learner should exhibit knowledge of the elements regarding airworthiness requirements as necessary based on their respective ACS.
Key Elements	1. CFR 91.205 – Required Instruments 2. CFR 91.213(d) – Deferral without MEL 3. Required Inspections
Elements	1. Inoperative Equipment Before Flight 2. Airworthiness 3. Obtaining a Special Flight Permit 4. Appropriate Record Keeping 5. Preventive Maintenance 6. Inoperative Equipment in 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 learner 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 certain documents must be on board and current, certain inspections must be completed, and certain instruments must be functioning, otherwise the airplane is unfit for flight and therefore unairworthy or illegal to fly. An unairworthy aircraft cannot be flown without a special flight permit.

How:

1. **RM: Inoperative Equipment Before Flight** AI.III.B.R1
   - A. Equipment requirements are designed for everyone's safety
     - i. Without them, individual pilots would be left to make subjective safety decisions
   - B. The following procedures describe the process for handling inoperative equipment found before flight
     - i. These are minimum requirements to be legal to fly
     - ii. If you're not comfortable with the state of the aircraft, don't fly it
       - a. Set personal equipment minimums as desired
   - C. Two basic methods for determining if inoperative equipment makes an aircraft unairworthy
     - i. Without a Minimum Equipment List (MEL) – most common & based on FAR requirements/specifications
     - ii. With an MEL – FAA approved list of required equipment based on the type of flight
2. **Airworthiness:** Required Equipment, Inspections, Documents, & Airworthiness Certificates
   - A. Airworthiness without an MEL (Required Instruments & Equipment)
     - i. Widely used due to the simplicity and minimal paperwork
     - ii. When inoperative equipment is found prior to flight, decide whether to:
       - a. Cancel the flight, have the inoperative equipment fixed prior to flight, or
       - b. Continue the flight by deferring the inoperative equipment (FAR 91.213(d)) AI.III.B.K3d
         - To defer, the item must not be required for flight (broken down in part C)
         - The inoperative equipment must be deactivated (or removed) and placarded INOPERATIVE
           - a Any necessary maintenance must be accomplished by certified maintenance personnel
     - iii. Required Equipment - 91.213(d) – Is the equipment required by any of the following: AI.III.B.K3
       - a. 14 CFR 91.205: Required Instruments and Equipment for Day and Night VFR Flight
         - Visual-Flight Rules (Day): TOMATO FFLAAMES
           - a **T**achometer for each engine
           - b **O**il pressure gauge for each engine
           - c **M**anifold pressure gauge for each altitude engine
           - d **A**irspeed Indicator

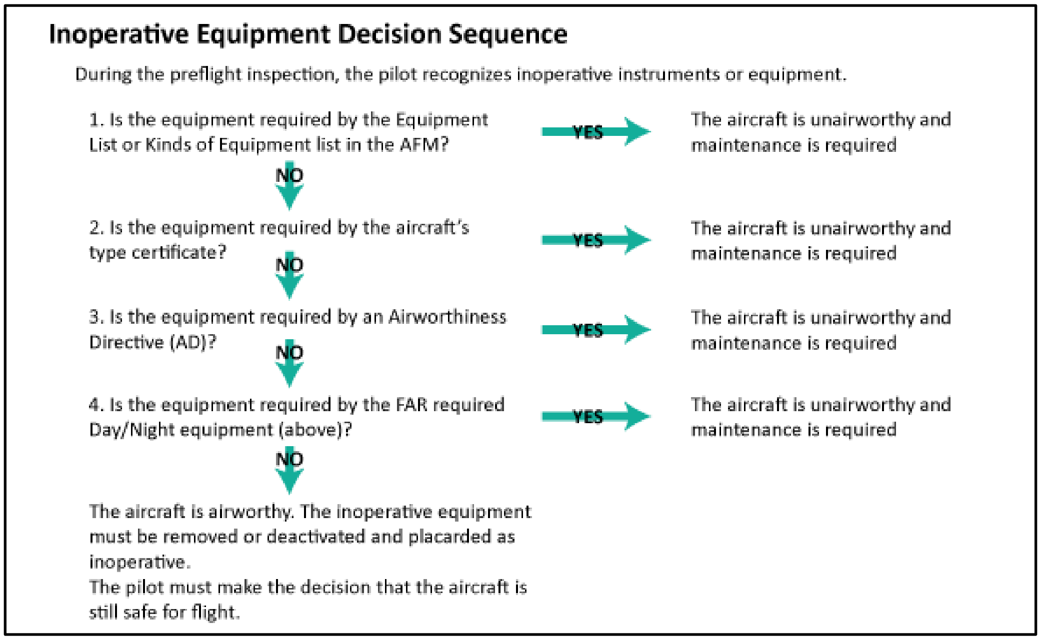
  e **T**emperature gauge for each liquid-cooled engine
  f **O**il temperature gauge for each air-cooled engine
  g **F**uel gauge indicating the quantity of fuel in each tank
  h **F**lotation gear (if operated for hire over water beyond power-off glide distance from shore)
  i **L**anding gear position indicator
  j **A**ltimeter
  k **A**nti-Collision Lights (if certified after March 11, 1996)
  l **M**agnetic compass
  m **E**mergency Locator Transmitter
  n **S**afety belts/Shoulder Harnesses
- Visual-Flight Rules (Night), The following instruments and equipment are required:
  a Everything for VFR day flight, as well as: FLAPS
    1. **F**uses (if required)
    2. **L**anding Light (Electric)
    3. **A**nti-Collision Lights
    4. **P**osition Lights
    5. **S**ource of electricity for all installed electrical and radio equipment

b. Kinds of Operation Equipment List and Equipment List AI.III.B.K3c
- Kinds of Equipment List (chapter 2 of the POH)
  a Lists the manufacturer's required equipment based on the type of flight (Day VFR, IFR, etc.)
- Equipment List (usually found in the weight and balance data, and / or the POH)
  a Specifies the required equipment and all equipment approved for installation in the aircraft

c. Type Certificate
- 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.
- Can be found on the FAA TCDS Website
- The type certificate will specify things like the type of engine, propeller, number of seats, etc.
  a Things on the TC cannot be changed without a supplemental type certificate

d. Airworthiness Directives (AD) AI.III.B.K1c
- Like a recall on a car – Used to notify of unsafe conditions and specify the actions that must be taken
- Two Categories of ADs:
  a Those of an emergency nature requiring immediate compliance prior to further flight
  b Those of a less urgent nature requiring compliance within a specific time period
- Regulatory in nature unless a specific exemption is granted
- If not complied with by the designated date and time, the aircraft is no longer airworthy
- Aircraft owner/operator's (PIC) responsibility to ensure compliance with ADs
- Compliance Records
  a 14 CFR part 91.417 requires a record to be maintained showing the status of applicable ADs.
- Special Airworthiness Information Bulletin (SAIB) AI.III.B.K1c
  a Non-regulatory or mandatory info & guidance for safety issues that don't meet AD criteria
  b SAIB Overview: Order 8110.100

c SAIB Database: FAA Dynamic Regulatory System



B. Airworthiness with an MEL AI.III.B.K3b
  i. Precise listing of required equipment based on the type of flight (less common in general aviation)
    a. Basically, combines FAR 91.205, Kinds of Equipment List, ADs, Type Certificate into one document
    b. A supplemental type certificate & is the authority to operate in a condition other than originally certificated
    c. Must be requested from the FAA
  ii. Required Equipment
    a. If equipment is broken, refer to the MEL to determine whether it is required for the type of flight
    b. 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 AI.III.B.K1b
  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
      - 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
      - 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

D. Required Documents (ARROW) AI.III.B.K1a
i. Airworthiness
ii. Registration
iii. Radio Operators License (if international)
iv. Operating Limitations (POH)
v. Weight and Balance (specific to the aircraft tail number)

E. Airworthiness Certificates AI.III.B.K4
i. Standard
a. White and issued for normal, utility, acrobatic, commuter or transport category aircraft
b. Issued by the FAA after an aircraft is found to meet Part 21 requirements and is safe for operation
c. Remains in effect if the aircraft receives required maintenance and is registered in the US

ii. Special
a. Pink and issued for Primary, Experimental, Restricted, Limited, Provisional and Light-Sport Aircraft
b. In general, aircraft with a special certificate, cannot be operated for hire, in some cases can't carry passengers, and may be restricted to operations only over sparsely populated areas or water
c. FAR 91.325 Primary Aircraft Operating Limitations
d. FAR 91.319 Experimental Aircraft Operating Limitations
e. FAR 91.313 Restricted Aircraft Operating Limitations
f. FAR 91.315 Limited Aircraft Operating Limitations
g. FAR 91.317 Provisional Aircraft Operating Limitations
h. FAR 91.327 Light Sport Aircraft with Special Airworthiness Certificate

3. Obtaining a Special Flight Permit AI.III.B.K1d

A. FAR 21.197: Special Flight Permit – authorization to fly an unairworthy aircraft that is safe for a specific flight
i. Ex: To a base where repairs can be made, or delivering an aircraft

B. Obtaining a Special Flight Permit
i. Contact the local FSDO or Designated Airworthiness Representative (DAR)
ii. FAR 21.199: Must submit a statement indicating the purpose, itinerary, crew, aircraft issues, & restrictions
iii. FAA Special Flight Permit Regs & Policies

4. Record Keeping (FAR 91.417) AI.III.B.K1a

A. The 100-Hour / Annual inspection as well as the inspections required for instruments and equipment necessary for IFR / VFR flight are 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. 14 CFR part 43, Appendix A: Major alterations shall be returned to service on FAA Form 337, by a certificated repair station, an FAA certificated A&P mechanic holding an IA, or a representative of the Administrator
ii. Minor alterations 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

5. Preventive Maintenance (AC 43-12) AI.III.B.K2

A. Who can Perform Preventive Maintenance?
   i. FAR 43.3(g): The holder of a pilot certificate issued under Part 61 may perform preventive maintenance
   ii. Part 43 Appendix A paragraph (c)(30): At least a private pilot who is a registered owner of the aircraft
B. Preventive Maintenance
   i. FAR 1.1: Simple or minor preservation operations and the replacement of small standard parts not involving complex assembly operations
   ii. Part 43 Appendix A paragraph (c) Provides an exhaustive list of authorized preventive maintenance
   iii. FAR 43.13 Performance Rules: Basically, requires quality work and parts
   iv. Conduct a self-analysis as to whether you can perform the work satisfactorily & safely
   v. FAR 43.9(a) Maintenance Record Entries - Any work done requires an entry in the logbook and must include:
      a. Description of the work done, Completion date, & Signature, certificate number, and kind of certificate
C. Return to Service
   i. FAR 43.7(f): A person holding at least a private pilot certificate may approve an aircraft for return to service after performing preventive maintenance under the provisions of 43.3(g)
D. FAASafety.gov Maintenance Aspects of Owning Your Own Aircraft

6. Inoperative Equipment in Flight AI.III.A.K3a

A. Maintenance deferrals are not used for inflight discrepancies
   i. The manufacturer's POH procedures are to be used in those situations
B. The POH takes precedence but combine risk assessment & mitigation techniques to assist in decision making
   i. Consider how the inoperative equipment affects the flight
   ii. PAVE checklist, and any other tools
   iii. Apply personal minimums & requirements

Conclusion:
Brief review of each main point

III.B. Airworthiness Requirements - FARS

References: 14 CFR Part 91

Objectives	The learner should exhibit knowledge of the elements regarding airworthiness requirements as necessary based on their respective ACS.
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 learner 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. Unlike in a car, we do not have the option to pull over to the side of the road in the case of a problem.

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 requirements that must be met to ensure an aircraft is safe and legal to fly.

Why:

For an airplane to be airworthy certain documents must be on board and current, certain inspections must be completed, and certain instruments must be functioning, otherwise the airplane is unfit for flight and therefore unairworthy or illegal to fly. An unairworthy aircraft cannot be flown. Determining airworthiness can be very complex. This lesson is designed to provide a basis to decide whether the airplane is airworthy.

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
   - C. Each PIC who deviates from a rule under paragraph (b) of this section shall, upon the request of the Administrator, send a written report of that deviation to the Administrator
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 The aircraft cannot be changed from its type certificate; must be in the condition it left the factory in
             1. The 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., 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 or Rotorcraft Flight Manual is required by FAR 21.5 of this chapter unless there is available in the aircraft a current, approved Airplane or Rotorcraft Flight Manual or the manual provided for in FAR 121.141(b); and
       - a. The Weight and Balance is included in the AFM, but is part of the type certificate and therefore required

    ii. For which an Airplane or Rotorcraft Flight Manual is not required by FAR 21.5 of this chapter, unless there is available in the aircraft a current approved Airplane or Rotorcraft Flight Manual, approved manual material, markings, and placards, or any combination thereof
  B. FAR 91.9 states that the AFM is required in the airplane for planes registered after 1979
    i. The AFM is not required for an airplane before 1979, unless the manufacturer submitted an AFM to the FAA, then it is required in the airplane
  C. FAR 91.9 also states that without the AFM, all placards, markings, etc. must be in the aircraft

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 within it the following:
    i. An appropriate and current airworthiness certificate…
      a. It must be displayed at the cabin or flight deck 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. MEL
    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 (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 - Inoperative equipment must be repaired, replaced, removed 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
    i. Rules governing maintenance, preventative maintenance, alterations of US registered civil aircraft
  B. FAR 91.405 - Maintenance Required
    i. Each owner or operator of an aircraft:
      a. Shall have that aircraft inspected as prescribed in subpart E of this part and shall between required inspections, have discrepancies repaired as prescribed in part 43 of this chapter
      b. Shall ensure that maintenance personnel make appropriate entries in the aircraft maintenance records indicating the aircraft has been approved for return to service
      c. Shall have any inoperative instrument/equipment, permitted to be inoperative by FAR 91.213(d)(2) of this part, 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

      a. Required every 24 calendar months
   E. FAR 91.413 - ATC Transponder Tests and Inspections
      i. Transponder tests and inspections required
         a. Required every 24 calendar months

8. **FAR 91.207 - Emergency Locator Transmitters (ELT)**
   A. Inspection requirements
      i. Every 12 calendar months
   B. The batteries must be replaced (or recharged)
      i. When the transmitter has been in use more than 1 cumulative hour
      ii. When 50% of their 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.

III.C. Weather Information

References: 14 CFR Part 91, Aviation Weather Handbook (FAA-H-8083-28), Aviation Weather Handbook (FAA-H-8083-28), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), AIM

Objectives

The learner should develop knowledge of the elements related to weather information with the ability to interpret several weather sources and make an educated Go/No Go decision.

Key Elements

1. Information Sources
2. FSS - 122.2
3. Go/No Go Decision

Elements

1. Atmospheric Composition & Stability
2. Wind
3. Temperature
4. Moisture & Precipitation
5. Weather System Formation
6. Clouds
7. Turbulence
8. Thunderstorms
9. Frost & Icing
10. Fog & Mist
11. Obstructions to Visibility
12. Importance of a Thorough Weather Briefing
13. Weather Information Sources
14. Weather Reports and Charts
    a. METAR, TAF, and GFA
    b. Model Output Statistics (MOS)
    c. Surface Analysis Chart
    d. Ceiling & Visibility Chart
    e. Winds and Temperature Aloft Chart
    f. Convective Outlook Chart
15. In-Flight Weather Advisories
16. 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 learner can effectively interpret the necessary weather information and 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 airborne in a thunderstorm or some other extreme weather, we should have a good understanding of weather information to know when to and not to fly.

Overview

Review Objectives and Elements/Key ideas

What

First, a discussion of weather – how it forms, interacts, and its relation to flying. And second, 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

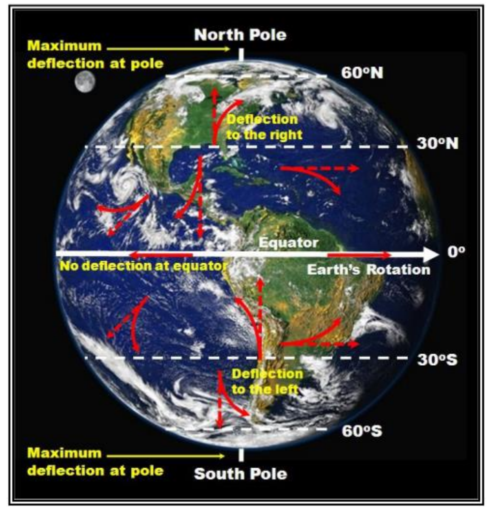
This knowledge, and the reports and forecasts enable pilots to make informed decisions regarding weather and flight safety.

How:

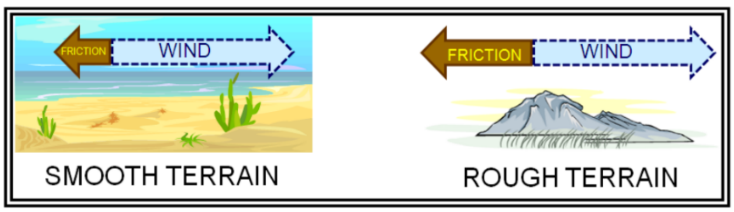
1. **Atmospheric Composition and Stability** AI.III.C.K3a
   - A. 4 gases make up 99.998% of the atmosphere - Nitrogen, Oxygen, Argon, and Carbon Dioxide
   - B. Atmosphere is divided into 5 concentric layers
     - i. Troposphere
       - a. Surface up to about 36,000' high (varies with temperature variations)
       - b. Temperature decreases with height & almost all weather occurs in this region
       - c. Transition layer between the troposphere and they layer above is called the tropopause
     - ii. Stratosphere
       - a. Tropopause up to 31 miles high (Holds 19% of the atmosphere's gases, but little water)
       - b. Temperature increases with height due to the absorption of UV radiation
       - c. Commercial aircraft often cruise in the lower stratosphere to avoid turbulence/convection
     - iii. Mesosphere
       - a. Stratopause to about 53 miles above the Earth.
       - b. Gases continue to thin leading to a decrease in temperature with height
     - iv. Thermosphere
       - a. Mesopause to 430 miles above the Earth (known as the upper atmosphere)
       - b. Temp increases with height and can reach 2,000 degrees Celsius near the top of the layer
       - c. High energy UV and X-ray radiation from the sun is absorbed
     - v. Exosphere
       - a. Thermopause to 6,200 miles above the surface (outermost layer of the atmosphere)
       - b. Atoms and molecules escape into space, and where satellites orbit the Earth
   - C. Standard Atmosphere (59°F/15°C, 29.92" Hg)
     - i. Average of conditions throughout the atmosphere for all latitudes, seasons, and altitudes
2. **Wind** AI.III.C.K3b
   - A. Air in motion relative to the surface. Wind causes the formation/dissipation/redistribution of weather
   - B. Forces that Affect the Wind

i. Pressure Gradient Force (PGF)
   a. Wind flows from areas of high to low pressure. These different pressures create the PGF
   b. Whenever a pressure difference develops, the PGF makes the wind blow to equalize the differences
   c. Wind speed is proportional to PGF which is proportional to the contour/isobar gradient

ii. Coriolis Force
   a. Deflects air to the right in the Northern Hemisphere & left in the Southern Hemisphere
      - At a right angle to wind direction
      - Directly proportional to wind speed
         a If wind speed doubles, Coriolis doubles
      - Coriolis varies with latitude
         a Zero at the equator & maximum at each pole



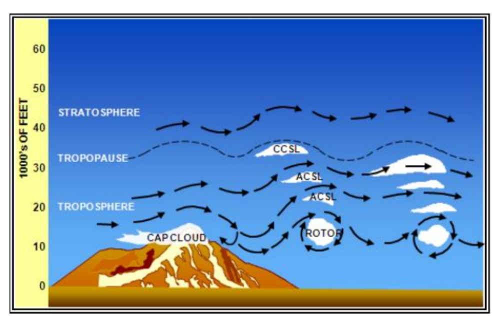
iii. Friction
   a. Friction between wind and the surface slows the wind
   b. Rougher terrain and stronger winds = greater friction
   c. Insignificant above the lowest few thousand feet or so
   d. Above the friction layer, only the PGF and Coriolis force affect the horizontal motion of the air



C. Adverse Winds

i. Wind Shear
   a. What is it?
      - A sudden, drastic change in wind speed and/or direction over a very small area
      - Can occur at any altitude
         a Low-level wind shear is especially hazardous due to the proximity to the ground
         b Low-level wind shear is commonly associated with passing frontal systems, thunderstorms, temperature inversions, and strong upper-level winds (greater than 25 knots)
   b. Why is it dangerous?
      - Can cause violent updrafts/downdrafts, and abrupt changes to horizontal movement
      - It can rapidly change performance and disrupt the normal flight attitude, for example:
         a A tailwind can quickly change to a headwind, increasing airspeed and performance
         b A headwind can quickly change to a tailwind, decreasing airspeed and performance
      - Although reported, it often remains undetected
         a Be alert for wind shear, especially when flying around thunderstorms & frontal systems

ii. Mountain Waves (AIM 7-6-7j)
   a. What is it?
      - The atmosphere is a fluid in motion
         a Just as a stream develops waves & eddies as it passes obstructions, so does the atmosphere
         b When the atmosphere encounters a mountainous



barrier, and the wind is sufficiently strong and the atmosphere is stable, a wave will develop
   1. Air hits the upwind side, creating a smooth updraft
   2. Passing the crest, it becomes a turbulent downdraft
   3. Turns into a wave that can last for miles
b. Hazards
   - Strong down drafts and/or turbulence on the immediate leeward side of the mountain
c. Visual Indicators
   - Sharp-edged, lens-shaped lenticular clouds
   - With sufficient moisture, clouds can include:
      a Cap clouds, Cirrocumulus Standing Lenticular (CCSL), Altocumulus Standing Lenticular (ACSL), and rotor clouds
      b These clouds provide evidence of mountain waves, but may be absent if the air is too dry
d. Types of Waves
   - For significantly more info, Aviation Weather Handbook Ch. 16 discusses many wave types
      a Gravity Waves, Kelvin-Helmholtz (K-H) Waves, Vertically Propagating Mountain Waves, Trapped Lee Waves, and more

3. Temperature AI.III.C.K3c

A. Temperature
   i. Represents the average kinetic energy of the molecules in matter
   ii. Heat Transfer
      a. Heat transfer is energy transfer because of temperature difference
      b. The heat source for the planet is the sun. Energy from the sun is transferred to the Earth's surface. There are 3 ways heat is transferred into and through our atmosphere:
         - Radiation (ex. Being near a fireplace – the sun radiates heat to the earth)
         - Conduction (transfer of energy from one substance to another)
         - Convection (transport of heat within a fluid, such as air or water)
            a Because air is a poor thermal conductor, convection plays a vital role in the Earth's atmospheric heat transfer process

B. Temperature & the Earth/Atmosphere
   i. Thermal Response: Water is much more resistant to temperature changes than land
   ii. Temperature Variations with Altitude
      a. Temperature generally decreases at an average of 2° Celsius per 1,000'
      b. But in the troposphere, temperature can remain constant or increase with altitude changes
         - Isothermal Layer: An atmospheric layer where temperature remains constant with height
         - Temperature Inversion: A layer in which the temperature increases with altitude

4. Moisture & Precipitation AI.III.C.K3d

A. Necessary Ingredients
   i. Water Vapor
   ii. Sufficient Lifting - condenses the water vapor into clouds
   iii. Growth Process - allows cold droplets to grow large and heavy enough to fall as precipitation
      a. Two growth processes allow cloud droplets to grow large enough to fall as precipitation
         - Collision-Coalescence (warm rain process)
            a Collisions between droplets of varying size and fall speeds coalesce to form larger drops

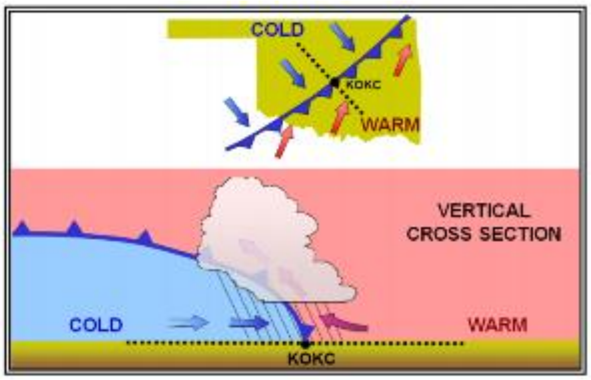
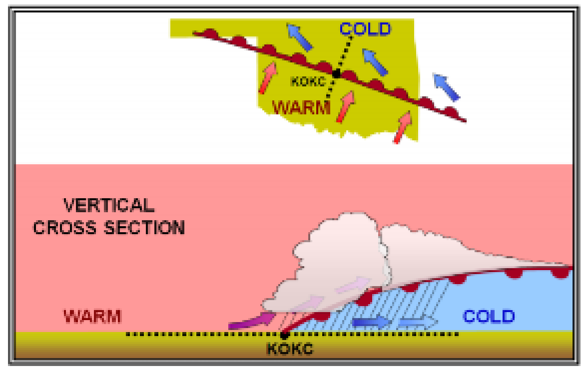
- Ice Crystal Process
    - a Water vapor directly on ice crystals which eventually become heavy enough to fall

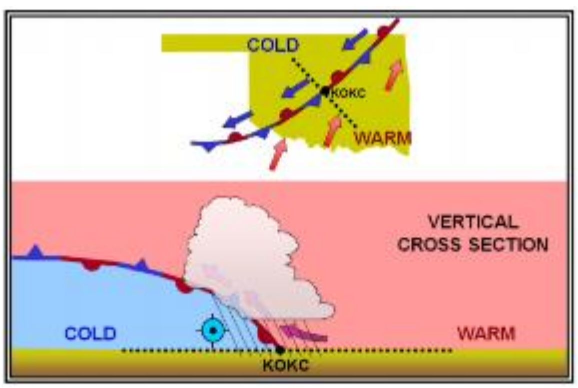
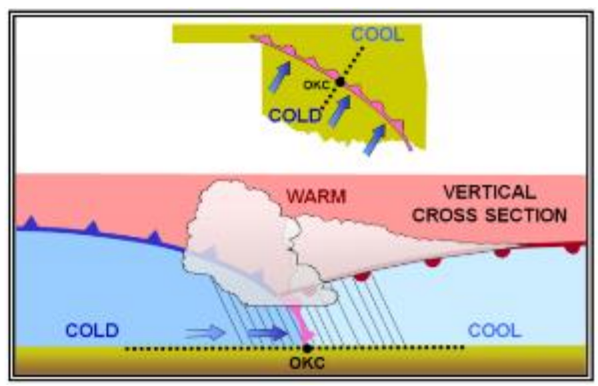
B. Precipitation Types
  i. The vertical distribution of temperature often determines the precipitation at the surface
  ii. Rain: Deep layer of above freezing air based at the surface
  iii. Snow: Occurs when the temperature is below freezing throughout the entire depth of the atmosphere
  iv. Ice Pellets: Require a shallow, above freezing layer aloft, and a deep, below freezing layer at the surface
  v. Freezing Rain: Deep, above freezing layer aloft and a shallow, below freezing layer at the surface

5. Weather System Formation AI.III.C.K3e

A. Air Masses
  i. A large body of air with generally uniform temperature and humidity.
  ii. Area from which an air mass originates is called a source region
  iii. Classified according to temperature and moisture properties of the source region
    a. Temperature Properties
      - Arctic: Extremely deep cold air mass; develops mostly in winter over arctic ice/snow
      - Polar: A relatively shallow cool to cold air mass which develops over high latitudes
      - Tropical: A warm to hot air mass which develops over low latitudes
    b. Moisture Properties
      - Continental: A dry air mass which develops over land
      - Maritime: A moist air mass which develops over water
    c. Types of Air Masses (Temperature + Moisture Properties)
      - Continental Arctic: Cold, dry
      - Continental Polar: Cold, dry
      - Continental Tropical: Hot, dry
      - Maritime Polar: Cool, moist
      - Maritime Tropical: Warm, moist
      - Maritime Arctic seldom, if ever, forms
  iv. As an air mass moves around the Earth, it can acquire different attributes

B. Fronts
  i. A boundary or transition zone between two air masses
    a. Most weather occurs along fronts
    b. Classified by which type of air mass (cold or warm) is replacing the other
  ii. Fronts are usually detectable at the surface in several ways:
    a. Significant temperature gradients
    b. Converging winds
    c. Pressure typically decreases as a front approaches and increases after it passes
  iii. Fronts do not only exist at the surface, but also have a vertical structure described here:

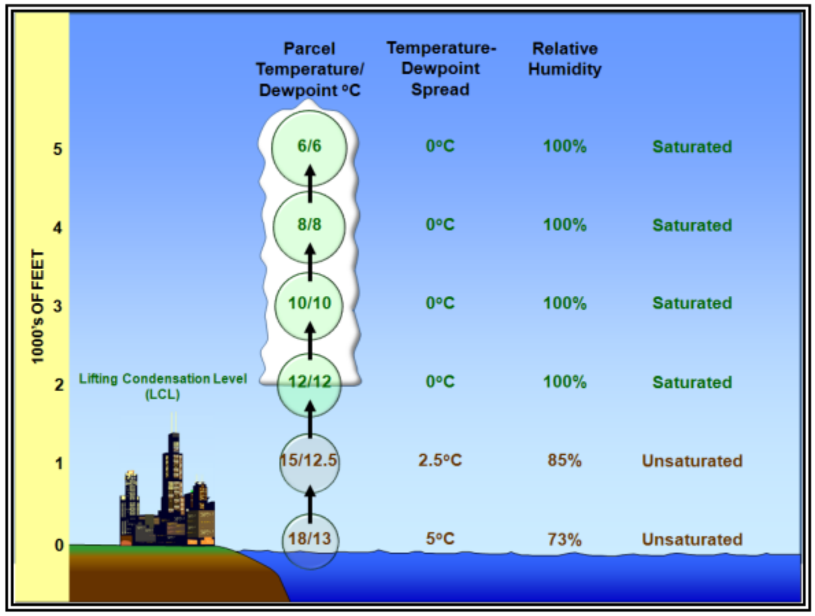
Cold Front	Warm Front
	
Cold fronts have a steep slope, and the warm air is forced up abruptly. If the warm rising air is unstable, this often leads to a narrow band of showers and thunderstorms along, or just ahead of, the front.	Warm fronts have a gentle slope, so the warm air rising along the frontal surface is gradual. This favors the development of widespread layered or stratiform cloudiness and precipitation along, and ahead of, the front if the warm rising air is stable.

Stationary Front	Occluded Front
	
Stationary frontal slopes can vary, but clouds and precipitation would still form in the warm rising air along the front.	Cold fronts typically move faster than warm fronts, so in time they catch up to warm fronts. As the two fronts merge, an occluded front forms. The cold air undercuts the retreating cooler air mass associated with the warm front, further lifting the already rising warm air Clouds and precipitation can occur in the areas of frontal lift along, ahead of, and behind the surface position of an occluded front

6. Clouds

AI.III.C.K3f

A. Vertical Motion & Cloud Formation
   - i. Air cools as it rises
     - a. As pressure decreases, the air parcel expands, which requires energy, cooling the air
     - b. Reaches a point where temp and dewpoint are equal, and the particle becomes saturated
   - ii. Lifted Condensation Level (LCL): Level at which a parcel of air becomes saturated
   - iii. Lifting above the LCL results in condensation, cloud formation and heat release
   - iv. As the air parcel expands and cools, water vapor content decreases
     - a. Some water vapor is condensed to droplets or deposited into ice crystals to form a cloud
     - b. The cloud grows vertically as the parcel continues to rise
   - v. Opposite occurs as a particle descends



B. Sources of Vertical Motion
   - i. Orographic Effects: Wind blowing across mountains and valleys causing the air to ascend/descend
   - ii. Frictional Effects
     - a. Winds diverge away from high pressure causing air to sink, compress, & war, dissipating clouds
     - b. Winds converge into low pressure causing air to rise, expand, & cool, favoring clouds & precipitation
   - iii. Frontal Lift: Cold, denser air wedges under warm, less dense air, forcing it upward
   - iv. Buoyancy
     - a. Air near the ground can warm at different rates
     - b. Temperature differences result in different air densities, allowing warm air to rise and cold to sink

C. Clouds
   - i. Cloud Forms
     - a. Cirri-form
       - High level clouds above 20,000' usually composed of ice crystals
       - Typically, thin, and white
       - Occur in fair weather and point in the direction of air movement
     - b. Nimbo-form (Nimbus comes from the Latin word meaning rain)
       - Typically, between 7,000 and 15,000' with steady precipitation
       - As clouds thicken and precipitation falls, the bases tend to lower
     - c. Cumuli-form
       - White, fluffy cotton balls (show the vertical motion in the atmosphere)
       - Flat cloud base indicates the level of condensation/cloud formation
       - Height depends on humidity of rising air (more humid = lower base)
       - Tops can reach > 60,000'


Cirri-form


Nimbo-form


Cumuli-form

d. Strati-form (Stratus is Latin for layer or blanket)
- Featureless low layer that can cover the entire sky, like a blanket
- Usually only a few hundred feet AGL
- As fog lifts due to heating, it can form a layer of low stratus clouds

ii. Cloud Levels

a. High, Middle, and Low

b. In each level, the clouds may be divided by type

Level	Polar Regions	Temperate Regions	Tropical Regions
High Clouds	10,000–25,000 ft (3–8 km)	16,500–40,000 ft (5–13 km)	20,000–60,000 ft (6–18 km)
Middle Clouds	6,500–13,000 ft (2–4 km)	6,500–23,000 ft (2–7 km)	6,500–25,000 ft (2–8 km)
Low Clouds	Surface–6,500 ft (0–2 km)	Surface–6,500 ft (0–2 km)	Surface–6,500 ft (0–2 km)

iii. Cloud Types

a. High Clouds

Cirrus	Cirrocumulus	Cirrostratus
		
Detached cirriform elements in the form of white, delicate filaments of white patches, or narrow bands. Many of the ice crystal particles are sufficiently large to acquire appreciable speed of fall; therefore, the clouds often trail downward in well-defined wisps called mares' tails. Cirrus clouds in themselves have little effect on aircraft and contain no significant icing or turbulence.	A cirriform type appearing as a thin, white patch, sheet, or layer of could without shading, and is composed of very small elements in the form of grains, ripples, etc. May be composed of highly super cooled water droplets, as well as small ice crystals, or a mix of both. Pilots can expect some turbulence and icing	Appears as a whiteish veil, usually fibrous but sometimes smooth, that may totally cover the sky, and that often produces halo phenomena. May be so thin and transparent as to render it nearly indiscernible – the existence of a halo around the sun or moon may be the only revealing feature. Composed primarily of ice crystals and contain little, if any, icing and no turbulence.

b. Middle Clouds

Altocumulus	Altocumulus Lenticularis	Altostratus
		
White and/or grey in color, that occurs as a layer or patch with a wave aspect, the elements of which appear as laminae, rounded masses, rolls, etc. Small liquid water droplets compose the major part of the composition of altocumulus. This results in sharp outline and small internal visibility. At very low temperatures ice crystals may form. Pilots can expect some turbulence and small amounts of icing	Commonly known as Altocumulus Standing Lenticular, they are an orographic cloud. They often form in patches in the shape of almonds or wave clouds. These formations are caused by wave motions in the atmosphere, and are frequently seen in mountainous or hilly areas. The cloud as a whole is usually stationary or slow moving. The clouds do not necessarily give an indication of the intensity of turbulence or strength of updrafts and downdrafts.	A cloud type in the form of a gray or bluish sheet or layer of striated, fibrous, or uniform appearance. It very often totally covers the sky. Portions of the layer are thin and it can have irregularly shaped and spaced gaps and rifts. Layers in the cloud: • Upper - mostly ice crystals • Middle - mixed ice crystals and/or snowflakes and super cooled water droplets • Lower- mostly super cooled or ordinary water droplets Pilots can expect little to no turbulence, but light to moderate icing in the super cooled water.
Nimbostratus		
	A gray cloud layer, often dark, rendered diffuse by more or less continuously falling rain, snow, ice pellets, etc. which in most cases reaches the ground. Not accompanied by lightning, thunder, or hail. Composed of suspended water droplets, sometimes super cooled, and failing raindrops/snow crystals or snowflakes. Nimbostratus has no well-defined base. A false base may occur where snow melts into rain. It produces very little turbulence, but can pose a serious icing problem if temperatures are near or below freezing.	

c. Low Clouds

<table>
<tr><td>Cumulus and Towering Cumulus</td><td>Stratocumulus</td><td>Stratus</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Individual, detached elements that are generally dense. They develop vertically, appearing as rising mounds, the upper parts of which often resemble cauliflower. Sunlit parts are white, while their bases are darker and nearly horizontal. The first stage of a thunderstorm.

If rain occurs, it is usually showery.

For cumulus with little vertical development, pilots can expect some turbulence and no significant icing. For towering cumulus, expect very strong turbulence and clear icing above the freezing level.</td><td>Predominantly stratiform, in the form of a gray/whiteish layer or patch, which nearly always has dark parts and is non-fibrous. Rounded/roll-shaped, and usually are arranged in orderly groups.

Composed of small water droplets, and sometimes larger droplets, soft hail, even snowflakes. The highest liquid content is in the tops (icing potential). Virga may form under the cloud. Precipitation rarely occurs.

Pilots can expect some turbulence and possible icing. Ceiling and visibility are usually better with low stratus.</td><td>A cloud type in the form of a gray layer with a fairly uniform base. The composition is quite uniform, usually of fairly widely dispersed water droplets, and at lower temperatures, ice crystals (rare).

Doesn't often create precipitation, but when it does, it is in the form of minute particles, such as drizzle, ice crystals, or snow grains.

Stratus produces little or no turbulence, but temperatures near or below freezing can create hazardous icing conditions.</td></tr>
<tr><td>Cumulonimbus</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Exceptionally dense and vertically developed cloud, occurring either as isolated clouds or as a line or wall of clouds. The upper part often is in the form of an anvil or vast plume. Under the base (often dark) there frequently exists virga, precipitation, and low, ragged clouds.

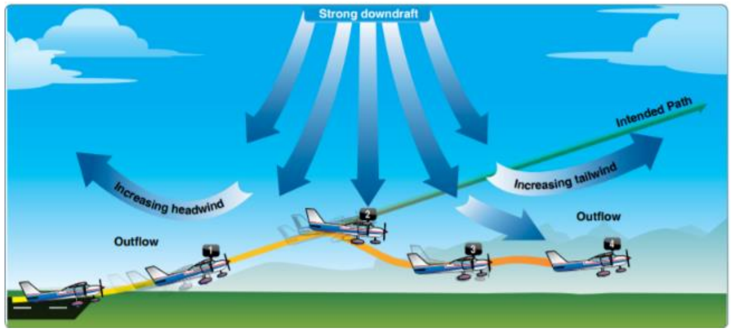
Composed of water droplets/ice crystals. Also contains large water drops, snowflakes, snow pellets, even hail. The water may be super cooled. Precipitation is often heavy/showery. Lightning is common.

Cumulonimbus contains nearly the entire spectrum of flying hazards, including extreme turbulence.</td></tr>
</table>

7. **Turbulence** AI.III.C.K3g
   A. Caused by convective currents, obstructions in the wind flow, and wind shear
   B. Convective Turbulence
      i. Turbulent vertical motions resulting from convective currents and the rising and sinking of air
      ii. Billowy cumuliform clouds indicate convective turbulence
         a. When air is too dry for cumuliform clouds, convective currents can still be active
   C. Mechanical Turbulence
      i. Caused by obstructions to the wind flow, such as trees, buildings, and mountains
      ii. Mountain Waves: Stable air passes over a mountain, developing waves above/downwind of mountains
         a. Often produce violent down drafts on the immediate leeward side of the mountain barrier
      iii. Cap clouds, cirrocumulus standing lenticular, altocumulus standing lenticular and rotor clouds are signs
   D. Wind Shear Turbulence
      i. Wind shear is the rate of change in wind direction and/or speed per unit distance
         a. Often occur across temperature inversion layers, which can generate turbulence
      ii. Clear Air Turbulence
         a. A higher altitude turbulence phenomenon occurring in cloud-free regions associated with wind shear, particularly between the core of a jet stream and the surrounding air
8. **Thunderstorms** AI.III.C.K3h
   A. Ingredients: Sufficient Water Vapor, Unstable Air, Lifting Mechanism
   B. Life Cycle
      i. Towering Cumulus: A strong convective updraft
      ii. Mature: When precipitation reaches the surface
         a. Precipitation descends drags air downward, creating a strong downdraft alongside the updraft
      iii. Dissipating: Strong downdraft embedded within the area of precipitation
         a. Subsiding air replaces the updraft, cutting off the moisture provided by the updraft
   C. Types of Thunderstorms
      i. Single Cell
         a. Consists of only one cell. Single cell thunderstorms are rare; almost all are multicell
      ii. Multicell
         a. Consists of a cluster of cells at various stages of their life cycle
         b. As the first cell matures, it is carried downwind, and a new cell forms upwind to take its place
            - New cells continue to form as long as ingredients exist
         c. A line of thunderstorms can extend laterally for hundreds of miles
            - Often too high to fly over, too long to fly around and too dangerous to fly under
      iii. Supercell
         a. Dangerous convective storm consisting of primarily a single, quasi-steady rotating updraft
         b. Organized internal structure produces especially dangerous weather (updrafts up to 9,000 fpm)
         c. May persist for hours; new cells will continue to form as long as the necessary ingredients exist
   D. Hazards
      i. Lightning, winds/microburst, turbulence, icing, hail, rapid altimeter changes, static electricity, tornado
   E. Microbursts
      i. The most severe type of wind shear; downdrafts up to 6,000 fpm
      ii. Flying through a microburst (depicted below)
         a. Performance increasing headwind, performance-decreasing downdrafts, rapidly increasing tailwind
         b. Airplane may be forced to the ground
      iii. 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. Aviation Weather Handbook (FAA-H-8083-28)



iv. Avoiding Microbursts/Wind Shear
a. Never takeoff or conduct low level 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)

9. Frost & Icing AI.III.C.K3i, AI.III.C.K3k

A. Frost
i. On cool, clear nights, cool ground can cause surrounding air to drop below the dewpoint
a. Moisture condenses on the ground, buildings, and other objects as dew (below freezing = frost)
ii. Dew poses no threat to aircraft, but frost poses a definite flight safety hazard
iii. An aircraft must be thoroughly cleaned and free of frost prior to beginning a flight

B. Types of Icing
i. Rime Icing
a. Rough, milky, opaque ice formed by the instant freezing of small, super cooled water droplets after they strike the aircraft
b. Favors colder temperatures, lower liquid water content and small droplets
ii. Clear Icing
a. A glossy, clear ice formed by slow freezing of large super cooled water droplets (smears as it freezes)
b. Exist in warmer temperatures, higher liquid water contents, and larger droplets
c. More hazardous than rime ice
- It tends to disrupt airflow considerably more than rime icing
- It is clear and more difficult to see and therefore can be difficult to recognize
- It is difficult to remove since it can spread beyond the deice/anti-ice capabilities

iii. Mixed Icing
a. A mixture of clear and rime ice - Poses a similar hazard to an aircraft as clear ice

C. Hazards of Icing
i. Structural icing degrades engine performance
ii. Destroys the smooth flow of air over the wing, increasing drag and decreasing the ability to create lift
iii. Actual weight of ice on an aircraft is insignificant when compared to the airflow disruption it causes

D. Freezing Level
i. Be alert for icing anytime the temperature approaches 0^{o} C and visible moisture is present
ii. When carried above the freezing level, water becomes supercooled
a. Supercooled water freezes on impact with an aircraft
b. The abundance of large, supercooled water droplets makes clear icing very rapid between 0 & -15^{o} C

10. Fog & Mist AI.III.C.K3j

A. Fog

i. Tiny water droplets at the surface that reduce visibility to less than 5/8 statute mile

B. Types of Fog
   i. Radiation Fog
      a. Produced over a land area when radiational cooling reduces the air temperature below its dew point
      b. Factors: Shallow surface layer of moist air beneath a dry layer, clear skies, light surface winds
      c. Ground fog usually burns off rapidly after sunrise. Other radiation fog generally clears before noon
   ii. Mountain/Valley Fog
      a. Ground cools overnight and the denser, cooler mountaintop air sinks into valleys and collects there
      b. Most common in fall and spring, and densest near sunrise when surface temperatures are lowest
   iii. Advection Fog
      a. Moist air moves over a colder surface, cooling the air to below its dew point
         - Most common along coastal areas, but often moves deep in continental areas.
   iv. Upslope Fog
      a. Moist, stable air being adiabatically cooled to or below its dewpoint as it moves up sloping terrain
      b. Wind speeds of 5-15 knots are most favorable
      c. Common along the eastern slopes of the Rockies, and less frequent east of the Appalachians
   v. Frontal Fog
      a. Formation
         - When warm, moist air is lifted over a front, clouds, and precipitation may form
         - If the cold air below is near its dewpoint, evaporation may saturate the cold air and form fog
         - Result is a continuous zone of condensed water droplets from the ground through the clouds
      b. Mostly associated with warm fronts but can occur with others as well.
   vi. Steam Fog
      a. Very cold air moves across relatively warm water, moisture evaporates to produce saturation
         - Rising water vapor meets the cold air & recondenses, rising with air being warmed from below
         - Appears as rising streamers that resemble steam
      b. Often very shallow; expect convective turbulence flying through it
   vii. Freezing Fog
      a. Tiny, supercooled liquid water droplets in fog freeze on exposed surfaces at/below freezing temps

C. Mist
   i. Tiny water droplets reducing visibility to less than 7 SM, but greater than, or equal to, 5/8 SM
   ii. Forms a thin grayish veil covering the landscape
   iii. Intermediate between fog and haze

11. Obstructions to Visibility AI.III.C.K3l

A. Haze
   i. Numerous extremely small particles giving the air an opalescent appearance
   ii. Occurs in stable air and is usually only a few thousand feet thick, but may extend upwards of 15,000’
   iii. Visibility varies greatly depending on whether you’re facing into or away from the sun

B. Smoke
   i. Suspension of small particles in the air produced by fires, industrial burning, etc.
   ii. Can reduce visibility to zero and contains many highly toxic compounds, like carbon monoxide (CO)
   iii. Must be dispersed by movement of air

C. Volcanic Ash
   i. Made up of fine particles of rock powder from a volcano (ash is composed of silica (glass))
   ii. Ash may not be visible at night or in IMC, even if visible, it’s hard to distinguish from ordinary clouds
   iii. Very hazardous to aircraft
      a. Piston aircraft: May not lose power, but severe engine damage is likely

        b. Causes abrasive damage
    D. Blowing Snow
        i. Snow lifted from the surface by the wind to a height of 6’ or more; Reduces visibility to less than 7 SM
        ii. Whiteout: Strong winds keep snow suspended up to 50’, obscuring the sky and reducing visibility to zero
        iii. Visibility improves rapidly when the wind subsides
    E. Dust Storms, Sandstorms, & Haboob
        i. Dust Storms
            a. Originate over regions when fine-grained soils, rich in clay and silt, are exposed to strong winds
                - Most common in the Southwest US
            b. Reduce visibility to near zero
            c. Creation & Dissipation
                - Extreme heating of barren ground + turbulent unstable air mass
                    a Surface winds 15 knots or greater (35 knots over desert rock fragments)
                    b Average height is 3,000 to 6,000’, but can reach up to 15,000’
                - Strong cooling after sunset settles the dust (temperature inversion)
            d. Hazards
                - Visibility can drop to zero in a matter of seconds
                - Dust can clog intakes, damage systems, and affect human health
                - Slant range visibility is greatly reduced compared to report surface visibility
        ii. Sandstorms
            a. Particles of sand carried aloft by a strong wind
            b. Like dust storms but on a more localized level since the sand particles are heavier (10’ to 50’ AGL)
        iii. Haboob
            a. Dust storm that forms as cold downdrafts from a thunderstorm lift dust and sand into the air
            b. Often short lived, but can be intense

12. 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

13. Weather Information Sources AI.III.C.K1
    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
        iv. AIM 7-1-2-C: Pilots can receive a regulatory compliant briefing without contacting flight service
            AC 91-92 – Pilot’s Guide to a Preflight Briefing
    C. RM: 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)

14. Weather Reports and Charts AI.III.C.K2a, AI.III.C.K2c, AI.III.C.K2d
    A. METAR, RAF, & 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. Model Output Statistics (MOS)

Note: Not required by the ACS, but if used during the checkride, the examiner may ask about it

i. What is it?
a. Takes weather models and applies statistics/historical observations to produce a specific forecast
b. Completely automated
c. Temp, chance and type of precipitation/thunderstorms, cloud cover and height, wind speed and direction at specific points across the country

ii. Uses: Better weather picture for aviation planning purposes

iii. Limitations
a. Not a legal weather source
b. Cannot forecast
- Multiple cloud layers, Forecast showers or fog in the vicinity, Precipitation intensity, Non-convective LLWS, No significant weather, Variable winds

c. Precipitation discrimination
d. Currently only in the US

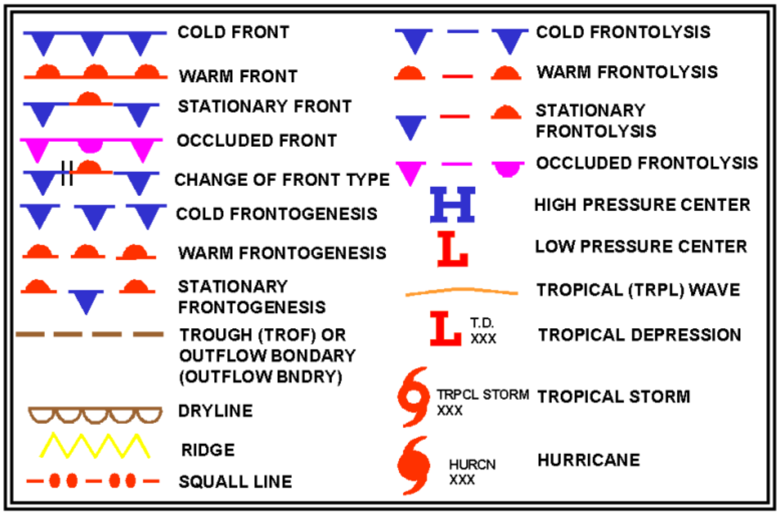
iv. Where to find it
a. ForeFlight – Airport weather tab
b. NWS MOS Text Bulletins
c. Raw MOS data breakdown: JetStream Max: MOS

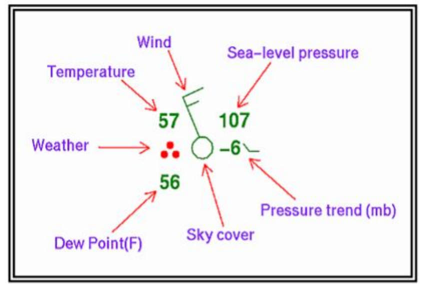
C. Surface Analysis Chart AI.III.C.K2b

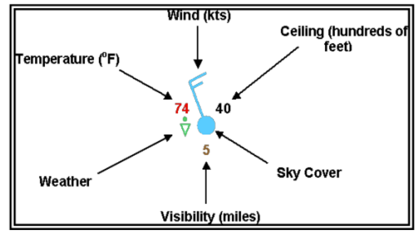
i. Depicts surface weather covering contiguous 48 states
a. Pressure, fronts, temps, dewpoints, wind direction/speed, local weather, visual obstructions

ii. Computer prepared report transmitted every 3 hours covering contiguous 48 states/adjacent areas

iii. Chart Symbols







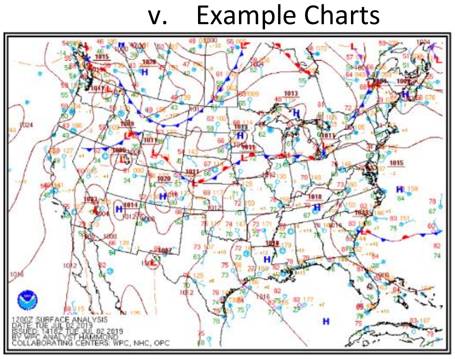
a. Additional chart symbols & explanations in the PowerPoint & full CFI lessons

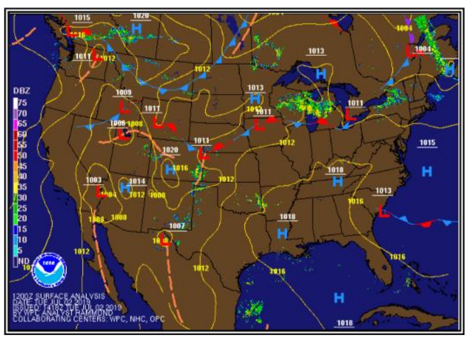
iv. Surface weather observations for reporting points across the US can be depicted

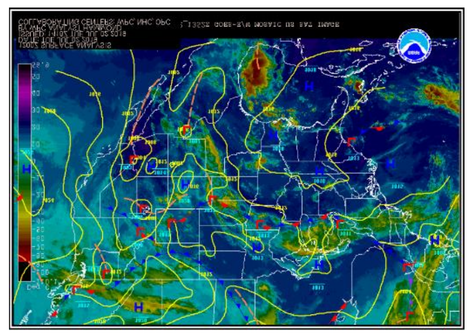
a. Each reporting point is illustrated by a station model (NWS Plot Model is pictured top right, NWS aviation model pictured bottom right). A station model will include:

- Type of Observation, Sky Cover, Clouds, Sea Level Pressure (SLP), Pressure Change/Tendency, Precipitation, Dewpoint, Present Weather, Temperature, Wind

v. Example Charts







a. Left: Surface analysis with surface observations, Center: Surface analysis with radar composite, Right: Surface analysis with satellite composite

D. Ceiling & Visibility Chart (CVA) AI.III.C.K2b

i. https://aviationweather.gov/gfa/#cigvis

ii. Use the Ceiling, Visibility, or Flight Category drop down for a large-scale overview of ceiling/visibility info

a. Drop down at top right (icon depicted to the right)

b. Use the legend icon at the bottom right to view color meanings

iii. Combines satellite & surface observations to show ceiling & visibility conditions across the US

a. Used for big picture planning and to avoid hazardous ceiling and visibility conditions

E. Winds and Temperatures Aloft Chart (FB) AI.III.C.K2e

i. Provide wind and temperature forecasts for specific locations twice a day (0Z/12Z)

ii. Wind

a. Direction = true north; Speed = knots (No forecasts within 1,500’ of station elevation)

b. 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

F. Convective Outlook Chart AI.III.C.K2f

i. Overview

a. Depicts areas forecast to have severe and non-severe (general) convection over 8 days

b. 4 charts: Day 1, Day 2, Day 3, Days 4-8

c. Aviation Weather Convective Outlook Chart

ii. 5 Levels of Risk (Day 1-3 Charts)

a. 5 levels of risk + thunderstorm coverage & intensity of severe weather

- General (TSTM)
- Marginal (MRGL), Slight (SLGT), Enhanced (ENH), Moderate (MDT), High (HIGH)
- Days 1 & 2: Also contain individual severe probabilities for tornados, wind, and/or hail
- Day 3: Combined probability of all 3 types of severe weather

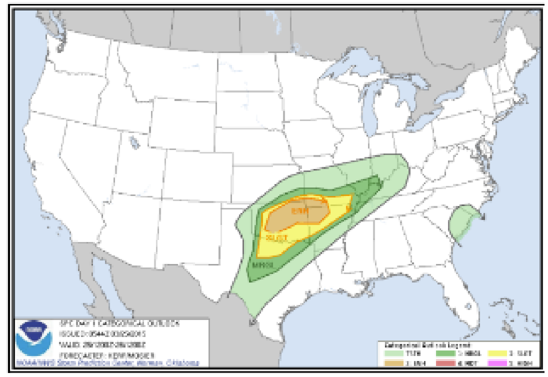


Figure 5-23. Categorical Outlook Legend for Days 1-3 Convective Outlook Graphic Example

b. Graphic Probability Requirements (probabilities are within 25 miles of any point)

c. Day 4-8 Chart

- Two thresholds of 15% and 30% can be forecast (equivalent to slight and enhanced)
  - a If no 15% areas forecast, you'll see Predictability too low, or Potential too low

15. RM: In-Flight Weather Advisories AI.III.C.K2g, AI.III.C.R1c

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. Center Weather Advisory (CWA)

i. Unscheduled inflight, flow control, air traffic, and air crew advisory

ii. Produced for weather beginning in the next 2 hours, and will be issued:

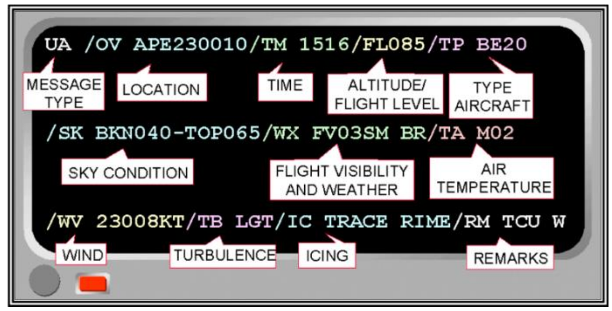
a. As a supplement to existing SIGMENT, Convective SIGMENT or AIRMET

b. When an inflight advisory has not been issued but weather conditions meet SIGMET/AIRMET criteria based on pilot reports & reinforced by other meteorological conditions

c. When observed or developing weather does not meet SIGMET, Convective SIGMET, or AIRMET criteria but pilot reports indicate the weather will adversely affect safe flow of air traffic

F. Inflight Weather Advisory Broadcasts
   i. ARTCCs broadcast Convective SIGMET, SIGMENT, or CWAs once on all frequencies (not emergency) when any part of the area described is within 150 miles of their airspace

G. PIREPS – Pilot generated report concerning meteorological phenomena encountered in flight
   i. Required Elements: Type, location, time, altitude, aircraft type, and at least 1 describing element
   ii. Urgent PIREP (UUA): Issued for tornados, severe/extreme turbulence, severe icing, hail, LLWS within 2,000' of the surface, volcanic ash, or any other phenomena considered to be hazardous
   iii. Route PIRPER (UA): Issued based on pilot reports that do not contain urgent information



H. Other Inflight Weather Information
   i. Contact the nearest FSS to obtain an update to a previous briefing by radio
      a. Enroute advisories tailored to the phase of flight are available on request
   ii. RM: Onboard Weather Equipment — AI.III.C.K4, AI.III.C.R2a
      a. Understand the operation and limitations of any onboard equipment
      b. ADS-B (Automatic Dependent Surveillance-Broadcast)
         - Free weather information on receivers that can receive the data
      c. FIS-B (Flight Information Services-Broadcast)
         - Free weather information on receivers that can receive the data
         - Wide range of weather products with national & regional focus
      d. Satellite weather

16. RM: Go/No Go Decision — AI.III.C.R1

A. Consider weather factors, aircraft, and equipment to be used, as well as yourself (PAVE checklist)
B. Set personal weather minimums and don't bend them — AI.III.C.R1b, AI.III.C.R1c
C. Recent Experience: Ensure currency AND proficiency; don't go beyond your abilities or the aircraft's abilities
D. Recognizing Weather Hazards
   i. Interpretation of aviation weather charts, reports, etc.
      a. Preflight planning alerts the pilot to potential hazards
   ii. Enroute updates and inflight reports alerts the pilot to changing conditions
      a. PIREPs, SIGMETs, METARs, LLWAS, ATC information/advice, weather tools (satellite, FIS-B), etc.
   iii. Visual indications: Cloud formations, vertical development, strong wind, etc.
E. Continual process of decision making — AI.III.C.R1a
   i. Don't be afraid to discontinue the flight or divert, if necessary
   ii. Reduced visibility (temp/dewpoint), hazardous weather (storms, icing, turbulence, etc.), PIREPs, conditions dropping below your personal minimums, etc. may lead to the decision to divert

RM: Use & limitations of aviation weather reports and forecasts — AI.III.C.R2b
   The lesson as a whole is a discussion of these concepts

Conclusion:
Brief review of the main points

MANEUVER TO BE PERFORMED IN FLIGHT

IV.A. Maneuver Lesson

The evaluator asks the applicant to present a preflight lesson on the selected maneuver as the lesson would be taught to a learner and determines the outcome of this Task before the flight portion of the practical test. Previously developed lesson plans from the instructor applicant's library may be used.

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

ACS Requirements:

The applicant demonstrates instructional knowledge by describing and explaining:

1. Purpose of the maneuver.
2. Elements of the maneuvers and the associated common errors.
3. Desired outcome(s), including completion standards.

Deliver instruction on the selected maneuver using a lesson plan, teaching methods, and teaching aids, as appropriate.

PREFLIGHT PROCEDURES

V.A. Preflight Assessment

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

Objectives	The learner should develop knowledge of the elements related to a comprehensive preflight inspection. The learner will understand what to look for during each part of the inspection and can perform the preflight inspection as required by the checklist and the ACS.
Key Elements	1. Aircraft Specific Checklist 2. Airworthy and Safe 3. Fuel Grade and Contamination 4. *Oil Level (4-6 Quarts)
Elements	1. Big Picture Preflight 2. Preflight Inspection 3. Loading and Securing 4. 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 learner can perform a comprehensive preflight inspection, understanding what to look for at each part of the inspection. The learner will be able to determine whether the airplane is airworthy and in a condition for safe flight.

Instructor Notes:

Introduction:

Attention

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

The preflight inspection is 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 which determines the airplane is legally airworthy, and that it is in a condition for safe flight.

How:

1. **RM: Big Picture Preflight** (PAVE Checklist) AI.V.A.K1, AI.V.A.R1
   - A. Pilot
     - i. IMSAFE
   - B. Aircraft AI.V.A.R2
     - i. Required documents/inspection, preflight checklist
     - ii. Equipment and systems operation
     - iii. Proper loading (baggage, fuel, people, weight & balance)
     - iv. Performance capabilities
   - C. enVironment AI.V.A.K4, AI.V.A.R3
     - i. Current and anticipated weather versus planned weather
     - ii. Terrain requirements; Day vs night
     - iii. Departure, route, destination, alternate(s) (weather, terrain, airspace, TFRs, NOTAMs)
     - iv. RM: Aviation security concerns - Congressional Research Service: Securing General Aviation AI.V.A.R5
       - a. Threats
         - Terrorists seek to exploit GA assets to attack critical infrastructure/high profile targets
         - Terrorists may exploit GA to gain knowledge and/or access to the US airspace system
       - b. Vulnerabilities
         - Minimal to nonexistent security at many small GA airports
         - Unattended airports
       - c. Mitigating GA Security Risks
         - Airport watch program: Like a neighborhood watch; be alert
           - a Report suspicious activity (1-866-GA SECURE)
           - b Call 911 if there is an immediate threat
         - Limit airport access when able
         - Flights School Specific
           - a TSA computer-based flight school security awareness training program
           - b Background checks for prospective employees

c Formal written security procedures for employees and customers
d Display of employee identification
e Limit access to aircraft and their keys to authorized personnel

D. External Pressures AI.V.A.R4
  i. Based on the particular flight
  ii. Stick to your standards and personal minimums – assess and attempt to mitigate risk

2. Preflight Inspection

A. Preflight Checklist
  i. Ensures the airplane meets airworthiness standards and is in a safe condition prior to flight
  ii. The POH must be the reference for the preflight inspection (Chapter 4)
    a. Always have a checklist on hand as a reference to ensure everything is checked
  iii. CE: Failure to use, or the improper use, of a checklist
  iv. CE: Hazards which may result from distractions interrupting an inspection

B. Inspection Overview
  i. The preflight logically moves around the airplane to ensure it is in a condition for safe flight
  ii. Begins while approaching the airplane on the ramp – Note the overall appearance / any issues

C. What to Inspect AI.V.A.K3a, AI.V.A.K3b
  i. Inside the Flight deck
    a. Airworthiness - Required Documents (AROW)
    b. Logbooks – Ensure tests / inspections complied with (may not be kept in the flight deck) AI.V.A.K3d
    c. Items located inside the airplane / items controlled inside the plane (lights, pitot heat, etc.)
  ii. Exterior of the Airplane
    a. Follow the checklist and inspect all exterior portions of the airplane
    b. CE: Inability to recognize discrepancies to determine airworthiness

D. Detecting Problems AI.V.A.K3c
  i. Visible Structural Damage (follow the POH procedures and inspection requirements)
    a. Check for dents, cracks, bending, separating, etc.
    b. Check for leaks/stains as they are signs of potential problems
    c. Look for missing rivets, bolts, etc.
    d. Inspect the propeller for damage including nicks and cracking
  ii. Flight Controls
    a. Move freely/correctly and are properly attached
    b. Check the flap movement and connections
  iii. Fuel Quantity and Contamination
    a. Confirm the fuel quantity indicated on the gauge
    b. Contamination
      - Type, Grade of Fuel – Critical to safe flight (100LL (AVGAS) – Blue with a familiar gasoline scent)
        a 80 is Red; 100LL is Blue; 100 is Green; Jet Fuel is Clear (kerosene scent)
      - Water and Other Sediment
        a Water is heavier than fuel and therefore accumulates in the low points
        b Sediment can come from dust/dirt entering the tanks
      - Check the grade and remove water and other contamination
  iv. Oil Quantity and Contamination
    a. Verify the oil is at an acceptable amount
      - Check the oil when the engine is cold (proper reading, oil is settled at the bottom)
    b. Contamination can be detected by discoloration
      - Oil darkens as operating hours increase; rapidly dark oil may point to cylinder problems
  v. CE: Failure to ensure servicing with the proper fuel and oil

   vi. Leaks (Fuel, Oil, Hydraulic) – verify no leaks under the plane, in the cowling, on the struts, etc.
   E. Ice and Frost
      i. Small amounts of ice/frost can disrupt the airflow over the wing, increase stall speed, and reduce lift
      ii. Do not fly unless the ice/frost is removed in accordance with the requirements in the POH

3. **Loading and Securing**
   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. CE: Failure to ensure proper loading / securing of baggage, cargo, and equipment
4. **Determining the Airplane is Safe** AI.V.A.K2
   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. For inoperative equipment, follow the procedures in III.B. Airworthiness Requirements and 91.213(d)
   D. 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. Flight Deck Management

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

Objectives	The learner should develop knowledge of the elements related to flight deck management. The learner should maintain an organized flight deck and properly position all controls for correct use. All equipment should be fully understood to assist in utilizing all possible resources.
Key Elements	1. Good Housekeeping 2. Passenger Briefings 3. Internal and External Resources
Elements	1. Occupant Briefing 2. Arranging & Securing 3. Seat Position & Controls 4. Navigation Data Currency 5. Checklists Usage 6. Inoperative Equipment 7. Resource Utilization 8. Aviate, Navigate, Communicate 9. Case Study: Eastern 401
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 efficiently and safely complete a flight as described in flight deck 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

Flight deck 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 flight deck management (single pilot resource management) provides for a considerably more efficient and safer flight.

How:

1. **Occupant Briefing** (SAFETY) AI.V.B.K1
   A. **S**: Seat Belts, Should harnesses, Seat positioned & locked
      i. FAR 91.107 – Must brief passengers on how to fasten & unfasten their safety belt/shoulder harness
         a. Seat belts required for taxi, takeoff, and landing; Shoulder harness required for takeoff and landing
   B. **A:** Air vents, All environmental controls, Action in case of discomfort
   C. **F**: Fire extinguisher location & operation
   D. **E**: Exit doors operation, Emergency evacuation plan, Emergency/survival kit location & contents
   E. **T**: Traffic (scanning, spotting, notifying pilot), Talking (sterile flick deck expectations)
   F. **Y**: Your Questions?
   G. For more details, see the FAASafety Passenger Briefing Card
2. **Arranging & Securing** AI.V.B.K4
   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. CE: Failure to place / secure essential materials and equipment for easy access during flight
3. **Seat Position & Controls**
   A. 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
   B. Seats
      i. On each flight, the pilot should be seated in the same position. Verify the seat is locked in position
   C. Rudder Pedals
      i. Adjust the rudder pedals forward or backward ensuring full/comfortable range of motion
   D. CE: Failure to properly adjust flight deck items, like safety belts, harnesses, rudder pedals, seat

E. CE: Failure to provide proper adjustment of equipment and controls

4. Navigation Data Currency AI.V.B.K3

A. Charts
  i. FAR 91.103 requires each PIC to become familiar with all available information concerning that flight
    a. Although it doesn't specifically require it, you should always carry current charts
  ii. Information changes rapidly, out of date charts may be missing crucial information
  iii. To confirm currency, refer to the next scheduled edition date printed on the cover
    a. Use Dates of Latest Editions & check NOTAMs and Safety Alerts and Charting Notices for changes

B. Database Currency
  i. AIM 1-1-17b1(c)(2) Database Currency: Databases must be updated for IFR operations
    a. Databases should be updated for all other operations
    b. No such requirement for databases to up updated for VFR navigation, however it is always a good idea

C. Violations
  i. It is not FAA policy to initiate enforcement action against a pilot for having an old chart or no chart, or for having an expired navigation database
  ii. However, if a pilot is involved in an investigation and there's evidence an out-of-date chart/database (or no chart) contributed to the situation, that information could be used in any enforcement action

5. Checklist Usage AI.V.B.K2

A. Ensure the proper and orderly use of the manufacturer's checklist
  i. Ensures every item is completed and checked in a logical order
  ii. Don't go on memory, always backup your actions with a checklist

6. RM: Inoperative Equipment AI.V.B.R2

A. On the Ground
  i. Perform a thorough preflight
  ii. Follow FAR 91.213(d) procedures to defer & placard equipment as inoperative
    a. See III.B. Airworthiness Requirements
  iii. Consider the effects the inoperative equipment will have on the flight
    a. Set and follow personal equipment minimums – just because it's legal, doesn't mean it's safe

B. Airborne
  i. If equipment becomes inoperative, a decision must be made to continue or divert
  ii. Considerations
    a. Would the equipment prevent flying if it happened on the ground? FAR 91.213(d)
    b. How does it affect the remainder of the flight or personal minimums?
    c. Other thoughts based on the situation

7. Resource Utilization

A. Resources can be found both inside and outside the flight deck. 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
  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. CE: Failure to utilize all resources required to operate a flight safely

8. **RM: Aviate, Navigate, Communicate**
   A. Distractions
      i. RM: Passengers Distractions AI.V.B.R3
         a. Use the preflight briefing as an opportunity to explain passenger expectations, sterile cockpit, etc.
         b. If a passenger is distracting, explain the situation to them, and ask them to stop
      ii. Other Distractions: They're dangerous, remove them from your view
   B. RM: Automation & PEDs (RM: Use of systems or equipment, including automation & PEDs) AI.V.B.R1
      i. Ensure understanding of equipment, systems, automation, electronic devices
         a. Great tools for SA and reduced workload, but a lack of understanding can quickly distract from flying
      ii. Over reliance on automation & technology creates an environment where basic airmanship skills are eroded
         a. Understand their operation, use them, but be able to fly proficiently/safely without them
9. **Case Study: Eastern 401**
   A. Multi-pilot airplanes have crashed due to minor distractions
   B. Eastern Airlines 401 crashed while preoccupied with a bulb and the pilots didn't realize the autopilot turned off
      i. YouTube Video (15 mins)
      ii. FAA Lessons Learned: Accident Board Findings & Key Safety Issues
      iii. Risk Management Concepts
         a. Excess of technology, loss of SA, distractions, systems understanding & malfunctions, task prioritization
         b. Discuss ways to mitigate these risks
   C. Extremely important in a single pilot aircraft that you divide attention, avoid distraction, and maintain SA

Conclusion:
Brief review of the main points

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 learner should develop knowledge of the elements related to engine starting as required in the ACS.
Key Elements	1. Checklist 2. Safety 3. Hand on the Throttle
Elements	1. POH Checklists 2. Safety Precautions 3. Normal Start Checklist 4. Atmospheric Conditions 5. Starting with External Power 6. 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 learner 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 reasons.

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. **POH Checklists**
   - A. Always use Manufacturer Checklists
     - i. Ensures every item is completed and checked in a logical order
   - B. RM: Engine Starting Limitations — AI.V.C.K3, AI.V.C.R3
     - i. Review associated engine start limitations in the POH
2. **RM: Safety Precautions** (RM: Propeller Safety) — AI.V.C.R1
   - A. Set the parking brake and/or hold the toe brakes (look outside to verify you're not moving)
   - B. 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
   - C. Anti-collision lights should be turned on prior to any start, at night use position lights too
   - D. Always call "CLEAR" out of the side window and wait for a response
   - E. When activating the starter, the wheel brakes must be depressed and/or parking bake set (check POH)
   - F. Engine Controls During Start
     - i. Always keep one hand on the throttle
       - a. After the engine is started, set the throttle and other controls as specified in the POH
     - ii. Monitor oil pressure after engine start
       - a. In most conditions, oil pressure should reach at least the lower limit within 30 seconds
       - b. If oil pressure does not rise to the POH values in the specified time, shutdown the engine
     - iii. Avoid excessive engine RPM and temperatures
       - a. Monitor the instruments and use the checklist if engine temperature begins to rise abnormally
     - iv. CE: Improper adjustment of engine controls during start
   - G. CE: Failure to use safety precautions related to starting, and ensure clearance of the prop
3. **Normal Start Checklist**
   - A. Review the normal start checklist in the POH
4. **Atmospheric Conditions** — AI.V.C.K1
   - 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
iv. Review Cold Weather Engine Starting checklist(s) and procedures
B. Hot Weather
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
iii. Review Hot Weather Engine Starting checklist(s) and procedures

5. *Starting with External Power (Supplement 1 in POH) AI.V.C.K2, AI.V.C.R2
A. RM: Ensure proper use and understanding of the external power unit
i. Follow steps in the owner's manual
ii. Besides not being able to start the plane, there is the risk of damaging the unit or aircraft systems
B. Follow the procedures prescribed in the POH
C. Be extremely cautious of people and equipment near the propeller during engine start (have a plan)

6. RM: Hand Propping Safety (RM: Propeller Safety) AI.V.C.R1
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. CE: Failure to use safety precautions related to starting
E. CE: 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, Airport Signs, & Lighting

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

Objectives	The learner should develop knowledge of the elements related to taxiing an airplane as required in the ACS.
Key Elements	1. Fast Walk 2. Crosswind Corrections 3. Taxi Diagram
Elements	1. Taxi Instructions 2. Plan, Brief, Review 3. Appropriate Flight Deck Activities 4. Taxiing 5. Wind Corrections 6. Night Operations 7. Low Visibility 8. Runway Incursions 9. Airport Markings 10. Airport Signs 11. Airport Lighting & 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 learner can safely maintain positive control of the airplane with the proper crosswind corrections. The learner 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 some 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. **Taxi Instructions** AI.V.D.K3
   - A. Communicating with ATC (Big Picture)
     - i. Always use standard ATC phraseology to facilitate clear and concise communication
     - ii. When making initial contact, state who you are, where you are on the airport, what you want
     - iii. Focus on the ATC clearance
       - a. Don't perform any nonessential tasks while communicating with ATC
       - b. RM: Eliminate expectation bias AI.V.D.R2
     - iv. Read back all clearances and verify the route/clearance on the taxi diagram
   - B. Controlled Airports (AIM 4-3-18 Taxiing) AI.V.D.K7b
     - i. Clearance is required:
       - a. To taxi onto the movement area
       - b. To taxi on a runway, take off, or land when an ATC tower is in operation
       - c. Prior to crossing any runway (ATC will issue an explicit clearance for *all* runway crossings)
     - ii. Prior to entering the movement area, contact Ground control for a taxi clearance
       - a. Frequencies & Procedures
         - Reference the Chart Supplement, Airport Diagram, and check NOTAMs for changes, closures, etc.
       - b. Taxi Request
         - Aircraft identification, location, type of operation (VFR/IFR), first point of intended landing
     - iii. When assigned a takeoff runway, ground will:
         - Specify the runway (or point to taxi to)
         - Issue taxi instructions
         - State any hold short instructions or runway crossing clearances
     - iv. After taxi instructions are received, always read back:
       - a. Runway assignment
       - b. Any clearance to enter a specific runway
       - c. Any instruction to hold short of a specific runway or line up and wait
         - Controllers are required to request readback of hold short instructions if not received
   - C. Uncontrolled Airports AI.V.D.K7b

- i. Planning
  - a. Be familiar with the local procedures, runway use, traffic pattern direction and altitude
  - b. Be alert, communicate intentions on the CTAF and listen for other aircraft
- ii. Communication
  - a. Monitor/communicate on the CTAF from engine start, taxi, and until 10 miles from the airport
  - b. Announce location and intentions on the CTAF
- iii. Maintain situational awareness

2. Plan, Brief, Review AI.V.D.K7a

- A. Route Planning
  - i. Current References: Review the Chart Supplement & airport diagram AI.V.D.K2
  - ii. Review any pre-designated, or standard, taxi routes
  - iii. Review NOTAMs, expected route(s), hot spots, etc.
- B. Taxi Brief
  - i. Can combine with the Passenger Brief, if not already completed
    - a. SAFETY brief (FAASafety Passenger Briefing Card)
      - Described in V.B. Flight Deck Management
  - ii. Technical
    - a. Expected departure runway and route, and overall plan
    - b. Critical locations (abnormalities, hot spots, taxiway/runway closures, NOTAMs, etc.)
    - c. Any other pertinent information
- C. Record & Review
  - i. Always write down ATC taxi instructions to prevent mistakes
  - ii. Review the route given by ATC, ask for help in case of confusion
  - iii. Benefits
    - a. Prevents mistakes and forgetfulness
    - b. RM: Combats expectation bias AI.V.D.R2
    - c. Increases SA
    - d. Clear up confusions/questions prior to moving
    - e. Operate with your head up/eyes outside to the max extent

3. RM: Appropriate Flight Deck Activities (RM: Activities & Distractions) AI.V.D.K7a, AI.V.D.R1

- A. For safety reasons the pilot's workload should be at a minimum during taxi operations
  - i. Complete pre-taxi checklists and data entry *prior* to taxi
  - ii. All heads down activities should be accomplished when the aircraft is stopped
- B. A sterile flight deck should be implemented from taxi through climb to focus on taxiing/ATC instruction
  - i. Remove distractions from view (explain the situation to a person, and ask them to stop)
- C. Taxiing Near Other Aircraft
  - i. Use a "continuous loop" process to monitor and update their progress and location in relation to you
  - ii. Awareness is enhanced by understanding the clearance issued to other pilots/aircraft and vehicles

4. Taxiing

- A. Basics
  - i. Steering is accomplished with the rudder pedals and brakes
    - a. To turn, apply rudder in the desired direction; inside brake can also be applied to tighten the turn
    - b. Rudder should be held until just short of the point where the turn is to be stopped
      - Pressure is then released, or opposite pressure is applied to maintain centerline
  - ii. Brakes are used to stop, slow, or aid in making a turn and should be applied smoothly and evenly
  - iii. Speed: Taxi at the speed of a fast walk
    - a. Controlled 1st with power and 2nd with brake pressure - Don't ride the brakes
    - b. CE: Improper use of brakes

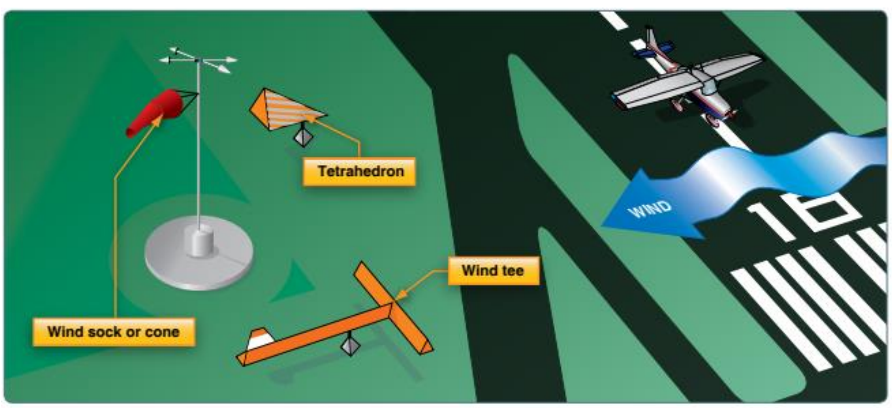
c.
iv. Centerline: Describe site picture for specific aircraft
v. When stopping, stop with the nose wheel straight to prevent side loading and to make moving again easier
vi. CE: Hazards of taxiing too fast

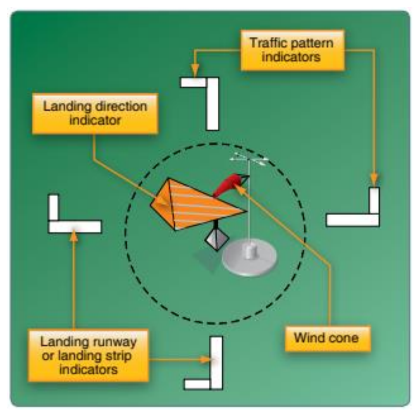
B. Taxi Checks
   i. Obtain taxi clearance and review and brief the route
   ii. Test the brakes for proper operation as soon as the airplane is put in motion
   iii. Apply taxi basics and appropriate flight deck activities
   iv. Taxi Check
      a. Attitude Indicator - No more than 5° of pitch or bank indicated
      b. Turn and Slip Indicator - Wings move with the turn/Ball opposite the turn/Inclinometer is full of fluid
      c. Magnetic compass and heading indicator are moving toward known headings (no cracks, leaks, bubbles)

C. Aircraft Lighting AI.V.D.K6
   i. Engines Running: Rotating beacon on
   ii. Taxiing: Prior to commencing taxi, turn on navigation, position, and anti-collision lights
      a. Turn on the taxi light when moving or intending to move on the ground
      b. Turn it off when stopped or yielding
      c. Strobe lights 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/Line Up and Wait: Turn on all lights, except for landing lights
   v. Takeoff: Landing lights on when takeoff clearance is received or when commencing takeoff roll

5. Wind Corrections AI.V.D.K5

A. Recognizing Wind Direction
   i. ATIS, ATC, FSS can provide wind direction
   ii. Wind Indicators
      a. Windsock or Cone: Wind direction is opposite the direction the sock is pointing
      b. Tetrahedron & Wind Tee: Move freely and align with the wind direction
      c. Generally, located in a central location near the runway

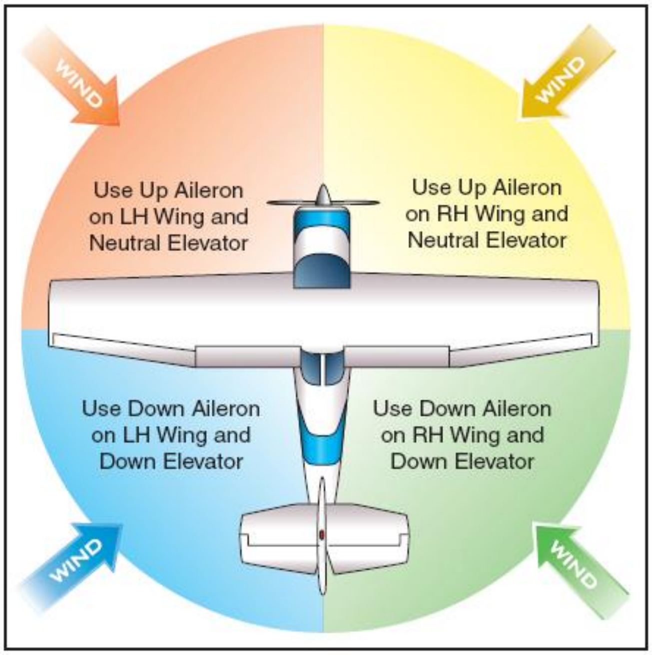


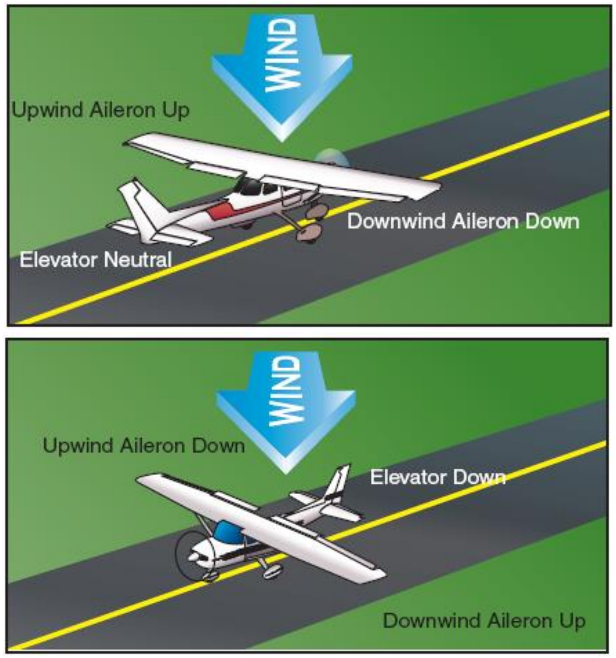


   iii. Use the heading indicator/heading bug to visualize wind in relation to the airplane

B. Quartering headwind: Ailerons turned into the wind and the elevator is held neutral

C. Quartering Tailwind: Flight controls are positioned to dive with the wind (tailwind requires less power)





6. **Night Operations** AI.V.D.K7d
   A. Exterior aircraft lights may be used to make an aircraft on the airport surface easier to see AI.V.D.K6
      i. On the Runway at Night: Line up slightly (3') off centerline to differentiate you from the runway lights
   B. Be more cautious at night
      i. Reduced visibility makes taxiing more difficult
      ii. Taxi slower
7. **Low Visibility** (AIM 4-3-19) AI.V.D.K7e
   A. Focus entire attention on the safe operation of the aircraft while it is moving
      i. Taxi slowly with focus outside
      ii. Sterile flight deck
      iii. Withold checklists and nonessential communication until stopped with the brakes set
   B. Notify the controller of difficulties or at the first indication of becoming disoriented
8. **RM: Runway Incursions** AI.V.D.R4
   A. Taxi First: Sterile flight deck, eyes outside, stop in the case of an emergency
      i. Sterile flight deck
      ii. If a checklist needs to be completed, or attention needs to be diverted from taxiing, wait until stopped
      iii. 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
      ii. Build a mental picture of other traffic on the airport
   C. Communication Matters
      i. Write down complex instructions, especially at unfamiliar airports
      ii. Read back all runway/taxiway crossing and hold instructions using proper phraseology/good discipline
   D. Be Conservative
      i. Taxi at a safe speed (fast walk)
   E. RM: Route and/or Runway Change AI.V.D.R3
      i. Ask for a safe place to stop, if necessary

    ii. Copy the new taxi instructions and review the route
    iii. Request progressive, if necessary
  F. Entering/Crossing Runways AI.V.D.K7c
    i. A specific clearance is required to cross all runways
    ii. Hold Lines
      a. Approaching from the dashed side, cross (no clearance necessary) and stop fully passed the solid lines
      b. Approaching from the solid side, do not cross without a clearance
      c. Prior to crossing hold lines, clear both directions (approach path & runway surface)
    iii. Lights on, as discussed
  G. Landing and Rollout
    i. Brief the landing/rollout plan
    ii. After landing, ensure that the entire aircraft, has crossed the landing runway's hold short line
    iii. If stopped between parallel runways, only cross when cleared to cross

9. Airport Markings AI.V.D.K4

  A. Runway Markings
    i. There are three types of markings for runways:
      a. Visual; Nonprecision Instrument; Precision Instrument
    ii. Diagram Notes
      a. Note 1: Required on runways serving category C & D aircraft, and for runways intended for international commercial air transport
      b. Note 2: Required on 4,200' or longer runways serving categories C & D airplanes
      c. Note 3: Required on 4,200' or longer instrumented runways
      d. Note 4: Used when the full runway pavement width may not be available for use as a runway

Runway Surface Marking Scheme	Threshold Approach Category		
	Visual Approach	Non-precision Approach (Approaches with vertical guidance not lower than 0.75 statute mile visibility)	Precision Approach (Approaches with vertical guidance lower than 0.75 statute mile visibility)
Runway diagram			
Landing Designator	Required	Required	Required
Centerline	Required	Required	Required
Threshold	Note 1	Required	Required
Aiming Point	Note 2	Note 3	Required
Touchdown Zone	(not applicable)	(not applicable)	Required
Edge Markings	Note 4	Note 4	Required

  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

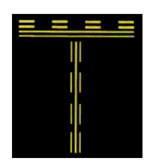
G. Runway Shoulder Markings
   i. Purpose - Identify pavement areas not intended for aircraft use
   ii. Markings - Yellow stripes

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

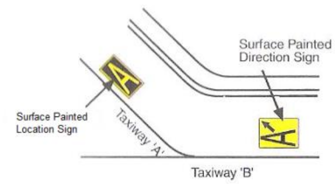
Runway Width	Stripes
60 feet	4
75 feet	6
100 feet	8
150 feet	12
200 feet	16

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)

J. Taxiway Markings
   i. General
      a. Taxiways should have centerline/runway holding position markings whenever intersecting a runway
      b. Edge markings separate the taxiway from areas not for aircraft use or define taxiway edges
   ii. Taxiway Centerline Markings
      a. Normal Centerline
         - Purpose - Provide a visual cue to permit taxiing along a designated path
         - Markings - A single continuous yellow line that is 6" - 12" wide
      b. Enhanced Centerline
         - Purpose - Same as above but at larger commercial airports to warn that a runway hold position marking is being approached
         - Markings - Parallel line of yellow dashes on both sides of the taxiway centerline



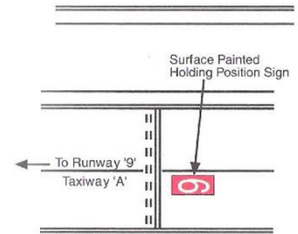
   iii. Taxiway Edge Markings
      a. Purpose - Defines the edge of the taxiway (usually when edge doesn't match up with pavement)
      b. Continuous Markings
         - Purpose - Define the taxiway edge from the shoulder/paved surface not for use by aircraft



- Markings - Continuous double yellow line

c. Dashed Markings
   - Purpose - Define the taxiway edge when adjoining pavement is intended for aircraft (apron)
   - Markings - Broken double yellow line

iv. Taxi Shoulder Markings
   a. Purpose - Shoulders prevent erosion but they may not support aircraft
   b. Markings - Taxiway edge markings will usually define this area



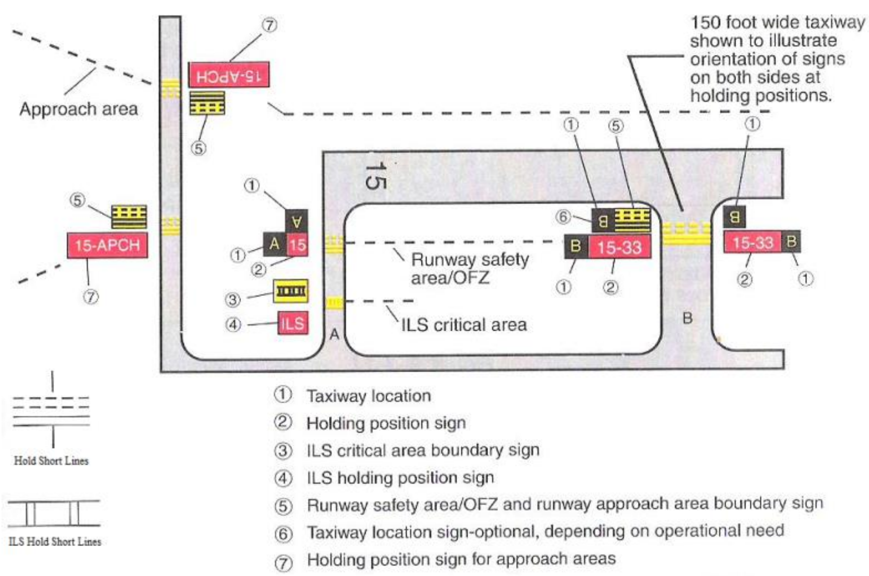
v. Surface Painted Taxiway Direction Signs
   a. Purpose - When it isn't possible to offer direction signs at intersections, or to supplement such signs
   b. Markings - Surface painted location signs with a yellow background and black inscription

vi. Surface Painted Location Signs
   a. Purpose - Location signs assisting in confirming the taxiway
   b. Markings - Black background with a yellow inscription

vii. Geographic Position Markings
   a. Purpose - Identifies aircraft location during low visibility operations
   b. Markings - Left of the taxiway centerline in the direction of taxiing
      - A circle with an outer black ring, inner white ring, and a pink circle

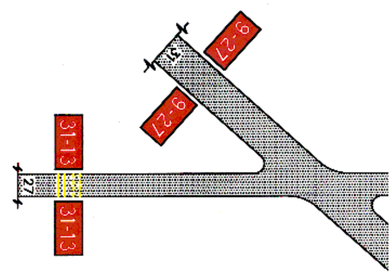
viii. When on dark pavements the white/black ring are reversed

K. Holding Position Markings

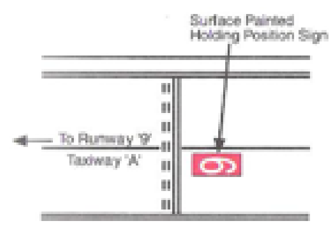


i. General
   a. Show where an aircraft is supposed to stop when approaching a runway (hold on the solid side)
   b. 4 yellow lines (2 solid / 2 dashed) across the width of the taxiway / runway / approach area

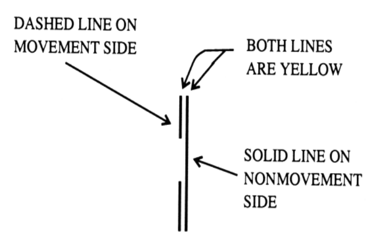
ii. Runway Holding Position Markings on Taxiways
   a. Purpose - Identify where to stop without a clearance onto the runway
iii. Runway Holding Position Markings on Runways (as shown to the right)
   a. Purpose - Only installed if normally used for LAHSO or taxiing operations
      a Must stop before markings / exit prior to reaching the position
   b. Markings - White inscription / red background next to hold markings



iv. Taxiways Located in Runway Approach Area
   a. Holding Position Markings for Instrument Landing System (ILS)
      - Purpose - Hold aircraft when the ILS critical area is being protected
      - Markings - 2 yellow solid lines 2’ apart joined by pairs of solid lines 10’ apart across the taxiway
   b. Holding Position Markings for Taxiway / Taxiway Intersections
      - Purpose - Installed on taxiways where ATC normally holds aircraft short of an intersection
      - Markings - Single dashed line extending across the width of the taxiway
   c. Surface Painted Holding Position Signs (pictured, right)
      - Purpose - Supplements signs located at the holding position
      - Markings - Red background / white text, on hold side, before hold lines



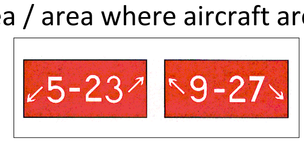
L. Other Markings
   i. Vehicle Roadway Markings
      a. Purpose - Defines a path for vehicle operations on the airport
      b. Markings - White solid line delineates each edge and a dashed line separates lanes
   ii. VOR Receiver Checkpoint Markings
      a. Purpose - Allow the pilot to check aircraft instruments with navigational aid signals
      b. Markings - Painted circle with an arrow in the middle (arrow is aligned toward the facility)
         - Located with a sign on the apron / taxiway; Black text on a yellow background
   iii. Nonmovement Area Boundary Markings (pictured, right)
      a. Purpose - Delineates movement area (area under control)
      b. Markings - 2 yellow lines (one solid and one dashed)

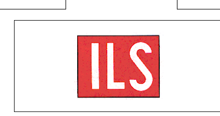


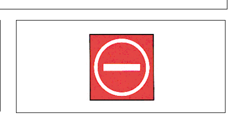
   iv. Marking and Lighting of Permanently Closed Runways
      a. Purpose - For runways and taxiways which are permanently closed
      b. Markings - The lighting circuits will be disconnected
         - Yellow crosses at each end of the runway and at 1,000’ intervals
   v. Temporarily Closed Runways and Taxiways
      a. Purpose – Indication that a runway is temporarily closed
      b. Markings - Yellow crosses are placed on the runway at each end
         - A visual indication may not be present depending on the reason / duration of closure
            a Check NOTAMs / ATIS
         - Closed taxiways are blockaded (yellow cross may also be used)

10. Airport Signs AI.V.D.K4

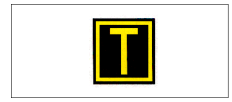
A. Mandatory Instruction
   i. Purpose - Denote entrance to runway or critical area / area where aircraft are prohibited
   ii. Markings - Red background with a white text
   iii. Typical Mandatory Signs and Applications
      a. Runway Holding Position Sign
      b. Runway Approach Area Holding Position Sign
      c. ILS Critical Area Holding Position Sign
      d. No Entry Sign





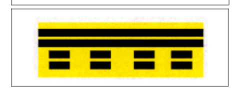


B. Location Signs
  i. Purpose - Identify either a taxiway or runway on which the aircraft is located
  ii. Taxiway Location Sign
    a. Purpose - Along taxiways to indicate location
    b. Markings - Black background with yellow inscription and border

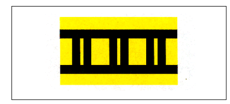


  iii. Runway Location Sign
    a. Purpose - Complement compass / heading info; typically, in areas with multiple runways
    b. Markings - Black background with yellow text

  iv. Runway Boundary Sign
    a. Purpose - Visual cue depicting when "clear of the runway"
    b. Markings - Yellow background / black lines

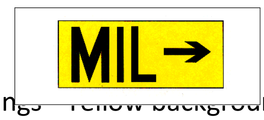


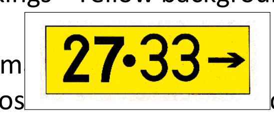
  v. ILS Critical Area Boundary Sign
    a. Purpose - Depicts where clear of the ILS critical area
    b. Markings - Yellow background / black lines



C. Direction Signs
  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
D. Destination Signs
  i. Purpose - Indicates a destination on the airport
    a. Destinations commonly shown are

• Runways	• Civil Aviation Areas
• Aprons	• Cargo Areas
• Terminals	• International Areas
• Military Areas	• FBOs



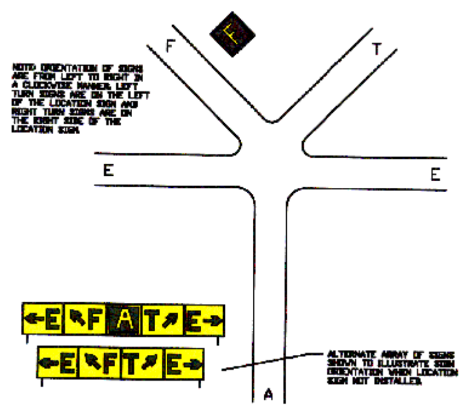


  ii. Markin[illegible]nd / black text
E. Inform[illegible]
  i. Purpos[illegible]on on things such as:
    a. Areas the tower can't see, radio frequencies, and noise abatement procedures
  ii. Markings - Yellow Background / black text
F. Runway Distance Remaining Signs
  i. Purpose – Informs the distance remaining on the runway
    a. Number indicates the thousands of feet of landing runway remaining
  ii. Markings - Black background / white number

G. CE: Failure to comply with airport, runway, taxiway sings and markings

11. Airport Lighting and Visual Aids AI.V.D.K4

A. Taxiway Lighting
  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

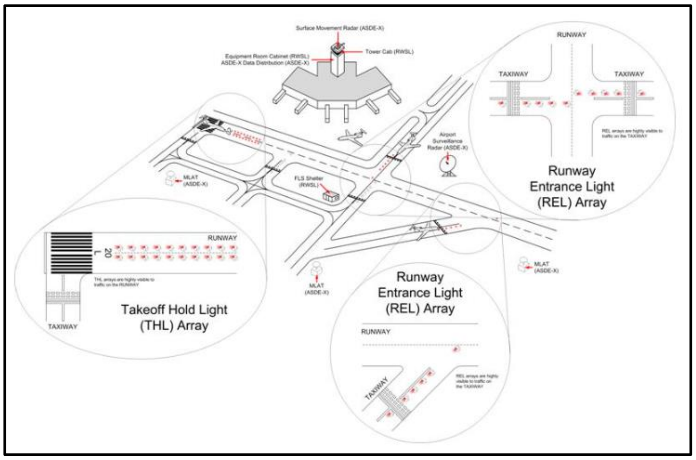
B. Runway Lighting

- i. Runway End Identifier Lights (REIL)
  - a. Installed to provide rapid / positive identification of the approach end of a runway
  - b. Configuration - Pair of synchronized flashing lights on each side of the runway threshold
- ii. Runway Edge Light Systems (HIRL, MIRL, LIRL)
  - a. Outline the edges of runways during dark / restricted visibility conditions
    - Classified according to the intensity or brightness: High Intensity (HIRL); Medium (MIRL); Low (LIRL)
  - b. Configuration
    - Runway edge lights - White
      - a Instrument runways – Yellow for the last 2,000,' or half the runway, whichever is shorter
    - Lights marking the end of the runway – Red / Green
      - a Red indicates the end of the runway to a departing aircraft
      - b Green indicates the threshold to landing aircraft
- iii. Runway Centerline Lighting System (RCLS)
  - a. 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
- iv. Touchdown Zone Lights (TDZL)
  - a. 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 the midpoint of the runway, whichever is less
- v. Taxiway Centerline Lead-Off Lights
  - a. 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
- vi. Taxiway Centerline Lead-on Lights
  - a. 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)
- vii. Land and Hold Short Lights

a. 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

viii. Runway Status Lights (RWSL)

a. Fully automated system providing indication that it's unsafe to enter, cross, takeoff, or land on a runway
  - Installed at several major US airports
  - Processes information from surveillance systems to turn red warning lights on/off
  - Used in conjunction with ATC – lights and ATC instructions must agree
b. Runway Entrance Lights (REL)
  - In-pavement red lights
  - Warns aircraft waiting to cross/enter a runway that there's conflicting traffic
c. Takeoff Hold Lights (THL)
  - In-pavement red lights
  - Warns aircraft in the takeoff position that the runway is occupied & takeoff is unsafe
d. More details: FAA Runway Status Lights



C. Control of Lighting Systems

i. Operation of approach light systems and runway lighting is controlled by the tower / FSS

a. Pilots may request the lights be turned on or off

ii. Pilot Control of Airport Lighting

a. Radio control of lighting is available at some airports by keying the microphone
  - 3 clicks for low lights, 5 for medium, and 7 for high (all clicks within 5 seconds – lasts 15 minutes)
b. Frequency is in Chart Supplement/standard instrument approach procedures publications (usually CTAF)

D. CE: Failure to comply with airport, runway, and taxiway lighting

AI.V.D.K1 – Just about every section is applicable to Elements of Safe Taxi Operations

Conclusion:
Brief review of the main points

V.F. Before Takeoff Check

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

Objectives	The learner should develop knowledge of the elements related to the before takeoff check, and perform the check as required in the manufacturer's POH and as required in the ACS.
Key Elements	1. Read and Do 2. Departure Brief 3. Incursions and Hazards
Elements	1. Engine Warm Up 2. Positioning the Aircraft 3. Division of Attention 4. Checklist 5. Go/No Go Decision 6. Departure Brief 7. Before Entering the Runway 8. Avoiding Incursions 9. Runway Change
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 elements involved in a proper, thorough, and safe before takeoff check. The learner 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 there is a problem with the airplane before taxiing onto the runway?

Overview

Review Objectives and Elements/Key ideas

What

The before takeoff check is 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. **Engine Warm Up**
   A. Before takeoff check is usually performed after taxiing to a position near the runway (usually a run-up area)
      i. Allows time to reach minimum operating temperatures ensuring lubrication and internal engine clearances
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. CE: Improper positioning of the airplane
3. **RM: Division of Attention** AI.V.F.R1
   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** AI.V.F.K1a. AI.V.F.K1b, AI.V.F.K1c
   A. Prepares the aircraft for takeoff and checks critical flight equipment and systems
   B. The before takeoff checklist provided by the manufacturer should be used to ensure a proper check
      i. Never go solely off memory
   C. Review the Before Takeoff Checklist with the learner
      i. Discuss reasons for checking each item and how to detect errors
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. CE: Improper acceptance of marginal engine performance
6. **RM: Departure Brief** AI.V.F.R4
   (RM: Potential engine failure or other malfunctions, considering operational factors)
   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. CE: Hazards of failure to review takeoff and emergency procedures
    i. Don't try to come up with a plan during an emergency

7. Before Entering the Runway

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
C. RM: Consider Wake Turbulence AI.V.F.R3
    i. Departing after a Large Aircraft
        a. On the same runway: Rotate prior to their rotation point and climb above their path until turning clear
        b. Executing a low approach, missed approach, or touch-and-go
            - Wait at least 2 minutes prior to a landing or takeoff
            - Vortex hazard may exist along the runway/in the flight path, particularly in a quartering tailwind
    ii. Intersection takeoffs on the same runway
        a. Be alert to adjacent large aircraft operations, particularly upwind of the runway of intended use
        b. Avoid headings that cross below the larger aircraft's path
    iii. For more details, see lesson VI.B. Traffic Patterns - Wake Turbulence

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. CE: Failure to avoid incursions & ensure no conflict with traffic prior to taxiing into takeoff position

9. RM: Runway Change AI.V.F.R2

A. Don't rush – Find a place to stop and make necessary changes
B. Performance
    i. Adjust for changes in runway length, wind direction, runway gradient, terrain, procedures, etc.
    ii. Ensure adequate performance and safety
    iii. Update navigation equipment (GPS, VOR, etc.)
C. Departure Brief: Note differences and brief the departure for the new runway
D. Taxi Instructions
    i. Review the taxi diagram
    ii. Request and readback taxi instructions
    iii. Confirm the route and begin the taxi

Conclusion:
Brief review of the main points

AIRPORT OPERATIONS

VI.A. Communications, Light Signals & Runway Lighting Systems

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

Objectives	The learner should develop knowledge of the elements related to radio communications and ATC light signals as described in the ACS.
Key Elements	1. Understanding 2. Who, Where, What 3. Plan Ahead
Elements	1. Radio Communication Procedures & Phraseology 2. ATC Clearances & Instructions 3. Selection and Use of Appropriate Frequencies 4. Radar Assistance 5. Transponders 6. Lost Communication 7. Runway Status Lights 8. Common 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 learner can properly use the radios throughout the flight. The learner 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. Light gun signals provide a means of communicating with the airplane in case radio communication becomes unavailable.

Why

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

How:

1. **Radio Communication Procedures & Phraseology** AI.VI.A.K2, AI.VI.A.R1
   - 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. RM: Radio Technique (RM: Communication)
     - i. LISTEN and THINK before you transmit
       - a. Know what you want to say before you say it
     - 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
   - 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
2. **ATC Clearances & 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

E. RM: Declaring Emergencies (AIM 6-1-2 Emergency Condition) AI.VI.A.R2
i. An emergency can either be a distress or urgency condition
a. Distress: Threatened by serious and/or imminent danger and requiring immediate assistance
b. Urgency: Concerned about safety and requiring timely but not immediate assistance
- Potential distress condition

ii. Do not hesitate to declare an emergency when faced with distress conditions
a. Ex: fire, mechanical failure, structural damage
iii. An aircraft is at least in an urgency condition the moment the pilot becomes doubtful about position, fuel endurance, weather, or any other condition that could adversely affect flight safety
a. This is the time to ask for help

3. Selection and Use of Appropriate Frequencies AI.VI.A.K1

A. Preflight Planning
i. Look up the primary frequencies you plan to use on the flight
a. ATIS, clearance delivery, ground, tower, & other useful frequencies at departure, arrival, divert airports
b. 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!)

4. Radar Assistance (AIM 4-1-17 & 18) AI.VI.A.K7

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. RM: Limitations
i. Based on controller discretion
ii. Guidance information is advisory and responsibility for safe flying remains with the pilot
iii. Cannot determine if flight into IMC will results from their instructions

C. Services include:
i. Basic Radar Service – Safety alerts, traffic advisories, limited radar vectoring (workload permitting)
a. Traffic advisories are issued based on radar targets and referenced in terms of the 12-hour clock
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

D. Radar Assistance does not relieve the pilot of the responsibility to see and avoid other aircraft

5. Transponders AI.VI.A.K4

A. Provides aircraft information to Air Traffic Control and other aircraft

B. Transponder Codes
i. When using flight following/radar assistance ATC assigns you a unique transponder code
a. Four numbers from 0-7 (4,096 possible codes)

b. When combined with radar returns, ATC can see the aircraft on their scope with the transponder info

ii. Standard Codes: VFR: 1200; Hijack: 7500; Lost Communication: 7600; Emergency: 7700

C. Different types/modes of transponders broadcast different information

i. Mode A: Transmits 4-digit code that identifies an aircraft and its position

ii. Mode C: Mode A + ATC can see the aircraft's altitude

iii. Mode S: Transmits a variety of information to ATC & other aircraft

a. Unique ICAO address (assigned to each aircraft), heading, speed, other flight related data

b. Integral to TCAS (Traffic Collision Avoidance System) and ADS-B

6. Lost Communication AI.VI.A.K3, AI.VI.A.K6

A. ATC Light Gun Signals and their Meaning (AIM 4-3-13)

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

iii. Disadvantages of Light Signals (AIM 4-3-13)

a. Pilots may not be looking at the control tower at the time a signal is directed toward their aircraft

b. Directions are limited since only approval/disapproval of a pilot's anticipated actions can be transmitted

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, 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 Light gun signals may not be necessary
- 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/acknowledge light gun signals

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

7. Runway Status Lights (RWSL) AI.VI.A.K8

A. Fully automated system providing a direct indication that it's unsafe to enter, cross, takeoff, or land on a runway

i. Installed at several major US airports

ii. Processes information from surveillance systems to turn red warning lights on/off

iii. Used in conjunction with ATC – lights and ATC instructions must agree

B. Runway Entrance Lights (REL)

i. In-pavement red lights

ii. Warns aircraft waiting to cross/enter a runway that there is conflicting traffic

C. Takeoff Hold Lights (THL)

i. In-pavement red lights

ii. Warns aircraft in the takeoff position that the runway is occupied & takeoff is unsafe

D. More details: FAA Runway Status Lights

8. Common Errors AI.VI.A.K9

A. Use of improper frequencies

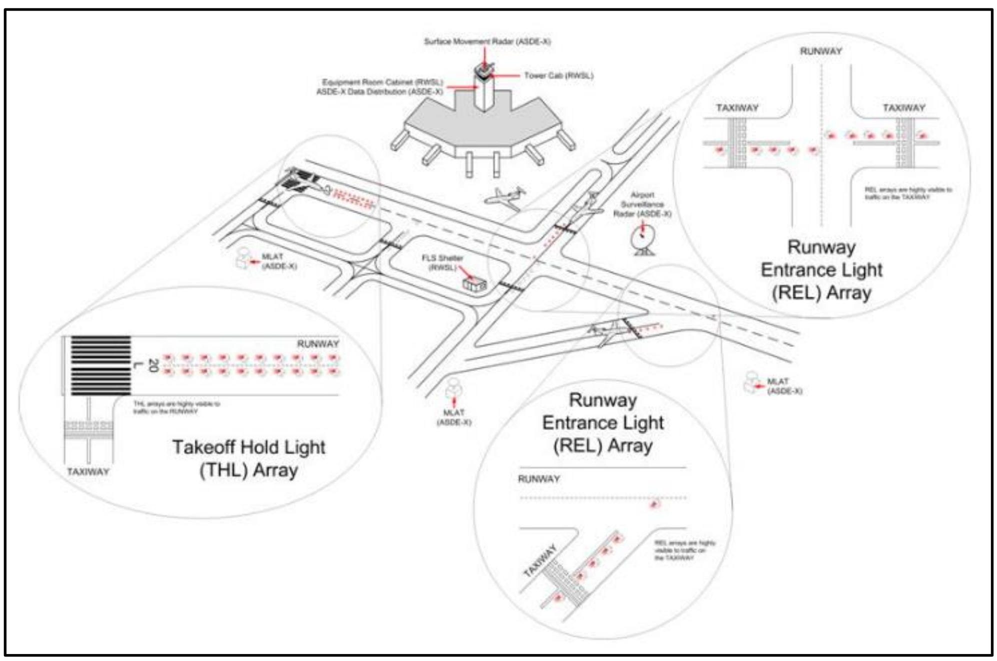
B. Improper procedure and phraseology for radio communications

C. Failure to acknowledge or properly comply with, ATC clearances and instructions

D. Failure to understand or properly comply with ATC light signals and/or RWSL

Conclusion:

Brief review of the main points



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 learner develops knowledge of the proper procedures, rules, and elements of the traffic pattern at controlled and uncontrolled fields. The learner will be able to demonstrate this knowledge as required in the ACS.
Key Elements	1. Entry Procedures 2. Communication 3. Orientation
Elements	1. The Pattern 2. Traffic Pattern Selection 3. Proper Spacing 4. Right-of-Way Rules 5. Common Errors 6. Hazards
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 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

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

Overview

Review Objectives and Elements/Key ideas

What

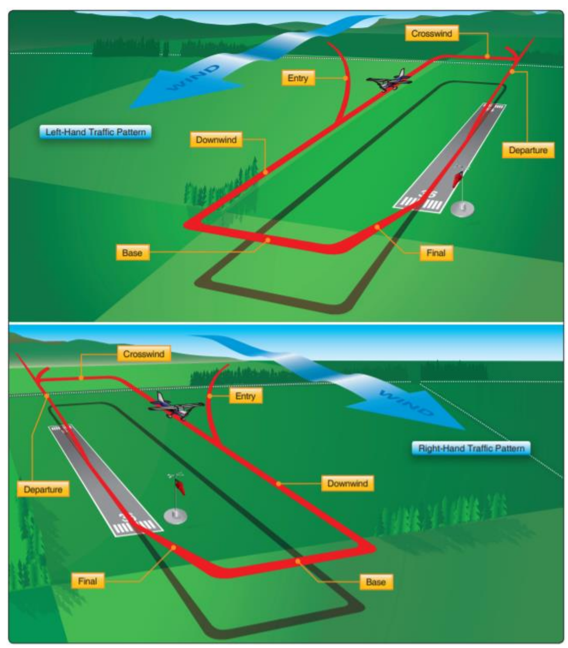
Traffic Patterns involve the rules and procedures associated with flying a proper traffic pattern at a controlled and uncontrolled airport.

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:

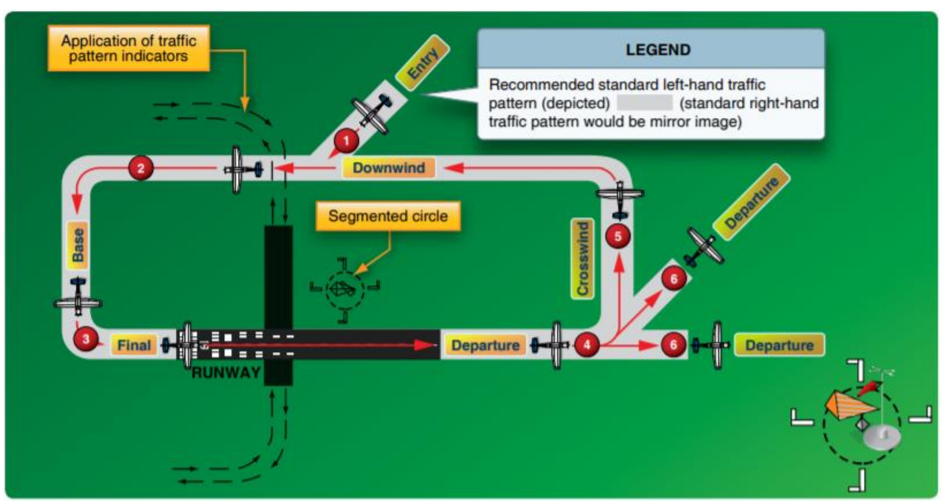
1. **The Pattern**
   A. Controlled - The pilot receives a clearance to approach / depart and pertinent pattern information
   B. Uncontrolled - It's up to the pilot to determine traffic direction, and comply with the appropriate rules
   C. Standard Traffic Pattern
      i. Pattern Altitude: Usually 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 Pattern: Left Turns
   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**,** about ½-1-mile from runway
      iii. Downwind - Parallel to the landing runway
         a. Heading is opposite the landing runway, approx. ½-1 mile from the runway
         b. Before landing checks & configuration
         c. Start descent abeam landing point
         d. Turn base 45° from the landing point
            - Adjust for winds, traffic, tower request, etc.
            - Stronger wind = closer base leg
               a Due to decreased groundspeed on final
      iv. Base - Perpendicular to the runway,
         a. Transition between downwind and final
         b. Ground track should be perpendicular to the centerline
         c. Continue descent, adjusting pitch and power to maintain airspeed and glidepath
         d. Landing configuration, if not already configured



- v. Turn to Final
  - a. Lead the turn 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 (on any leg in the pattern)
- i. Goal is to fly a rectangular pattern regardless of wind direction or speed
  - a. Crab into the wind
- 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. Flight Controls
  - a. Maintain a consistent crosscheck (90% outside, 10% inside)
  - b. Use small, controlled inputs to fly the airplane



2. Traffic Pattern Selection AI.VI.B.K2, AI.VI.B.K4

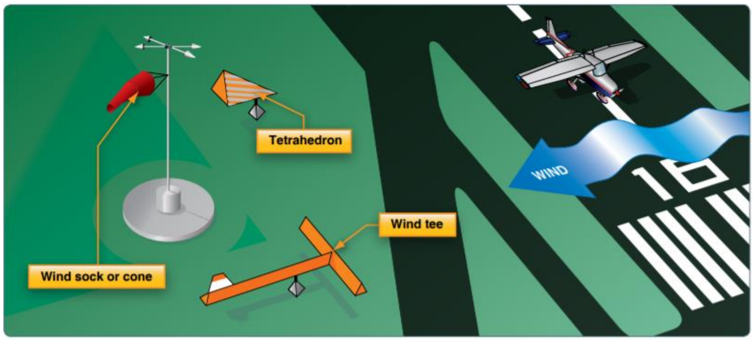
A. Controlled Field AI.VI.B.K1
- i. Generally, ATIS will inform the pilot of the runway(s) in use
- ii. The pilot receives a clearance to approach / depart as well as pertinent information about the pattern
- iii. ATC will specify pattern entry and departure procedures (Where / how to enter and depart)
- iv. During the pattern the controller may make adjustments (speed, legs lengths, turns for spacing, etc.)

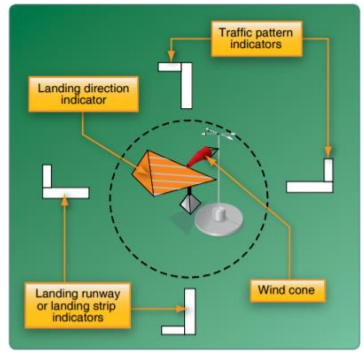
B. Uncontrolled Field AI.VI.B.K1
- i. Communication – 2 ways, depending on the airport
  - a. Communicating with an FSS that provides advisories (are not air traffic controllers)
    - Provide wind info, runway in use, altimeter setting, known traffic, NOTAMs, etc.
    - Initiate contact approximately 10 miles out with altitude, aircraft type, location
    - Departing: transmit tail number, type of flight, destination, services desired, etc.
  - b. Self-announced broadcast on CTAF

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

ii. Arriving

a. Observe other aircraft already in the pattern and conform to the traffic pattern in use
- If no other aircraft, use ground indicators and wind direction to determine the runway to use
  - a Check indicators 500’ – 1,000’ above pattern altitude



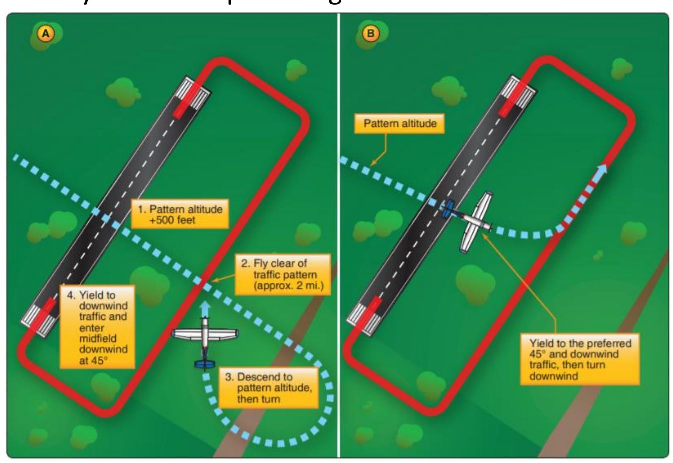


- Always enter the pattern at pattern altitude
  - a Descending into the pattern can be dangerous
  - b Avoids descending onto another aircraft and easier to visually acquire other traffic

b. Downwind Entry: Enter at a 45° to midfield downwind

c. Midfield Entry (pictured below, left)
- Cross midfield at least 500’ above pattern altitude
- When well clear of the pattern (approximately 2 miles), descend to pattern altitude
- Enter level, at pattern altitude, at a 45° angle to the downwind leg, abeam the runway midpoint
  - a Entry while descending creates collision hazards and should be avoided
  - b Another method of entry is a midfield entry from the upwind leg side

d. Alternate Midfield Entry (pictured, right)
- Enter at pattern altitude at midfield crosswind and turn downwind
- Should not be used when the pattern is congested



e. Runway Orientation AI.VI.B.R2
(RM: Disorientation)
- Visualize your position in relation to the runway on the heading indicator
- Confirm runway number with the heading indicator on all pattern legs
  - a Downwind – reciprocal of runway
  - b Base - 90° off
  - c Final – Same as the runway

iii. Departing

a. Generally, depart on the upwind or a 45° off the upwind

b. Monitor the radio for traffic in the local area, and announce your intentions

c. Clear aggressively (other aircraft may not be using radios)

3. RM: Proper Spacing (RM: Collision Hazards) AI.VI.B.R1

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. Maintain proper airspeed to blend in with the other traffic
    iii. On downwind with another aircraft on final, delay the base turn until abeam / past the other aircraft
    iv. Adjust upwind to accommodate aircraft on downwind
  B. The pilot is always responsible for seeing and avoiding whether at a controlled or uncontrolled field

4. Right-of-Way Rules (FAR 91.113) AI.VI.B.K3

  A. An aircraft in distress has the right-of-way over all other traffic
  B. Converging
    i. If aircraft of the same category are converging, the aircraft to the other's right has the right-of-way
    ii. Different Categories Converging (basically, least maneuverable aircraft has the right-of-way)
        a. Balloon, glider, and airship have right-of-way over airplanes
        b. An aircraft towing or refueling another aircraft has the right-of-way over all other engine driven aircraft
  C. Approaching Head-On: Each aircraft shall alter course to the right
  D. Overtaking: Aircraft being overtaken has the right-of-way; the overtaking aircraft shall alter course to the right
  E. Landing: Aircraft on final approach or landing have the right-of-way over other aircraft in flight or on the surface
        a. Shall not take advantage of this to force an aircraft which has already landed off the runway
    ii. When two or more aircraft are approaching an airport to land, the lower aircraft has the right-of-way
        a. Shall not take advantage of this rule to cut in front of another aircraft

5. Common Errors AI.VI.B.K5

  A. Failure to comply with traffic pattern instructions, procedures, and rules
  B. Improper correction for wind drift
  C. Inadequate spacing from other traffic
  D. Poor altitude or airspeed control

6. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

  A. See VII. RM Concepts – Wind Shear AI.VI.B.R3
  B. See VII. RM Concepts – Wake Turbulence AI.VI.B.R3
  C. See VII. RM Concepts – Distractions (Task Prioritization, Loss of SA, Disorientation) AI.VI.B.R2

Conclusion:

Brief review of the main points

TAKEOFFS, LANDINGS & GO-AROUNDS

VII.A. Normal Takeoff & 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 learner should be able to competently maintain control of the airplane and safely takeoff and climb with or without wind as described in the ACS.
Key Elements	1. Takeoff into the Wind 2. Left Turning Tendencies 3. *Rotation Speed (V_R - 44 knots)
Elements	1. Takeoff & Climb 2. Normal Takeoff 3. Crosswind Takeoff & Climb 4. Hazards & Emergencies
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 learner can walk through a normal or crosswind takeoff on the ground, providing knowledge of normal takeoff & climb common errors. The learner 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

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

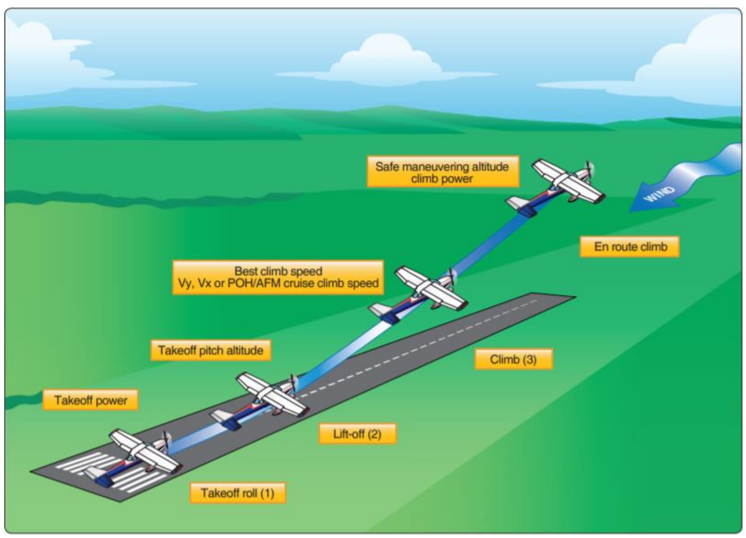
The procedures for safely guiding the airplane from the ground to the air in varying wind conditions.

Why

It is essential for every flight you will ever take! A smooth, skillful, and safe takeoff is a key element of pilot proficiency. Maneuvering near the ground can be hazardous and therefore it's important to be skilled in takeoff procedures.

How:

1. **Takeoff & Climb** AI.VII.A.K2



   A. A normal takeoff:
      i. Airplane is headed into the wind, or the wind is very light
      ii. Takeoff surface is firm and of sufficient length to gradually accelerate to normal lift-off/climb-out speed
      iii. No obstructions on the takeoff path
   B. RM: Runway Selection AI.VII.A.R1
      i. Wind: Reasons to take off into the wind
         a. Even motionless, a headwind will provide some airspeed due to wind moving over the wings
         b. Decreases wheel speed necessary to achieve flying speed
            - Shorter ground roll, less runway
            - Reduces wear/stress on the gear
         c. Increases climb performance
         d. RM: Tailwind increases required ground roll (RM: Effects of Tailwind) AI.VII.A.R2c
            - POH: Reference any max takeoff tailwind limitation
         e. Crosswind: Reference any crosswind limitations (POH)
            - Ensure proficiency & within personal minimums
      ii. Aircraft Performance
         a. Atmospheric Pressure
            - Since air is a gas, it can be compressed or expanded, affecting density
            - Changes in air density affect performance - As density increases, performance increases & vice versa
         b. What Changes Air Density (DA)? Barometric Pressure, Temperature, Altitude, and Humidity

- Density varies directly with pressure - As pressure increases, density increases and vice versa
- Density varies inversely with temperature – As temp increases, density decreases and vice versa
- Density varies inversely with altitude - As altitude increases, density decreases and vice versa
- Density varies inversely with humidity – As humidity increases, density decreases and vice versa

c. How it affects Performance
- 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

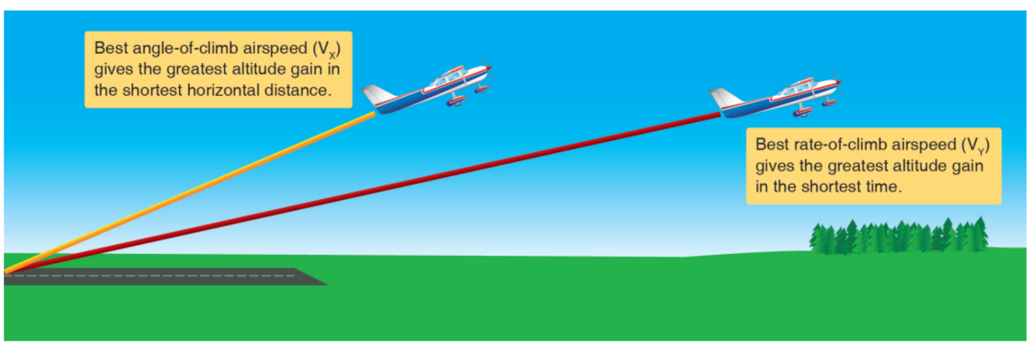
iii. Runway Characteristics AI.VII.A.R2e
- a. Surface: More friction associated with softer surfaces – increases takeoff roll
- b. Gradient: Upsloping runway increases takeoff roll – reference the Chart Supplement for runway gradient
- c. Condition: Dry, wet, snow, ice, etc. affects braking effectiveness
- d. Available Distance: Runway length available for takeoff

iv. Performance Charts
- a. Take into account all of the above information, and more (weight, configuration, etc.)
- b. Reference takeoff & climb performance charts (generally, takeoff distance & takeoff climb)
  - Verify required distance and climb abilities are compatible with the runway/environment

v. Pilot Capability
- a. Set and strictly adhere to personal minimums (runway length/width, winds, weather, etc.)
- b. Ensure proficiency and safety

C. Configuration AI.VII.A.K4
- i. Reference the POH and Before Takeoff checklist

D. Best Angle versus Best Rate of Climb AI.VII.A.K3
- i. Best Rate of Climb (V_Y)
  - a. Performed at the airspeed producing the most altitude gain in the least time (max feet per minute)
    - Airspeed where the most excess *power* is available over that required for level flight
  - b. Used in normal takeoff and climb procedures
- ii. Best Angle of Climb (V_X)
  - a. Performed at an airspeed that will produce the most altitude gain in a given distance
    - Airspeed where the most excess t*hrust* is available over that required for level flight
    - V_X will result in a steeper climb path, but will take longer to reach altitude than a climb at V_Y
      - a Therefore, V_X is used in clearing obstacles after takeoff



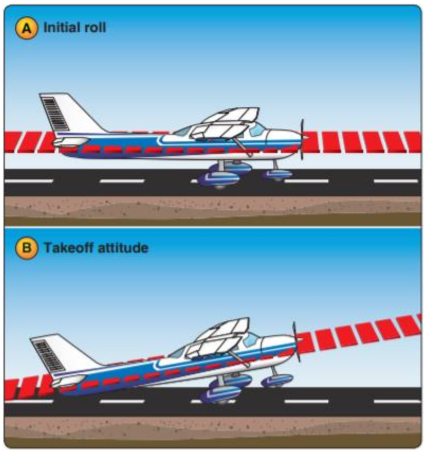
- iii. Normal Climb (Cruise Climb)
  - a. Performed at an airspeed recommended by the airplane manufacturer
    - Usually faster than the best rate of climb, but provides better cooling, control, and visibility

2. Normal Takeoff AI.VII.A.K1

A. Takeoff Roll

- i. Taxi onto the Runway
  - a. Complete the before takeoff checklist prior to taxiing onto the runway
  - b. Controlled Airport
    - Never taxi onto a runway for takeoff without a specific clearance
    - Clear the area prior to crossing the hold short lines
  - c. Uncontrolled Airport
    - Announce intentions on the CTAF to alert other aircraft of your position and intentions
    - Use other radio calls to build a mental picture of the traffic in the area and how it may affect you
    - Check the runway & final approach are clear
  - d. Entering any runway, verify the runway assigned matches the runway you are on
  - e. 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
- 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

B. Lift-Off



- i. Rotation (V_R)
  - a. As the aircraft reaches V_R, gently pull back to establish a climb at V_Y
    - Pitch 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
- ii. Initial Climb
  - a. Pitch for V_Y (V_Y + takeoff power = max altitude in min 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, repeat
    - 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. Climb Checklist
- Perform the climb checklist when at a safe altitude and under control (500' AGL, or as required)

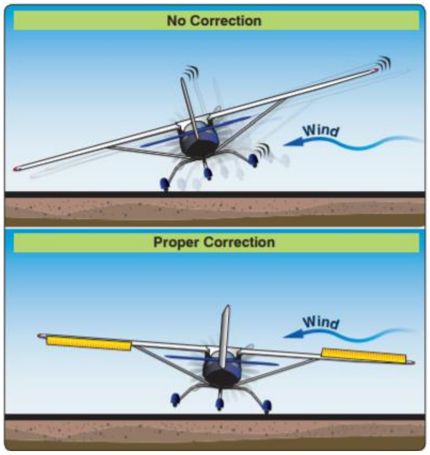
d. The checklist can be delayed to continue flying the aircraft, always fly first

C. Common Errors AI.VII.A.K5
i. Failure to review AFM/POH and performance charts prior to takeoff
ii. Failure to adequately clear the area prior to taxiing into position on the active runway
iii. Abrupt use of the throttle
iv. Failure to check engine instruments for signs of malfunction after applying takeoff power
v. Failure to anticipate left turning tendency on initial acceleration & Overcorrecting for left turning tendency
vi. Relying solely on the airspeed indicator rather than developing an understanding of visual references and tracking clues of airplane airspeed and controllability during acceleration and lift-off
vii. Failure to attain proper lift-off attitude
viii. Inadequate compensation for torque/P-factor during initial climb resulting in a sideslip
ix. Over-control of elevators during initial climb-out and lack of elevator trimming
x. Limiting scan to areas directly ahead of the airplane, causing a wing to drop immediately after lift-off
xi. Failure to attain/maintain best rate-of-climb airspeed (V_Y) or desired climb airspeed
xii. Failure to employ principles of attitude flying during climb-out, resulting in "chasing" the airspeed indicator

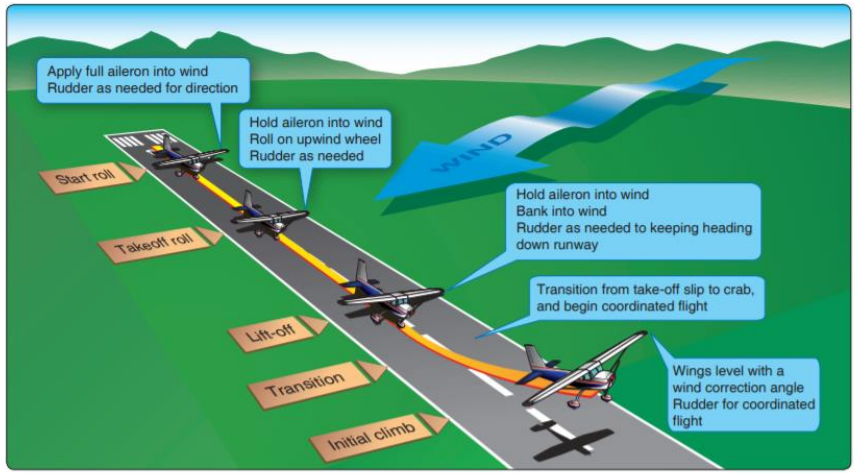
3. Crosswind Takeoff & Climb AI.VII.A.K1, AI.VII.A.R2a

A. Basics
i. Basic steps are the same as a normal takeoff
a. Differences ensure centerline is maintained and a smooth takeoff with wind pushing across the runway
ii. 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
iii. Improper corrections can result in skipping, sideways movement, and side stress on the landing gear

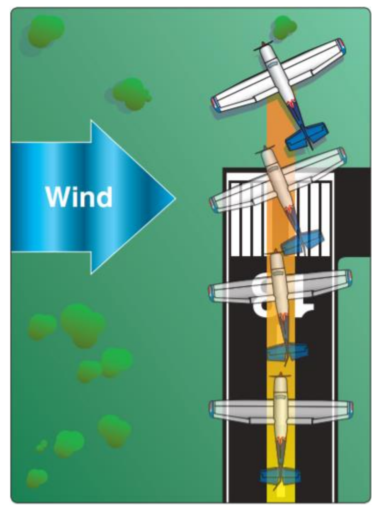


B. Takeoff Roll
i. Taxi onto the Runway
a. Complete the before takeoff checklist prior to taxiing onto the runway
b. Clear runway & approach path
c. Verify correct runway
d. Align with the runway and straighten the nosewheel
ii. Hold FULL aileron INTO the wind as the roll is started
a. Downward force on the upwind wing prevents it from raising
iii. Release the brakes
a. Same as a normal takeoff, but with full aileron into the wind
b. Smoothly and continuously advance the throttle to takeoff power
c. Apply rudder to counter left turning tendencies & weathervane
iv. Gaining Speed
a. As forward speed increases, ailerons become more effective, and the crosswind becomes more of a relative headwind



- b. Aileron pressure into the wind should gradually be reduced
- c. Adjust rudder to continue straight down the centerline

C. Lift-Off
- i. In a significant crosswind, stay on the ground slightly longer to ensure a smooth/definite takeoff
- ii. Apply back pressure to establish the pitch attitude for V_Y
- iii. Maintain crosswind corrections during liftoff to prevent drifting/skipping
  - a. Downwind wing and mainwheel may rise first - this is preferred to side skipping
- iv. 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



D. Initial Climb
- i. Maintain the sideslip until the climb is established, then crab into the wind
  - a. Sideslip creates excess drag and reduces performance
  - b. Turn the nose into the wind to offset the crosswind with the wings level
  - c. Turn coordinator ball should be centered for coordinated flight
- ii. Visually
  - a. Use an outside scan to maintain 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

E. *Climb Checklist
- i. Climb to 500' AGL, and perform the 'Climb Check'
  - a. Checklist can be delayed to fly the plane, if things are busy fly first

F. Common Errors AI.VII.A.K5
- i. Using less than full aileron pressure into the wind initially on the takeoff roll
- ii. Mechanical use of aileron control rather than judging lateral position of airplane on runway from visual clues and applying sufficient aileron to keep airplane centered laterally on runway
- iii. Side-skipping due to improper aileron application
- iv. Inadequate rudder control to maintain airplane parallel to centerline and pointed straight ahead in alignment with visual references
- v. Excessive aileron input in the latter stage of the takeoff roll resulting in a steep bank into the wind at lift-off.
- vi. Inadequate drift correction after lift-off

4. RM: Hazards & Emergencies

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. VII. RM Concepts – Rejected Takeoff AI.VII.A.R3a
B. VII. RM Concepts – Engine Failure AI.VII.A.R3b
C. VII. RM Concepts – Wind Shear AI.VII.A.R2b
D. VII. RM Concepts – Wake Turbulence AI.VII.A.R2d

E. VII. RM Concepts – Distractions, Task Prioritization, SA AI.VII.A.R6
F. VII. RM Concepts – Low Altitude Maneuvering AI.VII.A.R5
G. VII. RM Concepts – Collision Hazards AI.VII.A.R4
H. VII. RM Concepts – Runway Incursion AI.VII.A.R7

Conclusion:
Brief review of the main points

VII.B. Normal Approach & Landing

References: Airplane Flying Handbook (FAA-H-8083-3), Procedures during Taxi Operations (AC 91-73), Aviation Weather Handbook (FAA-H-8083-28), POH/AFM

Objectives	The learner should be able to perform a normal approach and landing as prescribed in ACS. 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. Runway Selection 2. Downwind Leg 3. Base Leg 4. Final Approach 5. Roundout 6. Touchdown 7. After-Landing Roll 8. Common Errors 9. Crosswind Approach 10. Hazards & 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 learner 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. At least according to the passengers, if 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 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 plane 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.

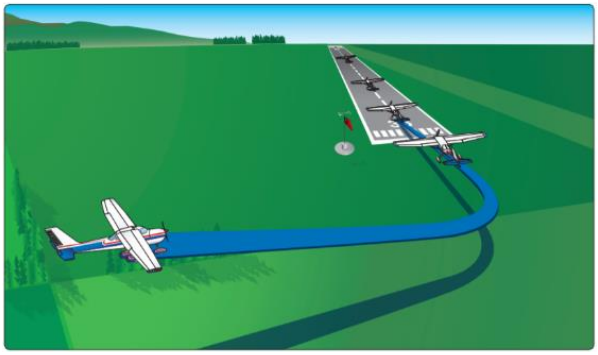
How:

1. **RM: Runway Selection** AI.VII.B.K3, AI.VII.B.R1
   A. Wind
      i. Headwind decreases groundspeed and therefore landing distance
      ii. RM: Tailwind increases groundspeed and therefore landing distance AI.VII.B.R2c
         a. Reference the POH for any max tailwind landing limitations
      iii. Crosswind: Reference any crosswind limitations (POH)
         a. Ensure proficiency & within personal minimums
   B. Aircraft Performance
      i. Atmospheric Pressure
         a. Since air is a gas, it can be compressed or expanded, affecting density
         b. Changes in air density affect performance - As density increases, performance increases & vice versa
      ii. What Changes Air Density (DA)? 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
      iii. How it affects Performance
         a. As the air becomes less dense, it reduces:
            - Power, since the engine takes in less air
            - Thrust, since the propeller is less efficient in thin air (less air is being moved for every rotation)
            - Lift, because the thin air exerts less force on the airfoils
         b. Density Altitude & Landing
            - Affects climb capability in the case of a go-around
            - Higher density altitude = higher true airspeed which increases the landing roll
   C. RM: Runway Characteristics AI.VII.B.R2e
      i. Surface: More friction associated with softer surfaces – decreases landing roll

   ii. Gradient: Down sloping runway increases landing roll – reference the Chart Supplement for runway gradient
   iii. Condition: Dry, wet, snow, ice, etc. affects braking effectiveness
   iv. Available Distance: Runway length available for landing
 D. Performance Charts
   i. Take into account all of the above information, and more (weight, configuration, etc.)
   ii. Reference landing & climb performance charts (generally, landing distance/performance & climb performance or balked landing climb charts)
     a. Verify required distance and climb abilities are compatible with the runway/environment
 E. Pilot Capability
   i. Set and strictly adhere to personal minimums (runway length/width, winds, weather, etc.)
   ii. Ensure proficiency and safety

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° angle from the runway threshold
   i. Shallow to medium bank – recall Rectangular Course procedures to compensate for wind
   ii. At the 45° point the airplane has descended approximately 200’ (800’ AGL) (varies with aircraft)

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. The Turn to Final
   i. Medium to shallow bank turn should align the airplane with the centerline of the runway
     a. No more than 30° of bank (stall speed increases rapidly above 30° of bank)
     b. 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° 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 POH approach speed
   i. Accomplish the Landing Checklist
   ii. Strong/Gusty Winds: Increase speed on final approach: Approach speed + ½ the gust factor
     a. Use flaps as recommended in the POH

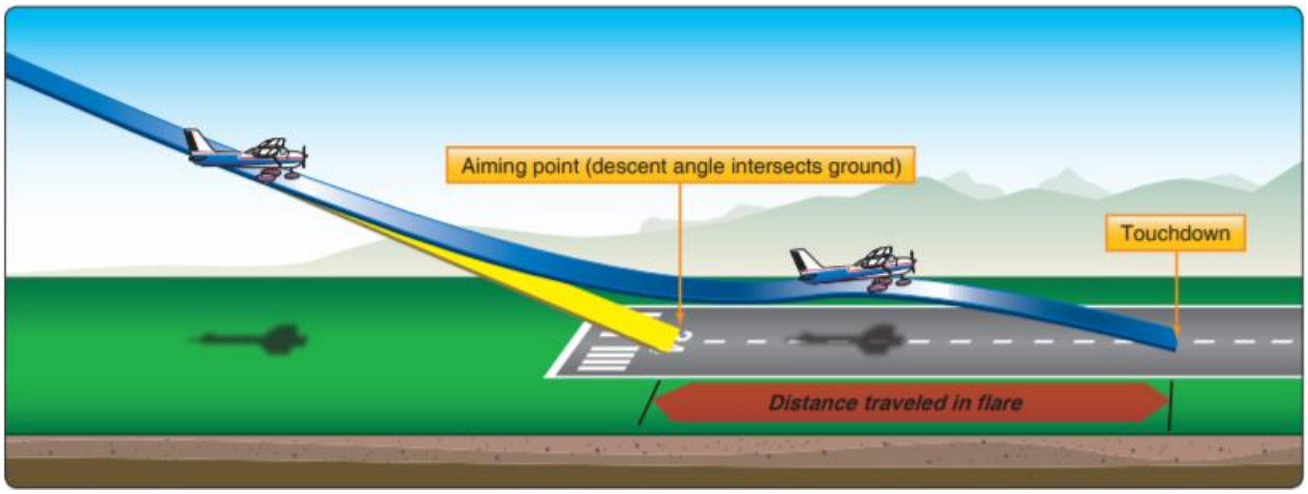
iii. Landing Checklist

C. Stable Approach AI.VII.B.K2

i. Stable approach: a constant glidepath towards a selected point on the landing runway
   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

ii. 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

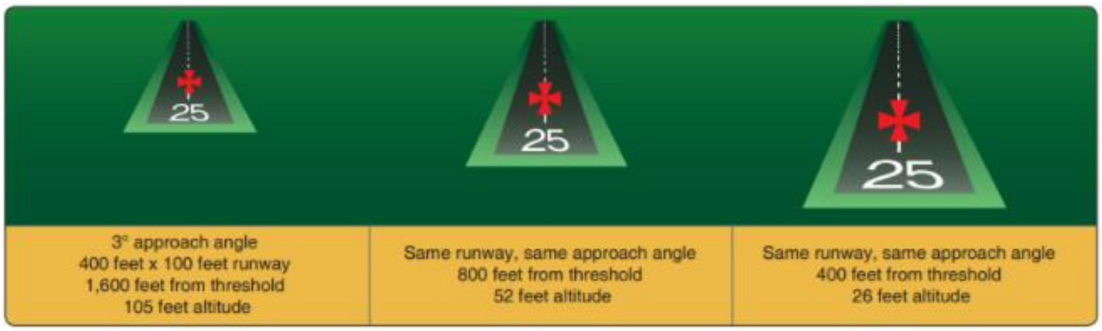
iii. Angle of Descent
   a. Aim Point



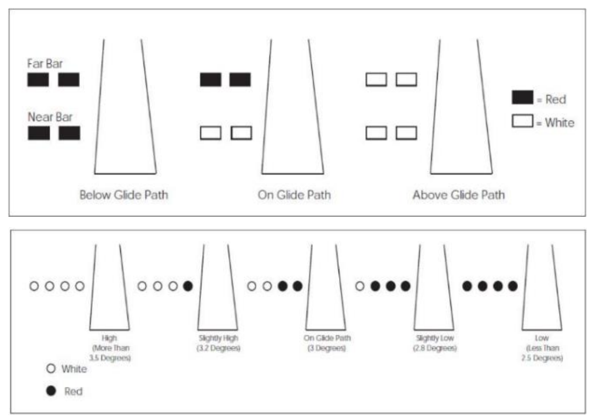
      - Point the plane would strike the ground if a constant glidepath was maintained (no flare)
         a The aim point should remain stationary in the windscreen
         b Aim point is not the spot the airplane will touchdown due to flare / float
      - Select an aiming point in front of the desired touchdown point (distance varies with aircraft)
      - Keep the aim point steady on the windscreen
         a If the point moves up on the windscreen, the airplane is getting too low
            1. Add power and raise the nose to maintain airspeed
         b If the point moves down on the windscreen, the airplane is getting too high
            1. Reduce power and lower the nose to maintain airspeed
         c Small, proactive corrections will result in a steady, stable approach to the aim point

iv. Runway Image
   a. A normal glidepath is 3° (300’ per nm descent)
   b. Too High – The runway will elongate and become narrower (overhead view of the runway)
   c. Too Low – The runway will shorten and become wider (flat view of the runway)

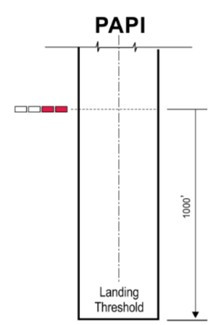
d. On Path – Runway shape (between high and low) remains the same but grows in size
e. The runway should maintain the same shape as the pilot continues down the approach path
   - Runway appears as a trapezoid – In the descent, it should maintain shape and grow



v. Visual Approach Lighting
   a. Visual Approach Slope Indicator (VASI)



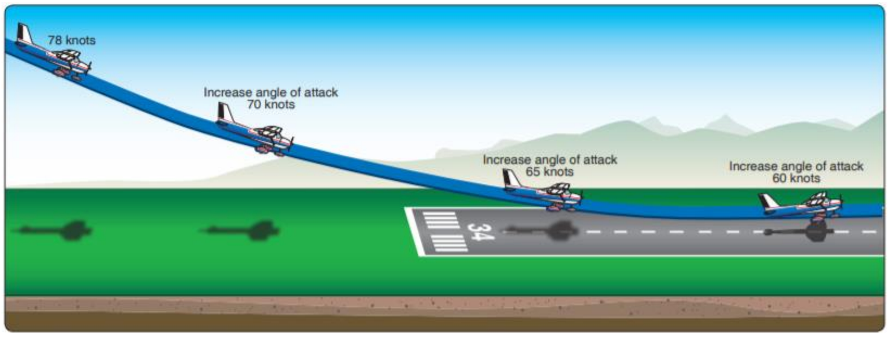
      - Visual descent guidance during approach
      - Visible from 3-5 miles during day and to 20 or more at night
         a Obstruction clearance within ± 10° of the centerline and 4 NM from the threshold
      - Two Bar VASI (most common – top right)
         a Below glidepath: All red
         b On glidepath: Red over white (normally 3°)
         c Above glidepath: All white
   b. Precision Approach Path Indicator (PAPI)



      - 4 lights perpendicular to the edge of the runway
      - Provides visual descent guidance during the approach to a runway
         a On glidepath: 2 red & 2 white
         b Below glidepath: 3 or 4 red
         c Above glidepath: 3 or 4 white
      - Designed to reduce controlled flight into terrain and runway over/underruns
vi. Effects of Wind
   a. The greater the headwind, the lower the rate of descent
      - More time to cover the same distance
   b. The lower the headwind or greater the tailwind, the higher the rate of descent (less time)
   c. Concepts discussed/site pictures remain the same - Still on a 3° glidepath

D. Landing Clearance: Ensure the controller gave you landing clearance, it was understood, and was read back

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 is 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
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
F. Always keep one hand on the throttle (within reason)

        a. 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

7. After-Landing Roll

- A. Deceleration to the normal taxi speed, or when brought to a complete stop 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. Used to counter crosswinds and keep the wings level
        - b. As speed decreases the ailerons become less effective, and increasing aileron must be applied into a crosswind to keep the wing from rising
    - iii. Be alert throughout the landing roll
        - a. 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
        - b. 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
- C. Braking
    - i. Slows the airplane, can also be used to aid in directional control when rudder is insufficient
    - ii. Using the Brakes
        - a. Toe brakes – Slide toes/feet up from the rudder pedals to the brake pedals (maintain 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
d. Firmly, smoothly, and evenly apply the brakes
- Max effectiveness is just short of the point where skidding occurs (not needed on most landings)
- If the brakes are applied so hard that skidding takes place, braking becomes ineffective
- Effectiveness is not enhanced by applying, releasing, and reapplying brake pressure (pumping)

D. Avoid a runway incursion: Have a plan to exit the runway (intended exit and stop point)
E. After Landing Checklist - Perform once safely clear of the runway

8. Common Errors (Normal Approach & Landing) AI.VII.B.K5

A. Failure to complete the landing checklist in a timely manner
B. Inadequate wind drift correction on the base leg.
C. An overshooting, undershooting, too steep, or too shallow a turn onto final approach.
D. A skidding turn from base leg to final approach as a result of overshooting/inadequate wind drift correction.
E. Poor coordination during turn from base to final approach.
F. Unstable approach.
G. Failure to adequately compensate for flap extension.
H. Poor trim technique on final approach.
I. Attempting to maintain altitude or reach the runway using elevator alone.
J. Focusing too close to the airplane resulting in a too high round out.
K. Focusing too far from the airplane resulting in a too low round out.
L. Touching down prior to attaining proper landing attitude.
M. Failure to hold sufficient back-elevator pressure after touchdown.
N. Excessive braking after touchdown.
O. Loss of aircraft control during touchdown and rollout

9. RM: Crosswind Approach (RM: Effects of crosswind) AI.VII.B.K1, AI.VII.B.K4, AI.VII.B.R2a

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

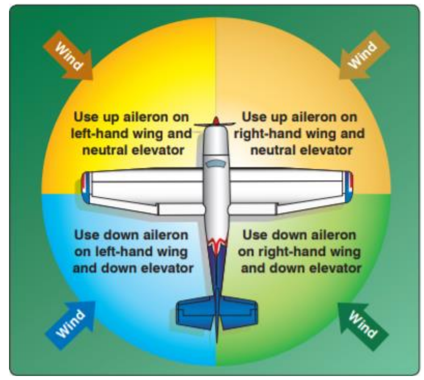
i. Sideslip (Wing-Low)
a. Aileron for drift & Rudder for heading

b. Align the airplane's heading with the centerline of the runway, noting the rate and direction of drift
c. Promptly apply drift correction by lowering the upwind wing
d. With wing lowered, the plane turns that direction
e. To compensate for the turn, use opposite rudder to align the longitudinal axis aligned with the runway
- Sideslipping so the flight path & ground track are aligned with the runway

f. Strong Crosswind
- At some point, there will be insufficient rudder to overcome the turn caused by the steepened bank
- If full rudder cannot prevent a turn, the wind is too strong (crosswind limit)
  a Find another runway

ii. Maintain a stabilized approach
a. Same as a normal approach, except with the added sideslip
- Drag is increased and more power is necessary to maintain descent rate

b. Pitch for airspeed; Power for altitude



E. Roundout
i. Like a normal landing approach, but the crosswind correction is maintained to prevent drifting
a. Don't level the wings. Keep the upwind wing down throughout the roundout
- Leveling the wings will result in drifting, which will side loading the gear

ii. Gradually increase the aileron and rudder pressure as the airplane slows

F. Touchdown
i. Touchdown on the upwind main wheel first
a. Maintain the crosswind corrections to prevent drift
b. During gusty or high wind conditions, prompt adjustments must be made

ii. As momentum decreases, the downwind main wheel will settle onto the runway, then the nosewheel
a. Nose-wheel steering: Nosewheel will not be aligned with the runway due to rudder input
- Relax rudder pressure as the nose touches down

iii. After Landing Roll
a. Continue to maintain directional control with rudders and crosswind control with ailerons
b. Increase aileron as the airplane decelerates – full aileron into the wind when coming to a stop

G. Common Errors AI.VII.B.K5
i. Attempted landing in crosswinds that exceed the airplane's maximum demonstrated crosswind component
ii. Undershooting or overshooting the turn from base leg to final approach
iii. Inadequate compensation for wind drift on final approach
iv. Unstable approach
v. Excessive sink rate or too low an airspeed from increased drag and reduced vertical lift during sideslip
vi. Failure to touch down with the longitudinal axis aligned with the runway
vii. Touching down while drifting
viii. Excessive airspeed on touchdown
ix. Failure to apply appropriate flight control inputs during rollout
x. Failure to maintain direction control on rollout
xi. Excessive braking
xii. Loss of aircraft control

10. RM: Hazards & Emergencies

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. VII. RM Concepts – Rejected Landing & Go-Around AI.VII.B.R3a
B. VII. RM Concepts – Land and Hold Short Operations (LAHSO) AI.VII.B.R3b
C. VII. RM Concepts – Wind Shear AI.VII.B.R2b
D. VII. RM Concepts – Wake Turbulence AI.VII.B.R2d
E. VII. RM Concepts – Distractions, Task Prioritization, SA AI.VII.B.R6
F. VII. RM Concepts – Low Altitude Maneuvering AI.VII.B.R5
G. VII. RM Concepts – Collision Hazards AI.VII.B.R4

Conclusion:
Brief review of the main points

VII.C. Soft-Field Takeoff & 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 learner should be able to demonstrate the soft-field takeoff to ACS 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 6. Common Errors 7. Hazards & 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 lesson is complete when the learner 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 learner 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 in off-road conditions?

Overview

Review Objectives and Elements/Key ideas

What

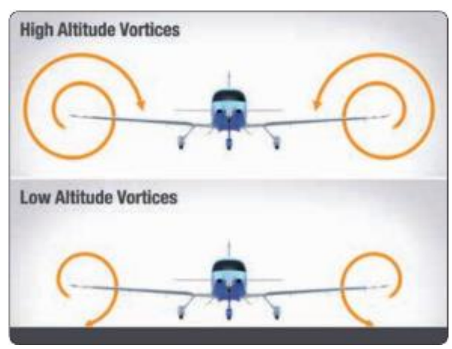
A takeoff from a "soft" field. Just like it says in the name, we are attempting to takeoff from a soft, often uneven surface which could produce enough drag to prevent the airplane from reaching normal takeoff speeds.

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** AI.VII.C.K1
   A. Differences from a Normal Takeoff: AI.VII.C.K6
      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. Ground Effect AI.VII.C.K5
      i. Associated with the reduction of induced drag
      ii. When close to the ground, the vertical component of the airflow around the wing is restricted by the ground
         a. Decreases induced drag
      iii. Effects on Flight
         a. Amount of thrust required to produce lift is reduced (plane can lift off at lower-than-normal speed)
         b. Climbing out of ground effect, the thrust required to sustain flight increases significantly
         c. If you climb before reaching normal takeoff speed, the plane can sink back to the surface

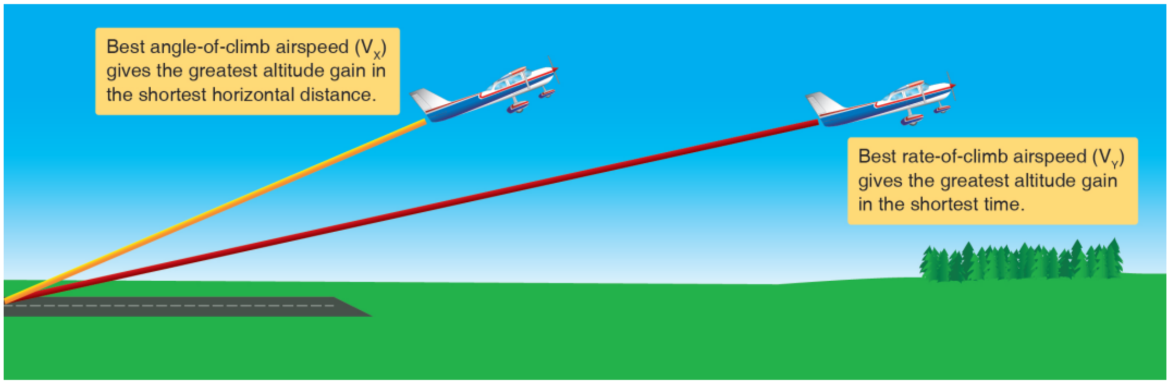


   C. Basics
      i. Maintain back pressure during the taxi and takeoff roll
         a. Keep as much weight as possible off the nose to prevent it from getting stuck, or digging in
      ii. Keep the aircraft moving – stopping may get the airplane stuck or require significant power to move
      iii. 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)

D. RM: Runway Selection AI.VII.C.K2, AI.VII.C.R1
 i. Wind: Reasons to take off into the wind
  a. Even motionless, a headwind will provide some airspeed due to wind moving over the wings
  b. Decreases wheel speed necessary to achieve flying speed
  c. Increases climb performance
  d. RM: Tailwind increases required ground roll (RM: Effects of Tailwind) AI.VII.C.R2c
   - POH: Reference any max takeoff tailwind limitation
  e. Crosswind: Reference any max crosswind limitation (POH)
   - Ensure proficiency & within personal minimums
 ii. Aircraft Performance
  a. Atmospheric Pressure
   - Since air is a gas, it can be compressed or expanded, affecting density
   - Changes in air density affect performance - As density increases, performance increases & vice versa
  b. What Changes Air Density (DA)? Barometric Pressure, Temperature, Altitude, and Humidity
   - Density varies directly with pressure - As pressure increases, density increases and vice versa
   - Density varies inversely with temperature – As temp increases, density decreases and vice versa
   - Density varies inversely with altitude - As altitude increases, density decreases and vice versa
   - Density varies inversely with humidity – As humidity increases, density decreases and vice versa
  c. How it affects Performance - As the air becomes less dense, it reduces:
   - Power, since the engine takes in less air
   - Thrust, since the propeller is less efficient in thin air (less air is being moved for every rotation)
   - Lift, because the thin air exerts less force on the airfoils
 iii. Runway Characteristics AI.VII.C.R2e
  a. Surface: More friction associated with softer surfaces – increases takeoff roll
  b. Gradient: Upsloping runway increases takeoff roll – reference the Chart Supplement for runway gradient
  c. Condition: Dry, wet, snow, ice, etc. affects braking effectiveness
  d. Available Distance: Runway length available for takeoff
 iv. Performance Charts
  a. Take into account all of the above information, and more (weight, configuration, etc.)
  b. Reference takeoff & climb performance charts (generally, takeoff distance & takeoff climb)
   - Verify required distance and climb abilities are compatible with the runway/environment
 v. Pilot Capability
  a. Set and strictly adhere to personal minimums (runway length/width, winds, weather, etc.)
  b. Ensure proficiency and safety

E. Best Angle versus Best Rate of Climb AI.VII.C.K3
 i. Best Rate of Climb (V_Y)
  a. Airspeed producing the most altitude gain in the least time (max feet per minute)
   - Airspeed where the most excess *power* is available over that required for level flight
  b. Used in normal takeoff and climb procedures
 ii. Best Angle of Climb (V_X)
  a. Airspeed that will produce the most altitude gain in a given distance
   - Airspeed where the most excess t*hrust* is available over that required for level flight
   - V_X will result in a steeper climb path, but will take longer to reach altitude than a climb at V_Y
    a Therefore, V_X is used in clearing obstacles after takeoff



F. Configuration: Reference the POH and Before Takeoff checklist AI.VII.C.K4

2. Taxi

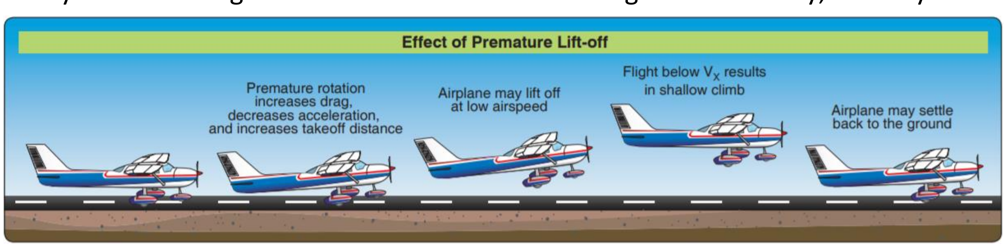
A. Keep the elevator fully aft for the entire taxi
   i. Keeps weight off the nose wheel keeping it from getting stuck or bogged down
B. More power is necessary due to the increased ground friction/drag
C. Keep turns shallow and don't stop (helps prevent the plane getting stuck or bogged down)
D. Airport 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 (approach area, and runway)

3. Takeoff Roll

A. Continue to maintain back elevator pressure and movement
   i. RM: Apply crosswind corrections in addition to the back pressure AI.VII.C.R2a
      a. Aileron into the wind, rudder for centerline – reduce aileron to maintain wings level as speed increases
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 AI.VII.C.K7
   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

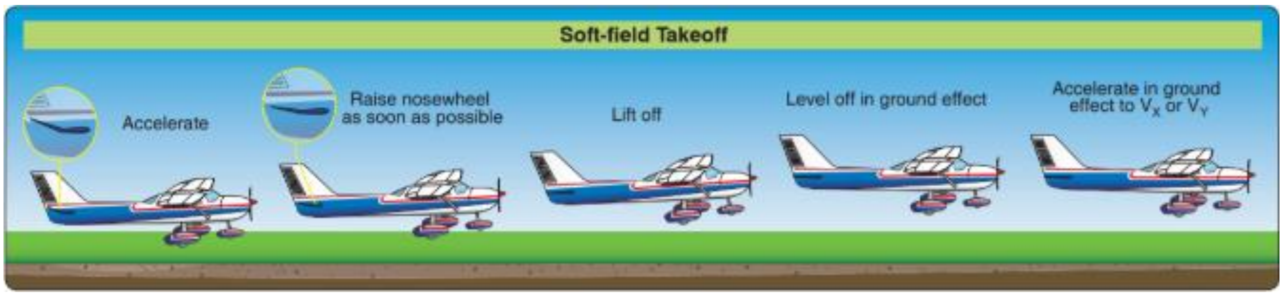
4. Lift-Off

A. Once off the ground, gently lower the nose and accelerate to V_X or V_Y in ground effect
   i. Remain within ½ wingspan 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
         - Initially can be very uncomfortable
   ii. Accelerate to V_Y for a normal climb, V_X if an obstacle must be cleared
      a. 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
C. Climb Checklist
    i. Accomplish the climb checklist at a safe altitude, with the airplane under control



6. Common Errors AI.VII.C.K8

A. Failure to review AFM/POH and performance charts prior to takeoff.
B. Failure to adequately clear the area.
C. Insufficient back-elevator pressure during initial takeoff roll resulting in inadequate AOA.
D. Failure to cross-check engine instruments for indications of proper operation after applying power.
E. Poor directional control.
F. Climbing too high after lift-off and not leveling off low enough to maintain ground effect attitude.
G. Abrupt and/or excessive elevator control while attempting to level off and accelerate after liftoff.
H. Allowing the airplane to "mush" or settle resulting in an inadvertent touchdown after lift-off.
I. Attempting to climb out of ground effect area before attaining sufficient climb speed.
J. Failure to anticipate an increase in pitch attitude as the airplane climbs out of ground effect.

7. RM: Hazards & Emergencies

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. VII. RM Concepts – Rejected Takeoff AI.VII.C.R3a
B. VII. RM Concepts – Engine Failure AI.VII.C.R3b
C. VII. RM Concepts – Wind Shear AI.VII.C.R2b
D. VII. RM Concepts – Wake Turbulence AI.VII.C.R2d
E. VII. RM Concepts – Distractions, Task Prioritization, SA AI.VII.C.R6
F. VII. RM Concepts – Low Altitude Maneuvering AI.VII.C.R5
G. VII. RM Concepts – Collision Hazards AI.VII.C.R4

Conclusion:

Brief review of the main points

VII.D. Soft-Field Approach & Landing

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

Objectives	The learner has the knowledge and ability to perform a soft field approach and landing as necessary based on the ACS 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. Runway Selection 3. Approach 4. Landing 5. After Landing Roll & Taxi 6. Common Errors 7. Hazards & Emergencies
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 learner can demonstrate knowledge of and has shown proficiency in Soft Field approaches and landings, without the assistance of a flight instructor. The learner can judge when to begin the flare, when to add power to the flare and can correct any misjudgments. Finally, the learner 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 AI.VII.D.K1

It is important to learn to land on soft field runways 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. **Runway Selection** AI.VII.D.K3, AI.VII.D.R1
   A. Wind
      i. Headwind decreases groundspeed and therefore landing distance
      ii. RM: Tailwind increases groundspeed and therefore landing distance AI.VII.D.R2c
         a. Reference the POH for any max tailwind landing limitations
      iii. Crosswind: Reference any crosswind limitations (POH)
         a. Ensure proficiency & within personal minimums
   B. Aircraft Performance
      i. Atmospheric Pressure
         a. Since air is a gas, it can be compressed or expanded, affecting density
         b. Changes in air density affect performance - As density increases, performance increases & vice versa
      ii. What Changes Air Density (DA)? 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
      iii. How it affects Performance
         a. As the air becomes less dense, it reduces:
            - Power, since the engine takes in less air
            - Thrust, since the propeller is less efficient in thin air (less air is being moved for every rotation)
            - Lift, because the thin air exerts less force on the airfoils
         b. Density Altitude & Landing

- Affects climb capability in the case of a go-around
- Higher density altitude = higher true airspeed which increases the landing roll

C. RM: Runway Characteristics AI.VII.D.R2e
   i. Surface: More friction associated with softer surfaces – decreases landing roll
   ii. Gradient: Down sloping runway increases landing roll – reference the Chart Supplement for runway gradient
   iii. Condition: Dry, wet, snow, ice, etc. affects braking effectiveness
   iv. Available Distance: Runway length available for landing

D. Performance Charts
   i. Charts take into account all of the above information, and more (weight, configuration, etc.)
   ii. Reference landing & climb performance charts (generally, landing distance/performance & climb performance or balked landing climb charts)
      a. Verify required distance and climb abilities are compatible with the runway/environment

E. Pilot Capability
   i. Set and strictly adhere to personal minimums (runway length/width, winds, weather, etc.)
   ii. Ensure proficiency and safety

F. Limitations - Chap 2 of the POH, Reference any applicable limitations for soft-field landings

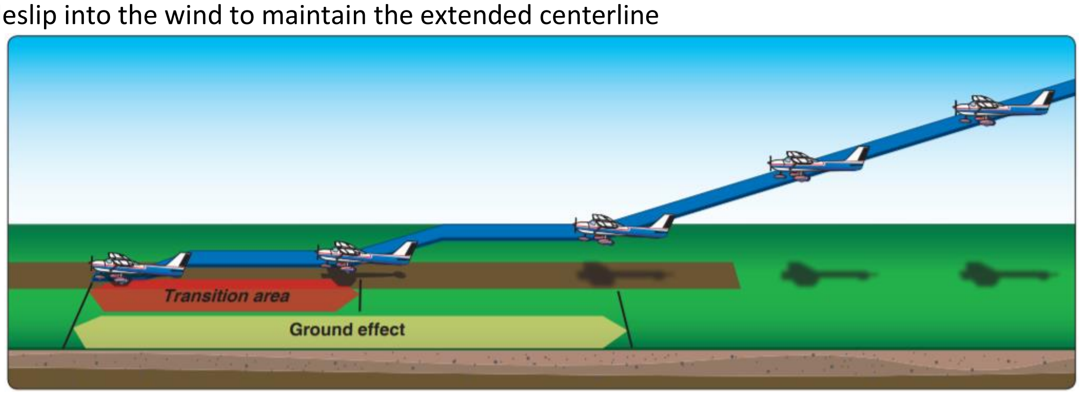
3. Approach

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.

B. Maintain a Stabilized Approach AI.VII.D.K2
   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. Always keep one hand on the throttle (within reason)

C. Maintain Coordination – All turns should be coordinated and no more than 30^{o} of bank

D. RM: Maintain a Precise Ground Track (RM: Effects of crosswind) AI.VII.D.K4, AI.VII.D.R2a
   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



4. Landing

A. The major differences between a soft-field and a normal landing:
   i. The airplane is held 1 to 2' above the ground, in ground effect as long as possible

a. The airplane should be flown onto the ground with the weight fully supported by the wings
ii. A small amount of power is used during touchdown to cushion the landing
iii. After main wheel touchdown, hold sufficient back pressure to keep the nose wheel off the surface

B. Touchdown
i. Continue to maintain one hand on the throttle lever
a. At any time, the pilot should be able to apply full power and perform a safe takeoff
ii. Increase power slightly just prior to touchdown to cushion landing & slowly transfer weight to the wheels
a. The addition of power will vary based on aircraft and the terrain
- Ex: Tall thick grass (more drag, therefore more power) versus packed dirt (less drag, less power)

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

F. Braking should be avoided to prevent the nose gear from striking the landing surface / digging in

G. RM: Landing in a Crosswind (RM: Effects of crosswind) AI.VII.D.K4, AI.VII.D.R2a
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

H. 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. After Landing Roll / Taxi

A. Continue to maintain full aft elevator pressure, as well as wind correction
B. Maintain directional control through the rudders
C. Braking is normally accomplished through surface friction with the ground
i. Often will need to add power to keep moving
D. Maintain enough speed to prevent becoming bogged down
E. Retract the flaps after the landing roll is completed
F. Perform the After-Landing Checklist once parked

6. Common Errors AI.VII.D.K5

A. Excessive descent rate on final approach.
B. Excessive airspeed on final approach.
C. Unstable approach.
D. Round out too high above the runway surface.
E. Poor power management during round out and touchdown.
F. Hard touchdown.
G. Inadequate control of the airplane weight transfer from wings to wheels after touchdown.
H. Allowing the nose-wheel to "fall" to the runway after touchdown rather than controlling its descent.

7. RM: Hazards & Emergencies

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. VII. RM Concepts – Rejected Landing & Go-Around AI.VII.D.R3a
B. VII. RM Concepts – Land and Hold Short Operations (LAHSO) AI.VII.D.R3b
C. VII. RM Concepts – Wind Shear AI.VII.D.R2b
D. VII. RM Concepts – Wake Turbulence AI.VII.D.R2d
E. VII. RM Concepts – Distractions, Task Prioritization, SA AI.VII.D.R6

F. VII. RM Concepts – Low Altitude Maneuvering AI.VII.D.R5
G. VII. RM Concepts – Collision Hazards AI.VII.D.R4

Procedures for a soft-field landing AI.VII.D.K1
The lesson as a whole is a discussion of soft-field procedures

Conclusion:
Brief review of the main points

VII.E. Short-Field Takeoff & Maximum Performance Climb

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

Objectives	The learner should develop knowledge of the elements related to short field takeoffs and maximum performance climbs. The learner can demonstrate a short field takeoff and climb as prescribed in the necessary ACS.
Key Elements	1. Use the Entire Runway 2. Maximum Performance Climb at V_X 3. Focus Outside the Airplane
Elements	1. Best Rate versus Best Angle of Climb 2. Pre-Takeoff 3. Short-Field Takeoff & Max Performance Climb 4. Common Errors 5. Hazards & 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 learner shows the ability to execute a proper short-field takeoff and climb by using the entire runway, after rotation 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

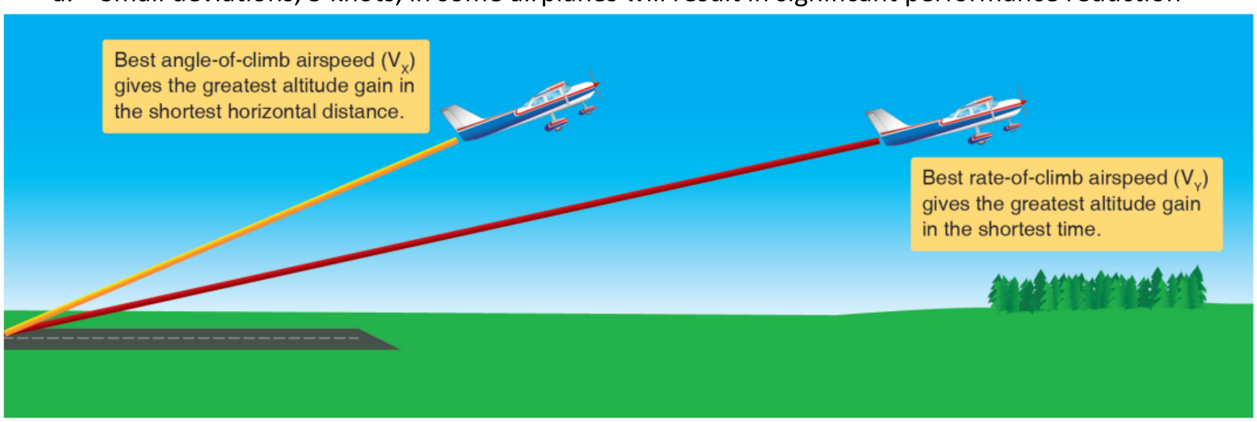
Takeoffs and climbs from fields where the takeoff area is short, or the available takeoff area is restricted by obstructions requiring the pilot to operate the airplane at the limit of its takeoff performance capabilities.

Why AI.VII.E.K1

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 and provides the pilot with the ability to use airports that they otherwise could not.

How:

1. **Best Rate versus Best Angle of Climb** AI.VII.E.K3
   A. Best Rate of Climb (V_Y)
      i. Performed at the airspeed producing the most altitude gain in the least time (max feet per minute)
         a. Airspeed where the most excess *power* is available over that required for level flight
      ii. Used in normal takeoff and climb procedures
   B. Best Angle of Climb (V_X)
      i. Performed at an airspeed that will produce the most altitude gain in a given distance
         a. Airspeed where the most excess t*hrust* is available over that required for level flight
      ii. V_X will result in a steeper climb path, but will take longer to reach altitude than a climb at V_Y
         a. Therefore, V_X is used in clearing obstacles after takeoff
      iii. Precise airspeed control is very important
         a. Small deviations, 5 knots, in some airplanes will result in significant performance reduction



2. **Pre-Takeoff**
   A. RM: Runway Selection AI.VII.E.K2, AI.VII.E.R1
      i. Wind: Reasons to take off into the wind

a. Even motionless, a headwind will provide some airspeed due to wind moving over the wings
b. Decreases wheel speed necessary to achieve flying speed
c. Increases climb performance
d. RM: Tailwind increases required ground roll (RM: Effects of Tailwind) AI.VII.E.R2c
   - Decreases performance
   - POH: Reference any max takeoff tailwind limitation
e. Crosswind: Reference any crosswind limitations (POH) and ensure proficiency & within personal mins

ii. Aircraft Performance
   a. Atmospheric Pressure
      - Since air is a gas, it can be compressed or expanded, affecting density
      - Changes in air density affect performance - As density increases, performance increases & vice versa
   b. What Changes Air Density (DA)? Barometric Pressure, Temperature, Altitude, and Humidity
      - Density varies directly with pressure - As pressure increases, density increases and vice versa
      - Density varies inversely with temperature – As temp increases, density decreases and vice versa
      - Density varies inversely with altitude - As altitude increases, density decreases and vice versa
      - Density varies inversely with humidity – As humidity increases, density decreases and vice versa
   c. How it affects Performance - As the air becomes less dense, it reduces:
      - Power, since the engine takes in less air
      - Thrust, since the propeller is less efficient in thin air (less air is being moved for every rotation)
      - Lift, because the thin air exerts less force on the airfoils

iii. Runway Characteristics AI.VII.E.R2e
   a. Surface: More friction associated with softer surfaces – increases takeoff roll
   b. Gradient: Upsloping runway increases takeoff roll – reference the Chart Supplement for runway gradient
   c. Condition: Dry, wet, snow, ice, etc. affects braking effectiveness
   d. Available Distance: Runway length available for takeoff

iv. Performance Charts
   a. Take into account all of the above information, and more (weight, configuration, etc.)
   b. Reference takeoff & climb performance charts (generally, takeoff distance & takeoff climb)
      - Verify required distance and climb abilities are compatible with the runway/environment

v. Pilot Capability
   a. Set and strictly adhere to personal minimums (runway length/width, winds, weather, etc.)
   b. Ensure proficiency and safety

vi. Limitations (Chapter 2 of the POH): Runway, crosswind, etc. limitations

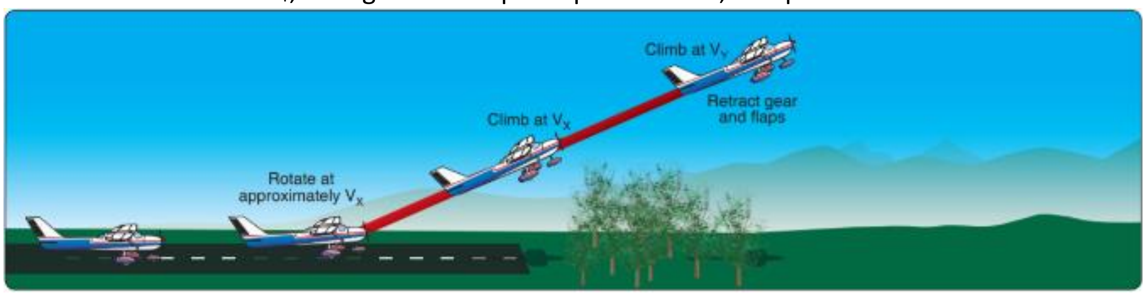
B. Configure according to the POH AI.VII.E.K4

3. Short-Field Takeoff & Climb

A. Takeoff Roll
   i. Start at the very beginning of the takeoff area. The field is short, don't waste runway
      a. Align the airplane with the runway centerline and come to a complete stop
      b. Apply crosswind correction AI.VII.E.R2a
         - Aileron into the wind, rudder for centerline – reduce aileron as speed increases
   ii. Smoothly and continuously advance the throttle to maximum power
      a. Follow the manufacturer's procedures (i.e., hold brakes and apply max power)
   iii. Check the instruments, announce "airspeed alive," "engine gauges green"
      a. Do not hesitate to abort the takeoff if there is a problem
   iv. Maintain directional control with the rudders
   v. The airplane should be allowed to roll with full weight on the main wheels and accelerate to liftoff speed
      a. Keep the elevator neutral to minimize drag/maximize acceleration

B. Lift-Off
   i. Smoothly and firmly rotate at V_R to the pitch attitude that will result in a V_X climb
      a. Use outside references/attitude indicator to maintain the correct attitude
   ii. In the case the airplane lifts off prior to V_R, allow the plane to accelerate in ground effect to V_X
      a. Preferable to forcing the airplane to remain on the ground with forward pressure
         - Could result in "wheel barrowing," reducing acceleration and performance
      b. Do not intentionally raise the nose prior to V_R – results in increased drag and prolonged roll
   iii. Once airborne, a wings level climb should be maintained at V_X until obstacles have been cleared
      a. Since the airplane accelerates after liftoff, additional back pressure is required to maintain V_X
      b. Remove crosswind corrections and crab into the wind AI.VII.E.R2a

C. Maximum Performance Climb
   i. Climb at V_X until clear of obstacles
      a. Maintain visual references, glance at the attitude / airspeed indicators to check pitch and V_X
   ii. Configuration is not changed until clear of obstacles (unless recommended by the manufacturer)
   iii. Once clear of obstacles pitch for V_Y
      a. Visually – Normal takeoff climb picture
      b. Once stabilized at V_Y, configure the airplane per the POH, complete the climb checklist as normal



4. Common Errors AI.VII.E.K5

A. Failure to review AFM/POH and performance charts prior to takeoff.
B. Failure to adequately clear the area.
C. Failure to utilize all available runway/takeoff area.
D. Failure to have the airplane properly trimmed prior to takeoff.
E. Premature lift-off resulting in high drag.
F. Holding the airplane on the ground unnecessarily with excessive forward-elevator pressure.
G. Inadequate rotation resulting in excessive speed after lift-off.
H. Inability to attain/maintain V_X and/or fixation on the airspeed indicator during initial climb.
I. Premature retraction of landing gear and/or wing flaps.

5. RM: Hazards & Emergencies

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. VII. RM Concepts – Rejected Takeoff AI.VII.E.R3a
B. VII. RM Concepts – Engine Failure AI.VII.E.R3b
C. VII. RM Concepts – Wind Shear AI.VII.E.R2b
D. VII. RM Concepts – Wake Turbulence AI.VII.E.R2d
E. VII. RM Concepts – Distractions, Task Prioritization, SA AI.VII.E.R6
F. VII. RM Concepts – Low Altitude Maneuvering AI.VII.E.R5
G. VII. RM Concepts – Collision Hazards AI.VII.E.R4

Conclusion:
Brief review of the main points

VII.F. Short-Field Approach & Landing

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

Objectives	The learner develops knowledge of the short-field approach and landing. The learner understands the procedures involved and can properly execute them as prescribed in the ACS.
Key Elements	1. 4º 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 4. Common Errors 5. Hazards & 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 learner can perform a well-coordinated and stabilized short-field approach and landing as required in the ACS.

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 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 AI.VII.F.K1

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, to land safely within confined areas. To land on a short field, the pilot must have precise, positive control of the rate of descent and airspeed.

How:

1. **Short-Field Considerations**
   A. Obstructions and Hazards
      i. The short field approach allows the pilot to land over obstacles limiting available landing area
         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
      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
   B. RM: Runway Selection AI.VII.F.K3, AI.VII.F.R1
      i. Wind
         a. Headwind decreases groundspeed and therefore landing distance
         b. RM: Tailwind increases groundspeed and therefore landing distance AI.VII.F.R2c
            - Reference the POH for any max tailwind landing limitations
         c. Crosswind: Reference any crosswind limitations (POH)
            - Ensure proficiency & within personal minimums
      ii. Aircraft Performance
         a. Atmospheric Pressure
            - Since air is a gas, it can be compressed or expanded, affecting density
            - Changes in air density affect performance - As density increases, performance increases & vice versa
         b. What Changes Air Density (DA)? Barometric Pressure, Temperature, Altitude, and Humidity
            - Density varies directly with pressure - As pressure increases, density increases and vice versa
            - Density varies inversely with temperature – As temp increases, density decreases and vice versa
            - Density varies inversely with altitude - As altitude increases, density decreases and vice versa

- Density varies inversely with humidity – As humidity increases, density decreases and vice versa

c. How it affects Performance
- 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
- Density Altitude & Landing
  - a Affects climb capability in the case of a go-around
  - b Higher density altitude = higher true airspeed which increases the landing roll

iii. RM: Runway Characteristics AI.VII.F.R2e
   a. Surface: More friction associated with softer surfaces – decreases landing roll
   b. Gradient: Down sloping runway increases landing roll – reference the Chart Supplement for gradient
   c. Condition: Dry, wet, snow, ice, etc. affects braking effectiveness
   d. Available Distance: Runway length available for landing

iv. Performance Charts
   a. Charts take into account all of the above information, and more (weight, configuration, etc.)
   b. Reference landing & climb performance charts (generally, landing distance/performance & climb performance or balked landing climb charts)
      - Verify required distance and climb abilities are compatible with the runway/environment

v. Pilot Capability
   a. Set and strictly adhere to personal minimums (runway length/width, winds, weather, etc.)
   b. Ensure proficiency and safety

vi. Limitations - Chap 2 of the POH, Reference any applicable limitations for short-field landings

2. Configuration, Coordination, & Trim

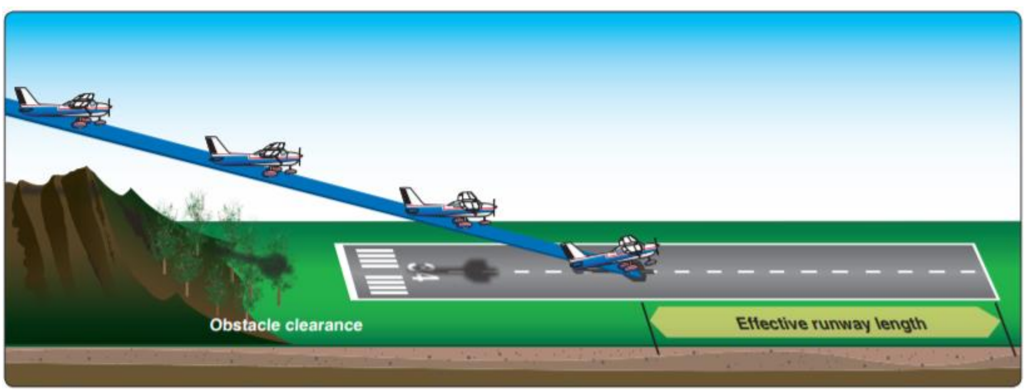
A. Configure per the POH

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 all turns coordinated

D. Trim to maintain approach speed (assists in more stable approach)

3. Short-Field Approach AI.VII.F.K1



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, configure as required and establish descent

B. Base Leg

i. Technique: Configure for the landing

a. Allows more time to get stabilized (trim for pitch/airspeed)

b. Another option is to configure on final

ii. Adjust the turn to final to roll out on the centerline (use a shallow, coordinated turn)

C. Final Approach

i. Configure, as required

a. Trim to maintain pitch/airspeed

ii. Usually started at least 500’ AGL (can vary based on obstacles / other requirements)

iii. Establish and maintain a 4° glide path

a. If you haven’t already, extend the landing flaps and trim for approach speed

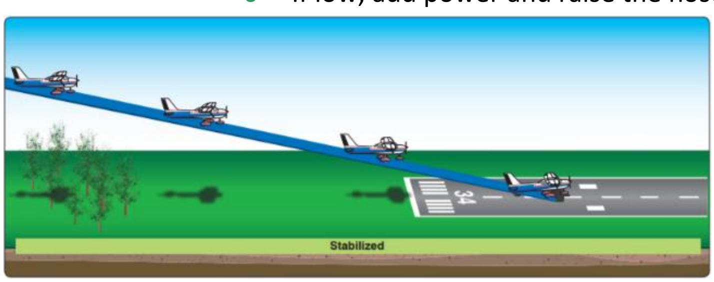
b. VASIs/PAPIs will indicate a high glide path
  - VASIs – Both bars White; PAPIs –4 White lights (Indicates above a 3.5° glide slope)

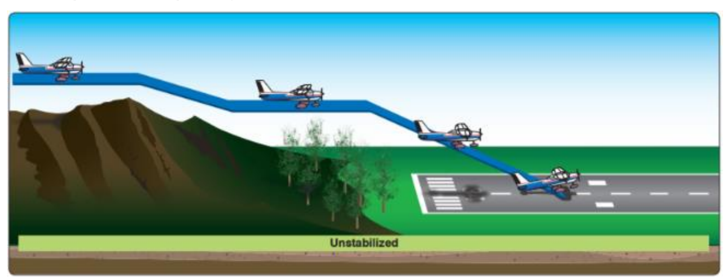
c. When practicing the approach / landing, an obstacle will be simulated at the approach end
  - The airplane should be approximately 100’ AGL at the approach end to ensure clearance

iv. Maintaining a Stabilized Approach AI.VII.F.K2

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





v. Wind Correction AI.VII.F.K4

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. RM: Crosswind/Ground Track (RM: Effects of crosswind) AI.VII.F.R2a
- Crab into the wind until ready to establish a sideslip for landing

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

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
a. Maintain a sideslip for crosswind conditions AI.VII.F.R2a
ii. Upon touchdown & closing the throttle:
a. Apply max effective braking (braking to the point just prior to skidding the tires)
b. In many aircraft, immediately retract flaps to decrease lift and transfer weight to the wheels
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

4. Common Errors AI.VII.F.K5

A. A final approach that necessitates an overly steep approach and high sink rate.
B. Unstable approach.
C. Undue delay in initiating glide path corrections.
D. Too low an airspeed on final resulting in inability to flare properly and landing hard.
E. Too high an airspeed resulting in floating on round out.
F. Prematurely reducing power to idle on round out resulting in hard landing.
G. Touchdown with excessive airspeed.
H. Excessive and/or unnecessary braking after touchdown.
I. Failure to maintain directional control.
J. Failure to recognize and abort a poor approach that cannot be completed safely.

5. RM: Hazards & Emergencies

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. VII. RM Concepts – Rejected Landing & Go-Around AI.VII.F.R3a
B. VII. RM Concepts – Land and Hold Short Operations (LAHSO) AI.VII.F.R3b
C. VII. RM Concepts – Wind Shear AI.VII.F.R2b
D. VII. RM Concepts – Wake Turbulence AI.VII.F.R2d
E. VII. RM Concepts – Distractions, Task Prioritization, SA AI.VII.F.R6
F. VII. RM Concepts – Low Altitude Maneuvering AI.VII.F.R5
G. VII. RM Concepts – Collision Hazards AI.VII.F.R4

Conclusion:

Brief review of the main points

VII.M. Slip to a Landing

References: Airplane Flying Handbook (FAA-H-8083-3), Pilot's Handbook of Aeronautical Knowledge (FAA-H-8083-25), Aviation Weather Handbook (FAA-H-8083-28), POH/AFM

Objectives	The learner should develop knowledge of the elements related to forward slips, as well as sideslips and can perform either one. The learner can perform the forward slip to a landing as required in the ACS.
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. Forward Slip Operations 4. Performing the Forward Slip 5. Performing the Sideslip 6. Runway Selection 7. Common Errors 8. Hazards & Emergencies
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 learner can 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

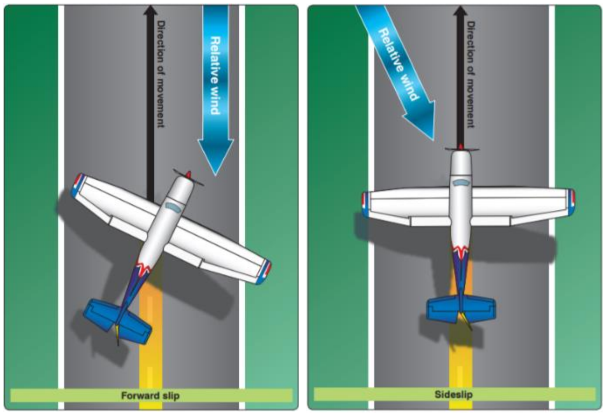
A slip occurs when the bank angle of an airplane is too steep for the rate of turn. The airplane is in essence flying sideways which increases drag as well as the rate of descent, without increasing the airspeed.

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?** AI.VII.M.K1
   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 to original path)
         c. The amount of slip (& sink rate) is determined by amount of bank
      ii. Sideslip – used in crosswind landings to keep aligned with the centerline & prevent drift
         a. Longitudinal axis remains parallel to the original flight path
         b. Lower one wing into the wind, & use opposite rudder to keep the longitudinal axis aligned with the centerline
            - Aileron corrects for wind; rudder keeps centerline alignment
         c. Touchdown occurs 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. RM: Forward Slip Operations AI.VII.M.R7

A. Airspeed Indicator Errors
    i. Airspeed indicators may have considerable error when in a slip
    ii. A change in either the static or ram pressure will result in a change in the airspeed
        a. Static Error Example – Static port on the left side, and pilot enters a slip to the left
            - Static port now receives some amount of ram air pressure
            - Static pressure increases, and for arguments sake, the ram (pitot) pressure remains the same
            - Results in a lower indicated airspeed than what is being flown
        b. Pitot Error Example
            - Pitot tube is no longer directly into the relative wind; ram air pressure accuracy may be reduced
    iii. Reference the POH, be aware of any airspeed indicator errors / limitations
    iv. The pilot must be aware of the potential for errors and recognize a properly performed slip by the:
        a. Airplane attitude, sound of the airflow, and feel of the flight controls

B. Stalls in a Slip
    i. If improperly flown, a cross-controlled stall can be entered in a slip
        a. Can be extremely hazardous close to the ground – some aircraft tend to roll over
    ii. Displays little of the yawing tendency that causes a skidding stall to develop into a spin
        a. Stall characteristics may be improved, the airplane may even tend to roll into a wings level attitude
        b. In a slip, the raised wing has a higher angle of attack than the low wing and will stall first
            - Often the stall of the high wing first will reduce the bank angle, preventing a further stall
    iii. Tail Stalls with Flaps
        a. Not recommended to slip some aircraft with flaps extended, because it can result in a tail stall
            - Generally, having the flaps extended at high AOAs blanks out the relative wind over the horizontal stabilizer and can result in a tail stall (may not be possible to recover)
        b. Follow the manufacturer's recommendations, and remove the slip at any indication of stall

C. Fuel Flow
    i. In uncoordinated flight forces may pull fuel away from the fuel lines
        a. Potential to cause fuel starvation and engine stoppage
        b. Risk is greatest when fuel levels are low
    ii. Remove the slip at any indication of engine coughing or roughness

4. Performing the Forward Slip AI.VII.M.K1, AI.VII.M.K2, AI.VII.M.K4

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)
    iv. Extend the flaps as necessary

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 the opposite direction so the airplane is at an angle to the original flight path
        a. The amount of yaw is such that the ground track is maintained
    iii. Raise the nose to prevent the airspeed from increasing

C. RM: Stabilized Approach AI.VII.M.R9

- i. 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
- ii. Pitch Attitude – smoothly adjust pitch to maintain the desired approach speed
- iii. 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
- iv. Crosscheck should increase during a slip
- v. Stable is safe. Excessive swings in descent rates, airspeed, or ground track is unsafe
  - a. 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. RM: Touching down in a forward slip could be hazardous to the pilot and aircraft AI.VII.M.R8
  - a. Never land in a forward slip. Can impose severe side loads on the gear

5. Performing the Sideslip AI.VII.M.K1, AI.VII.M.K2, AI.VII.M.K4

A. Entering
- 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
    - Always keep one hand on the throttle (within reason)
  - b. Extend flaps as necessary
- 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. RM: Crosswind Limits AI.VII.M.R2a
    - 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
    - Situation where a high rate of descent is required, and landing will be performed with a crosswind
  - b. The forward slip should be performed into the wind
  - c. On a normal glidepath, remove the forward slip, maintain airspeed/glidepath, and establish a sideslip

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. Use bank to counter the crosswind and rudder to align with the centerline
  - b. As conditions vary (gusts, etc.) adjust aileron and rudder
- iii. Excessive swings in descent, airspeed, and ground track can be hazardous; go around if unstable

C. Landing in a Sideslip AI.VII.M.R2a

   i. Maintain the slip during landing - Removing the sideslip over the runway will result in drifting
      a. 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 main, then the nosewheel
   iii. Maintain directional control after touchdown
      a. Directional control must be maintained to counter the crosswind after landing
      b. Keep the aileron into the wind. As speed decreases, increase aileron deflection

6. **RM: Runway Selection** AI.VII.M.R1
   A. Wind
      i. Preferred to land with a headwind – reduces landing distance
      ii. RM: Tailwinds increase ground speed/ground roll (verify limitations) (RM: Effects of tailwind) AI.VII.M.R2c
      iii. RM: Ensure any crosswind is within limits (personal & POH) (RM: Effects of crosswind) AI.VII.M.R2a
   B. Aircraft Performance
      i. Atmospheric Pressure
         a. Since air is a gas, it can be compressed or expanded, affecting density
         b. Changes in air density affect performance - As density increases, performance increases & vice versa
      ii. What Changes Air Density (DA)? 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
      iii. How it affects Performance
         a. As the air becomes less dense, it reduces:
            - Power, since the engine takes in less air
            - Thrust, since the propeller is less efficient in thin air (less air is being moved for every rotation)
            - Lift, because the thin air exerts less force on the airfoils
         b. Density Altitude & Landing
            - Affects climb capability in the case of a go-around
            - Higher density altitude = higher true airspeed which increases the landing roll
   C. RM: Runway Characteristics AI.VII.M.R2e
      i. Surface: More friction associated with softer surfaces decreases landing roll
      ii. Gradient: Down sloping runway increases landing roll
      iii. Condition : Dry, wet, snow, ice, etc. affect braking effectiveness
      iv. Available Distance: Compare to the required landing distance
   D. Performance Charts
      i. Take into account all of the above information, and more (weight, configuration, etc.)
      ii. Verify required landing distance based on the specific conditions (atmospheric, airplane, etc.)
   E. Pilot Capability: Strictly adhere to personal minimums – Ensure proficiency and safety
   F. Limitations: Reference any associated landing limitations in the POH

7. **Common Errors** AI.VII.M.K5
   A. Incorrect pitch adjustments that result in poor airspeed control.
   B. Reacting to erroneous airspeed indications.
   C. Using excess power while trying to lose altitude.
   D. A slip in the same direction as any crosswind.
   E. Poor glidepath control.
   F. Late transition to a sideslip during landing with crosswinds.
   G. Landing without the longitudinal axis parallel to runway.
   H. Landing off the centerline.

8. **RM: Hazards & Emergencies**

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. VII. RM Concepts – Rejected Landing & Go-Around AI.VII.M.R3a
B. VII. RM Concepts – Land and Hold Short Operations (LAHSO) AI.VII.M.R3b
C. VII. RM Concepts – Wind Shear AI.VII.M.R2b
D. VII. RM Concepts – Wake Turbulence AI.VII.M.R2d
E. VII. RM Concepts – Distractions, Task Prioritization, SA AI.VII.M.R6
F. VII. RM Concepts – Low Altitude Maneuvering AI.VII.M.R5
G. VII. RM Concepts – Collision Hazards AI.VII.M.R4

Conclusion:
Brief review of the main points

VII.N. Go-Around/Rejected Landing

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

Objectives	The learner develops knowledge of the Go-Around/Rejected Landing. The learner understands the importance of a prompt decision and can quickly and safely configure the airplane and adjust its attitude to accomplish a go-around. The learner will perform the maneuver to the standards prescribed in the ACS.
Key Elements	1. Power 2. Attitude 3. Configuration
Elements	1. Go-Around Situations 2. Making a Prompt Decision 3. Cardinal Principles 4. Climb Out 5. Communication 6. Performance Factors 7. Common Errors 8. Hazards
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 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 must discontinue a landing and set up another one. This may be a result of a dangerous situation or may just be necessary to re-establish an approach. Either way, we 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 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. It is warranted whenever landing conditions are not satisfactory and the landing should be abandoned or attempted again.

Why AI.VII.N.K1

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 proximity of the ground.

How:

1. **Go-Around Situations**
   - A. Air traffic control requirements
     - i. Low approach only request, told to go-around, etc.
   - B. Unstable Approach (emphasize the importance of a stable approach)
     - i. Too low, too high, not aligned with the runway, airspeed control, rate of descent
     - ii. A stable approach can be the most useful tool in avoiding a pilot induced go-around AI.VII.N.K2
       - a. Set pitch and power, and make proactive adjustments to manage energy
       - b. Maintain a stable site picture to the aim point
       - c. Wind correction on approach & landing AI.VII.N.K4
         - Crab to maintain track & transition to a sideslip when ready
   - C. Unexpected hazards on the runway (another airplane, vehicles, animals, etc.)
     - i. Runway incursion: Be prepared to go-around in the case another aircraft enters the runway AI.VII.N.R9
   - D. Overtaking another airplane
   - E. Wind Shear/Wake Turbulence
   - F. Mechanical Failure (Ex: Gear issues)
   - G. Whenever safety dictates
2. **RM: Making a Prompt Decision**
   - A. Not inherently dangerous, but becomes dangerous when unnecessarily delayed or executed improperly
   - B. RM: Delaying a go-around tends to stem from two sources: AI.VII.N.R2
     - i. Landing Expectancy: Belief that conditions are not threatening, and the approach will end safely
     - ii. Pride: Mistaken belief that the act of going around is an admission of failure
   - C. RM: Delayed Recognition of the Need to Go-Around AI.VII.N.R1
     (RM: Delayed performance of a go-around at low altitude)
     - i. Set and maintain standard operating procedures (SOPs) & altitude gates

a. Outside of SOP at the altitude gate = go-around. Examples will vary by aircraft, but could include:
    - 500' – Configured, airspeed ±5 knots, bank < 15°, on the desired approach path
    - 250' – Same as 500' but with crosswind corrections established

ii. Specific, measurable criteria allow for a logical easy decision (no emotion or questions)

D. 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. Stick to your decision. Safety first, always!

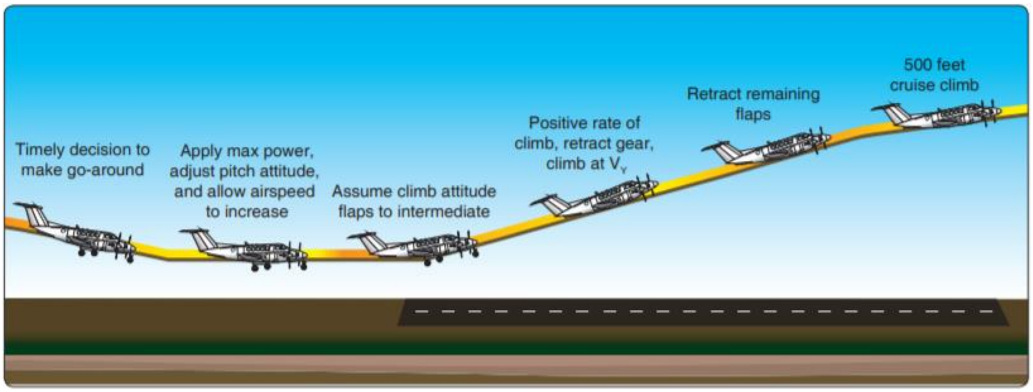
3. Cardinal Principles – Power, Attitude, Configuration AI.VII.N.K1

A. RM: Power – the pilot's first concern AI.VII.N.R3
  i. The instant the pilot decides to go-around, apply max takeoff power smoothly / without hesitation
  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)
    b. The nose will veer left
      - Right rudder pressure is necessary to counteract the left turning tendencies

B. Attitude
  i. Attitude is always critical when close to the ground
  ii. An attitude must be established to allow the plane to gain sufficient speed before climbing / turning
  iii. Establish power, stop the descent, and when able, pitch to climb at V_Y (V_X, if obstacles)
  iv. "Rough trim" the airplane
    a. Quick relieving of the control pressures. Trim more precisely once stable
  v. Controlling 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
  vi. Summary: Increase power to max, stop the descent, and when safe, pitch to climb at V_Y (or V_X)

C. RM: Configuration AI.VII.N.R4
  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

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. Wind Correction AI.VII.N.K4
    i. Crab into the wind to maintain the extended centerline
    ii. Select two or more visual reference points directly ahead of the plane and keep them aligned
    iii. Occasionally glance back toward the runway to ensure the proper track and no drift
    iv. Use a moving map to align your track with the extended runway centerline

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
B. RM: Go-around with a LAHSO clearance (AIM 4-3-11 b(6)) AI.VII.N.R8
    i. LAHSO clearance does not preclude a go-around
    ii. If necessary, execute the go-around, maintain safe separation from aircraft/vehicles, and notify ATC

6. Performance Factors AI.VII.N.K3

A. Atmospheric Conditions
    i. Atmospheric Pressure
        a. Since air is a gas, it can be compressed or expanded, affecting density
        b. Changes in air density affect performance - As density increases, performance increases & vice versa
    ii. What Changes Air Density (DA)? 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
    iii. How it affects Performance
        a. As the air becomes less dense, it reduces:
            - Power, since the engine takes in less air
            - Thrust, since the propeller is less efficient in thin air (less air is being moved for every rotation)
            - Lift, because the thin air exerts less force on the airfoils
B. Wind
    i. Headwinds increase climb performance (more airflow over the wings)
    ii. Tailwind decrease climb performance (reduced airflow over the wings)

7. Common Errors AI.VII.N.K5

A. Failure to recognize a situation where a go-around/rejected landing is necessary
B. Hazards of delaying a decision to perform a go-around/rejected landing
C. Improper power application
D. Failure to control pitch attitude
E. Failure to compensate for torque effect
F. Improper trim procedure
G. Failure to maintain recommended airspeeds
H. Improper wing flaps or landing gear retraction procedure
I. Failure to maintain proper track during climb-out
J. Failure to remain well clear of obstructions and other traffic

8. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. VII. RM Concepts – Distractions, Task Prioritization, SA AI.VII.N.R7
B. VII. RM Concepts – Low Altitude Maneuvering AI.VII.N.R6
C. VII. RM Concepts – Collision Hazards AI.VII.N.R5
D. VII. RM Concepts – Runway Incursion AI.VII.N.R9

Conclusion:
Brief review of the main points

VII.O. Power-Off 180º Accuracy Approach & Landing

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The learner develops knowledge of the elements related to the power-off 180º accuracy approach and landing as required in the ACS.
Key Elements	1. Best Glide Airspeed 2. Wind Correction 3. Stabilized Approach
Elements	1. Basics 2. Runway & Touchdown Point 3. The Maneuver 4. Common Errors 5. Hazards & 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 learner can perform a power-off 180º accuracy approach and landing, landing within 200' beyond the selected point. The learner can make the necessary corrections 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 180º pattern begun abeam a specified touchdown point on the runway to a touchdown at or within 200' beyond that point.

Why AI.VII.O.K1

It instills judgment and procedures necessary for accurately flying the plane, without power, to a safe landing.

How:

1. Basics AI.VII.O.K1

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 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, 45º from landing point

B. Configuring
    i. Normal landing configuration, but flaps are used as necessary to control the glide path of the approach
    ii. Trim for best glide airspeed

C. 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, Lower speeds result in rapid settling

D. Attempt to fly a normal pattern, but also keep in mind that: AI.VII.O.K3, AI.VII.O.K4
    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. RM: Forward Slips: Fuel Flow, Tail Stalls, and Airspeed Control AI.VII.O.R7
            - Fuel Flow: Uncoordinated flight may pull fuel away from the fuel lines/engine
            - Tail Stalls: At high AOAs the flaps/wings may block the horizontal stab from the relative wind
            - Airspeed: Potential for airspeed indications due to pitot/static ports position & relative wind
            - For more details, see VII.M. Slip to a Landing – Forward Slip Operations
        c. Airspeed – Faster or slower than best glide increases the rate of descent
        d. Size of the pattern – Turning base early/late, dogleg to final, S-turns

E. Don't attempt to increase the rate of turn with rudder; this could lead to a crossed-control stall

F. A stable approach is predictable - Trim to maintain best glide and avoid large swings in pitch/airspeed
    i. Correct for deviations from the glide path without power
        a. Configuration (configure early, or delay configuration as necessary), drag (slip), airspeed, etc.
    ii. Trim to relieve control pressures to help in stabilizing the approach

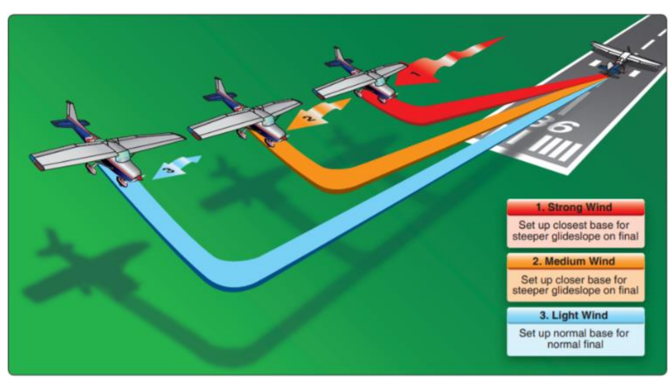
- iii. Do what's necessary if the approach cannot be completed safely
  - a. In the case of training, add power, go around, and try again
  - b. In a real-life power-off scenario, decide on and execute the best course of action based on the situation

2. Runway & Touchdown Point

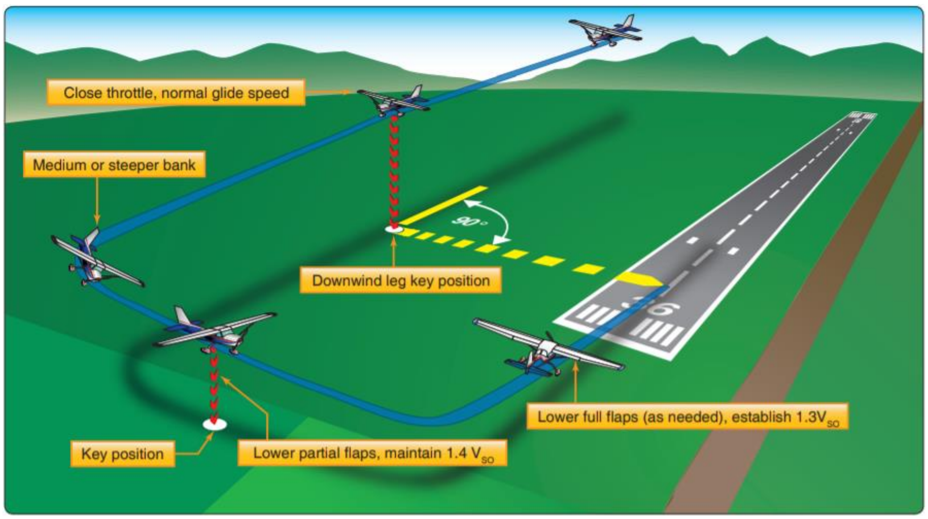
- A. RM: Runway Selection — AI.VII.O.R1
  - i. Wind
    - a. Preferred to land with a headwind – reduces landing distance
    - b. RM: Tailwinds increase ground speed and ground roll (RM: Effects of tailwind) — AI.VII.O.R2c
    - c. RM: Ensure any crosswind is within limits (personal & POH) (RM: Effects of crosswind) — AI.VII.O.R2a
  - ii. Atmospheric Conditions (density altitude)
    - a. Affects climb capability in the case of a go-around
    - b. Higher density altitude = higher true airspeed which increases the landing roll
  - iii. Runway Characteristics — AI.VII.O.R2e
    - a. Surface: More friction associated with softer surfaces decreases landing roll
    - b. Gradient: Down sloping runway increases landing roll
    - c. Condition : Dry, wet, snow, ice, etc. affect braking effectiveness
    - d. Available Distance: Compare to the required landing distance
  - iv. Performance Charts
    - a. Take into account all of the above information, and more (weight, configuration, etc.)
    - b. Verify required landing distance based on the specific conditions (atmospheric, airplane, etc.)
  - v. Pilot Capability: Strictly adhere to personal minimums – Ensure proficiency and safety
  - vi. Limitations: Reference any associated landing limitations in the POH
- B. Touchdown & Aiming Point
  - i. Select an easily recognizable touchdown point (Ex. specific centerline mark, the 500' or 1,000' markers, etc.)
    - a. Must touchdown at or within 200' beyond the point (Ensure ample space before/after the point)
  - ii. Choose an aiming point. Aim Point Considerations
    - a. Standard flare/float distance (varies with aircraft – i.e. DA20 will glide a lot further than an Archer)
    - b. Wind – headwind decreases float, aim closer to the touchdown point (opposite for tailwind)
    - c. Airspeed – If approaching faster than normal, aim earlier (longer float)

3. The Maneuver — AI.VII.O.K1

- 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 — AI.VII.O.K3, AI.VII.O.K4
    - 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
- 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 adjust



        - Ex: if very low, turn directly to the runway
    - b. Flaps are often used at this position (approach flaps; landing flaps only with landing assured)
        - Remember, once flaps are lowered, they should not be raised
  - iii. Tailwind on the base leg AI.VII.O.K3, AI.VII.O.K4
    - 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
  - 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. Turning 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 AI.VII.O.K2
    - 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. Crosswind (RM: Effect of crosswind) AI.VII.O.R2a
        - Crab into the wind until ready to establish a sideslip for landing
- 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. Use a sideslip during landing to correct for crosswinds AI.VII.O.R2a

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 and increase crosswind corrections while slowing

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

4. Common Errors AI.VII.O.K5

A. Failure to establish approach and landing configuration at proper time or in proper sequence
B. Failure to identify the key points in the pattern
C. Failure to establish and maintain a stabilized approach
D. Failure to consider the effect of wind and landing surface
E. Improper use of power, wing flaps, or trim
F. Improper procedure during roundout and touchdown
G. Failure to hold back elevator pressure after touchdown
H. Poor directional control after touchdown
I. Improper use of brakes

5. RM: Hazards & Emergencies

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

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B. VII. RM Concepts – Land and Hold Short Operations (LAHSO) AI.VII.O.R3b
C. VII. RM Concepts – Wind Shear AI.VII.O.R2b
D. VII. RM Concepts – Wake Turbulence AI.VII.O.R2d
E. VII. RM Concepts – Distractions, Task Prioritization, SA AI.VII.O.R6
F. VII. RM Concepts – Low Altitude Maneuvering AI.VII.O.R5
G. VII. RM Concepts – Collision Hazards AI.VII.O.R4

Conclusion:

Brief review of the main points

VII. RM Concepts

- For Takeoff lessons (Normal, Soft-field, Short-field) use the left Takeoff column & all following concepts
- For Landing lessons (Normal, Soft, Short, Slip, Power-Off 180), use the right Landing column & all following concepts
- For Traffic Patterns, only use Wind Shear, Wake Turbulence, and Distractions
- For Go-Arounds, only use Distractions, Low Altitude Maneuvering, Collision Avoidance, and Runway Incursion
- This is done to avoid repeating identical RM concepts 10x

TAKEOFF LESSONS

1. **Rejected Takeoff**
    - A. Circumstances such as engine malfunctions, inadequate acceleration, runways incursion, ATC conflict, or another emergency can result in a takeoff having to be rejected on the runway
        - i. Ensure sufficient runway to accelerate to V_R and stop on the runway
    - B. Prior to takeoff, identify a point at which the plane should be airborne
        - i. If not airborne, take immediate action
    - C. Rejected Takeoff Procedures
        - i. Follow procedures specified in the POH
        - ii. Generally, power idle, and apply maximum braking while maintaining directional control
    - D. If required to shut down the engine due to a fire, or any other reason
        - i. Mixture to idle cutoff and magnetos off
    - E. Soft-Field Takeoff
        - i. Maintain back pressure during the reject
            - a. Avoid the nose digging in and cartwheeling or flipping
        - ii. Max braking may be dangerous and unnecessary
    - F. Short-Field Takeoff
        - i. Especially important to take immediate action in the case of a rejected takeoff
        - ii. Delaying may result in running out of runway or inability to clear an obstacle

LANDING LESSONS

1. **Rejected Landing & Go-Around**
    - A. When to Go-Around
        - i. When it's hazardous to continue or if you're ever in doubt of the safety of the approach
    - B. Cardinal Principles: Power, Attitude, Configuration
    - C. Not inherently dangerous, but becomes dangerous when delayed or flown improperly
        - i. Delaying often stems from two sources:
            - Landing expectancy: Belief that conditions are not as threatening as they are, and the approach will end safely
            - Pride: Mistaken belief that a go around is an admission of failure
    - D. Decision making
        - i. Maintain a stabilized approach
            - a. *Momentary* deviations from speed, glidepath and centerline are acceptable
            - b. Set altitude gates
            - If you don't meet set criteria at specified altitudes, go-around (no questions asked)
            - Ex. Stable and configured for landing at 500'
        - ii. In an emergency, you may have to choose between a go around or continuing to land
            - a. Go Around Considerations
            - There are situations that can be handled better airborne than on the ground
                - a Ex: landing gear. Go around and attempt to solve the problem airborne
            - b. Continuing to Land Considerations
            - There are situations that can be better handled by landing instead of going around
                - a Ex: emergencies that can affect the airplane's ability to fly, or fire

2. Engine Failure

A. Time is of the essence
   i. Unless prepared in advance, there is a strong chance the pilot makes a poor decision or no decision
      a. "We don't rise to the level of our expectations; we fall to the level of our training"
      b. Practice, Plan, then Brief the plan

B. Procedures
   i. Step one, Maintain aircraft control
   ii. During the takeoff roll
      a. Reject the takeoff and stop straight ahead
   iii. Immediately following takeoff
      a. If there is sufficient runway available straight ahead, land on the remaining runway
      b. Ensure you know how much runway you need (descent + landing distance)
   iv. During the takeoff climb
      a. Aircraft will have full power, a high pitch attitude and right rudder
      b. When the engine fails, lower the nose (best glide) and release right rudder
      c. Once in control, establish a glide toward a plausible landing area & start emergency procedures
      d. Time and altitude permitting, notify ATC, accomplish applicable checklists, attempt a restart

2. Land and Hold Short Operations (LAHSO)

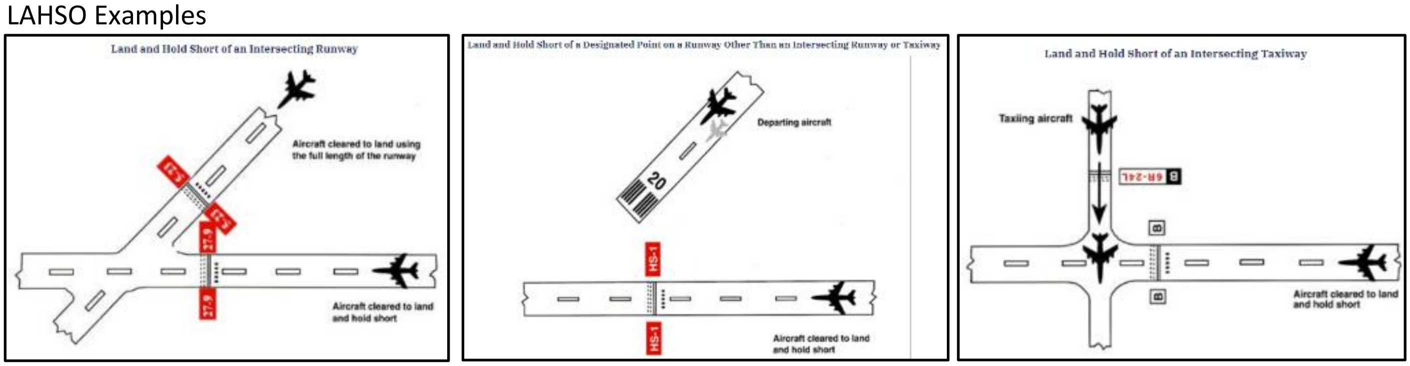
A. Basics
   i. Operations that include landing and holding short of an intersecting runway, taxiway, or other point

B. Pilot Responsibilities
   i. Preflight Planning
      a. Become familiar with all LAHSO information at the destination
      b. Landing performance – knowledge of landing data allows for a quick decision
   ii. PIC has the final authority to accept or decline any LAHSO clearance
      a. Once accepted, a LAHSO clearance must be adhered to, unless otherwise coordinated
         - Does not prevent a rejected landing
   iii. Full readback of LAHSO clearance is required

C. Situational Awareness
   i. Have current airport information (diagram, LAHSO procedures, etc.)
   ii. To conduct LAHSO operations properly, understand the following:
      a. Landing distance available
      b. Be advised by ATC as to why LAHSO are being conducted
      c. Advise if you cannot accept LAHSO
      d. LAHSO/airport signs, markings, lights
      e. Not authorized for solo student pilots
      f. Air carriers are often not authorized LAHSO if the other aircraft is GA
      g. Generally, not authorized at night
      h. Not authorized on wet runways
   iii. LAHSO Minimums
      a. Basic VFR: 1,000' ceiling & 3 SM visibility

D. LAHSO examples shown below

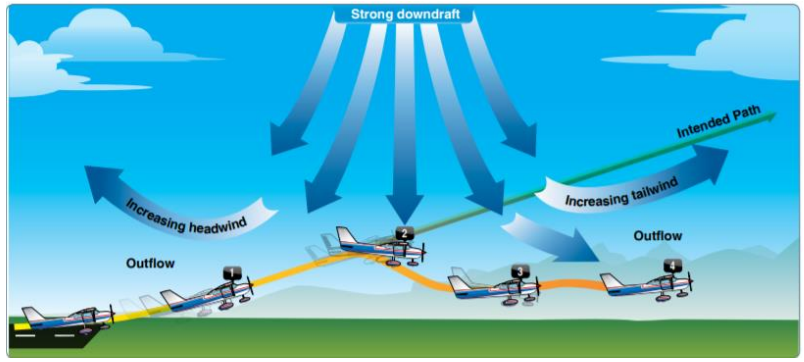
LAHSO Examples



3. Wind Shear

A. What is it?
  i. A sudden, drastic change in wind speed and/or direction over a very small area
  ii. While wind shear can occur at any altitude, low-level wind shear is especially hazardous

B. Why is it dangerous?
  i. Violent updrafts and downdrafts (up to 6,000 fpm) / abrupt changes to horizontal movement
  ii. Rapid changes in performance (tailwind shears to headwind, or headwind to tailwind)
  iii. Microbursts
    a. Most severe type of wind shear
    b. Characteristics
      - 1-2 miles across
      - Lifespan of 5-15 mins.
      - Strong downdrafts
      - Strong turbulence
      - Headwind gains/losses of 30-90 knots

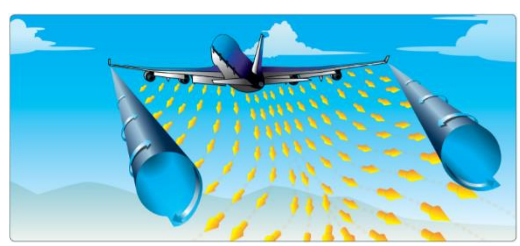


    c. Indications
      - Visual – Intense rain shaft at the surface, but virga at cloud base; ring of blowing dust
      - Alerting Systems
        a LLWAS-NE, TDWR, and ASR-9 WSP systems installed at major airports
        b Many airports, especially smaller airports, have no wind shear systems

C. Handling Wind Shear
  i. If possible, avoid it
    a. Never conduct traffic pattern operations near an active thunderstorm
    b. LLWAS (Low Level Wind Shear Alerting System) can warn of windshear
    c. PIREPS
  ii. Approach into Wind Shear
    a. Follow the POH procedures. If none, general techniques include:
      - Higher power and faster approach speed (add ½ the gust factor to approach speed)
      - Stay as high as feasible until necessary to descend
      - Go around at the first sign of an unexpected pitch or airspeed change
        a Important to get FULL power and get the airplane climbing
        b If the aircraft is descending toward the ground, ensure max power, increase pitch attitude as far as possible without stalling the airplane
          1. Intent is to keep the flying as long as possible in hope of exiting the shear
    b. Aviation Weather Handbook (FAA-H-8083-28)
      - See Ch. 22 pgs. 7-18 for details on recognizing/avoiding microbursts, and strategies for escape

4. Wake Turbulence (AC 90-23)

A. What is it?
  i. 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
  ii. All aircraft generate wake turbulence during flight
    a. The larger the aircraft, the stronger the vortices
    b. Vortices are strongest when the pressure differential is greatest (heavy, clean, slow)

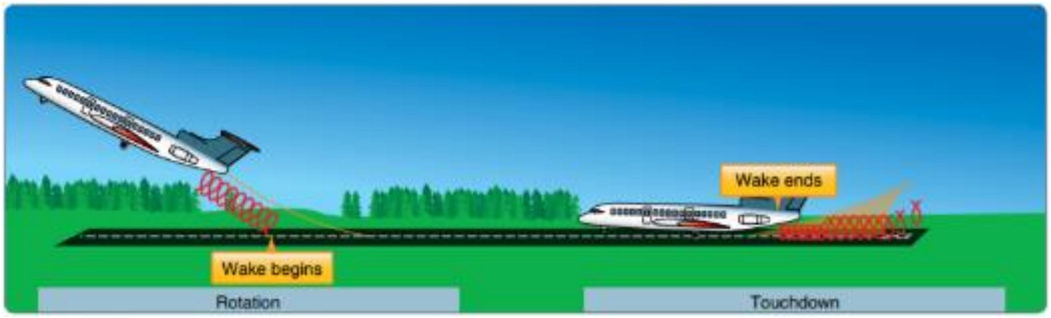


B. Why is it dangerous?
  i. Rolling moments can exceed control authority and/or damage

the aircraft

ii. Wake turbulence can be encountered in any phase of flight (usually strongest at departure)

C. Vortex Behavior

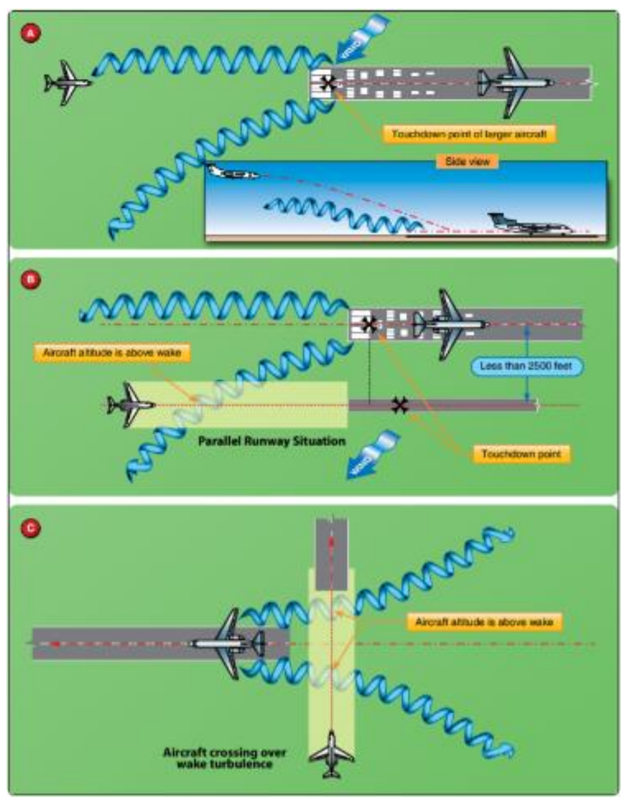


i. Vortices are generated when an aircraft leaves the ground until it touches down
ii. Remain about a wingspan apart and drift with wind at altitudes > a wingspan above the ground
iii. Sink at a rate of several hundred FPM, slowing descent and diminishing in strength over time
iv. When close to the ground (100-200'), tend to move laterally at 2-3 knots
v. A crosswind decreases lateral movement of upwind vortex, increases downwind vortex
vi. Light quartering tailwind can result in vortices along final approach centerline

D. Avoidance Procedures

i. Landing behind a large aircraft:
   a. On the same runway
      - Stay at/above their approach path & land beyond their touchdown point (Figure A)
   b. On a parallel runway (< 2,500' away)
      - Consider drift & stay at/above their flight path, note touchdown point (Figure B)
   c. On a crossing runway
      - Cross above their flight path (Figure C)
   d. Departing on the same runway
      - Land prior to their rotation point
   e. Departing a crossing runway: Note their rotation point, if that point is past the intersection, land prior to the intersection
      - If they rotate prior to the intersection, avoid flight below their flight path
      - Abandon the approach unless a landing is ensured well before reaching the intersection
   f. Executing a low approach, missed approach, or touch-and-go
      - Wait at least 2 minutes prior to a landing

ii. Departing after a large aircraft:
   a. On the same runway
      - Rotate prior to their rotation point and climb above their climb path until turning clear
   b. Executing a low approach, missed approach, or touch-and-go
      - Wait at least 2 minutes prior to takeoff
      - Vortex hazard may exist along the runway/in the flight path, particularly in a quartering tailwind



c. Intersection takeoffs on the same runway
- Note the larger aircraft's rotation point and rotate prior to it
- Be alert to adjacent large aircraft operations, particularly upwind of the runway
- Avoid headings that cross below the larger aircraft's path

5. Distractions (Task Prioritization, Loss of SA, Disorientation)

A. Distractions
i. They're dangerous - Remove them from view or, if a person, explain the situation and ask them to stop
ii. Sterile flight deck during taxi, takeoff, and climb as well as descent and landing
iii. Fly first! Aviate, Navigate, Communicate

B. Situational awareness (SA) & Disorientation
i. Extremely important, especially in the traffic pattern
ii. Maintain SA
a. Know where you are, what's coming next, and stay ahead of the airplane
b. Be aware of other traffic. Build a 3d picture based on what you see, and what you hear on the radio
c. If SA or orientation is lost, admit it, and fix it
iii. Disorientation: Get the aircraft to a safe attitude, airspeed, and altitude

C. Task Prioritization
i. Divide attention between the aircraft, scanning, and communicating (ATC or CTAF)
a. No one responsibility should take your full attention full more than a short period
ii. Understand what tasks need to be accomplished and when (use SOPs & checklists)
iii. Recognize when you are getting behind and find a way to catch up
a. If tasks are piling up, "Attack the closest alligator" – Deal with the most pressing problem
iv. Safety is the number one priority - Aviate, Navigate, Communicate

6. Low Altitude Maneuvering

A. A small problem at high altitude can quickly become a big problem at a low altitude
i. Quick, panicked maneuvers, especially when slow, can result in a stall or loss of control close to the ground

B. Low Altitude Stall/Spin
i. A low altitude stall or spin can leave little to no recovery time
a. ALWAYS maintain coordination, and airspeed at low altitudes
b. If you get any indication of a stall at low level, recover, and climb to a safe altitude
ii. Spin
a. A spin is a result of a stall + yaw
b. Prevention
- Recover at the first sign of a stall
- Maintain coordination
- Do not use abrupt, excessive pressure inputs (especially back elevator pressure)

c. Recovery (PARE)
- Power - Idle
- Ailerons - Neutral
- Rudder - Full rudder opposite the spin direction
- Elevator - Brisk, positive forward pressure (nose down)
- Once the spin has stopped, neutralize the rudders and raise the nose, being careful not to stall again

d. Different aircraft respond differently to spins and spin recoveries, follow the POH procedures

C. Low Altitude Maneuver Considerations
i. Engine Failure: Have one or more locations available for emergency landing
ii. Clear the Area: 2 90º turns looking left & right, above & below
iii. Disturbances: Be well away from people, congested areas, herds of livestock, etc.

D. CFIT (Controlled Flight into Terrain)
    i. AC 61-134: General Aviation CFIT Awareness
    ii. The solution to combating CFIT accidents starts on the ground
        a. Common themes include proper planning, good decision making, and being able to safely operate the aircraft throughout its entire operating range
    iii. Recommendations:
        a. Non-instrument rated VFR pilots should not attempt to fly in IMC
        b. Know and fly above minimum published safe altitudes
        c. If IFR, fly published procedures
        d. Verify proper altitude, especially at night or over water, through use of a correctly set altimeter
        e. Verify all ATC clearances. Question potentially hazardous clearances
        f. Maintain situational awareness both vertically and horizontally
        g. Comply with appropriate regulations for your specific operation
        h. Don't operate below minimum safe altitudes if uncertain of position or ATC clearance
        i. Be extra careful when operating in an area which you are not familiar
        j. Use current charts and all available information
        k. Use appropriate checklists
        l. Know your aircraft and its equipment

7. Collision Hazards

A. Collision Avoidance
    i. Scanning
        a. Series of short, regularly spaced eye movements bringing successive areas into the central visual field
            - Each movement should not exceed 10°, each area should be observed for at least one second
    ii. Clearing Procedures
        a. Before Takeoff: Scan the runway and final approach for other traffic
        b. Climbing: Execute gentle banks to allow scanning above/below the wings as well as other blind spots
        c. Pattern: Scan for other traffic, enter traffic pattern at pattern altitude
        d. Approach: Clear the runway
        e. Uncontrolled Fields: Be conservative with spacing during takeoff, landing, and in the pattern
            - Clearly communicate intentions & location at uncontrolled fields
    iii. Operation Lights On (voluntary FAA safety program)
        a. Turn on landing lights during takeoff and when operating below 10,000’, day or night
    iv. Right-of-Way Rules (FAR 91.113)
        a. An aircraft in distress has the right-of-way over all other traffic
        b. When aircraft of the same category are converging, the aircraft to the right has the right-of-way
            - If the aircraft are different categories:
                a Basically, the less maneuverable aircraft has the right-of-way
                    1. Balloons, gliders, and airships have the right of way over airplanes
                b An aircraft towing or refueling an aircraft has the right-of-way over all engine driven aircraft
        c. Approaching Head-on: Each pilot shall alter course to the right
        d. Overtaking: Aircraft being overtaken has the right-of-way; when overtaking, pass on the right
        e. Landing
            - Aircraft landing/on final approach have the right-of-way over those in flight or on the surface
                a Do not take advantage of this to force an aircraft off the runway which has already landed
            - When two or more aircraft are approaching for landing, the lower aircraft has the right-of-way
            - Don’t take advantage of this rule to cut in front of another aircraft

B. Terrain

        i. Be aware of terrain that could cause a hazard during the climb or descent into the airfield
            a. Study charts and use maximum elevation figures (MEFs) and other data
        ii. Day vs Night flying over terrain
            a. Be extra vigilant at night, when terrain may be impossible to see until it is too late
        iii. Minimum Safe Altitudes (FAR 91.119)
            a. Anywhere: An altitude allowing an emergency landing without undue hazard to persons or property
            b. Over Congested Areas: 1,000' above the highest obstacle within 2,000'
            c. Other than Congested Areas: 500' above the surface, except when over open water/sparsely populated areas, then no closer than 500' to any person, vessel, vehicle, or structure
    C. Obstacles and Wire Strikes
        i. Many structures can significantly affect safety below 500' AGL and particularly below 200' AGL
            a. Obstacles can be found in the NOTAMs, and the Terminal Procedures (IFR document)
            b. < 200' AGL are unmarked/lighted power lines, antenna towers, etc.
        ii. Antenna Towers: Numerous antennas extend over 1,000'-2,000' AGL
            a. Most are supported by guy wires which can extend 1,500' horizontally
        iii. Overhead Wires: Wires and lines span runway departures and landmarks pilots frequently follow
            a. Lakes, highways, railroad tracks, etc. (may not be lighted)
    D. Airport Surface
        i. Be alert for vehicles, persons, wildlife, or anything that could cause a hazard
            a. Reject or delay takeoff, as required. Go around if landing
        ii. Scan vigilantly during taxi for aircraft and obstacles
            a. If unsure of clearance, stop until you're sure it is safe to pass

8. Runway Incursion (Only required by Normal Takeoff & Go-Around)
    A. Be aware of the airplane's position and be aware of other aircraft and vehicle operations on the airport
    B. Readback all runway crossing and/or hold short instructions
    C. Review airport layouts
    D. Know airport signage
    E. Review NOTAMs
    F. Study & use proper phraseology
    G. Write down taxi instructions
    H. Request progressive taxi instructions when necessary
    I. Check for traffic before crossing any runway hold line or entering any taxiway
    J. Turn on lights and the rotating beacon or strobes when taxiing
    K. When landing, clear the runway as soon as possible and wait for taxi instructions before moving
    L. Go-Around/Rejected Landing
        i. Many of the above don't apply
        ii. Maintain situational awareness – be aware of aircraft and their position in the pattern or on the field
        iii. A runway incursion from another aircraft may require a go-around
            a. Confirm LAHSO ability and readback LAHSO instructions

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 learner should develop the ability to maintain straight-and-level flight primarily using outside visual references. The learner 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 Pressured & Trim
3. Integrated Flight Instruction
4. Straight and Level Flight
5. Common Errors
6. Hazards

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 how to keep the aircraft in straight-and-level flight. They can also relieve the control pressures by trimming the aircraft and provide 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. As simple as it may sound, it's the foundation for all maneuvers and where you'll spend the large majority of any flight (outside of training).

Overview

Review Objectives and Elements/Key ideas

What

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 AI.VIII.A.K1

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 fundamental flight maneuver. It is not uncommon to find a pilot whose basic flying ability consistently falls 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** AI.VIII.A.K2
   A. Axis of Rotation
      i. Pitch - Lateral Axis; Roll - Longitudinal Axis; Yaw - Vertical Axis
   B. 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
   C. 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
   D. 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 & Trim** AI.VIII.A.K2
   A. Control Pressures
      i. It is important to maintain a light grip on the flight controls (only grip with the fingertips)
      ii. Control pressures should be light and just enough to produce the desired result
      iii. Overcoming Tenseness / Over-controlling
         a. Signs of over-controlling
            - Jolty, large movements of the flight controls
            - White knuckles (look for the death grip)

- Overall nervousness

b. Prevention
- Point out over-controlling, help the learner stay calm, and demonstrate the pressures desired
- Technique: put a pencil on top of the middle & ring finger, and under the index & pointer finger
  - a Results in less fingers on the controls
  - b If overcontrolling, the pressure on the middle and ring finger reminds them to relax

B. Trim Technique

i. Most planes 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

a. Outside of this condition, one or more control surfaces must be held out of its streamlined position

b. Trim tabs offset the constant flight control pressure inputs needed from the pilot

ii. Trimming the Airplane

a. Establish, Trim, Crosscheck, Adjust, and repeat

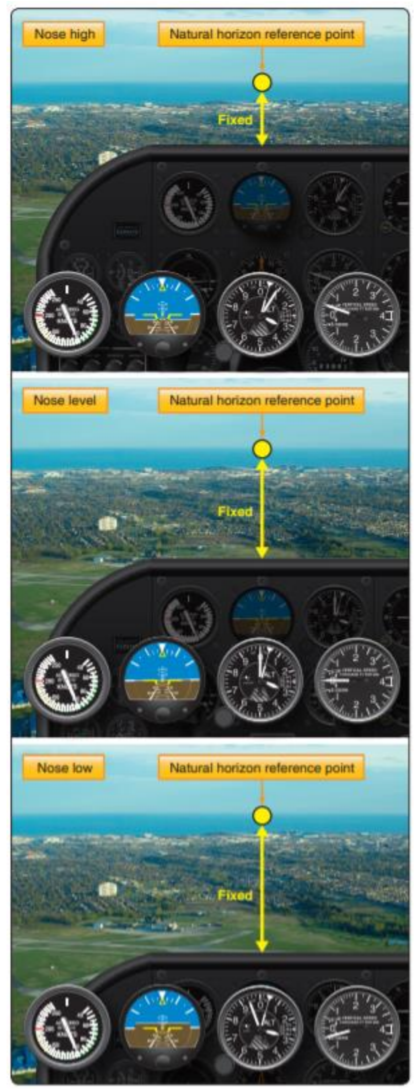
b. Set pitch and power, and let the airspeed stabilize

c. Trim to relieve control pressures (rudder, elevator, then aileron)

d. Changes in pitch and power require the plane to be trimmed again
- On longer flights, retrim as CG changes with decreasing fuel

e. Don't fly the airplane with trim

3. Integrated Flight Instruction AI.VIII.A.K4



A. Using outside references + flight instruments for flight

B. The Basic Elements

i. 90% outside, 10% inside

ii. Use outside references to fly, validate 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

4. Straight and Level Flight AI.VIII.A.K1

A. Overview

i. Straight and level flight is a matter of consciously fixing the relationship of a reference point on the airplane in relation to the natural horizon

ii. Objective is to detect small deviations from level flight as soon as they occur, necessitating only small corrections

B. Level Flight

i. Outside AI.VIII.A.K3

a. Select a reference (ex. glareshield) 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, and verify with instruments

C. Straight Flight

i. Outside

AI.VIII.A.K3

a. Wingtips: Level and equidistant from the horizon
b. Select two or more reference points directly ahead
- Form an imaginary line between them and keep the plane headed along the line

ii. Inside
a. Verify outside references against the Heading Indicator, Attitude Indicator, Turn Coordinator, Magnetic Compass

iii. Corrections (Control Procedure)
a. Ailerons are the control
b. Adjust bank to put both wings an equal distance from the horizon/realign the reference points

D. Power
i. Airspeed remains constant if power is constant
ii. Outside: Power/airspeed changes require pitch changes
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 must be adjusted
b. Increased power: As airspeed increases, progressively decrease pitch to maintain altitude
c. Decreased power: As airspeed decreases, progressively increase pitch to maintain altitude
d. Once stable and level, maintain the new visual reference in relation to the horizon

5. Common Errors AI.VIII.A.K5

A. Attempting to use improper pitch and bank references.
B. Forgetting the location of preselected reference points on subsequent flights.
C. Attempting to establish or correct airplane attitude using flight instruments rather than the natural horizon.
D. "Chasing" the flight instruments rather than adhering to the principles of attitude flying.
E. Mechanically pushing or pulling on the flight controls rather than exerting accurate and smooth pressure.
F. Not scanning outside the aircraft for other traffic and weather and terrain influences.
G. A tight palm grip on the flight controls resulting in a desensitized feeling of the hand and fingers.
H. Overcontrolling the airplane.
I. Habitually flying with one wing low or maintaining directional control using only the rudder control.
J. Failure to make timely and measured control inputs after a deviation from straight-and-level.
K. Inadequate attention to sensory inputs in developing feel for the airplane to establish attitude.

6. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. VIII. RM Concepts – Distractions, Task Prioritization, SA AI.VIII.A.R1
B. VIII. RM Concepts – Collision Hazards AI.VIII.A.R2

Conclusion:
Brief review of the main points

VIII.B. Level Turns

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The learner 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 & Trims 4. Integrated Flight Instruction 5. Level Turns 6. Common Errors 7. Hazards
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 learner can turn at varying degrees of bank, maintaining altitude and airspeed.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Level turns sound 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

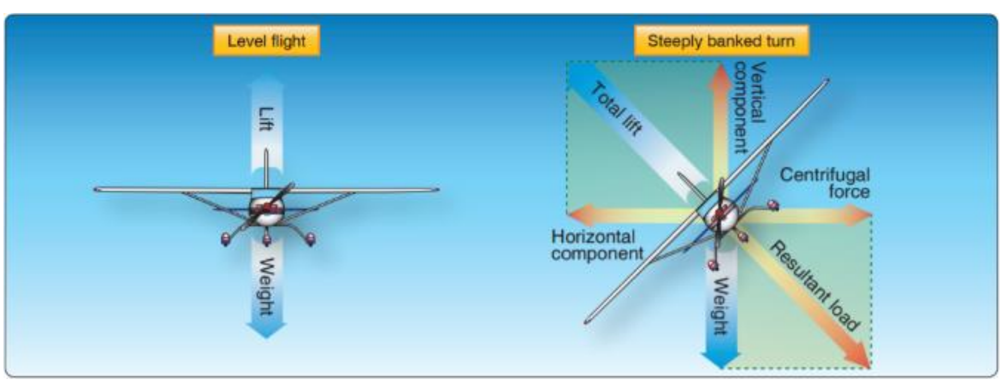
A turn at a specified angle of bank in which altitude and airspeed are maintained.

Why AI.VIII.B.K1

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:

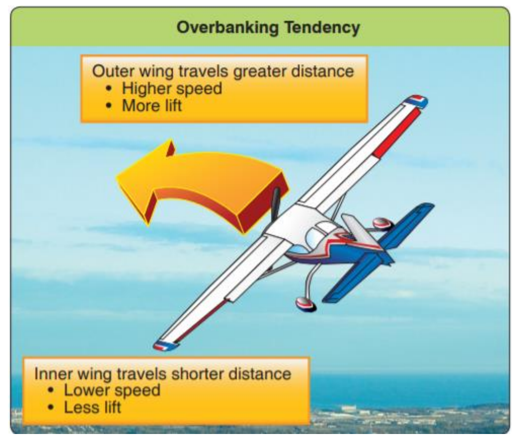
1. **Flight Controls**
   A. All four primary controls are used in coordination when making turns
      i. Ailerons - Bank the wings and determine the rate of turn at a given airspeed
      ii. Elevator - Moves the nose up or down in relation to the pilot, and perpendicular to the wings
         a. It 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 may be 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, the total lift is acting perpendicular to the wings and the Earth
         a. As the plane is banked, lift becomes the resultant of two components:
            - Vertical Component (VC) - Continues to act perpendicular to Earth and opposes gravity, or weight
            - Horizontal Component (HC) - Acts parallel to Earth's surface, opposes inertia (or Centrifugal Force)
         b. The vertical and horizontal components act at right angles to each other (shown in the picture below); total lift acts perpendicular to the banked wings
            - The horizontal component of lift is what actually turns the airplane



ii. Since a portion of vertical lift has been shifted to horizontal lift, AOA must be increased to maintain altitude

C. Adverse Yaw
   i. When ailerons are deflected, lift and drag are increased on the rising wing, and decreased on the lowering wing
   ii. The change in drag between the wings results in yaw in the opposite the direction of the turn (adverse yaw)
   iii. To counter adverse yaw, rudder pressure is applied with aileron in the direction of the turn

D. Overbanking Tendency
   i. As turn radius gets smaller, a significant difference develops between the speed of the inside wing and the 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 increases 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 controls
         - Aileron pressure is required opposite the turn to maintain bank angle



E. Rate of Turn
   i. Dependent on airspeed & horizontal component of lift (HCL)
      a. HCL (directly related to bank angle)
         - As bank increases, the HCL increases
         - Thus, steeper bank = higher the rate of turn
      b. As airspeed increases, 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 & Trim AI.VIII.B.K2

A. Control Pressures
   i. It is important to maintain a light grip on the flight controls (only grip with the fingertips)
   ii. Control pressures should be light and just enough to produce the desired result
      a. No jerky movements
   iii. Overcoming Tenseness / Over-controlling
      a. Signs of over-controlling
         - Jolty, large movements of the flight controls
         - White knuckles (look for the death grip)
         - Overall nervousness
      b. Prevention
         - Point out over-controlling, help the learner stay calm, and demonstrate the pressures desired

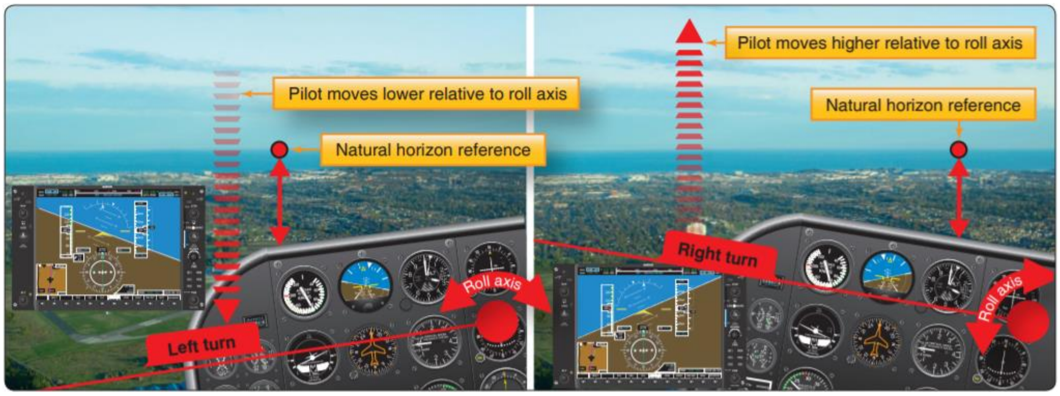
- Technique: put a pencil on top of the middle & ring finger, and under the index & pointer finger
    - a Results in less fingers on the controls
    - b If overcontrolling, the pressure on the middle and ring finger reminds them to relax

B. Trim Technique
  i. Most planes 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
    a. Outside of this condition, one or more control surfaces must be held out of its streamlined position
    b. Trim tabs offset the constant flight control pressure inputs needed from the pilot
  ii. Trimming the Airplane
    a. Establish, Trim, Crosscheck, Adjust, and repeat
    b. Set pitch and power, and let the airspeed stabilize
    c. Trim to relieve control pressures (rudder, elevator, then aileron)
    d. Changes in pitch and power require the plane to be trimmed again
      - On longer flights, retrim as CG changes with decreasing fuel
  iii. Don't fly the plane with trim

4. Integrated Flight Instruction AI.VIII.B.K4
  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

5. Level Turns AI.VIII.B.K1
  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 AI.VIII.B.K3
      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 to properly use visual references
- ii. Control Inputs AI.VIII.B.K2
  - a. Aileron and rudder pressure should be input together
    - Use small, smooth flight control inputs
    - The faster and firmer aileron is applied, the faster the roll
    - The longer the aileron pressure, the greater the bank
  - b. Coordination
    - 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
  - c. 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
  - d. 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 instruments
- ii. Outside References AI.VIII.B.K3
  - a. Maintain the relationship between the cowling and/or wings and horizon, while scanning for traffic
- iii. Control Inputs AI.VIII.B.K2
  - a. Aileron and Rudder (Maintaining Bank)
    - Rudder and aileron pressure should be relaxed or adjusted, depending on the bank angle
  - b. Elevator Pressure (Maintaining Altitude)
    - Back pressure on the elevator should not be relaxed 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

iv. 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 adjusted, re-trim the airplane
   c. Attitude and bank control
      - Understand the relationship between bank and pitch
      - Increased bank necessitates increased pitch to maintain altitude, and vice versa

D. Roll Out AI.VIII.B.K2
   i. Like the 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 AI.VIII.B.K3
   vi. Trim the airplane for level flight

6. Common Errors AI.VIII.B.K5

A. Failure to adequately clear in the direction of turn for aircraft traffic.
B. Gaining or losing altitude during the turn.
C. Not holding the desired bank angle constant.
D. Attempting to execute the turn solely by instrument reference.
E. Leaning away from the direction of the turn while seated.
F. Insufficient feel for the airplane as evidenced by the inability to detect slips or skids without flight instruments.
G. Attempting to maintain a constant bank angle by referencing only the airplane's nose.
H. Making skidding flat turns to avoid banking the airplane.
I. Holding excessive rudder in the direction of turn.
J. Gaining proficiency in turns in only one direction.
K. Failure to coordinate the controls

7. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. VIII. RM Concepts – Distractions, Task Prioritization, SA AI.VIII.B.R1
B. VIII. RM Concepts – Collision Hazards AI.VIII.B.R2

Conclusion:
Brief review of the main points

VIII.C. Straight Climbs & Climbing Turns

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives

The learner should develop knowledge of straight and turning climbs. The learner will demonstrate the ability to perform a constant airspeed climb during straight flight as well as in a turn. The learner 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 a Climb
3. Types of Climbs
4. Control Pressures & Trim
5. Integrated Flight Instruction
6. Straight Climb
7. Climbing Turn
8. Common Errors
9. Hazards

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 maintain a constant airspeed climb while maintaining coordination. The learner notices changes and properly corrects for them by using outside references and crosschecking them with the instruments.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

As simple as a climb sounds, the climb is a building block of your flying future. The knowledge and skill learned here will make more complicated maneuvers easier.

Overview

Review Objectives and Elements/Key ideas

What

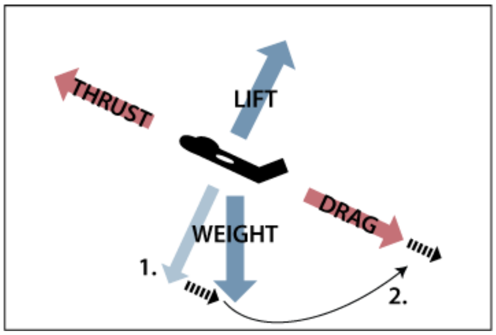
In straight and climbing turns the airplane is put into a climb attitude to gain altitude. The pitch and airspeed of the airplane are maintained together to accomplish the climb.

Why AI.VIII.C.K1

Climbs and climbing turns are part of the 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:

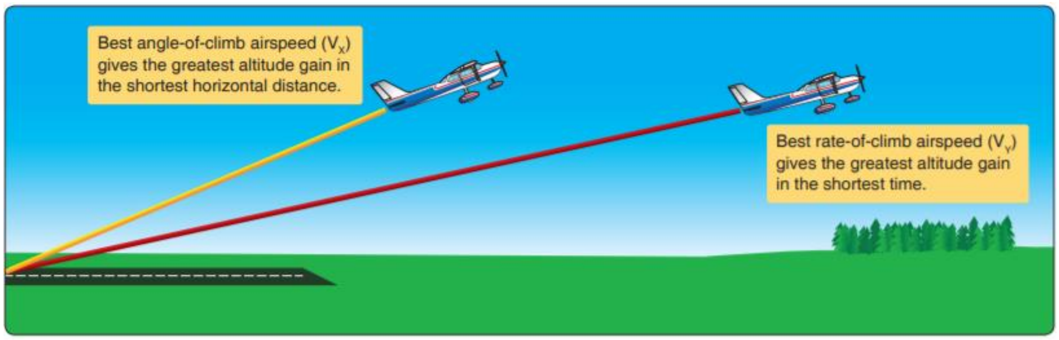
1. **Flight Controls**
   A. All four primary controls are used in coordination when making climbs and climbing turns
      i. Ailerons - Bank the wings and determine the rate of turn at a given airspeed
      ii. Elevator - Moves the nose up or down in relation to the pilot, and perpendicular to the wings
         a. 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 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)
            - This causes an increase in total drag requiring an increase in thrust (2)
         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**
   G. 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
   H. 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

I. 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 & Trim AI.VIII.C.K2

A. Control Pressures
  i. It is important to maintain a light grip on the flight controls (only grip with the fingertips)
    a. Control pressures should be light and just enough to produce the desired result
  ii. Overcoming Tenseness / Over-controlling
    a. Signs of over-controlling
      - Jolty, large movements of the flight controls
      - White knuckles (look for the death grip)
      - Overall nervousness
    b. Prevention
      - Point out over-controlling, help the learner stay calm, and demonstrate the pressures desired
      - Technique: put a pencil on top of the middle & ring finger, and under the index & pointer finger
        a Results in less fingers on the controls
        b If overcontrolling, the pressure on the middle and ring finger reminds them to relax

B. Trim Technique
  i. Most planes 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
    a. Outside of this condition, one or more control surfaces must be held out of its streamlined position
    b. Trim tabs offset the constant flight control pressure inputs needed from the pilot
  ii. Trimming the Airplane
    a. Establish, Trim, Crosscheck, Adjust, and repeat
    b. Set pitch and power, and let the airspeed stabilize
    c. Trim to relieve control pressures (rudder, elevator, then aileron)
    d. Changes in pitch and power require the plane to be trimmed again
      - On longer flights, retrim as CG changes with decreasing fuel
    e. Don't fly the airplane with the trim

5. Integrated Flight Instruction AI.VIII.C.K4

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

6. Straight Climb AI.VIII.C.K1, AI.VIII.C.K2

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
         - More info in lesson II.D. Principles of Flight
   ii. Trim to maintain the climb pitch attitude
   iii. Visual References (very similar to straight & level) AI.VIII.C.K3
      a. Pitch: Visually establish the pitch attitude for the climb and maintain it in reference to the horizon
      b. Straight Flight: Keep wingtips level relative to the horizon
         - Keep 2 points directly in front of the plane aligned

B. Maintaining the Straight Climb
   i. Pitch: Airspeed is controlled with elevator pressure
      a. Make small adjustments relative to the known pitch attitude
         - Crosscheck the change for the desired results on the instruments
      b. If the aircraft is too fast, raise the nose, let airspeed stabilize, and trim
         - Opposite if slow
   ii. Bank: Keep the wings level to maintain heading
      a. Continue to keep 2 points directly in front of the plane aligned
      b. If off heading, use a bank angle equal to the degrees off to correct back

C. Returning to Straight-and-Level Flight AI.VIII.C.K3
   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

7. Climbing Turn AI.VIII.C.K1, AI.VIII.C.K2

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. Keep turns coordinated
      b. Left turn: Less right rudder pressure is required than in a straight climb
      c. 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. Combine the level turns and straight climb references AI.VIII.C.K3
      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
   iii. Trim often to reduce 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

8. Common Errors AI.VIII.C.K5

A. Attempting to establish pitch attitude by primarily referencing the airspeed indicator and chasing the airspeed.
B. Applying elevator pressure too aggressively resulting in an excessive climb angle.
C. Inadequate or inappropriate rudder pressure during climbing turns.
D. Allowing the airplane to yaw during climbs usually due to inadequate right rudder pressure.

E. Fixation on the airplane's nose during straight climbs, resulting in climbing with one wing low.
F. Initiating a climbing turn without coordinated flight controls, resulting in no turn and a climb with one wing low.
G. Improper coordination resulting in a slip that counteracts the rate of climb, resulting in little or no altitude gain.
H. Inability to keep pitch and bank attitude constant during climbing turns.
I. Attempting to exceed the airplane's climb capability.
J. Using excessive forward elevator pressure during level-off resulting in a loss of altitude or excessive low G-force

9. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. VIII. RM Concepts – Distractions, Task Prioritization, SA AI.VIII.C.R1
B. VIII. RM Concepts – Collision Hazards AI.VIII.C.R2

Conclusion:

Brief review of the main points

VIII.D. Straight Descents & 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 can maintain a constant airspeed descent in both situations.
Key Elements	1. Decreased Drag 2. Coordination 3. Crosschecking
Elements	1. Flight Controls 2. Forces in a Descent 3. Types of Descents 4. Control Pressures & Trim 5. Integrated Flight Instruction 6. Straight Descents 7. Turning Descents 8. Common Errors 9. Hazards
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

Straight and turning descents are 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

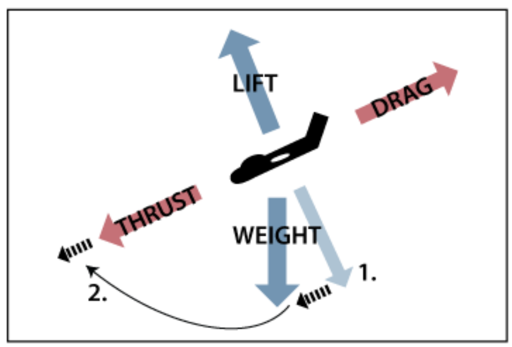
A descent is made when the aircraft is put in a configuration which will result in a loss of altitude.

Why AI.VIII.D.K1

Descents are a fundamental part of flight, understanding and being properly performing a descent will result in everything else being considerably 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. 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 a 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

4. Control Pressures & Trim AI.VIII.D.K2

A. Control Pressures
   i. It is important to maintain a light grip on the flight controls (only grip with the fingertips)
   ii. Control pressures should be light and just enough to produce the desired result
   iii. Overcoming Tenseness / Over-controlling
      a. Signs of over-controlling
         - Jolty, large movements of the flight controls
         - White knuckles (look for the death grip)
         - Overall nervousness
      b. Prevention
         - Point out over-controlling, help the learner stay calm, and demonstrate the pressures desired
         - Technique: put a pencil on top of the middle & ring finger, and under the index & pointer finger
            a Results in less fingers on the controls
            b If overcontrolling, the pressure on the middle and ring finger reminds them to relax

B. Trim Technique
   i. Most planes 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
      a. Outside of this condition, one or more control surfaces must be held out of its streamlined position
      b. Trim tabs offset the constant flight control pressure inputs needed from the pilot
   ii. Trimming the Airplane
      a. Establish, Trim, Crosscheck, Adjust, and repeat
      b. Set pitch and power, and let the airspeed stabilize
      c. Trim to relieve control pressures (rudder, elevator, then aileron)
      d. Changes in pitch and power require the plane to be trimmed again
         - On longer flights, retrim as CG changes with decreasing fuel

5. Integrated Flight Instruction AI.VIII.D.K4

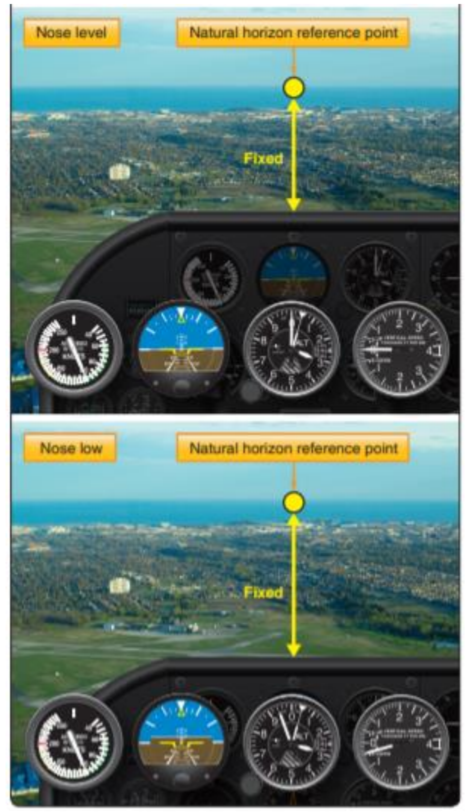
A. Using outside references + flight instruments to establish and maintain flight attitudes and performance

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

6. Straight Descents AI.VIII.D.K1, AI.VIII.D.K2

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 tends 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 AI.VIII.D.K3
      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

B. Maintaining the Descent AI.VIII.D.K3



i. Pitch: Airspeed is controlled with elevator pressure
   a. Make small adjustments relative to the known pitch attitude
      - Crosscheck the change on the instruments
   b. If too fast, raise the nose, let airspeed stabilize, and trim
   c. If too slow, lower the nose, let airspeed stabilize, and trim
ii. Bank: Keep the wings level to maintain heading
   a. Continue to keep 2 points directly in front of the plane aligned
   b. If off heading, use a bank angle equal to the approximate degrees off to correct back
iii. Maintain Coordination
   a. Little, if any, rudder is required with the low power setting
   b. Adverse yaw still exists

C. Returning to Straight-and-Level flight
   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
   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
   iv. and adjust as necessary

7. Turning Descents AI.VIII.D.K1, AI.VIII.D.K2

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 AI.VIII.D.K3
      a. Reduce 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
         - Trim to relieve control pressures

B. Maintaining the Turning Descent AI.VIII.D.K3
   i. Pitch adjustments are made in the same way as in a straight descent
   ii. Bank Adjustments
      a. Increase or decrease aileron pressure to maintain desired bank angle
         - Visually, use the wings/glareshield in relation to the horizon

b. Adjusting bank can affect airspeed and require a pitch change
- If airspeed increases, increase back pressure, and vice versa

iii. Maintain Coordination
a. Without power, the left turning tendencies are greatly reduced
b. Adverse yaw still exists

iv. Trim to relieve the control pressures

v. Crosscheck for the desired results on the instruments

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

8. Common Errors AI.VIII.D.K5

A. Failure to adequately clear for aircraft traffic in the turn direction or descent.
B. Inadequate elevator back pressure during glide entry resulting in an overly steep glide.
C. Failure to slow the airplane to approximate glide speed prior to lowering pitch attitude.
D. Attempting to establish/maintain a normal glide solely by reference to flight instruments.
E. Inability to sense changes in airspeed through sound and feel.
F. Inability to stabilize the glide (chasing the airspeed indicator).
G. Attempting to "stretch" the glide by applying back-elevator pressure.
H. Skidding or slipping during gliding turns and not recognizing the difference in rudder forces with/without power.
I. Failure to lower pitch attitude during gliding turn entry resulting in a decrease in airspeed.
J. Excessive rudder pressure during recovery from gliding turns.
K. Inadequate pitch control during recovery from straight glide.
L. Cross-controlling during gliding turns near the ground.
M. Failure to maintain constant bank angle during gliding turns.

9. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. VIII. RM Concepts – Distractions, Task Prioritization, SA AI.VIII.D.R1
B. VIII. RM Concepts – Collision Hazards AI.VIII.D.R2

Common Errors: AI.VIII.D.K5

- Failure to adequately clear for aircraft traffic in the turn direction or descent.
- Inadequate elevator back pressure during glide entry resulting in an overly steep glide.
- Failure to slow the airplane to approximate glide speed prior to lowering pitch attitude.
- Attempting to establish/maintain a normal glide solely by reference to flight instruments.
- Inability to sense changes in airspeed through sound and feel.
- Inability to stabilize the glide (chasing the airspeed indicator).
- Attempting to "stretch" the glide by applying back-elevator pressure.
- Skidding or slipping during gliding turns and not recognizing the difference in rudder forces with/without power.
- Failure to lower pitch attitude during gliding turn entry resulting in a decrease in airspeed.
- Excessive rudder pressure during recovery from gliding turns.

- Inadequate pitch control during recovery from straight glide.
- Cross-controlling during gliding turns near the ground.
- Failure to maintain constant bank angle during gliding turns.

Conclusion:
Brief review of the main points

VIII. RM Concepts

1. **Distractions, SA & Disorientation & Task Management**
   A. Distractions
      i. They're dangerous - Remove them from view or, if a person, explain the situation and ask them to stop
      ii. Maintain a sterile flight deck during taxi, takeoff, and climb as well as descent and landing
      iii. Fly first! Aviate, Navigate, Communicate
   B. Situational awareness (SA) & Disorientation
      i. Extremely important, lost SA has led to unsafe situations, mishaps, and incursions
      ii. Maintain SA
         a. Starts with preflight planning
         b. Know what's coming next and stay ahead of the airplane
         c. Divide attention between inside and outside references
         d. If SA is lost, admit it and fix the problem
      iii. Disorientation can be caused by, or lead to, an upset
         a. Push: Apply forward pressure to unload the plane
         b. Roll: Roll aggressively to the nearest horizon
         c. Thrust: Adjust as required
         d. Stabilize: Return to a safe flight condition
      iv. Lack of Visual References
         a. Can be very disorienting: Trust the instruments, use automation, ask for help, return to VMC
         b. For more details, see II.B. Visual Scanning & Collision Avoidance and II.M. Night Operations
   C. Task Management
      i. Divide attention between the aircraft, scanning, and communicating (ATC or CTAF)
      ii. Understand what tasks need to be accomplished and when
      iii. Recognize when you are getting behind and find a way to catch up
      iv. Proper task management can help prevent distractions, loss of SA, and disorientation
      v. Safety is the number one priority – Aviate, Navigate, Communicate
2. **Collision Hazards**
   A. Collision Avoidance
      i. Scanning
         a. Series of short, regularly spaced eye movements bringing successive areas into the central visual field
            - Each movement should not exceed 10º, each area should be observed for at least one second
         b. Divide attention between flying and scanning for aircraft
      ii. Clearing Procedures
         a. Climb/Descent: Execute gentle banks to scan above/below the wings as well as other blind spots
         b. Prior to any turn: Clear in the direction of the turn
         c. Pre-Maneuver: Clearing turns – clear above/below, in front/behind
      iii. Operation Lights On
         a. Voluntary FAA safety program
         b. Turn on landing lights during takeoff and when operating below 10,000', day or night
      iv. Right-of-Way Rules (FAR 91.113)
         a. An aircraft in distress has the right-of-way over all other traffic
         b. Converging Aircraft
            - When aircraft of the same category are converging, the aircraft to the right has the right-of-way
            - If the aircraft are different categories:
               a Basically, the less maneuverable aircraft has the right-of-way

1. Balloons, gliders, and airships have the right of way over airplanes

b An aircraft towing or refueling an aircraft has the right-of-way over all engine driven aircraft

c. Approaching Head-on: Each pilot shall alter course to the right
d. Overtaking: Aircraft being overtaken has the right-of-way; when overtaking, pass on the right
e. Landing
   - Aircraft landing/on final approach to land have the right-of-way over those in flight or on the surface
     a Do not take advantage of this rule to force an aircraft off the runway which has already landed
   - When two or more aircraft are approaching for landing, the lower aircraft has the right-of-way
     a Don't take advantage of this rule to cut in front of another aircraft

B. Terrain
   i. Study terminal charts and IFR/VFR chart altitudes, use Max Elevation Figures (MEFs)
   ii. Day vs Night flying over terrain
      a. Be extra vigilant at night, when terrain may be impossible to see until it is too late
   iii. Minimum Safe Altitudes (FAR 91.119)
      a. Anywhere: At an altitude allowing an emergency landing without undue hazard to persons or property
      b. Over Congested Areas: 1,000' above the highest obstacle within 2,000'
      c. Over other than Congested Areas: 500' above the surface, except when over open water/sparsely populated areas, then no closer than 500' to any person, vessel, vehicle, or structure

C. Obstacles and Wire Strike
   i. Antenna Towers
      a. Numerous antennas extend over 1,000'-2,000' AGL
         - Most are supported by guy wires which can extend 1,500' horizontally from the structure
   ii. Overhead Wires (may not be lighted)
      a. Overhead transmission wires and lines span runway departures and landmarks pilots frequently follow
         - Lakes, highways, railroad tracks, etc.

PERFORMANCE & GROUND REFERENCE MANEUVERS

IX.A. Steep Turns

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The learner should develop knowledge of steep turns (load factors, torque, adverse yaw, and the overbanking tendency), and can perform a steep turn as required in the ACS.
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 Turns 3. Performing the Steep Turn 4. Common Errors 5. Hazards
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 factors associated with a 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 are a fun maneuver! Steep bank, you feel some Gs and you're staring at the ground out the side window!

Overview

Review Objectives and Elements/Key ideas

What

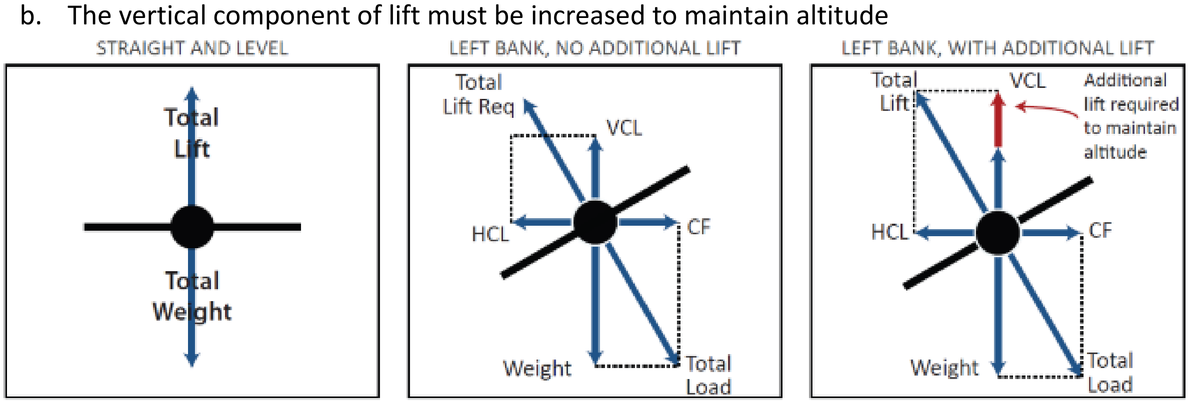
The steep turn maneuver consists of a constant altitude turn in either direction, using a bank angle between 45º to 60º (45º - Private, or 50º - Commercial). This will cause an overbanking tendency during which maximum turning performance is attained and relatively high load factors are imposed.

Why AI.IX.A.K1

Steep turns develop smoothness, coordination, orientation to outsides references, division of attention between control inputs and the constant need to scan for traffic, 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. An airplane's maximum turning performance is its fastest rate of turn and shortest radius of turn
     - i. This changes with both 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, the maximum bank angle is determined by the limiting load factor which can be maintained without stalling or exceeding the airplane's structural limitations
       - a. In most small airplanes the max bank is approx. 50º to 60º
2. **The Science Behind It** AI.IX.A.K3
   - A. What makes an airplane turn?
     - i. As an aircraft banks lift is divided into a horizontal as well as a vertical component
       - a. The horizontal component of lift pulls the aircraft through the turn
       - b. The vertical component of lift must be increased to maintain altitude



   - B. Bank Angle, Load Factor and Stall Speed AI.IX.A.K3d
     - i. Basics

a. Load factor is the result of two forces: Centrifugal force & Weight
b. Assuming level flight, as bank angle increases, the load factor and stall speed also increase
   - The opposite also applies – decreasing bank angle decreases load factor and stall speed

ii. Load Factors
   a. As bank increases beyond 45°, the loads on the aircraft increase rapidly
      - 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

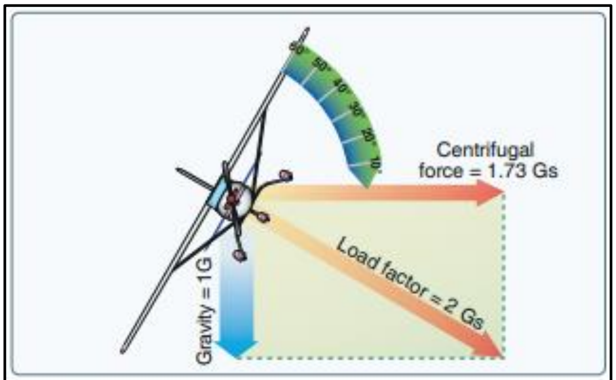
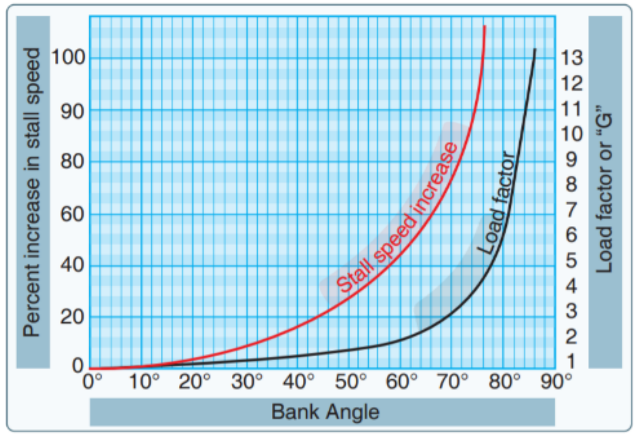
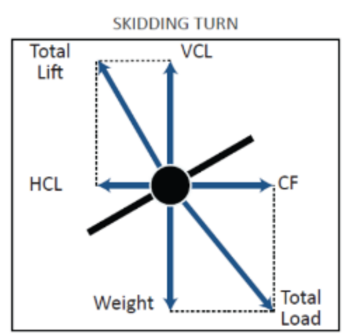


Figure 5-52. *Two forces cause load factor during turns.*

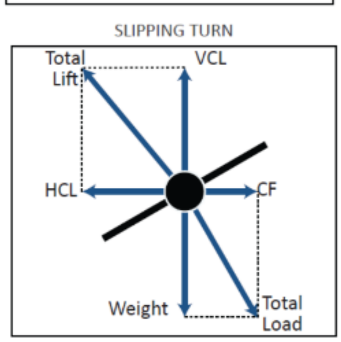


C. RM: Adverse Yaw (RM: Uncoordinated flight) AI.IX.A.R5
   i. When banking, lift and drag are increased on the raised wing, and decreased on the lowered wing
   ii. The difference in drag between the wings results in yaw in the opposite the direction of the turn
   iii. To counter adverse yaw, rudder is applied with aileron in the direction of the turn

D. RM: Torque Effect (RM: Uncoordinated flight) AI.IX.A.K3a, AI.IX.A.R5
   i. 1Newton'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



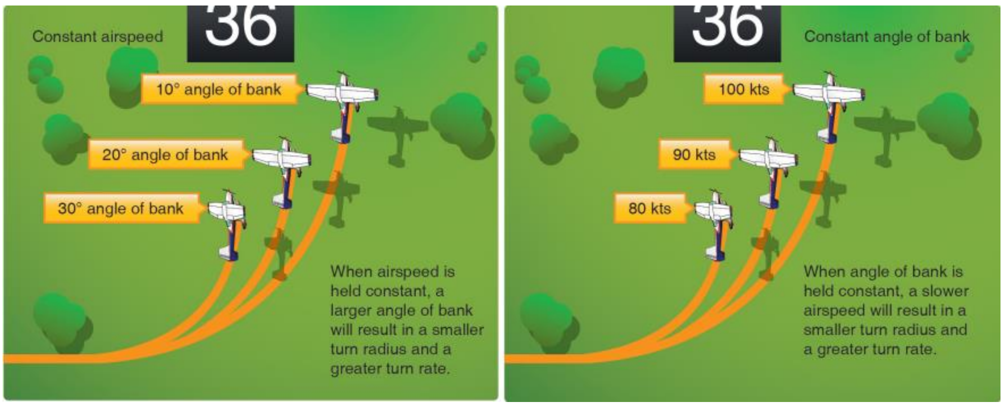
   ii. Torque Effect in Turns
      a. Torque is based on the speed the engine / propeller are rotating
         - The higher the power setting, the greater the turning tendency
      b. Trim tabs combat torque effect in cruise in most small planes
         - Thus, torque effect is generally negligible 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



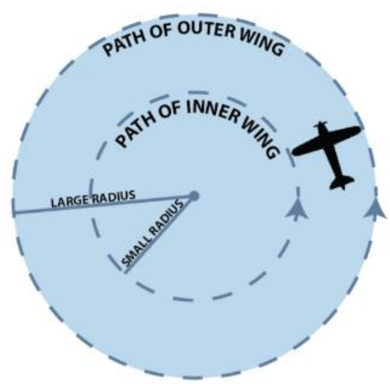
E. Turn Rate & Radius AI.IX.A.K3e

i. Turn Rate
   a. Degrees per second the aircraft is turning
   b. Rate of turn is affected by both the bank angle and airspeed
      - As bank angle increases, so does the rate of turn
      - As airspeed increases, the rate of turn decreases

ii. Turn Radius
   a. Size of circle an aircraft would fly during a turn
   b. Radius of turn is also affected by both the bank angle and airspeed (but opposite to Rate of Turn)
      - As bank angle increases, the radius of turn decreases
      - As airspeed increases, the radius of turn increases



F. Overbanking Tendency AI.IX.A.K3b
i. As turn radius becomes smaller, a difference develops between the speed of the inside wing & 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



G. Maneuvering Speed (V_A) AI.IX.A.K3c
i. Maximum speed at which the aircraft will stall prior to exceeding airframe limitations
   a. Above V_A, full control deflection can result in stresses greater than the aircraft is designed to handle
ii. Weight Changes (Bold Method Video)
   a. V_A increases with weight - This means the aircraft can maneuver at higher airspeeds when heavy
   b. The higher the weight, the higher the AOA needed to maintain level flight
      - Aircraft is closer to the critical AOA, meaning it takes less back pressure (or G load) before a stall
      - Less ability to put excess Gs on the airframe
iii. Perform all maneuvers, steep turns included, at or below V_A

3. Performing the Steep Turn AI.IX.A.K1, AI.IX.A.K2
A. Before Starting
   i. Select an altitude – No lower than 1,500’ AGL
   ii. Pre-maneuver checklist

iii. RM: Clearing turns (especially important due to rapid rate of turn) AI.IX.A.R2
iv. Establish the recommended entry airspeed, or a speed that does not exceed V_A
v. 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 – 45º (Private); 50º (Commercial)
    a. RM: Coordination - Simultaneously apply rudder to maintain coordination AI.IX.A.R5
      - Uncoordinated entries & changing rudder pressure in the turn overcomplicates the maneuver
    b. Passing about 30º 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

C. During the Turn
  i. RM: Do not focus or stare at any one object (RM: Division of attention) AI.IX.A.R1
    a. Awareness of the horizon relative to the nose/wings is necessary to maintain altitude & orientation
      - 90% outside, 10% inside
    b. Loss of orientation
      - Orientation is not just the bank/pitch attitude but where you are and what is around you
      - Note the entry heading and find a visual reference to use, continue to scan for traffic
      - Glance at the heading indicator and check visual references to know where you are in the turn
  ii. Adjustments
    a. Increasing/Decreasing 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 Increasing bank decreases lift; Decreasing bank increases lift
        b 1º to 3º of bank stays within bank tolerances
    b. Bank Angle
      - Adjust bank to maintain the required bank angle, pitch will likely need adjusted as well
      - If bank is shallow, increase bank and add back pressure to maintain altitude, and vice versa

D. Roll Out
  i. General rule: Begin the rollout approximately ½ the bank angle from your entry heading (20º – 25º)
  ii. Time the rollout so the wings reach level flight when on the heading from which the maneuver was started
  iii. Gradually reduce back pressure and power as bank is decreased
  iv. If elevator was trimmed up, remove the trim during the rollout to prevent a large increase in altitude
  v. Maintain orientation (know where you are in the turn)

4. Common Errors AI.IX.A.K4

A. Not clearing the area
B. Inadequate pitch control on entry or rollout
C. Gaining or losing altitude
D. Failure to maintain constant bank angle
E. Poor flight control coordination
F. Ineffective use of trim
G. Ineffective use of power
H. Inadequate airspeed control
I. Becoming disoriented

J. Performing by reference to the flight instruments rather than visual references
K. Failure to scan for other traffic during the maneuver
L. Attempting to start recovery prematurely
M. Failure to stop the turn on the designated heading

5. **RM: Hazards** (RM: Division of Attention, Distractions, SA & Disorientation, Task Prioritization)
   A. Dividing Attention AI.IX.A.R1
      i. 90% outside, 10% inside
      ii. Crosscheck should focus primarily on outside references with glances inside for airspeed, altitude, etc.
      iii. Orientation does not just include the aircraft attitude, but also where you are and what/who is around you
         a. Includes airspace, terrain, traffic, etc.
         b. Know what the airplane is doing and where you are (outside references are very helpful)
   B. Distractions AI.IX.A.R4
      i. They're dangerous – remove them from view (if it's a person, explain the situation and ask them to stop)
      ii. High task saturation
         a. Distractions can lead to excessive altitude change, loss of orientation, and an inability to clear for traffic
      iii. Focus on aircraft performance and clear for traffic
      iv. Aviate, navigate, communicate
   C. Situational Awareness & Disorientation AI.IX.A.R4
      i. High turn rate & G forces make disorientation/loss of SA more common in steep turns than many maneuvers
      ii. Note entry heading on the heading indicator as well as by a visual outside reference
      iii. Maintain SA & orientation
         a. Know where you are, what's coming next, and stay ahead of the airplane
         b. Be aware of other traffic
      iv. If disoriented, stop the maneuver, admit the problem, and take action to regain SA/orientation
         a. Get to a safe attitude, airspeed, and altitude
   D. Task Prioritization AI.IX.A.R4
      i. A lot happens quickly during a steep turn, but safely flying the aircraft comes first
      ii. Divide attention between the aircraft, scanning, & communicating
         a. No one responsibility should take full attention for more than a short period
         b. Establish a crosscheck and be very familiar with visual references
      iii. Understand what needs to be accomplished when
      iv. Recognize when you're behind and find a way to catch up
      v. Aviate, navigate, communicate

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

   E. IX. RM Concepts – Low Altitude Maneuvering AI.IX.A.R3
   F. IX. RM Concepts – Collision Hazards AI.IX.A.R2

Conclusion:
Brief review of the main points

IX.B. Steep Spirals

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The learner should be able to perform the steep spiral maneuver to ACS standards, adjusting for varying wind speed and direction as well as changing bank angles.
Key Elements	1. Like 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. Steep Spirals & Emergency Landings 2. Rules 3. Performing a Steep Spiral 4. Common Errors 5. Hazards
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 elements involved in a properly flown steep spiral and 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

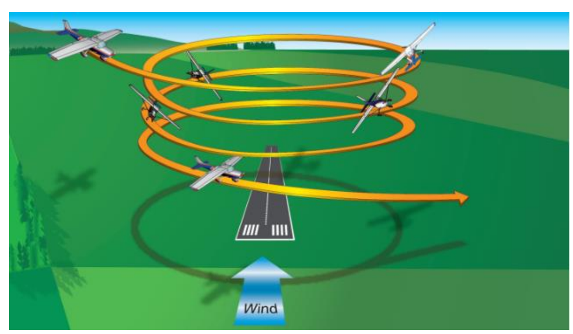
A steep spiral is a constant gliding turn, during which a constant radius around a point on the ground is maintained - similar to turns around a point.

Why AI.IX.B.K1

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.

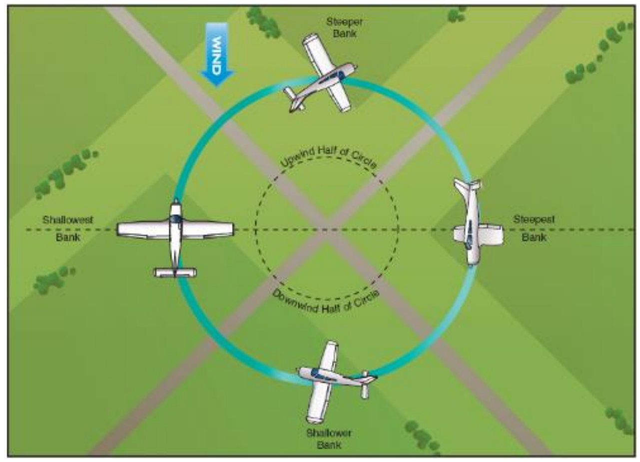
How:

1. **Steep Spirals & Emergency Landings** AI.IX.B.K2
   - A. Trains the pilot to efficiently manage an engine failure and set themselves up for a successful, controlled landing
   - B. In the case of an engine failure, proceed directly to an emergency landing airport/area
     - i. Arriving with too much altitude, the pilot can apply the steep spiral to:
       - a. Lose altitude while remaining directly over the landing zone
       - b. Control and plan the descent to enter downwind at the most suitable altitude based on conditions
       - c. Perform a controlled power-off 180 landing
2. **Rules** AI.IX.B.K3, AI.IX.B.K4
   - 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
       - a. The smaller the radius, the higher the required bank
     - ii. Turn Radius
       - a. Affected by bank angle and airspeed
         - As airspeed increases, radius increases
         - As bank increases, radius decreases
       - b. To maintain a constant radius, bank angle must be increased as groundspeed increases and decreased as groundspeed decreases



   - B. Enter on the downwind
     - i. Highest groundspeed establishes steepest bank at the start
   - C. Continue 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 plan a minimum entry altitude
   - D. Clear the engine when headed into the wind (minimizes variation in groundspeed and radius)
   - E. RM: Stay within all published aircraft limitations AI.IX.B.R7

3. Performing a Steep Spiral AI.IX.B.K 1, AI.IX.B.K3, AI.IX.B.K4



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, establish the recommended airspeed, trim the aircraft
   ii. When passing next to the point, the aircraft will block the pilot's view of the point
      a. Technique: Once the point disappears, wait a few seconds, and start the turn when past the reference point, establishing the ¼ radius (early turn puts you over the point)
   iii. Establish the initial bank angle and establish the proper site picture with the reference point
      a. 45° bank is a good starting point
      b. Discuss the site picture for your aircraft
C. During the Spiral
   i. Divide attention between the ground reference point/site picture. 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. RM: Wind Correction (RM: Effects of wind) AI.IX.B.R6
      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
         - Adjust 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 – Use small, smooth, proactive changes
   v. RM: Uncoordinated Flight AI.IX.B.R5
      a. Uncoordinated flight results in additional drag and airspeed changes
         - Failure to hold a constant airspeed varies turn radius and the required bank angle
      b. Do not use rudder to increase or decrease the rate of turn to adjust the ground track
D. Rolling out of the Turn
   i. After completing three complete rotations, roll out within 10° of the entry heading
      a. Maintain orientation - 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

4. Common Errors AI.IX.B.K5

A. Not clearing the area
B. Inadequate pitch control on entry or rollout
C. Not correcting the bank angle to compensate for wind
D. Poor flight control coordination
E. Ineffective use of trim
F. Inadequate airspeed control

G. Becoming disoriented
H. Performing by reference to the flight instruments rather than visual references
I. Not scanning for other traffic during the maneuver
J. Not completing the turn on the designated heading or reference

5. RM: Hazards

A. Dividing Attention between Aircraft Control & Orientation AI.IX.B.R1
   i. Crosscheck should focus primarily on outside references with glances inside for airspeed, altitude, etc.
      a. Fixation on one thing results in the others being neglected and a poorly performed maneuver
   ii. Orientation isn't just aircraft attitude, but also where you are and what or who is around you

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

B. IX. RM Concepts – Distractions, SA & Disorientation, Task Prioritization AI.IX.B.R4
C. IX. RM Concepts – Low Altitude Maneuvering AI.IX.B.R3
D. IX. RM Concepts – Collision Hazards AI.IX.B.R2

Conclusion:
Brief review of the main points

IX.C. Chandelles

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The learner can complete a Chandelle as prescribed in the ACS.
Key Elements	1. Maximum Performance 2. 1^{st} 90^{o} - Constant Bank, Changing Pitch 3. 2^{nd} 90^{o} - Constant Pitch, Changing Bank 4. Coordination
Elements	1. Aerodynamics Recap 2. Maximum Performance 3. Performing the Chandelle 4. Common Errors 5. Hazards
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 performs a smooth, well-coordinated chandelle without the instructor's guidance. The learner 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 180° 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 approximately straight and level flight and ending at the completion of a precise 180° turn in a wings level, nose high attitude at the minimum controllable airspeed. The airplane should gain the most altitude possible for a given degree of bank and power setting without stalling.

Why AI.IX.C.K1

This maneuver greatly develops the pilot's coordination, orientation, planning, and accuracy of control during maximum performance flight. In real-life scenarios, it provides the pilot with the ability to make a maximum performance climbing turn which can be useful in confined areas.

How:

1. **Aerodynamics Recap** AI.IX.C.K2
   A. Maneuvering Speed (V_A) AI.IX.C.K2c
      i. Maximum speed at which the aircraft will stall prior to exceeding airframe limitations
         a. Above V_A, full control deflection can result in stresses greater than the aircraft is designed to handle
      ii. Weight Changes (Bold Method Video)
         a. V_A increases with weight - This means the aircraft can maneuver at higher airspeeds when heavy
         b. The higher the weight, the higher the AOA needed to maintain level flight
            - Aircraft is closer to the critical AOA, meaning it takes less back pressure (or G load) before a stall
            - Less ability to put excess Gs on the airframe
      iii. Perform all maneuvers at or below V_A
   B. Bank Angle, Load Factor and Stall Speed AI.IX.C.K2d
      i. Basics
         a. Load factor is the result of two forces: Centrifugal force & Weight
         b. Assuming level flight, as bank angle increases, the load factor and stall speed also increase
            - The opposite also applies – decreasing bank angle decreases load factor and stall speed
      ii. Load Factors
         a. As bank increases beyond 45°, the loads on the aircraft increase rapidly
            - 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

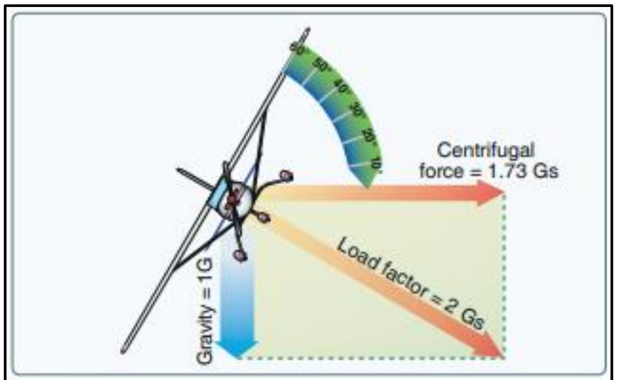
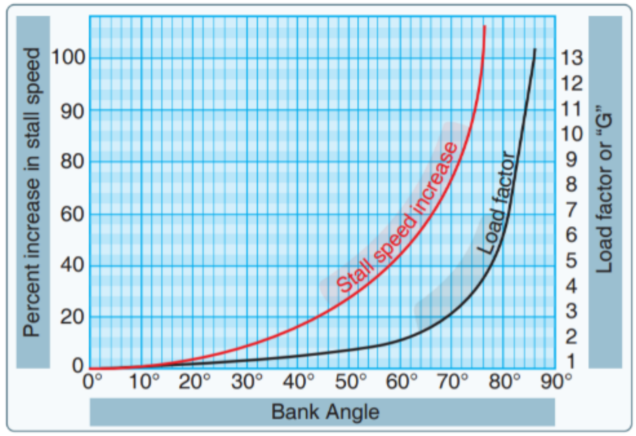
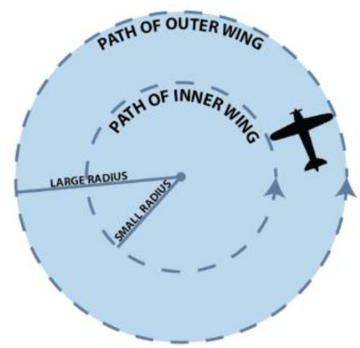


Figure 5-52. *Two forces cause load factor during turns.*

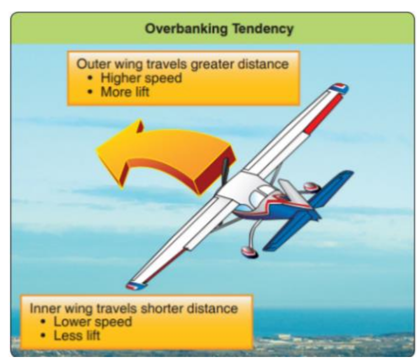


iv. Chandelles & Accelerated Stalls
   a. The airplane will stall at a higher indicated airspeed when excessive maneuvering loads are imposed
   b. Smoothly and positively apply the control pressures to execute the chandelle
      - Abrupt, aggressive control inputs could lead to an accelerated stall

C. Overbanking Tendency AI.IX.C.K2b



i. As turn radius becomes smaller, a difference develops between the speed of the inside wing & 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



ii. Overbanking Tendency and the Chandelle
   a. Opposite aileron is necessary in the slow, nose high turn near the top of the Chandelle to prevent overbanking

D. RM: Turn Rate & Radius AI.IX.C.R7
i. Rate of Turn
   a. Degrees per second the aircraft is turning
   b. Affected by both the bank angle and airspeed
      - As bank angle increases, so does the rate of turn
      - As airspeed increases, the rate of turn decreases

ii. Radius of Turn
   a. Size of circle an aircraft would fly during a turn
   b. Also affected by both the bank angle and airspeed (but opposite to Rate of Turn)
      - As bank angle increases, the

radius of turn decreases
- As airspeed increases, the radius of turn increases

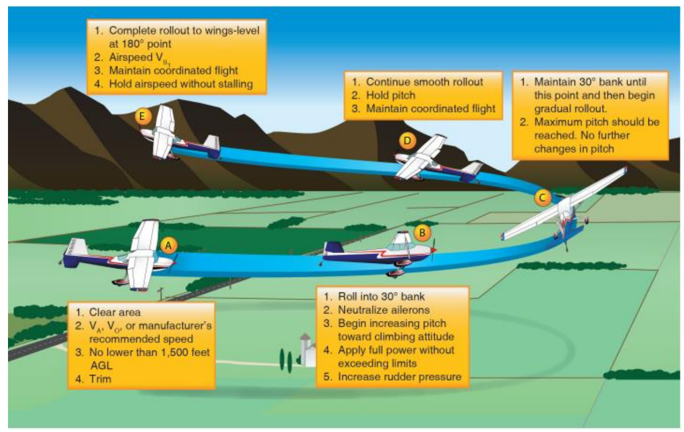
iii. Confined Area Operations
   a. Minimizing radius and maximizing turn rate provides the most confined area for a turn
      - Higher bank and slower airspeed

2. Maximum Performance

A. The plane should gain the most altitude possible for a degree of bank and power setting without stalling
   i. However, since numerous variables affect the amount of altitude gained, altitude gained is not a criterion on the quality of the chandelle

B. RM: Energy Management AI.IX.C.R6
   i. If pitch is increased too little or too slowly, climb performance is limited
   ii. If pitch is increased too high, or too quickly, the aircraft will stall before completion
   iii. Balance in energy to maximize performance

3. Performing the Chandelle AI.IX.C.K1, AI.IX.C.K3, AI.IX.C.K4



A. Before Starting
   i. Select an altitude – no lower than 1,500' AGL
   ii. Pre-maneuver checklist; clear the area
   iii. Straight-and-level at V_A, with flaps/gear UP
   iv. Note/bug the heading
      a. Rollout will be on the reciprocal heading
   v. Choose a visual reference point 90° off the wing in the direction of the turn

B. First 90° – Constant bank, Changing pitch
   i. Smoothly enter a coordinated 30° turn
      a. Maintain bank until 90° point
      b. Adjust for variations/overbanking tendency
         - As speed decreases, overbanking increases
   ii. With bank established, apply max power, maintain coordination, 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 90° of the turn is completed
         - Intent is to be halfway between entry speed and min controllable airspeed at 90° point
         - Divide attention between visual references, the 90° reference point, and instruments
         - If the pitch is increased too quickly the aircraft will stall before reaching 180°
         - If the pitch is increased too slowly, the aircraft will not come close to the stall speed
   iii. RM: Maintain Coordination (RM: Uncoordinated flight) AI.IX.C.K2a, AI.IX.C.R5
      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
   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° – 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
   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

D. The Rollout
    i. Time the rollout so that wings are level at the 180º point
    ii. Pitch attitude should be held momentarily while at the minimum controllable airspeed
    iii. RM: Left Chandelle Rollout – Requires considerable right rudder AI.IX.C.R5
    iv. RM: Right Chandelle Rollout – Less right rudder correction is needed AI.IX.C.R5
        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
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. RM: Dividing Attention AI.IX.C.R1
    i. Crosscheck should focus primarily on outside references with glances inside for airspeed, altitude, etc.
        a. Over concentration inside or outside will result in the other being neglected and a poor maneuver
        b. Allows the pilot to divide attention between aircraft control and orientation
            - Orientation is not just aircraft attitude, but also where you are and what or who is around you
    ii. In the case of an unsafe situation or orientation stop the maneuver and fix the problem. Safety comes first

4. Common Errors AI.IX.C.K5

A. Not clearing the area
B. Initial bank is too shallow resulting in a stall
C. Initial bank is too steep resulting in failure to gain maximum performance
D. Allowing the bank angle to increase after initial establishment
E. Not starting the recovery at the 90° point in the turn
F. Allowing the pitch attitude to increase as the bank is rolled out during the second 90° of turn
G. Leveling the wings prior to the 180° point being reached
H. Pitch attitude is low on recovery resulting in airspeed well above stall speed
I. Application of flight control pressures is not smooth
J. Poor flight control coordination
K. Stalling at any point during the maneuver
L. Execution of a steep turn instead of a climbing maneuver
M. Not scanning for other traffic during the maneuver
N. Performing by reference to the instruments rather than visual references

5. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. IX. RM Concepts – Distractions, SA & Disorientation, Task Prioritization AI.IX.C.R4
B. IX. RM Concepts – Low Altitude Maneuvering AI.IX.C.R3
C. IX. RM Concepts – Collision Hazards AI.IX.C.R2

Conclusion:

Brief review of the main points

IX.D. Lazy Eights

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The learner understands the elements and control inputs necessary to perform the lazy eight maneuver. The learner shows the ability to perform a coordinated, well planned, and oriented lazy eight as prescribed in the ACS.
Key Elements	1. Transfer of Energy 2. Constantly changing control pressures 3. Symmetry
Elements	1. Relating the Maneuver 2. Performing the Lazy Eight 3. Energy Management 4. Overbanking Tendency 5. Rudder Control 6. Summary 7. Common Errors 8. Hazards
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 elements involved in performing a lazy eight and can 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

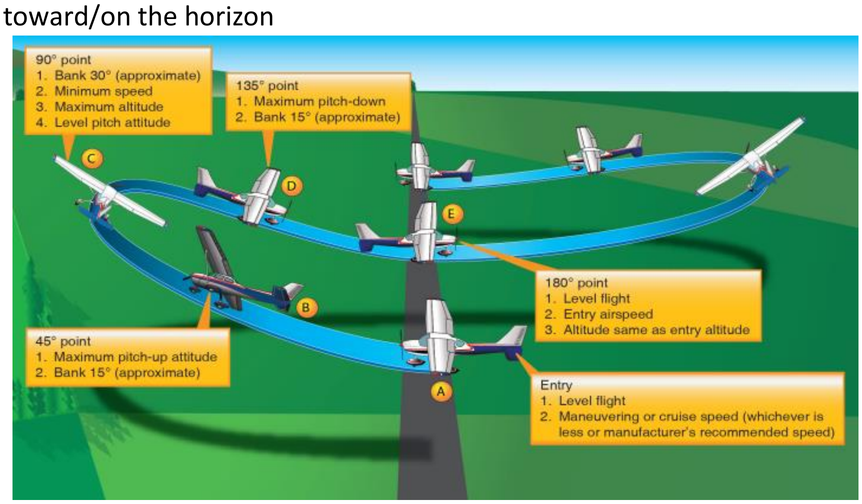
A maneuver consisting of two 180° turns in opposite directions, while making a climb and descent in a symmetrical pattern during each of the turns. It is designed to develop proper coordination of controls through a wide range of airspeeds and attitudes so that certain accuracy points are reached with planned attitude and airspeed. It is the only standard flight training maneuver during which at no time do the forces on the controls remain constant.

Why AI.IX.D.K1

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** AI.IX.D.K1, AI.IX.D.K3, AI.IX.D.K4
   - A. Before Starting
     - i. Select an altitude – No lower than 1,500' AGL
     - ii. Pre-maneuver checklist; Clear the area
     - iii. Straight-and-level flight, at or below V_A (reference any other applicable performance/airspeed limitations)
     - iv. Choose visual reference points at 45°, 90°, & 135° in the direction of turn
       - a. Should be easily identifiable and toward/on the horizon
   - B. Starting the Lazy Eight
     - i. Begin a *gradual* climbing turn toward the 45° reference point
       - a. Intent is to reach maximum pitch/15° bank at the 45° point
       - b. Pitch must be increased faster than bank
         - As pitch is increased, speed decreases and rate of turn increases
           - a Since bank is also being increased, rate of turn



is further increasing

- Decreasing airspeed means increased torque requiring 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. RM: Dividing Attention AI.IX.D.R1
   i. Crosscheck should focus primarily on outside references with glances inside for airspeed, altitude, etc.
      a. Over concentration inside or outside will result in the other being neglected and a poor maneuver
      b. Allows the pilot to divide attention between aircraft control and orientation
         - Orientation is not just bank/pitch attitude, but also where you are and what or who is around you
   ii. In the case of an unsafe situation or orientation stop the maneuver and fix the problem. Safety first

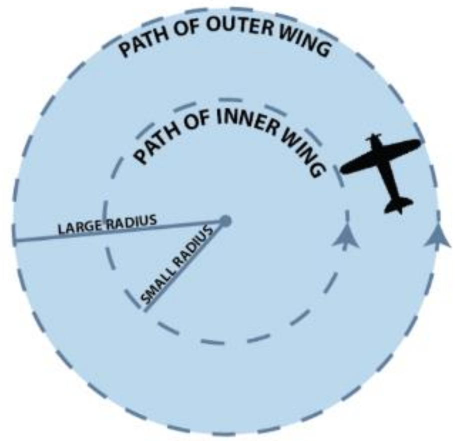
3. RM: Energy Management AI.IX.D.R6

A. Unsymmetrical Eights
   i. A lazy eight should consist of two symmetrical 180-degree turns, in opposite directions
   ii. A failure to manage energy leads to unsymmetrical turns. Differences between the two turns can include:
      a. Differing pitch attitudes and/or bank angles
      b. Differing rate of pitch and/or bank
      c. Uncoordinated flight

B. Altitude Changes
   i. If excess power is used, the aircraft will have gained altitude at the end of the maneuver
   ii. If insufficient power is used, the aircraft will have lost altitude

4. Overbanking Tendency AI.IX.D.K2

A. As turn radius becomes smaller, a difference develops between the speed of the inside wing & outside wing
   i. Outside wing travels a longer path, but in the same amount of time as the inside wing
      a. Outside wing generates more lift
      b. Difference in lift can increase bank
   ii. Shallow bank: difference in lift is overcome by lateral stability
   iii. Medium bank: the lift differential matches lateral stability
   iv. High bank: the difference in lift outweighs lateral stability
      a. Aircraft continues to bank even with neutral flight controls
      b. Aileron pressure is required in the direction opposite the turn to maintain bank angle



B. Overbanking Tendency and the Lazy Eight
   i. When in a nose high turning attitude at a slow airspeed, as at the top of the maneuver, bank will increase
   ii. Use opposite aileron to maintain desired bank angle and prevent overbanking (
      a. Most noticeable at 90º

5. RM: Rudder Control (RM: Uncoordinated flight) AI.IX.D.K2, AI.IX.D.R5

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

6. Summary

A. The maneuver requires constantly changing control pressures
   i. Not possible to perform it mechanically
B. Divide attention between visual references, reference points, and pitch, bank, airspeed, & coordination
   i. Talk through the maneuver at each 45º point. Know what you're going to do
C. Use smooth, controlled inputs to obtain constant rate pitch and bank changes - Don't be aggressive

7. Common Errors AI.IX.D.K5

A. Not clearing the area
B. Maneuver is not symmetrical across each 180°
C. Inadequate or improper selection or use of 45°, 90°, 135° references
D. Ineffective planning
E. Gain or loss of altitude at each 180° point
F. Poor control at the top of each climb segment resulting in the pitch rapidly falling through the horizon
G. Airspeed or bank angle standards not met
H. Control roughness
I. Poor flight control coordination
J. Stalling at any point during the maneuver
K. Execution of a steep turn instead of a climbing maneuver
L. Not scanning for other traffic during the maneuver
M. Performing by reference to the flight instruments rather than visual references

8. RM: Hazards

A. Accelerated Stalls AI.IX.D.R7
   i. The aircraft will stall at a higher indicated airspeed when excessive maneuvering loads are imposed on it
      a. Pitching and rolling actions tend to be more sudden
   ii. Recovery
      a. Promptly release back elevator pressure, increase power, return to straight and level, coordinated flight
   iii. Accelerated Stalls and Lazy Eights
      a. Use smooth, controlled inputs. Avoid aggressive/excessive control inputs, especially close to the ground
      b. Fly it as described, lazy
B. Dividing Attention AI.IX.D.R1
   i. Crosscheck should focus primarily on outside references with glances inside for airspeed, altitude, etc.
      a. Constantly changing control forces requires effective attention management
   ii. Divide attention between aircraft control and orientation
      a. Orientation is not just aircraft attitude, but also where you are and what or who is around you
   iii. In the case of an unsafe situation or orientation stop the maneuver and fix the problem. Safety comes first

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

C. IX. RM Concepts – Distractions, SA & Disorientation, Task Prioritization AI.IX.D.R4
D. IX. RM Concepts – Low Altitude Maneuvering AI.IX.D.R3
E. IX. RM Concepts – Collision Hazards AI.IX.D.R2

Conclusion:
Brief review of the main points

IX.E. Ground Reference Maneuvers

The ACS combines Rectangular Course, S-Turns, and Turns Around a Point into a single task. We’ve kept them as individual lessons.

- **Rectangular Course**
- **S-Turns**
- **Turns Around a Point**

IX.E. Rectangular Course

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The learner should develop knowledge of the rectangular course and the elements involved in maintaining a proper ground track. The learner can perform the maneuver as required in the ACS.
Key Elements	1. Plan Ahead 2. Wind Corrections 3. Coordination
Elements	1. Purpose 2. Basics 3. Performing the Rectangular Course 4. Common Errors 5. Hazards
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 how wind can affect the ground track of the airplane and can make the necessary corrections to maintain a uniform ground track, especially 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 training maneuver in which the ground track of the airplane is equidistant from all sides of a selected rectangular area on the ground.

Why AI.IX.E.K1

This maneuver simulates the conditions encountered in a traffic pattern and therefore prepares the learner for traffic pattern work.

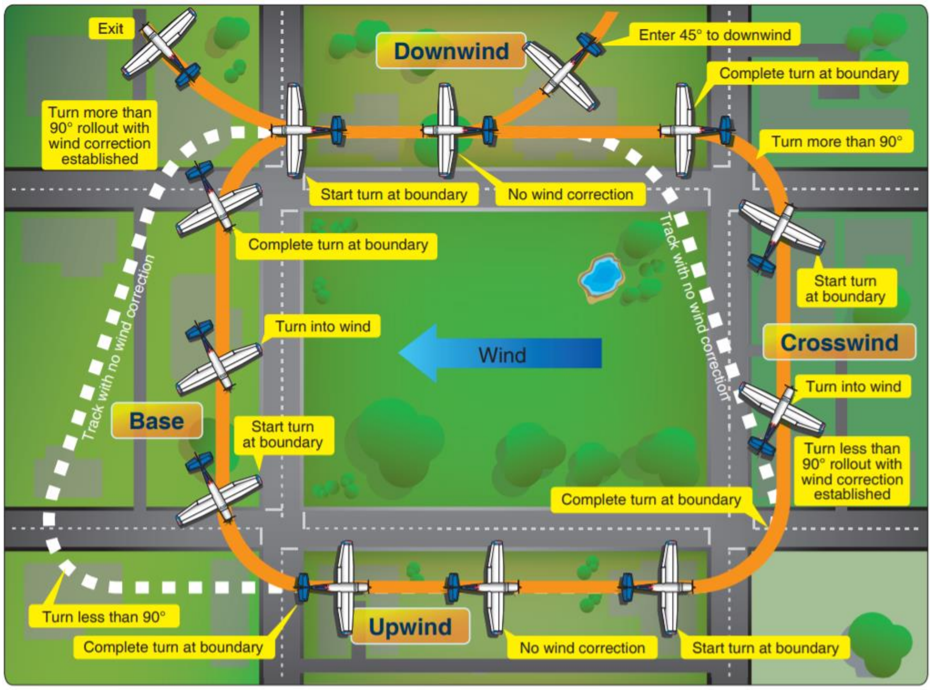
How:

Purpose AI.IX.E.K1

- Maintaining relationship between the plane and ground
- Dividing attention between the flightpath, ground references, flight controls, scanning, & instruments
- Adjusting the bank angle during turns to correct for groundspeed changes to maintain constant radius turns
- Rolling out from a turn with the required wind correction angle to compensate for wind drift
- Establishing and correcting the wind correction angle to maintain the track over the ground
- Preparing for the traffic pattern and landing practice

1. **The Basics** AI.IX.E.K2, AI.IX.E.K3, AI.IX.E.K4
    A. The 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. Turn Rate & Radius Recap
        i. Rate of Turn
            a. Degrees per second the aircraft is turning
            b. Affected by both the bank angle and airspeed
                - As bank angle increases, so does the rate of turn
                - As airspeed increases, the rate of turn decreases
        ii. Radius of Turn
            a. Size of circle an aircraft would fly during a turn
            b. Also affected by both the bank angle and airspeed (but opposite to Rate of Turn)
                - As bank angle increases, the radius of turn decreases
                - As airspeed increases, the radius of turn increases
    E. 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

F. RM: Coordination (RM: Uncoordinated flight) AI.IX.E.R5
   iv. 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

G. Airspeed (± 10 knots)
   i. Keep airspeed in your crosscheck. Increase or decrease power as necessary

H. RM: Division of Attention AI.IX.E.R1
   i. The maneuver requires you to divide attention between the leg distance, turns, altitude, and airspeed, as well as coordination and scanning
   ii. Crosscheck should focus primarily on outside references with glances inside for airspeed, altitude, etc.
      a. Over concentration inside or outside will result in the other being neglected and a poor maneuver
      b. Allows the pilot to divide attention between aircraft control and the orientation
         - Orientation is not just the bank/pitch attitude, but also where you are and what/who is around you
   iii. In the case of an unsafe situation or orientation stop the maneuver and fix the problem. Safety first
   iv. Poor planning, orientation, or division of attention leads to poorly executed turns and wind correction

2. Performing the Rectangular Course AI.IX.E.K1

A. Selecting a Suitable Altitude
   i. Entry altitude: 600' - 1,000' AGL (per the ACS)
      a. ± 100' restrictions (800' AGL is a good balance with room above / below the altitude requirement)

B. Selecting a Suitable Reference Point

- i. A square or rectangular field, or an area with suitable ground references on all four sides
  - a. Similar to a traffic pattern, sides should be 5,000 – 10,000' in length (one to two miles)
- ii. Wind direction must be estimated (METAR, smoke, water, trees, fields, a 360° turn noting ground track)
  - a. Per the ACS, the maneuver should be entered on a 45° angle to the downwind leg
- iii. Allows for an emergency landing & clear of populated areas, obstructions, hazards

C. 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

D. 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

- > 90º 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

xi. Anomalies

a. In a perfect scenario, drift is not encountered on the upwind/downwind legs
- Difficult to find a situation where the wind is blowing exactly parallel to the boundaries

3. Common Errors AI.IX.E.K5

A. Failure to adequately clear the surrounding area for safety hazards, initially and throughout the maneuver.
B. Failure to establish a constant, level altitude prior to entering the maneuver.
C. Failure to maintain altitude during the maneuver.
D. Failure to properly assess wind direction.
E. Failure to establish the appropriate wind correction angle.
F. Failure to apply coordinated aileron and rudder pressure, resulting in slips and skids.
G. Failure to manipulate the flight controls in a smooth and continuous manner.
H. Failure to properly divide attention between airplane control and orientation with ground references.
I. Failure to execute turns with accurate timing.

4. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. IX. RM Concepts – Distractions, SA & Disorientation, Task Prioritization AI.IX.E.R4
B. IX. RM Concepts – Low Altitude Maneuvering AI.IX.E.R3
C. IX. RM Concepts – Collision Hazards AI.IX.E.R2

Conclusion:

Brief review of the main points

IX.E. S-Turns

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The learner should develop knowledge of S-turns as described in the ACS.
Key Elements	1. Wind Correction 2. Coordination 3. Emergency Landing Area
Elements	1. Purpose of S-turns 2. Basics 3. Performing S-Turns 4. Common Errors 5. Hazards
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 effect of wind on maintaining equilateral radii on each side of a reference line. They can make the necessary adjustments through 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

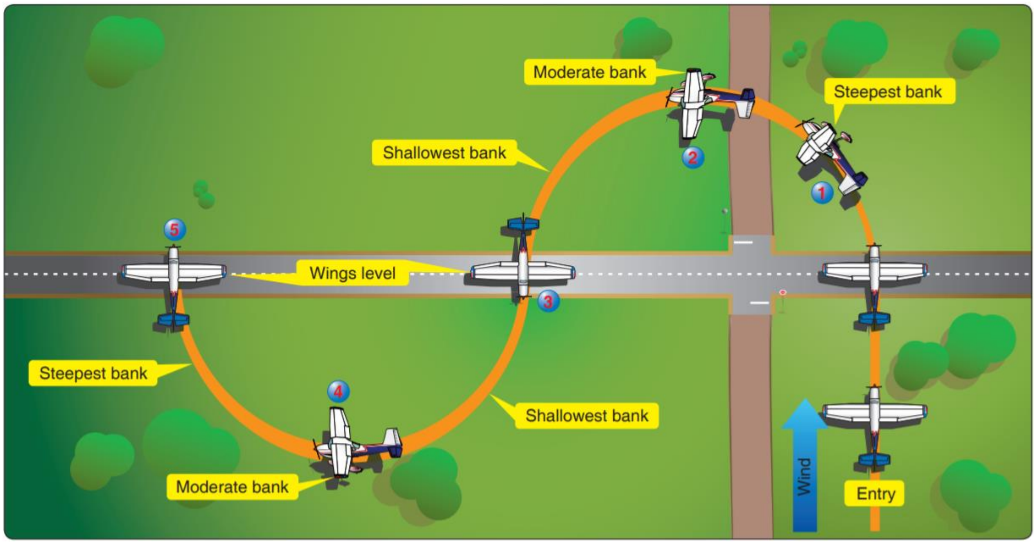
Why

To understand and learn to adjust for winds and their effect on the aircraft's ground track throughout turns in opposite directions.

How:

1. **Purpose** AI.IX.E.K1
    - Maintain a relationship between the plane and ground
    - Divide attention between the flightpath, ground references, the flight controls, scanning for outside hazards, and instrument indications
    - Adjust bank during turns to correct for groundspeed changes to maintain constant radius turns
    - Roll out from a turn with the required wind correction angle to compensate for any wind drift
    - Establish and correct the wind correction angle to maintain track over the ground
    - Compensate for drift in quickly changing orientations
    - Arrive at specific points on required headings
2. **The Basics** AI.IX.E.K2, AI.IX.E.K3
    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. Turn Rate & Radius Recap
        i. Rate of Turn (degrees per second the aircraft is turning)
            a. Affected by both the bank angle and airspeed
                - As bank angle increases, so does the rate of turn
                - As airspeed increases, the rate of turn decreases
        ii. Radius of Turn (size of circle an aircraft would fly during a turn)
            a. Also affected by both the bank angle and airspeed (but opposite to Rate of Turn)
                - As bank angle increases, the radius of turn decreases
                - As airspeed increases, the radius of turn increases
    C. 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: 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



3. Performing S-Turns AI.IX.E.K1

A. Prior to Entry
   i. Selecting a Suitable Altitude
      a. Entry altitude should be 600' - 1,000' AGL per the ACS
         - ± 100' restrictions (800' AGL is a good balance with room above/below the altitude requirement)
   ii. 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, and allows for an emergency landing
   iii. Pre-Maneuver Checklist; Clear the area
   iv. Airspeed – Recommended airspeed, and trimmed for hands off, level flight

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
         - 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

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

E. RM: Coordination (RM: Uncoordinated flight) AI.IX.E.R5
   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)

4. Common Errors AI.IX.E.K5

A. Failure to adequately clear surrounding area for safety hazards, initially and throughout the maneuver.
B. Failure to establish a constant, level altitude prior to entering the maneuver.
C. Failure to maintain altitude during the maneuver.
D. Failure to properly assess wind direction.
E. Failure to properly execute constant radius turns.
F. Failure to manipulate the flight controls in a smooth and continuous manner when transitioning into turns.
G. Failure to establish the appropriate wind correction angle.
H. Failure to apply coordinated aileron and rudder pressure, resulting in slips or skids

5. RM: Hazards

A. Division of Attention AI.IX.E.R1
   i. Crosscheck should focus primarily on outside references with glances inside for airspeed, altitude, etc.
      a. Over concentration inside or outside will result in the other being neglected and a poor maneuver
      b. Allows the pilot to divide attention between aircraft control and the orientation
         - Orientation is not just bank/pitch attitude, but also where you are and what or who is around you
   ii. In the case of an unsafe situation or orientation stop the maneuver and fix the problem. Safety first

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

B. IX. RM Concepts – Distractions, SA & Disorientation, Task Prioritization AI.IX.E.R4
C. IX. RM Concepts – Low Altitude Maneuvering AI.IX.E.R3
D. IX. RM Concepts – Collision Hazards AI.IX.E.R2

Conclusion:
Brief review of the main points

IX.E. Turns Around a Point

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The learner 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 standards.
Key Elements	1. Increased Groundspeed = Increased Bank 2. Decreased Groundspeed = Decreased Bank 3. Maintain Coordination
Elements	1. Purpose 2. Basics 3. Performing Turns Around a Point 4. Common Errors 5. Hazards
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 learner can demonstrate knowledge and proficiency in turns around a point. The learner 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

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

To learn to adjust for wind and its effect on the aircraft's ground track as throughout turns

How:

1. **Purpose** AI.IX.E.K1
   - Maintain a relationship between the plane & ground
   - Divide attention between the flightpath, ground references, the flight controls, scanning for outside hazards, and instrument indications
   - Adjust bank during turns to correct for groundspeed changes to maintain a constant radius
   - Improve skill in managing quickly changing bank angles
   - Establish and adjust the wind correction angle 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
2. **The Basics** AI.IX.E.K2, AI.IX.E.K3
   - 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. Turn Rate & Radius Recap
     - i. Rate of Turn
       - a. Degrees per second the aircraft is turning
       - b. Affected by both the bank angle and airspeed
         - As bank angle increases, so does the rate of turn
         - As airspeed increases, the rate of turn decreases
     - ii. Radius of Turn
       - a. Size of circle an aircraft would fly during a turn
       - b. Also affected by both the bank angle and airspeed (but opposite to Rate of Turn)
         - As bank angle increases, the radius of turn decreases
         - As airspeed increases, the radius of turn increases
   - C. 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

D. RM: Division of Attention AI.IX.E.R1
- 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

3. Performing Turns Around a Point AI.IX.E.K1

A. Prior to Entry
- i. Select an Altitude
  - a. Entry altitude should be 600'-1,000' AGL per the ACS (± 100' restrictions - 800' AGL is a good balance)
- ii. Select a Reference Point
  - a. Should be prominent and easily distinguishable / small enough for precise reference (Ex. crossroads)
    - 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
  - c. Allows for an emergency landing, if necessary
- iii. Pre-Maneuver Checklist; Clear the area
- iv. 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

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
  - 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
  - d. RM: Always keep the turn coordinated (RM: Uncoordinated flight) AI.IX.E.R5
    - As the bank is reduced, rudder pressure will reduce
  - 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

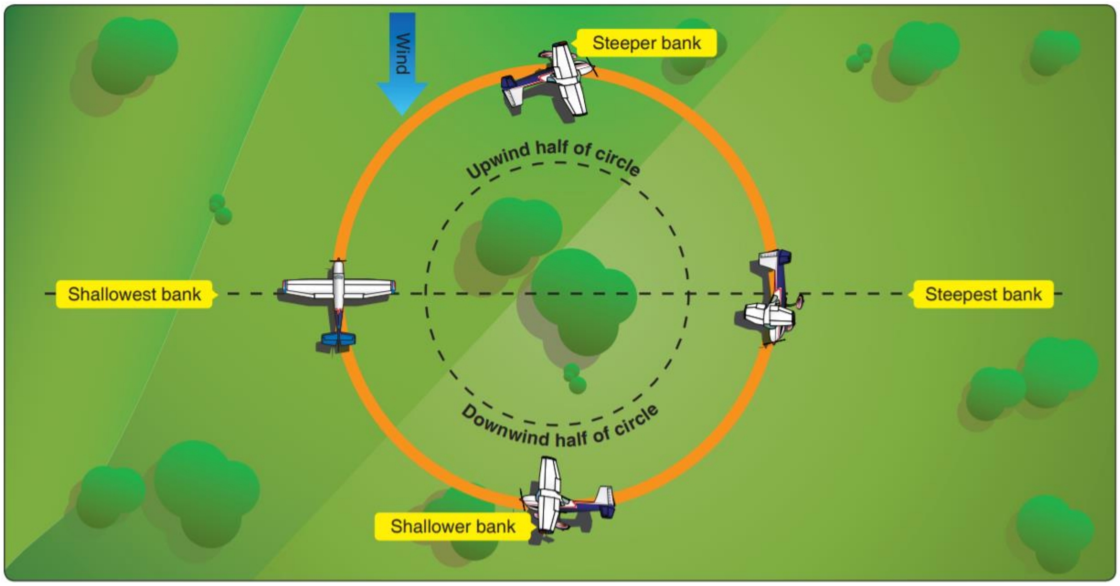
c. Progressively crab outside the turn to establish max wind correction angle at the 90° point
- Decrease wind correction angle from the 90° point until completing the first half of the turn

d. RM: Always keep the turn coordinated (RM: Uncoordinated flight) AI.IX.E.R5
- As the bank is reduced, rudder pressure will reduce

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



4. Common Errors AI.IX.E.K5

A. Failure to adequately clear the surrounding area for safety hazards, initially and throughout the maneuver.

B. Failure to establish a constant, level altitude prior to entering the maneuver.

C. Failure to maintain altitude during the maneuver.

D. Failure to properly assess wind direction.

E. Failure to properly execute constant radius turns.

F. Failure to manipulate the flight controls in a smooth and continuous manner.

G. Failure to establish the appropriate wind correction angle.

H. Failure to apply coordinated aileron and rudder pressure, resulting in slips or skids.

5. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. IX. RM Concepts – Distractions, SA & Disorientation, Task Prioritization AI.IX.E.R4

B. IX. RM Concepts – Low Altitude Maneuvering AI.IX.E.R3

C. IX. RM Concepts – Collision Hazards AI.IX.E.R2

Conclusion:

Brief review of the main points

IX.F. Eights on Pylons

References: Airplane Flying Handbook (FAA-H-8083-3)

Objectives	The learner should develop knowledge of the elements behind the Eights on Pylons maneuver and can perform the maneuver to ACS 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 5. Common Errors 6. Hazards
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 learner understands Pivotal Altitude and the accompanying concepts to Eights on Pylons. The learner also can 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 to maintain a constant view of a target, allowing the gunner to destroy it. 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 flight deck.

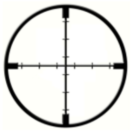
The maneuver itself involves flying the airplane in a figure eight path around two selected points, or pylons, on the ground. However, no attempt is made to maintain a uniform distance from the pylon. Instead, the goal is to have an imaginary line that extends from the pilot's eyes to the pylon. This line must be imagined to always be parallel to the airplane's lateral axis. 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. At no time should the string be at an angle to the lateral axis.

Why AI.IX.F.K1

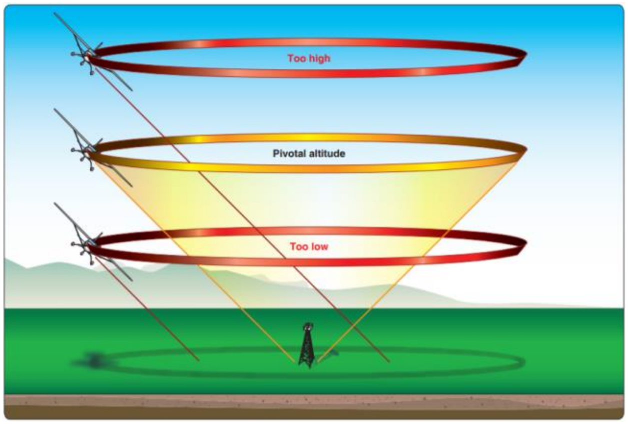
The objective of this maneuver is to develop the ability to maneuver the airplane accurately while dividing one's attention between the flight path and the selected points on the ground. Eights on Pylons are extremely helpful in teaching, developing, and testing subconscious control of the airplane.

How:

1. **What is Pivotal Altitude** AI.IX.F.K3
    A. Altitude which keeps a pylon in the same position relative to the aircraft as the plane turns around it
        i. Varies with groundspeed
        ii. The reference line is parallel with the lateral axis (off wingtip or position on the window)
    B. When turning at the pivotal altitude, the wingtip appears to be fixed to a point on the landscape
        i. Above the pivotal altitude, the wingtip appears to move backward
        ii. Below the pivotal altitude, the wingtip appears to move forward

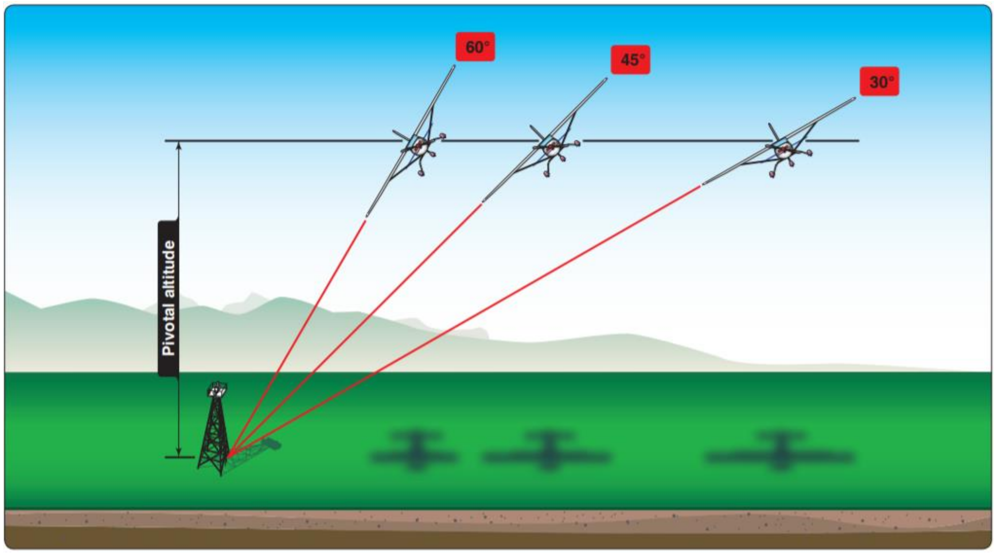


2. **The Basics** AI.IX.F.K2, AI.IX.F.K3
    A. Pivotal Altitude is Based on Groundspeed
        i. As groundspeed increases, pivotal altitude increases, and vice versa
            a. Does not change with bank angle
            b. Distance from pylon affects bank angle
        ii. Circling the reference 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 References



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. RM: Uncoordinated flight AI.IX.F.R5
      - Always maintain coordinated flight
      - Use altitude changes, not 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. RM: Energy Management & Power AI.IX.F.R6
   a. Pivotal altitude is based on groundspeed
      - Set power prior to entering the maneuver to keep the desired indicated airspeed consistent
      - Changes in power lead to changes in airspeed which change pivotal altitude
      - The more consistent the power setting, the more consistent the airspeed

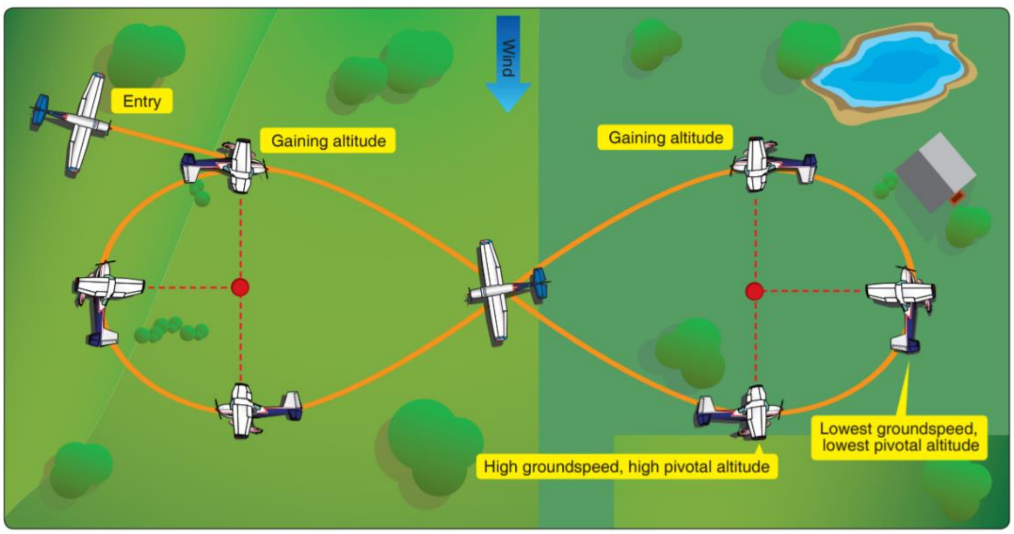
3. Calculating Pivotal Altitude AI.IX.F.K3

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

- 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 AI.IX.F.K1, AI.IX.F.K5

- A. Selecting the 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. RM: Ensure a suitable emergency landing area within gliding distance AI.IX.F.R7



- B. Pre-Maneuver
  - i. Pre-maneuver checklist; Clear the area of traffic
  - ii. Trimmed for straight and level flight, at or below V_A
- C. Entry
  - 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
- 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 AI.IX.F.K4
- 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 AI.IX.F.K4
iv. Initiate a turn in the opposite direction as the pylon aligns with the reference point

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 AI.IX.F.K4

G. Exit
i. Roll wings level after completing one rotation around each pylon and exit on the entry heading

5. Common Errors AI.IX.F.K6

A. Failure to adequately clear the surrounding area for safety hazards, initially and throughout the maneuver.
B. Skidding or slipping in turns (whether trying to hold the pylon with rudder or not).
C. Excessive gain or loss of altitude.
D. Poor choice of pylons.
E. Not entering the pylon turns into the wind.
F. Failure to assume a heading when flying between pylons that will compensate sufficiently for drift.
G. Failure to time the bank so that the turn entry is completed with the pylon in position.
H. Abrupt control usage.
I. Inability to select pivotal altitude.

6. RM: Hazards

A. Division of Attention AI.IX.F.R1
i. Crosscheck should focus primarily on outside references with glances inside for airspeed, altitude, etc.
a. Over concentration inside or outside will result in the other being neglected and a poor maneuver
b. Allows the pilot to divide attention between aircraft control and the orientation
- Orientation is not just bank/pitch attitude, but also where you are and what or who is around you

ii. In the case of an unsafe situation or orientation stop the maneuver and fix the problem. Safety first
iii. Don't fixate, divide attention between the turn, wind, flying the aircraft, and your surroundings
iv. Be proactive in making corrections

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

B. IX. RM Concepts - Distractions, SA & Disorientation, Task Prioritization AI.IX.F.R4
C. IX. RM Concepts - Low Altitude Maneuvering AI.IX.F.R3
D. IX. RM Concepts - Collision Hazards AI.IX.F.R2

Conclusion:
Brief review of the main points

IX. RM Concepts

1. **Distractions, SA & Disorientation, & Task Management**
   A. Distractions
      i. They're dangerous - Remove them from view or, if a person, explain the situation and ask them to stop
      ii. Focus on aircraft performance and clear for traffic - If distracted, recognize it and fix it – Safety first
      iii. Fly first! Aviate, Navigate, Communicate
   B. Situational awareness (SA) & Disorientation
      i. Extremely important, lost SA has led to unsafe situations, mishaps, and incursions
      ii. Maintain SA
         a. Starts with preflight planning
         b. Know what's coming next and stay ahead of the airplane
         c. Divide attention between inside and outside references
         d. If SA is lost, admit it and fix the problem
      iii. If disoriented, stop what you're doing and get to a safe attitude, airspeed, and altitude
         a. Disorientation can be caused by, or lead to, an upset
            - Push: Apply forward pressure to unload the plane
            - Roll: Roll aggressively to the nearest horizon
            - Thrust: Adjust as required
            - Stabilize: Return to a safe flight condition
   C. Task Management
      i. Divide attention between the aircraft, scanning, and communicating (ATC or CTAF)
      ii. Understand what tasks need to be accomplished and when
      iii. Recognize when you are getting behind and find a way to catch up
      iv. Proper task management can help prevent distractions, loss of SA, and disorientation
      v. Safety is the number one priority – Aviate, Navigate, Communicate
2. **Low Altitude Maneuvering**
   A. A small problem at high altitude can quickly become a big problem at a low altitude
   B. Be aware of, and avoid, obstructions, towers, etc.
      i. Quick, panicked maneuvers, especially when slow, can result in a stall or loss of control close to the ground
   C. Low Altitude Stall/Spin
      i. A low altitude stall or spin can leave little to no recovery time
         a. ALWAYS maintain coordination, and airspeed at low altitudes
         b. If you get any indication of a stall at low level, recover, and climb to a safe altitude
      ii. Spin
         a. A spin is a result of a stall + yaw
         b. Prevention
            - Maintain coordination
            - Do not use abrupt, excessive pressure inputs (especially back elevator pressure)
            - Stop whatever you're doing and recover at the first sign of a stall
         c. Recovery (PARE)
            - Power - Idle
            - Ailerons - Neutral
            - Rudder - Full rudder opposite the spin direction
            - Elevator - Brisk, positive forward pressure (nose down)
            - Once the spin has stopped, neutralize the rudders and raise the nose, being careful not to stall again
         d. Different aircraft respond differently to spins and spin recoveries, follow the POH procedures

D. CFIT (Controlled Flight into Terrain)
    i. AC 61-134: General Aviation CFIT Awareness
    ii. The solution to combating CFIT accidents starts on the ground
        a. Common themes include proper planning, good decision making, and being able to safely operate the aircraft throughout its entire operating range
    iii. Recommendations:
        a. Non-instrument rated VFR pilots should not attempt to fly in IMC
        b. Know and fly above minimum published safe altitudes
        c. If IFR, fly published procedures
        d. Verify proper altitude, especially at night or over water, through use of a correctly set altimeter
        e. Verify all ATC clearances. Question potentially hazardous clearances
        f. Maintain situational awareness both vertically and horizontally
        g. Comply with appropriate regulations for your specific operation
        h. Don't operate below minimum safe altitudes if uncertain of position or ATC clearance
        i. Be extra careful when operating in an area which you are not familiar
        j. Use current charts and all available information
        k. Use appropriate checklists
        l. Know your aircraft and its equipment

3. Collision Hazards

A. Collision Avoidance
    i. Scanning
        a. Series of short, regularly spaced eye movements bringing successive areas into the central visual field
            - Each movement should not exceed 10°, each area should be observed for at least one second
        b. Divide attention between flying and scanning for aircraft
    ii. Clearing Procedures
        a. Climb/Descent: Execute gentle banks to scan above/below the wings as well as other blind spots
        b. Prior to any turn: Clear in the direction of the turn
        c. Maneuvers: Clearing turns – clear above/below, in front/behind, continue to clear during maneuvers
    iii. Operation Lights On
        a. Voluntary FAA safety program
        b. Turn on landing lights during takeoff and when operating below 10,000', day or night
    iv. Right-of-Way Rules (FAR 91.113)
        a. An aircraft in distress has the right-of-way over all other traffic
        b. Converging Aircraft
            - When aircraft of the same category are converging, the aircraft to the right has the right-of-way
            - If the aircraft are different categories:
                a Basically, the less maneuverable aircraft has the right-of-way
                    1. Balloons, gliders, and airships have the right of way over airplanes
                b An aircraft towing or refueling an aircraft has the right-of-way over all engine driven aircraft
        c. Approaching Head-on: Each pilot shall alter course to the right
        d. Overtaking: Aircraft being overtaken has the right-of-way; when overtaking, pass on the right
        e. Landing
            - Aircraft landing/on final approach to land have the right-of-way over those in flight or on the surface
                a Do not take advantage of this rule to force an aircraft off the runway which has already landed
            - When two or more aircraft are approaching for landing, the lower aircraft has the right-of-way
                a Don't take advantage of this rule to cut in front of another aircraft

B. Terrain
    i. Study terminal charts and IFR/VFR chart altitudes, use Max Elevation Figures (MEFs)

- ii. Day vs Night flying over terrain
  - a. Be extra vigilant at night, when terrain may be impossible to see until it is too late
- iii. Minimum Safe Altitudes (FAR 91.119)
  - a. Anywhere: At an altitude allowing an emergency landing without undue hazard to persons or property
  - b. Over Congested Areas: 1,000’ above the highest obstacle within 2,000’
  - c. Over other than Congested Areas: 500’ above the surface, except when over open water/sparsely populated areas, then no closer than 500’ to any person, vessel, vehicle, or structure

C. Obstacles and Wire Strike

- i. Research obstacles nearby airports (Terminal Procedures, NOTAMs, etc.)
- ii. Antenna Towers
  - a. Numerous antennas extend over 1,000’-2,000’ AGL
    - Most are supported by guy wires which can extend 1,500’ horizontally from the structure
- iii. Overhead Wires (may not be lighted)
  - a. Overhead transmission wires and lines span runway departures and landmarks pilots frequently follow
    - Lakes, highways, railroad tracks, etc.

SLOW FLIGHT, STALLS & SPINS

X.A. Maneuvering During Slow Flight

References: Airplane Flying Handbook, Pilot's Handbook of Aeronautical Knowledge, POH/AFM

Objectives	To develop an understanding and proficiency of the flight characteristics and controllability of an aircraft in slow flight. A "feel" for the airplane at low speeds should be developed to avoid inadvertent stalls and to operate with precision. The learner should perform to ACS standards.
Key Elements	1. Pitch for Airspeed 2. Power for Altitude 3. Stay Coordinated

Elements	1. What is Slow Flight
	2. Slow Flight Aerodynamics
	  a. Airspeed
	  b. Power & the Region of Reversed Command
	  c. Yaw Effects
	  d. Maneuvering Loads & Turns
	  e. Weight
	  f. Center of Gravity
	  g. Environmental Elements
	3. Critical Flight Situations
	4. Slow Flight and the Senses
	5. Performing Slow Flight
	6. Common Errors
	7. Hazards

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 factors affecting flight characteristics and controllability and shows the ability to control the airplane effectively in different slow flight configurations.

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

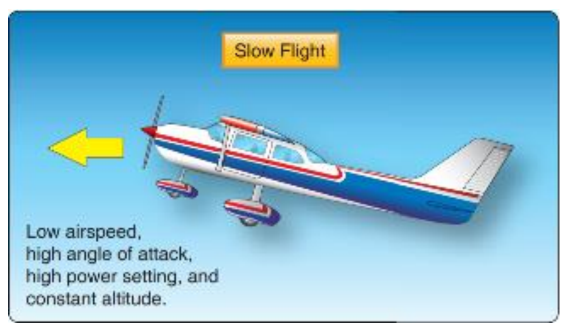
Slow flight is flight at a speed at which any further increase in angle of attack or load factor, or reduction in power will result in a stall warning.

Why AI.X.A.K1

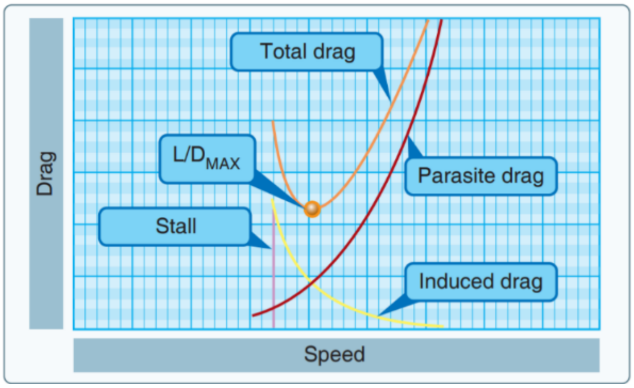
The aircraft performs and is controlled differently at slower airspeeds. Maneuvering during slow flight demonstrates the flight characteristics and degree of controllability of an aircraft near the critical AOA. In normal operations, the aircraft would not be flown this close to the critical AOA, but because the aircraft is flown at higher angles of attack and slower airspeeds in many phases of flight (takeoff, landing, go-around), understanding how the aircraft performs and is controlled at reduced speeds is essential, especially in the case the aircraft ends up slower than intended.

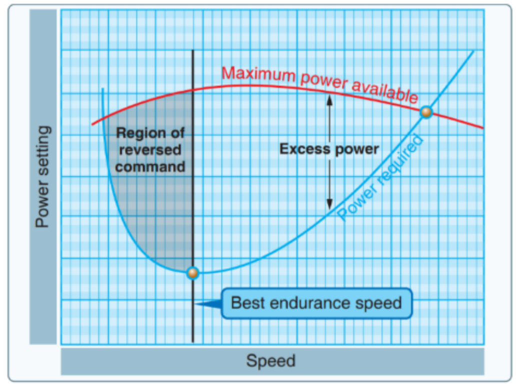
How:

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 further increase in AOA/load factor, or power reduction results in a stall warning
         a. This description is used for the slow flight maneuver



2. **Slow Flight Aerodynamics** AI.X.A.K2
   A. **Airspeed**
      i. An increase or decrease in airspeed increases or decreases lift, affecting AOA and attitude
      ii. In relation to slow flight, the slower the airspeed, the higher the AOA required (closer to critical AOA)
   B. **Power & the Region of Reversed Command**
      i. Normal 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





C. **Yaw Effects**

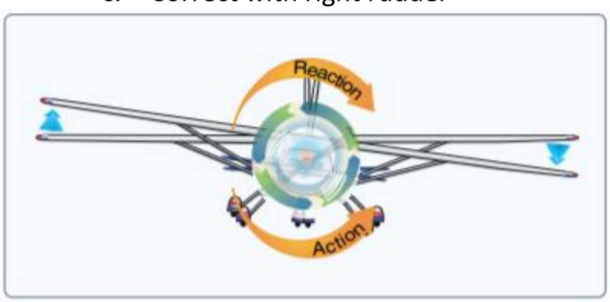
i. Increased power at slow airspeeds and high angles of attack results in increased left turning tendencies
   a. Anticipate considerable right rudder to maintain coordination

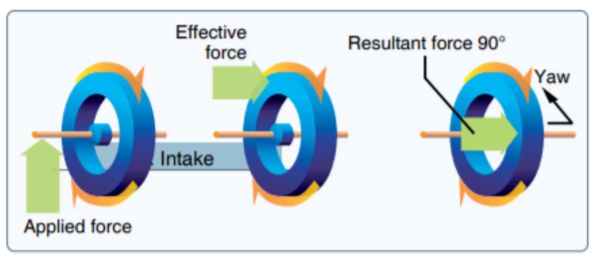
ii. Torque Reaction – Based on Newton's 3rd Law
   a. The engine parts/propeller rotate right, an equal force attempts to rotate the plane left
   b. In flight: left rolling tendency; On ground: left turning
   c. Corrected by offsetting the engine, aileron trim tabs, and/or aileron and rudder use

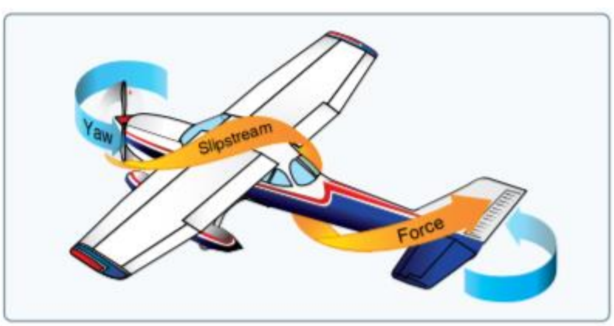
iii. Corkscrew/Slipstream Effect
   a. Corkscrewing propeller air strikes the left side of the vertical stabilizer - pushes nose left (shown below)
   b. Strongest at high prop speeds/low forward speeds

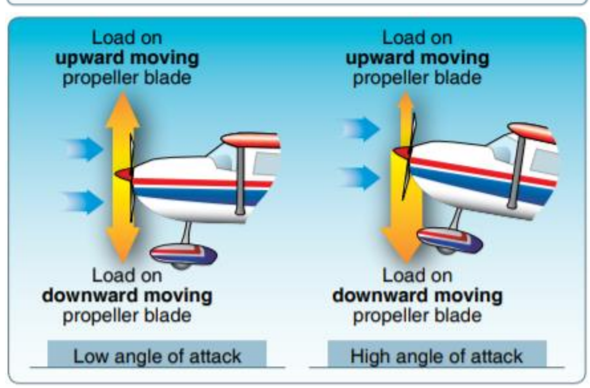
iv. Gyroscopic Action
   a. Precession - Any force takes effect 90° ahead of, and in the direction of rotation
   b. Pitch results in a yawing moment and vice versa
   c. Correct with rudder/elevator

v. Asymmetric Loading (P Factor)
   a. At high AOAs, the bite of the down moving blade is greater than the up moving blade
   b. Center of thrust moves to the right of the propeller disc, causing a yaw to the left
   c. Correct with right rudder





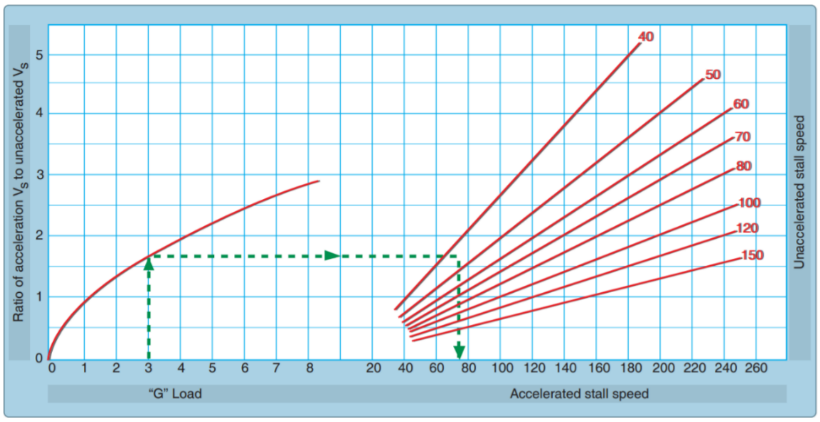


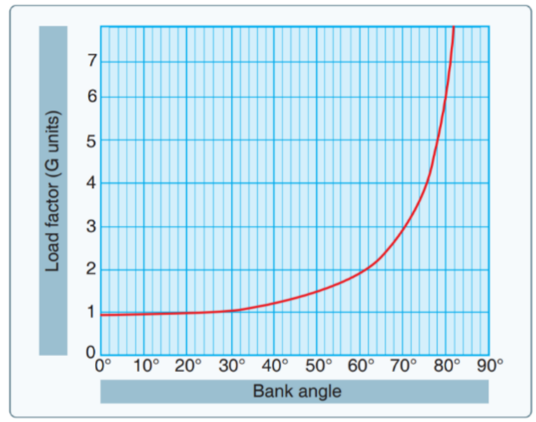


vi. Big Picture

a. Considerable right rudder is required to maintain coordination during slow flight
b. A right turn requires even more right rudder
c. A left turn requires less right rudder (still requires right rudder)

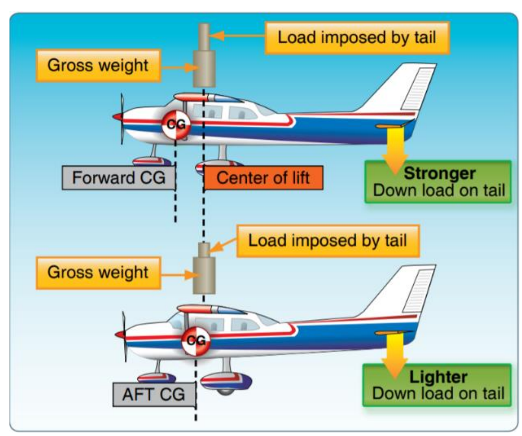
D. **Maneuvering Loads & Turns**
  i. Load factor: Ratio of the total load acting on the plane to the gross weight of the plane
    a. Expressed in terms of G's
    b. Increased load factor increases stall speed
  ii. Turns
    a. Increased load factors are a part of all banked turns
    b. Load factor 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
    b. Use gentle, coordinated, low bank turns during slow flight to prevent a potential stall
      - Right turn = more right rudder; Left turn = less right rudder (still requires right rudder)





E. **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

F. **Center of Gravity**
  i. Forward Loaded Aircraft
    a. Acts heavier, and consequently slower
      - More nose up elevator is required to maintain altitude
      - Tail must produce a greater down load 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 (like 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. Critical Flight Situations

A. In general, takeoffs, climbs, landings, and go-arounds – area of reversed command & close to the ground
B. RM: Inadvertent slow flight (distractions, disorientation, microburst, etc.) AI.X.A.R1
i. If unexpectedly in a slow flight or stall airspeed situation, proper control & recovery is imperative
a. A lack of understanding and/or ability could rapidly lead to a loss of control
C. Ex: High sink rate during a short field landing, or 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
D. RM: Stall Warning Range & Limitations AI.X.A.R2
i. Buffet: Tends to occur prior to the stall horn
a. May not always occur (Ex: Cross controlled stalls can occur with little to no warning)
ii. Stall Horn: Designed to provide warning of an approaching stall and time for stall recovery
a. Per 23.207
- Clear & distinct stall warning with the flaps/gear in any normal position, in straight and turning flight
- Warning must begin at least 5 knots above stall speed and continue until the stall occurs
- Must provide the pilot time to take action to avert the stall

iii. Stall indications and horns have different operational ranges and limitations
a. Reference the POH for specific information (ex: Uncoordinated flight may inhibit airflow at the indicator)

5. Performing Slow Flight AI.X.A.K1, AI.X.A.R1

A. Purpose
i. Demonstrate the flight characteristics and controllability of the airplane at its minimum flying speed
ii. RM: Provide the pilot the tools to recognize & recover from inadvertent slow flight preventing loss of control
B. 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)
C. Pre-Maneuver
i. Pre-maneuver checklist; Clear the area
ii. Select an altitude (no lower than 1,500' AGL)
iii. Configuration: Different configurations can be used to develop a feel for different situations
a. The 'dirtier' (more flaps), the slower we can get
D. Establishing Slow Flight
i. Gently reduce the throttle, maintaining altitude as airspeed is lost and trimming
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 adjust pitch for airspeed

a. Set the approximate pitch and power settings for your aircraft and adjust from there
b. RM: Anticipate the need for right rudder & maintain coordination AI.X.A.R3

E. 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° at a time)
    b. A change in pitch generally requires a corresponding change in power to maintain altitude
  ii. Power for Altitude
    a. If low, increase power; If high, decrease power
    b. A change in power generally requires a corresponding change in pitch to maintain airspeed
    c. Always keep one hand on the throttles (within reason)
  iii. Crosscheck: Divide attention between outside and quick glances to the instruments to ensure performance
  iv. Heading: Maintain coordination, keep heading/coordination in crosscheck
  v. 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.)
  vi. 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

F. Returning to Cruise Flight (very similar to a 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

6. Common Errors AI.X.A.K3

A. Failure to adequately clear the area
B. Inadequate back-elevator pressure as power is reduced, resulting in altitude loss
C. Excessive back-elevator pressure as power is reduced, resulting in a climb followed by rapid reduction in speed
D. Insufficient right rudder to compensate for left yaw
E. Fixation on the flight instruments
F. Failure to anticipate changes in AOA as flaps are extended or retracted
G. Inadequate power managements
H. Inability to adequately divide attention between airplane control & orientation
I. Failure to properly trim the airplane
J. Failure to respond to a stall warning

7. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. X. RM Concepts – Environmental Elements AI.X.A.R4
B. X. RM Concepts – Collision Hazards AI.X.A.R5
C. X. RM Concepts – Distractions, SA & Disorientation, & Task Management AI.X.A.R6

Conclusion:

Brief review of the main points

X.B. Demonstration of Flight Characteristics

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

Objectives	The learner develops an understanding of flight characteristics and power required at different airspeeds and configurations appropriate to the make and model of airplane flow, can apply that knowledge, manage associated risks, and provide effective instruction.
Key Elements	1. Region of Reversed Command 2. Slower Speeds Require Larger Control Movements 3. Stay Coordinated
Elements	1. Stall Aerodynamics 2. Various Factors & Stalls 3. Airspeeds 4. Control Inputs, Configuration, & Airspeeds 5. Demonstrating Flight Characteristics 6. Common Errors 7. Hazards
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 demonstration can be performed and described to ACS standards.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

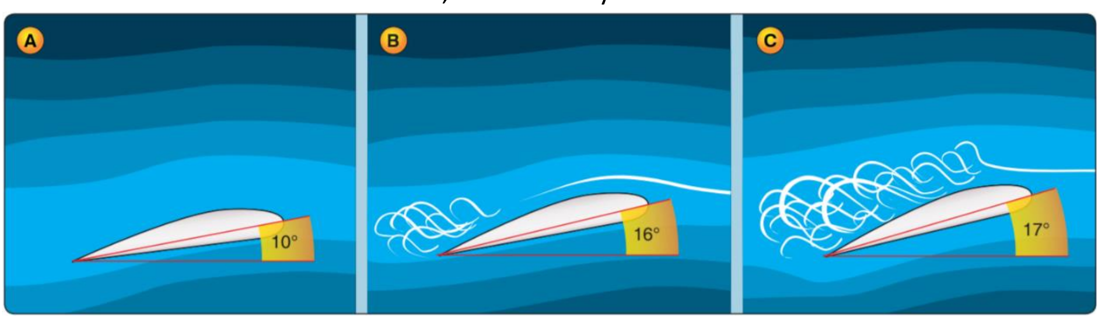
A demonstration of the control inputs, power, trim, and aircraft performance in various phases of flight and configurations.

Why AI.X.B.K1

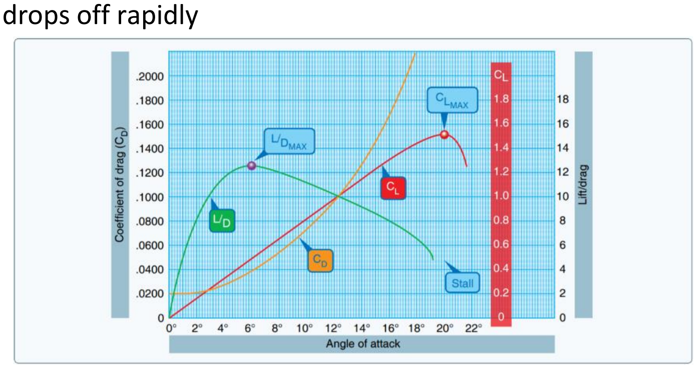
This demonstration provides the learner with a baseline for the changing pitch attitudes, power settings, trim requirements, etc. as airspeed and configuration is varied between the clean and landing configurations. This knowledge can be applied to numerous maneuvers and situations going forward.

How:

1. **Stall Aerodynamics** AI.X.B.K4
   A. A stall occurs when the smooth airflow over the wing is disrupted, and lift decreases rapidly
      i. This happens when the wing exceeds its critical angle of attack (AOA)
         a. The critical AOA varies with aircraft, but is usually around 15-20º in GA aircraft



   B. The Critical Angle of Attack/C_{LMAX}
      i. 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)
         b. C_L = Coefficient of Lift – Measurement of lift as it relates to AOA
            - Determined by wind tunnel tests; based on airfoil design/AOA
         c. Any AOA beyond C_{LMAX} results in a stall and lift drops off rapidly
   C. 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 AOA at the wing tip compared to the wing root

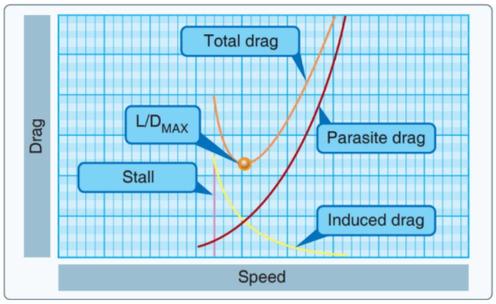


b. Adding strips to the first 20-25% of the leading edge to induce a stall earlier than otherwise

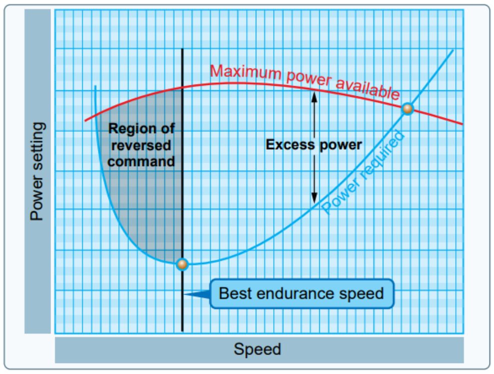
D. There's More than One Way to Exceed the Critical AOA
  i. If at *ANY* time the AOA becomes excessive, the aircraft will stall
  ii. Low Speed
    a. As airspeed decreases, the AOA must be increased to maintain altitude
    b. At a slow enough speed, the critical AOA is exceeded
  iii. High Speed
    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
      - If during the turn the AOA becomes excessive, the aircraft will stall

2. Various Factors and Stalls AI.X.B.K4

A. Airspeed & Power
  i. Airspeed
    a. An increase or decrease in airspeed increases or decreases lift, affecting AOA and attitude
    b. In relation to slow flight, the slower the airspeed, the higher the AOA required (closer to critical AOA)
  ii. Power & the Region of Reversed Command
    a. Normal Command



      - Normal Command
        a As airspeed decreases, total drag decreases, until reaching a point (L/D$_{MAX}$)
        b Higher speeds require higher power settings, and vice versa
      - Region of Reversed Command
        a Airspeeds below L/D$_{MAX}$, where total drag begins to increase
      - Slower speeds require higher power settings, and vice versa
    b. Minimum Power Required Airspeed AI.X.B.K3



      - Generally,
        a Aircraft aerodynamic properties determine the power required at various conditions
        b Powerplant capabilities determine the power available at various conditions
        c Visualized on the power required curve (pictured)
      - Lowest point on the curve is the speed at which the lowest brake horsepower sustains level flight
        a Best endurance, or minimum power required speed
        b Delineates regions of reversed & normal command

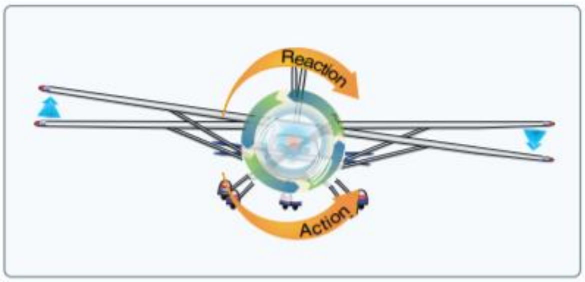
B. Yaw Effects
  i. Increased power at slow airspeeds and high angles of attack results in increased left turning tendencies
    a. Anticipate considerable right rudder to maintain coordination
  ii. Torque Reaction – Based on Newton's 3rd Law
    a. The engine parts/propeller rotate right, an equal force attempts to rotate the plane left

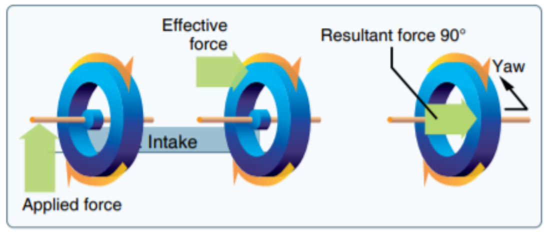
   b. In flight: left rolling tendency; On ground: left turning
   c. Corrected by offsetting the engine, aileron trim tabs, and/or aileron and rudder use

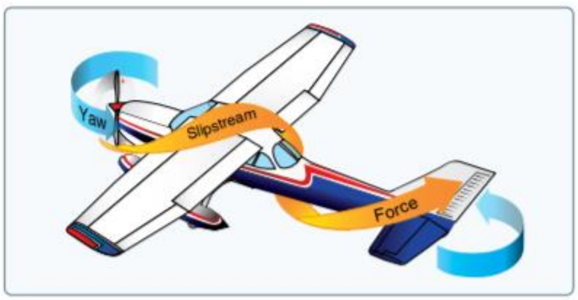
iii. Corkscrew/Slipstream Effect
   a. Corkscrewing propeller air strikes the left side of the vertical stabilizer - pushes nose left (shown below)
   b. Strongest at high prop speeds/low forward speeds

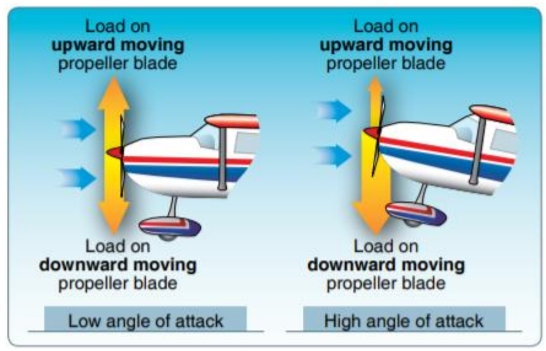
iv. Gyroscopic Action
   a. Precession - Any force takes effect 90° ahead of, and in the direction of rotation
   b. Pitch results in a yawing moment and vice versa
   c. Correct with rudder/elevator

v. Asymmetric Loading (P Factor)
   a. At high AOAs, the bite of the down moving blade is greater than the up moving blade
   b. Center of thrust moves to the right of the propeller disc, causing a yaw to the left
   c. Correct with right rudder



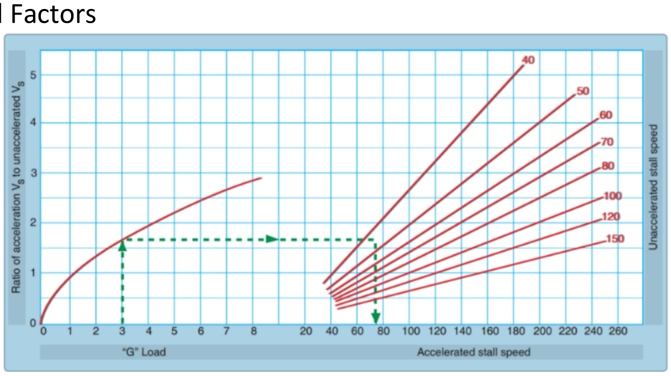


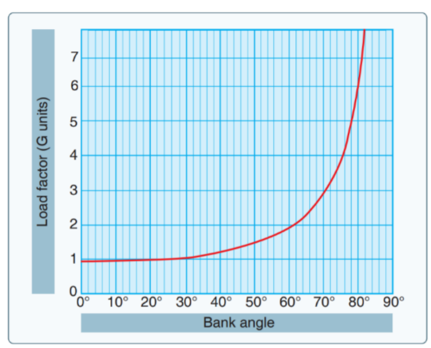




vi. Big Picture
   a. Considerable right rudder is required to maintain coordination during slow flight
   b. A right turn requires even more right rudder
      - A left turn requires less right rudder (still requires right rudder)

C. Load Factors

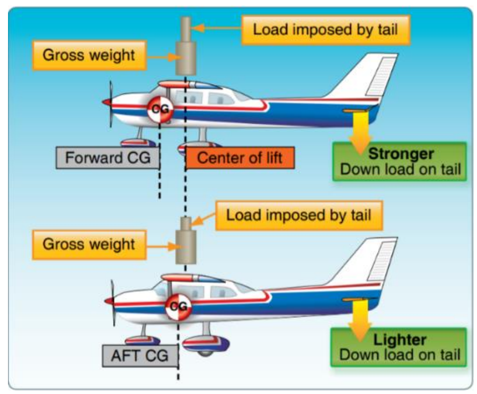




i. Load factor: Ratio of the total load acting on the plane to the gross weight of the plane
   a. Expressed in terms of G's
   b. Increased load factor increases stall speed

ii. Turns

    a. Increased load factors are a part of all banked turns (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
    b. Use gentle, coordinated, low bank turns during slow flight to prevent a potential stall
      - Right turn = more right rudder; Left turn = less right rudder (still requires right rudder)
D. 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
    a. The increased weight and stability can help in controlling the aircraft
E. Center of Gravity & Controllability
  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 down load resulting in greater wing loading
      - Wing loading requires increased lift to maintain altitude
    b. Higher AOA results in more induced drag and a higher stall speed (like a heavy aircraft)
    c. Controllability
      - More controllable than aft loaded aircraft
      - Due to the longer arm from elevator to CG



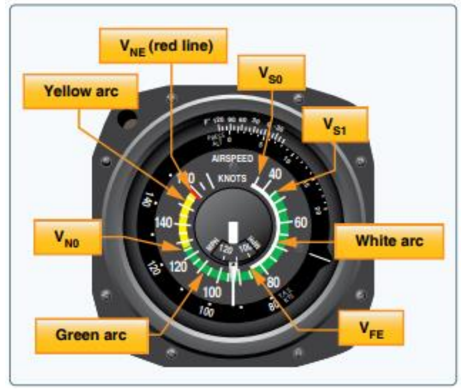
  ii. Aft Loaded Aircraft
    a. Acts lighter, and consequently faster
      - Less back pressure required meaning less down load
      - Decreased down load reduces wing loading, decreasing lift required to maintain altitude
    b. Lower AOA results in less induced drag allowing for a faster cruise speed and a lower stall speed
    c. Controllability
      - Recovery from a stall becomes progressively more difficult as the CG moves aft
        a Shortens arm from CG to elevator
F. 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

3. Airspeeds (Review the following airspeeds in the POH, as applicable) AI.X.B.K7

A. White Arc
  i. Flap operating range AI.X.B.K7c, AI.X.B.K7f
  ii. Lower Limit of the White Arc (V_{S0})
    a. Power-off stall speed at the maximum landing weight in the landing configuration (gear & flaps down)
  iii. Upper Limit of the White Arc (V_{FE})
    a. Maximum speed with the flaps extended
  iv. Flaps Operating Speed (V_{FO})

a. Highest speed permissible for extending/retracting the flaps
b. Not depicted

B. Green Arc
- i. Normal operating range of the aircraft
- ii. Lower Limit of the Green Arc (V_{S1})
  - a. Power-off stall speed at the max takeoff weight in the clean configuration (flaps/gear up, if retractable)
- iii. Upper Limit of the Green Arc (V_{NO})
  - a. Maximum structural cruising speed
  - b. Do not exceed except in smooth air



C. Yellow Arc
- i. Caution range
  - a. Fly in this range only in smooth air and then only with caution
- ii. Red Line (V_{NE})
  - a. Never exceed speed
- iii. Operating above this speed is prohibited – may result in damage or structural failure

D. Other Airspeeds (not depicted)
- i. Best Angle of Climb Speed (V_X)
  - a. Speed at which the aircraft gains the most altitude in a given distance
- ii. Best Rate of Climb Speed (V_Y)
  - a. Speed at which the aircraft gains the most altitude in a given time
- iii. Design Maneuvering Speed (V_A) AI.X.B.K7a
  - a. Calibrated design maneuvering speed
  - b. Maximum speed at which the limit load can be imposed without causing structural damage
- iv. Best Glide Speed AI.X.B.K7d
  - a. Airspeed at which the aircraft glides the furthest for the least altitude lost in non-powered flight
- v. Reference Landing Speed (V_{REF}) AI.X.B.K7e
  - a. Speed flown during the final stages of the approach to landing, generally, 1.3 V_{S0}
- vi. Landing Gear AI.X.B.K7b
  - a. Landing Gear Operating Speed (V_{LO})
    - Maximum speed for extending or retracting landing gear
  - b. Landing Gear Extended Speed (V_{LE})
    - Maximum speed at which an aircraft can be safely flown with the landing gear extended

E. Reference any other applicable speeds

F. RM: POH Range, Limitations & Characteristics AI.X.B.R1

(RM: Lack of familiarity with airspeed limitations and indicator interpretation of the airspeed indicator)
- i. Published speeds and limitations exist for the sake of safety
  - a. RM: Exceeding Limitations AI.X.B.R2
    - Operating outside of published speeds/limitations is dangerous and can negate performance data
- ii. Reference the POH for any specific airspeed indicator characteristics or limitations

4. Control Inputs, Configuration, & Airspeed (generic info provided below, adjust for your aircraft) AI.X.B.K5

A. Level Flight
- i. Review Cruise Pitch, Power, & Trim Settings
- ii. As the airspeed slows, back pressure is increased to maintain altitude – trim to relieve pressure
- iii. Power is initially reduced, but will have to be increased entering the region of reversed command
  - a. As power is increased, right rudder is required to counter left turning tendencies

B. Turns
- i. Review Turn Pitch, Power, & Trim Settings

  ii. Back pressure is required to maintain altitude – lift is divided between a horizontal & vertical component
  iii. Power is required to maintain airspeed – additional lift increases drag
    a. More power = more right rudder
  iv. Adverse yaw – increased lift and drag on the outside wing requires rudder in the direction of turn
  v. Overbanking Tendency: The greater the difference in lift between the wings, the greater the opposite aileron required to maintain bank
    a. More prominent as the aircraft slows

C. Climbs
  i. Review Climb Pitch, Power, & Trim Settings
  ii. Region of Normal Command
    a. Pitch for altitude (to climb)
    b. Power for airspeed
  iii. With the aircraft pitched up, a component of weight acts alongside drag
    a. Additional power is required to maintain airspeed
  iv. Region of reversed command
    a. Pitch for airspeed & power for altitude (to climb)
  v. Right rudder to counter left turning tendencies

D. Descents
  i. Review Descent Pitch, Power, & Trim Settings
  ii. A component of weight acts alongside thrust
    a. If power is reduced, lower pitch to maintain speed
    b. If pitch is lowered, reduce power to maintain airspeed
  iii. Region of Reversed Command
    a. Reduce power to establish the descent, adjust pitch for the desired airspeed
  iv. Lower power reduces left turning tendencies
  v. Changes in pitch require trim adjustment

E. RM: Critically Slow Airspeeds (RM: Maneuvering at critically slow airspeeds) AI.X.B.K2, AI.X.B.R9
  i. RM: Flight characteristics in the region of reversed command & potential for loss of control AI.X.B.R3
    a. Precise aircraft control is required at critically slow airspeeds
    a. Requires more power to maintain level flight at slower airspeeds
    b. Pitch for airspeed, power for altitude
    c. Control & Power
      - High power and pitch attitude to maintain level flight
      - Less effective controls requiring bigger movements
      - Significant right rudder to maintain coordination
      - Overbanking tendency is prevalent
    d. A lack of understanding and/or ability could rapidly lead to a loss of control
      - Common sense does not prevail in the region of reversed command
  ii. RM: Stall Indications (Warning Range & Limitations) AI.X.B.R5
    a. Decreased noise as the aircraft slows, controls become sluggish/less effective
    b. Buffet: Tends to occur prior to the stall horn
    c. Stall Horn: Designed to provide warning of an approaching stall and time for stall recovery
      - Reference the POH for operational ranges and limitations
  iii. RM: Unacknowledged Stall Indications AI.X.B.R6
    a. Unacknowledged indications can be the result of various factors
      - Unfamiliarity with stall indications, distractions, fear (fight/flight reaction), confusion, etc.
    b. The farther an aircraft continues into the stall, the more hazardous and the greater loss of altitude

c. Be familiar with and able to recognize *all* stall indications
- Rod Machado has a great article on The Stall Horn Fallacy of Stall Prevention

iv. RM: Inadvertent Stall (RM: Inadvertent exceedance of the critical AOA) AI.X.B.R4

a. Recover immediately (push, roll, thrust, stabilize)
- This is not the time to figure out what happened or how it happened

b. By ensuring recognition & recovery at any stage, a learner is better protected from inadvertent stalls

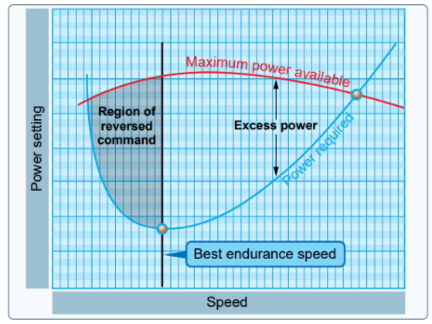
F. Configuration Changes AI.X.B.K6

i. Flaps (review flaps settings & their characteristics)

a. Generally, as flaps are extended, lift is increased along with drag
- Increased camber and AOA (chord line gets steeper)

b. Reduce pitch to maintain altitude and increase power to maintain airspeed

ii. Gear



a. Introduces considerable drag and can affect the pitching moment

b. Add power to maintain speed & adjust pitch to maintain level flight

c. Ability to climb is based on excess thrust/power (pictured)
- The additional power required to maintain altitude with the gear down reduces climb ability
- Greatest combined effect is slow flight (high power required to maintain altitude + gear drag)

5. Demonstrating Flight Characteristics AI.X.B.K1, AI.X.B.K2

Apply the above characteristics to the following procedures:

A. Pre-Maneuver

i. Pre-maneuver checklist, select an altitude (no lower than 1,500' AGL), & clear the area

B. Clean Configuration Demo

i. Establish and maintain level flight at maneuvering speed

a. Describe pitch, power, and trim inputs to maintain airspeed/altitude

ii. Slow to and maintain best glide airspeed

a. Note power setting required to maintain best glide speed

b. Describe changes in pitch, trim, control pressures/control feel and coordination requirements

iii. Slow to a speed at which any increase in AOA, load factor, or power reduction would result in a stall (V_{S1})

a. Describe changes in pitch, trim, control pressures and feel, right rudder requirements

b. Describe power required to maintain level flight (note change in noise, AOA, etc.)

c. Verbally acknowledge stall indications

iv. Without changing power, lower pitch and accelerate until reestablishing level flight

a. Note the new airspeed and altitude lost

v. Return to normal cruise flight

C. Landing Configuration Demo

i. Maintain maneuvering speed at the selected altitude

a. Describe pitch, power, and trim inputs to maintain airspeed/altitude

ii. While maintaining altitude, slow to the limiting airspeeds and fully extend gear and flaps

iii. Once configured, slow to and maintain reference landing speed

a. Note power required and changes in trim and control pressures and control feel

iv. Slow to a speed at which an increase in AOA, load factor, or power reduction would result in a stall (V_{S0})

a. Maintain this airspeed in level flight

b. Note airspeed and power setting, as well as control inputs and trim

c. Verbally acknowledge stall indications

v. Without changing power, lower pitch and accelerate to until reestablishing level flight

a. Note the new airspeed and altitude lost

vi. Return to normal cruise flight at the heading & altitude specified

6. **Common Errors** (duplicated from Slow Flight due to similarities and because none are in the AFH) AI.X.B.K8
   A. Failure to adequately clear the area
   B. Inadequate back-elevator pressure as power is reduced, resulting in altitude loss
   C. Excessive back-elevator pressure as power is reduced, resulting in a climb followed by rapid reduction in speed
   D. Insufficient right rudder to compensate for left yaw
   E. Fixation on the flight instruments
   F. Failure to anticipate changes in AOA as flaps are extended or retracted
   G. Inadequate power managements
   H. Inability to adequately divide attention between airplane control & orientation
   I. Failure to properly trim the airplane
   J. Failure to respond to a stall warning
7. **RM: Hazards**

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

   A. X. RM Concepts – Environmental Elements AI.X.B.R7
   B. X. RM Concepts – Collision Hazards AI.X.B.R8

Common Errors: (duplicated from Slow Flight due to similarities and because none are in the AFH) AI.X.B.K8

- Failure to adequately clear the area
- Inadequate back-elevator pressure as power is reduced, resulting in altitude loss
- Excessive back-elevator pressure as power is reduced, resulting in a climb followed by rapid reduction in speed
- Insufficient right rudder to compensate for left yaw
- Fixation on the flight instruments
- Failure to anticipate changes in AOA as flaps are extended or retracted
- Inadequate power managements
- Inability to adequately divide attention between airplane control & orientation
- Failure to properly trim the airplane
- Failure to respond to a stall warning

Conclusion:
Brief review of the main points

X.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 learner should develop knowledge of power-off stalls including aerodynamics, factors associated with stall speeds, as well as proper recovery techniques. The learner understands situations in which power off stalls are most common and most dangerous and can perform a power-off stall as required in the ACS.
Key Elements	1. Critical Angle of Attack 2. Reduce the AOA 3. Disconnect, Pitch, Roll, Thrust, Stabilize, Configure
Elements	1. Aerodynamics 2. Various Factors and their Effect on Stall Speed 3. Power-Off Stall Situations 4. Power-Off Stalls 5. Common Errors 6. Hazards
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 is familiar with the conditions that produce power-off stalls and develops the habit of taking prompt preventative and/or corrective action at the first indication of a 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. A stall can occur at any airspeed, in any attitude, or any power setting.

Overview

Review Objectives and Elements/Key ideas

What

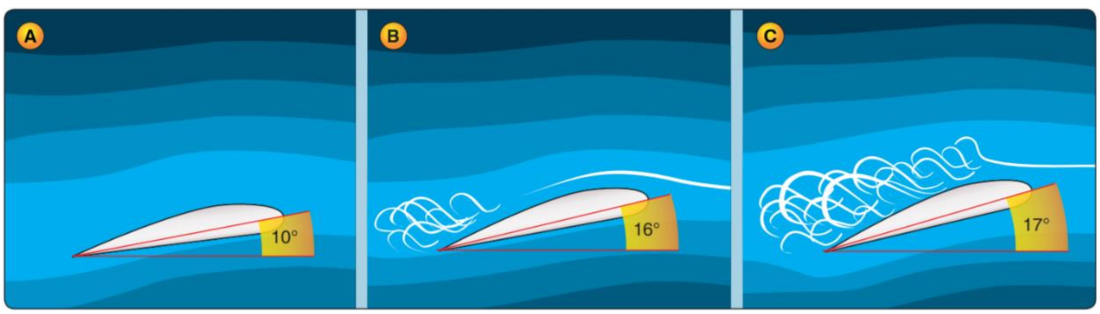
A stall occurs when the critical AOA is exceeded. When this happens, the smooth airflow over the wing is disrupted resulting in a loss of lift and increased drag. Power off stalls simulate stalls in the approach and landing configuration.

Why AI.X.C.K1

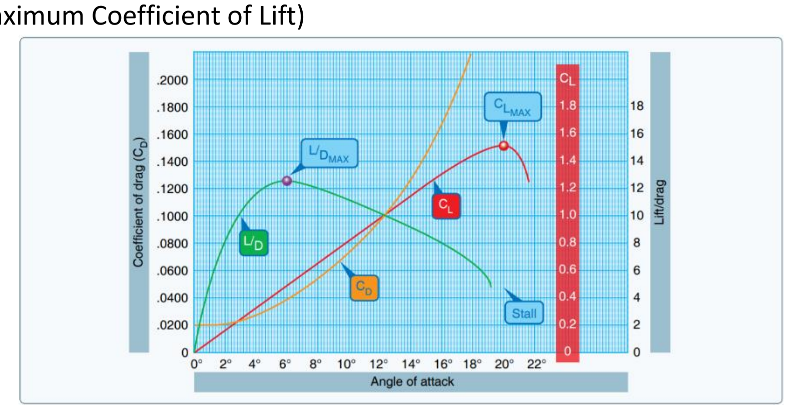
In general, stalls are practiced to become familiar with an aircraft's particular stall characteristics and to avoid putting the aircraft into a potentially dangerous situation. Power-off stalls are essential to understanding the aircraft's stall characteristics in the landing configuration. It is important to understand how they happen, how to avoid them, and how to recover from them.

How:

1. **Aerodynamics** AI.X.C.K2
   A. A stall occurs when the smooth airflow over the wing is disrupted, and lift decreases rapidly
      i. This happens when the wing exceeds its critical angle of attack (AOA)
         a. The critical AOA varies with aircraft, but is usually around 15-20° in GA aircraft



   B. The Critical Angle of Attack/C_{LMAX}
      i. 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)
         d. C_L = Coefficient of Lift – Measurement of lift as it relates to AOA
            - Determined by wind tunnel tests; based on airfoil design/AOA
         e. Any AOA beyond C_{LMAX} results in a stall and lift drops off rapidly



   C. 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

D. 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

i. If during the turn the AOA becomes excessive, the aircraft will stall

2. Various Factors and their Effect on Stall Speed AI.X.C.K2

A. A stall can occur at any airspeed, attitude, or power setting, depending on the total factors affecting the aircraft

B. Airspeed & Power Settings

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. Yaw Effects

i. Increased power at slow airspeeds and high angles of attack results in increased left turning tendencies

a. Anticipate considerable right rudder to maintain coordination

ii. Torque Reaction – Based on Newton's 3rd Law

a. The engine parts/propeller rotate right, an equal force attempts to rotate the plane left

b. In flight: left rolling tendency; On the ground: left turning

c. Corrected by offsetting the engine, aileron trim tabs, and/or aileron and rudder use

iii. Corkscrew/Slipstream Effect

a. Corkscrewing propeller air strikes the left side of the vertical stabilizer - pushes nose left (shown below)

b. Strongest at high prop speeds/low forward speeds

iv. Gyroscopic Action

a. Precession - Any force takes effect 90^{o} ahead of, and in the direction of rotation

b. Pitch results in a yawing moment and vice versa

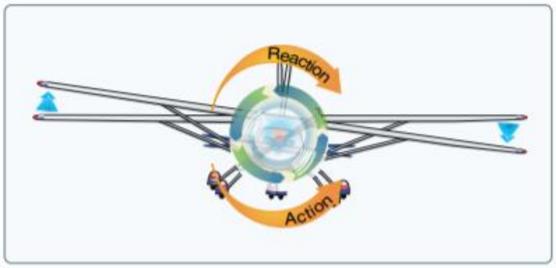
c. Correct with rudder/elevator

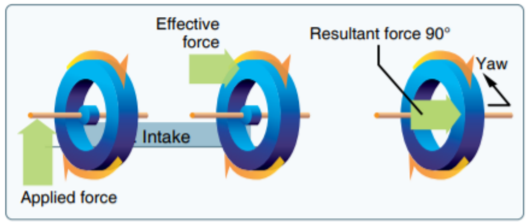
v. Asymmetric Loading (P Factor)

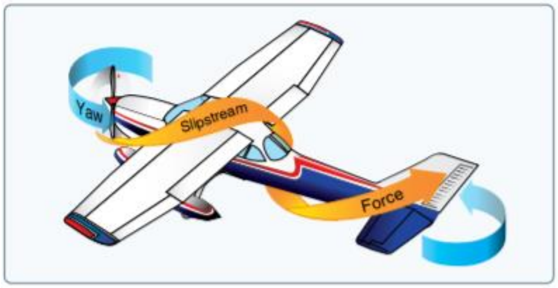
a. At high AOAs, the bite of the down moving blade is greater than the up moving blade

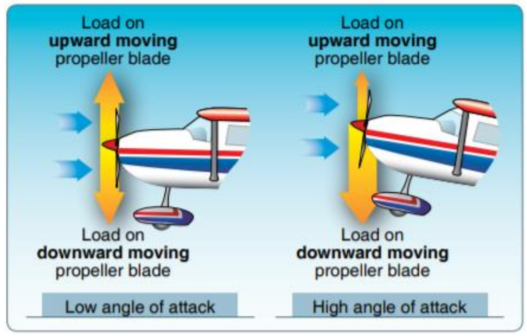
b. Center of thrust moves to the right of the propeller disc, causing a yaw to the left

c. Correct with right rudder

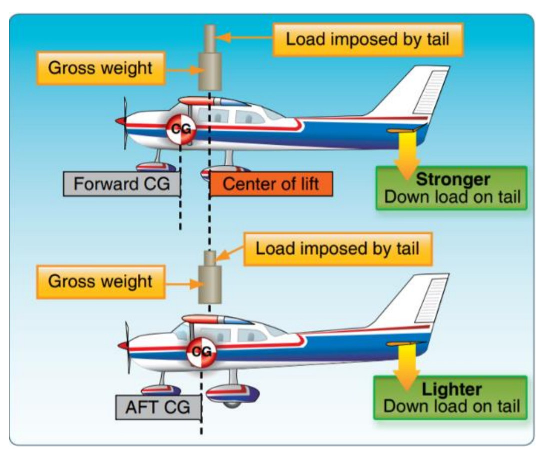






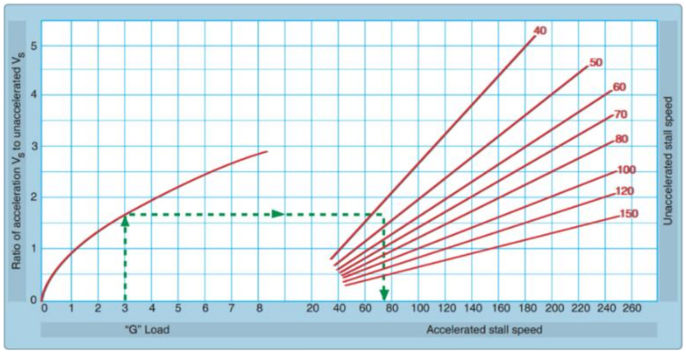


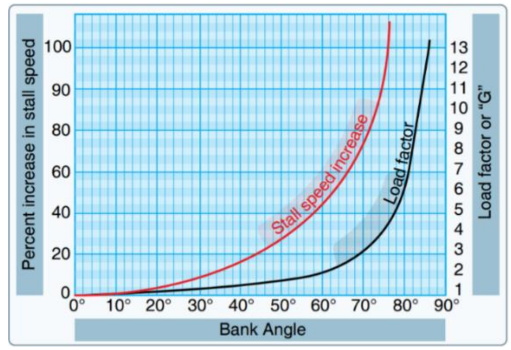
D. Configuration (Gear and Flaps)
   i. Flaps - Reduce the stall speed of an aircraft
      a. Most flaps increase the camber of the wing and change the chord line, producing more lift
      b. Note the differing speeds on the airspeed indicator (green arc vs white arc)
   ii. Gear
      a. The effects 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
E. 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)
F. 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 must 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 for the nose to pitch down on its own



G. 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.
    H. Bank Angle & Load Factor
        i. Increased load factors are a characteristic of all banked turns





        ii. Tremendous loads are imposed on an airplane at bank angles above 45°
    I. 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%

3. RM: Power-Off Stall Situations AI.X.C.K4, AI.X.C.R1

    A. Generally associated with approach to landing conditions and configurations
    B. Attempting to recover from a high sink rate on final approach using only an increased pitch attitude
    C. Improper airspeed control on final approach and other segments of the traffic pattern
        i. Distractions, disorientation, windshear, poor region of reversed command understanding & control, etc.

4. Power-Off Stalls AI.X.C.K1

    A. Entry
        i. Pre-Maneuver Checklist; Clear the area
        ii. Select an altitude - Must recover prior to 1,500' AGL
        iii. Landing configuration
        iv. Note the heading (bug the heading)
    B. Getting into the Straight Stall
        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
            b. 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
        ii. When the power is set and the descent established, establish the desired bank angle
        iii. Aileron pressure must be continually adjusted to keep the bank constant
            a. Overbanking tendency
        iv. Maintain coordination
        v. Increase control pressure as the aircraft slows and controls become less effective

D. Recognizing the Stall AI.X.C.K3
  i. Announce the stages of the stall: Stall Warning Horn, Reduced Control Effectiveness, Buffet, Stall
  ii. Sight: Attitude of the plane
  iii. Sound: Stall warning horn, reduced RPM, slowing airspeed / airflow
  iv. Feel – Mushy/less effective controls, leaning back, buffeting and vibrations just before stall
  v. Kinesthesia (sensing of movements by feel, “seat of the pants,” your “spidey sense”)
    a. Experience based. When properly developed you can recognize when something doesn’t feel right
    b. Sinking feeling
  vi. Aircraft Specific: Note any aircraft specific designs, indicators, characteristics, etc.
  vii. RM: Stall Warning Range & Limitations AI.X.C.R2
    a. Buffet: Tends to occur prior to the stall horn
      - May not always occur (Ex: Cross controlled stalls can occur with little to no warning)
    b. Stall Horn: Designed to provide warning of an approaching stall and time for stall recovery
      - Per 23.207
        a Clear/distinct stall warning with the flaps/gear in any normal position, in straight & turning flight
        b Warning must begin at least 5 knots above stall speed and continue until the stall occurs
        c Must provide the pilot time to take action to avert the stall
    c. Stall indications and horns have different operational ranges and limitations
      - Reference the POH for specific info (ex: uncoordinated flight may inhibit airflow at the indicator)

E. RM: Recovery (RM: Stall recovery procedure) AI.X.C.K5, AI.X.C.R4
  i. Basics: Disconnect, Pitch, Roll, Thrust, Stabilize, Configure (perform each step as appropriate)
    a. Disconnect the autopilot (if applicable)
    b. Pitch nose-down – AOA must be decreased positively and immediately
      - Trim nose-down, if required
    c. Roll wings level – Regain / maintain directional control with coordinated aileron and rudder
      - Reorients the lift vector vertical for a more effective recovery and climb
      - Do not attempt to level the wings prior to reducing angle of attack (can aggravate stall)
    c. Thrust/power as necessary - Stalls can occur at high/low power & airspeeds, adjust as required
      - Generally, in a power-off stall, maximum allowable power should be applied
      - Right rudder will be required to maintain coordination/heading
    d. Stabilize/establish the desired flight path - Go around and climb at the desired airspeed V_Y (V_X)
    e. Configure – Once in a climb, configure as required (same flap and gear retraction as a go around)

F. Ailerons & 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

G. 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

5. **Common Errors** (AFH 5-21) AI.X.C.K6
   - A. Failure to adequately clear the area.
   - B. Over-reliance on the airspeed indicator and slip-skid indicator while excluding other cues after recovery.
   - C. Inability to recognize an impending stall condition.
   - D. Failure to prevent a full stall during the conduct of impending stalls, or recovering too early on a full stall
   - E. Failure to maintain a constant bank angle during turning stalls.
   - F. Failure to maintain proper coordination with the rudder throughout the stall and recovery.
   - G. Not disconnecting the wing leveler or autopilot, if equipped, prior to reducing AOA.
   - H. Recovery is attempted without recognizing the importance of pitch control and AOA
   - I. Not holding nose down controls until the stall warning is eliminated, or excessive forward pressure (negative Gs)
   - J. Pilot attempts to level the wings and/or recover with power before reducing AOA.
   - K. Failure to roll wings level after AOA reduction and stall warning is eliminated.
   - L. Inadvertent accelerated stall by pulling too fast on entry, & inadvertent secondary stall during recovery.
   - M. Excessive airspeed buildup during recovery.
   - N. Losing situational awareness and failing to return to desired flightpath or follow ATC instructions.
6. **RM: Hazards**
   - A. Stall Warning during Normal Operation AI.X.C.R3
     - i. Recover
     - ii. The first thought is not how and why is this happening, the first reaction is to recover/fix the problem
       - a. When safe, then you can figure out how it happened
   - B. Secondary Stalls AI.X.C.R5
     - i. Occurs after recovery from a preceding stall
       - a. Pilot does not sufficiently reduce AOA or attempts to recover using only pitch or power
     - ii. Perform the stall recovery procedure again, but do it right
     - iii. Mitigation: Practice & perform proper recovery procedures (Push, Roll, Thrust, Stabilize)
   - C. Accelerated Stalls AI.X.C.R5
     - i. Higher G loads increase the stall speed (Ex. Steep turns, aggressive pull up)
     - ii. Recover at the first indication of a stall
       - a. Push, roll, thrust, stabilize
       - b. Often, just removing the back pressure will break the stall
     - iii. Mitigation: Use smooth control pressures
   - D. Cross-Controlled Stalls AI.X.C.R5
     - i. Aileron and rudder in opposite directions can lead to a cross-controlled stall
       - a. Most common in the traffic pattern
     - ii. May have little to no warning of the impending stall
       - a. Release the crossed-controls and recover: Push, Roll, Thrust, Stabilize
     - iii. Mitigation: Maintain coordination

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

E. X. RM Concepts – Environmental Elements AI.X.C.R6
F. X. RM Concepts – Collision Hazards AI.X.C.R7
G. X. RM Concepts – Distractions, SA & Disorientation, & Task Management AI.X.C.R8

Conclusion:
Brief review of the main points

X.D. 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 learner develops knowledge of stalls including aerodynamics, factors associated with stall speeds, as well as proper recovery techniques. The learner understands situations in which power on stalls are most common and most dangerous and can perform a power-on stall as required in the ACS.
Key Elements	1. Critical Angle of Attack 2. Reduce the AOA 3. Disconnect, Pitch, Roll, Thrust, Stabilize, Configure
Elements	1. Stall Aerodynamics 2. Various Factors and their Effect on Stall Speed 3. Power-On Stall Situations 4. Power-On Stalls 5. Common Errors 6. Hazards
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 is familiar with the conditions that produce power-on stalls and develops the habit of taking prompt preventative and/or corrective action at the first indication of 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. A stall can occur at any airspeed, in any attitude, or any power setting.

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.

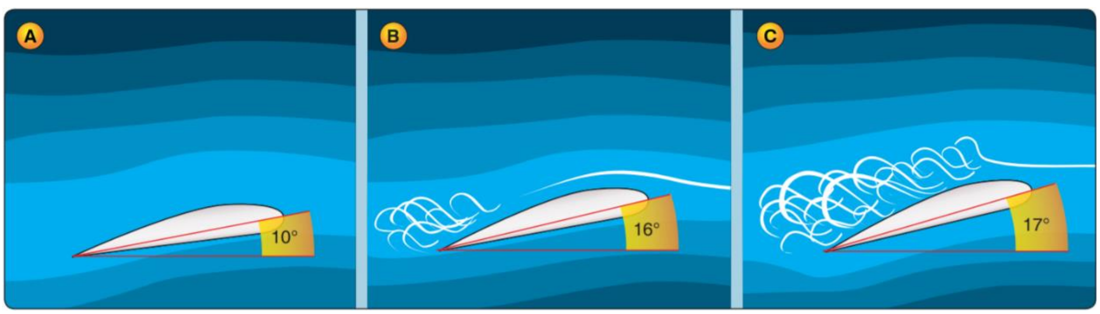
Why AI.X.D.K1

In general, stalls are practiced to become familiar with an aircraft's particular stall characteristics and to avoid putting the aircraft into a potentially dangerous situation. Power-on stalls allow the pilot to become familiar with the stall characteristics in the takeoff configuration.

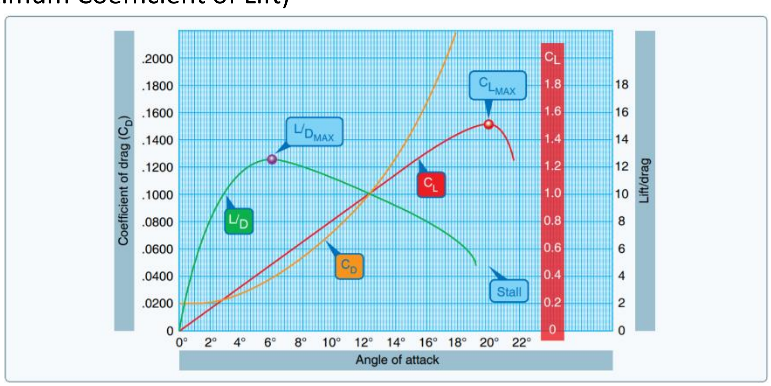
How:

1. Stall Aerodynamics AI.X.D.K2

A. A stall occurs when the smooth airflow over the wing is disrupted, and lift decreases rapidly
   i. This happens when the wing exceeds its critical angle of attack (AOA)
      a. The critical AOA varies with aircraft, but is usually around 15-20º in GA aircraft



B. The Critical Angle of Attack/C_{LMAX}
   i. 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)
      f. C_L = Coefficient of Lift – Measurement of lift as it relates to AOA
         - Determined by wind tunnel tests; based on airfoil design/AOA
      g. Any AOA beyond C_{LMAX} results in a stall and lift drops off rapidly



C. 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

D. 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 AI.X.D.K2

A. A stall can occur at any airspeed, attitude, or power setting, depending on the total factors affecting the aircraft

B. Airspeed & Power Settings

i. Low Speed and / or Low Power Setting (same as above)

ii. High Speed and / or High-Power Setting (same as above)

c. 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. Yaw Effects

i. Increased power at slow airspeeds and high angles of attack results in increased left turning tendencies

c. Anticipate considerable right rudder to maintain coordination

ii. Torque Reaction – Based on Newton's 3rd Law

c. The engine parts/propeller rotate right, an equal force attempts to rotate the plane left
d. In flight: left rolling tendency; On ground: left turning
e. Corrected by offsetting the engine, aileron trim tabs, and/or aileron and rudder use

iii. Corkscrew/Slipstream Effect

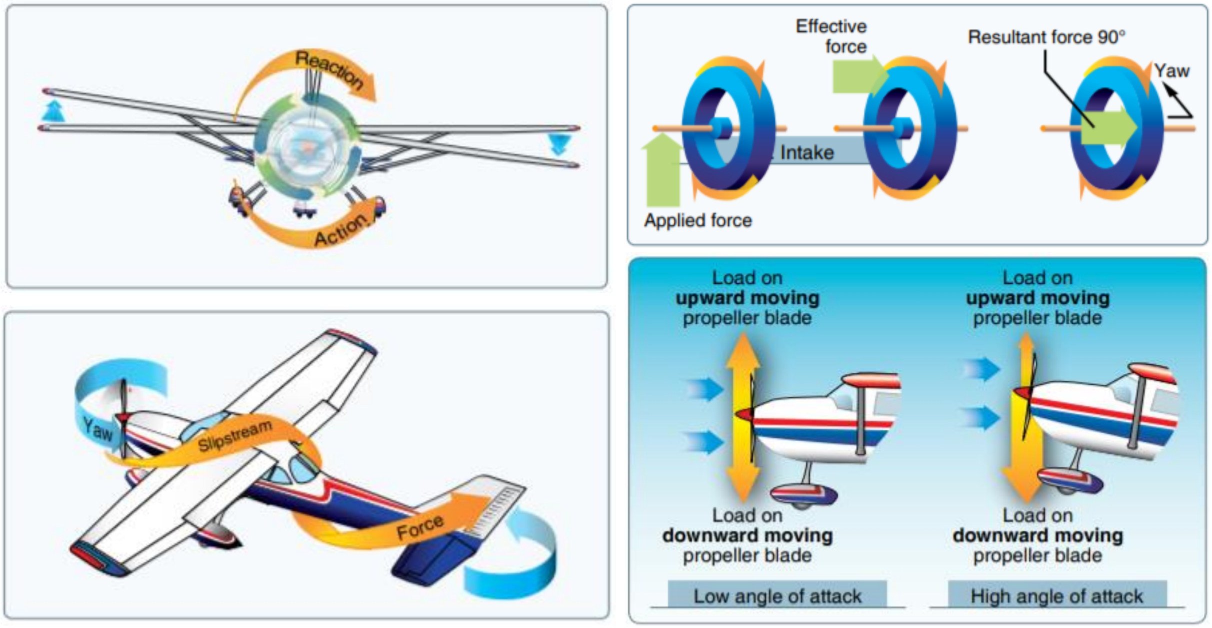
c. Corkscrewing propeller air strikes the left side of the vertical stabilizer - pushes nose left (shown below)
d. Strongest at high prop speeds/low forward speeds

iv. Gyroscopic Action

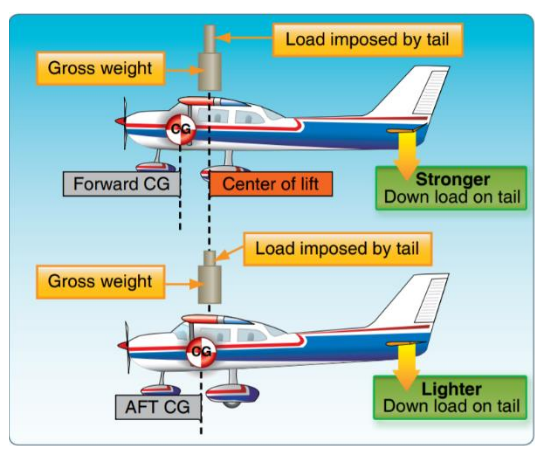
c. Precession - Any force takes effect 90° ahead of, and in the direction of rotation
d. Pitch results in a yawing moment and vice versa
e. Correct with rudder/elevator

v. Asymmetric Loading (P Factor)

c. At high AOAs, the bite of the down moving blade is greater than the up moving blade
d. Center of thrust moves to the right of the propeller disc, causing a yaw to the left
e. Correct with right rudder



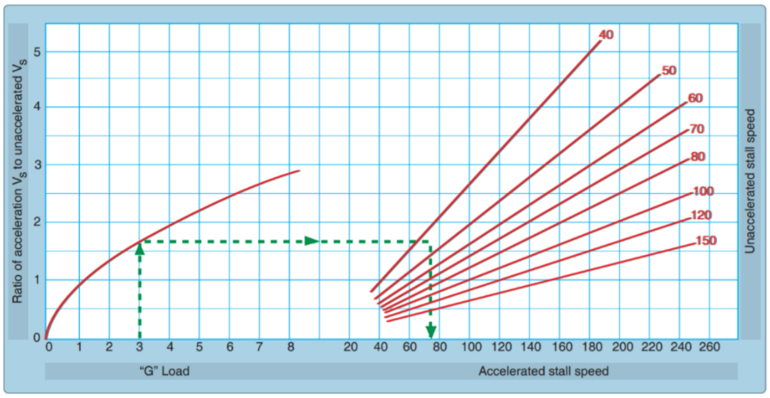
D. Configuration (Gear and Flaps)
  i. Flaps - Reduce the stall speed of an aircraft
    c. Most flaps increase the camber of the wing and change the chord line, producing more lift
    d. Note the differing speeds on the airspeed indicator (green arc vs white arc)
  ii. Gear
    c. The effects of gear can vary based on the aircraft design and characteristics
    d. Gear extension increases drag and if not properly compensated for could lead to a stall
E. 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
    c. Closer to the critical angle of attack
  ii. A lighter aircraft will stall at a slower airspeed (opposite of a heavy aircraft)
F. Center of Gravity
  i. Forward Center of Gravity (CG)
    c. Increases stall speed (same effect as a heavier aircraft)
    d. The farther forward the CG moves, the higher the AOA must be to compensate for the extra load imposed by the tail (see picture)
      • Aircraft is closer to the critical AOA
    e. More controllable due to the longer arm from CG to elevator, improving stall recovery ability
    f. Additionally, the farther forward the CG, the greater the tendency for the nose to pitch down
  ii. Aft CG
    c. Decreases stall speed
    d. 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
    e. 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

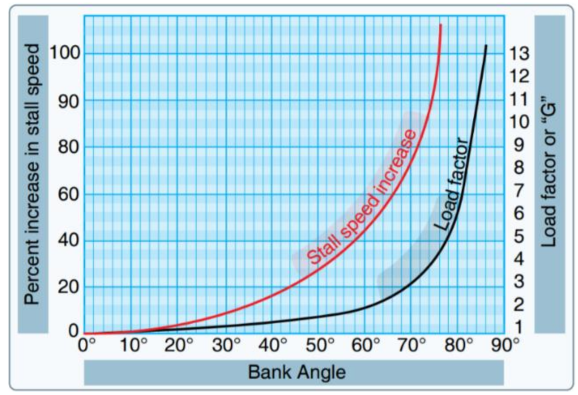


for the nose to pitch down on its own

G. Load Factor
   i. Any increase in the load factor increases the stall speed
      c. 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.

H. Bank Angle & Load Factor
   i. Increased load factors are a characteristic of all banked turns
   ii. Tremendous loads are imposed on an airplane at bank angles above 45°





I. 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
      c. 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
      d. As little as .8 millimeters of ice on the upper wing increases drag and reduces lift by 25%

3. RM: Power-On Stall Situations AI.X.D.K4, AI.X.D.R1

A. High power, high pitch situations

B. Generally associated with takeoff, climb, and go arounds. Most hazardous of these situations are likely:
   i. Short field takeoff – high pitch, V_X climb – closer to the stall speed
   ii. Go Around – changing configuration, pitch, power. Significant nose up trim, and distractions

B. Improper airspeed control in high power, high pitch, or similar situations

4. Power-On Stalls AI.X.D.K1

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)

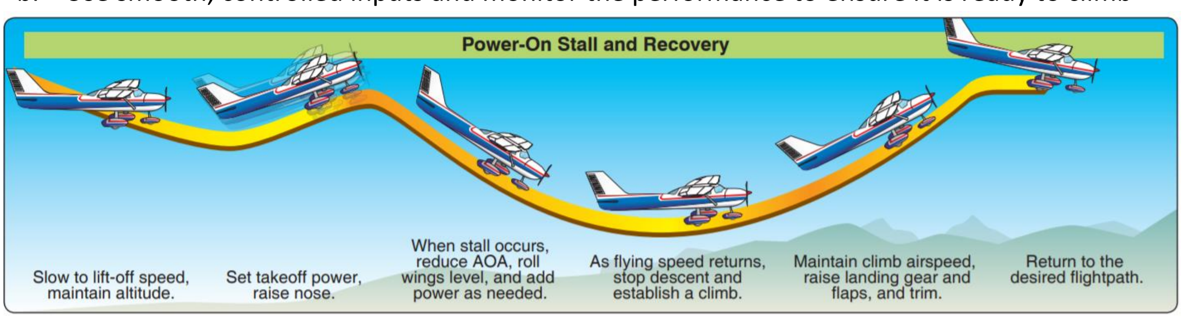
C. Getting into the Straight-Ahead Stall
   i. Reduce power to slow to normal lift off speed while maintaining altitude
      a. Visually - Nose pitches above the horizon; use a cloud, or other high visual reference
   ii. At V_R, increase to takeoff power and maintain the specified climb attitude
      a. 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
      d. Use smooth movements to control the aircraft, nothing jerky

D. Getting into the Turning Stall

i. Same as a straight stall, except a specific bank is maintained (15-20° - Airplane Flying Handbook)
ii. Apply power / pitch for the climb, and then establish the desired bank angle
iii. Continually adjust aileron pressure to maintain bank
    a. Reduced airspeed / control effectiveness
    b. Overbanking tendency requires opposite aileron
iv. Maintain coordination
    a. Especially important in a turning, power on stall due to the increased chance of a spin

E. Recognizing the Stall AI.X.D.K3
    i. Announce the stages of the stall: Stall Warning Horn, Reduced Control Effectiveness, Buffet, Stall
    ii. Sight: Nose high attitude (especially high in a power on stall)
    iii. Sound: Stall warning horn, reduced RPM due to propeller load, slowing airspeed / airflow
    iv. Feel: Mushy / less effective controls, leaning back, buffeting and vibrations just before stall
    v. Kinesthesia (sensing of movements by feel, “seat of the pants,” your “spidey sense”)
        a. Experience based. When properly developed you can recognize when something doesn’t feel right
    vi. Aircraft Specific: Note any aircraft specific designs, indicators, characteristics, etc.
    vii. RM: Stall Warning Range & Limitations AI.X.D.R2
        a. Buffet: Tends to occur prior to the stall horn
            - May not always occur (Ex: Cross controlled stalls can occur with little to no warning)
        b. Stall Horn: Designed to provide warning of an approaching stall and time for stall recovery
            - Per 23.207
                a Clear & distinct stall warning with flaps/gear in any normal position, in straight and turning flight
                b Warning must begin at least 5 knots above stall speed and continue until the stall occurs
                c Must provide the pilot time to take action to avert the stall
        c. Stall indications and horns have different operational ranges and limitations
            - Reference the POH for specific info (ex: Uncoordinated flight may inhibit airflow at the indicator)

F. RM: Recovery - Disconnect, Pitch, Roll, Thrust, Stabilize, Configure AI.X.D.K5, AI.X.D.R4
    i. Perform each step as appropriate
    ii. Disconnect the autopilot
    iii. Pitch nose down – Pitch attitude must be decreased immediately
    iv. Roll wings level – Regain / maintain directional control with coordinated aileron and rudder
    v. 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
    vi. Stabilize/establish the desired flight path – Establish a climb at the desired airspeed V_Y (or V_X)
        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



G. 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

H. 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

5. Common Errors (AFH 5-21) AI.X.D.K6

A. Failure to adequately clear the area.
B. Over-reliance on the airspeed indicator and slip-skid indicator while excluding other cues after recovery.
C. Inability to recognize an impending stall condition.
D. Failure to prevent a full stall during the conduct of impending stalls, or recovering too early on a full stall
E. Failure to maintain a constant bank angle during turning stalls.
F. Failure to maintain proper coordination with the rudder throughout the stall and recovery.
G. Not disconnecting the wing leveler or autopilot, if equipped, prior to reducing AOA.
H. Recovery is attempted without recognizing the importance of pitch control and AOA
I. Not holding nose down controls until the stall warning is eliminated, or excessive forward pressure (negative Gs)
J. Pilot attempts to level the wings and/or recover with power before reducing AOA.
K. Failure to roll wings level after AOA reduction and stall warning is eliminated.
L. Inadvertent accelerated stall by pulling too fast on entry, & inadvertent secondary stall during recovery.
M. Excessive airspeed buildup during recovery.
N. Losing situational awareness and failing to return to the desired flightpath or follow ATC instructions.

5. RM: Hazards

A. Stall Warning during Normal Operation AI.X.D.R3
  i. Recover
  ii. The first thought is not how and why is this happening, the first reaction is to recover/fix the problem
    a. When safe, then you can figure out how it happened

B. Secondary Stalls AI.X.D.R5
  i. Occurs after recovery from a preceding stall
    a. Pilot does not sufficiently reduce AOA or attempts to recover using only pitch or power
  ii. Perform the stall recovery procedure again, but do it right
  iii. Mitigation: Practice & perform proper recovery procedures (Push, Roll, Thrust, Stabilize)

C. Accelerated Stalls AI.X.D.R5
  i. Higher G loads increase the stall speed (Ex. Steep turns, aggressive pull up)
  ii. Recover at the first indication of a stall
    a. Push, roll, thrust, stabilize
    b. Often, just removing the back pressure will break the stall
  iii. Mitigation: Use smooth control pressures

D. Elevator Trim Stalls AI.X.D.R5
  i. Effects of adding full power for a go-around with nose-up trim for the approach without maintaining control

   ii. Recover
      a. Push - Regain control of the pitch attitude
         - Rough trim the airplane (fine tune later) to remove the excessive nose up pitch
      b. Roll, Thrust, Stabilize as necessary
      c. Once safe/under control, continue the go-around
   iii. Preventing Elevator Trim Stalls
      a. Use smooth power applications
      b. Anticipate and overcome the trim forces pitching the nose up, and maintain positive control
E. Cross-Controlled Stalls AI.X.D.R5
   i. Aileron and rudder in opposite directions can lead to a cross-controlled stall
      a. Most common in the traffic pattern
   ii. May have little to no warning of the impending stall
      a. Release the crossed-controls and recover: Push, Roll, Thrust, Stabilize
   iii. Mitigation: Maintain coordination

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

F. X. RM Concepts – Environmental Elements AI.X.D.R6
G. X. RM Concepts – Collision Hazards AI.X.D.R7
H. X. RM Concepts – Distractions, SA & Disorientation, & Task Management AI.X.D.R8

Conclusion:
Brief review of the main points

X.E. Accelerated Stalls

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

Objectives	The learner should develop knowledge of accelerated stalls and develop the ability to recognize the stalls and take prompt, effective recovery action.
Key Elements	1. Excessive Maneuvering Loads 2. Unusual Stall Attitudes 3. Normal Recovery
Elements	1. Accelerated Stall Aerodynamics 2. Various Factors & their Effect on Stall Speed 3. Accelerated Stall Situations 4. Accelerated Stall Procedures 5. Common Errors 6. Hazards
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 situations in which an accelerated stall is possible and can 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

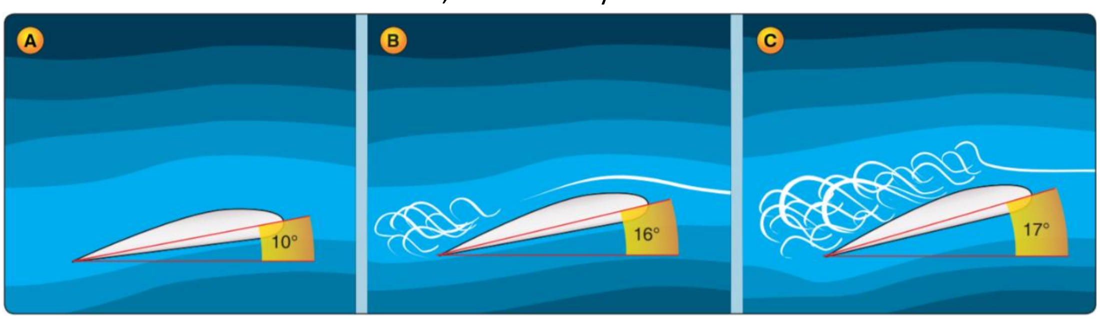
Stalls entered from flight situations that impose excessive maneuvering loads on the airplane. Situations such as steeps turns, pull-ups, or other abrupt changes in flightpath.

Why AI.X.E.K1

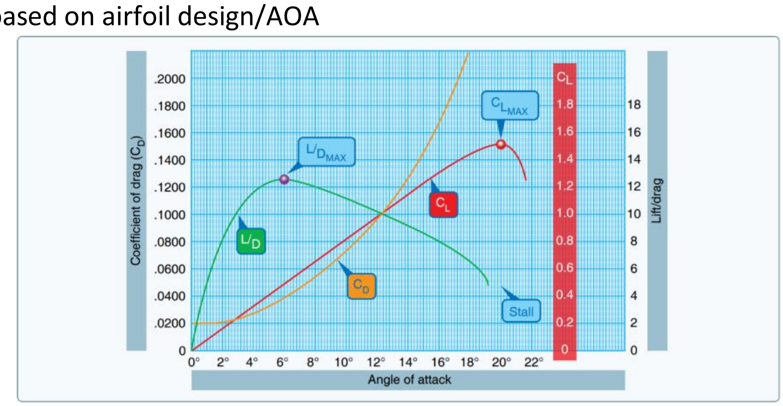
Stalls which result from abrupt maneuvers tend to be more rapid, or severe, than the unaccelerated stalls, and because they occur at higher-than-normal airspeeds, and/or at lower than anticipated pitch, they may be unexpected.

How:

1. **Accelerated Stall Aerodynamics** AI.X.E.K2
   E. A stall occurs when the smooth airflow over the wing is disrupted, and lift decreases rapidly
      i. This happens when the wing exceeds its critical angle of attack (AOA)
         a. The critical AOA varies with aircraft, but is usually around 15-20º in GA aircraft



   F. The Critical Angle of Attack/C_{LMAX}
      i. 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)
         h. C_L = Coefficient of Lift – Measurement of lift as it relates to AOA
            - Determined by wind tunnel tests; based on airfoil design/AOA
         i. Any AOA beyond C_{LMAX} results in a stall and lift drops off rapidly



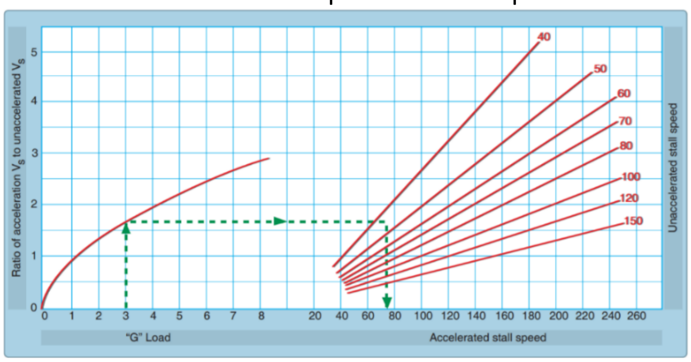
   G. Stall Characteristics
      i. Most general aviation aircraft are designed to stall at the wing root and progress out to the wing tips
         a. Aileron effectiveness is maintained at the wingtips, maintaining control
      ii. Various design can be used to accomplish this:

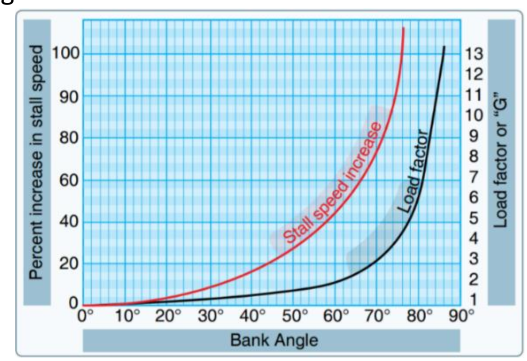
a. Twisting the wing to create a lower angle of attack at the wing tip compared to the wing root
b. Adding strips to the first 20-25% of the leading edge to induce a stall earlier than otherwise

C. 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

H. A prolonged accelerated stall may result in a spin or departure from controlled flight

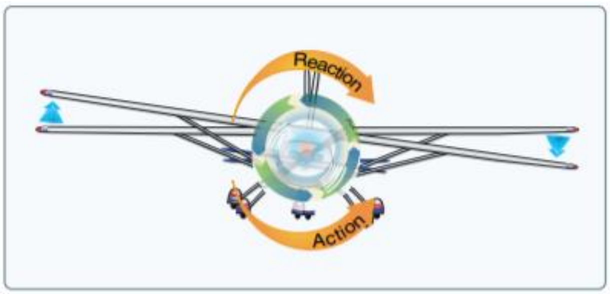
2. Various Factors & their Effect on Stall Speed AI.X.E.K2

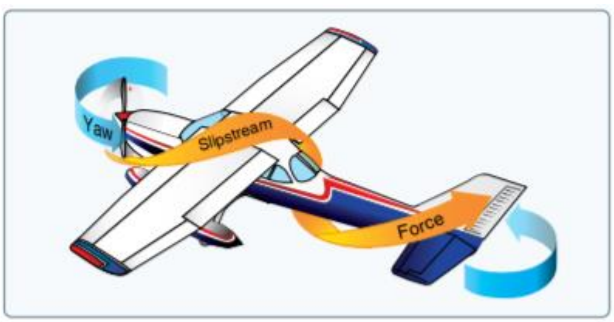
A. A stall can occur at any airspeed, attitude, or power setting, depending on the total factors affecting the aircraft

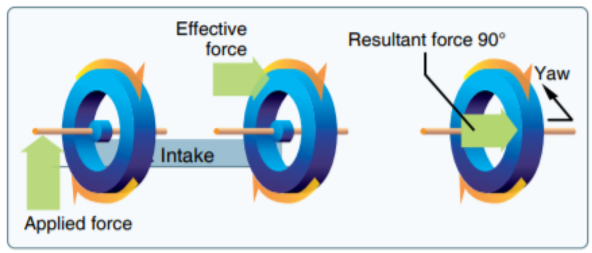
B. Airspeed & Power Settings
   i. Low Speed and / or Low Power Setting (same as above)
   ii. High Speed and / or High-Power Setting (same as above)
      a. Additionally, in low wing planes, high power settings may reduce stall speed and increase lift
         - Propeller airflow over the wing roots can provide some lift even if the wing is stalled

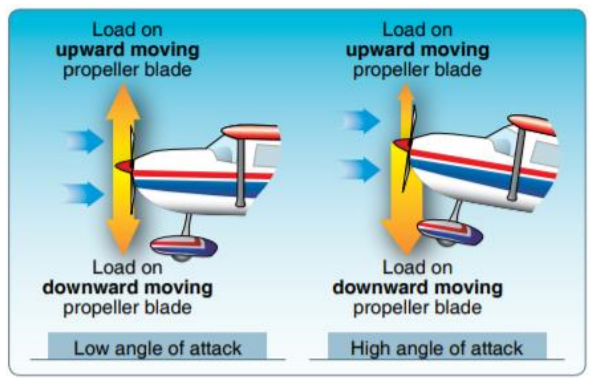
C. Yaw Effects
   i. Increased power at slow airspeeds and high angles of attack results in increased left turning tendencies
      a. Anticipate considerable right rudder to maintain coordination

- ii. Torque Reaction – Based on Newton's 3rd Law
    - a. The engine parts/propeller rotate right, an equal force attempts to rotate the plane left
    - b. In flight: left rolling tendency; On ground: left turning
    - c. Corrected by offsetting the engine, aileron trim tabs, and/or aileron and rudder use
- iii. Corkscrew/Slipstream Effect
    - a. Corkscrewing propeller air strikes the left side of the vertical stabilizer - pushes nose left (shown below)
    - b. Strongest at high prop speeds/low forward speeds
- iv. Gyroscopic Action
    - a. Precession - Any force takes effect 90° ahead of, and in the direction of rotation
    - b. Pitch results in a yawing moment and vice versa
    - c. Correct with rudder/elevator
- v. Asymmetric Loading (P Factor)
    - a. At high AOAs, the bite of the down moving blade is greater than the up moving blade
    - b. Center of thrust moves to the right of the propeller disc, causing a yaw to the left
    - c. Correct with right rudder

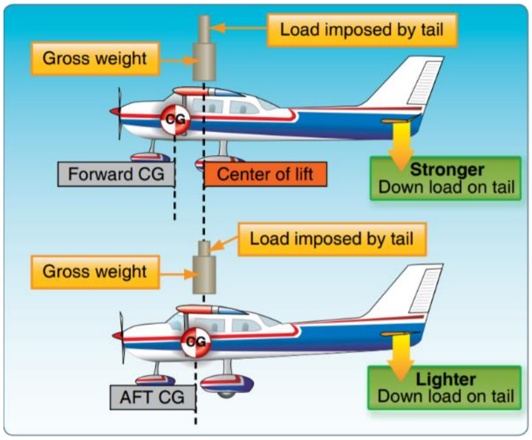








- D. Configuration (Gear and Flaps)
    - i. Flaps - Reduce the stall speed of an aircraft
        - a. Most flaps increase the camber of the wing and change the chord line, producing more lift
        - b. Note the differing speeds on the airspeed indicator (green arc vs white arc)
    - ii. Gear
        - 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
- E. 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)
- F. 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 must 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 for the nose to pitch down on its own

G. 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%

3. RM: Accelerated Stall Situations AI.X.E.K4, AI.X.E.R1

A. Steep, aggressive pull ups, or other abrupt changes in the aircraft's flightpath
B. Steep turns
C. Stall and spin recoveries, especially when close to the ground
D. Basically, anything that increases G-loading on the aircraft

4. Accelerated Stalls AI.X.E.K1

A. Pre-Maneuver
   i. Pre-maneuver checklist and clear the area
   ii. Select a safe altitude: Recover no lower than 3,000' AGL
   iii. Configure as required
      a. Never practice accelerated stalls with flaps extended due to the lower design G-load limitations
B. Performing
   i. Two methods for performing an accelerated stall per the Airplane Flying Handbook
      a. Below V_A, roll into 45° of bank and smoothly increase back pressure to induce a stall (most common)
      b. Roll into a 45° bank above V_A, and after the airspeed reaches V_A, increase back pressure
   ii. Establish the desired flight attitude
      a. At or Below V_A (at this speed the airplane will stall before the limit load factor can be exceeded)
   iii. From straight and level, roll into a steep, level turn (About 45°)
   iv. Smoothly, firmly, and progressively increase the AOA until a stall occurs (at/below V_A)
      a. Increases wing loading, decrease airspeed, and the centrifugal force will push the pilot into the seat
C. Recognizing the Stall AI.X.E.K3
   i. Buffet, stall warning horn will indicate an impending stall
      a. The nose high attitude and reduction in noise as the aircraft slows doesn't occur in accelerated stalls
   ii. The airplane typically stalls during a coordinated steep turn exactly as it does from straight and level flight,

except the buffet tends to be sharper, and the pitching and rolling actions tend to be more sudden
- If coordinated - Both wings stall simultaneously, just like straight and level
- If slipping - Tends to roll rapidly toward the outside of the turn (Outside wing stalls 1st)
- If skidding - Tends to roll rapidly toward the inside of the turn (Inside wing stalls 1st)

iii. High or increasing descent rate
iv. Note any aircraft specific indicators, characteristics, designs, etc.
v. RM: Stall Warning Range & Limitations AI.X.E.R2
   a. Buffet: Tends to occur prior to the stall horn
      - May not always occur (Ex: Cross controlled stalls can occur with little to no warning)
   b. Stall Horn: Designed to provide warning of an approaching stall and time for stall recovery
      - Per 23.207
         a Clear & distinct stall warning with flaps/gear in any normal position, in straight and turning flight
         b Warning must begin at least 5 knots above stall speed and continue until the stall occurs
         c Must provide the pilot time to take action to avert the stall
   c. Stall indications and horns have different operational ranges and limitations
      - Reference the POH for specific info (ex: uncoordinated flight may inhibit airflow at the indicator)

D. RM: Recovery - Disconnect, Pitch, Roll, Thrust, Stabilize, Configure AI.X.E.K5, AI.X.E.R4
   i. Perform each step as appropriate
   ii. Disconnect: the autopilot is likely already disconnected
   iii. Pitch: The elevator pressure should be released
      a. Reduce the AOA and eliminate the stall warning
   iv. Roll: Use coordinated aileron and rudder pressures to level the wings
   v. Thrust: Adjust power as necessary
      a. If a high airspeed already exists, additional power may not be necessary
      b. Power may even need to be reduced depending on the airspeed and attitude
      c. If a spin were to develop, power should be taken to idle
   vi. Stabilize: Return to the desired flight path
   vii. Configure: Likely no changes applicable, but establish the desired configuration

5. **Common Errors** (AFH 5-21) AI.X.E.K6
   A. Failure to adequately clear the area.
   B. Over-reliance on the airspeed indicator and slip-skid indicator while excluding other cues after recovery.
   C. Inability to recognize an impending stall condition.
   D. Failure to prevent a full stall during the conduct of impending stalls, or recovering too early on a full stall
   E. Failure to maintain a constant bank angle during turning stalls.
   F. Failure to maintain proper coordination with the rudder throughout the stall and recovery.
   G. Not disconnecting the wing leveler or autopilot, if equipped, prior to reducing AOA.
   H. Recovery is attempted without recognizing the importance of pitch control and AOA
   I. Not holding nose down controls until the stall warning is eliminated, or excessive forward pressure (negative Gs)
   J. Pilot attempts to level the wings and/or recover with power before reducing AOA.
   K. Failure to roll wings level after AOA reduction and stall warning is eliminated.
   L. Inadvertent accelerated stall by pulling too fast on entry, & inadvertent secondary stall during recovery.
   M. Excessive airspeed buildup during recovery.
   N. Losing situational awareness and failing to return to the desired flightpath or follow ATC instructions.

6. **RM: Hazards**
   A. Stall Warning during Normal Operation AI.X.E.R3
      i. Recover
      ii. The first thought is not how and why is this happening, the first reaction is to recover/fix the problem

a. When safe, then you can figure out how it happened

B. Secondary Stalls AI.X.E.R5
   i. Occurs after recovery from a preceding stall
      a. Pilot does not sufficiently reduce AOA or attempts to recover using only pitch or power
   ii. Perform the stall recovery procedure again, but do it right
   iii. Mitigation: Practice & perform proper recovery procedures (Push, Roll, Thrust, Stabilize)

C. Cross-Controlled Stalls AI.X.E.R5
   i. Aileron and rudder in opposite directions can lead to a cross-controlled stall
      a. Most common in the traffic pattern
   ii. May have little to no warning of the impending stall
      a. Release the crossed-controls and recover: Push, Roll, Thrust, Stabilize
   iii. Mitigation: Maintain coordination

D. Spins AI.X.E.R5
   i. Stall + Yaw (or uncoordinated flight)
   ii. In the case a spin develops, recover using PARE:
      a. Power idle, Ailerons neutral, Rudder opposite the spin, Elevator forward
         - Once rotation stops, Rudder neutral, and elevator back pressure to raise the nose
   iii. Mitigation: Prevent a stall (recover at the first sign), in the case of a stall, maintain coordination

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

E. X. RM Concepts – Environmental Elements AI.X.E.R6

F. X. RM Concepts – Collision Hazards AI.X.E.R7

G. X. RM Concepts – Distractions, SA & Disorientation, & Task Management AI.X.E.R8

Common Errors: AI.X.E.K6

- Failure to establish selected configuration prior to entry
- Improper or inadequate demonstration of the recognition and recovery
- Failure to present simulated learner 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.

X.F. Cross-Controlled Stalls

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

Objectives	The learner understands the dynamics of a cross-controlled stall and can recognize situations which could lead to a cross-controlled stall. The learner 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. Cross-Controlled Stall Aerodynamics 2. Recognizing Cross-Controlled Stalls 3. Cross-Controlled Stall Procedures 4. Common Errors 5. Hazards
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 learner 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 if the airplane is in a cross-controlled condition.

How:

Very interesting read on cross-controlled stalls from APS (Aviation Performance Solutions)

1. **Cross-Controlled Stall Aerodynamics** AI.X.F.K1, AI.X.F.K2
   A. Situation
      i. 30^{o} 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 (with 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. Instinctual reactions will aggravate the situation
  iii. In the case of an overshoot, or a cross controlled situation, go around and avoid the risk

D. RM: Limitations AI.X.F.R4
  i. Chapter 2 of the POH - Reference any aircraft limitations associated with cross-controlled stalls

2. Recognizing Cross-Controlled Stalls AI.X.F.K2, AI.X.F.K3

A. Understand the conditions that can lead to a cross-controlled stall (opposite, uncoordinated aileron/rudder)
  i. Be alert for these conditions, especially at low altitudes
  ii. Most likely to occur in the pattern during an overshooting turn from base to final

3. Cross-Controlled Stall Procedures AI.X.F.K4

A. Safe Altitude
  i. Very important to be at a safe altitude due to potential extreme nose down attitude & loss of altitude
  ii. Per the ACS: Select an entry altitude that allows the Task to be completed no lower than 3,000' AGL

B. Pre-Maneuver Checklist and 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 (trim the aircraft)

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. 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

E. RM: Recovery - Disconnect, Pitch, Roll, Thrust, Stabilize, Configure AI.X.F.K5, AI.X.F.R1
  i. Perform each step as appropriate
  ii. Recovery must be made before the airplane enters an abnormal attitude
  iii. 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
  iv. Configure: Likely not applicable, but establish the configuration required

F. Spin Recovery
  i. This maneuver can result in a spin
  ii. Recovery (PARE)
    a. Power - Idle
    b. Ailerons - Neutral

   c. Rudder - Opposite
   d. Elevator - Briskly forward
      - Break the stall
   e. Rudder - Relaxed
   f. Elevator - To pull out of stall

G. Bottom Line: Stay coordinated to avoid a cross-controlled stall!

4. Common Errors (AFH 5-21) AI.X.F.K6

A. Failure to adequately clear the area.
B. Over-reliance on the airspeed indicator and slip-skid indicator while excluding other cues after recovery.
C. Inability to recognize an impending stall condition.
D. Failure to prevent a full stall during the conduct of impending stalls, or recovering too early on a full stall
E. Failure to maintain a constant bank angle during turning stalls.
F. Failure to maintain proper coordination with the rudder throughout the stall and recovery.
G. Not disconnecting the wing leveler or autopilot, if equipped, prior to reducing AOA.
H. Recovery is attempted without recognizing the importance of pitch control and AOA
I. Not holding nose down controls until the stall warning is eliminated, or excessive forward pressure (negative Gs)
J. Pilot attempts to level the wings and/or recover with power before reducing AOA.
K. Failure to roll wings level after AOA reduction and stall warning is eliminated.
L. Inadvertent accelerated stall by pulling too fast on entry, & inadvertent secondary stall during recovery.
M. Excessive airspeed buildup during recovery.
N. Losing situational awareness and failing to return to the desired flightpath or follow ATC instructions.

5. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. X. RM Concepts – Environmental Elements AI.X.F.R2
B. X. RM Concepts – Collision Hazards AI.X.F.R3
C. X. RM Concepts – Distractions, SA & Disorientation, & Task Management AI.X.F.R5

Conclusion:
Brief review of the main points

X.G. Elevator Trim Stalls

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

Objectives	The learner develops knowledge of elevator trim stalls and their application in executing a safe go-around. The learner 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. Stall Aerodynamics 2. Elevator Trim Stall Situations 3. Elevator Trim Stall Procedures 4. Common Errors 5. Hazards
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 safely recover from an elevator trim stall and properly and safely perform a go-around procedure, correcting for any unintentional changes in airplane attitude, without stalling.

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

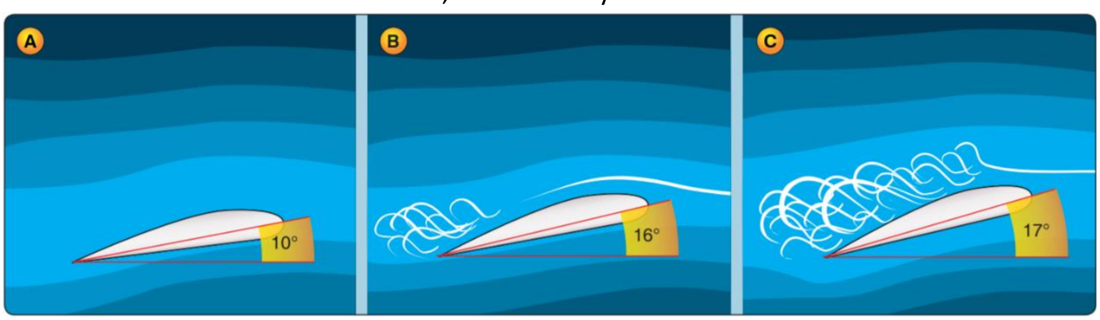
The elevator trim stall maneuver shows what can happen when full power is applied to an aircraft with nose-up trim and positive control of the airplane is not maintained.

Why

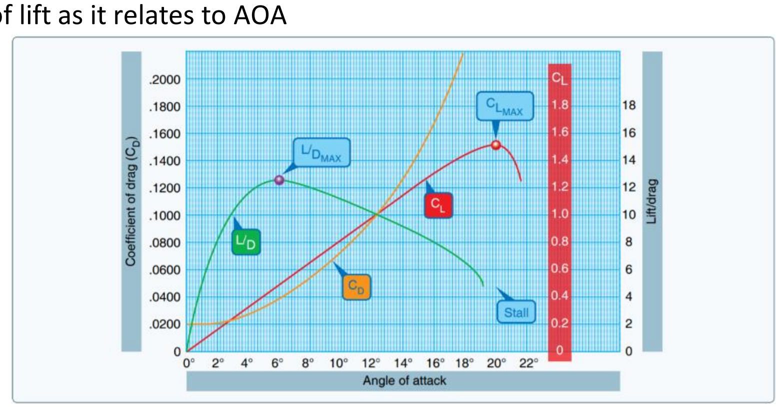
A situation like this could occur during a go-around procedure or immediately after takeoff. The objective is to show the importance of making smooth power applications, overcoming strong trim forces, maintaining positive control of the airplane, and using proper trim techniques. It's imperative a stall doesn't occur during an actual go-around.

How:

1. **Stall Aerodynamics** AI.X.G.K1
    - A. A stall occurs when the smooth airflow over the wing is disrupted, and lift decreases rapidly
        - i. This happens when the wing exceeds its critical angle of attack (AOA)
            - a. The critical AOA varies with aircraft, but is usually around 15-20º in GA aircraft



    - B. The Critical Angle of Attack/C_{LMAX}
        - i. 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)
            - j. C_L = Coefficient of Lift – Measurement of lift as it relates to AOA
                - Determined by wind tunnel tests; based on airfoil design/AOA
            - k. Any AOA beyond C_{LMAX} results in a stall and lift drops off rapidly



    - C. 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 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. If uncontrolled, the excessive nose-up pitch can result in a stall
    b. If uncorrected, the uncoordinated left turn/yaw can lead to a spin

D. RM: Limitations: Chapter 2 of the POH AI.X.G.R4
  i. Reference any aircraft limitations associated with elevator trim stalls

2. Elevator Trim Stall Situations AI.X.G.K2

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 or a simulated forced landing followed by a climb
  ii. Immediately after takeoff with the trim still set for the landing approach (nose high trim)

3. Elevator Trim Stall Procedures

A. Entry AI.X.G.K4
  i. Pre-Maneuver
    a. Pre-Maneuver Checklist; Clear the area
    b. Select an altitude – Per the ACS: Task must be completed no lower than 3,000' 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

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 learner to see the hazards without compromising safety
  ii. Recognizing the stall is imminent AI.X.G.K3
    a. Rapid pitch up combined with rapid loss of airspeed
    b. Stall warning horn and buffeting

C. RM: Recovery - Disconnect, Pitch, Roll, Thrust, Stabilize, Configure AI.X.G.K5, AI.X.G.R1
  i. Perform each step as appropriate
  ii. Disconnect the autopilot (this may be the reason for the excessive trim)
  iii. Pitch: Sufficient forward pressure must be applied to return to normal climbing attitude
    a. If necessary, rough trim the airplane to relieve pressure

iv. Roll: Coordinated roll as necessary to establish wings level
v. Thrust: As required (likely max power if it's not already there)
vi. Stabilize: Trim should be relieved, and the normal go-around and level-off procedures completed
vii. Configure: As you would for a normal go-around
viii. 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
ix. correction for torque and up-elevator trim during go-around and other maneuvers

D. Additional Concerns
    i. Often, 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 & inability to climb while close to the ground

4. Common Errors (AFH 5-21) AI.X.G.K6

A. Failure to adequately clear the area.
B. Over-reliance on the airspeed indicator and slip-skid indicator while excluding other cues after recovery.
C. Inability to recognize an impending stall condition.
D. Failure to prevent a full stall during the conduct of impending stalls, or recovering too early on a full stall
E. Failure to maintain a constant bank angle during turning stalls.
F. Failure to maintain proper coordination with the rudder throughout the stall and recovery.
G. Not disconnecting the wing leveler or autopilot, if equipped, prior to reducing AOA.
H. Recovery is attempted without recognizing the importance of pitch control and AOA
I. Not holding nose down controls until the stall warning is eliminated, or excessive forward pressure (negative Gs)
J. Pilot attempts to level the wings and/or recover with power before reducing AOA.
K. Failure to roll wings level after AOA reduction and stall warning is eliminated.
L. Inadvertent accelerated stall by pulling too fast on entry, & inadvertent secondary stall during recovery.
M. Excessive airspeed buildup during recovery.
N. Losing situational awareness and failing to return to the desired flightpath or follow ATC instructions.

5. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. X. RM Concepts – Environmental Elements AI.X.G.R2
B. X. RM Concepts – Collision Hazards AI.X.G.R3
C. X. RM Concepts – Distractions, SA & Disorientation, & Task Management AI.X.G.R5

Conclusion:
Brief review of the main points

X.H. 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 learner develops 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. Stall Aerodynamics 2. Secondary Stall Situations 3. Secondary Stall Procedures 4. Common Errors 5. Hazards
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 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.

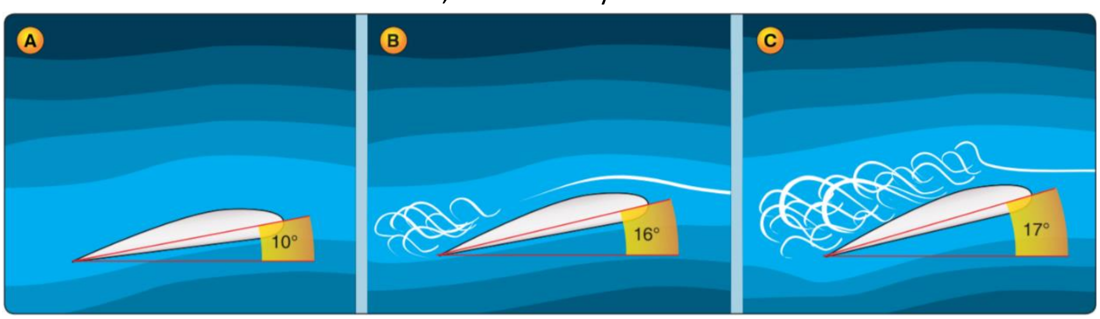
Why

The loss of altitude associated with a single stall can be potentially hazardous. By stalling a second time while still 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.

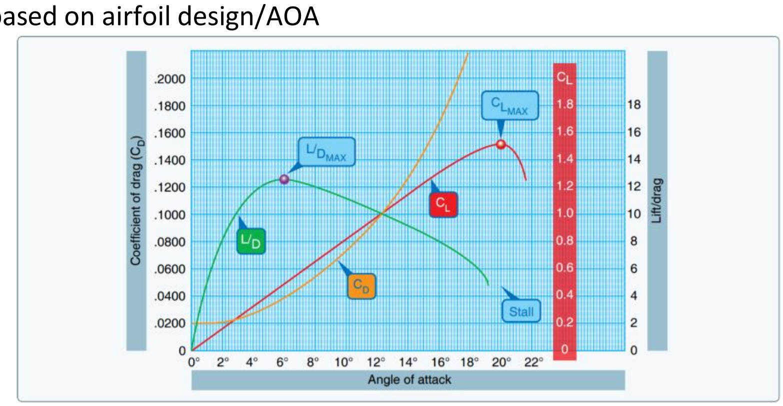
How:

1. Aerodynamics AI.X.H.K1

A. A stall occurs when the smooth airflow over the wing is disrupted, and lift decreases rapidly
   i. This happens when the wing exceeds its critical angle of attack (AOA)
      a. The critical AOA varies with aircraft, but is usually around 15-20º in GA aircraft



B. The Critical Angle of Attack/C_{LMAX}
   i. 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)
      l. C_L = Coefficient of Lift – Measurement of lift as it relates to AOA
         - Determined by wind tunnel tests; based on airfoil design/AOA
      m. Any AOA beyond C_{LMAX} results in a stall and lift drops off rapidly



C. 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
a. Adding strips to the first 20-25% of the leading edge to induce a stall earlier than otherwise

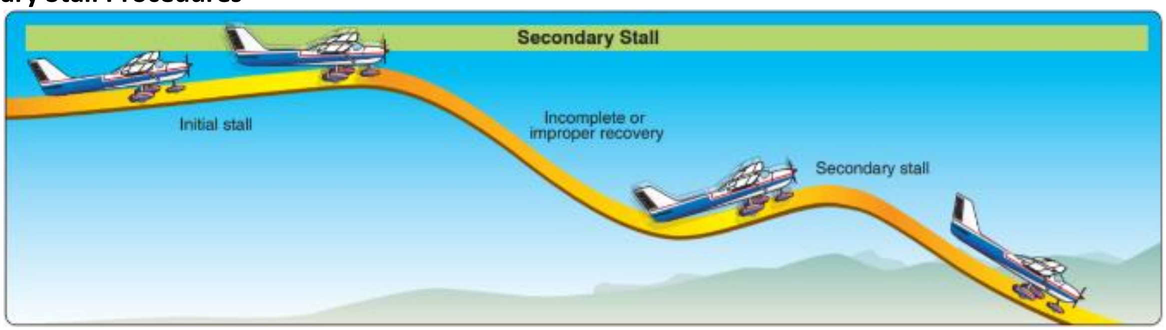
D. Specific to a Secondary Stall
   i. Causes: Aggressive recovery, recovery with only power, recovering before breaking the stall
   i. Secondary stall is often deeper / more aggressive than the first
   ii. Hazards Associated with a Secondary Stall
      a. Prolonged Recovery – Takes longer to recover 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
         - Spin / Loss of Control – Deeper, unexpected stall means a greater chance of loss of control/spin

E. RM: Limitations: Chapter 2 of the POH AI.X.H.R4
   i. Reference any aircraft limitations associated with elevator trim stalls

2. Secondary Stall Situations AI.X.H.K2

A. Attempting to recover from a stall using only pitch
B. Attempting to recover using power only – Pitch must be used to recover, the AOA must be reduced
C. Stall recovery close to the ground – To avoid the ground, the pilot may try to raise the nose too early
D. Abrupt, overaggressive control movements

3. Secondary Stall Procedures



A. Pre-Maneuver AI.X.H.K4
   i. Pre-maneuver checklist; Clear the area
   ii. Select a safe altitude (ACS: Task to be completed no lower than 3,000' AGL)
   iii. Setup and configure for a power on or power off stall, as required

B. Getting into the Secondary 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. Recognizing the Stall AI.X.H.K3
   i. Like a normal stall, but often more aggressive/pronounced
      a. The stall warning horn will sound again
      b. Buffeting rapidly returns
      c. Excessive back pressure
      d. Controls are "mushy", loss of control effectiveness
      e. Nose down pitch, high sink rate
      f. Yaw (Depends on the stall characteristics, power on vs power off, coordination, etc.)

D. RM: Recovery: Disconnect, Pitch, Roll, Thrust, Stabilize, Configure AI.X.H.K5, AI.X.H.R1
   i. Perform each step as appropriate
   ii. Disconnect: Autopilot is likely already disconnected
   iii. 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

    iv. Roll: Coordinated roll to return to wings level
    v. Thrust: Apply maximum power and maintain coordination with right rudder
    vi. Stabilize: With sufficient airspeed, return to straight-and-level or establish a climb at (V_X or V_Y)
    vii. Configure: Once stabilized, establish the desired configuration based on the phase of flight

6. **Common Errors** (AFH 5-21) AI.X.H.K6
    A. Failure to adequately clear the area.
    B. Over-reliance on the airspeed indicator and slip-skid indicator while excluding other cues after recovery.
    C. Inability to recognize an impending stall condition.
    D. Failure to prevent a full stall during the conduct of impending stalls, or recovering too early on a full stall
    E. Failure to maintain a constant bank angle during turning stalls.
    F. Failure to maintain proper coordination with the rudder throughout the stall and recovery.
    G. Not disconnecting the wing leveler or autopilot, if equipped, prior to reducing AOA.
    H. Recovery is attempted without recognizing the importance of pitch control and AOA
    I. Not holding nose down controls until the stall warning is eliminated, or excessive forward pressure (negative Gs)
    J. Pilot attempts to level the wings and/or recover with power before reducing AOA.
    K. Failure to roll wings level after AOA reduction and stall warning is eliminated.
    L. Inadvertent accelerated stall by pulling too fast on entry, & inadvertent secondary stall during recovery.
    M. Excessive airspeed buildup during recovery.
    N. Losing situational awareness and failing to return to the desired flightpath or follow ATC instructions.

4. **RM: Hazards**

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

    A. X. RM Concepts – Environmental Elements AI.X.H.R2
    B. X. RM Concepts – Collision Hazards AI.X.H.R3
    C. X. RM Concepts – Distractions, SA & Disorientation, & Task Management AI.X.H.R5

Conclusion:

Brief review of the main points

Properly recover from the stall the first time. The second stall likely will be more pronounced and is worth avoiding.

X.I. Spin Awareness & 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 learner develops knowledge of the elements related to spins. The learner will learn how to recognize a spin, prevent a spin, and in the case of a spin, apply proper recovery procedures.
Key Elements	1. Stall + Yaw = Spin 2. Brisk and Positive Recovery 3. Ensure Spins are Approved
Elements	1. Spins & Anxiety 2. Spin Aerodynamics 3. Various Factors & Spins 4. Recognizing Spin Situations 5. Intentional Spins 6. Spin Procedures 7. Common Errors 8. Hazards
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 factors involved in creating and maintaining a spin and is competent in 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 fear spins 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.

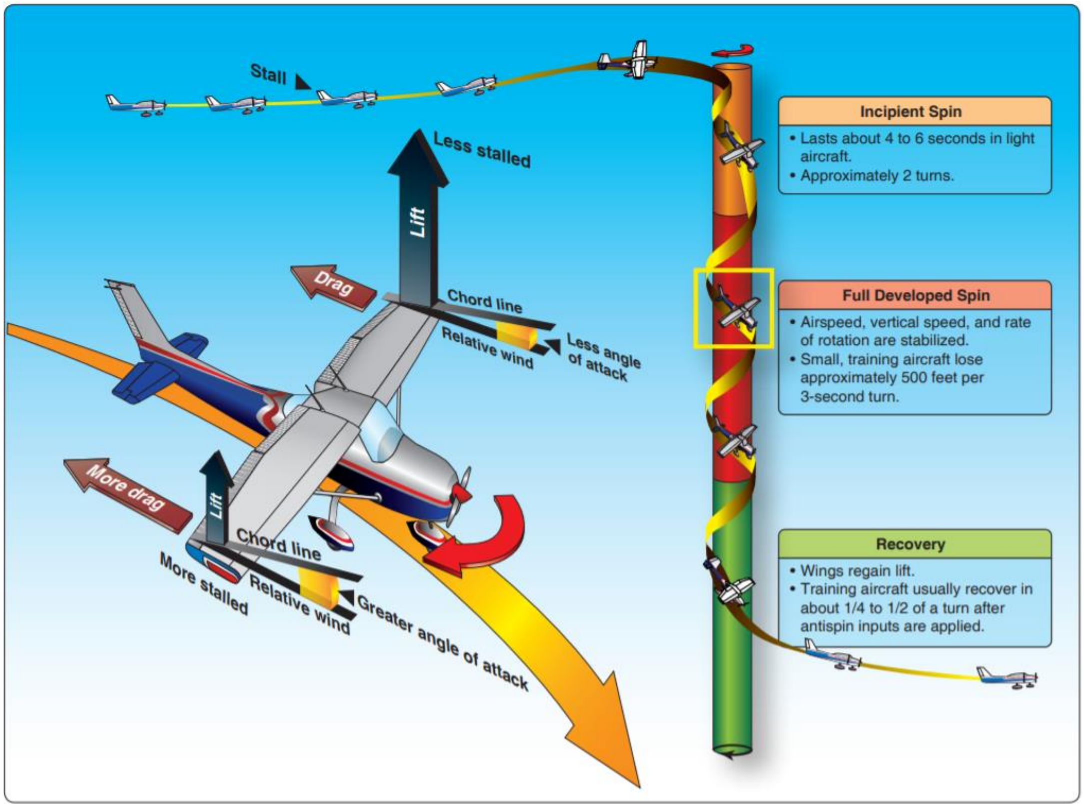
Why

An understanding of spins and the proper procedures to recover from them is necessary for safety. Understanding spins also increases confidence and reduces the anxiety associated with spins.

How:

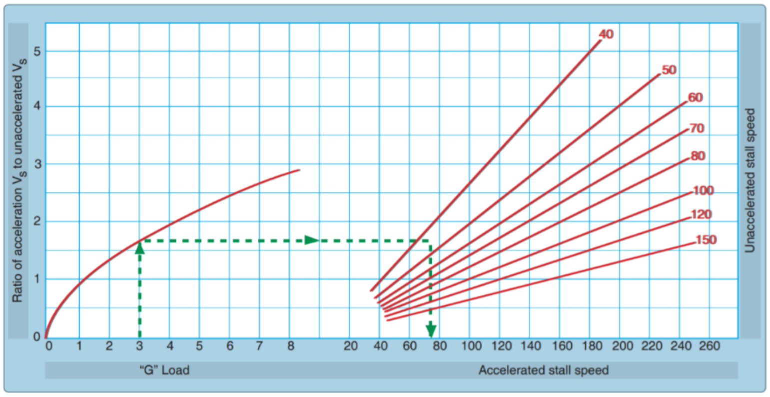
1. **Spins & Anxiety** AI.X.I.K1, AI.X.I.K5
   A. A common perception to those unfamiliar with aviation is that a spin is a death sentence
   B. Knowledge and training can remove the anxiety and make you a far safer and competent pilot
      i. You're trained to avoid a stall, and if you do stall, you're 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. **Spin Aerodynamics** AI.X.I.K3
   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

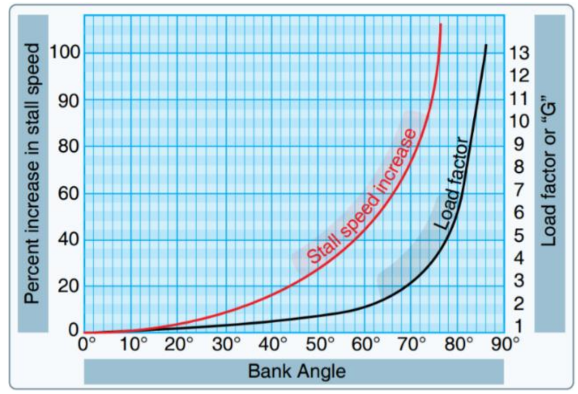
b. Recovery Phase – Rotation ceases, and AOA is decreased below the critical AOA



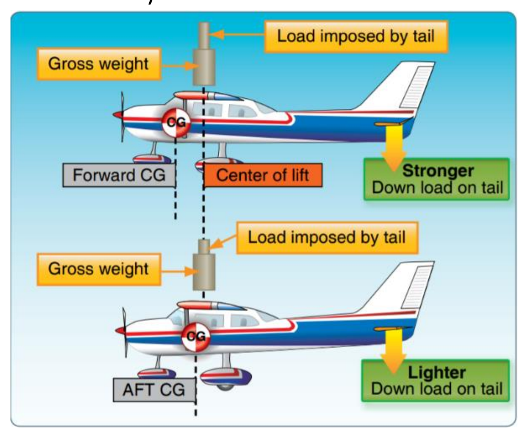
3. **Various Factors & Spins** (Very similar to info in the Stall lessons since a stall leads to a spin) AI.X.I.K2
   A. A stall can occur at any airspeed, attitude, or power setting, depending on the total factors affecting the aircraft
   B. Airspeed & Power Settings
      i. Low Speed
         a. As airspeed decreases, the AOA must be increased to maintain altitude
         b. At a slow enough speed, the critical AOA is exceeded
      ii. 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
      iii. High power settings, especially at slow airspeeds and high AOA increases left turning tendencies
         a. Anticipate considerable right rudder to maintain coordination (extremely important in preventing a spin)
         b. 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
      i. Flaps – generally increase the lifting ability of the wings and decrease stall speed (arcs on airspeed indicator)
      ii. Gear – the effects of gear can vary based on the aircraft design and characteristics (increases drag)
   D. 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.
   E. Bank Angle & Load Factor
      i. Increased load factors are a characteristic of all banked turns

ii. Tremendous loads are imposed on an airplane at bank angles above 45°





F. Weight
   i. Heavier plane = higher stall speed (more lift / higher AOA to maintain altitude)
   ii. Lighter plane = lower stall speed (opposite of above)



G. Center of Gravity
   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 for the nose to pitch down on its own
H. Snow, Ice, and Frost
   i. Increase the stall speed
   ii. Disrupt 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. Yaw Effects
   i. Stall + Yaw = Spin
      a. Directional control and preventing yaw before stall recovery is initiated is essential to averting a spin
      b. Pilot must apply the correct amount of rudder to keep the nose from yawing and wings from banking
   ii. Common causes of yaw:
      a. Adverse yaw, engine/propeller effects, wind shear, wake turbulence, incorrect rudder use
   iii. Coordination is key to preventing spins

4. RM: Recognizing Spin Situations AI.X.I.K7, AI.X.I.R1

A. Any situation in which you have both a stall and yaw
   i. Uncoordinated Go-around/Short field takeoff – High pitch attitude, high power, low airspeed situations
   ii. Turn from base to final – Cross controlled to avoid overshooting the runway without excessive bank
   iii. Sloppy stall recovery

- iv. Unrecognized Stall Conditions
- v. RM: Stall Warning Range & Limitations AI.X.I.R2
  - a. Buffet: Tends to occur prior to the stall horn
    - May not always occur (Ex: Cross controlled stalls can occur with little to no warning)
  - b. Stall Horn: Designed to provide warning of an approaching stall and time for stall recovery
    - Per 23.207
      - a Clear/distinct stall warning with the flaps/gear in any normal position, in straight & turning flight
      - b Warning must begin at least 5 knots above stall speed and continue until the stall occurs
      - c Must provide the pilot time to take action to avert the stall
  - c. Stall indications and horns have different operational ranges and limitations
    - Reference the POH for specific info (ex: Uncoordinated flight may inhibit airflow at the indicator)
- B. Recognizing Potential Spins AI.X.I.K10
  - i. Understand what causes a spin, and be aware of situations where spins are likely to occur
  - ii. Continued stall/spin practice makes the pilot more competent in recognizing & avoiding potential spins

5. Intentional Spins AI.X.I.K6

- A. Not all aircraft are approved for spins
- B. DO NOT intentionally spin an aircraft that is not authorized for spins
- C. 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"
- D. In the case spins are approved, also check:
  - i. Weight and Balance limitations
    - a. Even minor weight and balance changes can affect spin recovery characteristics
    - b. Utility category plane approved for spins but loaded for the normal category may not be recoverable
  - ii. Recommended entry and recovery procedures

6. Spin Procedures AI.X.I.K1

- A. Preflight
  - i. Thorough preflight inspection with special emphasis on:
    - a. Excess or loose items that may affect weight, CG, and controllability
    - b. Within CG limitations
    - c. Slack or loose cables (especially rudder/elevator) could prevent recovery
- B. Pre-Maneuver AI.X.I.K8
  - i. Pre-maneuver checklist; Clear the Area
  - ii. Safe altitude – ACS: Task to be completed no lower than 4,000' AGL
    - a. Airplane Flying Handbook: Complete recovery no lower than 1,500' AGL
      - First turn loses about 1,000', each subsequent turn loses about 500'
- C. Maneuver
  - i. Entry Phase
    - a. Procedure (like a power off stall)
      - Reduce power to idle while raising the nose to a stalling pitch attitude
      - 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 AI.X.I.K9
    - c. Maintaining Orientation During a Spin AI.X.I.K11
      - 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)

ii. Incipient Phase – The aerodynamic and inertial forces have not reached a balance
    a. Airspeed is near/below stalling 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
iv. RM: Recovery Phase (PARE – Power, Ailerons, Rudder, Elevator) AI.X.I.K4, AI.X.I.K12, AI.X.I.R3
    a. General procedures described below (follow manufacturer's procedures, if published)
        - Can last ¼ of a turn to several turns
    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

7. Common Errors (AFH 5-21) AI.X.I.K13

A. Failure to apply full rudder pressure (to the stops) in the desired spin direction during spin entry
B. Failure to apply and maintain full up-elevator pressure during spin entry, resulting in a spiral
C. Failure to achieve a fully stalled condition prior to spin entry
D. Failure to apply full rudder (to the stops) briskly against the spin during recovery
E. Failure to apply sufficient forward-elevator during recovery
F. Waiting for rotation to stop before applying forward-elevator
G. Failure to neutralize the rudder after rotation stops, possibly resulting in a secondary spin
H. Slow and overly cautious control movements during recovery
I. Excessive back-elevator pressure after rotation stops, possibly resulting in secondary stall
J. Insufficient back-elevator pressure during recovery resulting in excessive airspeed

8. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. X. RM Concepts – Environmental Elements AI.X.K.R4
B. X. RM Concepts – Collision Hazards AI.X.K.R5
C. X. RM Concepts – Distractions, SA & Disorientation, & Task Management AI.X.K.R6

Conclusion:

Brief review of the main points

X. RM Concepts

1. **RM: Environmental Elements**
   A. Turbulence
      i. Can increase the stall speed
         a. Sudden changes in relative wind, and/or aggressive control inputs to maintain altitude can exceed the critical AOA
         b. In moderate to severe turbulence or strong crosswinds, use a higher-than-normal approach speed
      ii. When flying below minimum drag speed (L/D_{MAX}) the aircraft exhibits speed instability
         a. If disturbed by turbulence and airspeed decreases, total drag increases, leading to further loss of speed
         b. Total drag continues to rise, and airspeed continues to fall
   B. Microbursts
      i. Can induce windspeeds greater than 100 knots and downdrafts as strong as 6,000 fpm
      ii. Depending on strength, climb ability can be minimized if not entirely eliminated
         a. Instinct can be to pitch excessively to counter the descent and avoid ground contact
            - Can quickly lead to a stall making the problem far worse than it already is
            - In the case of potential ground contact, increase pitch to minimize sink while avoiding a stall
      iii. Do not fly in or around thunderstorms or heavy rain showers where microbursts are most common
         a. The best risk mitigation starts with effective planning
      iv. In the case of a microburst follow the POH procedures
      v. Aviation Weather Handbook (FAA-H-8083-28)
         a. See Ch. 22 pgs. 7-18 for details on recognizing/avoiding microbursts, and strategies for successful escape
   C. High Density Altitude
      i. Atmospheric Pressure
         a. Since air is a gas, it can be compressed or expanded, affecting density
         b. Changes in air density affect performance - As density increases, performance increases & vice versa
      ii. What Changes Air Density (DA)? 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
      iii. How it affects Performance
         a. As the air becomes less dense, it reduces:
            - Power, since the engine takes in less air
            - Thrust, since the propeller is less efficient in thin air (less air is being moved for every rotation)
            - Lift, because the thin air exerts less force on the airfoils
2. **Collision Hazards**
   A. Collision Avoidance
      i. Clearing Procedures
         a. Climb/Descent: Execute gentle banks to scan above/below the wings as well as other blind spots
         b. Prior to any turn: Clear in the direction of the turn
         c. Pre-Maneuver: Clearing turns – clear above/below, in front/behind
         d. Clearly communicate intentions & location in practice areas
      ii. Scanning
         a. Series of short, regularly spaced eye movements bringing successive areas into the central visual field
            - Each movement should not exceed 10º, each area should be observed for at least one second
         b. Divide attention between flying and scanning for aircraft

iii. Operation Lights On
    a. Voluntary FAA safety program
    b. Turn on landing lights during takeoff and when operating below 10,000', day or night
iv. Right-of-Way Rules (FAR 91.113)
    a. An aircraft in distress has the right-of-way over all other traffic
    b. Converging Aircraft
        - When aircraft of the same category are converging, the aircraft to the right has the right-of-way
        - If the aircraft are different categories:
            a Basically, the less maneuverable aircraft has the right-of-way
                1. Balloons, gliders, and airships have the right of way over airplanes
            b An aircraft towing or refueling an aircraft has the right-of-way over all engine driven aircraft
    c. Approaching Head-on: Each pilot shall alter course to the right
    d. Overtaking: Aircraft being overtaken has the right-of-way; when overtaking, pass on the right
    e. Landing
        - Aircraft landing/on final approach to land have the right-of-way over those in flight or on the surface
            a Do not take advantage of this rule to force an aircraft off the runway which has already landed
        - When two or more aircraft are approaching for landing, the lower aircraft has the right-of-way
            a Don't take advantage of this rule to cut in front of another aircraft

B. Terrain
    i. Study terminal charts and IFR/VFR chart altitudes, use Max Elevation Figures (MEFs)
    ii. Day vs Night flying over terrain
        a. Be extra vigilant at night, when terrain may be impossible to see until it is too late
    iii. Minimum Safe Altitudes (FAR 91.119)
        a. Anywhere: At an altitude allowing an emergency landing without undue hazard to persons or property
        b. Over Congested Areas: 1,000' above the highest obstacle within 2,000'
        c. Over other than Congested Areas: 500' above the surface, except when over open water/sparsely populated areas, then no closer than 500' to any person, vessel, vehicle, or structure

C. Obstacles and Wire Strike
    i. Antenna Towers
        a. Numerous antennas extend over 1,000'-2,000' AGL
            - Most are supported by guy wires which can extend 1,500' horizontally from the structure
    ii. Overhead Wires (may not be lighted)
        a. Overhead transmission wires and lines span runway departures and landmarks pilots frequently follow
            - Lakes, highways, railroad tracks, etc.

3. Distractions, SA & Disorientation, & Task Management

A. Distractions
    i. They're dangerous - Remove them from view or, if a person, explain the situation and ask them to stop
    ii. Focus on performance & clear for traffic - If distracted, recognize the problem, and fix it
    iii. Sterile cockpit procedures
    iv. Fly first! Aviate, Navigate, Communicate

B. Situational awareness (SA) & Disorientation
    i. Extremely important, lost SA has led to unsafe situations, mishaps, and incursions
    ii. Maintain SA
        a. Starts with preflight planning
        b. Know what's coming next and stay ahead of the airplane
        c. If SA is lost, admit it, and fix the problem
    iii. Disorientation can be caused by, or lead to, an upset

  - a. Push: Apply forward pressure to unload the plane
  - b. Roll: Roll aggressively to the nearest horizon
  - c. Thrust: Adjust as required
  - d. Stabilize: Return to a safe flight condition

C. Task Prioritization
- i. Divide attention between the aircraft, scanning, and communicating (ATC or CTAF)
- ii. Understand what tasks need to be accomplished and when (use SOPs & checklists)
- iii. Recognize when you are getting behind and find a way to catch up
  - a. "Attack the closest alligator" – handle the most pressing problem and go from there
- iv. Proper task management can help prevent distractions, loss of SA, and disorientation
- v. Safety is the number one priority – Aviate, Navigate, Communicate

BASIC INSTRUMENT MANEUVERS

XI.A-D. Basic Attitude Instrument Flight

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

Objectives	The learner develops knowledge of basic attitude instrument flight and can smoothly and steadily control the aircraft, without the use of outside references. The learner will be able to perform this as required in the ACS.
Key Elements	1. Pitch + Power = Performance 2. Trim 3. Crosscheck 4. Adjust
Elements	1. Instrument Flying Hazards 2. Control & Performance 3. Establish 4. Trim 5. Crosscheck 6. Adjust 7. Straight-and-Level Flight 8. Turns to Headings 9. Constant Airspeed Climb 10. Constant Airspeed Descent 11. Common Errors 12. Hazards
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 smoothly and steadily control the airplane by reference to the instruments. They 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 plan.

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, or don't have an outside horizon (night over water, haze, etc.) it is essential to be proficient flying the airplane without outside, visual references.

How:

1. **RM: Instrument Flying Hazards** AI.XI.A.R1
   A. Failure to Maintain VFR
      i. Risks include disorientation, loss of control, getting lost, icing, stress, midair/terrain collision, and more
   B. Spatial Disorientation & Loss of Control
      i. Lack of orientation about the position, attitude, or movement of the airplane in space
      ii. In visual flight, the eyes prevail over any false sensations
      iii. In IMC, the eyes cannot correct for false sensations which can lead to disorientation
         a. For more details, see II.A. Human Factors
   C. Stress & Fatigue
      i. Inadvertent IMC is a stressful and mentally fatiguing exercise, especially to the non-proficient pilot
   D. Pilot Actions (Mitigation)
      i. Keep proficient in flight by reference to instruments
         a. Statistics show that a pilot who isn't trained in instrument flying, or has let their skills erode, loses control after about 10 minutes once forced to rely solely on instruments
         b. "We don't rise to the level of our expectations; we fall to the level of our training"
      ii. Thorough preflight planning and weather briefings (weather reports & charts, alternates, terrain avoidance)
      iii. Have a general plan (automation, ATC, GPS, etc.) to safely navigate to an airport
      iv. In the case unexpected weather results in less than VMC, use all options to safely exit:
         a. Flight Instruments – Transition to & trust the instruments
         b. Automation – Use it to make your job easier
         c. ATC – Request assistance (Other options: Guard, FSS, other aircraft, cell phone, etc.)
         d. GPS – The moving map & magenta line can be great for SA
   E. RM: Assistance & Emergencies AI.XI.A.R2
      i. An emergency can either be a distress or urgency condition
         a. Distress: Threatened by serious and/or imminent danger and of requiring immediate assistance

- Do not hesitate to declare an emergency (ex: fire, mechanical failure, structural damage)

b. Urgency: Concerned about safety, requiring timely but not immediate help; potential distress condition

ii. An aircraft is at least in an urgency condition the moment the pilot becomes doubtful about position, fuel endurance, weather, or any other condition that could adversely affect flight safety

a. This is the time to ask for help, not after it develops into a distress situation

2. 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

C. Procedural Steps

i. *Establish* - an attitude and power setting on the control instruments to obtain desired performance

ii. *Trim* - until control pressures are neutralized

iii. *Crosscheck* - the performance instruments to determine if the desired performance is being obtained

iv. *Adjust* - the attitude or power setting on the control instruments as necessary, trim and repeat

3. Establish AI.XI.A.K1a, AI.XI.A.K1b, AI.XI.A.K1c

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

a. Operation

- Horizon disk is attached to double gimbal
  - 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. Limitations & Errors

- Can spill if subjected to excessive pitch/bank attitudes (n/a to solid state/G1000 systems)
- May be a slight nose-up indication during a rapid acceleration and vice versa
- Possibility of a small bank angle and pitch error after a 180° turn
- Tiny amounts of friction over time can cause precession/tilting
  - a Erection mechanism (pull the knob) returns the gyro to the proper position

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

4. RM: Trim AI.XI.A.R8

A. Trim for hands off flight. Don't fly with trim; set pitch / power and trim the control pressures away

5. Crosscheck AI.XI.A.K1d

A. The continuous / logical observation of instruments for attitude and performance information
B. Select Radial Crosscheck (most popular method)
   i. "Hub and Spoke" method (based off 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. RM: Fixation AI.XI.A.R5
      a. Staring at a single instrument
      b. Occurs for a variety of reasons and eliminates the crosscheck of other pertinent instruments
   ii. RM: Omission AI.XI.A.R5
      a. Omitting an instrument from the crosscheck
      b. May be caused by failure to anticipate major instrument indications following attitude changes
   iii. 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. RM: Instrument Interpretation AI.XI.A.R6
   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
G. Instrument Operation & Limitations AI.XI.A.K1a, AI.XI.A.K1c
   i. Heading Indicator
      a. Gyro turns in a vertical plane, sensing rotation about the plane's vertical axis
      b. Compass is used to set the appropriate heading and rigidity causes it to maintain this heading
      c. Precession causes heading to drift & Earth rotates 15° per hour
         - Precession + rotation means heading should be checked/reset every 15 min
   ii. Turn Coordinator
      a. Canted gimbal allowing the gyro to sense both rate of roll as well as rate of turn
         - A rapid roll rate causes the mini aircraft to bank more steeply than a slow roll rate
      b. Used to establish and maintain a standard-rate turn (3° per second)
         - Align the wing of the mini aircraft with the turn index
   iii. Airspeed Indicator
      a. Differential pressure gauge indicating the difference between pitot and static pressure
      b. Diaphragm receives pressure from pitot tube & instrument case receives pressure from static port

        c. Increasing pitot pressure/decreasing static pressure expands the diaphragm and vice versa
        d. Gearing indicates changes in airspeed
    iv. Altimeter
        a. Measures absolute pressure of the ambient air, displays it as feet above selected pressure level
            - 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)
        b. 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
            - From hot to cold, or from high to low, look out below!
    v. Vertical Speed Indicator
        a. Differential pressure instrument
        b. Diaphragm and casing are connected to static pressure
            - Diaphragm is directly connected while the case has a delayed connection
        c. 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

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

7. Straight-and-Level Flight AI.XI.A.K1b

Pitch + Power = Desired Performance

Nose on Horizon/Wings Level + Cruise Power = Straight and Level

Control		Performance	
Pitch	On Horizon	Altimeter	Constant
Bank	Constant	VSI	0 fpm
Power	Cruise	Airspeed	Constant
		Heading	Constant
		Turn Coord	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. Turns to Headings AI.XI.D.K1b

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

Control		Performance	
Pitch	Nose Slightly High	Altimeter	Constant
Bank	Wings Banked	VSI	0 fpm
Power	Cruise	Airspeed	Constant
		Heading	Turning
		Turn Coord	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

9. Constant Airspeed Climb AI.XI.B.K1b

Pitch + Power = Desired Performance
10º Nose Up + Full Power = Constant Airspeed Climb

Control		Performance	
Pitch	10º Nose Up	Altimeter	Climbing
Bank	Level	VSI	Positive Climb
Power	Climb Power	Airspeed	Constant
		Heading	Constant
		Turn Coord	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

10. Constant Airspeed Descent AI.XI.C.K1b

Pitch + Power = Desired Performance
3° Nose Down + Descent Power = Constant Airspeed Descent

Control		Performance	
Pitch	3° Nose Down	Altimeter	Descending
Bank	Level	VSI	Negative Climb
Power	Descent Power	Airspeed	Constant
		Heading	Constant
		Turn Coord	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

11. Common Errors AI.XI.A.K2

A. "Fixation," "Omission," and "Emphasis" errors during instrument cross-check
B. Improper instrument interpretation
C. Improper control applications
D. Failure to establish proper pitch, bank, or power adjustments during altitude, heading, or airspeed corrections
E. Improper entry or level-off procedure (specific to Constant Airspeed Climbs and Descents)
F. Improper entry or roll-out procedure (specific to Turns to Headings)
G. Faulty trim procedure

12. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. XI. RM Concepts – Collision Hazards AI.XI.A.R3
B. XI. RM Concepts – Distractions, SA & Disorientation, Task Prioritization AI.XI.A.R4

RM: Control application solely by reference to instruments AI.XI.A.R7

The lesson as a whole is basically an RM discussion of control solely by reference to instruments

Conclusion:

Brief review of the main points

XI.E. Recovery from Unusual Flight Attitudes

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

Objectives	The learner develops knowledge of unusual flight attitude recoveries as required in the ACS.
Key Elements	1. Crosscheck 2. Recovery 3. Coordination
Elements	1. General 2. Unusual Attitude Situations and Conditions 3. Preventing Unusual Attitudes 4. Recognizing Unusual Attitudes 5. Recovery Basics 6. Nose High (Climbing Turn) Recovery 7. Nose Low (Diving Spiral) Recovery 8. Coordination During Recovery 9. Common Errors 10. Hazards
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 how unusual flight attitudes can occur, and the proper recovery procedure for a nose low or nose high unusual flight attitude. They can perform the recoveries in the airplane to ACS standards.

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 recovery training in 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 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** AI.XI.E.R1, AI.XI.E.R3
   A. Unusual attitudes may result from various situations/conditions, such as:
      - Turbulence
      - Disorientation/Confusion
      - Instrument Failure
      - Stress or Confusion
      - Preoccupation with flight deck duties
      - Task saturation
      - Errors in instrument interpretation/crosscheck
      - RM: Control input errors leading to a UA
3. **Preventing Unusual Attitudes** (Top Causal Factors – Environmental, Mechanical, Human) AI.XI.E.K1
   A. Environmental Factors
      i. Turbulence or large variations in wind velocity over a short distance
         a. Clear air turbulence, mountain waves, wind shear, thunderstorms, microbursts
      ii. Preflight planning, weather reports, PIREPs, etc. can be used to avoid this weather
   B. Mechanical Factors
      i. Mechanical Failures
         a. May cause departure from normal flight (asymmetric flaps, malfunctioning controls, runaway trim, etc.)
      ii. Instrument Failures
      iii. Autopilot Malfunctions AI.XI.E.K4
         a. Can be insidious – the pilot may not be aware there's a problem until deep in a UA
         b. Disengage the autopilot and fly the airplane

- iv. Improper Trim Technique
  - a. Failure to keep the plane trimmed can turn a momentary distraction into an unusual attitude
- v. Big picture: Knowledge of systems and POH procedures helps minimize failures and prevent UAs

C. Human Factors
- i. VMC to IMC
  - a. A loss of the natural horizon significantly increases the chances of spatial disorientation & vertigo
- ii. Diversion of Attention
  - a. Diverting attention from flying to an anomaly, malfunction, or any other distraction can lead to a UA
- iii. Task Saturation
  - a. Poor SRM/CRM skills
    - Major cause of CRM accidents is a failure to maintain an organized flight deck
  - b. The margin of safety is the difference between task requirements & pilot capabilities
- iv. Fixation
  - a. Too much attention is focused on one instrument – keep the crosscheck moving
- v. Sensory Overload/Deprivation
  - a. A pilot's ability to correlate and manage warnings, annunciations, instrument indications is limited
    - Especially during a UA that can present multiple visual, auditory, and tactile warnings
  - b. Confusion can also ensue if expected warnings are not provided when they should be
  - c. An effective crosscheck is very important to determine the issue and maintain control
- vi. Spatial Disorientation (SD)
  - a. Significant factor in many upset accidents
  - b. Pilots experience SD or perceive the situation in one of the following ways:
    - Recognized SD: Pilot recognizes the situation & safely corrects
    - Unrecognized SD: Unaware of the UA and fails to take corrective action
    - Incapacitating SD: Unable to recover due to some combination of:
      - a Not understanding the events
      - b Lacking the skills required
      - c Exceeds psychological or physiological ability to cope with the situation
  - c. Understanding, training & practice are necessary to maintain situation awareness and recover safely
- vii. Flight by sensory sensations other than sight
  - a. Flight by instinct almost always leads to erroneous corrections
- viii. Surprise & Startle Response
  - a. Surprise: Unexpected event that violates expectations & affects the mental process used to respond
  - b. Startle: Uncontrollable, automatic muscle reflexes, raised heart rate, blood pressure, etc., elicited by exposure to a sudden, intense event that violates a pilot's expectations
  - c. Untrained pilots often experience a state of surprise & startle response to UAs
  - d. "We don't rise to the level of our expectations; we fall to the level of our training"
- ix. Failure to practice Basic Attitude Instrument (BAI) flight
  - a. If you don't use it, you lose it – BAI skills diminish if they're not practiced
- x. See lesson II.A. Human Factors for more details on illusions, spatial disorientation, etc.

4. RM: Recognizing Unusual Attitudes (Assessment of Unusual Attitudes) AI.XI.E.R2

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

5. RM: Recovery Basics (Interpreting Flight Instruments) AI.XI.E.K2, AI.XI.E.R6

- 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 flight deck, the attitude indicator is very helpful and can be used for recovery
- C. RM: Nose High vs Nose Low Unusual Attitudes (Operating Envelope Considerations) AI.XI.E.R8
  - i. Although similar, the recovery procedures for each are different
  - ii. The basic intent of the nose high recovery is to prevent a stall
  - iii. The basic intent of the nose low recovery is to prevent over stressing the airplane

6. Nose High (Climbing Turn) Recovery AI.XI.E.K2

- A. Nose High Attitudes (Main Point: Avoid a stall) - If the airspeed is decreasing, or below that desired:

- B. Procedure – the steps listed are made in the sequence below, but occur almost simultaneously
  - i. Power – Increase as necessary (in proportion to the deceleration)
  - ii. Pitch – Apply forward elevator pressure to lower the nose (reduces AOA preventing stall)
  - iii. Bank – Use coordinated aileron / rudder to level the wings (reference turn coordinator)
- C. After the initial correction, accelerate the cross-check to verify performance
  - i. As the altimeter and airspeed needles slow, attitude is approaching level flight
  - ii. When the needles stop and reverse direction, the aircraft is passing through level flight
- D. Return to the desired altitude, and establish / verify straight-and-level, coordinated cruise flight
  - i. Level flight is indicated by reversal and stabilization of the altimeter and airspeed indicator
  - ii. Straight, coordinated flight is indicated on the turn coordinator by a level aircraft / centered ball
  - iii. Set power for the desired airspeed once the airspeed is under control

7. Nose Low (Diving Spiral) Recovery AI.XI.E.K2

A. Nose Low Attitudes (Main Point: Avoid over G-ing) - If the airspeed is increasing, or above that desired:

B. Procedure
   i. Power – Reduce power to prevent excessive airspeed and loss of altitude
   ii. Bank – Use coordinate aileron / rudder to level the wings using the turn coordinator
      a. Leveling the wings prior to raising the nose reduces load factors in the recovery
   iii. Pitch – Raise the nose to level flight attitude with smooth back pressure
      a. If ground contact is a concern, use whatever back pressure necessary to survive
   iv. All components should be changed simultaneously for a smooth, proficient recovery

C. After the initial correction, accelerate the cross-check to verify performance
   i. As the altimeter and airspeed needles slow, attitude is approaching level flight
   ii. When the needles stop and reverse direction, the aircraft is passing through level flight

D. Return to the desired altitude, and establish/verify straight-and-level, coordinated cruise flight
   i. Level flight is indicated by reversal and stabilization of the altimeter and airspeed indicator
   ii. Straight, coordinated flight is indicated on the turn coordinator by a level aircraft / centered ball
   iii. Set power for the desired airspeed once the airspeed is under control

8. Coordination During Recovery

A. Use the turn coordinator and attitude indicator, if available, to determine and maintain coordinated flight
B. Skidding and slipping sensations can aggravate disorientation and retard recovery
C. A nose low recovery could result in excessive G's *and* uncoordinated flight
D. A nose high recovery could result in an uncoordinated stall, and potentially a spin

9. Common Errors AI.XI.E.K5

A. RM: Inappropriate control applications during recovery (can aggravate or further induce a UA) AI.XI.E.R3
B. Failure to recognize an unusual flight attitude
C. Consequences of attempting to recover from a UA by "feel" rather than by instrument indications
D. Inappropriate control applications during recovery
E. Failure to recognize from instrument indications when the airplane is passing through a level flight attitude

10. RM: Hazards

A. Inadvertent Flight into IMC AI.XI.E.K3
   i. Importance of Instrument Flight
      a. Statistics show that a pilot who isn't trained in instrument flying, or has let their skills erode, loses control after about 10 minutes once forced to rely solely on instruments
   ii. Recognize
      a. Anytime a pilot is unable to maintain control by reference to the natural horizon, the condition is IMC
      b. Recognize the situation and accept it as a genuine emergency requiring action
   iii. RM: Maintain Control (Control Application Solely by Reference to Instruments) AI.XI.E.R7
      a. The *only* way to control the airplane safely is by using and trusting the flight instruments

b. The most important concern at this point is to keep the wings level
   - An uncontrolled turn usually leads to difficulties with overall control and can lead to disorientation

c. Believe the flight instruments regardless of your senses

d. Attitude Control
   - Trim for hands-off level flight at cruise speed
   - Don't over-control
   - Make smooth and small attitude changes
     a No more than one bar width movements up or down
   - Use any aids (autopilot, wing leveler, etc.) AI.XI.E.K4
   - Maintain cruise speed (turns, climbs, descents) until required to slow for landing
   - For more details, see XI.A-D. Basic Attitude Instrument Flight

iv. Obtain Assistance
   a. ATC, Guard, FSS, etc.
   b. Weather charts - Be aware of expected VMC conditions

v. Find/Return to VMC
   a. The best option may be to bug your heading, engage the autopilot (if available) and perform a 180° turn
      - Return to the last known VMC (terrain, airspace, etc. permitting)

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

B. XI. RM Concepts – Collision Hazards AI.XI.E.R4

C. XI. RM Concepts – Distractions, SA & Disorientation, Task Prioritization AI.XI.E.R5

Conclusion:
Brief review of the main points

XI. RM Concepts

1. **Collision Hazards**
   A. Collision Avoidance
      i. Clearing Procedures (as able in instrument flight) (AIM 4-4-15 Visual Clearing & Scanning Techniques)
         a. Climb/Descent: Execute gentle banks to scan above/below the wings as well as other blind spots
         b. Prior to any turn: Clear in the direction of the turn
         c. Pre-Maneuver: Clearing turns – clear above/below, in front/behind
         d. Clearly communicate intentions & location in practice areas
      ii. Scanning (as able during instrument flight) (AIM 4-4-14)
         a. Short, regularly spaced eye movements bringing successive areas into the central visual field
            - Each movement should not exceed 10°, each area should be observed for at least one second
         b. Divide attention between flying and scanning for aircraft
      iii. Operation Lights On (voluntary FAA safety program)
         a. Turn on landing lights during takeoff and when operating below 10,000', day or night
      iv. Right-of-Way Rules (FAR 91.113)
         a. An aircraft in distress has the right-of-way over all other traffic
         b. Converging Aircraft
            - When aircraft of the same category are converging, the aircraft to the right has the right-of-way
            - If the aircraft are different categories:
               a Basically, the less maneuverable aircraft has the right-of-way
                  1. Balloons, gliders, and airships have the right of way over airplanes
               b An aircraft towing or refueling an aircraft has the right-of-way over all engine driven aircraft
         c. Approaching Head-on: Each pilot shall alter course to the right
         d. Overtaking: Aircraft being overtaken has the right-of-way; when overtaking, pass on the right
         e. Landing
            - Aircraft landing/on final approach have the right-of-way over those in flight or on the surface
               a Do not take advantage of this to force an aircraft off the runway which has already landed
            - When two or more aircraft are approaching for landing, the lower aircraft has the right-of-way
               a Don't take advantage of this rule to cut in front of another aircraft
   B. Terrain
      i. Study terminal charts and IFR/VFR chart altitudes, use Max Elevation Figures (MEFs)
      ii. Be extra vigilant at night, when terrain may be impossible to see until it is too late
      iii. Minimum Safe Altitudes (FAR 91.119)
         a. Anywhere: At an altitude allowing an emergency landing without undue hazard to persons or property
         b. Over Congested Areas: 1,000' above the highest obstacle within 2,000'
         c. Over other than Congested Areas: 500' above the surface, except when over open water/sparsely populated areas, then no closer than 500' to any person, vessel, vehicle, or structure
   C. Obstacles and Wire Strike (AIM 7-6-4 Obstructions to Flight)
      i. Be familiar with any obstacles near the airport(s) – Charts, Terminal procedures, & NOTAMs
      ii. Antenna Towers can extend over 1,000'-2,000' AGL
         a. Most are supported by guy wires which can extend 1,500' horizontally from the structure
      iii. Overhead Wires (may not be lighted)
         a. Overhead transmission wires and lines span runway departures and landmarks pilots frequently follow
            - Lakes, highways, railroad tracks, etc.
2. **Distractions, SA & Disorientation, & Task Management**
   A. Distractions

  i. They're dangerous - Remove them from view or, if a person, explain the situation and ask them to stop
  ii. Focus on performance, especially without visual references
    a. If distracted, recognize the problem, and fix it
  iii. Fly first! Aviate, Navigate, Communicate

B. Situational awareness (SA) & Disorientation
  i. Extremely important, lost SA has led to unsafe situations, mishaps, and incursions
  ii. Maintain SA
    a. Starts with preflight planning
    b. Know what's coming next and stay ahead of the airplane
    c. If SA is lost, admit it, and fix the problem
  iii. Disorientation can be caused by, or lead to, an upset
    a. Push: Apply forward pressure to unload the plane
    b. Roll: Roll aggressively to the nearest horizon
    c. Thrust: Adjust as required
    d. Stabilize: Return to a safe flight condition
  iv. Lack of Visual References
    a. Can be very disorienting: Trust the instruments, use automation, ask for help, return to VMC
    b. For more details, see II.B. Visual Scanning & Collision Avoidance and II.M. Night Operations

C. Task Prioritization
  i. Divide attention between the aircraft, scanning, and communicating (ATC or CTAF)
  ii. Understand what tasks need to be accomplished and when (use SOPs & checklists)
  iii. Recognize when you are getting behind and find a way to catch up
    a. "Attack the closest alligator" – handle the most pressing problem and go from there
  iv. Proper task management can help prevent distractions, loss of SA, and disorientation
  v. Safety is the number one priority – Aviate, Navigate, Communicate

EMERGENCY OPERATIONS

XII.A. Emergency Descent

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

Objectives	The learner should develop knowledge of when an emergency descent is required, and the proper procedure to perform the maneuver. The learner can perform the maneuver as required in the ACS.
Key Elements	1. Configuration 2. Airspeed and Load 3. Recovery
Elements	1. Basics 2. Emergency Descent Procedures 3. Descent Factors 4. Common Errors 5. Hazards
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 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 for survival.

How:

1. **Basics** AI.XII.A.K1, AI.XII.A.K2
   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.)
   C. POH AI.XII.A.K3, AI.XII.A.K4, AI.XII.A.K5
      i. Follow the procedures outlined in the POH
         a. Review immediate action/memory items
      ii. Reference & note any applicable aircraft limitations
         a. V_{NE}, V_{LE}, $V_{FE,}$ V_A in turbulent air
         b. Performance: Expected rate of descent at target airspeed(s)
            - Review any associated performance charts
2. **Emergency Descent Procedures** AI.XII.A.K1
   A. Prior to the Maneuver
      i. Pre-maneuver checklist; Clear the area
   B. Procedure
      i. Reduce power to idle
      ii. Configuration AI.XII.A.R3
         a. Extend the flaps and gear as specified by the manufacturer
            - Provides maximum drag to increase the rate of descent, without excessive airspeed
      iii. Set the propeller to the low pitch (high rpm) setting
      iv. Lower the nose to maintain maximum allowable airspeed
         a. Speed may vary based on flaps, nature of the emergency, and turbulent conditions
            - Don't exceed V_{NE} or V_{FE}, and in the case of turbulence, do not exceed V_A
      v. As the nose is lowered, begin a 90° 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
      vi. Technique: 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

3. RM: Descent Factors AI.XII.A.R1

A. Altitude
    i. Dictates the amount of descent
        a. Recommended to level at/below 10,000' in case of depressurization, safety permitting
    ii. In the case of an engine failure, altitude will dictate the distance the aircraft can travel

B. Wind
    i. Headwind decreases the distance traveled; Tailwind increases the distance traveled
        a. Becomes much more important in the case of an engine failure
    ii. Landing
        a. Maximum Demonstrated Crosswind Component
        b. Tailwind increases landing distance, verify performance (comply with limitations, exception: emergency)

C. Terrain & Obstructions
    i. Preflight planning: Study and know terrain on the route and safe altitudes/max elevation figures
    ii. Be familiar with and especially cautious of terrain & obstructions during an emergency descent

D. Glide Distance
    i. In the case the engine fails, and the aircraft must glide to the landing area
        a. The farther the emergency descent is extended, the less glide distance available
    ii. Terminate the emergency descent at an altitude appropriate to ensure a precautionary/emergency landing
    iii. Know glide distance data and transition to the engine failure emergency landing

4. Common Errors AI.XII.A.K6

A. The consequences of failing to identify reason for executing an emergency descent
B. Improper use of the prescribed emergency checklist to verify accomplishment of procedures for initiating the emergency descent
C. Improper use of clearing procedures for initiating the emergency descent
D. Improper procedures for recovering from an emergency descent

5. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. XII. RM Concepts – Collision Hazards AI.XII.A.R2
B. XII. RM Concepts – Distractions, SA & Disorientation, Task Prioritization AI.XII.A.R4

Conclusion:
Brief review of the main points

XII.B. Emergency Approach & Landing

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

Objectives	The learner develops knowledge of the elements related to performing an emergency approach and landing. The learner will be able to perform the maneuver as required in the ACS.
Key Elements	1. Best Glide Airspeed 2. Emergency Checklists 3. Soft Field Power Off Approach and Landing
Elements	1. Best Glide Speed 2. ABC Checklist 3. Emergency Approach 4. Contacting ATC 5. Emergency Landing 6. Descent Factors 7. Emergency Locating Devices 8. Mental Attitude 9. Common Errors 10. Hazards
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 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

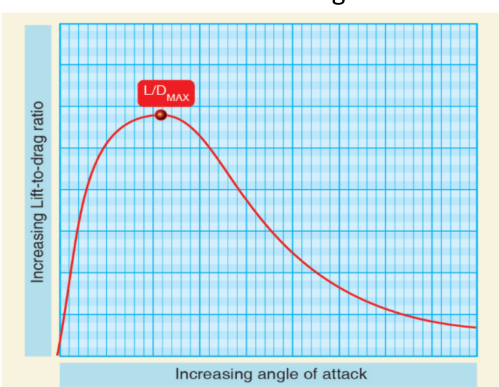
A simulated emergency landing occurs when the power is pulled, simulating a lost engine, and the pilot must run the checklist to attempt to restart the engine while properly configuring the airplane for an approach and landing usually in a nearby field.

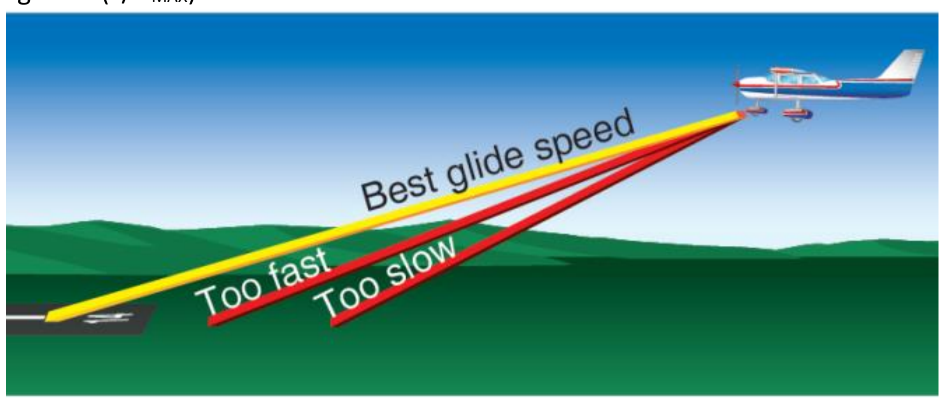
Why

To develop accuracy, judgment, planning, technique, and confidence when little or no power is available.

How:

1. **Best Glide Speed** AI.XII.B.K2
   A. Airspeed at which the aircraft glides the furthest for the least altitude lost in non-powered flight AI.XII.B.K2a
      i. Occurs at the highest lift-to-drag ratio (L/D_{MAX})



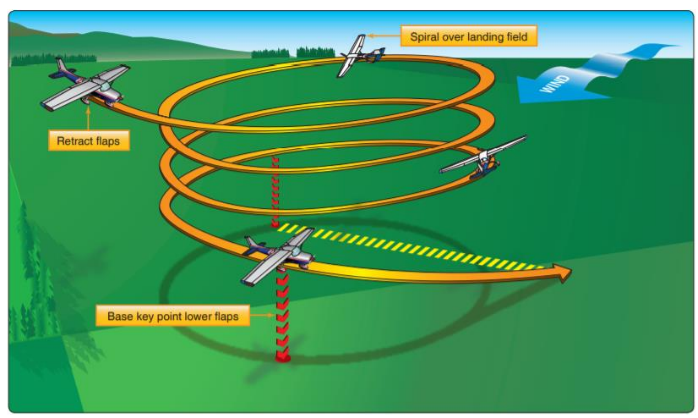


   B. Glide Ratio: Distance the airplane travels in relation to the altitude it loses
      i. Provides an estimate of how far you can fly
      ii. Any increase or decrease from best glide reduces the glide ratio
   C. Best Glide & Weight
      i. L/D determines the distance the airplane can glide, not weight
      ii. If the pilot maintains the proper speed, changes in weight don't affect the best glide angle or distance flown
      iii. However, a heavier plane needs to fly at a higher airspeed to obtain the same glide ratio
   D. Best Glide & Wind AI.XII.B.K2c
      i. With a tailwind, the airplane glides farther because of the higher groundspeed
      ii. With a headwind, the airplane does not glide as far because of the lower groundspeed
   E. Best Glide & Configuration
      i. When drag increases, the airplane must be pitched down to maintain airspeed (no longer at L/D max)
      ii. To maximize distance traveled, minimize drag-producing components
   F. Minimum Sink Speed AI.XII.B.K2b

        i. Airspeed used to maximize the time that the airplane remains in flight
            a. Results in losing altitude at the lowest rate (lowest vertical speed)
        ii. Less distance traveled versus best glide airspeed
        iii. Not often published but generally a few knots less than best glide airspeed
    G. Cardinal Rule: Do not attempt to "stretch" a glide by increasing back pressure/slowing below best glide
        i. Any speed other than best glide reduces distance traveled

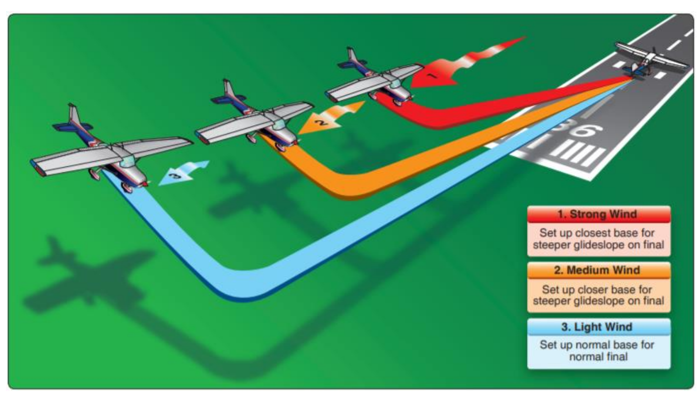
2. ABC(D) Checklist AI.XII.B.K1

    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
    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
        v. Always continue to clear for traffic
    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
    D. Can add D – Distress Call
        i. When able, inform ATC or Guard



3. Emergency Approach

    A. Governed by:
        i. Wind direction and speed
        ii. Dimensions and slope of the field
        iii. 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 (steep spiral)
            a. Turn in the same direction you intend to fly the pattern
        iii. RM: Following or changing the flight path to the landing area AI.XII.B.R2
            a. Adjust as conditions change
            b. Best practice is to go directly to the landing area and circle overhead, with a plan to enter 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 AI.XII.B.K3
- 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

- E. Stable Approach AI.XII.B.K4
  - i. The more stable the approach, the more predictable the approach
  - ii. Flying the airplane is the highest priority
- F. Configuration AI.XII.B.R4
  - i. Intent is to touchdown in a normal landing configuration (emergency permitting)
  - ii. Flaps will be gradually lowered based on the conditions, situation, airplane performance, etc.
    - a. Have a standard position to lower the flaps and adjust based on the day
      - Too high: Configure earlier (or delay configuration and slip, vary the base leg, etc.)
      - Too low: Delay configuration (tighten the base leg and/or turn to final)
    - b. Once flaps are lowered, they should not be retracted
    - c. Landing flaps should only be lowered once the landing area is assured

4. Contacting 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
  - iii. If time and conditions permit, squawk emergency - 7700
- B. ATC Emergency Services AI.XII.B.K6
  - i. Priority: The frequency is basically yours, whatever you need
  - ii. Aircraft Separation: Any other potentially hazardous aircraft will be moved out of your way
  - iii. Advice: Nearby airports, etc.
  - iv. Emergency Response: ATC will coordinate with the tower or local emergency response

5. 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

6. RM: Descent Factors AI.XII.B.R1
- A. Altitude
  - i. Dictates the distance the aircraft can travel (use AGL, not MSL)
    - a. Know approximate distance traveled at best glide per 1,000' – apply to the situation
  - ii. Goal is to put the aircraft at a normal pattern altitude at a normal key position
- B. Wind

   i. During the approach
      a. It can influence glide distance (headwind vs tailwind vs crosswind)
      b. The stronger the wind on final, the closer the base leg needs to be to make a normal approach
   ii. Tailwind
      a. A tailwind increases the runway required for landing
   iii. Maximum Demonstrated Crosswind Component
      a. If possible, don't exceed it as the aircraft may not be able to remain with the confines of the runway
C. Terrain & Obstructions
   i. Be especially cautious of terrain/obstructions during an emergency approach & landing
   ii. Without an engine, there may not be enough energy to clear the terrain
D. Available Landing Distance
   i. Be familiar with the landing distance required for an emergency approach and pick a suitable landing area
      a. The landing distance at off airport landing areas will have to be estimated from the air

7. Emergency Locating Devices AI.XII.B.K5

A. ELT: Small, self-contained radio transmitter that will automatically, upon impact, transmit an emergency signal
   i. Transmits on 121.5, 243, and/or 406 MHz
B. Numerous private companies produce emergency locating devices that can be carried on oneself
   i. Basic Personal Locator Beacons (PLBs)
   ii. Satellite Messengers

8. Mental Attitude

A. The survival records favor pilots who maintain their composure and know how to apply the concepts and procedures developed through the years. Success is as much a matter of the mind as of skills
   i. "We don't rise to the level of our expectations; we fall to the level of our training"

9. Common Errors AI.XII.B.K7

A. Improper airspeed control
B. Poor judgment in the selection of an emergency landing area
C. Failure to estimate the approximate wind speed and direction
D. Failure to fly the most suitable pattern for existing situation
E. Failure to accomplish the emergency checklist
F. Undershooting or overshooting selected emergency landing area

10. RM: Hazards

NOTE: The remaining RM concepts shown below are organized in this order in a document at the end of the section. Just (hold control &) click the top link, or whichever one you need, and continue through the content.

A. XII. RM Concepts – Low Altitude Maneuvering AI.XII.B.R5
B. XII. RM Concepts – Collision Hazards AI.XII.B.R3
C. XII. RM Concepts – Distractions, SA & Disorientation, Task Prioritization AI.XII.B.R6

Conclusion:

Brief review of the main points

XII.C. System & Equipment Malfunctions

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

Objectives	The learner should develop knowledge of emergency procedures and be able to explain the proper procedures for certain situations based on the ACS.
Key Elements	1. Understand the Problem 2. Follow the Checklist 3. Safety of Those Onboard
Elements	1. Malfunction Procedures 2. Power Loss 3. Electrical Malfunction 4. Vacuum/Pressure Malfunctions 5. Pitot Static Malfunction 6. EFD Malfunction 7. Flap Malfunction 8. Hydraulic Malfunction 9. Landing Gear Malfunction 10. Inoperative or "Runaway" Trim 11. Smoke & Fire 12. Door or Window Opening in Flight 13. Pressurization Malfunction 14. Other Malfunctions 15. Common Errors 16. Hazards
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 understand problems and why they may occur in the airplane. The learner 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, 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 & malfunction discussions. Always follow the POH procedures.

1. **Malfunction Procedures (MATL)**
   - A. Maintain Aircraft Control
     - i. Fly the airplane, get to a safe flight state (straight-and-level, etc.)
     - ii. Trim the aircraft and turn on the autopilot, if possible
     - iii. Maintaining control continues throughout the malfunction
     - iv. RM: Undesired aircraft state (UAS) AI.XII.C.R4
       - a. Some mechanical failures can directly cause departure from normal flight
         - Ex: Asymmetric flaps, malfunctioning/binding controls, runaway trim
         - Knowledge of systems/POH procedures helps minimize mechanical issue's impact & prevent upsets
       - b. Distractions can lead to, and quickly amplify, the malfunction being dealt with
       - c. Maintaining control is the top priority – in the case of an UAS:
         - Push, Roll, Thrust, Stabilize
         - Understand the specific malfunction may limit or prevent recovery
           - a Further emphasizes the need to maintain control
   - B. Analyze the Situation
     - i. Indications, lights, sounds, sight (i.e., smoke, leaks, fire, etc.), smells, etc.
     - ii. Use all available information to determine the issue
   - C. Take the Proper Action
     - i. Apply any memory items
     - ii. RM: Checklist usage – Use the appropriate checklist from the POH AI.XII.C.R2
   - D. Land, as conditions require/permit
     - i. Based on the emergency, decide on a landing area (divert, field, ditching, etc.)
2. **Power Loss** AI.XII.C.K1
   - A. Rough running engine:

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
Induction Icing	Leave icing conditions, use alternate air source
Low Oil	Reduce Power. Land ASAP
Carburetor or induction icing	Apply carb heat
Clogged air filter	Switch to unfiltered/alternate air position

B. Oil Pressure Malfunctions
   i. High Oil Pressure
      a. Possible Cause - Cold oil or possible internal plugging
      b. Corrective Action - If cold, allow the engine to warm, if not, reduce power and land ASAP
   ii. Low Oil Pressure
      a. Possible Cause – Broken pressure relief valve, insufficient oil, burned out bearings
      b. Corrective Action – Land as soon as possible or feather the propeller and stop the engine (multi-engine)
   iii. Fluctuating Oil Pressure
      a. Possible Cause – Low oil supply, loose oil lines, defective pressure relief valve
      b. Corrective Action – Land as soon as possible or feather propeller and stop engine (multi-engine)

C. Engine Overheat
   i. The oil temperature gauge is the primary instrument in determining if the engine is overheating

D. Fuel Starvation
   i. Normally indicated by a rough running engine, and can be caused by blocked lines or empty tanks
   ii. In general, turn on boost pumps, switch tanks, verify fuel is on, adjust mixture

3. Electrical Malfunction AI.XII.C.K2a

A. Electrical Power
   i. Generally, power comes from a generator or alternator
   ii. If the generator/alternator fails, typically a battery provides power for a limited amount of time

B. Battery Time
   i. The higher the amperage load (electrical draw) on the battery, the faster the energy gets consumed
   ii. Very important to shed non-essential loads to provide maximum time

C. Consumers (see picture to right for average amperage)
   i. Gear and flaps use significant amounts of power

D. Procedures
   i. Follow the applicable checklist(s) in the POH
   ii. Generic Steps:
      a. Shed all but the most necessary electrical equipment
      b. Notify ATC immediately
      c. Expect a no-flap landing and manual gear extension

Electrical Loads for Light Single	Number of units	Total Amperes
A. Continuous Load		
Pitot Heating (Operating)	1	3.30
Wingtip Lights	4	3.00
Heater Igniter	1	1-20
**Navigation Receivers	1-4	1-2 each
**Communications Receivers	1-2	1-2 each
Fuel Indicator	1	0.40
Instrument Lights (overhead)	2	0.60
Engine Indicator	1	0.30
Compass Light	1	0.20
Landing Gear Indicator	1	0.17
Flap Indicator	1	0.17
B. Intermittent Load		
Starter	1	100.00
Landing Lights	2	17.80
Heater Blower Motor	1	14.00
Flap Motor	1	13.00
Landing Gear Motor	1	10.00
Cigarette Lighter	1	7.50
Transceiver (keyed)	1	5-7
Fuel Boost Pump	1	2.00
Cowl Flap Motor	1	1.00
Stall Warning Horn	1	1.50

** Amperage for radios varies with equipment.
In general, the more recent the model, the less amperage required.
NOTE: Panel and indicator lights usually draw less than one amp.

4. Vacuum/Pressure Malfunctions AI.XII.C.K2b

A. What's Lost?
   i. Heading Indicator, Attitude Indicator

   ii. Traditionally, turn coordinators use a different power source than the heading & attitude indicators
B. Failure results from a loss of the suction or pressure source
C. As the gyro slow, they will begin to wander, displaying incorrect information - Can be slow and insidious
D. Many small aircraft do not have a warning system for vacuum failure
   i. Look for failure indications – monitor vacuum pressure gauge
E. Compare the Attitude Indicator with the Turn Coordinator and VSI
   i. Compares the static, suction, and electric systems
   ii. Identify failed component(s) and use functional instruments
F. Assess the situation - when and where to land may vary based on the conditions and failure(s)
   i. Ex. day VMC versus night over water

5. Pitot Static Malfunction AI.XII.C.K2c

A. General
   i. Errors in the ASI/VSI often indicate a pitot and/or static blockage
B. Blocked Pitot System
   i. Pitot system measures the difference between ram & static pressure
   ii. Ram air blocked, with drain hole open
      a. Air in the system vents through the drain hole, remaining pressure in the pitot tube drops to match the outside (static) pressure
      b. Airspeed decreases to zero
   iii. Ram air blocked, and drain hole blocked
      a. Big Picture
         - Airspeed indicator acts like an altimeter
         - Ram air pressure in the pitot tube is trapped
            a Accelerating/decelerating does not affect indications
         - Static pressure changes with altitude
C. Blocked Static System
   i. Static system blocked, with pitot tube open
      a. Airspeed
         - Above the altitude where the port was blocked, airspeed indicates lower than actual
         - At a lower altitude, airspeed indicates higher than actual
      b. Altimeter freezes at the altitude where the block occurred
      c. Vertical Speed shows a continuous zero indication
D. Alternate Static Source
   i. Alternate source of static pressure in case the primary is blocked
   ii. Normally inside the flight deck
      a. Cabin pressure is lower than exterior pressure
   iii. Instrument indications when the alternate static source is used:
      a. Altimeter indicates slightly higher than actual
      b. Airspeed indicates greater than actual

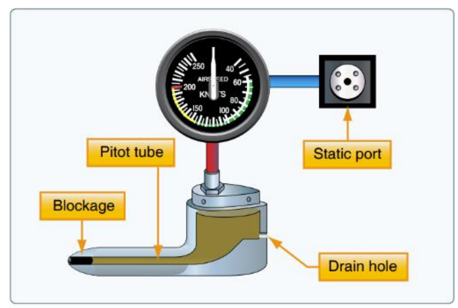


Figure 8-9. *A blocked pitot tube, but clear drain hole.*

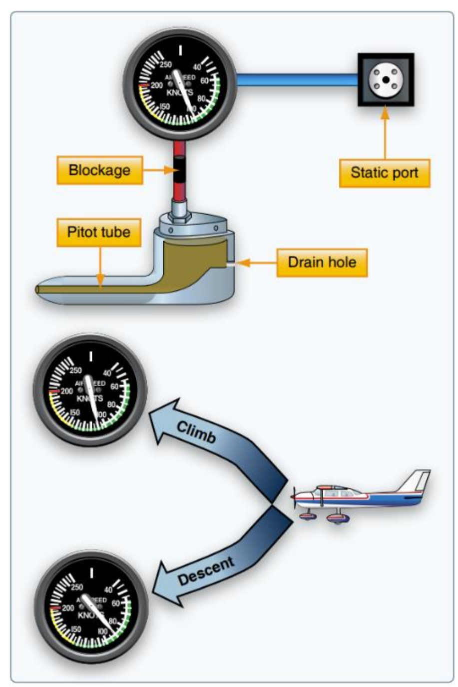
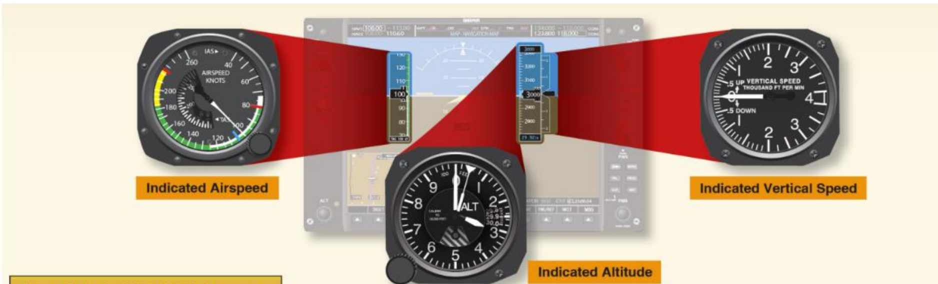


Figure 8-10. *Blocked pitot system with clear static system.*

c. Vertical speed shows a momentary climb and then stabilizes



Effect of Blocked Pitot/Static Sources on Airspeed, Altimeter, and Vertical Speed Indications	Indicated Airspeed	Indicated Altitude	Indicated Vertical Speed
Pitot source blocked	Increases with altitude gain, decreases with altitude loss.	Unaffected	Unaffected
One static source blocked	Inaccurate while sideslipping; very sensitive in turbulence.		
Both static sources blocked	Decreases with altitude gain, increases with altitude loss.	Does not change with actual gain or loss of altitude.	Does not change with actual variations in vertical speed.
Both static and pitot sources blocked	All indications remain constant, regardless of actual changes in airspeed, altitude, and vertical speed.		

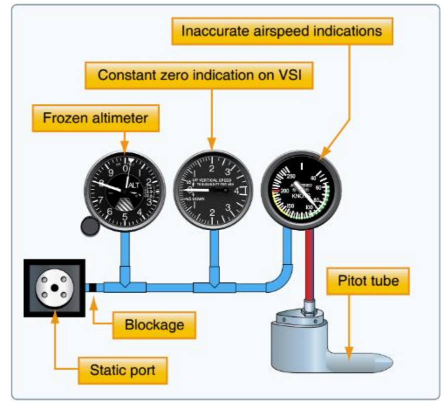


Figure 8-11. *Blocked static system.*

6. **Electronic Flight Display (EFD) Malfunction** AI.XII.C.K2d
   A. In an EFD failure, the system reverts to a composite, reversionary mode
      i. Moving map is removed
      ii. PFD & engine instruments are combined on the remaining screen
   B. Pilots often become overly reliant on the moving map
      i. Significant loss of SA if the pilot is not prepared for this failure
   C. Stay Prepared
      i. Follow the flight on an enroute chart & have a Chart Supplement on hand

Display Failure / Reversionary Mode

7. **Flap Malfunction** AI.XII.C.K2e
   A. Total Flap Failure (no flap approach and landing)
      i. Requires substantially more runway than normal (as much as 50% more)
      ii. Losing altitude is more difficult so a wider, longer pattern may be necessary
      iii. Flown in a relatively nose-high attitude compared to flaps extended
      iv. Landing
         a. Airplane is slightly less stable in pitch and roll axes with power reduced and flaps retracted
         b. Tend to float during roundout - Don't force the plane onto the ground
         c. Don't flare excessively as it risks a tail strike
   B. Asymmetric (Split) Flap
      i. A situation in which one flap deploys or retracts while the other remains in position
         a. Indicated by a roll toward the wing with the least flap deflection
      ii. Countered with opposite aileron
      iii. Be aware of the differing stall speeds of each wing
      iv. Approach and landing should be flown at a higher-than-normal airspeed
8. **Hydraulic Malfunction** AI.XII.C.K2e
   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

9. Landing Gear Malfunction AI.XII.C.K2e

A. Alternate gear extension procedure
   i. If this does not solve the problem, a gear up landing is required
B. Considerations
   i. Airport with crash and rescue facilities
   ii. A smooth, hard runway surface tends to cause less damage than a rough, unimproved grass strip
      a. The hard surface creates sparks that could ignite fuel
   iii. Burn off excess fuel (if limited to one leg, consume as much fuel from that side as practicable)
C. Landing the Airplane
   i. One Leg Retracted
      a. Land in a nose-high attitude with wings level
      b. As airspeed slows, apply aileron to keep the unsupported wing airborne as long as possible
      c. After touchdown use full rudder and aggressive braking to maintain some degree of directional control
      d. On a narrow runway, or one with ditches/obstacles on the edges, landing with all gear up may be safer
   ii. Nose Wheel Retracted
      a. Hold the nose off the ground until almost full-up elevator is applied
      b. Release back pressure to allow the nose to slowly settle to the surface
      c. Do not apply brakes unless necessary to avoid a collision with obstacles
   iii. Main Gear Retracted (Nose extended)
      a. Initial contact should be made on the aft fuselage with a nose high attitude
      b. Allow the nose-wheel to gradually touchdown & use nose-wheel steering as necessary

10. Inoperative or "Runaway" Trim AI.XII.C.K2f

A. Grip the controls and maintain control of the plane while disengaging the electric trim system
B. If the reason for the runaway trim is obvious and has been resolved, engage the breaker

11. Smoke & Fire AI.XII.C.K3

A. In any fire, it is essential the source is discovered first
   i. Identifying the source allows the pilot to fight the fire most effectively
      a. Identify/shutdown the faulty component, use the extinguisher effectively, run the proper checklist, etc.
B. In-Flight Smoke / Fire
   i. Engine Fire
      a. Usually caused by a failure allowing a combustible substance to contact a hot surface
      b. Indicated by smoke and 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 possible, 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 available; initiate an immediate descent (likely emergency descent)

C. Smoke & Fire – On the Ground
  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

12. Door or Window Opening in Flight AI.XII.C.K5

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

13. Pressurization Malfunction AI.XII.C.K4

A. Descend or use supplemental oxygen (emergency descent)
B. Hypoxia is the primary danger of decompression

14. Other Malfunctions (supplemental oxygen, deicing, etc.) AI.XII.C.K4

A. Reference the POH and/or user's manual for specific procedures

15. Common Errors AI.XII.C.K6

A. Inaccurate diagnoses of the malfunction
B. Use of an improper checklist/procedure
C. Lack of control throughout the malfunction
D. Fixation on the malfunction at the expense of the aircraft & safe flight

16. RM: Hazards

A. Startle Response AI.XII.C.R1
  i. Uncontrollable, automatic muscle reflex, raised heart rate, blood pressure, etc. elicited by exposure to a sudden intense event that violates a pilot's expectations
  ii. Protect against startle response through scenario-based training incorporating realistic distractions
  iii. The pilot should react in a calm, controlled manner and:
    a. Maintain control, Analyze the situation, Take the proper action, Land, as conditions require/permit
  iv. Reactions or inputs outside of checklists may aggravate the situation

NOTE: The remaining RM concept shown below is in a document at the end of the section.
Just (hold control &) click the link and continue through the content.

B. XII. RM Concepts – Distractions, SA & Disorientation, Task Prioritization AI.XII.C.R3

Conclusion:
Brief review of the main points

XII.D. Emergency Equipment and Survival Gear

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

Objectives	The learner develops knowledge of emergency equipment and survival gear, understanding that certain equipment should be taken on certain flights to aid in survival and rescue operations. The learner will have knowledge in accordance with the ACS.
Key Elements	1. Equipment for the Situation 2. Equipment Care 3. Equipment Storage
Elements	1. Appropriate Equipment 2. Equipment Use and Care 3. Ballistic Parachute 4. Emergency Autoland Systems 5. Common Errors
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 learner understands that flights over different terrain, and during different seasons require different emergency equipment and survival gear. The learner 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 that should be carried onboard an airplane based on the flight being taken to aid in survival and rescue operations.

Why

By carrying and understanding flight tailored survival equipment you will greatly increase odds of survival & rescue.

How:

1. **Appropriate Equipment** AI.XII.D.K3
    A. For flight over uninhabited areas, it's wise to have/understand proper survival equipment for the climate/terrain
        i. General plan is equipment and gear for 48-72 hours, adjust as required
    B. A survival kit should provide sustenance, shelter, medical care, and a means to summon help
    C. Consider the terrain, the climate/season, and type of emergency communication equipment needed
    D. General items to consider
        i. First Aid Kit & Field Medical Guide
        ii. Flashlight and batteries
        iii. Food and Water (water purification/filtration)
        iv. Tackle kit, Equipment to attain food
        v. Rope, paracord
        vi. Multi-tool or Knife, hatchet
        vi. Fire starter
        vii. Shelter, survival blanket
        viii. Signaling device(s), PLBs, GPS etc.
        ix. Maps & Compass
        x. Water/windproof layer
        xi. Sunscreen, bug spray
    E. Think outside the box
        i. What parts of the airplane/baggage could be used for survival?
            a. Ex: The aircraft cover could be used for shelter, warmth, etc.
    F. More specific items should be considered based on the type of terrain and wildlife
        i. Climate Extremes AI.XII.D.K3a
            a. Cold
                - Warm clothes and layers, gloves, headgear, boots, snowshoes
                - Waterproof layer(s)
                - Blanket(s)
                - Shovel
                - Hand/body warmers
            b. Hot
                - Light clothing & hat (sun protection), sunglasses, sunscreen, extra water
        ii. Mountainous Terrain AI.XII.D.K3b
            a. Mosquito head net

- b. Hiking boots
- c. Warm/Cold weather clothing to adapt to temperature changes
- d. Bear spray, or similar items depending on the wildlife

iii. Overwater AI.XII.D.K3c
- a. Life vests, Dry suit/survival suit
- b. Raft

2. Equipment Use and Care

A. Onboard emergency equipment often consists of an ELT, fire extinguisher, emergency axe, & your survival gear

B. ELT AI.XII.D.K1

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
- c. Storage – Usually installed by the manufacturer to prevent damage to the device in a crash

C. Fire Extinguisher AI.XII.D.K2

i. Purpose - Used to fight / extinguish fires (check the types of fires it's intended to fight)

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. RM: Survival Gear (for 48-72 hours) AI.XII.D.R1

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 to be 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

3. Ballistic Parachute AI.XII.D.K4

A. Alternative to certain emergency situations

i. Parachute deploys from the plane allowing a slow descent allowing occupants to survive with minimal injury

ii. Understand and follow the procedures for arming/disarming and conditions under which it should be used

B. Conditions for Deployment

i. Examples include catastrophic loss of controllability, pilot incapacitation, and loss of control

ii. Airframe will be lost, but if deployed in an acceptable flight regime it can prevent injuries & save lives

C. Passenger Brief

i. RM: Conditions for a safe deployment AI.XII.D.R2

            a. When & How to deploy it
            b. What to expect
        ii. Applicable hazards (Ex. Ground hazards with a deployed parachute, surface winds)
        iii. Evacuation procedures once on the ground
    D. Instructor ACS Appendix 3 XII.D.
        i. Follow the manufacturer's procedures for arming/disarming the system before and after flight
        ii. Knowledge testing may include simulation and briefing of procedures but not actual deployment

4. Emergency Autoland (EAL) Systems AI.XII.D.K5

- A. Designed to be deployed in the case of pilot incapacitation
- B. How it Works
    - i. Manually activated by a pilot or passenger
    - ii. Automatic Activation
        - a. If the system sense erratic flying, it stabilizes the aircraft, and checks for pilot responsiveness
        - b. Without further input, it initiates an emergency descent
        - c. If no further input, it initiates the process for an automated landing
    - iii. Transmits automated messages on the last selected frequency and Guard & squawks 7700
        - a. Call sign and intention to divert to a particular airport and runway
- C. Passenger Brief
    - i. RM: Conditions for a safe deployment AI.XII.D.R3
        - a. When & How to deploy it
        - b. What to expect
    - ii. Evacuation procedures on the ground
    - iii. Any applicable hazards
- D. FAA Safety Team Emergency Autoland Overview

5. Common Errors AI.XII.D.K6

- A. Failure to carry appropriate gear & equipment for the route of flight
- B. Failure to maintain the equipment/gear
- C. Lack of understanding of the operation and use of emergency gear & equipment
- D. Failure to understand when and how to deploy emergency systems (i.e., parachute & Autoland)

Conclusion:
Brief review of the main points

XII. RM Concepts

1. **Low Altitude Maneuvering**
   A. A small problem at high altitude can quickly become a big problem at a low altitude, and during an emergency
   B. Quick, panicked maneuvers can result in a stall or loss of control close to the ground
      i. Especially important in engine failure emergencies
      ii. Be aware of, and avoid, obstructions, towers, etc.
   C. Low Altitude Stall/Spin
      i. A low altitude stall or spin can leave little to no recovery time
         a. ALWAYS maintain coordination, and airspeed at low altitudes
            - During engine failures, maintain best glide – a stall could be catastrophic low & without power
         b. If you get any indication of a stall at low level, recover, and climb (if able) to a safe altitude
            - Without power, recover from the stall and adjust as required to make an emergency landing
      ii. Spin
         a. A spin is a result of a stall + yaw
         b. Prevention
            - Maintain coordination – don't cross the controls especially during an emergency landing
            - Do not use abrupt, excessive pressure inputs (especially back elevator pressure)
            - Stop whatever you're doing and recover at the first sign of a stall
         c. Recovery (PARE)
            - Power - Idle
            - Ailerons - Neutral
            - Rudder - Full rudder opposite the spin direction
            - Elevator - Brisk, positive forward pressure (nose down)
            - Once the spin has stopped, neutralize the rudders and raise the nose, being careful not to stall again
         d. Different aircraft respond differently to spins and spin recoveries, follow the POH procedures
   D. CFIT (Controlled Flight into Terrain)
      i. AC 61-134: General Aviation CFIT Awareness
      ii. The solution to combating CFIT accidents starts on the ground
         a. Common themes include proper planning, good decision making, and being able to safely operate the aircraft throughout its entire operating range
         b. Don't push the envelope during training – if there's a possibility of CFIT, go around and try again
      iii. Recommendations:
         a. Non-instrument rated VFR pilots should not attempt to fly in IMC
         b. Know and fly above minimum published safe altitudes
         c. If IFR, fly published procedures
         d. Verify proper altitude, especially at night or over water, through use of a correctly set altimeter
         e. Verify all ATC clearances. Question potentially hazardous clearances
         f. Maintain situational awareness both vertically and horizontally
         g. Comply with appropriate regulations for your specific operation
         h. Don't operate below minimum safe altitudes if uncertain of position or ATC clearance
         i. Be extra careful when operating in an area which you are not familiar
         j. Use current charts and all available information
         k. Use appropriate checklists
         l. Know your aircraft and equipment
2. **Collision Hazards**
   A. Collision Avoidance

i. Scanning
   a. Short, regularly spaced eye movements bringing successive areas into the central visual field
      - Each movement should not exceed 10º, each area should be observed for at least one second
   b. Divide attention between flying and scanning for aircraft
ii. Clearing Procedures
   a. Climb/Descent: Execute gentle banks to scan above/below the wings as well as other blind spots
   b. Prior to any turn: Clear in the direction of the turn
   c. Pre-Maneuver: Clearing turns – clear above/below, in front/behind
iii. Operation Lights On (voluntary FAA safety program)
   a. Turn on landing lights during takeoff and when operating below 10,000', day or night
iv. Right-of-Way Rules (FAR 91.113)
   a. Pertinent to emergencies: An aircraft in distress has the right-of-way over all other traffic
      - Be cautious, other aircraft may not know you're in distress

B. Terrain
   i. Study terminal charts and IFR/VFR chart altitudes, use Max Elevation Figures (MEFs)
   ii. Be extra vigilant at night, when terrain may be impossible to see until it is too late
   iii. Minimum Safe Altitudes (FAR 91.119)
      a. Anywhere: At an altitude allowing an emergency landing without undue hazard to persons or property
      b. Over Congested Areas: 1,000' above the highest obstacle within 2,000'
      c. Over other than Congested Areas: 500' above the surface, except when over open water/sparsely populated areas, then no closer than 500' to any person, vessel, vehicle, or structure

C. Obstacles and Wire Strike
   i. Research obstacles in the area (practice/airfield/emergency landing area)
      a. Charts, NOTAMs, Terminal procedures, etc.
   ii. Antenna Towers can extend over 1,000'-2,000' AGL
      a. Most are supported by guy wires which can extend 1,500' horizontally from the structure
   iii. Overhead Wires (may not be lighted)
      a. Overhead transmission wires and lines span runway departures and landmarks pilots frequently follow
         - Lakes, highways, railroad tracks, etc.

D. Airport Surface
   i. Scan vigilantly during taxi for aircraft and obstacles
      a. Ensure proper clearance - If unsure of clearance, stop until you're sure it is safe to pass
   ii. Vehicles, Persons, Wildlife, etc.
      a. Be alert for anyone/anything that may cause a hazard – adjust as required/able
      b. Check NOTAMs for work on the airfield

3. Distractions, SA & Disorientation, & Task Management

A. Distractions
   i. They're dangerous - Remove them from view or, if a person, explain the situation and ask them to stop
   ii. Focus on aircraft performance & clear for traffic - If distracted, recognize the problem and fix it
   iii. Fly first! Aviate, Navigate, Communicate
      a. Especially important to avoid distractions in an emergency with numerous tasks to manage

B. Situational awareness (SA) & Disorientation
   i. Extremely important, lost SA has led to unsafe situations, mishaps, and incursions
   ii. High task load during an emergency can lead to a loss of SA
   iii. Maintain SA
      a. Starts with preflight planning
      b. Know what's coming next and stay ahead of the airplane
      c. Divide attention between inside and outside references

    d. If SA is lost, admit it, and fix the problem
    e. Emergency Descent: Maintain SA in relation to the level-off altitude, emergency & associated procedures, airplane configuration, and the plan (diversion)
  iv. Disorientation can be caused by, or lead to, an upset
    a. Push: Apply forward pressure to unload the plane
    b. Roll: Roll aggressively to the nearest horizon
    c. Thrust: Adjust as required
    d. Stabilize: Return to a safe flight condition

C. Task Prioritization
  i. Divide attention between the aircraft, scanning, and communicating (ATC or CTAF)
    a. No one responsibility should take your full attention for more than a short period
  ii. Understand what tasks need to be accomplished and when
    a. Organization is especially important in situations like this – many tasks, little time
  iii. “Attack the closest alligator”
    a. When tasks are piling up, handle the most threatening problem
  iv. Proper task management can help prevent distractions, loss of SA, and disorientation
    a. Safety is the number one priority – Aviate, Navigate, Communicate

POSTFLIGHT PROCEDURES

XIV.A. After Landing, Parking, & Securing

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

Objectives	The learner should develop knowledge of postflight procedures and be able to perform them as required in the ACS.
Key Elements	1. Shutdown Checklist 2. Postflight Inspection 3. Securing the Airplane
Elements	1. Parking 2. Engine Shutdown 3. Deplaning passengers 4. Postflight Inspection 5. Securing the Aircraft 6. Common 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 learner 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, shut down, and properly secured.

Why

The postflight is just as important as preflight in maintaining the aircraft and keeping it in a safe condition 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** AI.XIV.A.K1
   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
      i. Read each item aloud and perform the task (Read and Do)
   E. CE: Hazards resulting from failure to follow recommended procedures
3. RM: **Deplaning Passengers** AI.XIV.A.R3
   A. Ensure passengers understand the safe procedures for exiting the airplane (after engine shutdown)
   B. Ensure passengers are aware of potential hazards nearby – other aircraft starting, taxiing in/out, etc.
   C. Do not let the passengers disembark until required checklists are complete and safety precautions met
4. **Postflight Inspection** AI.XIV.A.K1
   A. Postflight Inspection
      i. Check the general condition of the aircraft

a. Inspect the outside for any damage that may have occurred
b. Look for leaks, streaks, stains
c. Check oil, and other required fluids and replenish as necessary

B. Document all Discrepancies AI.XIV.A.K2
  i. Don't leave the problem for someone else
  ii. Allows maintenance to fix issues
  iii. If not fixed, informs the next pilot of the discrepancies so they can make an informed go/no go decision
  iv. Can see trends/repeating problems

C. Fuel the Airplane
  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 AI.XIV.A.K1

A. An essential part of every flight
  i. Remove personal belongings
  ii. Verify the nosewheel is straight
  iii. Parking Brake/Tiedown/Chocked, as necessary
  iv. Flight controls secured, gust locks
  v. Covered (airframe, propeller, shades, inlet covers, pitot covers, etc.) and/or hangered
  vi. Windows closed
  vii. Locked
  viii. Any other requirements for your aircraft

B. RM: Airport Specific Security Procedures AI.XIV.A.R2
  i. Address any specific procedures (hours of operation, gates, codes, other requirements)

6. CE: 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

B. RM: Activities & Distractions AI.XIV.A.R1
  i. Taxiing and parking around buildings, people, etc. is no time to be distracted (sterile flight deck)
  ii. Follow all checklist(s) step by step, and ensure the airplane is left in a safe condition for the next flight
  iii. Do not skip the postflight inspection, assuming the next pilot will catch any issues in their preflight
    a. If a discrepancy is noted, attempt to have the issue inspected/fixed prior to the next flight
  iv. If unsure about something, ask (avoid faulty judgment)
    a. Don't assume "it will be OK"
    b. Don't make a safety decision for the next pilot – inform them and let them make the decision
    c. Verify with the POH, a flight instructor, Chief Pilot, maintenance, etc.
  v. Leaving the airplane in an unsafe place, condition, or situation can result in damage and/or injuries

Common Errors: AI.XIV.A.K3

- 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

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 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].

A. Flight Review

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)
  - Flight deck 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 learner'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

"High" Alt

1. **SLOW FLIGHT & STALLS**
   - Maneuvering during Slow Flight
   - Power-Off Stalls
   - Power-On Stalls
2. **PERFORMANCE MANEUVER**
   - Steep Turns
3. **BAI FLIGHT**
   - Straight-and-Level
   - Constant Airspeed Descent
   - Constant Airspeed Climb
   - Turns to Heading
   - Unusual Attitudes

Descent

4. **EMERGENCY OPERATIONS**
   - Systems & Equipment Malfunctions
   - Emergency Approach / Go-Around

Low Alt

5. **GROUND REFERENCE MANEUVERS**
   - Rectangular Course
   - S-Turns
   - Turns Around a Point
6. **TAKEOFFS & LANDINGS**
   - Normal / Crosswind
   - Soft-Field
   - Short-Field
   - Slip to a Landing
   - Go-Around

COMMERCIAL PILOT

Climb

1. **PERFORMANCE MANEUVER**
   - Chandelles (Up to altitude)

"High" Alt

2. **SLOW FLIGHT & STALLS**
   - Maneuvering During Slow Flight
   - Power-On Stalls
   - Power-Off Stalls
3. **PERFORMANCE MANEUVERS (CONT)**
   - Steep Turns
   - Lazy Eights

Descent

4. **EMERGENCY OPERATIONS**
   - Systems & Equipment Malfunctions
   - Steep Spiral / Emergency Approach

Low Alt

5. **GROUND REFERENCE MANEUVERS**
   - Eights on Pylons
6. **TAKEOFFS & LANDINGS**
   - Normal / Crosswind
   - Soft-Field
   - Short-Field
   - Power-Off 180
   - Go-Around

The learner 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

Low Alt

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

Climb

3. **BAI FLIGHT**
   - Straight-and-Level
   - Constant Airspeed Climb
   - Constant Airspeed Descent
   - Turns to Heading
   - Unusual Attitudes

"High" Alt

4. **SLOW FLIGHT & STALLS**
   - Maneuvering during Slow Flight
   - Power-Off Stalls
   - Power-On Stalls
5. **PERFORMANCE MANEUVER**
   - Steep Turns

Descent

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 learner 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

C. Common Carriage

References:

- FAA Order 8900.1. Volume 2, Chapter 2, Section 2
- CFR 61.133
- AC 120-12A: Private vs Common Carriage
- NBAA Certification of Commercial Aircraft Operations – Which Rules Apply?

This is a basic overview of common vs private carriage, certificates, and the like. For considerably more detail, use the reference links above, and additional information here:

- How to Become a Certificated Air Carrier
- FAR Part 119 – Certification: Air Carriers and Commercial Operators

1. **FAR 61.133: Privileges and Limitations**
   A. Privileges – A person holding a commercial pilot certificate may act as PIC of an aircraft:
      i. Carrying persons or property for compensation or hire
      ii. For compensation or hire
      iii. In both cases, the pilot must be qualified for the type of operation
   B. Limitations
      i. Commercial certificate without an instrument rating in the same category and class
         a. Carriage of passengers for hire on cross-country flights in excess of 50 nautical miles at night is prohibited
            - Limitations is lifted with an instrument rating in the same category and class
   C. These privileges allow the pilot to act as PIC – i.e., someone can hire you to fly their plane
      i. Commercial certificate does not allow you to operate as an air carrier or commercial operator
   D. The type of operation you're hired to fly for will dictate the applicable FARs and governing regulations that they (and therefore you, as the pilot) operate under
      i. The operation has to decide whether they fall under common carriage or private carriage and drill down from there
         a. Also applies if you'd like to start you own business as an air carrier or commercial operator
2. **What is Common Carriage & Private Carriage?**
   A. Common Carriage and Private Carriage are common law terms
      i. The Federal Aviation Act of 1958 uses the term "common carriage" but does not define it
      ii. AC 120-12 provides guidelines to define common carriage and its opposite, private carriage
   B. Common Carriage
      i. A carrier becomes a common carrier when it "holds itself out" to the public (or a segment of the public) as willing to provide transportation to any person who wants it
      ii. Holding Out
         a. Makes a person a common carrier
         b. Can be done in many ways, does not matter how it's done
         c. Examples
            - Signs and advertising are most direct means of holding out
            - Actions of agents or salesman who obtain passengers from the general public
            - A reputation to serve all (even without advertising)
      iii. 4 elements defining a common carrier
         a. A holding out of a willingness to

   b. Transport persons or property
   c. From place to place
   d. For compensation
 iv. As a pilot with a commercial certificate, you cannot "hold out"
   a. Illegal without the proper Part 119 certificates (more below)

C. Private Carriage
   a. Carriage for hire which does not involve "holding out"
   b. Carriage for one or several select customers, generally on a long-term basis
      - Too many contracts = willingness to make a contract with anybody (common carriage)

3. Governing Regulations

A. Once you've decided whether the operation falls under common carriage or private carriage, the next step is to decide what FAR regulations it falls under

B. Common carriage operations are required to be conducted under FAR Part 121, or Part 135 (depending on the type of aircraft, seating configuration, and payload capacity)
   i. An operational certificate is required (issued under Part 119)
   ii. Two basic types of Air Operator Certificates:
      a. Air Carrier Certificate: Issued for interstate, foreign, or overseas transportation, or to carry mail
      b. Operating Certificate: Intrastate common carriage operations

C. Private carriage, on the other hand, is conducted under Part 125, Part 135 (again, depending on the type of aircraft, seating configuration, and payload capacity), or Part 91 Subpart D
   i. Most private carriage also requires an operating certificate (exceptions for Part 91)

D. If they both require operating certificates, then what's the difference?
   i. Regulations and limitations
   ii. Generally, private carriage is less regulated than common carriage
      a. Ex. Part 121 pilots rest rules

4. Kind of Operation

A. Note: this is getting into extra, possible overly confusing information. Unless the learner is considering starting their own operation it may not be necessary

B. The final step is to decide the kind of operation
   i. Part 121
      a. Domestic: Between two points inside the contiguous 48 states
      b. Flag: Between a point outside of contiguous 48 states to a point inside the contiguous 48
      c. Supplemental: Cargo, charter, departure location/times are negotiated with customer (vs scheduled)
   ii. Part 135
      a. Commuter: Scheduled time and locations with at least 5 round trip flights per week
      b. On-demand: Departure time and location and arrival location are negotiated with the customer

C. FAA Order 8900.1. Volume 2, Chapter 2, Section 2
   i. Table 2-4 looks at the Operating Certificate, Seating/Payload, 14 CFR Operating Part, & Kind of Op.

5. FAR 119.1(e) Exceptions

A. Operations for compensation or hire that do not require an air carrier or commercial operator certificate
   i. Learner instruction
   ii. Nonstop commercial air tours (a lot more detail to this in the FAR)
   iii. Ferry or training flight
   iv. Aerial work (crop dusting, seeding, spraying, banner towering, aerial photography, and more)
   v. Parachute operations within 25 statute miles of the airport
   vi. Part 375 operations (foreign civil aircraft in the US)
   vii. Emergency mail service
   viii. Operations under part 91.321 (carriage of candidates in elections)

6. Confused?

A. Discuss any proposed operation with the FAA
   i. Early discussions can prevent a lot of pitfalls and potential illegal operations

B. As a commercial pilot you can be hired to fly for an operation but, other than the FAR 119.1(e) exceptions, you cannot hold out or offer your services without the proper FAA/FAR approval and certificates

D. ADM, CRM & SRM

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

Objectives	The learner understands the importance of ADM, CRM, and risk management and can apply the concepts to future flights.
Elements	1. Aeronautical Decision Making 2. Hazardous Attitudes 3. Stress 4. Risk Assessment & Management 5. SRM & CRM 6. Decision Making Process 7. 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	4. Participate in discussion 5. Take notes 6. Ask and respond to questions
Completion Standards	The learner can apply CRM, ADM, and risk management concepts to future flights.

Instructor Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

A systematic approach to the mental process used by aircraft pilots to consistently determine the best course of action in response to a given set of circumstances

Why

Despite all the changes in technology to improve flight safety, one factor remains the same: the human factor which leads to errors.

How:

1. **Aeronautical Decision Making (ADM)**
   - A. A systematic approach to the mental process used by aircraft pilots to consistently determine the best course of action in response to a given set of circumstances
   - B. Teaching pilots to make sound decisions is the key to preventing accidents
     - i. It is estimated that approximately 80% of all aviation accidents are a result of human factors
   - C. Steps for Good Decision Making
     - i. Identify personal attitudes hazardous to safety & learn behavior modification techniques
     - ii. Learn how to recognize and cope with stress
     - iii. Develop risk assessment skills
     - iv. Use all resources
     - v. Evaluate effectiveness of one's ADM skills
2. **Risk Assessment & Management**
   - A. 4 Fundamental Principles of Risk Management
     - i. Goal of these principles is to proactively identify safety-related hazards and mitigate associated risks
     - ii. Accept no Unnecessary Risk
       - a. Only accept the necessary risk
         - Flying is impossible without risk, do not make a situation more dangerous than necessary
     - iii. Make Risk Decisions at the Appropriate Level
       - a. In single pilot situations, the pilot makes decisions (not ATC, or passengers)
       - b. In other situations, it may be beneficial to "go up the ladder" for a decision
         - i.e., Talk to the chief pilot or experienced CFI about a potentially risky situation
     - iv. Accept Risk When Benefits Outweigh the Costs
       - a. Analyze costs and benefits, make an informed decision
     - v. Integrate Risk Management into Planning at All Levels
       - a. Safety requires risk management planning in all stages of flight
         - Plan early and throughout to avoid unnecessary, amplified risk
   - B. Risk Management Process
     - i. Step 1: Identify the Hazard
       - a. A hazard is any real or potential condition that can cause degradation, injury, illness, death, damage to

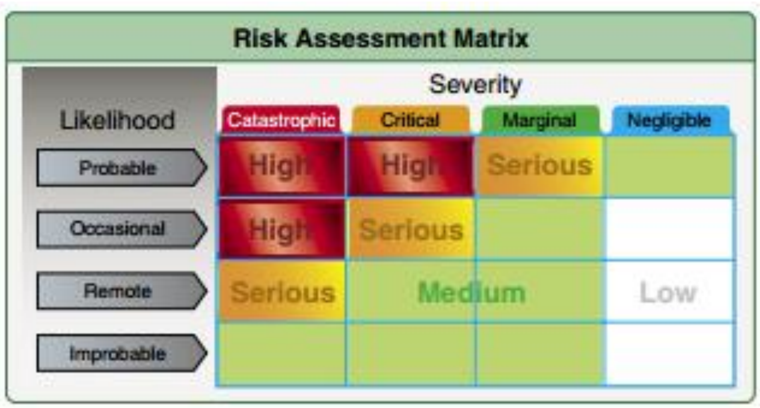
or loss of equipment or property

ii. Step 2: Assess the Risk
   a. Determine the level of risk associated with the identified hazards
      - Assess in terms of its likelihood (probability) and its severity (consequences)
   b. Develop a method to tangibly measure risk (Risk Assessment Matrix, below)

iii. Step 3: Mitigate the Risk
   a. Look into ways to reduce, mitigate, or eliminate the risk
   b. All risks have 2 components: Probability of occurrence & Severity of the hazard
      - Try to reduce or eliminate at least one component
   c. Use the Cost/Benefit analysis to decide if it is worth accepting the risk

C. Level of Risk
   i. The level of risk posed by a given hazard is measured in terms of:
      a. Severity (extent of possible loss)
      b. Probability (likelihood that a hazard will cause a loss)

D. Assessing Risk
   i. Pilots must differentiate *in advance* between a low risk flight and a high-risk flight
   ii. Establish a review process and develop strategies to minimize risk on the high and low risk flights
   iii. The Risk Matrix is a helpful risk assessment model
      a. Assesses the likelihood of an event occurring and the consequences of that event
         - Likelihood (probability of occurrence): Probable, Occasional, Remote, Improbable
            a i.e., Likelihood of a pilot flying MVFR to encounter IFR conditions
         - Severity: Catastrophic, Critical, Marginal, Negligible
            a i.e., How severe the consequences could be if the pilot is not IFR rated
      b. High Probability/Severity is bad and vice versa:



E. Mitigating Risk
   i. After determining the level of risk, the pilot needs to reduce the risk
      a. Analyze options that can reduce unnecessary risk
         - i.e., Cancel/delay flight, bring CFI or more experienced pilot, etc.
   ii. By effectively mitigating known risks to acceptable levels, pilots can complete their flights safely or ensure alternate options are selected for the occasions when the flight cannot be accomplished

F. PAVE Checklist
   i. Another way to mitigate risk
   ii. The risks of flight are divided into 4 categories
      a. Once the risks have been identified, decide whether the risk or combination or risks can be managed safely and successfully. If not, the flight should be cancelled
   iii. **P**ilot in Command: Am I ready? (IMSAFE Checklist, proficiency, recency, currency, etc.)

- iv. **A**ircraft: Is the aircraft appropriate for the trip?
  - a. Maintenance, Landing Distance, Performance Capabilities, Equipment, Fuel load, Altitude, etc.
- v. En**V**ironment: Weather, Terrain, Airports, Airspace, Day/Night, etc.
- vi. **E**xternal Pressures: Influences outside of the flight that create pressure to complete the flight, often at the expense of safety
  - a. This is the most important key to risk management because it is the one risk factor category that can cause a pilot to ignore all the other risk factors
  - b. Follow your own personal operating procedures (don't bend the rules for anyone), plan for delays, and manage passenger's expectations to reduce external pressure

3. Single Pilot Resource Management / Crew Resource Management (Use all Resources)

- A. What is it?
  - i. How to gather information, analyze it, and make decisions
  - ii. Application of team management concepts in the flight deck environment
    - a. Includes all groups routinely working with the flight crew who are involved in decisions required to operate a flight safely
      - Pilots, dispatchers, cabin crew, maintenance, ATC
  - iii. Pilots of small and large aircraft must make effective us of all available resources
- B. Use of Resources
  - i. Use all available resources,
    - a. Think outside the box
  - ii. Internal Resources
    - a. Found in the flight deck during flight
      - Equipment, systems, charts, books, etc.
      - Ingenuity, knowledge, and skill
      - Other passengers (even if they are not pilots)
  - iii. External Resources
    - a. ATC and flight service specialists
      - Traffic advisories, vectors, weather info, emergency assistance
  - iv. Workload Management
    - a. Plan, prioritize, and sequence to prevent overload
    - b. Prepare for high workload situations
      - Don't wait until you're in the situation
      - i.e., prepare for the approach before it begins
    - 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
- C. 5 P's Check
  - i. Used to evaluate the pilot's current situation at key decision points during the flight, or when an emergency arises
    - a. This is a very helpful portion of Single Pilot Resource Management (SRM)
    - b. Based on the idea that the pilot has five variables that impact the environment and can cause the pilot to make a single critical decision, or several less critical decisions, that when added together can create a critical outcome
    - c. The process is simple; at least 5 times before/during the flight, review and consider the 5 P's and make the appropriate decision required by the current situation
      - The decision points include 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

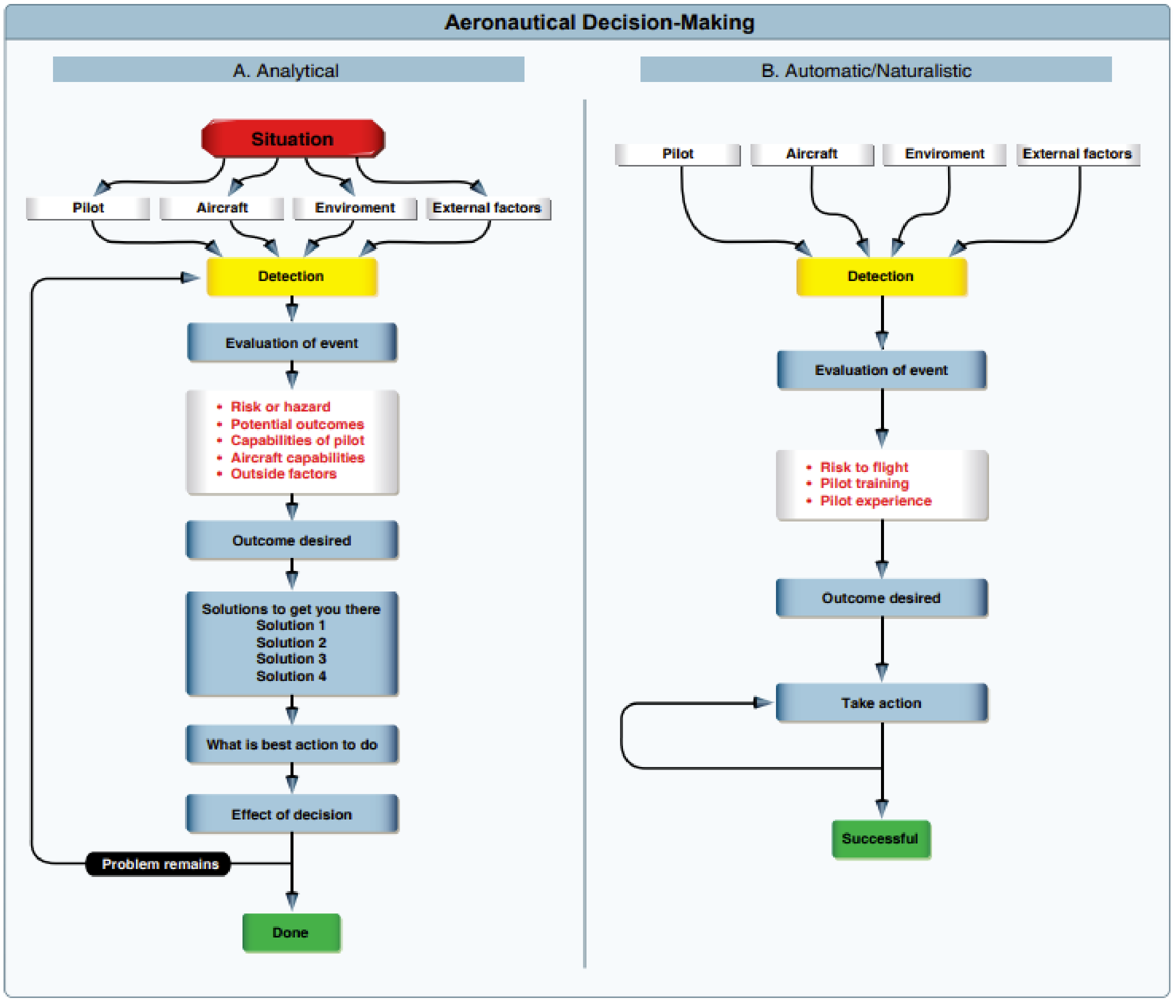
ii. The 5 P's:
  a. The Plan
    - The mission. It contains planning, weather, route, fuel, publication currency, etc.
    - The plan is always changing (weather changes, delays, restrictions, etc.), adjust with it
  b. The Plane
    - Condition, abilities (performance, but also automation, database currency, etc.), equipment, systems, etc.
  c. The Pilot
    - IMSAFE
    - Allows the pilot to recognize and review his/her physiological situation
  d. The Passengers
    - Passenger's desires can have an influence on decision making and risk management
      a Plan as much as possible
    - Ensure passengers are involved in decision making process
      a Ensure they understand risk involved in situations
        1. i.e., IFR approach below minimums or takeoff with IFR below landing minimums
    - Understand what passengers want to do
      a They may be more risk averse than you
  e. The Programming
    - Plan when and where programming approaches/route changes, and airport information gathering should be accomplished, as well as when it should not be accomplished
    - Pilot familiarity with the equipment, the route, the local air traffic control environment, and personal capabilities should drive when, where, how the automation is programmed and used
    - Always consider pilot capabilities in relation to programming

4. Decision Making Process

A. DECIDE Model (pictured below)
  i. Detect, Estimate, Choose, Identify, Do, Evaluate

B. Analytical Models
  i. Examples include DECIDE model and 5 Ps
  ii. Good decisions result when pilots gather all information, review it, analyze the options, rate the options, select a course of action, and evaluate the course of action for correctness
    a. This level of analysis is not always possible

C. Automatic or Naturalized Decision Making
  i. Reflexive type of decision making anchored in training and experience
  ii. In an emergency, a pilot may not survive if they apply analytical models to every decision
  iii. Automatic or Naturalized Process
    a. Experts faced with a task loaded with uncertainty first assess if the situation looks familiar
    b. Rather than comparing pros and cons of different approaches (analytical model), they imagine how one or a few courses of action will play out and take the first workable option they find
    c. May not be the best of all possible choices, but it often works remarkably well
  iv. Experienced based actions trigger response to specific situations
  v. Improves with training and experience



The DECIDE model

1. **Detect.** The decision maker detects the fact that change has occurred.
2. **Estimate.** The decision maker estimates the need to counter or react to the change.
3. **Choose.** The decision maker chooses a desirable outcome (in terms of success) for the flight.
4. **Identify.** The decision maker identifies actions which could successfully control the change.
5. **Do.** The decision maker takes the necessary action.
6. **Evaluate.** The decision maker evaluates the effect(s) of his/her action countering the change.

Figure 2-14. *The DECIDE model has been recognized worldwide. Its application is illustrated in column A while automatic/naturalistic decision-making is shown in column B.*

vi. Operational Pitfalls

a. Pitfalls/behavioral traps also come with experience

- As a rule, more experienced pilots try to complete flights as planned, please passengers, meet schedules
- Can have an adverse effect on safety and contribute to unrealistic assessment of skills
- Tendencies must be eliminated

Operational Pitfalls
Peer pressure Poor decision-making may be based upon an emotional response to peers, rather than evaluating a situation objectively.
Mindset A pilot displays mind set through an inability to recognize and cope with changes in a given situation.
Get-there-itis This disposition impairs pilot judgment through a fixation on the original goal or destination, combined with a disregard for any alternative course of action.
Duck-under syndrome A pilot may be tempted to make it into an airport by descending below minimums during an approach. There may be a belief that there is a built-in margin of error in every approach procedure, or a pilot may want to admit that the landing cannot be completed and a missed approach must be initiated.
Scud running This occurs when a pilot tries to maintain visual contact with the terrain at low altitudes while instrument conditions exist.
Continuing visual flight rules (VFR) into instrument conditions Spatial disorientation or collision with ground/obstacles may occur when a pilot continues VFR into instrument conditions. This can be even more dangerous if the pilot is not instrument rated or current.
Getting behind the aircraft This pitfall can be caused by allowing events or the situation to control pilot actions. A constant state of surprise at what happens next may be exhibited when the pilot is getting behind the aircraft.
Loss of positional or situational awareness In extreme cases, when a pilot gets behind the aircraft, a loss of positional or situational awareness may result. The pilot may not know the aircraft's geographical location or may be unable to recognize deteriorating circumstances.
Operating without adequate fuel reserves Ignoring minimum fuel reserve requirements is generally the result of overconfidence, lack of flight planning, or disregarding applicable regulations.
Descent below the minimum en route altitude The duck-under syndrome, as mentioned above, can also occur during the en route portion of an IFR flight.
Flying outside the envelope The assumed high performance capability of a particular aircraft may cause a mistaken belief that it can meet the demands imposed by a pilot's overestimated flying skills.
Neglect of flight planning, preflight inspections, and checklists A pilot may rely on short- and long-term memory, regular flying skills, and familiar routes instead of established procedures and published checklists. This can be particularly true of experienced pilots.

5. **Evaluation**
   A. Review and debrief each flight
      i. What went well?
      ii. What could have gone better?
      iii. What will I (or we) do next time?
   B. Areas to Consider in the Evaluation
      i. Planning & Decision Making
      ii. Leadership Effectiveness
      iii. Situational Awareness
      iv. Communication
      v. Monitor/Cross-Check
      vi. Workload Management
      vii. Automation Management

Conclusion:
Brief review of the main points