CFII LESSONS

WORD DOCUMENT INSTRUCTIONS

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DATE	LESSON	UPDATE
June 2018	Various Lessons	June 2018 ACS Revision - ACS Skills Reqs Updates
Sep 2018	II.D. Logbook Entries	Simulator Recency Requirements
Oct 2018	I.D & I.G.	Added notes on Scenario Based Training

CONTENTS

FUNDAMENTALS OF INSTRUCTING

I.A. The Learning Process

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

Objectives	The student should develop knowledge of the elements related to the learning process as required in the PTS.
Elements	1. The Learning Theory 2. Characteristics of Learning 3. Principles of Learning 4. Levels of Learning 5. Learning Physical Skills 6. Memory 7. 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 student understands the learning process and can integrate the knowledge when instructing students.

Instructors 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 students is imperative. Understanding how people learn and how to apply that knowledge is the basis for effective teaching.

How:

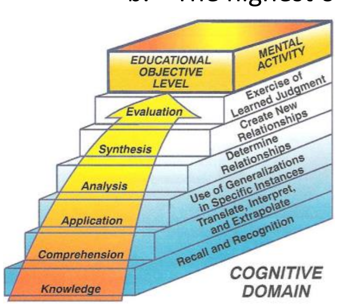
1. **The Learning Theory**
   - A. Definition – A body of principles used to explain how people acquire skills, knowledge, and attitudes
   - B. Learning is explained by a combination of 2 basic approaches: Behaviorism and the Cognitive Theory
   - C. Behaviorism (Positive Reinforcement, rather than no reinforcement or punishment)
     - i. Stresses the importance of having a particular form of behavior reinforced by someone, other than the student, to shape or control what is learned
       - a. The instructor provides the reinforcement
     - ii. Frequent positive reinforcement and rewards accelerate learning
     - iii. The theory provides the instructor ways to manipulate students with stimuli, induce the desired behavior or response, and reinforce the behavior with appropriate rewards
   - D. Cognitive Theory (Focuses on what is going on inside the student's mind)
     - i. Learning isn't just a change in behavior; it is a change in the way a student thinks/understands/feels
     - ii. Two Major Branches of the Cognitive Theory
       - a. The Information Processing Model
         - The student's brain has internal structures which select and process incoming material, store/retrieve it, use it to produce behavior, and receive/process feedback on the results
       - b. The Social Interaction Theory
         - Stress that learning and subsequent changes in behavior take place as a result of interaction between the student and the environment
         - The social environment to which the student is exposed demonstrates or models behaviors, and the student cognitively processes the observed behaviors and consequences
         - Techniques for learning include direct modeling and verbal instruction
         - Behavior, personal factors, and environmental events all work together to produce learning
     - iii. Both models have common principles
       - a. They both acknowledge the importance of reinforcing behavior and measuring changes
       - b. Some means of measuring student knowledge, performance, and behavior is necessary
   - E. Behavioral + Cognitive
     - i. Plan, manage, and conduct aviation training with the best features of each theory
     - ii. Provides a way to measure the behavioral outcomes and promote cognitive learning

2. **Characteristics of Learning** (PRMA)
    A. To be effective, the learning situation should be purposeful, a result of experience, multifaceted, and involve an active process
    B. **P**urposeful
        i. In the process of learning, the student's goals are of paramount significance
            a. Each student has specific intentions and goals
            b. Students learn from any activity that tends to further their goals
            c. Individual needs and attitudes may determine what they learn as much as what the instructor is trying to get them to learn
        ii. To be effective, instructors need to find ways to relate new learning to the student's goals
    C. **R**esult of Experience (Learn by Doing)
        i. Learning is an individual process and the student can learn only from personal experiences
            a. Previous experiences conditions a person to respond to some things and to ignore others
            b. Instructors are faced with the problem of providing learning experiences that are meaningful, varied, and appropriate
        ii. If an experience challenges the student, requires involvement with feelings, thoughts, memory of past experiences, or physical activity, it is more effective
        iii. If students are to use sound judgment and develop decision making skills, they need learning experiences that involve knowledge of general principles and require the use of judgment in solving realistic problems
    D. **M**ultifaceted
        i. The learning process may include verbal elements, conceptual elements, perceptual elements, emotional elements, and problem-solving elements all taking place at once
        ii. While learning the subject at hand, students may be learning other things as well
            a. They may be developing attitudes about aviation, they may learn self-reliance, etc.
    E. **A**ctive Process (Constantly Engage the Student)
        i. If learning is a process of changing behavior, that process must be an active one
            a. For students to learn, they need to react and respond, perhaps outwardly, perhaps only inwardly, emotionally, or intellectually
3. **Principles of Learning** (REEPIR)
    A. Principles of learning provide additional insight into what makes people learn most effectively
    B. **R**eadiness
        i. Individuals learn best when they're ready to learn and don't learn well if there's no reason to learn
        ii. if students have a strong purpose, clear objective, and a definite reason for learning, they make more progress than if they lack motivation
        iii. Under certain circumstances, the instructor can do little, if anything, to inspire a readiness to learn
            a. If outside responsibilities, interests, worries, etc. weigh heavily, they may have little interest
    C. **E**xercise
        i. Things most often repeated are best remembered
        ii. Students learn by applying what they have been told and shown
            a. Every time practice occurs, learning continues
        iii. The instructor must provide opportunities for students to practice, and at the same time make sure that this process is directed toward a goal

- D. **E**ffect
  - i. Learning is strengthened when accompanied by a pleasant or satisfying feeling, and that learning is weakened when associated with an unpleasant feeling
  - ii. Whatever the learning situation, it should contain elements that affect the student positively and give them a feeling of satisfaction
- E. **P**rimacy
  - i. The state of being first, often creates a strong, almost unshakable impression
    - a. For the instructor, this means that what is taught must be right the first time
  - ii. Every student should be started right; Un-teaching is much more difficult than teaching
  - iii. The first experience should be positive, functional, and lay the foundation for all that is to follow
- F. **I**ntensity
  - i. A vivid, dramatic, or exciting learning experience teaches more than a routine or boring experience
    - a. A student will learn more from the real thing than from a substitute
  - ii. The instructor should use their imagination in approaching reality as closely as possible
    - a. Instruction can benefit from a wide variety of instructional aides to improve realism, motivate learning and challenge students
- G. **R**ecency
  - i. Things most recently learned are best remembered
    - a. The further removed time-wise from a new fact/understanding, the more difficult to remember
  - ii. Repeat, restate, or reemphasize, important points at the end of a lesson to help in remembering

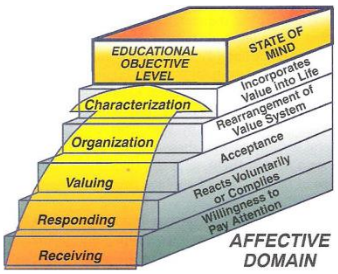
4. Levels of Learning

- A. Four Basic Levels
  - i. Rote Learning – The ability to repeat something which one has been taught, without understanding or being able to apply what has been learned
  - ii. Understanding – Comprehension of what has been taught
    - a. The student consolidates old and new perceptions into an insight on a subject/maneuver
  - iii. Application – The skill for applying what has been learned
    - a. Understands, has had demonstrations, and has practiced until consistent
    - b. Don't stop here!
  - iv. Correlation – Correlation of what has been learned with things previously learned/subsequently encountered
    - a. The objective in aviation instruction
    - b. EX: Can correlate the elements of turn entries with performing lazy eights and chandelles
- B. Domains of Learning (What is to be learned: Knowledge, Change in Attitude, Physical Skill, or combo)
  - i. Besides the 4 basic levels of learning, several additional levels have been developed:
  - ii. **C**ognitive Domain (Knowledge); often referred to as Bloom's Taxonomy of Educational Objectives
    - a. Educational objectives refer to knowledge which might be gained as the result of attending a ground school, reading about aircraft systems, listening to a preflight briefing, etc.
    - b. The highest objective level may be shown by learning to properly evaluate a maneuver



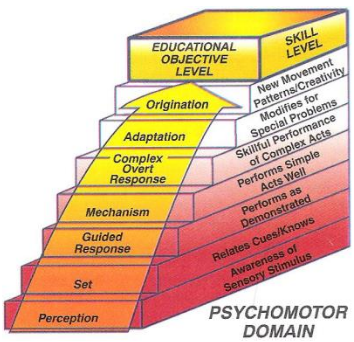
Objective Level	Action Verbs
Evaluation	Assess, evaluate, interpret, judge, rate, score, write
Synthesis	Compile, compose, design, reconstruct, formulate
Analysis	Compare, discriminate, distinguish, separate
Application	Compute, demonstrate, employ, operate, solve
Comprehension	Convert, explain, locate, report, restate, select
Knowledge	Describe, identify, name, point to, recognize, recall

iii. **A**ffective Domain (Attitudes, Beliefs, and Values)
   a. This hierarchy attempts to arrange attitudinal objectives in an order of difficulty
      - Measuring educational objectives in this domain is not easy (concerned with attitudes, etc.)
   b. Most techniques for evaluation of achievement rely on indirect inferences
      - EX: Evaluating a positive attitude toward safety



Objective Level	Action Verbs
Characterization	Assess, delegate, practice, influence, revise, maintain
Organization	Accept responsibility, adhere, defend, formulate
Valuing	Appreciate, follow, join, justify, show, concern, share
Responding	Conform, greet, help, perform, recite, write
Receiving	Ask, choose, give, locate, select, rely, use

iv. **P**sychomotor Domain (Physical Skills)
   a. Typical activities include learning to fly a precision approach, programming a GPS receiver
   b. As physical tasks and equipment become more complex, the requirement for integration of cognitive and physical skills increases



Objective Level	Action Verbs
Origination	Combine, compose, construct, design, originate
Adaptation	Adapt, alter, change, rearrange, reorganize, revise
Complex Overt Response	Same as below except more highly coordinated
Mechanism	Same as below except with greater proficiency
Guided Response	Assemble, build, calibrate, fix, grind, mend
Set	Begin, move, react, respond, start, select
Perception	Choose, detect, identify, isolate, compare

v. All 3 domains of learning are pertinent
   a. A high level of knowledge and skill is required as well as a well-developed, positive attitude

5. Learning Physical Skills

A. The process of learning a psychomotor skill is much the same as cognitive learning

B. Physical Skills Involve more than Muscles

i. Desire to Learn
   a. Students learn much more readily when they learn skills that appeal to their needs (Readiness)
   b. When the desire to learn is missing, it is unlikely that any improvement will occur
   c. To improve, one must not only recognize mistakes, but also make an effort to correct them
   d. Objectives should be related to student's intentions/needs, building on his natural enthusiasm

ii. Patterns to Follow
   a. The best way to prepare a student to perform a task is to provide a clear, step-by-step example
   b. Students need to have a clear impression of what they are to do

iii. Perform the Skill
   a. Practice is necessary
      - The student needs coordination between muscles and visual and tactile senses
   b. As the student gains proficiency, verbal instructions mean more
      - A long-detailed explanation is confusing before the student begins performing
         a Specific comments are more meaningful/useful after the skill has been partially learned

iv. Knowledge of Results
   a. The instructor provides a helpful/critical function ensuring students are aware of their progress

- It is as important for students to know when they are right as when they are wrong

v. Progress Follows a Pattern
   a. Skill learning usually follows the same pattern
      - There is rapid improvement early, then the curve levels off and may stay level for a while
         a This is a typical learning plateau
         b Apparent lack of increasing proficiency does not necessarily mean learning has ceased
      - In learning motor skills, a plateau is normal and should be expected after a fast initial period
         a If the student is aware of this learning plateau, frustration may be minimized

vi. Duration and Organization of a Lesson
   a. Beginning students reach a point where additional practice is unproductive, and may be harmful
      - When this point is reached, errors increase and motivation declines
      - As the student gains experience, longer periods of practice are profitable
   b. Keep maneuver repetitions to 2 or 3 (landings can be practiced more)
   c. The practice period may be divided or be one continuous integrated sequence depending on the nature of the skill being learned

vii. Evaluation vs. Critique
   a. Beginning students profit when their performance is critiqued constructively to eliminate errors
      - Practical suggestions are more valuable to the students than a grade
   b. The observations can identify strengths/weaknesses, a prerequisite for constructive criticism

viii. Application of Skill
   a. For the student to be able to use the skill that has been learned, two conditions must be present
      - The student must learn the skill so well that it becomes easy, even habitual
      - The student must recognize the types of situations where it is appropriate to use the skill

6. Memory

A. General
   i. Memory includes 3 parts: Sensory, Short Term, and Long Term
   ii. The total system operates like a computer
      a. Accepts input, a processing apparatus is contained, storage capability, and an output function

B. Sensory Register (Quick Scan, Precoding)
   i. Receives input and quickly processes it according to a preconceived concept of what is important
      a. Other factors can influence reception of info
         - If it is dramatic or impacts more than one of the senses it is more likely to make an impression
      b. It immediately recognizes certain stimuli and sends them to the working memory for action
         - This is called precoding (EX: Fire Alarm – working memory is immediately made aware of the alarm and preset responses begin to take place)

C. Working or Short-Term Memory (Coding, Rehearsal, Recoding)
   i. Within seconds relevant info is passed here where it may temp remain or rapidly fade, depending on individual priorities
   ii. Rehearsal or repetition of the information and sorting or categorization into chucks help retention
      a. Sorting process is called Coding (Usually takes 5 - 10 seconds; if interrupted, the information is lost after 20 seconds)
   iii. Time limited and Capacity limited (time limitation can be overcome by repetition)
   iv. The coding process may involve recoding to adjust info to individual experiences
      a. This is when actual learning begins to take place
      b. Recoding: the process of relating incoming information to concepts or knowledge already in memory

v. Developing a logical strategy for coding information is a significant step in the learning process

D. Long-Term Memory (Process, Store, Recall)
   i. Where information is stored for future use
      a. For it to be useful, some special effort must have been expended during the coding process
         - The more effective the coding process, the easier the recall
   ii. One of the major responsibilities of the instructor is to help students use their memories effectively

E. Theories of Forgetting
   i. **R**epression
      a. The submersion of ideas into the subconscious mind
      b. Material that is unpleasant or produces anxiety may be treated this way, but not intentionally
         - It is subconscious and protective
   ii. **I**nterference
      a. We forget things because an experience has overshadowed it, or the learning of similar things has intervened
      b. Two conclusions from interference:
         - Similar material seems to interfere with memory more than dissimilar material
         - Material not well learned suffers most from interference
   iii. **D**isuse
      a. A person forgets those things which are not used
      b. But, the memory is actually there locked in the recesses of the mind
         - The difficulty is summoning it up to consciousness

F. Retention of Learning
   i. The instructor needs to make certain that the student's learning is readily available for recall
      a. Teach thoroughly and with meaning
   ii. Praise Stimulates Remembering
   iii. Recall is Promoted by Association
      a. Each bit of information/action which is associated with something to be learned tends to be recalled
   iv. Favorable Attitudes Aid Retention
      a. Without motivation there isn't learning; the most effective motivation is rewarding objectives
   v. Learning with all our senses is most effective
   vi. Meaningful Repetition Aids Recall (mere repetition does not guarantee retention - Rote)

7. Transfer of Learning

A. Primary Objective is to promote Positive Transfer
   i. Positive Transfer - If the learning of skill A helps to learn skill B (e.g. slow flight and short field landings)
   ii. Negative Transfer - If the learning of skill A hinders learning of skill B (landing an airplane vs a helicopter)
   iii. A degree of transfer is involved in all learning since all learning is based on prior learned experience
      a. People interpret new things in terms of what they already know
   iv. Achieving Positive Transfer
      a. Plan for transfer as a primary objective
      b. Make certain the student understands that what is learned can be applied in other situations
      c. Maintain high-order learning standards
      d. Provide meaningful learning experiences that build confidence in the ability to transfer learning
      e. Use material that helps form valid concepts and generalizations (make relationships clear)

B. Habit Formation
   i. It's the instructor's task to insist on correct techniques/procedures to provide proper habit patterns

ii. Training traditionally has followed a building block concept

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant exhibits instructional knowledge of the elements of the learning process by describing:
1. Learning theories.
2. Characteristics of learning.
3. Principles of learning.
4. Levels of learning.
5. Learning physical skills.
6. Memory.
7. Transfer of learning.

I.B. Human Behavior and Effective Communication

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

Objectives	The student should develop knowledge of the elements related to human behavior and effective communication as required in the PTS.
Elements	1. Human Behavior 2. Effective Communication
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student will understand the 3 basic elements of the communicative process, recognize the various barriers to communication, and develop communication skills in order to convey the desired information to students.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

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

Overview

Review Objectives and Elements/Key ideas

What

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

Why

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

How:

1. **Human Behavior**
   A. Control of Human Behavior
      i. Students tend to submit to authority as a valid means of control
         a. The instructor's challenge is to know what controls are best for existing circumstances
         b. Create an atmosphere that enables/encourages students to help themselves toward their goals
      ii. It is the instructor's responsibility to discover how to realize the potential in each student
         a. See the motivation and human nature generalizations (pg. 2-1)
      iii. How to mold a solid, healthy, productive relationship depends on the instructor's knowledge of students as human beings and of the needs, drives, and desires they continually try to satisfy
   B. Human Needs
      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
               a Thus, the person strives to satisfy the needs of the next higher level

      ii. Physical
         a. Food, rest, and protection from the elements
      iii. Safety
         a. Protection against danger, threats, deprivation affect student behavior
      iv. Social
         a. Belong, to associate, and to give and receive friendship and love
            - Students are usually out of their normal surroundings so this need will be more pronounced
         b. Ensure new students feel at ease and their decision to pursue aviation is reinforced
      v. Ego
         a. Needs consist of two types:
            - Relating to self-esteem: confidence, independence, achievement, competence, knowledge
            - Relating to reputation: status, recognition, appreciation, and respect of associates
         b. This may be the main reason for the student's interest in aviation
      vi. Self-Fulfillment
         a. Realizing one's own potential for continued development/Reaching personal goals & potential

vii. Help students satisfy their own needs in a manner that will create a healthy learning environment

C. Defense Mechanisms
    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. Compensation
        a. Students attempt to disguise the presence of a weak quality by emphasizing a more positive one
        b. May accept and develop a less preferred but more attainable objective instead of a more preferred but less attainable objective
    iii. Projection
        a. Blame is relegated to others for their own shortcomings, mistakes, and transgressions
        b. Motives, desires, characteristics, and impulses are attributed to others
    iv. Rationalization
        a. If students cannot accept the real reasons for their behavior, they may rationalize
            - This permits them to substitute excuses for reasons, and they are acceptable to themselves
        b. When true rationalization takes place, individuals sincerely believe in their excuses
    v. Denial of Reality
        a. Occasionally, students may ignore or refuse to acknowledge disagreeable realities
    vi. Reaction Formation
        a. Sometimes individuals protect themselves from dangerous desires by not only repressing them, but actually developing conscious attitudes and behavior patterns that are just the opposite
    vii. Flight
        a. Students often escape from frustrating situations by taking flight, physical or mental
            - Physically – Symptoms may be developed, providing an excuse to remove from frustration
            - Mentally – Daydreaming (a simple and satisfying escape from problems)
    viii. Aggression
        a. Aggressiveness may be expressed in subtle ways (emotions are repressed for safety)
            - They may ask irrelevant questions, refuse to participate in/disrupt activities
    ix. Resignation
        a. Students become so frustrated that they lose interest and give up, accepting defeat
        b. Most often when completing an early phase of training without grasping the fundamentals, a student becomes bewildered/lost in the more advanced phases

D. The Flight Instructor as a Practical Psychologist
    i. Anxiety – "A state of mental uneasiness arising from fear…"
        a. Most significant psychological factor affecting flight instruction
        b. Anxiety can be countered by reinforcing enjoyment of flying, and by teaching to cope with fear
            - Treat fears as a normal reaction, do not ignore it
        c. Introduce maneuvers with care so student knows what to expect/what their reaction should be
        d. Anxiety can be minimized by emphasizing the benefits/pleasurable parts of flying
            - Not the unhappy consequences of faulty performances
    ii. Normal Reactions to Stress
        a. Respond rapidly and exactly, within the limits of their experience and training
    iii. Abnormal Reactions to Stress
        a. Response may be completely absent or at least inadequate
        b. Responses may be random or illogical, or they may do more than is called for by the situation
        c. Abnormal Reactions:
            - Inappropriate reaction, such as extreme over-cooperation, painstaking self-control, inappropriate laughter or singing, and very rapid changes in emotion

        - Marked changes in mood on different lessons (excellent morale/deep depression)
        - Severe anger to the instructor, service personnel, and others
    - iv. Flight Instructors Actions Regarding Seriously Abnormal Students
        - a. Refrain from certifying the student and assure he doesn't continue training/become certificated
        - b. This is done by:
            - Arranging for another instructor (not acquainted with student) to conduct an evaluation flight
            - An informal discussion should be initiate with the FSDO
            - A discussion should be held with an AME (preferably the one who issued the medical)

2. Effective Communication

- A. Doesn't occur automatically, a style of communication must be developed that can convey information to students
- B. Basic Elements
    - i. Communication takes place when one person transmits ideas or feelings to another
    - ii. Its effectiveness is measured by the similarity between the idea transmitted and the idea received
        - a. Receiver reacts with understanding and changes their behavior accordingly
    - 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:
            - An ability to select and use language is essential for transmitting meaningful symbols
                - a Effectiveness of communication is dependent on understanding of the words used
            - Reveals attitudes toward themselves, ideas being communicated, and students
                - a Must reveal a positive attitude
            - Material is accurate, up-to-date, and stimulating
                - a Out of date info causes the instructor to lose credibility in the student's eyes
    - v. The Symbols (words or signs, or simple oral and visual codes)
        - a. Determine the symbols best to start/end and those best for explaining, clarifying, emphasizing
            - Then, determine which medium is best suited for transmission (hearing, seeing, touch)
        - b. Monitor the feedback from a student as symbols may need to be modified for clarity
        - c. Students need feedback on how they are doing (Negative feedback in private only)
    - vi. The Receiver (the listener, reader, or student)
        - a. Effective communication: When students react w/understanding and change their behavior accordingly
        - b. To change behavior, the student's abilities, attitudes, and experiences need to be understood
            - Students come with a wide variety of abilities
                - a Those abilities must be determined to properly communicate with them
                    - 1. This is complicated by differences in age, gender, cultural background, education
            - The attitudes students exhibit may indicate resistance, willingness, or passive neutrality
                - a To gain and hold attention, attitudes should be in forms that promote reception of info
                - b A varied communicative approach will succeed best in reaching most students
            - Experience, background, and education level will determine the instructor's approach
                - a Student's knowledge, with their abilities and attitudes will guide the instructor in comm.
- C. Barriers to Effective Communication
    - i. Lack of Common Experience
        - a. Greatest single barrier to effective communication
        - b. A communicator's words cannot communicate the desired meaning to another person unless he has had some experience with the objects or concepts to which these words refer

- It is essential that instructors speak the same language as the students
- If instructor terminology is needed, make certain the student understands the terminology

c. For communication to be effective, the student's understanding of the words must match the instructor's

ii. Confusion Between the Symbol and the Symbolized Object

a. This results when a word is confused with what it is meant to represent

b. Words and symbols do not always represent the same thing to everyone

- Make sure associations are clear

iii. Overuse of Abstractions (Abstractions are words that are general rather than specific)

a. Abstractions do not evoke the intended items of experience in the minds of students

- Avoid abstractions in most cases

iv. Interference

a. Physiological Interference is any biological problem that may inhibit symbol reception

- Hearing loss, injury, physical illness

b. Environmental Interference is caused by external physical conditions (like noise)

c. Psychological Interference is a product of how the student/instructor feel during the communication process

- If either isn't committed, or if fear/mistrust exist communication is impaired

D. Developing Communication Skills

i. Role Playing

a. Practice instructing to develop communication skills, techniques, etc.

ii. Instructional Communication

a. Know the topic well

b. Do not be afraid to use examples of past experience to illustrate particular points

c. Determine the level of understanding by use of some sort of evaluation

iii. Listening

a. One way to become better acquainted with students is to be a good listener (Figure 3-4)

b. Students also need to want to listen

- Teaching students how to listen will improve information transfer

c. The pilot must be ready to listen and be responsible for listening

d. Listen to understand, rather than refute

- If certain areas arouse emotion, be aware of this and take extra measures to listen

e. Listen for the main ideas

f. Don't daydream

g. Take notes (no one can remember everything)

iv. Questioning

a. Good questioning can determine how well a student understands

b. Ask open ended and focused questions

- Open ended all the student to explain more fully
- Focused all the instructor to concentrate on desired areas

c. Paraphrasing and perception checking can confirm understanding is in the same way

- Perception checking gets into feelings by stating the instructor's perceptions of student behavior and the student can clarify them as necessary

v. Instructional Enhancement

a. The deeper the knowledge about an area, the better the instructor is at conveying it

Conclusion:

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

PTS Requirements:

To determine that the applicant exhibits instructional knowledge of the elements of human behavior and effective communication as it applies to the teaching/learning process by describing:

1. Human behavior
   a. control of human behavior.
   b. human needs.
   c. defense mechanisms.
   d. the flight instructor as a practical psychologist.
2. Effective communication
   a. basic elements of communication.
   b. barriers of effective communication.
   c. developing communication skills.

I.C. The Teaching Process

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

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

Instructors Notes:

Introduction:

Attention

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

Overview

Review Objectives and Elements/Key ideas

What

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

Why

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

How:

1. **General**
   - A. The teaching process is broken down into steps: Preparation, Presentation, Application, Review/Evaluation
2. **Preparation**
   - A. A lesson must be planned – Objectives, procedures and facilities, goals to be attained, review/evaluation
   - B. **Performance Based Objectives**
     - i. Set measurable, reasonable standards that describe the desired performance before moving on
       - a. Objectives must be clear, measurable, and repeatable
     - ii. Begin writing a lesson with performance based objectives (PTS or syllabus objectives can be used)
     - iii. 3 Parts: Description of the Skill/Behavior, Conditions, Criteria
     - iv. Description of the Skill or Behavior
       - a. Explains the desired outcome of the instruction
         - Should be in concrete terms that can be measured
     - v. Conditions
       - a. Specifically explain the rules under which the skill or behavior is demonstrated
         - Info such as equipment, tools, reference material, and limiting parameters are included
     - vi. Criteria
       - a. A list of standards which measure the accomplishment of the objective
         - Criteria should be stated so that there is no question whether the objective has been met
3. **Presentation**
   - A. Several Methods of Presentation
     - i. Lecture Method
       - a. Suitable for presenting new material, for summarizing ideas, and for showing relationships
       - b. Most effective when combined with instructional aids and training devices
     - ii. Demonstration-Performance Method
       - a. Desirable for teaching a skill
       - b. Many lessons can combine the lecture and demonstration-performance methods
         - The initial info is given in a classroom with a lecture
         - Then the info is applied in the airplane
     - iii. Guided Discussion Method

        a. Encourages active participation of the students
        b. Helpful in areas where students can use initiative and imagination in addressing problems

4. **Application** (Where the student uses what the instructor has presented)
    A. The student may be asked to explain the material, or perform a procedure
        i. The instructor will have to watch for mistakes and provide further demonstrations if necessary
            a. It is very important each student learns the right way the first few times (Primacy)
    B. Periodic review and evaluation is necessary to ensure bad habits have not been acquired
5. **Review and Evaluation**
    A. Review what has been covered and require the student to demonstrate if the objectives have been met
    B. Students should be made aware of the progress and ensure standards are met before moving on
    C. The feedback must adequately compare the performance to the completion standards of the lesson
        i. This way the student knows how he is doing
            a. Students may be discouraged when the instructor is doing well and they aren't
    D. If deficiencies not associated with the present lesson are noted, they should be pointed out and fixed
    E. The instructor and the student have a valid picture of where the student is in respect to the standards

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant exhibits instructional knowledge of the teaching process by describing:
1. Preparation of a lesson for a ground or flight instructional period.
2. Presentation methods.
3. Application, by the student, of the material or procedure that was presented.
4. Review and evaluation of student performance.
5. Problem-based learning.

I.D. Teaching Methods

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

Objectives	The student should develop knowledge of the elements related to the different teaching methods as described in the CFI PTS.
Elements	1. Material Organization 2. The Lecture Method 3. The Group Learning Method 4. The Guided Discussion Method 5. The Demonstration-Performance Method 6. Computer Based Training Method 7. Scenario Based Training Method
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can organize material and select and properly utilize a teaching method appropriate to the particular lesson.

Instructors Notes:

Introduction:

Attention

Do you ever wonder how or why an instructor decided to teach you material in a certain way?

Overview

Review Objectives and Elements/Key ideas

What

Teaching methods are specific recommendations for the actual conduct of the teaching process.

Why

These methods and procedures have been tested and found to be effective. Implementation of these methods will complement student learning.

How:

1. **Material Organization**
   A. Introduction (Sets the stage for everything to come)
      i. Attention (Focuses the student's attention on the lesson)
         a. Begin by telling a story, an unexpected, surprising statement, ask a question, tell a joke
            - Regardless of what is used, it should relate to the subject and establish a background
      ii. Motivation (Offers specific reasons why the lesson content is important)
         a. Talk about a situation where the knowledge/skill was applied
         b. It should engender a desire to learn the material
      iii. Overview (Tells what will be covered during the lesson)
         a. A clear/concise presentation of the objective/key ideas gives a road map of what will be covered
   B. Development (The main part of the lesson)
      i. Develop the subject matter in a manner that helps achieve the desired learning outcomes
         a. The info must be logically organized to show relationships between main points
      ii. Relationships are shown by developing main points in one of the following ways:
         a. Past to Present
            - Subject matter is arranged chronologically, from past to present or present to past
            - This is most suitable when history is an important consideration (radio nav development)
         b. Simple to Complex
            - The student is lead from simple facts/ideas to an understanding of involved concepts
         c. Known to Unknown
            - By using something the known as the point of departure, new concepts/ideas are reached
         d. Most Frequently Used to Least Frequently Used
            - Start with common usage before proceeding to the rarer ones
   C. Conclusion (Retraces the important elements of the lesson and relates them to the objective)
      i. A review and wrap up of ideas reinforces student learning and improves retention
2. **The Lecture Method**
   A. General
      i. Used for introduction of new subjects, summarizing ideas, showing relationships between theory and practice, and reemphasizing main points
      ii. Several different types of lectures:

a. Illustrated Talk – The speaker relies heavily on visual aids to convey ideas
b. Briefing – a concise array of facts is presented without elaboration of supporting material
c. Formal Lecture – Inform, persuade, or entertain with little or no student participation
d. Teaching Lecture – Oral presentation in a manner that allows some student participation

B. Teaching Lecture
  i. Preparing
    a. Establishing the Objective and Desired Outcomes (what should the student be able to do)
    b. Research the Subject
    c. Organizing Material (How will the information be discussed, there should be a logical order)
    d. Planning Productive Classroom Activities (Quiz, projects, games, etc.)
  ii. Suitable Language
    a. Simple rather than complex words should be used whenever possible
    b. Specific rather than general words should be used
    c. Vary the tone of voice and pace of speaking
      - Vary sentence length (short and medium length sentences)
  iii. Types of Delivery
    a. Reading from a manuscript
    b. Reciting memorized material without a manuscript
    c. Speaking extemporaneously from an outline
      - The best delivery: it is more personalized, more flexible, and holds student attention better
    d. Speaking impromptu without preparation
  iv. Use of Notes (Jog the memory, dispel the fear of forgetting, and are essential for complicated info)
    a. Should be used sparingly and unobtrusively

C. Formal versus Informal Lectures
  i. Informal – Involves active student participation and is therefore encouraged
  ii. Formal – Still preferred in some situations, such as introducing new subject matter

D. Advantages and Disadvantages of the Lecture
  i. Advantages
    a. Easy to instruct large groups
    b. Present info that can be difficult for a student to get in other ways
    c. Can usefully and successfully supplement other teaching devices and methods
    d. Many ideas can be presented in a short time (The most economical teaching method)
    e. Suitable for introducing a new subject and explaining necessary background info
  ii. Disadvantages
    a. Too often inhibits student participation and students allow the instructor to do all the work
    b. Learning is an active process and lectures tend to foster passiveness and teach dependence
    c. Doesn't bring about maximum attainment of certain types of learning (motor skills for example)
    d. Student understanding cannot be easily estimated
    e. It's difficult to hold student attention through an entire lecture (retention drop after 10/15 min)

3. Cooperative or Group Learning Method

A. General
  i. Students are organized into groups to work together, maximizing their own/each other's learning
  ii. Students tend to have higher test scores, self-esteem, social skills, and comprehension of the subject
  iii. Most significant characteristic: Continually requires active participation of the student

B. Conditions and Controls (For success, certain conditions must be met/certain controls must be in place)
  i. The instructor must describe clear and specific learning objectives

- ii. Heterogeneous Groups
  - a. Small groups of 3-6 that are mixed heterogeneously, considering academic abilities, ethnic backgrounds, race and gender
  - b. The main advantages are interaction at higher levels/in ways rarely found otherwise
    - Tolerance of diverse viewpoints, consider thoughts/feelings of others, seek more support and clarification of various opinions
- iii. Clear, Complete Directions and Instructions
  - a. Clear, precise terms of what to do, in what order, with what should be generated
- iv. All Students in the Group must buy into the Targeted Objectives
  - a. Students must perceive these objectives as their own
  - b. They must understand and believe that everyone needs to master the essential info
- v. Positive Interdependence
  - a. Learning tasks should be structured so that students sink or swim together
    - Tasks are structured so that students must depend on one another for success
- vi. Opportunity for Success
  - a. Every student must believe he has an equal chance of learning the content/abilities
    - The student must not feel penalized for being placed in a particular group
- vii. Access to Must Learn Information
  - a. Students need access to and be able to comprehend the specific info they must learn
- viii. Sufficient Time for Learning
  - a. If students do not spend sufficient time learning, the benefits will be limited
- ix. Positive Social Interaction Behaviors and Attitudes
  - a. Students should be positioned face to face for direct eye contact and face to face conversations
  - b. Instructors need to describe the expected social interaction behaviors and attitudes of students
    - Particular students should be given specific roles
- x. Individual Accountability
  - a. Main reason groups are used is so to individually achieve greater success than if studying alone
  - b. Each student must be held accountable for doing their own share of the work and learning
- xi. Recognition and Rewards for Group Success
  - a. Only groups that meet the established levels for achievement receive the rewards or recognition
    - The specific awards must be something valued by the student
- xii. Debrief on Group Efforts
  - a. Students should spend time to reflect on how they worked together as a team and what they can do to be more successful

4. Guided Discussion Method

- A. General
  - i. The instructor relies on the students to provide ideas, experiences, opinions, and information
  - ii. The goal is to draw out what the students know rather than tell them
  - iii. The instructor acts as a facilitator to encourage discussion
- B. Use of Questions
  - i. Learning is achieved through the use of skillful questions
    - a. Effective use of questions may result in more learning than any other single technique
  - ii. Lead Off Question – Opens up the area of discussion
    - a. Function – Leads off the discussion
    - b. Purpose – Get the discussion started
  - iii. Follow-Up Question
    - a. Reasons for this vary; the student may need to explain something more, or the discussion needs to be refocused

iv. Overhead Question – Directed toward the entire group to stimulate everyone
v. Rhetorical Question – Also spurs group thought, but the instructor asks and answers it
  a. More commonly used in lecture than guided discussion
vi. Direct Question – Directed to an individual student
vii. Reverse Question – Rather than answer, the instructor can redirect a question to another student
viii. Relay Question – Redirected to the group rather than an individual
ix. In general, ask open ended questions that are thought provoking and don't just require repetition

C. Characteristics of an Effective Question
  i. Have a specific purpose
  ii. Be clear in meaning
  iii. Contain a single idea
  iv. Stimulate thought
  v. Require definite answers
  vi. Relate to previously covered information
  vii. Open ended, requiring elaboration

D. Planning
  i. Basically, the same as planning a lecture:
  ii. Select a topic the students can profitably discuss (the students have to have knowledge)
  iii. Establish a specific lesson objective with desired learning outcomes
  iv. Conduct adequate research to become familiar with the topic
  v. Organize the main and subordinate points of the lesson in a logical sequence
    a. 3 main parts: Intro, discussion, conclusion – just like a lecture
  vi. Plan at least one lead off question for each desired learning outcome (How/Why questions)

E. Student Preparation
  i. Help the students prepare – make them aware of the lesson objective as they prepare
  ii. If possible provide preliminary work to build their knowledge

F. Guiding a Discussion
  i. Introduction
    a. Introduced the same way as a lecture but provide a lead off question at the end of the intro
  ii. Discussion
    a. After asking a question, be patient, and provide the students time to react
    b. By using how and why follow-up questions, the discussion can be guided toward the objective
    c. Once the students have discussed the info, the instructor should summarize
      - The interim summary is one of the most useful things available to the instructor
        a It brings ideas together and helps in transition
  iii. Conclusion
    a. Summarize the material covered and tie together the various points discussed
    b. Any material not understood should be re-clarified

5. Demonstration Performance

A. Based on the Learn by Doing principle – students learn physical/mental skills by doing

B. Explanation Phase
  i. The instructor must convey the precise actions to be performed and the end result of these efforts
    a. Encourage students to ask questions about any step of the procedure they do not understand

C. Demonstration Phase
  i. Show the actions necessary to perform a skill
    a. If the demonstration does not conform to the explanation, the deviation should be immediately acknowledged and explained

D. Student Performance and Instructor Supervision Phase

i. The students are given an opportunity to perform the skill
ii. The instructor supervises the performance

E. Evaluation Phase
i. The instructor judges student performance to see if the desired outcomes were met, if not try again
a. From this measurement, the instructor determines the effectiveness of instruction

6. **Computer Based Training** (The use of personal computers as training devices)
A. Students can progress at a rate which is comfortable to them and at their own convenience
B. Some presentations vary based on the student's responses
i. Students can learn about particular areas of interest or areas of need
C. The computer should be thought of as a very valuable tool to be used to aid the instructor
D. Limitations
i. Excessive use should be avoided (Don't have it teach the student and then have them demonstrate)
a. The instructor should be actively involved with students when using instructional aids
b. The computer does not know when a student is having difficulty and the instructor must monitor progress and intervene when necessary

7. **Scenario Based Training** (SBT)
A. SBT is a realistic situation that allows the student to rehearse mentally for a situation and requires practical application of various bits of knowledge
i. The overall learning objective of SBT is for the student to be more ready to exercise sound judgement and make good decisions
ii. These scenarios require the pilot to manage the resources available in the flight deck, exercise sound judgment, and make timely decisions.
B. The aviation instructor is the key to successful SBT
i. The scenario may not have one right or one wrong answer, which reflects situations faced in the real world. It is important for the instructor to understand in advance which outcomes are positive and/or negative and give the student freedom to make both good and poor decisions without jeopardizing safety. This allows the student to make decisions that fit his or her experience level and result in positive outcomes.
C. A good scenario:
i. Has a clear set of objective
ii. Is tailored to the needs of the student
iii. Capitalizes on the nuances of the local environment
iv. Is not a test
v. Will not have one, right answer
vi. Does not offer an obvious answer
vii. Should not promote errors
viii. Should promote situational awareness and opportunities for decision-making
D. There is no list of "canned" scenarios that can be used for all students
i. Instructors must learn to devise their own scenarios by considering what each student needs to practice, and exploiting features of the local environment that allow them to do it

Conclusion:
Brief review of the main points
An effective instructor needs to be familiar with as many teaching methods as possible. The instructor's success is determined to a large degree by the ability to organize material and to select and utilize a teaching method appropriate to a particular lesson.

PTS Requirements:

To determine that the applicant exhibits instructional knowledge of the elements of the teaching methods by describing:

1. Material organization.
2. The lecture method.
3. The cooperative or group learning method.
4. The guided discussion method.
5. The demonstration-performance method.
6. Computer-based training method.
7. Scenario-based training method.

I.E. Critique and Evaluation

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

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

Instructors Notes:

Introduction:

Attention

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

Overview

Review Objectives and Elements/Key ideas

What

The critique refers to the instructor's role as a critic, and the evaluation portion discusses creating and conducting effective evaluations.

Why

The instructor must be able to appraise student performance and convey this information back to the student. Also, throughout a course, and at the end of a course, a student must be evaluated to measure and document whether or not the course objectives have been met.

How:

1. **Critique**
   - A. Purpose
     - i. Should provide the student with something constructive they can work on
     - ii. Provide direction and guidance to raise their level of performance
     - iii. Can be used for re-teaching in the case that several students falter at the same step
   - B. Characteristics
     - i. Objective
       - a. Focused on student performance, not personal opinions, likes, dislikes, or biases
       - b. To be objective, a critique must be honest, and based on the performance as it was
     - ii. Flexible
       - a. The performance must be examined in the context it was accomplished
       - b. Fit the tone, technique and content of the critique to the occasion as well as the student
       - c. Allow for variables and be flexible to satisfy the requirements of the moment
     - iii. Acceptable
       - a. Before accepting the critique, students must accept the instructor
         - Must be confidence in qualifications, teaching ability, sincerity, competence and authority
       - b. Present it fairly, with authority, conviction, sincerity, and from a position of competence
     - iv. Comprehensive
       - a. Cover strengths AND weaknesses
       - b. What will provide the greatest benefit?
         - A few major points or more minor points
         - Critique what most needs improved or only what can be reasonably expected to improve
     - v. Constructive
       - a. The critique is pointless unless the student profits from it
       - b. Don't offer a negative critique without a solution
     - vi. Organized
       - a. It needs to follow some pattern of organization otherwise it may lose its impact
         - Any pattern is acceptable as long as it is logical and makes sense to student and instructor

b. Options include:
  - The sequence of the performance itself
  - Work backward from where the demonstration failed (or was successful)
  - Break the whole into parts or build the parts into a whole

vii. Thoughtful
  a. Reflects thoughtfulness to self-esteem, recognition, and approval from others
    - Ridicule, anger, or fun at a student's expense have no place in a critique

viii. Specific (rather than general)
  a. Tell the student why something was not good and how to improve it
  b. Students should have no doubt what was good, and what was poor, and how they can improve

C. Methods
  i. Instructor/Student Critique
    a. The instructor leads a group discussion in which students offer criticism of a performance
      - This should be controlled carefully and directed with a firm purpose (not a free-for-all)
  ii. Student Led Critique
    a. A student is asked to lead the critique
    b. This can generate student interest and learning, and be effective
  iii. Small Group Critique
    a. Small groups are assigned a specific area to analyze and present their findings on
      - Results in a comprehensive critique
  iv. Individual Student Critique by another Student
    a. Another student is requested to present the entire critique
      - The instructor must maintain firm control over the process
  v. Self-Critique
    a. A student is required to critique personal performance
    b. Do not leave controversial issues unresolved, or erroneous impressions uncorrected
    c. Make sure the student realizes the mistakes
  vi. Written Critique
    a. 3 advantages
      - Instructor can devote more time and thought to it
      - The student can keep written critiques and refer to them whenever they wish
      - The student has record of suggestions, recommendations, and opinions of all other students
    b. Disadvantage is that the other members of the class do not benefit

D. Ground Rules
  i. Do not extend the critique beyond its scheduled time limit and into time allotted for other activities
    a. Point of diminishing returns is reached very quickly
    b. No more than 10 – 15 min (Definitely not more than 30 min)
  ii. Avoid trying to cover too much
    a. 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 (most rules have exceptions)
  v. Avoid controversies with the class and don't take sides
  vi. Never allow yourself to maneuvered into defending criticism
    a. Don't let the student argue and tell you that you are wrong
  vii. If part of the critique is written, ensure it is consistent with the oral portion

2. Evaluation

A. Purpose – To determine how a student is progressing in the course
   i. Evaluations: Oral Quiz, Written Test, Performance Test
B. Oral Questions
   i. Effective Oral Questions:
      a. Have only one correct answer
      b. Must apply to the subject of instruction
      c. Should be brief and concise, but also clear and definite
      d. Must be adapted to the ability, experience, and stage of training of the students
      e. Center on only one idea
      f. Should be limited to who, what, where, when, why, or how and not a combination
      g. Must present a challenge to the student
      h. Demand and deserve the use of proper English
   ii. Types of Questions to Avoid
      a. "Do you understand?" / "Do you have any questions?" have no place in effective quizzing
      b. Puzzle Questions
      c. Oversize
      d. Toss-up
      e. Bewilderment
      f. Trick Questions
      g. Irrelevant Questions
C. Responding to Student Questions
   i. The question must be clearly understood by the instructor before an answer is attempted
   ii. Display interest in the student's question and frame an answer that's direct and accurate
   iii. Determine whether the question has been completely answered, and if the answer is satisfactory
   iv. If it is unwise to introduce more complicated info explain that the Q was good/pertinent but an answer would complicate the learning tasks and reintroduce the Q later in training if it's not covered
   v. If an answer is unknown, freely admit not knowing, but promise to get the answer or help look it up
D. Written Questions
   i. Characteristics of a Good Written Test
      a. Reliability – The degree to which test results are consistent with repeated measurements
         - Does the test give consistent measurement to a particular individual or group
      b. Validity – the extent to which a test measures what it is supposed to measure
         - The most important consideration in test evaluation
         - Items that do not pertain directly to the objectives of the course should be removed
      c. Usability – Refers to the functionality of tests
         - Easily read, clear and concise, clearly used and drawn graphics, easily graded
      d. Objectivity – Describes singleness of scoring of a test
         - Biases of the person grading are not reflected (Easily graded in a fair manner)
      e. Comprehensiveness – The degree to which a test measures the overall objectives
         - A test must sample an appropriate cross section of the objectives of instruction
      f. Discrimination – The degree to which a test distinguishes the difference between students
         - A test must be able to measure small differences in achievement in relation to the objectives
         - When constructed this way, it has 3 features:
            a A wide range of scores
            b All levels of difficulty are included

c Each item distinguishes between high and low achievers of course objectives

ii. Developing Written Test Questions – Each item:
  a. Should test a concept or idea that is important the student knows/understands
  b. Must be stated so that everyone competent in the area would agree on the correct response
  c. Should be stated in language the student will understand
  d. Should be worded in a simple, direct, and unambiguous way, and it should be edited for brevity
  e. Should include sketches, diagrams, etc. when necessary to visualize the problem/add realism
  f. Should present a problem that demands knowledge of the subject or course

3. Performance Tests
A. Characteristics
  i. Criterion Referenced* because the objective is for all applicants to meet the FAR standards
    a. *Or, each student's performance is evaluated against a written, measurable standard
  ii. The PTS purpose is to delineate the standards by which FAA inspectors and DPE conduct tests
  iii. Parts include Areas of Operations and Tasks
    a. Area of Operations define phases of the practical test arranged in a logical sequence within each standard
    b. Tasks are titles of knowledge areas/flight procedures/maneuvers appropriate to an Area of Operation
B. Uses
  i. The instructor trains the applicants to PTS acceptable standards in all areas
  ii. The evaluation of the student is only in relation to the standards listed in the PTS
    a. Although students should be trained to the very highest level possible

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant exhibits instructional knowledge of the elements of critique and evaluation by describing:
1. Critique
   a. purpose and characteristics of an effective critique.
   b. methods and ground rules for a critique.
2. Evaluation
   a. characteristics of effective oral questions and what types to avoid.
   b. responses to student questions.
   c. characteristics and development of effective written test.
   d. characteristics and uses of performance tests, specifically, the FAA Practical Test Standards.
   e. collaborative assessment (or learner-centered grading (LCG)).

I.F. Flight Instructor Characteristics and Responsibilities

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

Objectives	The student should develop knowledge of the elements related to flight instructor characteristics and responsibilities as necessary in the CFI PTS.
Elements	1. Aviation Instructor Responsibilities 2. Flight Instructor Responsibilities 3. Professionalism
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 responsibilities associated with instructing as well as the characteristics related to being a professional.

Instructors Notes:

Introduction:

Attention

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

Why

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

How:

1. **Aviation Instructor Responsibilities**
    - A. Providing Adequate Instruction
        - i. Carefully and correctly analyze each student's personality, thinking, and ability
            - a. The same instruction cannot be equally effective for each student
        - ii. Incorrectly analyzing a student may result in the instruction not producing the desired outcome
        - iii. Students experiencing slow progress due to discouragement/lack of confidence should be assigned sub-goals which are easier to attain than the normal learning goals
            - a. Complex lessons can be broken down into elements, and each element can be practiced, culminating with the entire maneuver
            - b. As confidence and ability are gained, difficulty should be increased until progress is normal
        - iv. Fast learners may assume correcting errors is unimportant since they make few mistakes
            - a. This overconfidence may soon result in faulty performance
            - b. For such students, constantly raise the standard of performance for each lesson
        - v. Individuals learn when they are aware of their errors
            - a. But, deficiencies should not be invented
    - B. Establishing Standards of Performance
        - i. Instructors fail to provide competent instruction when they permit their students to get by with substandard performance, or without learning thoroughly some necessary item of knowledge
        - ii. Accepting lower standards to please a student does not result in a genuine improvement in the student-instructor relationship
            - a. An earnest student does not resent reasonable standards that are fairly/consistently applied
    - C. Emphasizing the Positive
        - i. The way instructors conduct themselves, the attitudes displayed, and the manner instruction is developed all contribute to the formation of either positive or negative impressions by their students
        - ii. The success of an instructor depends, in large measure, on the ability to present instruction so that students develop a positive image of aviation
        - iii. Every reasonable effort should be made so instruction is given under the most favorable conditions
        - iv. Emphasize the positive because positive instruction results in positive learning

2. Flight Instructor Responsibilities

A. Student Pilot Evaluation
   i. Evaluation of ability during flight must be based on established standards of performance
      a. These standards should be modified to apply to the student's experience
   ii. It is important the student is kept informed of progress
      a. When explaining errors, point out elements where deficiencies are believed to have originated
         - If possible, suggest appropriate corrective measures
   iii. If the procedure is performed correctly but not fully understood require it to be varied
      a. Or, combine it with other operations, or apply the same elements to another maneuver

B. Pilot Supervision
   i. Flight instructors have the responsibility to provide guidance and restraint with respect to solo ops
      a. This is by far the most important responsibility since the instructor is the only person in a position to make the determination that a student is ready for solo ops
   ii. Before endorsing solo flight, the student should display consistent ability to perform the maneuvers
      a. The student should also be capable of handling ordinary problems that might occur

C. Practical Test Recommendations
   i. Signing a recommendation imposes a serious responsibility on the instructor
      a. Students should show a thorough demonstration of the knowledge and skill level necessary
         - This demonstration should be in NO INSTANCE less than the complete procedure in the PTS
   ii. If a student is unprepared, the instructor is logically held accountable for deficient performance
   iii. Examiners rely on recommendations as evidence of qualification for certification
   iv. Be very protective of your record – Never sign someone off who is not ready
      a. This is not good for the instructor's record or for the student

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

E. Additional Training Endorsements (AC 61-98)
   i. Flight Reviews
      a. This is not a test/check ride, but an instructional service designed to assess knowledge and skill
      b. Must be based on specific objectives and standards
         - Should include a thorough checkout appropriate to certificate/ratings held
         - Before beginning agree fully on the objectives and standards
         - As training progresses keep the pilot informed of progress toward achieving the goals
   ii. Instrument Proficiency Checks
      a. Use the Instrument PTS as the primary reference for the associated maneuvers and tolerances
   iii. Aircraft Checkouts/Transitions (High performance, tailwheels, high altitude training)
      a. By performing these, you are accepting a major responsibility for the safety of future passengers
      b. All checkouts should be conducted to the performance standards shown in the PTS
      c. Do not attempt to checkout a pilot in an airplane you are not current in
      d. Record in the pilot's logbook the exact extent of any checkout conducted
      e. If insufficient, thoroughly debrief the pilot and schedule further instruction

3. Professionalism

A. Personal Characteristics
   i. Sincerity
      a. Be straight forward and honest
      b. Do not attempt to hide some inadequacy behind a smokescreen or unrelated instruction
         - Teaching is based upon acceptance of the instructor as qualified, and an expert pilot
   ii. Acceptance of the Student
      a. The instructor must accept all students as they are, including all faults and problems
      b. Under no circumstance should the instructor do something which implies degrading the student
      c. Acceptance, rather than ridicule, and support, rather than reproof, will encourage learning
   iii. Personal Appearance and Habits
      a. Instructors are expected to be neat, clean, and appropriately dressed
         - Attire worn should be to a professional status
      b. Personal habits have a significant effect on the professional image
         - Exercising common courtesy is perhaps the most important of these
            a A rude, thoughtless, inattentive instructor cannot hold anyone's respect
         - Personal cleanliness is important as well (it can be distracting)
   iv. Demeanor
      a. Attitude and behavior can contribute much to a professional image
         - Requires development of a calm, thoughtful, and disciplined, but not somber, demeanor
      b. Instruction is best done with a calm, pleasant, thoughtful approach putting the student at ease
      c. The instructor must constantly portray competence in the subject matter and genuine interest in the student's well being

B. Minimizing Student Frustration
   i. Motivate Students
      a. More can be gained from wanting to learn than being forced to learn
         - When students see the benefits or purpose of a lesson their enjoyment/efforts will increase
   ii. Keep Students Informed
      a. Students feel insecure when they don't know what is expected/what will happen to them
         - Telling students what is expected of them and what they can expect in return
      b. Keep students informed by:
         - Giving them an overview of the course, keeping them posted on progress and giving adequate notice of exams, assignments, or other requirements
         - Talk about money when necessary
   iii. Approach Students as Individuals
      a. Each individual within a group has a unique personality that should be constantly considered
   iv. Give Credit When Due
      a. Praise/credit from the instructor usually is ample reward and provides an incentive to do better
         - Praise pays dividends, but when given too freely it becomes valueless
   v. Criticize Constructively
      a. It is important to identify mistakes and failures
      b. If the student is briefed on the errors AND is told how to correct them, progress can be made
   vi. Be Consistent
      a. Students have a keen interest in knowing what is required to please the instructor
         - The instructor's philosophy and actions must be consistent to avoid student confusion
   vii. *Be Well Prepared (Over prepare)
      a. Students are spending a lot of money and deserve a well-prepared instructor

Conclusion:
Brief review of the main points

PTS Requirements:

To determine that the applicant exhibits instructional knowledge of the elements of instructor responsibilities and professionalism by describing:

1. Aviation instructor responsibilities in-
   a. providing adequate instruction.
   b. establishing standards of performance.
   c. emphasizing the positive.
2. Flight instructor responsibilities in-
   a. providing student pilot evaluation and supervision.
   b. preparing practical test recommendations and endorsements.
   c. determining requirements for conducting additional training and endorsement requirements.
3. Professionalism as an instructor by-
   a. explaining important personal characteristics.
   b. describing methods to minimize student frustration.

I.G. Planning Instructional Activity

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

Objectives	The student should develop knowledge of the elements related to planning instructional activity as required in the CFI PTS.
Elements	1. Developing Objective and Standards 2. Building Blocks of Learning 3. Developing a Training Syllabus 4. Lesson Plans 5. Scenario Based Training
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to effectively and properly plan instructional activity. The student can develop objectives and standards for a training course, he understands the use of the building blocks of learning, and is aware of the requirements for developing a training syllabus, as well as the purpose and characteristics of a lesson plan.

Instructors Notes:

Introduction:

Attention

Want to be your own boss, and have your own flight school? This is oriented to the instructor who may be instructing independently.

Overview

Review Objectives and Elements/Key ideas

What

The planning required by the instructor as it relates to the course of training, blocks of learning, training syllabus, and lesson plans.

Why

Learning to plan instructional activity effectively results in high-quality training on an individual basis.

How:

1. **Developing Objectives and Standards**
   - A. Before any important instruction can begin, a determination of objectives and standards in necessary
   - B. Objectives
     - i. The desired level of learning should be incorporated into the performance based objectives
       - a. Aviation training aspires to a level of learning at the application level or higher
   - C. Standards
     - i. Closely tied to objectives, since they include a description of the desired knowledge, behavior, or skill stated in specific terms, along with conditions and criteria
     - ii. When a student performs according to well-defined standards, evidence of learning is apparent
     - iii. Comprehensive examples of the desired learning outcomes, or behaviors, should be included
       - a. Writing standards for affective learning can be more difficult than cognitive/psychomotor
   - D. The overall objective of a training course is usually well established, and the general standards are included in various rules and related publications
     - i. Eligibility, knowledge, proficiency, and experience requirements are stipulated in the regulations
       - a. Instructional objectives should extend beyond those listed in publications
         - Successful instructors teach not only how, but also why and when
     - ii. Standards are published in the applicable PTS
2. **Building Blocks of Learning**
   - A. The blocks of learning constitute the necessary parts of the total training objectives
   - B. Early identification of the foundation of blocks of learning is essential
     - i. They should represent units of learning which can be measured and evaluated
   - C. By developing blocks, a student can master the segments (blocks) individually
     - i. The blocks can be progressively combined with other segments until reaching the overall objective
   - D. When identifying the blocks of learning for each training activity, be sure that it is truly integral
     - i. Extraneous blocks of instruction are expensive frills, and detract from the final objective
   - E. Any student problems can be divided into blocks of learning in order to help solve that problem
     - i. EX. Steep turns can be broken into blocks which can be mastered or fixed to perfect the maneuver

3. **Training Syllabus Development Requirements**
   A. Designed to provide a road map showing how to accomplish the overall objective of a course
      i. Intended to be a summary of a course of training
         a. It should be fairly brief but comprehensive enough to cover the essential information
   B. The syllabus should always be in the form of an abstract or digest of the course training
      i. It should include blocks of learning to be completed in the most efficient order
   C. Effective training relies on organized blocks of learning
      i. Therefore, all syllabi should stress well defined objectives and standards for each lesson
         a. Appropriate objectives/standards should be established for the overall course, the separate flight and ground segments, and for each stage of training
         b. Other details may be added to explain how to use it and describe pertinent reference materials
   D. Using a Training Syllabus
      i. The syllabus must be flexible, and should be used primarily as a guide
         a. When necessary, the order of training should be altered to suit progress/special demands
         b. When departing from the syllabus, it is the instructor's responsibility to consider how the blocks of learning are affected
      ii. Ground Lessons
         a. Tend to focus on cognitive domain learning
            - But, many areas concern safety/ADM/judgment which are related to the affective domain
               a Thus, instructors who can stress these factors along with traditional aviation subjects can favorably influence a student's attitudes, beliefs, and values
      iii. Flight Lessons
         a. Generally emphasize the psychomotor domain
            - Affective domain is also important
               a Thus, attitude toward flight safety, ADM, and judgment should be a major concern
   E. A syllabus should include special emphasis areas that are cause factors in accidents or incidents
      i. EX. Emphasize collision and wake turbulence avoidance
4. **Purpose and Characteristics of a Lesson Plan**
   A. Purpose
      i. Designed to assure each student receives the best possible instruction under existing conditions
         a. Help instructors keep a check on their own activity, as well as their students
         b. The instructor has in essence taught the lesson to themselves prior to teaching students
      ii. An adequate lesson plan, when properly used, should:
         a. Assure a wise selection of material and the elimination of unimportant details
         b. Make certain that due consideration is given to each part of the lesson
         c. Aid the instructor in presenting the material in a suitable sequence for efficient learning
         d. Provide an outline for the teaching procedure to be used
         e. Serve as a means of relating the lesson to the objectives of the course of training
         f. Give the inexperienced instructor confidence
         g. Promote uniformity of instruction regardless of the instructor or date on which the less is given
   B. Characteristics
      i. A lesson plan should be a working document that should be revised as changes occur or are needed
      ii. Unity – should be a unified segment of instruction
         a. No extraneous info not important to the objective
      iii. Content – Each lesson should contain new material, but, it should be related to previous lessons
      iv. Scope – Each lesson should be reasonable in scope
         a. Keep the objectives realistic as a person can only master a few principles at a time
      v. Practicality – Plan each lesson in terms of the conditions under which training is to be done

a. Lesson plans in the airplane will differ from those in the classroom
b. Also, the kinds/quantities of instructional aides available have a great influence

vi. Flexibility – A degree of flexibility should be incorporate even though there is an outline
vii. Relation to a Course of Training – Plan and teach each lesson so its relation to objectives are clear
   a. EX. A lesson on short field T/O and LDGs should be related to certification and safety objectives
viii. Instructional Steps – Every lesson, when adequately developed, falls logically into the four steps of the teaching process (Preparation, Presentation, Application, Evaluation)

5. Scenario Based Training

A. SBT is a realistic situation that allows the student to rehearse mentally for a situation and requires practical application of various bits of knowledge
   i. The overall learning objective of SBT is for the student to be more ready to exercise sound judgement and make good decisions
   ii. Research and practical experience have demonstrated the usefulness of practicing in realistic scenarios
B. Instructors must devise scenarios that allow students to practice what they have learned
   i. This is challenging because different students need to practice different things at different times, and because different working environments present different practice opportunities
C. A good scenario:
   i. Has a clear set of objective
   ii. Is tailored to the needs of the student
   iii. Capitalizes on the nuances of the local environment
   iv. Is not a test
   v. Will not have one, right answer
   vi. Does not offer an obvious answer
   vii. Should not promote errors
   viii. Should promote situational awareness and opportunities for decision-making
D. There is no list of "canned" scenarios that can be used for all students
   i. Instructors must learn to devise their own scenarios by considering what each student needs to practice, and exploiting features of the local environment that allow them to do it

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant exhibits instructional knowledge of the elements of planning instructional activity by describing:
1. Developing objectives and standards for a course of training.
2. Theory of building blocks of learning.
3. Requirements for developing a training syllabus.
4. Purpose and characteristics of a lesson plan.
5. How a scenario-based lesson is developed.

TECHNICAL SUBJECT AREAS

II.A. Aircraft Flight Instruments & Navigation Equipment

References: Instrument Flying Handbook (FAA-H-8083-15), POH/AFM

Objectives	The student should develop knowledge of the elements related to the operation of flight instruments as well as the characteristics and operation of navigation equipment.
Key Elements	1. Pitot/Static Errors 2. Compass Corrections 3. VOR Navigation
Elements	1. Flight Instruments 2. Navigation Equipment 3. Anti-Ice/Deicing
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can describe the different flight and navigation instruments and their operation, as well as potential errors associated with the instruments.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

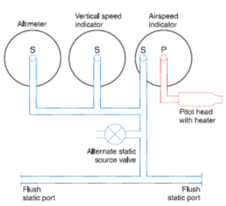
An explanation of how your flight instruments and navigation instruments parts and operation, the errors associated with them, as well as their proper use.

Why

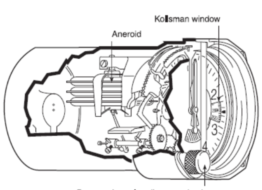
A thorough understanding of the operation of the flight instruments is necessary in order to understand the errors and potential problems associated with them. An understanding of the different types of navigation equipment is important for proper use in flight.

How:

1. **Flight Instruments**
    A. Pitot-Static System (Altimeter, VSI, ASI)
        i. How it Works
            a. Flight instruments depend on accurate sampling of the ambient atmospheric pressure
                - This is used to determine the height and speed of movement of the aircraft through the air



            b. Static Pressure (still air pressure) is measured at a flush port where air is not disturbed
                - Pressure of the air that is still or not moving, measured perpendicular to the aircraft surface
            c. Pitot Pressure (impact air pressure) is measured through a tube pointed into the relative wind
                - Ram air pressure used to measure airspeed
            d. The Pitot Tube connects to the ASI; the Static Port connects to all 3 instruments
        ii. Sensitive Altimeter
            a. An aneroid barometer that measures the absolute pressure of the ambient air and displays it as feet above a selected pressure level
            b. Principle of Operation

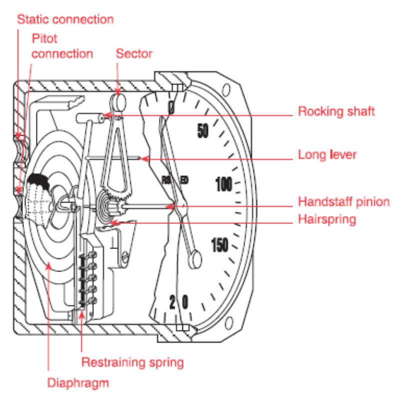


                - The sensitive element is a stack of evacuated, corrugated bronze aneroid capsules
                    a Air pressure tries to compress them, while natural springiness tries to expand them
                    b This results in their thickness changing as their air pressure changes
                        1. The change in thickness moves the gears/linkages to change the altitude displayed
                - Contains an adjustable barometric scale (visible in the Kollsman window)
                    a This allows you to set the reference pressure from which the altitude is measured
                    b Rotating the knob changes the barometric scale: 1” Hg is equal to 1,000’
                        1. Standard pressure lapse rate below 5,000’
                    c Pressure altitude is when the kollsman window is set to 29.92” Hg
                    d When you want to display indicated altitude, adjust to the local altimeter setting
                        1. This will indicate the height above the existing sea level pressure
            c. Errors (Mechanical and Inherent)
                - Nonstandard Temperature
                    a When in warmer than standard air, air is less dense and pressure levels are farther apart

1. At 5,000' indicated, true altitude is higher than it would be if the air were cooler
   a. The pressure level for that alt is higher than it would be at standard temp
- b If air is colder than standard, it is denser, and pressure levels are closer together
  1. At 5,000' indicated, true altitude is lower than it would be if the air were warmer
     a. The pressure level for that alt is higher than it would be at standard temp
- Nonstandard Pressure
  - a High pressure to Low pressure
    1. As the pressure decreases, the altimeter reads it as though the airplane is climbing
       a. The altimeter increases although the airplane is at the same altitude
          i. To compensate for this the pilot will descend, therefore lowering true altitude and putting the aircraft in a potentially dangerous position (lower than the altimeter indicates)
  - b The opposite applies from Low pressure to High pressure
- REMEMBER: From hot to cold, or from high to low, look out below!

iii. Vertical Speed Indicator
   a. A rate-of-pressure change instrument giving an indication of deviation from a constant pressure level
   b. Principle of Operation
      - Inside the instrument case is an aneroid
        - a Both the aneroid and the inside of the instrument case are vented to the static system
          1. But, the case is vented through a calibrated orifice that causes the pressure inside to change more slowly than that inside the aneroid
      - As the aircraft ascends, the static pressure becomes lower (Descent is the opposite)
        - a The pressure inside the case compresses the aneroid, moving the pointer upward
      - When the aircraft levels off, the pressure no longer changes
        - a The pressure inside the case becomes the same as that inside the aneroid

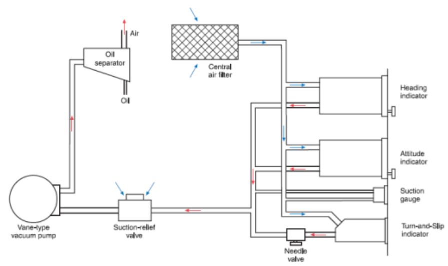
iv. Airspeed Indicator
   a. A differential pressure gauge measuring the dynamic pressure of the air the aircraft is in
      - Dynamic Pressure: the difference in ambient static air pressure and the total, or ram, pressure caused by the motion of the aircraft through the air
   b. Principle of Operation
      - Consists of a thin, corrugated phosphor bronze aneroid, or diaphragm, receiving its pressure from the pitot tube
      - The instrument is sealed and connected to the static port(s)
      - As pitot pressure increases/ static decreases, the diaphragm expands and vice versa
        - a A rocking shaft and set of gears drives the airspeed needle



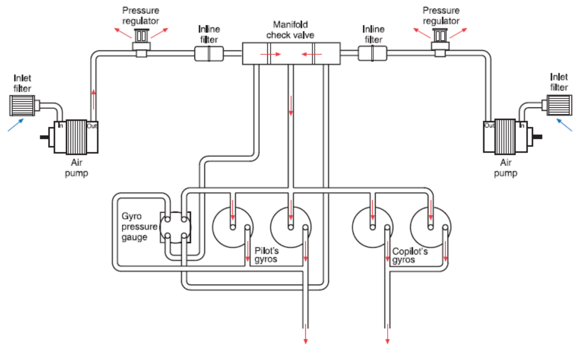
B. Gyroscopic System (AI, HI, TC)
   i. How it Works
      a. The 2 characteristics of gyroscopes: Rigidity and Precession
         - Rigidity: Characteristic that prevents its axis or rotation tilting as the Earth rotates
         - Precession: Characteristic that causes an applied force to be felt 90° from that point in the direction of rotation
      b. The instruments contain a gyro (small wheel with its weight concentrated around its periphery)
         - When spun at a high speed, the wheel becomes rigid, resisting any attempt to tilt or turn in any direction other than around its spin axis

- a Attitude/Heading instruments operate on the principle of rigidity
  1. The gyro remains *rigid* in its case and the aircraft rotates about it
- Rate indicators (turn indicators/turn coordinators) operate on the principle of precession
  - a The gyro precesses (or rolls over) proportionate to the rate the aircraft rotates about one or more of its axis

c. Power Sources
- Electrical Systems
- Pneumatic Systems
  - a Driven by a jet of air impinging on buckets cut into the periphery 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) is connected to the instruments
       a. This creates a suction
- 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
  - c Excess air can be used inflate deicer boots



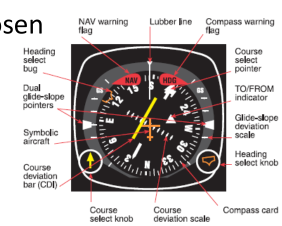
- Dry-Air Pump Systems
  - a At high altitudes, more air is needed in the instruments as the air is less dense
    1. Air pumps that do not mix oil with the discharge air are used in high flying
  - b Vanes are made of a special formulation of carbon which do not need lubricating
- Pressure Systems
  - a 2 dry air pumps are used with filters to filter anything that could damage the fragile carbon vanes in the pump
  - b The discharge air from the pump flows through a regulator, where excess air is bled off to maintain the pressure in the system at the desired level
  - c The regulated air then flows through inline filters to remove any contamination that could have been picked up from the pump, and from there into a manifold check valve
  - d If either engine becomes inoperative, or if either pump fails, the check valve will isolate the inoperative system and the instruments will be driven by air from the other system
  - e After passing through the instruments/driving the gyros, air is exhausted from the case
  - f The gyro pressure gauge measures the pressure drop across the instruments



ii. Attitude Indicator
  a. Principle of Operation
    - Its operating mechanism is a small brass wheel with a vertical spin axis
      a It is spun by either a stream of air on buckets cut into its periphery or an electric motor
    - Mounted in a double gimbal which allows the aircraft to pitch and roll about the gyro
      a A type of mount in which the axes of the two gimbals are at right angles to the spin of the axis of the gyro allowing free motion in two planes around the gyro
    - A horizon disk is attached to the gimbals so it remains in the same plane as the gyro
      a The airplane pitches and rolls around the horizon disk
    - A small aircraft is put in the instrument case so it appears to be flying relative to the horizon
      a The aircraft can be raised or lowered
    - To function properly, the gyro must remain vertically upright while the aircraft pitches/rolls
      a The bearings have a minimum of friction, but even the small amount causes precession
        1. To minimize tilting, an erection mechanism applies a force any time the gyro tilts to return it to the upright position
  b. Errors
    - Free from most errors, but…
      a There may be a slight nose-up indication during a rapid acceleration and vice versa
      b There is also the possibility of a small bank angle and pitch error after a 180^{o} turn

iii. Heading Indicator
  a. The gyro is mounted in a double gimbal axis in such a way that its spin axis is horizontal
    - Senses rotation about the vertical axis of the airplane
  b. Must be set to the appropriate heading by referring to a magnetic compass
    - Rigidity causes them to maintain this heading indication
  c. Air driven: air flows into the case, blowing against buckets in the periphery of the wheel
  d. The instrument should be checked every 15 minutes to ensure it matches the magnetic compass

iv. Horizontal Situation Indicator (HSI)
  a. A direction indicator which combines the MC with nav signals and a glide slope
    - Uses the output from a flux valve to drive the dial, which acts as the compass card
    - All of this gives an indication of location with relationship to the course chosen



v. RMI
  a. A typical system consists of an HSI, the slaving control and compensator unit
  b. Slaving Control and Compensator Unit
    - Has a pushbutton means of selecting either slaved or free gyro mode
    - Also has a slaving meter and 2 manual heading drive buttons
      a Slaving meter indicates the difference between displayed heading and magnetic heading
      b In free gyro mode, the card is adjusted with the appropriate heading drive button

- The magnetic Slaving Transmitter
    - a A separate unit mounted remotely (usually in the wingtip), to eliminate interference
    - b Contains the flux valve, which is the direction sensing device of the system
        1. The signal relayed to the HI operates a torque motor which precesses the gyro until aligned with the transmitter signal

vi. Turn Indicators

a. Rate instruments operate on the principle of precession

b. Turn-and-Slip Indicator

- A small gyro mounted in a single gimbal
    - a Gyro spin axis is parallel to the lateral axis; the gimbal axis is parallel to the longitudinal
- Yawing, or rotating about the vertical axis, produces a force in the horizontal plane
    - a This, due to precession, causes the gyro and its gimbal to rotate about the gimbal axis
- Inclinometer
    - a A black glass ball sealed inside a curved glass tube that is partially filled with a liquid
    - b When straight and level, there is no inertia acting on the ball and it remains centered
    - c In a turn with too steep a bank angle, gravity exceeds inertia and the ball rolls inward
    - d In a turn with too shallow of bank, inertia exceeds gravity and the ball rolls outward
    - e Only indicates the relationship between the angle of bank and the rate of yaw

c. Turn Coordinator

- Similar to the Turn and Slip Indicator, but its gimbal frame is angled upward about 30° from the longitudinal axis of the airplane
    - a This allows it to sense both roll and yaw (not just yaw like the T&S Indicator)
- The inclinometer is the same, and called a coordination ball
    - a Shows the relationship between the bank angle and rate of yaw
        1. Skidding when the ball rolls outside the turn
        2. Slipping when the ball rolls inside the turn

C. Magnetic Compass

i. Operation

a. Two small magnets attached to a metal float sealed inside a bowl of clear compass fluid

b. A card is wrapped around the float and visible from the outside with a lubber line

- Lubber Line: The reference line used in a magnetic compass or heading indicator

c. The float/card has a steel pivot in the center riding inside a spring loaded, hard glass jewel cup

- The buoyancy of the float takes most of the weight off the pivot
- The jewel and pivot type mounting allow the float to rotate and tilt up to approximately 18°

d. The magnets align with the Earth's magnetic field and direction is read opposite the lubber line

- The pilot sees the card from its backside
    - a The reason for this is the card remains stationary and the housing/pilot turn around it

ii. Errors

a. Variation

- Caused by the difference in the locations of the magnetic and geographic north pole
- The north magnetic pole is not collocated with the geographic north pole
    - a The difference between true and magnetic directions
- Isogonic Lines: Lines drawn across aeronautical charts connecting points have the same magnetic variation
- Agonic Line: An irregular imaginary line across the surface of the Earth along which the magnetic and geographic poles are aligned and along which there is no magnetic variation

b. Deviation

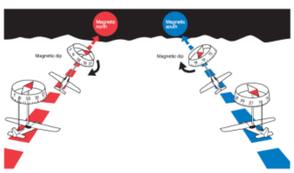
- Caused by local magnetic fields within the aircraft; different on each heading
- The magnets in a compass align with any magnetic field
  - a Local magnets caused by electrical currents will conflict with the Earth's field
- Deviation varies by heading and is shown on a compass correction card

c. Finding the Compass Course

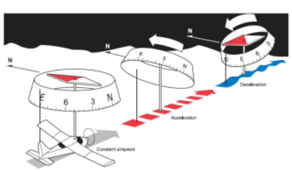
- True Course ± Variation = Magnetic Course ± Deviation = Compass Course
- Remember: East is Least, West is Best
  - a Subtract variation from true course, Add variation to true course

d. Dip Errors

- What's Going On
  - a The lines of magnetic flux are considered to leave the Earth at the magnetic N pole and enter at the magnetic S pole
    1. At both poles, the lines are perpendicular to the surface
    2. Over the equator, the lines are parallel to the surface
  - b The magnets align with these fields and near the poles they dip, tilt, the float/card
  - c The float is balanced with a small dip compensating weight, so it stays relatively level
- Northerly Turning Error
  - a Caused by the pull of the vertical component of the Earth's magnetic field
  - b When flying on a heading of N, a turn to the E results in:



    1. The aircraft banking to the right and the compass card tilting to the right
    2. Then, the vertical component pulls the N seeking end of the compass to the right
       a. The float rotates, causing the card to rotate toward the W (opposite the turn)
  - c The same happens when turning to the W; the float rotates to the E (opposite)
  - d Remember: When starting a turn from a N heading, the compass lags behind the turn
  - e When flying on a heading of S, a turn to the E results in:
    1. The Earth's field pulling on the end of the magnet that rotates the card toward the E (same as the turn)
  - f When turning to the W, the same happens; the float rotates to the W (same direction)
  - g Remember: When starting a turn from a S heading, the compass leads the turn
  - h Remember: UNOS - Undershoot North, Overshoot South
- Acceleration Error



  - a The dip-correction weight causes the end of the float and card marked N (S seeking end) to be heavier than the opposite end
  - b If the aircraft accelerates on a heading of E, the inertia of the weight holds its end of the float back, and the card rotates toward the N
  - c If the aircraft decelerates on a heading of E, inertia causes the weight to move ahead and the card rotates to the S
  - d When flying on a heading of W, the same things happen
  - e Remember: ANDS – Accelerate→North, Decelerate→South

e. Oscillation Error

- Oscillation is a combination of all the other errors
  - a It results in the compass card swinging back and forth around the heading being flown
- When setting the HI to the MC, use the average indication

2. Navigation Equipment

A. Very High Frequency Omni-Directional Range (VOR)

i. Three types of VORS

a. VOR – The VOR by itself, provides magnetic bearing information to and from the station

b. VOR/DME – When DME (Distance Measuring Equipment) is also installed with the VOR
c. VORTAC – When military tactical air navigations (TACAN) equipment is installed with a VOR
- DME is always an integral part of a VORTAC

ii. What is it?
a. Omni means all
- An *omni*directional range is a VHF radio transmitting ground station that projects straight line courses (or radials) from the station in *all* directions
  - a It can be visualized from the top as being similar to the spokes from the hub of a wheel

b. The distance the radials are projected depends on the power output of the transmitter
c. The radials projected are referenced to magnetic north
- A radial is defined as a line of magnetic bearing extending outward from the VOR station
- The accuracy of course alignment with radials is considered to be excellent (within +/- 1°)

d. VOR ground stations transmit within a VHF frequency band of 108.0 – 117.95 MHz
- Because the equipment is VHF, the signals are subject to line-of-sight restrictions
  - a Therefore, range varies in direct proportion to the altitude of the receiving equipment

e. VORs are classed according to operational use in 3 classes with varying normal useful ranges:
- T (Terminal); L (Low Altitude); H (High Altitude)

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

iii. VOR Checks
a. The best assurance of maintaining an accurate VOR receiver is periodic checks and calibrations
- Not a regulation for VFR flight

b. Checks (checkpoints are listed in the A/FD)
- FAA VOR Test Facility (VOT)
- Certified Airborne Checkpoints
- Certified Ground Checkpoints located on airport surfaces
- Dual VOR check

c. Verifies the VOR radials received are aligned with the radials the station transmits
d. IFR tolerances required are +/- 4° for ground checks and +/- 6° for airborne checks

iv. Using the VOR
a. Identifying It
- Station can be identified by its Morse code ID or a voice stating the name and VOR
- If the VOR is out of service, the coded identification is removed and not transmitted
  - a It should not be used for navigation
- VOR receivers have an alarm flag to indicate when signal strength is inadequate
  - a The plane is either too far or too low and is out of the line-of-sight of the signal

b. There are 2 required components for VOR radio navigation
- The ground transmitter and the receiver

- a Transmitter is at a specific position on the ground and transmits on an assigned frequency
- b Airplane equipment includes the receiver with a tuning device and a VOR instrument
  1. The navigation instrument consists of:
     - **a.** An OBS (Omnibearing Selector), referred to as the course selector
     - **b.** A CDI (Course Deviation Indicator) Needle
     - **c.** A To/From Indicator
- Course selector is an azimuth dial that is rotated to select a radial/determine the radial on
  - a In addition, the magnetic course TO or FROM the station can be determine
- When the OBS is rotated, the CDI moves showing the radial relative to the airplane
- If centered, the CDI will show the radial (MC FROM)/its reciprocal (MC TO)
- The CDI will also move to the right or left if the airplane is away from the radial selected

c. TO and FROM
- By centering the needle, either the course "FROM" or "TO" the station will be indicated
  - a If the flag displays "TO," the course on the course selector must be flown to the station
  - b If "FROM" is displayed and the course followed, the plane flies away from the station

v. VOR Tips
- a. Positively identify the station by its code or voice identification
- b. Remember, VOR signals are line-of-sight
- c. When navigating TO, determine the inbound radial and use it (Don't reset radial, correct drift)
- d. When flying TO a station always fly the selected course with a TO indication
- e. When flying FROM a station always fly the selected course with a FROM indication

B. Distance Measuring Equipment (DME)

i. Function
- a. When with a VOR, DME can determine position, including bearing and distance TO/FROM
- b. Used for determining the distance from a ground DME transmitter
- c. The info can be used to determine position or fly a track at a constant distance from a station

ii. How it Works
- a. The aircraft DME transmits interrogating RF pulses which a DME antenna on the ground receives
- b. The signal triggers ground receiver equipment to respond back to the interrogating aircraft
- c. The airborne DME measures the elapsed time between the sent signal and the reply signal
  - The time measurement is converted into NMs from the station
- d. Some receivers provide GS by monitoring the rate of change of position to the station
- e. DME operates on UHF frequencies between 962 MHz and 1213 MHz

iii. Components
- a. Ground Equipment
  - VOR/DME, VORTAC, ILS/DME, and LOC/DME provide DME course and distance info
- b. Airborne Equipment
  - An antenna and a receiver
- c. Pilot Controllable Features
  - Channel (frequency) Selector: To select the proper channel/frequency desired
  - On/Off/Volume: Can be used to identify the DME (Morse code plays 1x for every 3-4x VOR)
  - Mode Switch: Cycles between Distance, GS and time to station
  - Altitude: Some correct for slant range error

iv. Errors
- a. DME signals are line of sight
- b. Slant Range Distance

- The mileage readout is the straight-line distance from the aircraft to the ground facility
- Differs from the distance from the station to the point on the ground beneath the aircraft
- This error is the smallest at low altitudes and long range
    - a It is greatest when over the ground facility, when it will display altitude above
    - b Negligible if 1 mile or more away from the facility for each 1,000' above facility elevation

C. Instrument Landing System (ILS)

i. An electronic system that provides both horizontal and vertical guidance to a specific runway, used to execute a precision instrument approach procedure

ii. Ground Components

a. Localizer: Provides horizontal guidance along the centerline of the runway

- The portion of the ILS that gives left/right guidance info down the centerline of the instrument runway for final approach
- Located on the extended centerline
- Radiates a field pattern, which develops a course down the centerline toward the MM/OMs
    - a Also radiates a similar course along the runway centerline in the opposite direction
        1. These are the front and back courses, respectively
- Provides course guidance between 108.1 and 111.95 MHz (odd tenths only)
    - a Guidance is given from 18 nm from the antenna up to 4,500' above antenna elevation
- Localizer Course is very narrow, normally 5°
    - a A full-scale deflection shows when 2.5° to either side of the centerline
        1. With no more than ¼ scale deflection, the airplane will be aligned with the runway

b. Glide Slope: Provides vertical guidance toward the runway touchdown point, usually a 3° slope

- Part of the ILS that projects a radio beam upward at an angle of approximately 3° from the approach end of an instrument runway to provide vertical guidance for final approach
- Equipment is housed in a building approximately 750-1250' down from the approach end of the runway, and 400-600' to one side of the centerline
- The course projected is basically the same as a localizer on its side
    - a The projection angle is normally 2.5-3.5° above the horizontal
        1. This intersects the MM at about 200'/OM at about 1,400' above runway elevation
- Only radiates signal in the direction of the final approach on the front course
- Normally a 1.4° thick glide path (at 10 nm, this equals 1,500' and narrows to a few feet at TD)

c. Marker Beacons: Provide range info along the approach path

- A low powered transmitter that directs its signal upward in a small, fan shaped pattern. Used along the flightpath when approaching an airport for landing, marker beacons indicate, both aurally and visually, when the aircraft is directly over the facility
- Two VHF marker beacons, Outer and Middle, are normally used in the ILS system
    - a A third beacon, Inner, is used where Category II ops are certified
- The Outer Marker (OM)
    - a Located on the localizer front course 4 to 7 miles from the airport
    - b Indicates where, when at the appropriate alt, on the localizer one will intercept glide path
- The Middle Marker (MM)
    - a Approximately 3,500' from the landing threshold on the centerline of the localizer front course
    - b It is at a position where the glide-slope centerline is about 200' above the landing threshold

- The Inner Marker (IM)
    - a Located on the front course between the MM and the landing threshold
    - b Indicates the decision height on a Category II ILS approach
- Compass Locator
    - a Low powered NDBs which are received and indicated by the ADF receiver
    - b When used in conjunction with an ILS front course, the compass locator facilities are collocated with the outer and/or MM facilities

d. Approach Lights: Assist in the transition from instrument to visual flight
- Visual stage of the instrument approach
    - a The landing is continued with reference to runway touchdown zone markers
- Visual identification of the ALS must be instantaneous, so it's important to know the type
    - a ALSF, SSALR, MALSR, REL, MALSF, ODALS, also VASIs

iii. Airborne Components: Include receivers for the:

a. Localizer
- Typical VOR receiver is also a localizer receiver and functions the same way

b. Glide Slope
- Glide slope is tuned automatically to the proper frequency when the localizer is tuned
- Each localizer frequency is paired with a corresponding glide slope frequency

c. Marker Beacon
- OM
    - a Low-pitch tone
    - b Continuous dashes at the rate of 2 per second
    - c Purple/blue marker beacon light
- MM
    - a Intermediate tone
    - b Alternate dots and dashes at a rate of 95 dot/dash combinations per minute
    - c Amber marker beacon light
- IM
    - a High-pitched tone
    - b Continuous dots at the rate of 6 per second
    - c White marker beacon light
- BCM (Back Course Marker)
    - a High pitched tone
    - b Two dots at a rate of 72 to 75 two dot combinations per minute
    - c White marker beacon light
- Sensitivity: can be selected as high or low
    - a Low provides the sharpest indication of position and should be used on approach

d. ADF

e. DME

f. And the respective indicator instruments

iv. Other components (not specific components but may be incorporated for safety and utility)

a. Compass Locators: Provide transition from en route NAVAIDS to the ILS system
- Assist in holding procedures, tracking the localizer course, identifying marker beacon sites, and providing a FAF for ADF approaches

b. DME collocated with Glide Slope Transmitter: Provides positive distance to touchdown info

v. Three Types

a. Category I: Provide for approach to a height above touchdown of not less than 200'

b. Category II: Provide for approach to a height above touchdown of not less than 100’
c. Category III: Provide lower minimums for approaches without a decision height minimum
- II and III require special certification for the pilots, as well as ground/airborne equipment

vi. Errors
a. Reflection: Surface vehicles/aircraft below 5,000’ AGL may disturb the signal
b. False Courses: GS facilities inherently produce additional courses at higher vertical angles
- If the approach is made at the altitudes shown on the charts, they won’t be encountered

D. Automatic Direction Finder (ADF)
i. The NDB is a ground based radio transmitter that transmits radio energy in all directions
a. The ADF, when used with an NDB, determines the bearing from the aircraft to the station
ii. The ADF needle points to the NDB ground station to determine the relative bearing
a. Relative Bearing: The number of degrees measured clockwise between the heading of the aircraft and the direction from which the bearing is taken
iii. Magnetic Heading + Relative Bearing = Magnetic Bearing
a. Mary Had + Roast Beef= Marry Barfed
b. Magnetic Heading: The direction an aircraft is pointed with respect to magnetic North
c. Magnetic Bearing: The direction to or from a radio transmitting station measured relative to magnetic North
d. NDB Components
- The ground equipment, the NDB, which transmits between 190 to 535 KHz
- The aircraft must be in operational range of the NDB
  a Depends on the strength of the station

e. ADF Components
- The airborne equipment; includes 2 antennas, a receiver, and the indicator instrument
- Antenna
  a Sense Antenna: (Non-directional) Receives signals nearly equally from all directions
  b Loop Antenna: (Bi directional) Receives signals better from 2 directions
  c When put together in the ADF it can receive well in all directions but 1
    1. Therefore, resolving any directional ambiguity
- Indicator Instrument

  a 3 kinds: Fixed card ADF, Movable Card ADF, or the RMI
  b Fixed Card ADF
    1. Always indicates 0 at the top and the needle indicates RB to the station
  c Movable Card ADF
    1. Rotates to allow the current heading to be at the top of the instrument
       a. This allows the head of the needle to indicate the MB to the station
       b. The tail indicates MB from the station

  d RMI
    1. Automatically rotates the azimuth card to represent aircraft heading
    2. Has 2 needles which can be used for nav info from either the ADF or VOR receivers
    3. When the ADF is driving the needle, the head indicates MB TO the station tuned
       a. The tail is the MB FROM the station tuned
    4. With the VOR driving, the needle shows location radially with respect to the station
       a. The needle points to the bearing TO the station
       b. The tail points to the radial of the VOR the aircraft is currently on/crossing

f. Using the NDB
- Orientation

- a The ADF needle points TO the station, regardless of heading or position
  1. RB indicated thus is the angular relationship between heading and the station
     a. Measured clockwise from the nose of the aircraft
- b Visualize the ADF dial in terms of the longitudinal axis
  1. When the needle points to 0º, the nose points directly to the station
  2. With the pointer on 210º, the station is 30º to the left of the tail
  3. With the pointed on 090º, the station is off the right wingtip
  4. The RB itself does not indicate position
     a. The RB must be related to aircraft heading to determine direction TO/FROM

E. Global Position System (GPS)

i. Satellite based navigation systems include
   a. GPS (Global Positioning System), WAAS (Wide Area Augmentation System), LAAS (Local…)

ii. GPS
   a. The GPS system is composed of 3 major elements
      - The Space Segment
        - a Composed of a constellation of 24 satellites approximately 11,000 NM above the earth
          1. Arranged so at any time, 5 are in view to any receiver (4 are necessary for operation)
          2. Each satellite orbits the Earth in approximately 12 hours
          3. Equipped with highly stable atomic clocks and transmit a unique code/nav message
        - b The satellites broadcast in the UHF range (so they are virtually unaffected by weather)
          1. Although they are subjected to line-of-sight references
             a. Must be above the horizon (as seen by the antenna) to be usable for navigation
      - The Control Segment
        - a Consists of a master control station, 5 monitoring stations, and 3 ground antennas
        - b The monitoring stations and ground antennas are distributed around the earth to allow continual monitoring and communications with satellites
          1. Nav message updates are uplinked as satellites pass over the ground antennas
      - The User Segment
        - a Consists of all components associated with the GPS receiver
          1. Range from portable, hand-held receivers to permanently installed
        - b The receiver utilizes the signals from the satellites to provide:
          1. Positioning, velocity, and precise timing to the user
   b. Solving for Location
      - The receiver utilizes the signals of at least 4 of the best positioned satellites to yield a 3D fix
        - a 3D - Latitude, longitude, and altitude
        - b Using distance/position info from the satellite, the receiver calculates its location
   c. Navigating
      - VFR navigation with GPS can be as simple as selecting a destination and tracking the course
      - GPS Tracking
        - a Course deviation is linear, there is no increase in sensitivity closer to waypoints
      - It can be very tempting to rely exclusively on GPS, but never rely on one means of navigation
   d. Receiver Autonomous Integrity Monitoring (RAIM)
      - RAIM is the GPS receiver's ability to verify the integrity (usability) of the signals received from the GPS constellation
        - a Without RAIM capability, the pilot has no assurance of the accuracy of the GPS position

- RAIM needs a minimum of 5 satellites in view, or 4 satellites and a barometric altimeter baro-aiding to detect an integrity anomaly
    - a Some receivers have the ability to isolate and remove a corrupt signal if 6 satellites, (or 5 with baro-aiding) are in view
- Generally, there are 2 types of RAIM messages
    - a One indicates that there are not enough satellites in view to provide RAIM
    - b Another indicates that the RAIM has detected a potential error that exceeds the limit required for the current phase of flight
- Aircraft using GPS navigation equipment under IFR must be equipped with an approved and operation alternate means of navigation appropriate to the route of flight, but active monitoring of the alternative navigation equipment is not required if the GPS receiver uses RAIM for integrity monitoring
    - a Active monitoring of navigation equipment is required when the RAIM capability of the GPS equipment is lost though
    - b In situations where the loss of RAIM capability is predicted to occur, the flight must rely on other approved equipment, delay departure, or cancel the flight

e. GPS Substitution

- GPS systems, certified for IFR en route and terminal operations, may be used as a substitute for ADF and DME receivers when conducting the following operations within the NAS:
    - a Determining the aircraft position over a DME fix
    - b Flying a DME arc
    - c Navigation TO/FROM an NDB/Compass Locator
    - d Determining the aircraft position over an NDB/compass locator
    - e Determining the aircraft position over a fix defined by an NDB/Compass Locator bearing crossing a VOR/LOC course
    - f Holding over an NDB/Compass Locator

iii. WAAS

a. Designed to improve the accuracy, integrity, and availability of GPS signals

- The integrity is improved through real-time monitoring of the satellites, the accuracy is improved by providing corrections to the satellites to reduce errors. As a result, performance improvement is sufficient to enable approach procedures with GPS/WAAS glidepaths

b. Approach Capabilities

- WAAS receivers support all basic GPS approach functions and provide additional capabilities with the key benefit to generate an electronic glidepath, independent of ground equipment or barometric aiding
    - a This eliminates several problems, such as cold temperature effects, incorrect altimeter setting, or lack of a local altimeter source, and allows approach procedures to be built without the cost of installing ground stations at each airport.
- A new class of approach procedures, which provide vertical guidance requirements for precision approaches, has been developed. These procedures are called Approach with Vertical Guidance (APV) and include approaches such as LNAV/VNAV procedures presently being flown

iv. LAAS

a. A ground based augmentation system that uses a GPS-reference facility located on or in the vicinity of the airport being serviced

- This facility has a reference receiver that measures GPS satellite pseudo-range and timing and retransmits the signal.
- Aircraft landing at LAAS-equipped airports are able to conduct approaches to Category I level and above for properly equipped aircraft

3. Anti-Ice/Deicing

A. General

i. Different aircraft use different systems to deice/anti-ice primary surfaces (often the wings, tail, engines and sometimes the prop)

a. These systems can vary greatly; examples include:

- Weeping Wing
  - a The DA42, for example, uses the weeping wing system – an anti-ice mixture is stored in the nose and when the system is turned on, it is excreted through tiny holes or pores in the wing. The fluid runs over the wing while in flight (i.e. weeping wing). This system is used to prevent ice build-up in flight
- Heated Surfaces
  - a Jet aircraft often take hot bleed air from the engines and vent it to the wings and tail in order to prevent ice build-up in cold/wet conditions
- Boots
  - a Boots are also often used on jets to remove ice from critical surfaces. In the case of boots, bleed air is used to inflate the leading edge "boots" in order to break up and remove ice

B. The DA40 doesn't contain any specific deice or anti-ice equipment, but two pieces of equipment that can have an effect on ice build-up are the pitot-heat and windshield defrost:

i. Pitot Heat

a. Using pitot heat is absolutely necessary in the case of potential icing. Of course, make every attempt to get out of icing or get on the ground, but pitot heat can prevent a frozen pitot/static port and therefore unreliable instrument indications

ii. Windshield Defrost

a. Can be used to deice the windshield (if the icing is light)

b. This may provide additional, needed visibility while trying to exit the icing conditions, find an airport, and safely land the aircraft

iii. The bottom line: Avoid icing conditions. Don't fly. If you get in icing conditions, leave them as soon as possible.

Conclusion:

Brief review of the main points

PTS Requirements:

To determine that the applicant exhibits instructional knowledge of aircraft:

1. Flight instrument systems and their operating characteristics to include-
   a. pitot-static system.
   b. attitude indicator.
   c. heading indicator/horizontal situation indicator/radio magnetic indicator.
   d. magnetic compass.
   e. turn-and-slip indicator/turn coordinator.
   f. electrical system.
   g. vacuum system.

   h. electronic engine instrument display.
   i. primary flight display, if installed.

2. Navigation equipment and their operating characteristics to include–
   a. VHF omnirange (VOR).
   b. distance measuring equipment (DME).
   c. instrument landing system (ILS)
   d. marker beacon receiver/indicators.
   e. automatic direction finder (ADF).
   f. transponder/altitude encoding.
   g. electronic flight instrument display.
   h. global positioning system (GPS)
   i. automatic pilot.
   j. flight management system (FMS).
   k. multifunction display, if installed.
3. Anti-ice/deicing and weather detection equipment and their operating characteristics to include-
   a. airframe.
   b. propeller or rotor.
   c. air intake.
   d. fuel system.
   e. pitot-static system.
   f. radar/lightning detection system.
   g. other inflight weather systems.

II.B. Aeromedical Factors

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

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

Instructors Notes:

Introduction:

Attention

To be safe in the airplane requires knowledge of the possible factors that could have pretty rough consequences if we were not aware of them and how to treat them. Hypoxia can result in symptoms of euphoria and the inability to make any sort of rational decision. You may be thinking you are riding a butterfly through a rainbow – which is obviously not a good thing while you're trying to fly a plane.

Overview

Review Objectives and Elements/Key ideas

What

Aeromedical factors are a number of health factors and physiological effects that can be linked to flying. Some are minor, while others are important enough to require special attention to ensure safe flight.

Why

As a pilot, it is important to stay aware of the mental and physical standards required for the type of flying done. In some cases, these factors can lead to in-flight emergencies.

How:

1. **Obtaining an Appropriate Medical Certificate**
   - A. Medical Certificate
     - i. Issued after a routine medical examination which by administered only by FAA-designated doctors called Aviation Medical Examiners (AME)
     - ii. FAA Directory of AMEs
       - a. FSDOs
       - b. FSSs
       - c. FAA Offices
     - iii. Medical Certificate with a Possible Medical Deficiency
       - a. Even with a medical deficiency, a medical certificate can be issued
         - Operating limitations may be imposed, depending on the nature of the deficiency
         - Obtain assistance from an AME and the local FSDO
           - a The assistance is only available on request
     - iv. Regulation
       - a. Once a medical is obtained, it is self-regulating
         - Can you fly with an injury, possible sickness?
           - a It's the pilot's judgment (be safe, and conservative)
     - v. A medical is not required when:
       - a. Exercising the privileges of a flight instructor certificate if the person is not acting as PIC or serving as a required flight crewmember
       - b. Exercising the privileges of a ground instructor certificate
       - c. When a military pilot of the US Armed Forces can show evidence of an up-to-date medical examination authorizing pilot flight status issued by the US Armed Forces and
         - The flight does not require higher than a 3rd class medical certificate
         - The flight conducted is a domestic flight within US airspace
     - vi. Operations requiring a Medical OR U.S. Driver's License

a. A person must hold and possess either a medical certificate or a U.S. driver's license when:
    - Exercising the privileges of a student pilot certificate while seeking sport pilot privileges in a light-sport aircraft other than a glider or balloon
    - Exercising the privileges of a sport pilot certificate in a light sport aircraft other than a glider or a balloon
    - Exercising the privileges of a flight instructor certificate with a sport pilot rating while acting as PIC or serving as a required flight crewmember of a light-sport aircraft other than a glider or a balloon
    - Serving as an examiner and administering a practical test for the issuance of a sport pilot certificate in a light-sport aircraft other than a glider or a balloon

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

      a

vii. Student Pilot Update

a. As of April 2016, the student pilot certificate is longer included on the medical

b. Student Pilot Certificate Application - FAR 61.85
    - Submit an application to a Flight Standards District Office, a designated pilot examiner, an airman certification representative associated with a pilot school, a flight instructor, or other person authorized by the Administrator
    - The FAA estimates it will take approximately 3 weeks to approve and return the new plastic student pilot certificates to applicants by mail

c. Here's more info than you'll ever need: https://www.federalregister.gov/articles/2016/01/12/2016-00199/student-pilot-application-requirements

B. BasicMed

v. Overview

c. Beginning May 1, 2017, pilots may take advantage of the regulatory relief in the new BasicMed rule and operate without an FAA medical certificate, or opt to continue to use their FAA medical certificate
    - Under BasicMed, a pilot will be required to complete a medical education course, undergo a medical examination every four years, and comply with aircraft and operating restrictions

d. FAA BasicMed Info

e. FAA BasicMed FAQ

vi. Pilot Requirements

c. Possess a U.S. driver's license

d. Have held a medical that was valid at any time after July 15, 2006.

e. Have not had the most recently held medical certificate revoked, suspended, or withdrawn.

f. Have not had the most recent application for medical certification completed and denied.

g. Have completed a medical education course described in FESSA within the past 24 calendar months

h. Have received a comprehensive medical examination from a State-licensed physician within the previous 48 months.
i. Be under the care and treatment of a physician for certain conditions
j. When applicable, have been found eligible for special issuance of a medical certificate for certain specified mental health, neurological, or cardiovascular conditions
k. Make certain health attestations and agree to a National Driver Register check

vii. Aircraft Requirements
c. Any aircraft authorized under federal law to carry not more than 6 occupants
d. Has a maximum certificated takeoff weight of not more than 6,000 pounds

viii. Basic Operating Requirements
c. Carries not more than 5 passengers
d. Operates under VFR or IFR, within the United States, at less than 18,000' MSL, and not exceeding 250 knots
e. Flight not operated for compensation or hire

2. Hypoxia

A. Hypoxia means "reduced oxygen" or "not enough oxygen"
v. The most concern is with getting enough oxygen to the brain, since it is particularly vulnerable to oxygen deprivation
vi. Hypoxia can be caused by several factors including:
c. An insufficient supply of oxygen
d. Inadequate transportation of oxygen
e. Inability of the body tissues to use oxygen

B. Hypoxic Hypoxia
v. A result of insufficient oxygen available to the lungs
vi. A blocked airway or drowning are obvious examples of how the lungs can be deprived of oxygen
c. The reduction in partial pressure of oxygen at high altitude is an appropriate example for pilots
vii. Although the percentage of oxygen in the atmosphere is constant, its partial pressure decreases proportionately as atmospheric pressure decreases
c. As the airplane ascends during flight, the percentage of each gas remains the same, but there are fewer molecules available at the pressure required for them to pass between the membranes in the respiratory system
d. This decrease of oxygen molecules at sufficient pressure can lead to hypoxic hypoxia

C. Hypemic Hypoxia
v. Occurs when the blood is not able to take up and transport a sufficient amount of oxygen to the cells in the body
vi. Hypemic means "not enough blood"
vii. This type of hypoxia is a result of oxygen deficiency in the blood
viii. Possible Causes:
c. Not enough blood volume
- Due to severe bleeding
- Due to blood donation

d. Certain blood diseases, such as anemia
e. Hemoglobin, the actual blood molecule that transports oxygen, is chemically unable to bind oxygen molecules
f. Carbon monoxide poisoning

ix. Although the effects of blood loss are slight at ground level, there are risks when flying during this time

D. Stagnant Hypoxia

v. Stagnant means "not flowing" and stagnant hypoxia results when the oxygen rich blood in the lungs isn't moving, for one reason or another, to the tissues that need it
vi. An arm or leg going to sleep because the blood flow has accidentally been shut off is one form of stagnant hypoxia
vii. This type of hypoxia can result from:
    c. Shock
    d. The heart failing to pump blood effectively
    e. A constricted artery
viii. During flight, stagnant can occur when pulling excessive positive G's
ix. Cold temperatures can also reduce circumstances and decrease the blood supplied to extremities

E. Histotoxic Hypoxia
v. The inability of the cells to effectively use oxygen
    c. "Histo" refers to tissues or cells, and "Toxic" means poison
vi. In this case, plenty of oxygen is being transported to the cells that need it, but they are unable to make use of it
vii. Causes:
    c. Alcohol and other drugs, such as narcotics and poison
        - Research shows that drinking one ounce of alcohol can equate to about an additional 2,000 ft. of physiological altitude

F. Symptoms of Hypoxia
v. The first symptoms are euphoria and a carefree feeling. With increased oxygen starvation, the extremities become less responsive and flying becomes less coordinated.
vi. As it worsens, the field of vision begins to narrow and instrument interpretation can become difficult
vii. Common symptoms include:
    c. Cyanosis (blue fingernails and lips)
    d. Headache
    e. Decreased reaction time
    f. Impaired judgment
    g. Euphoria
    h. Visual Impairment
    i. Drowsiness
    j. Lightheaded or dizzy sensation
    k. Tingling in fingers or toes
    l. Numbness
    m. Even with all of these symptoms, the effects of hypoxia can cause a pilot to have a false sense of security and be deceived into believing that everything is normal

G. Useful Consciousness
v. Describes the maximum time the pilot has to make rational, lifesaving decisions and carry them out at a given altitude without supplemental oxygen
vi. As altitude increases above 10,000 ft., the symptoms of hypoxia increase in severity, and the time of useful consciousness 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

H. Treatment
   v. Flying at lower altitudes
      c. Emergency Descent
   vi. Using supplemental oxygen

3. Hyperventilation

A. Occurs when an individual is experiencing emotional stress, fright, or pain, and the breathing rate and depth increase, although carbon dioxide level in the blood is at a reduced level
   v. The result is an excessive loss of carbon dioxide from the body, which can lead to unconsciousness due to the respiratory system's overriding mechanism to regain control of breathing

B. Pilots encountering a stressful situation may unconsciously increase their breathing rate
   v. If flying at higher altitudes, with or without oxygen, a pilot may have a tendency to breathe more rapidly than normal, which often leads to hyperventilation

C. Since many symptoms of hyperventilation are similar to those of hypoxia, it is important to correctly diagnose and treat the proper condition.

D. Common Symptoms:
   v. Headache
   vi. Decreased reaction time
   vii. Impaired judgment
   viii. Euphoria
   ix. Visual Impairment
   x. Drowsiness
   xi. Lightheaded or dizzy sensation
   xii. Tingling in fingers and toes
   xiii. Numbness
   xiv. Pale, clammy appearance
   xv. Muscle spasms

E. Treatment
   v. Involves restoring the proper carbon dioxide level in the body
   vi. If using supplemental oxygen, check the equipment and flow rate to ensure the symptoms are not hypoxia related
   vii. Breathing normally is both the best prevention and the best cure for hyperventilation
   viii. Breathing into a paper bag or talking aloud helps to overcome hyperventilation
   ix. Recovery is usually rapid once the breathing rate is returned to normal

4. Middle Ear and Sinus Problems

A. Middle Ear Problems
   v. Explanation
      c. The physiological explanation is a difference between the pressure of the air outside the body and the air inside the middle ear and nasal sinuses.
      d. The middle ear is a small cavity located in the bone of the skull
         - Normally, the pressure differences between the middle ear and the outside world are equalized by a tube leading from inside each ear to the back of the throat on each side called the *Eustachian tube*

- a These tubes are usually closed, but open during chewing, yawning or swallowing to equalize pressure.

vi. Symptoms
- c. Can be an extremely painful condition
  - Can damage the eardrums
- d. Temporary reduction in hearing sensitivity

vii. Relation to flying
- c. During a climb, middle ear air pressure may exceed the pressure of the air in the external ear canal, causing the ear drum to bulge outward
- d. During a descent, the reverse happens: while the pressure of the air in the external ear canal increases, the middle ear cavity (which equalized with the lower pressure at altitude) is at lower pressure than the external ear canal.
  - Results in the higher outside pressure causing the ear drum to bulge inward

viii. Treatment
- c. Can be difficult to relieve due to the fact that the partial vacuum tends to constrict the walls of the Eustachian tube
- d. Pinch the nostrils shut, close the lips and mouth, and blow slowly and gently in the mouth and nose
  - This forces air through the Eustachian tube into the middle ear
  - It may not be possible to equalize the pressure in the ears if a pilot has a cold, an ear infection, or sore throat
- e. If experiencing minor congestion, nose drops or nasal sprays may reduce the chance of painful ear blockage

B. Sinus Problems

v. Explanation
- c. Air pressure in the sinuses equalizes with the pressure in the cockpit through small openings that connect the sinuses to the nasal passages
- d. An upper respiratory infection (cold or sinusitis) or a nasal allergic condition can produce enough congestion around an opening to slow equalization

vi. Symptoms
- c. Excruciating pain over the sinus area
- d. A maxillary sinus block can also make the upper teeth ache
- e. Bloody mucus may discharge from the nasal passages

vii. Relation to flying
- c. As the difference in pressure between the sinus and the cockpit increases, congestion may plug the opening
- d. The “sinus block” occurs most frequently during descents

viii. Treatment
- c. Slow descent rates can reduce the associated pain
- d. Can be avoided by not flying with an upper respiratory infection or nasal allergic condition

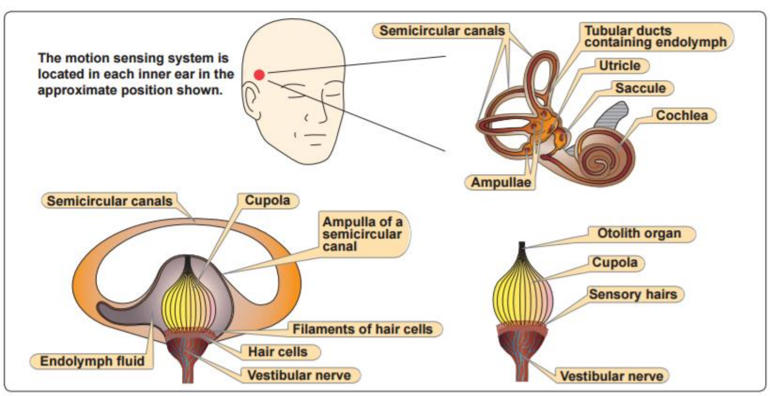
5. Spatial Disorientation

A. Explanation
- v. Orientation is the awareness of the position of the aircraft and of oneself in relation to a specific reference point
- vi. Disorientation is the lack of orientation
- vii. Spatial Disorientation specifically refers to the lack of orientation with regard to the position, attitude, or movement of the airplane in space.

viii. The body uses three integrated systems working together to ascertain orientation and movement in space
  c. Visual: The eye, by far the largest source of information
  d. Postural: The sensation of position, movement, and tension perceived through nerves, muscles, and tendons.
  e. Vestibular System: A very sensitive motion sensing system located in the inner ears. It reports head position, orientation, and movement in three-dimensional space

ix. All of this info comes together in the brain, and most of the time, the three streams of information agree, giving a clear idea of where and how the body is moving

B. Relation to flight
  v. Flying can sometimes cause these systems to supply conflicting information to the brain, which can lead to disorientation
  vi. Visual System (eyes)
    c. Flight in VMC
      - During flight the eyes are the major meteorological source and usually prevail over false sensations from other systems
    d. Flight in IMC
      - When visual cues are taken away, false sensations can cause a pilot to quickly become disoriented
  vii. Vestibular System (ears)
    c. The vestibular system in the inner ear allows the pilot to sense movement and determine orientation in the surrounding environment
    d. Two major parts: Semicircular Canals and Otolith Organs
    e. Semicircular Canals
      - Explanation
        a Detect angular acceleration
        b Three tubes at right angles to each other
          1. One on each of the three axes; pitch, roll, and yaw
        c Each canal is filled with a fluid, called Endolymph Fluid
        d In the center of the canal is the cupola, a gelatinous structure that rests upon sensory hairs located at the end of the vestibular nerves
      - How they work: In a Turn

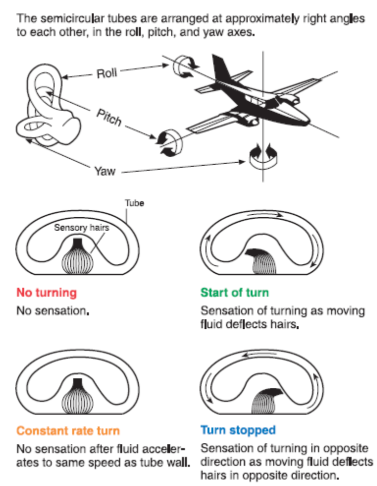


        a Turn Detection
          1. In straight and level flight, with no acceleration, the hair cells are upright, and the brain does not sense a turn

2. Placing the aircraft into a turn puts the semicircular canal and its fluid into motion, with the fluid within the semicircular canal lagging behind the accelerated canal walls
    a. This lag creates a relative movement of the fluid within the canal. The canal wall and the cupola move in the opposite direction from the motion of the fluid
3. The brain interprets the movement of the hairs to be a turn in the same direction as the canal wall

b The ear only detects turns of a short duration

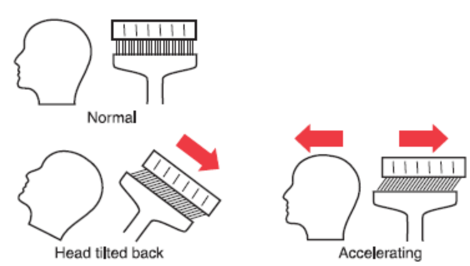
1. After approximately 20 seconds, the motion of the fluid in the canals catches up with the canal walls and the hairs are no longer bent
2. At the same speed, the hairs detect no relative movement and the sensation of turning ceases (it feels like straight and level flight)
    a. With the hair cells upright, the brain receives the false impression that the turning has stopped
3. When the aircraft rolls back to straight-and-level flight, the fluid in the canal moves briefly in the opposite direction. This sends a signal to the brain that is falsely interpreted as a turn in the opposite direction
    a. In an attempt to correct the falsely perceived turn, the pilot may reenter the original turn



c This can be demonstrated: Establish a 30° bank turn, tell the student to close their eyes and let you know when the aircraft is flying straight. Maintain the turn, after about 20 seconds the student should feel as though the aircraft is out of the turn, have them open their eyes. Try it again, but this time once they believe the aircraft is straight, roll out of the bank. The student will feel like the aircraft is turning in the opposite direction.

f. Otolith Organs

- Explanation
    - a Detect linear acceleration/gravity
    - b A gelatinous membrane containing chalk like crystals covers the sensory hairs
    - c When the pilot tilts his head, the weight of these crystals causes this membrane to shift due to gravity and the sensory hairs detect the shift
    - d The brain orients this new position to what it perceives as vertical



- Acceleration
    - a Forward acceleration gives the illusion of the head tilting backward

viii. Postural System (nerves)

c. Nerves in the body's skin, muscles, and joints constantly send signals to the brain, which signals the body's relation to gravity
d. Acceleration will be felt as the pilot is pushed back into the seat
e. False Sensations

- Forces created in turns can lead to false sensations of the true direction of gravity, and may give the pilot a false sense of which way is up
- Uncoordinated turns, especially climbing turns, can cause misleading signals to be sent to the brain
- Skids and slips give the sensation of banking or tilting
- Turbulence can create motions that confuse the brain as well
- Fatigue or illness can exacerbate these sensations and ultimately lead to subtle incapacitation

C. Countering the sensations
  v. Recognize the problem, disregard the false sensations, and while relying totally on the flight instruments, use the eyes to determine the aircraft attitude
  vi. The pilot must have an understanding of the problem and the self-confidence to control the aircraft using only instrument indications

6. Motion Sickness

A. Cause
  v. Caused by the brain receiving conflicting messages about the state of the body
  vi. Anxiety and stress are also a cause

B. Symptoms
  v. General discomfort
  vi. Nausea
  vii. Dizziness
  viii. Paleness
  ix. Sweating
  x. Vomiting

C. Treatment
  v. Open fresh air vents
  vi. Focus on objects outside the airplane
  vii. Avoid unnecessary head movement
  viii. Generally goes away after a few flight lessons
    c. After more used to flying and stress/anxiety are reduced

7. Carbon Monoxide Poisoning

A. How it Happens – In the Plane
  v. Carbon Monoxide (CO) is a colorless, odorless gas produced by all internal combustion engines
  vi. Aircraft heater vents and defrost vents provide CO a passageway into the cabin, particularly if the engine exhaust system has a leak or is damaged

B. How it Happens – In the Body
  v. CO attaches itself to the hemoglobin in the blood
    c. It does this about 200 times easier than oxygen
  vi. CO prevents the hemoglobin from carrying oxygen to the cells
    c. Resulting in Hypemic Hypoxia
  vii. It can take up to 48 hours for the body to dispose of CO
  viii. If the poison is severe enough it can result in death

C. Effects of CO
  v. Headache
  vi. Blurred vision
  vii. Dizziness
  viii. Drowsiness
  ix. Loss of muscle power

D. Detecting and Correction
    v. If a strong odor of exhaust gases is detected, assume the CO is present
        c. However, CO may be present in dangerous amounts even if no exhaust odor is detected
    vi. If exhaust odor is noticed or any symptoms are experienced immediate corrective actions should be taken
        c. Turn off the heater
        d. Open fresh air vents and windows
        e. Use supplemental oxygen, if available

8. Stress and Fatigue

A. Stress
    v. The body's response to physical and psychological demands placed upon it
    vi. Body's Reaction
        c. Releasing chemical hormones (such as adrenaline) into the blood
        d. Increasing metabolism to provide more energy to the muscles
        e. The blood sugar, heart rate, respiration, blood pressure, and perspiration all increase
    vii. Stressors
        c. Physical stress (noise or vibration)
        d. Physiological stress (fatigue)
        e. Psychological stress (difficult work or personal situations)
    viii. Categories of Stress
        c. Acute Stress (short term)
            - Involves an immediate threat that is perceived as danger
            - The type of stress that triggers a "fight or flight" response in an individual
            - Normally, a healthy person can cope with acute stress and prevent stress overload
            - On-going acute stress can develop into chronic stress
    ix. Chronic Stress (long term)
        c. A level of stress that presents an intolerable burden, exceeds the ability of an individual to cope, and causes individual performance to fall sharply
        d. Causes
            - Unrelenting psychological pressures such as loneliness, financial worries and relationship or work problems
        e. Pilots experiencing this level of stress are not safe and should not exercise their airman privileges

B. Fatigue
    v. Effects
        c. Degradation of attention and concentration
        d. Impaired coordination
        e. Decreased ability to communicate
    vi. Causes
        c. Sleep loss
        d. Exercise
        e. Physical work
        f. Stress and prolonged performance of cognitive work can result in mental fatigue
    vii. Categories
        c. Acute Fatigue (short term)
            - Definition
                a Normal occurrence in everyday life

- b Tiredness felt after a period of strenuous effort, excitement, or lack of sleep
- Skill Fatigue – A special type of acute fatigue
  - a Effects on performance
    1. Timing Disruption
       a. Appearing to perform a task as usual, but the timing of each component is slightly off.
       b. Makes a pattern of the operation less smooth as each component is performed as if it is separate instead of part of an integrated activity
    2. Disruption of the perceptual field
       a. Concentrating attention upon movements or objects in the center of vision and neglecting those in the periphery
       b. May be accompanied by loss of accuracy and smoothness in control movements
- Causes
  - a Mild hypoxia
  - b Physical stress
  - c Psychological stress
  - d Depletion of physical energy resulting from psychological stress
- Prevention
  - a Proper diet
    1. Prevents the body from having to consume its own tissues as an energy source
  - b Adequate rest and sleep
    1. Maintains the body's store of vital energy

d. Chronic Fatigue
- Definition
  - a Fatigue extending over a long period of time
  - b Usually has psychological roots, although an underlying disease is sometimes responsible
- Symptoms
  - a Weakness
  - b Tiredness
  - c Palpitations of the heart
  - d Breathlessness
  - e Headaches
  - f Irritability
  - g Stomach or intestinal problems (rare)
  - h Generalized aches and pains throughout the body
  - i Emotional Illness (when conditions become serious enough)
- Prevention
  - a Usually requires treatment by a physician

viii. Prevention

c. If suffering from acute fatigue, stay on the ground

d. Fatigue in the cockpit cannot be overcome through training or experience

e. Getting adequate rest is the only way to prevent fatigue
- Avoid flying without:
  - a A full night's rest
  - b After working excessive hours
  - c After an especially exhausting or stressful day

f. Suspected chronic fatigue should be treated by a physician

9. Dehydration

A. Definition
   v. Critical loss of water from the body
B. Effects
   v. First noticeable effect is fatigue
      c. In turn, makes top physical and mental performance difficult, if not impossible
C. How it affects flying
   v. As a pilot, flying for long periods of time hot summer temperatures or at high altitudes increases the susceptibility of dehydration since the dry air at altitude tends to increase the rate of water loss from the body
   vi. If the fluid is not replaced, fatigue progresses to dizziness, weakness, nausea, tingling of the hands and feet, abdominal cramps, and extreme thirst
D. Prevention
   v. Carry an ample supply of water to be used frequently on any long flight, whether thirsty or not
   vi. If the airplane has a canopy or roof window, wearing light colored, porous clothing and a hat will provide protection
   vii. Keep the cockpit well ventilated

10. Alcohol and Other Drugs

A. DON'T drink and fly
   v. Hangover can impair pilots
   vi. More susceptible to disorientation and hypoxia
   vii. FARS – 8 hours 'from bottle to throttle'
B. Medications
   v. Can affect pilot performance
      c. Side effects of medicines impair judgment, coordination, vision
   vi. Anything that depresses nervous system can make a pilot more susceptible to hypoxia
   vii. Do not fly while taking any medication, unless approved by the FAA

11. Nitrogen and Scuba Diving

A. Provide the body with enough time to rid itself of excess nitrogen absorbed from diving
   v. Otherwise decompression sickness can occur and create an in-flight emergency
      c. Bubbles in the bloodstream
   vi. Wait at least 12 hours after a dive which did not require a controlled ascent
      c. Before flight altitudes up to 8,000'
   vii. Wait at least 24 hours after a dive which has required a controlled ascent
   viii. For flights above 8,000' wait at least 24 hours

12. IM SAFE

A. Your own preflight
   v. Illness
   vi. Medical
   vii. Stress
   viii. Alcohol
   ix. Fatigue
   x. Emotion

Conclusion:
Brief review of the main points

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

PTS Requirements:

To determine that the applicant exhibits instructional knowledge of the elements related to aeromedical factors by describing the effects, corrective action, and safety considerations of:

1. Hypoxia.
2. Hyperventilation.
3. Middle ear and sinus problems.
4. Spatial disorientation.
5. Motion sickness.
6. Alcohol and drugs.
7. Carbon monoxide poisoning.
8. Evolved gases from scuba diving.
9. Stress and fatigue.

II.C. Regulations and Publications Related to IFR Operations

References: 14 CFR Parts 61, 71, 91, 95, and 97, Instrument Flying Handbook (FAA-H-8083-15), AIM

Objectives	The student should develop knowledge of the elements related to the FARs related to IFR certification as well as IFR flight. The student also will become familiar with publications useful to IFR flight.
Key Elements	1. Instrument Rating Requirements 2. Part 91 IFR Regs 3. Useful Publications
Elements	1. 14 CFR Part 61 2. 14 CFR Part 91 3. Instrument Flying Handbook 4. AIM 5. Practical Test Standards 6. A/FD 7. En Route Charts 8. Terminal Procedures Publication (TPP) 9. Standard Departures/Terminal Arrivals 10. Standard Instrument Approach Procedures
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the requirements and rules for IFR flight and has a basic understanding of the publications available to assist in flight and in learning.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

An overview and introduction to the various FARs governing the issuance of the instrument rating as well as the rules required for IFR flight. Furthermore, the lesson will introduce the student to a variety of publications necessary for IFR flight and learning.

Why

This lesson introduces everything that is instrument flying; the basis of how one obtains the instrument rating and how one must operate in the IFR world. It also is important to know what publications are available and necessary to comfortably operate with an instrument rating.

How:

1. **14 CFR part 61 – Certification: Pilots, Flight Instructors, and Ground Instructors**
   A. Purpose/General Content
      i. The requirements for issuing pilot, flight instructor, and ground instructor certificates and ratings
      ii. The conditions under which those certificates and ratings are necessary
      iii. Privileges and limitations of those certificates and ratings
   B. Subparts
      i. Aircraft Ratings and Pilot Authorization
         a. 61.57 - Recent Flight Experience: PIC
         b. 61.65 - Instrument Rating Requirements (Specifics are Below)
      ii. Student Pilots
      iii. Recreational Pilots
      iv. Private Pilots
      v. Commercial Pilots
      vi. Airline Transport Pilots
      vii. Flight Instructors
         a. 61.183(c)(2)(iv) – Eligibility Requirements
         b. 61.187(b)(7) – Areas of Operation
         c. 61.191 – Additional Flight Instructor Ratings
      viii. Ground Instructors
      ix. Sport Pilots

   C. **Part 61 and IFR Pilots**
      i. 61.65(a) - Instrument Rating Requirements
         a. A person who applies for an instrument rating must:
            - Hold at least a current PPL cert. with an airplane rating suitable to the Instrument Rating sought
            - Be able to read, speak, write, and understand the English language

- Receive and log ground training from an authorized instructor or accomplish a home-study course on the aeronautical knowledge areas that apply to the instr. rating sought
- Receive a logbook or training record endorsement from an authorized instructor certifying that the person is prepared to take the required knowledge test;
- Receive and log training on the areas of operation from an authorized instructor in an aircraft, flight simulator, or flight training device
- Receive a logbook or training record endorsement from an authorized instructor certifying that the person is prepared to take the required practical test
- Pass the required knowledge test on the aeronautical knowledge areas
- Pass the required practical test on the areas of operation necessary

ii. 61.65(b) - Aeronautical Knowledge
iii. 61.65(c) - Flight Proficiency
iv. 61.65(d) - Aeronautical Experience
  a. Must have logged the following:
    - At least 50 hours of X-country flight time as PIC, at least 10 hours must be in airplanes
    - 40 hours of actual or simulated instrument time on the areas of operation, to include:
      a At least 15 hours of instrument flight training from an authorized instructor in the aircraft category for which the instrument rating is sought
      b At least 3 hours of instrument training in preparation for the practical test within 2 calendar months preceding the date of the test
    - Instrument training on X-country flight procedures specific to airplanes that includes at least one X-country flight performed under IFR, and consists of—
      a A distance of at least 250 nautical miles along airways or ATC-directed routing
      b An instrument approach at each airport
      c Three different kinds of approaches with the use of navigation systems

v. 61.65(h) - Use of Flight Simulators or FTDs
vi. 61.65(i) - Use of an aviation training device
vii. 61.57(c) - Recent Flight Experience: Pilot in Command
  a. Within the last 6 months must have performed and logged under actual or simulated conditions:
      a At least 6 instrument approaches
      b Holding procedures
      c Intercepting and tracking courses through the use of navigation systems

2. Part 91 – General Operating and Flight Rules

A. Purpose/General Content
  i. Describes rules governing the operation of aircraft

B. Subparts
  i. **A** - General
  ii. **B** - Flight Rules
    a. General - 91.101
      - Preflight Action - 91.103
      - Flight Instruction; Simulated Instrument Flight… - 91.109
    b. Visual - 91.151
    c. Instrument - 91.167 up to Subpart C
  iii. **C** - Equipment, Instrument, and Certificate Requirements
    a. Instrument Flight Rules - 91.205(d)
  iv. **D** - Special Flight Operations
  v. **E** - Maintenance, Preventive Maintenance, and Alterations
    a. Inspection Requirements - 91.411
  vi. **F** - Large and Turbine Powered Multiengine Airplanes and Fractional Ownership Program Aircraft
  vii. **G** - Additional Equipment and Operating Requirements for Large and Transport Category Aircraft
  viii. **H** - Foreign Aircraft Operations and operations of US Registry Civil Aircraft Outside of the US; and rules Governing Persons on Board Such Aircraft
    a. Operating Noise Limits
    b. Waivers
    c. Fractional Ownership Operations

C. **Part 91 and IFR Pilots**
  i. Can the Airplane Fly IFR?
    a. 91.205(d) - IFR Required Instruments and Equipment
      - VFR Day Instruments (TOMATOFFLAMES)
      - VFR Night Instruments (FLAPS)
      - IFR Instruments (GRABCARD)
        a **G**enerator/Alternator of adequate capacity
        b **R**adio (Two way) and Nav. Equipment appropriate to the route
        c **A**ltimeter (Sensitive)
        d **B**all (of Turn Coordinator)
        e **C**lock (w/second hand)
        f **A**ttitude Indicator
        g **R**ate of Turn Indicator
        h **D**irectional Gyro (DG)
    b. 91.411 - Altimeter and Altitude Reporting Equipment Tests and Inspections
      - Within the preceding 24 months:
        a Each static pressure system
        b Each altimeter instrument
        c Each automatic pressure altitude reporting system
    c. 91.171 VOR Equipment Check for IFR Operations
      - The VOR must have been operationally checked within the preceding 30 days
        a VOT: Maximum bearing error is ± 4°
          1. VOR should read 180° TO or 360/0° FROM

- b Designated as a VOR system checkpoint: Maximum bearing error is ± 4°
- c Airborne checkpoint: Maximum bearing error is ± 6° degrees
- d If no check signal/point available, select a VOR radial on the centerline of a VOR airway
  1. Select a prominent ground point along the radial and maneuver directly over it
  2. Note the VOR bearing indicated; it must be ± 6° of the published radial
- e Dual system VOR: Maximum bearing error is +/- 4° of each other
  1. Ground checkpoint: ± 4°
  2. Airborne Checkpoint: ± 6°

ii. IFR Preflight

a. 91.103 - Preflight Actions

- IFR Specific:
  - a Weather reports and forecasts
  - b Fuel requirements
  - c Alternatives available if the planned flight cannot be completed
  - d Any known traffic delays which the PIC has been advised by ATC
- For any flight… runway lengths, T/O and LDG distances, etc.

b. 91. 169 - IFR Alternate Requirements

- An alternate is not required when:
  - a At least 1 hour before/1 hour after the ETA the ceiling is ≥ 2,000’ ***AND*** visibility is ≥ 3 SM
    1. If ceiling is forecast < 2,000’ **OR** visibility is forecast < 3 SM an alternate is needed
- An airport cannot be an alternate unless at the ETA, the ceiling/visibility are at/above:
  - a For a Precision Approach: 600’ and 2 SM
  - b For a Non-Precision Approach: 800’ and 2 SM
  - c No Approach: The ceiling/visibility must allow descent from MEA, Approach, LDG under VFR

c. 91.167 - Fuel Requirements

- Must carry enough fuel to:
  - a Complete the flight to the first airport of intended landing
  - b Fly from that airport to the alternate airport (if required)
  - c Fly for an additional 45 minutes at normal cruising speed

iii. IFR Departure

a. 91.173 - ATC Clearance and Flight Plan Required

- You may not operate in controlled airspace under IFR unless you have:
  - a Filed an IFR flight plan
  - b Received an appropriate ATC clearance

b. 91.175 - Takeoff and Landing Under IFR

- 0/0 takeoffs are legal under part 91
  - a Recommended to use published T/O minimums or approach minimums (if no T/O) as a guideline

iv. IFR En Route

a. 91.177 - Minimum Altitudes for IFR Operations

- Except for T/O’s and LDGs, you may not operate below:
  - a The applicable minimum altitudes prescribed in parts 95 and 97
  - b However, if no minimum is prescribed:
    1. Mountainous Area: 2,000’ above the highest obstacle w/in 4 nm of the course flown
    2. Non-Mountainous: 1,000’ above the highest obstacle w/in 4 nm of the course flown

- If an MEA and MOCA are prescribed, you may operate below the MEA, but not below the MOCA, when w/in 22 NM of the VOR concerned
- Climb to a higher minimum IFR altitude immediately after passing the point beyond which that minimum altitude applies
  - a Except when ground obstructions intervene, the point shall be crossed at or above the applicable MCA

b. 91.179 - IFR Cruising Altitude or Flight Level
- Controlled Airspace: Maintain the altitude of FL assigned by ATC
  - a If cleared for VFR on top, maintain altitude based on 91.159
- Uncontrolled Airspace: Below 18,000' MSL, and
  - a On a magnetic course of 0° through 179°: Any ODD Thousand-foot MSL altitude
  - b On a magnetic course of 180° through 359°: Any EVEN Thousand-foot MSL altitude

c. 91.181 - Course to be Flown
- You must:
  - a Be on an ATS route, along the centerline of that airway
  - b On any other route, along the direct course between nav aids or fixes defining the route
    1. Doesn't prohibit maneuvering to pass well clear of other aircraft/clearing flight path

d. 91.183 - IFR Communications
- You must report the following as soon as possible
  - a The **time/altitude** of passing each designated reporting point or those desired by ATC
    1. Except while under radar control: Report those specifically requested by ATC
  - b Any **unforecast weather conditions** encountered
  - c Any other information relating to the **safety** of the flight

e. 91.185 - IFR Operations: Two-Way Radio Communications Failure
- VFR Conditions: Continue the flight under VFR and land as soon as practicable
- IFR Conditions: Continue the flight according to the following rules:
  - a Route - AVE F (In order of importance; if one is absent move to the next)
    1. **A**ssigned - By the route assigned in the last ATC clearance received
    2. **V**ectored - By the direct route from the point of failure to where being vectored
    3. **E**xpect - By the route ATC has advised may be expected in a further clearance
    4. **F**iled - By the route filed in the flight plan
  - b Altitude - MEA (The highest of the following altitudes)
    1. **M**inimum Altitude – The minimum altitude prescribed for IFR operations (MEA)
    2. **E**xpected - The altitude ATC has advised may be expected in a further clearance
    3. **A**ssigned - The altitude assigned in the last ATC clearance received
  - c Leaving a Clearance Limit
    1. If the limit is a fix from which an approach begins:
       a. Commence descent as close as possible to the expect further clearance time
          i. If one has not been received, leave as close as possible to the ETA filed
    2. If the limit is not a fix from which an approach begins:
       a. Leave the limit at the expect further clearance time
       b. If one has not been received, leave upon arrival over the clearance limit and proceed to a fix from which an approach begins and commence descent as close as possible to the ETA filed

f. 91.187 - Operations Under IFR in Controlled Airspace: Malfunction Reports
- The PIC shall report as soon as practical to ATC any malfunctions of:
  - a Nav Equipment

    - b Approach Equipment
    - c Communication Equipment
  - In each report, include:
    - a Aircraft Identification
    - b Equipment Affected
    - c Degree to which the capability of the pilot to operate IFR under ATC is impaired
    - d Nature and extent of assistance desired from ATC

v. IFR Approaches
  a. 91.175(a)(c) - Takeoff and Landing Under IFR
    - When an instrument approach is necessary, must use one given in part 97 for that airport
    - May not operate below the authorized MDA or continue below the DA/DH unless:
      - a The aircraft is continuously in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal maneuvers
      - b The flight visibility is not less than that prescribed in the approach being used
      - c At least one of the following visual references for the intended runway is distinctly visible/identifiable:
        1. The approach light system
           a. May not descend below 100' above the TD zone elevation using the approach lights unless the red terminating bars or the red side row bars are visible and identifiable
        2. The Threshold
        3. The Threshold Lights
        4. The Runway End Identifier Lights
        5. The Visual Approach Slope Indicator
        6. The Touchdown Zone or TD Zone Markings
        7. The TD Zone Lights
        8. The Runway or Runway Markings
        9. The Runway Lights

vi. 91.175(k) ILS Components
  a. The following means may be used to substitute for an OM
    - Compass Locator
    - Precision Approach Radar or Airport Surveillance Radar
    - DME, VOR, or NDB fixes authorized in the standard instrument approach procedures
    - Suitable RNAV system in conjunction with a fix identified in the approach procedures

vii. 91.175(d) - Landing
  a. May not land if the flight visibility is less than the visibility prescribed in the approach being used

viii. 91.175(e) - Missed Approach Procedures
  a. Immediately execute a missed approach when either of the following conditions exist:
    - When operating under paragraph (c) and the requirements aren't met when:
      - a The aircraft is being operated below MDA
      - b Upon arrival at the missed approach point, including a DA/DH where a DA/DH is specified and its use is required, and at any time after that until touchdown
    - Whenever an identifiable part of the airport is not distinctly visible during a circling maneuver at or above MDA

ix. 91.175(j) - Limitations on Procedure Turns
  a. No pilot may make a procedure turn (unless cleared to do so) in the case of:
    - A radar vector to a final approach course or a fix

- A timed approach from a holding fix
- An approach for which the procedure specifies “No PT”

D. Part 95 – IFR Altitudes
    i. Prescribes altitudes governing the operation of aircraft under IFR on ATS routes, or other direct routes for which an MEA is designated in this part
        a. In addition, it designates mountainous areas and changeover points
    ii. Subparts
        a. General
        b. Designated Mountainous Areas
        c. En Route IFR Altitudes Over Particular Routes and Intersections
        d. Changeover Points
E. Part 97 – Standard instrument Procedures
    i. Subparts
        a. General
        b. Procedures
        c. TERPS Procedures

3. Instrument Flying Handbook

A. Purpose
    i. Designed for use by instrument flight instructors and pilots preparing for instrument rating tests
        a. The discussion and explanations reflect the most commonly used practices and principles
    ii. All of the aeronautical knowledge and skills required to operate in IMC are detailed
B. General Content
    i. Human/Aerodynamic Factors in Instr. Flight
    ii. The Flight Instruments
    iii. Attitude Instrument Flying for Airplanes
    iv. Basic Flight Maneuvers used in IMC
    v. Attitude Instrument Flying for Helicopters
    vi. Navigation Systems
    vii. The National Airspace System (NAS)
    viii. The Air Traffic Control (ATC) system
    ix. IFR Flight Procedures
    x. IFR Emergencies
C. Revised occasionally by the FAA to update the latest practices (latest version is 2007)

4. Aeronautical Information Manual (AIM)

A. Provides pilots with a vast amount of basic flight info and ATC procedures in the US
B. The AIM has a comprehensive and useful index to help find topics of interest

5. Practical Test Standards

A. FARS specify areas in which knowledge/skill must be shown before the issuance of a certificate
    i. FARS provide flexibility to permit the FAA to publish PTSs with the tasks skill must be shown
B. Current PTSs
    i. Sport, Private, Instrument, Commercial, Flight Instructor (Instrument), ATP and Type Rating

6. AFD

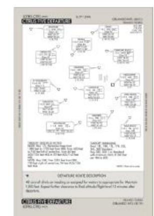
A. A Civil Flight Information Publication published/distributed every 8 weeks by NACO
    i. NACO – National Aeronautical Charting Office, a division of the FAA
B. Directory of all airports, seaplane bases, and heliports open to the public; communication data; nav facilities; and certain special notices and procedures
C. A directory is published for each of seven geographical districts (NW, SW, NC, SC, EC, NE, SE)
D. The A/FD is a vital publication for cross country planning
    i. All pertinent info regarding airports, FSS contact info, etc. is contained in the AFD

7. En Route Charts (Low Altitude)

A. Aeronautical charts for en route IFR navigation in the low stratum (below 18,000' MSL)
B. Purpose
    i. The equivalent of the VFR sectional chart
    ii. Allows one to effectively depart and navigate en route under instrument conditions
C. General Content

i. Airport Information
ii. Charted IFR Altitudes
  a. MEA – Minimum En Route Altitude
  b. MOCA – Minimum Obstacle Clearance Altitude
  c. MRA – Minimum Reception Altitude
  d. MCA – Minimum Crossing Altitude
  e. MAA – Maximum Authorized Altitude
iii. Navigation Features
  a. NAVAIDS
  b. Airways and Intersections
  c. Other Route Information
  d. Weather Information and Communication Features
    - RCO
    - HIWAS

D. Revision
  i. Revised every 56 days

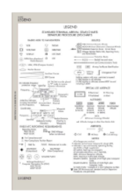
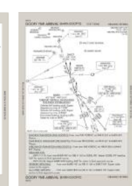



8. Terminal Procedures Publication (TPP)

A. Published by NACO
B. Includes approach procedures, arrival and DPs, and airport diagrams by region

9. Standard Departures/Terminal Arrivals

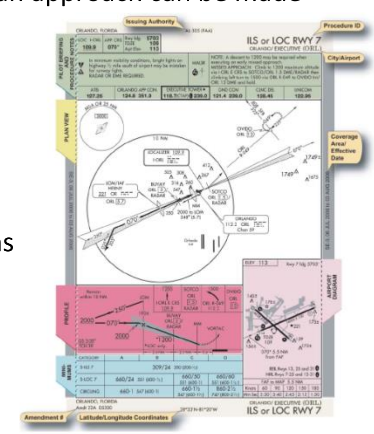
A. Departure Procedures
  i. Preplanned IFR ATC departure/obstacle avoidance procedures, published for use in textual and graphic format
  ii. Textual DPs are listed by airport in the *IFR T/O Mins and Departure Procedures* section (C) of the TPP
  iii. Graphic DPs are included after the respective airport's IAP
  iv. Purpose
    a. Provide obstacle clearance protection, while reducing communications and departure delays
    b. They provide a way to depart the airport and transition to the en route phase safely
  v. General Content
    a. Both textual and graphical
    b. Provide clearance provided the aircraft clears the end of the runway at least 35' AGL, climbs to 400' above airport elevation before turning, and climbs at least 200' per NM
      - Unless a higher climb gradient is specified
  vi. Revisions
    a. Every 56 days

B. Standard Terminal Arrival Routes (STARs)
  i. Preplanned IFR ATC arrival procedures, published for use in textual and graphic format
  ii. STARs are shown by airport in the *Standard Terminal Arrival Charts* section (P) of the TPP
  iii. Purpose
    a. Transition from the en route structure to a terminal area fix, where an approach can be made
  iv. General Content
    a. Graphical with textual description
  v. Revisions
    a. Every 56 days

10. Standard Instrument Approach Procedure Charts

A. Purpose
  i. Provide the method to descend and land safely in low visibility conditions
B. General Content
  i. Maneuvers, including altitude changes, course corrections, and other limitations are prescribed in the IAPs
  ii. Main Sections
    a. Margin Identification



- The top and bottom areas on an IAP that depict info about the procedure including airport location and procedure identification

b. Plan View
- Overhead view of an approach procedure on an IAP chart

c. Profile View
- Side view of an approach procedure on an IAP chart illustrating the vertical approach path altitudes, headings, distances, and fixes

d. Landing Minimums (and notes)
- The area on an IAP chart that displays the lowest altitude and visibility requirements for the approach

e. Airport Diagram
- The section of an IAP chart that shows a detailed diagram of the airport including surface features and airport configuration information

C. Revisions

i. Revised every 56 days

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant exhibits instructional knowledge of the elements related to regulations and publications, (related to instrument flight and instrument flight instruction) their purpose, general content, availability, and method of revision by describing:

1. 14 CFR parts 61, 71, 91, 95, and 97.
2. FAA-H-8083-15, Instrument Flying Handbook.
3. Aeronautical Information Manual.
4. Practical Test Standards.
5. Airport Facility Directory.
6. Standard Instrument Departures/Terminal Arrivals.
7. En Route Charts.
8. Standard Instrument Approach Procedure Charts.

II.D. Logbook Entries Related to Instrument Instruction

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

Objectives	This lesson applies to the instructor. The instructor should understand how to log flight instruction as well as the endorsements required for IFR operations.
Key Elements	1. Logging Time 2. Endorsements
Elements	1. Logbook Entries 2. Practical test Recommendation 3. IPC Endorsement 4. Flight Instructor Records
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP’s Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP’s Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The instructor is competent logging time and endorsing a student as necessary.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

Logging time and signing off students for checkrides and instrument proficiency checks while maintaining the proper documentation.

Why

It's your job.

How:

1. **Logbook Entries**
    A. 61.51 (g): Logging Instrument Flight Time
        i. May log instrument time only for that flight time when the person operates the aircraft solely by reference to instruments under actual or simulated instrument flight conditions
        ii. An instructor may log instrument time when instructing in actual IFR conditions
    B. A flight sim/FTD may be used for instrument time, provided an instructor is present
        i. FAR 61.51(g): A person may use time in a full flight simulator, flight training device, or aviation training device for acquiring instrument aeronautical experience for a pilot certificate or rating provided an authorized instructor is present to observe that time and signs the person's logbook or training record to verify the time and the content of the training session.
        ii. **Effective July 27, 2018, an instructor does not need to be present to accomplish required recency experience in a flight simulator or aviation training device. FAR 61.51(g):
            a. A person may use time in a full flight simulator, flight training device, or aviation training device for satisfying instrument recency experience requirements provided a logbook or training record is maintained to specify the training device, time, and the content (no instructor required)
        iii. **Effective November 26, 2018, recency requirements accomplished in an ATD will expire every 6 months (rather than 2 months), and any combination of aircraft and ATD will be able to satisfy the recency requirements
    C. The following must be recorded in the logbook to meet the recent experience requirements (61.57(c)):
        i. The location and type of instrument approach accomplished
        ii. The name of the safety pilot, if required
        iii. 61.51(b) – Logbook Entries; Also enter
            a. Date
            b. Total Flight Time or Lesson Time
            c. Location of Departure and Arrival
                - For sim, where the lesson occurred
            d. Type and ID of aircraft, sim, FTD
            e. Type of experience or training
            f. Conditions of flight
    D. Ground Instruction

    i. Must have received and logged ground training from an instructor on 61.65(b)
        a. 61.51(h) – Logging Training Time
            - Training time must be logged in a logbook and must:
                a Be endorsed in a legible manner by the authorized instructor
                b And Include:
                    1. Description of the training given
                    2. Length of the training lesson
                    3. Instructor's signature, certificate number, and expiration date

2. **Practical Test Recommendation**
    A. Hold at least a PPC
    B. Read, speak, write, understand English
    C. Receive and log ground training from an authorized instructor or accomplish a home study course of training the aeronautical knowledge areas of paragraph 61.65(b)
    D. Receive an endorsement certifying the person is prepared for the knowledge test and pass it
    E. Receive and log training in the areas of operation of paragraph 61.65(c)
    F. Receive an endorsement certifying the person is prepared for the practical test
        i. I certify that (____) has received the required training of section 61.65(c) and (d). I have determined he/she is prepared for the instrument airplane practical test.
        ii. I certify that within the last 2 calendar months I have given Mr./Ms. [Name] the flight instruction required by FAR 61.65(c)(1) through (8) and ground instruction required by FAR 61.65(b)(1) through (10) including a review of those areas found deficient on the instrument pilot knowledge test and find him/her competent to perform each pilot operation safely as an Instrument Pilot in and Airplane
3. **IPC Endorsement**
    A. I certify that (name), (pilot cert), (cert #), has satisfactorily completed the instrument proficiency check of section 61.57(d) in a (make and model aircraft) on (date)
4. **61.189 – Flight Instructor Records**
    A. A flight instructor must sign the logbook of each person to whom that instructor has given flight training or ground training
    B. Must maintain a record of the name of each person endorsed for a knowledge or practical test
        i. Also record the kind of test, the date, and the results
            a. Maintain the records for at least 3 years

Conclusion:
Brief review of the main points

PTS Requirements:

To determine that the applicant exhibits instructional knowledge of logbook entries related to instrument instruction by describing:

1. Logbook entries or training records for instrument flight/instrument flight instruction or ground instruction given.
2. Preparation of a recommendation for an instrument rating practical test, including appropriate logbook entry.
3. Required endorsement of a pilot logbook for satisfactory completion of an instrument proficiency check.
4. Required flight instructor records.

PREFLIGHT PREPARATION

III.A. Weather Information

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

Objectives	The student should develop knowledge of the elements related to weather information with the ability to interpret several sources and make a well-educated Go/No Go decision.
Key Elements	1. Information Sources 2. EFAS – 122.0 3. Go/No Go Decision
Elements	1. Importance of a Thorough Weather Briefing 2. Weather Information Sources 3. Weather Theory 4. METAR, TAF, FA 5. Surface Analysis Chart 6. Radar Summary Chart 7. Significant Weather Prognostic Chart 8. Winds and Temperatures Aloft Chart 9. Freezing Level Chart 10. Stability Chart 11. Convective Outlook Chart 12. SIGMETs, AIRMETs, and PIREPs 13. ATIS, AWOS, ASOS Reports 14. Go/No Go Decision 15. Alternate Requirements
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign Homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can effectively interpret weather information and has the ability to make a competent Go/No Go decision.

Instructors Notes:

Introduction:

Attention

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

Overview

Review Objectives and Elements/Key ideas

What

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

Why

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

How:

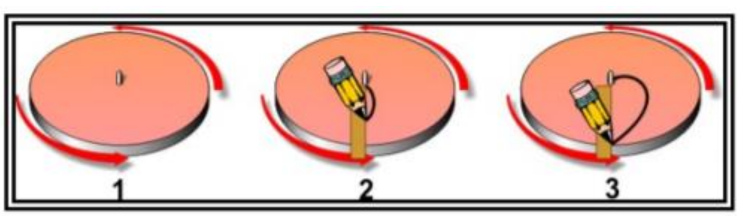
1. **Importance of a Thorough Weather Briefing**
   - A. 1st step in determining if the flight can be conducted safely and where and when problems may occur
   - B. 91.103 – You are required to become familiar with the weather reports and forecasts
   - C. Weather can be dangerous, if you know what to expect, unforecast conditions will alert you to hazards
2. **Weather Information Sources**
   - A. General Awareness of the Overall Weather
     - i. TIBS – Transcribed Information Briefing Service
       - a. Continuous telephone recordings of meteorological and aeronautical info (Phone #'s in the AFD)
         - Specifically, area and route briefings, airspace procedures, and special announcements
     - ii. PATWAS – Pilots Automatic Weather Answering Service
       - a. No longer described in Aviation Weather Services
     - iii. TWEB – Transcribed Weather Broadcast ('T' in the upper right corner of the navaid ID box)
       - a. Weather report transmitted continuously over a selected navaid
         - Route orientated info - Route forecast, forecast outlook, winds aloft, other selected weather
           - a For an area w/in 50 nm of FSS
         - Valid for 12 hours and updated 4 times a day
     - iv. TV/Internet
   - B. Detailed Briefing (Specific to the flight)
     - i. FSS (1-800-WX BRIEF)
       - a. Primary source for preflight weather
     - ii. DUAT(S)
     - iii. NWS – National Weather Service
     - iv. SWSL – Supplemental Weather Service Location
       - a. FSS/DUATS proved NOTAM info and filing of flight plans, while NWS/SWSL provide weather only
   - C. Inflight Weather
     - i. EFAS (Flight Watch) – 122.0
       - a. Weather advisories tailored to the type of flight, route, cruising altitude
       - b. 6 a.m. – 10 p.m. from 5,000' AGL to 17,500' AGL
     - ii. HIWAS ('H' in the upper right corner of the navaid identification box)

      a. Hazardous weather info broadcast continuously over selected navaids
         - AIRMETs, SIGEMTs, Convective SIGEMTs, urgent PIREPs
   iii. TWEB

3. **Weather Theory** (AC 00-6B is a great reference)
   A. Atmospheric Composition and Stability
      i. Atmospheric Composition
         a. Composition
            - 4 gases make up 99.998% of the Earth's atmosphere
               a Nitrogen (by far the most common), Oxygen, Argon and Carbon Dioxide
         b. Vertical Structure
            - The Earth's atmosphere is divided into 5 concentric layers based on the vertical profile of average air temperature changes, chemical composition, movement and density
               a Troposphere
                  1. Begins at the Earth's surface and extends up to about 36,000' high. As the gases decrease with height, the air becomes thinner, therefore the temperature also decreases with height. Almost all weather occurs in this region
                  2. The vertical height of the troposphere varies due to temperature variations. The transition layer between the troposphere and they layer above is called the tropopause
               b Stratosphere
                  1. Extends from the tropopause up to 31 miles above the Earth's surface. This layer holds 19% of the atmosphere's gases, but very little water. Temperature increases with height due to the absorption of UV radiation
                  2. Commercial aircraft often cruise in the lower stratosphere to avoid atmospheric turbulence and convection in the tropopause
                     a. Disadvantages of flying in the stratosphere include increased fuel consumption due to warmer temperatures, increased levels of radiation, and increased ozone concentrations
               c Mesosphere
                  1. Extends from the Stratopause to about 53 miles above the Earth. The gases, continue to become thinner so the warming becomes less and less pronounced, leading to a decrease in temperature with height
               d Thermosphere
                  1. Extends from the Mesopause to 430 miles above the Earth. This layer is known as the upper atmosphere. The gases become increasingly thin compared to the mesosphere and only the higher energy UV and X ray radiation from the sun is absorbed. Because of this absorption, the temperature increases with height and can reach as high as 2,000 degrees Celsius near the top of the layer
                     a. Despite the high temperature, this layer of the atmosphere would still feel very cold to our skin, because of the extremely thin air
               e Exosphere
                  1. The outermost layer of the atmosphere, and extends from the thermopause to 6,200 miles above the Earth. In this layer, atoms and molecules escape into space and satellites orbit the Earth
         c. Standard Atmosphere
            - Continuous fluctuations of atmospheric properties create problems for engineers and meteorologists who require a fixed standard for reference. To solve this problem, they defined a standard atmosphere, which represents an average of conditions throughout the

atmosphere for all latitudes, seasons, and altitudes. Standard atmosphere is a hypothetical vertical distribution of atmospheric temperature, pressure, and density that, by international agreement, is taken to be representative of the atmosphere for purposes of pressure altimeter calibrations, aircraft performance calculations, aircraft and missile design, ballistic tables, etc.

B. Wind
   i. Wind is the air in motion relative to the surface of the Earth. Winds cause the formation, dissipation, and redistribution of weather
   ii. Forces that Affect the Wind
      a. Pressure Gradient Force
         - Wind is driven by different pressures which create the Pressure Gradient Force (PGF). Whenever a pressure difference develops over an area, the PGF makes the wind blow in an attempt to equalize the pressure differences.
            a This force is identified by height contour gradients and constant pressure charts and by isobar gradient on surface charts
         - PGF is directed from higher pressure to lower pressure and is perpendicular to contours/isobars
         - Wind speed is directly proportional to the PGF which is directly proportional to the contour/isobar gradient
            a Closely spaced contours/isobars indicate strong winds, while widely spaced indicates light winds
         - Wind would flow from high to low pressure if the PGF was the only force acting on it, however because of the Earth's rotation, the Coriolis force affects the direction of wind flow as well
      b. Coriolis Force
         - A moving mass travels in a straight line until acted on by some outside force. However, if one views the moving mass from a rotating platform, the path of the moving mass relative to his platform appears to be deflected or curved.
            a To illustrate, consider a turntable. If one used a pencil and a ruler to draw a straight line from the center to the outer edge of the turntable, the pencil will have traveled in a straight line. However, stopping the turntable, it is evident that the line spirals outward from the center. To a viewer on the turntable, some apparent force deflected the pencil to the right.



         - The force deflects air to the right in the Northern Hemisphere and left in the Southern Hemisphere
      c. Friction
         - Friction between the wind and the terrain surface slows the wind. The rougher the terrain, the greater the frictional effect and the stronger the wind speed, the greater the friction.
         - The frictional drag of the ground normally decreases with height and becomes insignificant above the lowest few thousand feet or so.

- In the atmosphere above the friction layer, only the PGF and Coriolis force affect the horizontal motion of the air.

C. Temperature

i. Temperature

a. Temperature is one of the most basic variables used to describe the state of the atmosphere
b. Heat is the total kinetic energy of the atoms and molecules composing a substance.
c. Temperature is a numerical value representing the average kinetic energy of the atoms and molecules within matter. Higher temperatures indicate a higher average kinetic energy and lower indicate a lower average kinetic energy. Temperature is an indicator of the internal energy of air.
d. Heat Transfer
    - Heat transfer is energy transfer as a consequence of temperature difference
        a When an object or fluid is at a different temperature than its surroundings heat transfer occurs in such a way that the object or fluid and the surroundings reach thermal equilibrium (balance)
    - 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:
        a Radiation
            1. Standing in front of a fireplace or near a campfire is an example of radiation. The side of your body nearest the fire warms, while your other side remains unaffected by the heat. Although you are surrounded by air, the air has nothing to do with this type of heat transfer.
                a. The sun radiates heat to the Earth

        b Conduction
            1. The transfer of energy by molecular activity from one substance to another in contact, or through, a substance
                a. Heat always flows from the warmer substance to the colder substance
                b. The warmer substance cools and loses heat energy while the cooler substance warms and gains energy

        c Convection
            1. The transport of heat within a fluid, such as air or water, via motions of the fluid itself
                a. Water boiling in a pot is an example of convection
            2. Because air is a poor thermal conductor, convection plays a vital role in the Earth's atmospheric heat transfer process

ii. Heat and the Earth

a. Water is much more resistant to temperature changes than land. It warms up and cools down more slowly than land and helps moderate nearby air temperature
    - This is why islands and ocean cities experience smaller seasonal temperature variations than inland locations
b. Temperature's generally decrease at an average rate of 2 degrees Celsius per 1,000'
    - But, in the troposphere, sometimes temperature remains constant with altitude changes or increases with changes in altitude
        a Isothermal Layer: A layer within the atmosphere where the temperature remains constant with height
        b Temperature Inversion: A layer in which the temperature increases with altitude
            1. If the base is at the surface, it is a surface-based inversion

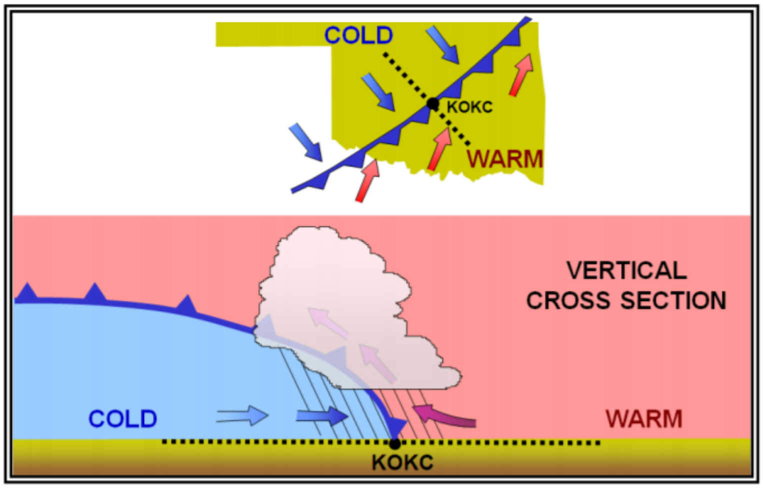
a. Typically occurs over land on clear nights with light wind. The ground radiates and cools much faster than the overlying air. Air in contact with the ground becomes cool, while the temperature a few hundred feet above changes very little. Thus, temperature increases with height.

2. If it is not at the surface, it is an inversion aloft
    a. For example, a current of warm air aloft overrunning cold air near the surface produces an inversion aloft
3. The principle characteristic of an inversion layer is its marked stability, so that very little turbulence can occur within it.

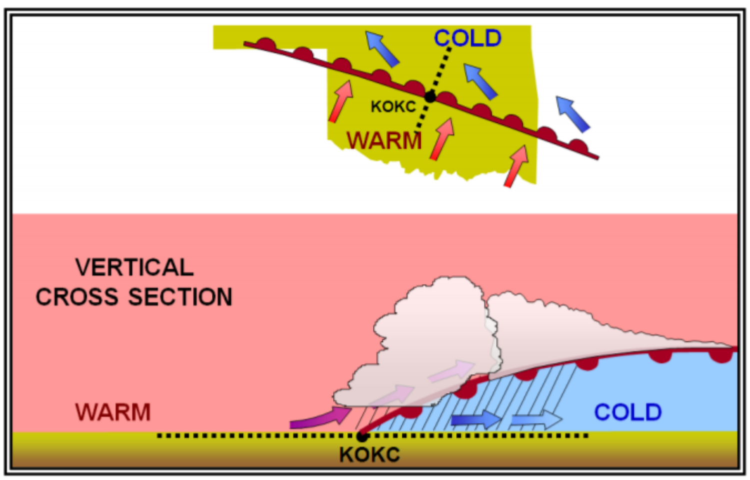
D. Moisture/Precipitation
  i. Necessary Ingredients
    a. Water Vapor
    b. Sufficient Lift to condense the water vapor into clouds
    c. Growth Process that allows could droplets to grow large and heavy enough to fall as precipitation
      - All clouds contain water, but only some produce precipitation. This is because cloud droplets and/or ice crystals are too small and light to fall to the ground as precipitation.
      - Two growth processes exist which allow cloud droplets to grow large enough to reach the ground as precipitation
        a Collision-Coalescence (warm rain process)
          1. Collisions occur between cloud droplets of varying size and different fall speeds, sticking together or coalescing to form larger drops. Finally, the drops become too large to be suspended in the air, and they fall to the ground as rain.
          2. This is the primary growth process in warm, tropical air masses where the freezing level is very high
        b Ice Crystal Process
          1. This occurs in colder clouds when both ice crystals and water droplets are present. In this situation, it is easier for water vapor to deposit directly onto the ice crystals. The crystals eventually become heavy enough to fall. If it is cold near the surface it may snow, otherwise, the snowflakes may melt to rain
          2. This is thought to be the primary growth process in mid and high latitudes.
  ii. Precipitation Types
    a. The vertical distribution of temperature will often determine the type of precipitation that occurs at the surface
    b. Snow
      - Occurs when the temperature remains below freezing throughout the entire depth of the atmosphere
    c. Ice Pellets
      - Occur when there is a shallow layer aloft with above freezing temperatures with a deep layer of below freezing air based at the surface
        a As snow falls into the shallow warm layer, the snowflakes partially melt. As the precipitation reenters the air that is below freezing, it refreezes into ice pellets
    d. Freezing Rain
      - Occurs when there is a deep layer aloft with above freezing temperatures and with a shallow layer of below freezing air at the surface
        a It can begin as rain or snow, but all becomes rain in the warm layer. The rain falls back into below freezing air, but since the depth is shallow, the rain does not have time to freeze into ice pellets. The drops freeze on contact with the ground or exposed objects

e. Rain
   - Occurs when there is a deep layer of above freezing air based at the surface

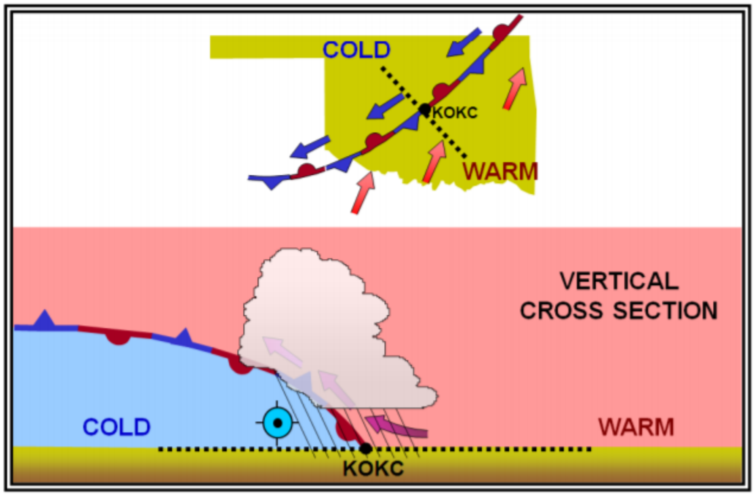
E. Weather System Formation, Including Air Masses and Fronts
   i. Air Masses
      a. A large body of air with generally uniform temperature and humidity. The area from which an air mass originates is called a source region
         - Source Regions range from extensive snow-covered polar areas to deserts to tropical oceans. The longer an air mass stays over its source region, the more likely it will acquire the properties of the surface below.
      b. Air masses are classified according to temperature and moisture properties of the source region
         - Temperature Properties
            a Arctic – Extremely deep cold air mass which develops mostly in winter over arctic surfaces of ice and snow
            b Polar – A relatively shallow cool to cold air mass which develops over high latitudes
            c Tropical – A warm to hot air mass which develops over low latitudes
         - Moisture Properties
            a Continental – A dry air mass which develops over land
            b Maritime – A moist air mass which develops over water
         - Types of Air Masses (Temperature + Moisture Properties)
            a Continental Arctic – Cold, dry
            b Continental Polar – Cold, dry
            c Continental Tropical – Hot, dry
            d Maritime Polar – Cool, moist
            e Maritime Tropical – Warm, moist
            f Maritime Arctic seldom, if ever, forms
      c. Air Mass Modification
         - As air moves around the Earth, they can acquire different attributes
            a For example, in the winter an arctic air mass (cold and dry) can move over the ocean, picking up warmth and moisture from the warmer ocean and become a maritime polar air mass
   ii. Fronts
      a. Air masses can control weather for a relatively long-time period ranging from days to months. Most weather occurs along the periphery of these air masses at boundaries called fronts. A front is a boundary or transition zone between two air masses
         - Fronts are classified by which type of air mass (cold or warm) is replacing the other
      b. Fronts are usually detectable at the surface in a number of ways:
         - Significant temperature gradients
         - Winds usually converge
         - Pressure typically decreases as a front approaches and increases after it passes
      c. Fronts do not only exist at the surface, they have a vertical structure as well
         - Cold fronts have a steep slope, and the warm air is forced up abruptly
            a 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



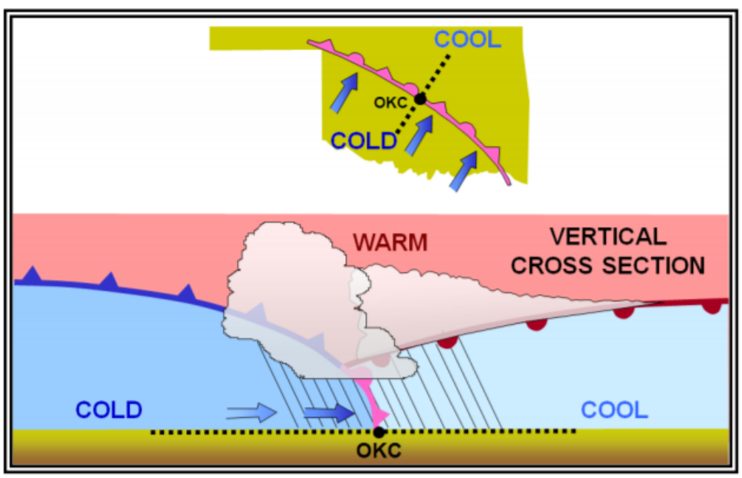
- Warm fronts have a gentle slope, so the warm air rising along the frontal surface is gradual
  a This favors the development of widespread layered or stratiform cloudiness and precipitation along, and ahead of, the front is the warm rising air is stable



- Stationary frontal slopes can vary, but clouds and precipitation would still form in the warm rising air along the front



- Occluded Fronts
  a 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
    1. The cold air undercuts the retreating cooler air mass associated with the warm front, further lifting the already rising warm air
    2. Clouds and precipitation can occur in the areas of frontal lift along, ahead of, and behind the surface position of an occluded front



F. Clouds
  i. Cloud Levels
    a. The part of the atmosphere in which clouds are usually present has been divided into three levels: High, Middle, and Low
  ii. Cloud Types
    a. In each level, the clouds may be divided my type
    b. High Clouds
      - Cirrus
        a Detached cirriform elements on 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

- Cirrocumulus
    a 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.

- Cirrostratus
    a 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.

c. Middle Clouds
- Altocumulus
  a 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.

- Altocumulus Lenticularis
  a Commonly known as Altocumulus Standing Lenticular, they are an orographic (of or relating to mountains) type of cloud. They often appear to be dissolving in some places and forming in others. They often form in patches in the shape of almonds or wave

clouds which is caused by wave motions in the atmosphere, and are frequently seen in mountainous or hilly areas. The cloud elements form at the windward edge of the cloud and are carried to the downwind edge where they evaporate. The cloud as a whole is usually stationary or slow moving.

b The ASCL clouds indicate the position of the wave crests but do not necessarily give an indication of the intensity of turbulence or strength of updrafts and downdrafts. A well-defined wave may be visible in weak updrafts where there is an adequate supply of moisture, but may not be visible when the environment is very dry, even if the wave is intense.

- Altostratus
  a 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 and may cover an area of several thousand square miles. The layer has parts thin enough to reveal the position of the sun and if can have irregularly shaped and spaced gaps and rifts.
  b Within the large vertical extent of the cloud, very distinguished layers exist:
    1. An upper part of mostly or entirely ice crystals
    2. A middle part of mixed ice crystals and/or snowflakes and super cooled water droplets
    3. A lower part of mostly or entirely super cooled or ordinary water droplets
  c Pilots can expect little or no turbulence, but light to moderate icing in the super cooled water regions

- Nimbostratus
  a A gray cloud layer, often dark, rendered diffuse by more of 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 of failing raindrops and/or snow crystals or snowflakes. Nimbostratus has no well-defined base, but rather a deep zone of visibility attenuation. Frequently a false base may occur where snow melts into rain. It is officially classified as a middle cloud, although it may merge into very low stratus or stratocumulus. It produces very little turbulence, but can pose a serious icing problem if temperatures are near or below freezing.

d. Low Clouds

- Cumulus and Towering Cumulus
  a Individual, detached elements that are generally dense and possess sharp, non-fibrous outlines. These elements develop vertically, appearing as rising mounds, domes or towers, the upper parts of which often resemble cauliflower. The sunlit parts are brilliant white, while their bases are relatively dark and nearly horizontal. If precipitation occurs, it is usually of a showery nature. For cumulus with little vertical development, pilots can expect some turbulence and no significant icing. However, for towering cumulus pilots can expect very strong turbulence and some clear icing above the freezing level (where temperatures are negative). Towering cumulonimbus is also referred to as the first stage of a thunderstorm.

- Stratocumulus

a Predominantly stratiform, in the form of a gray and/or whiteish layer or patch, which nearly always has dark parts and is non-fibrous (except for virga). It elements are rounded, roll-shaped, etc.; they may or may not be merged, and usually are arranged in orderly groups, lines, or undulations, giving the appearance of a simple wave system.
b Stratocumulus is composed of small water droplets, sometimes accompanied by larger droplets, soft hail, and (rarely) by snowflakes. The highest liquid content is in the tops of the clouds where the icing threat is the greatest, if cold enough. Virga may form under the cloud, particularly at low temperatures. Precipitations rarely occurs. Pilots can expect some turbulence and possible freezing at subfreezing temperatures. Ceiling and visibility and usually better with low stratus.

- Stratus
  a A cloud type in the form of a gray layer with a fairly uniform base. Stratus does not usually produce precipitation, but when it does occur, it is in the form of minute particles, such as drizzle, ice crystals, or snow grains. The composition of stratus is quite uniform, usually of fairly widely dispersed water droplets, and at lower temperatures, of ice crystals (much less common). Stratus produces little or no turbulence, but temperatures near or below freezing can create hazardous icing conditions

- Cumulonimbus
  a. An exceptionally dense and vertically developed cloud type, occurring either as isolated clouds or as a line or wall of clouds with separated upper portions. These clouds appear as mountains or huge towers, at least the part of the upper portions of which are usually smooth, fibrous, or striated, and almost flattened as it approaches the tropopause. This part often spreads out in the form of an anvil or vast plume. Under the base, which is often very dark, there frequently exist virga, precipitation, and low, ragged clouds. The precipitation is often heavy and always of a showery nature. The usual occurrence of lightning and thunder within or form this cloud leads to its popular names: thundercloud, thunderhead, and thunderstorm.
  b. Composed of water droplets and ice crystals. It also contains large water drops, snowflakes, snow pellets, and sometimes hail. The liquid water forms may be substantially super cooled. Cumulonimbus contains nearly the entire spectrum of flying hazards, including extreme turbulence.

G. Turbulence
   i. Causes
      a. Turbulence is caused by convective currents, obstructions in the wind flow, and wind shear
         - Convective Turbulence
            a Turbulent vertical motions that result from convective currents and the subsequent rising and sinking of air. For every rising current, there is a compensating downward current
            b Billowy cumuliform clouds, usually seen overland during sunny afternoons, are signposts in the sky indicating convective turbulence
            c A pilot can expect turbulence beneath or in the clouds
               1. When air is too dry for cumuliform clouds, convective currents can still be active. A pilot has little or no indication of their presence.
         - Mechanical Turbulence
            a Caused by obstructions to the wind flow, such as trees, buildings, mountains, and so on. Obstructions to the wind flow disrupt smooth wind into a complex snarl of eddies
            b Mountain Waves: When stable air flow passes over a mountain or ridge, developing waves above and downwind of mountains. These can extend 600 miles or more downwind and (incredibly) vertically up to 200,000' and higher
            c Mountain waves often produce violent down drafts on the immediate leeward side of the mountain barrier and if the air is moist enough, cap clouds, cirrocumulus standing lenticular, altocumulus standing lenticular and rotor clouds are a clear sign of mountain waves.
         - Wind Shear Turbulence
            a Wind shear is the rate of change in wind direction and/or speed per unit distance and may be associated with either a wind shift or a wind speed gradient at any level in the atmosphere
            b Temperature Inversion
               1. A layer of the atmosphere in which temperature increases with altitude. Strong wind shears often occur across temperature inversion layers, which can generate turbulence
            c Clear Air Turbulence

1. A higher altitude turbulence phenomena occurring in cloud-free regions associated with wind shear, particularly between the core of a jet stream and the surrounding air

H. Thunderstorms and Microbursts
  i. Ingredients
    a. Sufficient Water Vapor
      - Commonly measured using dew point, must be present to produce unstable air
    b. Unstable Air
      - Virtually all showers and thunderstorms form in an air mass that is classified as conditionally unstable
    c. Lifting Mechanism
      - A conditionally unstable air mass requires a lifting mechanism strong enough to release the instability. These include:
        a Converging winds around surface lows and troughs, fronts, upslope flow, drylines, outflow boundaries generated by prior storms, and local winds, such as sea breeze, lake breeze, land breeze, and valley breeze circulations
  ii. Life Cycle
    a. Towering Cumulus
      - A strong convective updraft. The updraft is a bubble of warm, rising air concentrated near the top of the cloud which leaves a cloudy trail in its wake
    b. Mature
      - The cell transitions to the mature stage when precipitation reaches the surface. Precipitation descends through the cloud and drags adjacent air downward, creating a strong downdraft alongside the updraft. The downdraft spreads out along the surface as a mass of cool, gusty air
    c. Dissipating
      - The dissipating stage is marked by a strong downdraft embedded within the area of precipitation. Subsiding air replaces the updraft throughout the cloud, effectively cutting off the supply of moisture provided by the updraft. Precipitation tapers off and ends. The convective cloud gradually vaporizes from below
  iii. Types of Thunderstorms
    a. Single Cell
      - Consists of only one cell. Easily circumnavigated, except at night or when embedded in other clouds. Single cell thunderstorms are rare; almost all are multicell
    b. Multicell
      - Consists of a cluster of cells at various stages of their life cycle. As the first cell matures, it is carried downwind, and a new cell forms upwind to take its place. New cells will continue to form as long as the ingredients exist.
      - More difficult to circumnavigate due to its size
      - A line of thunderstorms can extend laterally for hundreds of miles. New cells continually reform at the leading edge and the line can persist for many hours as long as the necessary ingredients exist. These are often too high to fly over, too long to fly around and too dangerous to fly under (the storms in the line can also be supercells)
    c. Supercell
      - A dangerous convective storm that consists of primarily a single, quasi-steady rotating updraft that persists for an extended period of time. It has a very organized internal structure that enables it to produce especially dangerous weather for pilots who encounter

them (updrafts may reach 9,000 fpm). A supercell may persist for hours; new cells will continue to form as long as the necessary ingredients exist

iv. Hazards
   a. Lightning, adverse wind, downburst, turbulence, icing, hail, rapid altimeter changes, static electricity, tornado

I. Icing and Freezing Level Information
   i. Types of Icing
      a. Structural Icing
         - Rime Icing
            a Rough, milky, and opaque ice formed by the instantaneous freezing of small, super cooled water droplets after they strike the aircraft
            b Rime icing formation favors colder temperatures, lower liquid water content and small droplets. It grows when droplets rapidly freeze upon striking an aircraft. The rapid freezing traps air and forms a porous, brittle, opaque, and milky colored ice.
         - Clear Icing
            a A glossy, clear, or translucent ice formed by relatively slow freezing of large, super cooled water droplets
            b Clear icing conditions exist more often in an environment with warmer temperatures, higher liquid water contents, and larger droplets
            c Clear ice forms when only a small portion of the drop freezes immediately while the remaining unfrozen portion flows or smears over the aircraft surface and gradually freezes
            d Clear ice is more hazardous than rime ice
               1. It tends to disrupt airflow considerably more than rime icing
               2. It is clear and more difficult to see and therefore can be difficult to recognize
               3. It is difficult to remove since it can spread beyond the deicing/anti-icing equipment's capabilities
         - Mixed Icing
            a A mixture of clear and rime ice
            b Poses a similar hazard to an aircraft as clear ice
   ii. Hazards of Icing
      a. Structural icing degrades engine performance
      b. It destroys the smooth flow of air over the wing, increasing drag while decreasing the ability to create lift
         - As power is added to compensate for the additional drag, and the nose is lifted to maintain altitude, the angle of attack is increased allowing the underside of the wings and fuselage to accumulate additional ice
         - Wind tunnel and flight tests have shown that ice accumulations no thicker than a piece of coarse sandpaper can reduce lift by 30% and increase drag by 40%. Larger accretions can reduce lift even more and increase drag by 80% or more.
         - The aircraft may stall at much higher speeds and lower angles of attack than normal
      c. The actual weight of ice on an aircraft is insignificant when compared to the airflow disruption it causes
   iii. Freezing Level
      a. Pilots should be alert for icing anytime the temperature approaches 0 degrees Celsius and visible moisture is present
      b. When carried above the freezing level, water becomes supercooled
         - Supercooled water freezes on impact with an aircraft

    a When the temperature cools to about -15 degrees C, much of the remaining water vapor sublimates as ice crystals. Above this level, the amount of supercooled water decreases
- Clear icing can occur at any level above the freezing level, but at high levels, icing from smaller droplets may be rime or mixed rime and clear ice
- The abundance of large, supercooled water droplets makes clear icing very rapid between 0 and -15 degrees C

J. Fog
  i. A visible aggregate of minute water droplets that are based at the surface and reduce visibility to less than 5/8 stature mile. Fog differs from cloud only in that it's base must be at the surface, while clouds are above the surface
  ii. Types of Fog
    a. Radiation Fog
      - Produced over a land area when radiational cooling reduces the air temperature below its dew point. Radiation fog is generally a nighttime occurrence and often does not dissipate until after sunrise
        a Terrestrial radiation cools the ground, the ground cools the air and when the air reaches its dew point, fog forms
      - Factors favoring formation: Shallow surface layer of relatively moist air beneath a dry layer, Clear skies, and Light surface winds
        a Radiation fog is restricted to land because water surfaces cool little from nighttime radiation. It is shallow when wind is calm. Winds up to about 5 knots mix the air slightly and tend to deepen the fog by spreading the cooling through a deeper layer. Stronger winds disperse the fog or mix the air through a still deeper layer with stratus clouds forming at the top of the mixing layer.
      - Ground fog usually burns off rapidly after sunrise. Other radiation fog generally clears before noon (unless clouds move in over the fog)
    b. Advection Fog
      - Forms when moist air moves over a colder surface, and the subsequent cooling of that air to below its dew point. Most common along coastal areas, but often moves deep in continental areas. Advection fog deepens as wind speed increases up to 15 knots; winds much stronger than 15 knots lifts the fog into a layer of low stratus or stratocumulus clouds.
        a West coast of the US is quite vulnerable to advection fog which frequently forms offshore as a result of cold water and then is carried inland by the wind. It can remain for weeks, advancing over the land during the night and retreating back over the water the next morning
      - A pilot will notice little difference flying over advection and radiation fog
    c. Upslope Fog
      - Forms as a result of moist, stable air being adiabatically cooled to or below its dewpoint as it moves up sloping terrain
      - Wind speeds of 5-15 knots are most favorable; stronger winds tend to lift the fog into a low layer of stratus clouds
      - Common along the eastern slopes of the Rockies, and somewhat less frequent east of the Appalachians. It is often quite dense and extends to high altitudes.
    d. Frontal Fog
      - 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. The

result is more or less a continuous zone of condensed water droplets reaching from the ground up through the clouds

- Most commonly associated with warm fronts, but can occur with others as well. Can be quite dense and continue for an extended period of time.

e. Steam Fog

- When very cold air moves across relatively warm water, enough moisture may evaporate from the water surface to produce saturation. As the rising water vapor meets the cold air, it immediately recondenses and rises with the air being warmed from below. Because the air is destabilized, fog appears as rising streamers that resemble steam
- Steam fog is often very shallow; as the steam rises, it reevaporates in the unsaturated air above
- Expect convective turbulence flying through it

K. Frost

i. On cool, clear nights, the temperature of the ground and objects on the surface can cause temperatures of the surrounding air to drop below the dew point. When this occurs, the moisture in the air condenses and deposits itself on the ground, buildings, and other objects like aircraft

a. The moisture is dew. If the temperature is below freezing, the moisture is deposited in the form of frost

b. While dew poses no threat to aircraft, frost poses a definite flight safety hazard

- Frost disrupts the smooth airflow over the wing and can drastically reduce the production of lift. It also increases drag, which when combined with lowered lift production, can adversely affect the ability to takeoff

ii. An aircraft must be thoroughly cleaned and free of frost prior to beginning a flight

4. METAR, TAF, and FA

A. METAR (Aviation Routine Weather Report)

i. An observation of current surface weather reported in a standard international format

ii. Contains the following information:

a. **Type of Report** – There are 2 types. The first is the routine METAR report, transmitted hourly.

- The 2nd is the aviation selected special weather report (SPECI).
    - a Is given any time to update a METAR for rapidly changing weather, aircraft mishaps, etc.

b. **Station Identifier** – Four letter code (ex. KAHN). K is the country identifier and AHN is the airport identifier. (Alaska always begins with "PA" and Hawaii identifiers always begin with "PH")

c. **Date and Time of Report** – (161753Z) Reported in a six-digit group. The first 2 digits are the date; the last 4 are the time, in UTC.

d. **Modifier** – Denote that the METAR came from an automated source or was corrected

- "AUTO" indicates the report came from an automated source
- "AO1" and "AO2" indicate the type of precipitation sensors at the station
- "COR" identifies a corrected report.

e. **Wind** – (14021G26)

- Reported with 5 digits unless speed is > 99 knots, then it is 6
    - a The first 3 digits indicate wind direction in tens of degrees
    - b The last 2 digits indicate the speed of the wind in knots
        1. Gusting winds (G) show with the peak gust after the "G"
    - c If wind varies more than 60 degrees and the speed > 6 knots, a separate group of numbers, separated by a "V" will indicate the extremes of the directions

f. **Visibility** – (3/4SM)

- Reported in statute miles
- RVR is sometimes reported following the visibility,

a. RVR is the distance a pilot can see down the runway in a moving aircraft.
   1. Shown with an "R" then the runway number, a slant, and the visual range in feet.

g. **Weather** – (-RA BR) Two different categories: Qualifiers and Weather Phenomenon
- Qualifiers show intensity or proximity as well as descriptor codes
  a. -, +, VC, SH, TS, FZ, etc.
- Phenomena describe the different precipitation, obscuration, and other phenomena
  a. DZ, RA, HZ, SS, DS, SN, etc.

h. **Sky Condition** – (BKN008 OVC012)
- Always reported in the sequence of amount, height, and type
  a. Heights are depicted with three digits in hundreds of feet above ground
     1. Clouds above 12,000 ft. are not detected
  b. TCU and CB clouds are reported with their height
  c. The amount of sky coverage is reported in eighths of the sky from horizon to horizon.

Sky Cover	< 1/8 Clear	1/8 – 2/8 Few	3/8 – 4/8 Scattered	5/8 – 7/8 Broken	8/8 Overcast
Contraction	**SKC/CLR/FEW**	**FEW**	**SCT**	**BKN**	**OVC**

i. **Temperature and Dewpoint** – (18/17)
- In degrees Celsius (Temp below 0 degrees Celsius are preceded by the letter "M")

j. **Altimeter Setting** – (A2970)
- Preceded by the letter "A" and reported as inches of mercury in a four-digit number
- "PRESRR" or "PRESFR" represent rising or falling pressure

k. **Remarks** – RMK
- May include wind data, variable visibility, begin/end times of phenomenon, pressure info, and various other necessary info

EXAMPLE:
METAR BTR 161753Z 14021G26 ¾SM –RA BR BKN008 OVC012 18/17 A2970 RMK PRESFR

EXPLANATION:
Type of Report: Routine METAR
Location: Baton Rouge, Louisiana
Date: 16th day of the month
Time: 1753 Zulu
Modifier: None shown
Wind Information: Winds 140 at 21 knots gusting to 26 knots
Visibility: ¾ SM
Weather: Light rain and mist
Sky Conditions: Skies broken 800 ft., Overcast 1,200 ft.
Temperature: Temp 18 degrees C, Dewpoint 17 degrees C
Altimeter: 29.70 in. Hg.
Remarks: Barometric pressure is falling

B. Terminal Aerodrome Forecast (TAF)
   i. A terminal aerodrome forecast is a report established for the 5 s.m. radius around an airport
   ii. Valid for a 24-hour period, and is updated four times a day at 0000Z, 0600Z, 1200Z, and 1800Z.
   iii. The TAF utilizes the same descriptors and abbreviations as the METAR.
   iv. Includes the following information in sequential order:
      a. **Type of Report** – Can either be a routine forecast (TAF) or an amended forecast (TAF AMD)
      b. **ICAO Station Identifiers** – (KAHN) Same as METAR

c. **Date and Time of Origin** – Six number code. First 2 are the date; last four are the time, in UTC
d. **Valid Period Date and Time** – Given by a 6-digit number group. The first 2 are the date, the next 2 are the beginning time for the valid period and the last 2 are the end time
e. **Forecast Wind** – The wind direction and speed forecasts are given in a five-digit number group
f. **Forecast Visibility** – Given in statute miles (Greater than 6 SM is shows as "P6SM")
g. **Forecast Significant Weather** – Coded the same as a META (No sig wx forecast "NSW" shown)
h. **Forecast Sky Condition** – Given same as the METAR. Only "CB" clouds are forecast
i. **Forecast Change Group** – For any significant weather change forecast to occur, the expected conditions and time period are included, this information can be shown as:
    - FM - From is used when a rapid and significant change, usually within an hour, is expected
    - BECMG - Becoming is used when a gradual change is expected over no more than 2 hours
    - TEMPO - Temporary is used for temporary fluctuations, expected to last for less than an hour
j. **Probability Forecast** – The given percentage that describes the probability of thunderstorms and precipitation occurring in the coming hours

EXAMPLE:
TAF
KPIR 111130Z 111212 15012KT P6SM BKN090
TEMPO 1214 5SM BR
FM1500 16015G25KT P6SM BKN080 OVC150 PROB40 0004 3SM TSRA BKN030CB
FM0400 1408KT P6SM SCT040 OVC080 TEMPO 0408 3SM TSRA OVC030CB
BECMG 0810 32007KT=

EXPLANATION
Routine TAF for Pierre, South Dakota. On the 11th day of the month, at 11:30Z. Valid for 24 hours from 1200Z on the 11th to 1200Z on the 12th. Wind from 150 at 12 knots. Greater than 6 SM visibility. Broken clouds at 9,000 ft. Temporarily, between 1200Z and 1400Z, visibility 5 SM in mist.
From 1500Z winds from 160 at 15 knots, gusting to 25 knots. Visibility greater than 6SM, and clouds broken at 8,000ft, overcast at 15,000 ft. Between 0000Z and 0400Z, there is a 40 percent probability of visibility 3 statute miles, thunderstorm with moderate rain showers, clouds broken at 3,000 ft. with cumulonimbus clouds.
From 0400Z winds are from 140 at 18 kts, visibility greater than 6 SM. Clouds at 4,000 ft. scattered and overcast at 8,000. Temporarily between 0400Z and 0800Z, visibility 3 SM, thunderstorms with moderate rain. Clouds overcast at 3,000 ft. with cumulonimbus clouds.
Becoming between 0800Z and 1000Z, wind from 320 at 7 knots. End of report =

C. Area Forecasts (FA)
  i. The FA gives a picture of clouds, general weather conditions, and VMC expected over a large area encompassing several states. This forecast gives information vital to en route operations as well as forecast information for smaller airports that do not have terminal forecasts.
  ii. There are six areas for which area forecasts are published in the contiguous 48 states
  iii. Area forecasts are issued 3 times a day and are valid for 18 hours
  iv. Four Sections
    a. **Header** – Gives the location identifier of the source of the FA, the date and time of issuance, the valid forecast time, and the area of coverage

EXAMPLE
DFWC FA 120945
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 130400

CLDS/WX VALID UNTIL 122200…OTLK VALID 122200-130400
OK TX AR LA MS AL AND CSTL WTRS

EXPLANATION
The area forecast shows information given by Dallas Fort Worth, for the region of Oklahoma, Texas, Arkansas, Louisiana, Mississippi, and Alabama, as well as a portion of the gulf coast waters. It was issued on the 12th day of the month at 0945. The synopsis is valid from the time of issuance until 0400 hours on the 13th. VFR clouds and weather information on this area forecast is valid until 2200 hours on the 12th and the outlook is valid until 0400 hours on the 13th.

b. **Precautionary Statements** – IFR conditions, mountain obscurations, and thunderstorm hazards are described. Statements of height are in MSL - if given otherwise, AGL or CIG will be noted

EXAMPLE
SEE AIRMET SIERRA FOR IFR CONDITIONS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG

EXPLANATION:
The FA covers VFR clouds and weather, so the precautionary statement warns that AIRMET Sierra should be referenced for IFR conditions and mountain obscuration. The code TS indicates the possibility of thunderstorms and implies there may be occurrences of severe or greater turbulence, severe icing, low-level wind shear, and IFR conditions. The final line of precautionary statement alerts the user that heights for the most part are mean sea level (MSL). Those that are not MSL will be above ground level (AGL) or ceiling (CIG).

c. **Synopsis** – A brief summary identifying the location/movement of pressure systems, fronts, and circulation patterns

EXAMPLE:
SYNOPSIS…LOW PRES TROF 10Z OK/TX PNHDL AREA FCST MOV EWD INTO CNTRL-SWRN OK BY 04Z. WRMFRNT 10Z CNTRL OK-SRN AR-NRN MS FCST LIFT NWD INTO NERN OK-NRN AR EXTRM NRN MS BY 04Z.

EXPLANATION:
As of 1000Z, there is a low-pressure trough over the Oklahoma and Texas panhandle area, which is forecast to move eastward into central southwestern Oklahoma by 0400Z. A warm front is located over Central Oklahoma, southern Arkansas, and northern Mississippi at 1000Z is forecast to lift northwestward into northeastern Oklahoma, northern Arkansas, and extreme northern Mississippi by 0400Z.

d. **VFR Clouds and Weather** – Lists expected sky conditions, visibility, and weather for the next 12 hours and an outlook for the following 6 hours

EXAMPLE:
S CNTRL AND SERN TX
AGL SCT-BKN010. TOPS 030. VIS 3-5SM BR.
14-16Z BECMG AGL SCT 030. 19Z AGL SCT050.
OTLK… VFR

OK
PNDL AND NW… AGL SCT030 SCT-BKN100. TOPS FL200
15Z AGL SCT040 SCT100. AFT20Z SCT TSRA
DVLPG..FEW POSS SEV. CB TOPS FL450.

OTLK… VFR

EXPLANATION:
In south central and southeastern Texas, there is a scattered to broken layer of clouds from 1000ft AGL with tops at 3,000 ft., visibility is 3 to 5 statute miles in mist. Between 1400 Zulu and 1600 Zulu, the cloud bases are expected to increase to 3,000 ft. AGL. After 1900Z, the cloud bases are expected to continue to increase to 5,000 ft. AGL and the outlook is VFR.

In northwestern Oklahoma and panhandle, the clouds are scattered at 3,000 ft. with another scattered to broken layer at 10,000 ft. AGL, with tops at 20,000 ft. At 1500Z, the lowest cloud base is expected to increase to 4,000 ft. AGL with a scattered layer at 10,000 ft. AGL. After 2000Z, the forecast calls for scattered thunderstorms with rain developing and a few becoming severe; the cumulonimbus clouds will have tops at flight level 450 or 45,000 ft. MSL.

5. **Surface Analysis Chart**
   A. Depicts an analysis of the current surface weather
   B. Computer prepared report transmitted every 3 hours covering contiguous 48 states and adjacent areas
   C. Shows areas of high/low pressure, fronts, temps, dewpoints, wind direction/speed, local weather, visual obstructions
   D. Surface weather observations for reporting points across the US are also depicted on this chart. Each of these reporting points is illustrated by a station model. A station model will include:
      i. Type of Observation – Round indicates official weather observer, square is automated station
      ii. Sky Cover – Shown as clear, scattered, broken, overcast, or obscured/partially obscured
      iii. Clouds – Cloud types are represented by specific symbols. Low cloud symbols are placed beneath the station model, while middle and high cloud symbols are placed directly above the station model. Typically, only one type of cloud will be depicted with the station model.
      iv. Sea Level Pressure – Given in 3 digits to the nearest tenth of a millibar. For 1000 mbs or greater, prefix a 10 to the 3 digits; for less than 1000 mbs, prefix a 9 to the 3 digits
      v. Pressure Change/Tendency –In tenths of mbs over the past 3 hours, depicted directly below the sea level pressure
      vi. Precipitation – Precipitation that has fallen over the last 6 hours to the nearest hundredth of an inch
      vii. Dewpoint – In degrees Fahrenheit
      viii. Present Weather – Many different weather symbols are used to describe the current weather
      ix. Temperature – Given in degrees Fahrenheit
      x. Wind – True direction of wind is given by the wind pointer line, indicating the direction from which the wind is coming (A short barb is 5 knots, a long barb is 10 knots, and a pennant is 50 knots)

6. **Radar Summary Chart**
   A. A graphically depicted collection of radar weather reports (SDs) displaying areas of precipitation as well as information regarding the characteristics of precipitation
   B. The chart is published hourly at 35 min past the hour
   C. A radar summary chart includes:
      i. No information – If info isn't reported it will say "NA." if no echoes are detected, it will say "NE"
      ii. Precipitation Intensity Contours – Described as one of 6 levels and shown by 3 contour intervals
      iii. Height of Tops – The heights of the echo tops are given in hundreds of feet MSL
      iv. Movement of Cells –Indicated by an arrow pointing in the direction of movement, speed in knots is at the top of the arrow heard ("LM" indicates little movement)
      v. Type of Precipitation - Marked using specific symbols (not those used on the METAR)

vi. Echo Configuration – Echoes are shown as being areas, cells, or lines
vii. Weather Watches – Depicted by boxes outlined with heavy dashed lines

D. Limitations
   i. Only depicts areas of precipitation
   ii. Will not show areas of clouds and fog with no appreciable precipitation,
   iii. Will not show the heights of the tops and bases of the clouds

E. Depiction of current precipitation and should be with current METAR and weather forecasts

7. Significant Weather Prognostic Charts

A. Portray forecasts of selected weather conditions at specified valid times
   i. Forecasts are made from a comprehensive set of observed weather conditions. The observed conditions are extended forward in time and become forecasts by considering atmospheric and environmental processes.

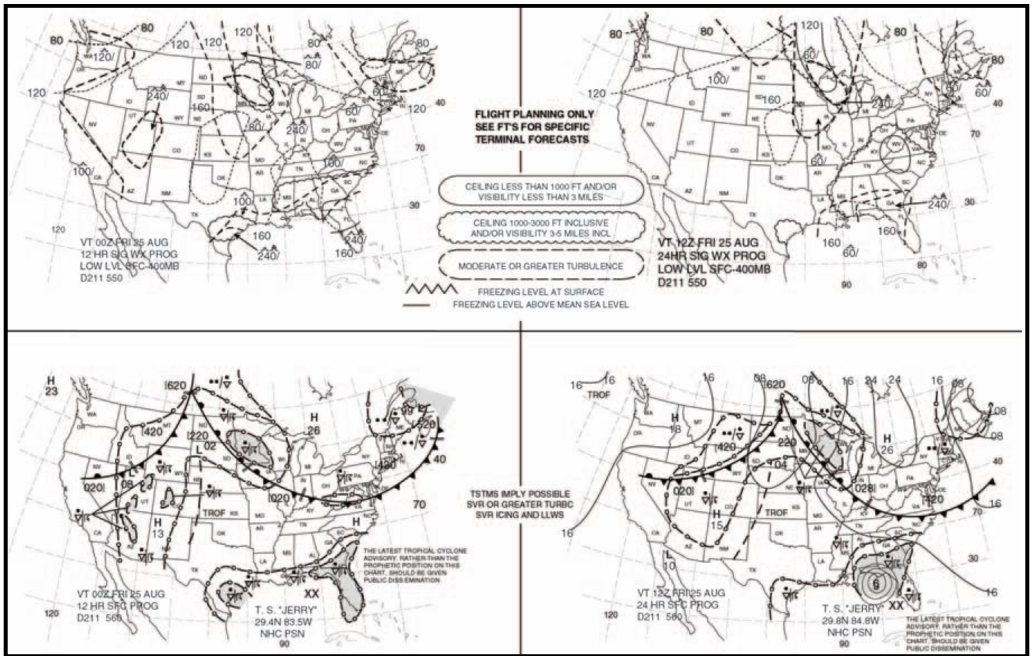
B. Forecasts are made for various periods of time
   i. Each valid time is the time at which the forecast conditions are expected to occur
      a. The valid time is printed on the lower left-hand corner of each panel
      b. A 12-hour prog is a forecast of conditions with a valid time 12 hours after the observed time
         - EX: A 12-hour forecast based on 00Z observations is valid at 12Z
   ii. Forecasts are issued four times a day at 0000Z, 0600Z, 1200Z, 1800Z

C. Altitude information is referenced to MSL. (Below 18,000' are true, above 18,00' are pressure)

D. The prog charts are generated for two general time periods
   i. Day 1 progs are forecast for the first 24-hour period and are prepared for 2 altitude references
   ii. Day 2 progs are forecast for the second 24-hour period

E. Charts are available for low-level significant weather and high-level significant weather
   i. Low Level Chart
      a. A day 1 forecast of significant weather for the conterminous US
      b. Weather information pertains to the layer from surface to FL240 (400 mbs)
         - The information is provided for two forecast periods: 12 hours and 24 hours
      c. The chart is composed into 4 panels:
         - The upper two panels depict the 12 and 24-hour significant weather progs
            a The Significant weather panels display forecast weather flying categories (VFR/IFR/MVFR), freezing levels, and turbulence
               1. A legend on the chart illustrates symbols and criteria used for these conditions
         - The lower two panels depict the 12 and 24-hour Surface Progs
            a Display forecast positions and characteristics of pressure systems, fronts, precipitation
               1. Standard symbols are used to show fronts and pressure centers
               2. Direction of movement of the pressure center is depicted by an arrow
               3. The speed is in knots and is shown next to the arrow
               4. Areas of forecast precipitation and thunderstorms are outlined
                  a. Shaded areas of precipitation indicate at least ½ the area is affected by the precipitation
                  b. Unique symbols indicate the type of precipitation and the manner it occurs
      d. Using the chart
         - Provides an overview of selected flying weather conditions up to 24,000 ft. for day 1
         - Surface winds can be inferred from surface pressure patterns
         - Structural icing can be inferred in areas with clouds and precipitation, above freezing levels, and in areas of freezing precipitation
         - Use to obtain an overview of the progression of weather during day 1

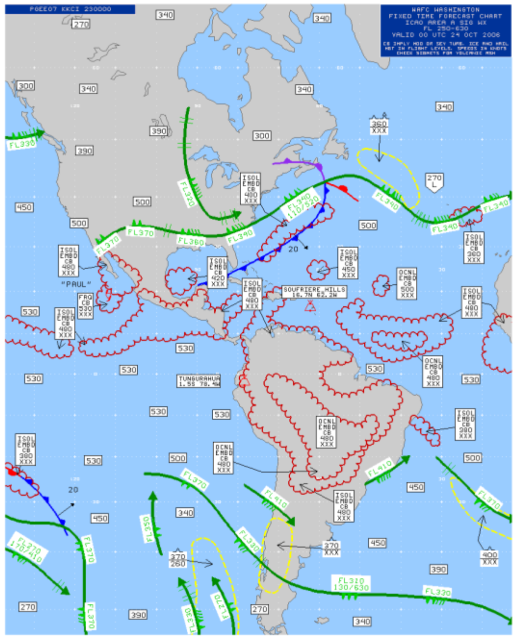
EXAMPLE:



ii. 36 and 48-hour Surface Prog
   a. A day 2 forecast of general weather for the conterminous US
      - An extension of the day 1 low-level prog chart issued from the same observed data base
   b. The chart is issued two times daily at 0000Z and 1200Z and valid 36/48 hours after observed
      - EX: A chart issued based on 00Z Tuesday observations has a 36-hour valid time of 12Z Wednesday and a 48-hour valid time of 00Z Thursday
   c. The chart is composed of two panels and a forecast discussion
      - The two panels contain the 36 and 48-hour surface progs
   d. The panels display forecast positions/characteristics of pressure patterns, fronts, precipitation
      - Provides info regarding only surface weather forecasts, includes a discussion of the forecast
      - Standard symbols are used to show fronts and pressure centers
      - Precipitation areas are outlined on each panel
      - The forecast discussion is a discussion of the day 1 and day 2 forecast package, including identification/characterization of weather systems and associated weather conditions portrayed on the prog charts
   e. Using the chart
      - The 36 and 48-hour surface prog provides a general weather conditions outlook for day 2
      - The chart can be used to assess the progression of weather through day 2

iii. High-Level Significant Weather Prog
   a. The high-level significant weather prog chart is a day 1 forecast of significant weather covering a large portion of the Northern Hemisphere and a limited portion of the Southern Hemisphere
   b. Weather information pertains to the layer from above 24,000 to 60,000 ft.
      - Conditions routinely appearing are jet streams, CB clouds, turbulence, and tropopause heights, surface front are also included to add perspective
   c. Tropical cyclones, squall lines, eruptions, sandstorms, dust storms will appear
   d. Each prog chart is issued 4 times a day and is valid times at 00Z, 06Z, 12Z, 18Z
   e. Using the chart
      - This chart is used to get an overview of selected flying weather conditions above 24,000 ft.

EXAMPLE:



F. Prognostic charts are an excellent source of information for preflight planning; however, this chart should be viewed in light of current conditions and specific local area forecasts

8. Winds and Temperatures Aloft Chart (FD)

A. Provide wind and temperature forecasts for specific locations

B. The forecasts are made twice a day based at 0000Z and 1200Z

C. Through 12,000 ft. are true altitudes and above 18,000 ft. are pressure altitudes

D. Wind

- i. Direction is always in reference to true north and wind speed is always given in knots
- ii. No winds are forecast when a given level is within 1,500 ft. of station elevation
- iii. Wind direction and speed are listed together in a four-digit code
  - a. The first two numbers indicate the direction the wind is blowing from in tens of degrees
  - b. The second two numbers indicate the speed of the wind
- iv. If the wind speed is forecast to be greater than 100 knots but less than 199 knots, 50 is added to the direction and 100 is subtracted from the speed
  - a. To decode, the reverse must be accomplished
    - EX: For 7319 - Subtract 50 from the direction, add 100 to the speed to get 230^{o} at 119 knots
- v. If the wind speed is forecast to be 200 knots or greater, the wind group is coded as 99 knots
  - a. EX: For 7799 - Subtract 50 from the direction, add 100 to 99 to get 270 at 199 knots or greater
- vi. Light and Variable wind is coded "9900"

E. Temperature

- i. Temperature is always given in Celsius
- ii. No temperatures are forecast for any station with 2,500 ft. of station elevation
- iii. Temperatures above 24,000 feet MSL are negative.

EXAMPLE:

FD KWBC 151640
BASED ON 151200Z DATA
VALID 151800Z FOR USE 1700-2100Z
TEMPS NEGATIVE ABV 24000

FD	3000	6000	9000	12000	18000	24000	30000
AMA		2714	2725+00	2625-04	2531-15	2542-27	265842
DEN			2321-04	2532-08	2434-19	2441-31	235347

EXPLANATION:
The heading indicates that this FD was transmitted on the 15th of the month at 1640Z and is based on the 1200 Zulu radiosonde. The valid time is 1800 Zulu on the same day and should be used for the period between 1700Z and 2100Z. The heading also indicates that the temperatures above 24,000 feet MSL are negative. Since the temperatures above 24,000 feet are negative, the minus sign is omitted. A 4-digit data group shows the wind direction in reference to true north, and the wind speed in knots. The elevation at Amarillo, TX (AMA) is 3,605 feet, so the lowest reportable altitude is 6,000 feet for the forecast winds. In this case, “2714” means the wind is forecast to be from 270° at a speed of 14 knots. A 6-digit group includes the forecast temperature aloft. The elevation at Denver (DEN) is 5,431 feet, so the lowest reportable altitude is 9,000 feet for the winds and temperature forecast. In this case, “2321-04” indicates the wind is forecast to be from 230° at a speed of 21 knots with a temperature of –4°C.

9. Freezing Level Charts

A. Used to assess the lowest freezing level heights in order to avoid clear, rime and mixed ice
B. Format
   i. Color levels represent the height of the lowest freezing level

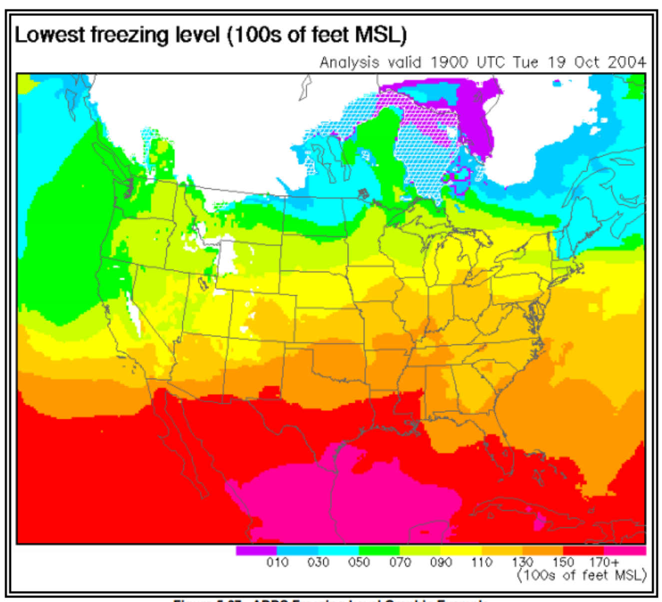


Figure 5-37. ADDS Freezing Level Graphic Example

10. Stability Charts

A. The LI (Lifted Index) is a measure of atmospheric stability
   - i. A positive LI = Stable
   - ii. A negative LI = Unstable
   - iii. The LI is shown above the station circle

B. The K Index
   - i. A measure of thunderstorm potential
   - ii. The higher the positive number, the greater the likelihood of thunderstorms
   - iii. The KI is shown below the station circle

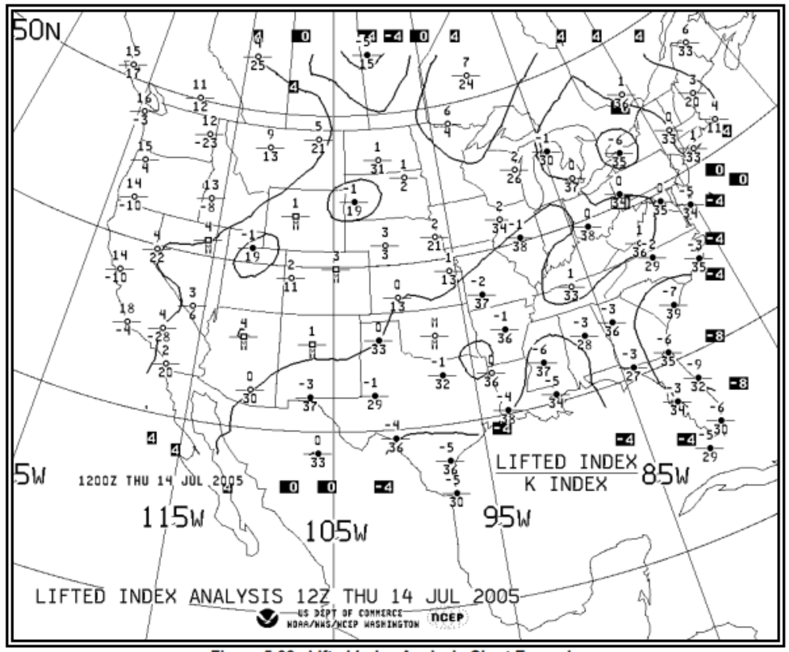


Figure 5-38. Lifted Index Analysis Chart Example

K INDEX West of the Rockies	K INDEX East of the Rockies	Coverage of General Thunderstorms
less than 15	less than 20	None
15 to 20	20 to 25	Isolated thunderstorms
21 to 25	26 to 30	Widely scattered thunderstorms
26 to 30	31 to 35	Scattered thunderstorms
Above 30	Above 35	Numerous thunderstorms
Note: K value may not be representative of air mass if 850 mb level is near the surface.		

11. Convective Outlook Chart

A. Delineates areas forecast to have thunderstorms

B. Presented in two panels
   - i. The left-hand panel is the Day 1 Convective Outlook
     - a. Outlined areas are where thunderstorms are forecasted during the day 1 period
       - The outlook issued qualifies the risk (SLGT, MDT, HIGH) and areas of general thunderstorms
     - b. Issued 5 times daily
       - 1st issuance is 06Z and is the initial Day 1 Outlook, valid 12Z until 12Z the following day
       - The other issuances are 1300Z, 1630Z, 2000Z, and 0100Z
       - All issuances are valid until 12Z the next day
   - ii. The right-hand panel is the Day 2 Convective Outlook
     - a. Contains the same information as the Day 1 Outlook
     - b. It is issued 2 times a day
       - The first issuance is at 0830Z during standard time and 0730Z during daylight time
       - It is updated at 1730Z
     - c. The timeframe covered is from 12Z the following day to 12Z the next day
       - EX: If today is Mon, the Day 2 Outlook will cover the period 12Z Tuesday to 12Z Wednesday
   - iii. Levels of Risk

a. Risk areas come in 3 varieties based on the number of severe thunderstorm reports per geographical unit and forecaster confidence
    - SEE TEXT is used for situations where slight risk was considered, but at the time of the forecast, was not warranted
    - SLGT risk - Well-organized severe T-storms expected but in small numbers/low coverage
    - MDT risks - Greater concentration of severe T-storms, and greater magnitude of severe weather
    - HIGH risk - Almost always means a major weather outbreak is expected, with great coverage
    - In addition to the risk areas, general T-storms are outline, but not labeled

NOTATION	EXPLANATION
SEE TEXT	Used for those situations where a slight risk was considered, but at the time of the forecast, was not warranted
SLGT	A high probability of 5-29 reports of 1 inch or larger hail, and/or 3-5 tornadoes, and/or 5-29 wind events,…or…a low/moderate probability of moderate to high risk being issued later if some conditions come together
MDT	A high probability of at least 30 reports of hail 1 inch or larger; 6-19 tornadoes; or numerous wind events (30)
HIGH	A high probability of at least 20 tornadoes with at least two of them rated F3 (or higher), or an extreme derecho causing widespread (50 or more) wind events with numerous higher-end wind (80 mph or higher) and structure damage reports

b. Using the chart
    - A flight planning tool used to determine forecast areas of thunderstorms

12. SIGMETs and AIRMETs

A. Forecasts that detail potentially hazardous weather

B. AIRMET (WA)
  i. Issued every 6 hours with intermediate updates issued as needed for a particular area forecast region
  ii. Info is of interest to all aircraft but the weather section concerns phenomena 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. Sever icing/extreme turbulence/CAT not associated with T-storms; dust/sand storms lowering visibility to less than 3 miles and volcanic ash
  iii. Unscheduled forecasts valid for 4 hours (hurricane SIGMET is valid for 6)

D. Convective SIGMENT (WST)
  i. Weather advisory issued for hazardous convective weather that affects the safety of every flight
  ii. Issued for
    a. Severe T-storms with
      - Surface winds greater than 50 knots
      - Hail at the surface >/= ¾ inch in diameter
      - Tornadoes
    b. Embedded T-storms
    c. A line of T-storms

        d. T-storms with heavy or greater precipitation affecting 40% or more of a 3,000 square feet or greater area
- E. PIREPS
    - i. A pilot generated report concerning meteorological phenomena encountered in flight
        - a. Aircraft in flight are the only way to observe cloud tops, icing and turbulence
- F. Help to fill the gaps between reporting stations

13. ASOS, AWOS, and ATIS

- A. ASOS (Automated Surface Observing System)
    - i. Continuous min-by-min observations to generate a METAR and can provide other information
    - ii. ASOS software transmits a SPECI report whenever it determines a significant change in conditions
    - iii. Types of Observations
        - a. Every ASOS contains:
            - Cloud height indicator
            - Visibility Sensor
            - Precipitation identification sensor
            - Freezing rain sensor (at select sites)
            - Pressure sensors
            - Ambient temperature and dew point temp sensors
            - Anemometer (wind direction & speed)
            - Rainfall accumulation sensor
        - b. Some include precipitation discriminator which differentiates liquid/frozen precipitation
            - If it has this capability, it's designated as A02 in the remarks section (otherwise A01)
        - c. At selected ASOS installations lightning detection equipment is installed
    - iv. Limitations
        - a. ASOS cannot distinguish between stratus and cumulonimbus clouds
        - b. It is limited in its ability to identify restrictions to visibility
            - No prevailing, sector, tower visibility (Input from a trained human observer is integral part)
    - v. Levels of service
        - a. LEVEL A- The highest – which is typically available at major airports like those in or near Class B
            - Other levels offer less human augmentation, with fewer types of weather reported
        - b. LEVEL B – Has human observers available 24 hours a day
            - LEVEL C – At airports with part-time towers (Human augmentation ends when tower closes)
        - c. LEVEL D – Found at smaller, nontowered airports meeting the FAA or NWS criteria for the ASOS
            - Unattended, and always contain the AUTO designation when in a METAR
- B. AWOS (Automated Weather Observing System)
    - i. First widely installed automated weather data gathering system at US airports
    - ii. AWOS is available in lesser configurations without all the types of observations listed above
    - iii. Levels of service:
        - a. AWOS-A: Only reports the altimeter setting
        - b. AWOS-1: Also measures and reports wind speed, direction, gusts, temperature, and dew point
        - c. AWOS-2: Adds visibility information
        - d. AWOS-3: Most capable system – also includes cloud/ceiling data (essentially equivalent to ASOS)
            - Like ASOS, AWOS-3 can include precipitation discrimination sensors indicated by A02
            - Lightning detection is also a possible enhancement for selected AWOS-3 sites
    - iv. Difference between ASOS/AWOS is ability to identify/report significant changes in surface weather
        - a. AWOS transmits 3 reports per hour at fixed intervals and cannot issue a special report as needed

C. ATIS (Automatic Terminal Information Service)
   i. A continuous broadcast of recorded non-control information in busier terminal areas
   ii. Contain essential info - weather, active runways, approaches, and other required info (NOTAMs)
   iii. Updated when there is a significant change in the information; it is given a letter designation
   iv. In its simplest form, the ATIS is a continuously playing recording of a person reading the message
   v. Re-recorded at every update (which is several times per hour at least), which is quite cumbersome
   vi. Data may be entered by hand, coming from a METAR, or be taken directly from sensors
      a. Modern systems are fully automated and do not require a controller except in case of sensor failures/unusual activities
   vii. Some airports have separate ATISs for arriving/departing aircraft, each on its own frequency

14. Go/No Go Decision

A. Weather factors must be considered in relation to the equipment to be flown
   i. Can the plane handle the flight?
   ii. The following conditions may lead to a No Go Decision
      a. T-Storms of any kind, especially embedded
      b. Fast-moving fronts or squall lines
      c. Moderate or greater turbulence
      d. Icing
      e. Fog, or other visual obscurations

B. Physical/Mental condition
   i. Sick, tired, upset, depressed – These factors can greatly affect the ability to handle any problem

C. Recent Flight Experience
   i. Don't go beyond your abilities or the airplane's abilities
   ii. EX: Are you comfortable in MVFR if you haven't flown in a while

D. Flying is a continual process of decision making through the entire flight

15. Alternate Requirements (91.169)

A. An alternate is not required when:
   i. At least 1 hour before/1 hour after the ETA the ceiling is ≥ 2,000' ***AND*** visibility is ≥ 3 SM
      a. If ceiling is forecast < 2,000' **OR** visibility is forecast < 3 SM an alternate is needed

B. An airport cannot be an alternate unless at the ETA, the ceiling/visibility are at/above:
   i. For a Precision Approach: 600' and 2 SM
   ii. For a Non-Precision Approach: 800' and 2 SM
   iii. No Approach: The ceiling/visibility must allow descent from MEA, Approach, and landing under VFR

Conclusion:

Brief review of the main points

It is very important to be able to interpret and make a Go/No Go decision based on the weather information attained. A safe flight begins with a thorough weather briefing to ensure the pilot understands the meteorological factors that may affect the flight. A pilot must also use this information to decide whether an alternate is necessary and to choose a suitable alternate based on the weather as well as fuel and performance requirements.

PTS Requirements:

To determine that the applicant exhibits instructional knowledge related to IFR weather information:

1. Sources of weather-
   A. AWOS, ASOS, and ATIS reports.

B. PATWAS and TIBS.
C. TWEB.

2. Weather reports and charts-
    A. METAR, TAF, FA, and radar reports.
    B. inflight weather advisories.
    C. surface analysis, weather depiction, and radar summary charts.
    D. significant weather prognostic charts.
    E. winds and temperatures aloft charts.
    F. pilot weather reports (PIREPS).
    G. freezing level charts.
    H. stability charts.
    I. severe weather outlook charts.
    J. SIGMETS and AIRMETS.

III.B. Cross-Country Flight Planning

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), AIM

Objectives	The student should develop knowledge of the elements related to developing a cross country IFR flight plan.
Key Elements	1. Applicable IFR Regulations 2. Choosing course/altitude 3. Filing a Flight Plan
Elements	1. IFR Regulatory Requirements 2. Computing Estimated Time En Route and Fuel Requirements 3. Selection and interpretation of en route charts, DP's, STAR's, & approach procedure charts 4. NOTAM Information 5. Preparation and filing of an actual or simulated IFR flight plan
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can competently develop and file an IFR flight plan based on current weather and NOTAM information obtained.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

The information and regulations necessary for an IFR flight plan, a process somewhat simpler than creating a VFR flight plan.

Why

You can't take an IFR flight without it.

How:

1. IFR Regulatory Requirements
    A. IFR Preflight
        i. 91.103 - Preflight Actions
            a. IFR Specific:
                - Weather reports and forecasts
                - Fuel requirements
                - Alternatives available if the planned flight cannot be completed
                - Any known traffic delays which the PIC has been advised by ATC
            b. For any flight… runway lengths, T/O and LDG distances, etc.
        ii. 91.167 - Fuel Requirements
            a. Must carry enough fuel to:
                - Complete the flight to the first airport of intended landing
                - Fly from that airport to the alternate airport (if required)
                - Fly for an additional 45 minutes at normal cruising speed
    B. IFR Departure
        i. 91.173 - ATC Clearance and Flight Plan Required
            a. You may not operate in controlled airspace under IFR unless you have:
                - Filed an IFR flight plan
                - Received an appropriate ATC clearance
        ii. 91.175 - Takeoff and Landing Under IFR
            a. 0/0 takeoffs are legal under part 91
                - Recommended to use published T/O mins or approach mins (if no T/O) as a guideline
    C. IFR En Route
        i. 91.135 – Operations in Class A airspace
            a. Must be conducted under IFR with ATC clearance
        ii. AIM - Class B Airspace
            a. For IFR operations, an operable VOR or TACAN receiver is required
        iii. 91.177 - Minimum Altitudes for IFR Operations
            a. Except for takeoffs and landings, you may not operate below:
                - The applicable minimum altitudes prescribed in parts 95 and 97

- However, if no minimum is prescribed:
  - a Mountainous Area: 2,000' above the highest obstacle w/in 4 nm of the course flown
  - b Non-Mountainous: 1,000' above the highest obstacle w/in 4 nm of the course flown

b. If an MEA and MOCA are prescribed, you may operate below the MEA, but not below the MOCA, when w/in 22 NM of the VOR concerned

c. Climb to a higher minimum IFR altitude immediately after passing the point beyond which that minimum altitude applies
- Except when ground obstructions intervene, the point shall be crossed at or above the applicable MCA

iv. 91.179 - IFR Cruising Altitude or Flight Level

a. Controlled Airspace: Maintain the altitude of FL assigned by ATC
- If cleared for VFR on top, maintain altitude based on 91.159

b. Uncontrolled Airspace: Below 18,000' MSL, and
- On a magnetic course of 0° through 179°: Any ODD Thousand-foot MSL altitude
- On a magnetic course of 180° through 359°: Any EVEN Thousand-foot MSL altitude

v. 91.181 - Course to be Flown

a. You must:
- Be on an ATS route, along the centerline of that airway
- On any other route, along the direct course between nav aids or fixes defining the route
  - a Doesn't prohibit maneuvering to pass well clear of other aircraft/clearing flight path

vi. 91.183 - IFR Communications

a. You must report the following as soon as possible
- The **time/altitude** of passing each designated reporting point or those desired by ATC
  - a Except while under radar control: Report those specifically requested by ATC
- Any **unforecast weather conditions** encountered
- Any other information relating to the **safety** of the flight

vii. Restricted Area

a. If not active, ATC will allow IFR traffic to operate without issuing a specific clearance to do so

b. If active, and has not been released, ATC will issue a clearance which will avoid the airspace
- Unless it has permission to enter the restricted area

viii. MOA

a. IFR traffic may be cleared through if IFR separation can be provided by ATC; otherwise, ATC will reroute or restrict nonparticipating IFR traffic

2. Computing Estimated Time En Route and Fuel Requirements

A. Choose, record route on IFR nav log

i. DPs

ii. Consider preferred IFR, tower en route control (TEC), airway, and direct (RNAV, GPS) routes

iii. STARs, IAPs and IAFs

iv. List defining navigation fixes/waypoints for each leg

v. Record magnetic courses and Distances (each leg and total)

B. Decide operating altitude or flight level based on

i. Minimum IFR altitude (91.177)

ii. Airplane performance and equipment (POH/FM)

iii. Weather factors

a. Winds aloft

b. Temperature, freezing level, icing, cloud tops

c. Turbulence

- iv. Duration of flight
- v. Oxygen availability
- C. Choose **power setting** (MP, RPM) at cruise altitude and estimate **TAS** and **fuel flow** (POH Section 5http://greggordon.org/flying/CTR182Perf80.htm)
- D. Use TAS and **wind** data to determine GS, **ETE** (for each leg and total to destination) and **fuel requirement** (record on flight nav log)
  - i. Start with time, fuel and distance to climb using POH Section 5
    - a. Include fuel for start, taxi and takeoff
  - ii. Add time and fuel for flight from reaching cruise altitude to first point of intended landing
  - iii. This **ETE** added to takeoff time determines **ETA** at first point of intended landing
    - a. The time to start approach in event of radio communications failure if no EFC received (91.185)
  - iv. If an alternate is required (91.167), estimate time/fuel for flight from first point of intended landing to alternate airport
  - v. Add fuel for **45 minutes** at normal cruise speed to determine minimum fuel required by 91.167

3. Selection and correct interpretation of the current and applicable en route charts, DP's, STAR's, and standard instrument approach procedure charts

- A. Confirm correct and current en route charts and TPPs (includes DPs, STARs and IAPs)
  - i. Confirm effective dates on front of charts and booklets
  - ii. Dates of latest editions of charts online (28 and 56-day product effective dates)
  - iii. Check for changes between effective dates
    - a. Aeronautical Chart Bulletin online or in a current AFD
      - Chart Bulletin: http://www.naco.faa.gov/index.asp?xml=naco/online/chart_bulletins
    - b. NOTAMs
- B. NACO Chart User's Guide for interpretation of chart symbols
  - i. Recommend: VFR charts may also prove helpful

4. NOTAM information

- A. Time-critical aeronautical information of a temporary nature or not known in time to be published on charts or other publications receives immediate dissemination via the NOTAM system
  - i. NOTAM information could affect a pilot's go/no-go decision
  - ii. Three categories
    - a. NOTAM (D) or distant - widely disseminated
      - Data file maintained at Weather Message Switching Center (WMSC), Atlanta, GA
      - Distributed automatically via Service A telecommunications system
    - b. NOTAM (L) or local - distributed locally only by the area FSS
    - c. FDC NOTAMs
      - Regulatory information (e.g., chart and IAP changes, TFRs)
      - Each FSS keeps file of current unpublished FDC NOTAMs applicable within 400 NM
      - DUATS provides FDC NOTAMs only upon site-specific (location identifier) request
  - iii. NOTAMs (D) and some (L) expected to last longer than 7 days and FDC NOTAMs are published every 28 days in the Notices to Airmen Publication (NTAP)
  - iv. GPS NOTAMs available from ARTCC Special Notices

5. Preparation and filing of an actual or simulated IFR flight plan

- A. Before entering controlled airspace under IFR, file an IFR flight plan and receive an ATC clearance (91.173)
  - i. IFR flight plan information may be reviewed in the AIM, 5-1-8
  - ii. For determining equipment suffix, consider GPS to be RNAV
    - a. Mode C transponder and GPS with en route and terminal capability = **/G**

B. ICAO Flight Plans
   i. As of June 2017, the FAA will transition to the International Flight Plan Format for all VFR and IFR civil flights within the NAS (National Airspace System) and to Canada
   ii. Much of the information is identical to what would have been entered in an FAA Domestic flight plan. The biggest changes are in the Flight Rules, Type of Flight, Wake Turbulence Category, and the Aircraft Equipment Categories (this information comes from guidance developed by AOPA and the FAA and expected to be in the November 2017 AIM)
      a. Flight Rules
         - Flight rules are always required.
         - Flight rules should indicate:
            a I for IFR
            b V for VFR
            c For a composite flight, (IFR then VFR or VFR then IFR), submit separate flight plans for the IFR and VFR portions of the flight. Filing a single flight plan for a composite flight (flight rules "Y" or "Z") is not supported at this time. The IFR plan will be routed to ATC, and the VFR flight plan will be route to a Flight Service for Search and Rescue services.
               1. YFR (Y) will be for flights beginning under IFR flight rules followed by one or more changes in flight rules.
               2. ZFR (Z) will be for flights beginning under VFR flight rules, then followed by one or more changes in flight rules.
               3. For both YFR and ZFR, the point where the flight rules change will need to be noted in the route of flight. This point of change determines when the flight plan will be sent to ATC as appropriate.
      b. Type of Flight
         - Entering the type of flight is entirely optional for flights wholly within US Domestic Airspace
         - In the case that you do need to include the type of flight, indicate it as follows:
            a G - General Aviation
            b S - Scheduled Air Service
            c N - Non-Scheduled Air Transport Operation
            d M – Military
            e D - DVFR
            f X - other than any of the defined categories above
      c. Wake Turbulence Category
         - Include the wake turbulence category as follows:
            a H - HEAVY, to indicate an aircraft type with a maximum certificated take-off mass of 300,000 lbs. or more
            b M - MEDIUM, to indicate an aircraft type with a maximum certificated take-off mass of less than 300,000 lbs. but more than 15,500 lbs.
            c L - LIGHT, to indicate an aircraft type with a maximum certificated take-off mass of 15,500 lbs. or less
      d. Aircraft Equipment
         - Whereas the FAA Domestic flight plan used single letter designations to represent entire avionics packages (for example, G = RNAV capability with GNSS and without RVSM), the ICAO system lets the pilot pick and choose the equipment and capabilities specific to their aircraft.
         - Equipment and capabilities that requires indication include:
            a Navigation

- b Transponder
- c ADS-B
- d Additional information may be required in the Remarks section for:
  1. PBN
  2. RVSM
  3. Data Communications
  4. More on this below
- There are two parts to the Equipment box. The first part is the Aircraft Equipment followed by a slash and the second portion, the Transponder Capability.
  - a Aircraft Equipment
    1. Standard Capability (S)
       a. In order to simplify filing, the code "S" can be included to indicate Standard Capability, which includes VHF radio, VOR, and ILS
       b. The use of S removes the need to list these 3 capabilities separately
    2. No Capability (N)
       a. When there is no navigation, communications, or approach capability then file only the letter N
    3. More Capabilities

TBL 5-1-4

Aircraft COM, NAV, and Approach Equipment Qualifiers

INSERT one letter as follows:

N if no COM/NAV/approach aid equipment for the route to be flown is carried, or the equipment is unserviceable,

(OR)

S if standard COM/NAV/approach aid equipment for the route to be flown is carried and serviceable (see Note 1),

(AND/OR)

INSERT one or more of the following letters to indicate the COM/NAV/approach aid equipment available and serviceable:

NOTE-

The capabilities described below comprise the following elements:

a. Presence of relevant serviceable equipment on board the aircraft.

b. Equipment and capabilities commensurate with flight crew qualifications.

c. Where applicable, authorization from the appropriate authority.

A	GBAS landing system	J6	CPDLC FANS 1/A SATCOM (MTSAT)
B	LPV (APV with SBAS)	J7	CPDLC FANS 1/A SATCOM (Iridium)
C	LORAN C	L	ILS
D	DME	M1	ATC RTF SATCOM (INMARSAT)
E1	FMC WPR ACARS	M2	ATC RTF (MTSAT)
E2	D-FIS ACARS	M3	ATC RTF (Iridium)
E3	PDC ACARS	O	VOR
F	ADF	P1–P9	Reserved for RCP
G	(GNSS) – *see Note 2*	R	PBN approved - *see Note 4*
H	HF RTF	T	TACAN
I	Inertial navigation	U	UHF RTF
J1	CPDLC ATN VDL Mode 2 – *see Note 3*	V	VHF RTF
J2	CPDLC FANS 1/A HFDL	W	RVSM approved
J3	CPDLC FANS 1/A VDL Mode 4	X	MNPS approved/North Atlantic (NAT) High Level Airspace (HLA) approved
J4	CPDLC FANS 1/A VDL Mode 2	Y	VHF with 8.33 kHz channel spacing capability
J5	CPDLC FANS 1/A SATCOM (INMARSAT)	Z	Other equipment carried or other capabilities - *see Note 5*

NOTE-

1. *If the letter S is used, standard equipment is considered to be VHF RTF, VOR, and ILS within U.S. domestic airspace.*

2. *If the letter G is used, the types of external GNSS augmentation, if any, are specified in Item 18 following the indicator NAV/ and separated by a space.*

3. *See RTCA/EUROCAE Interoperability Requirements Standard For ATN Baseline 1 (ATN B1 INTEROP Standard – DO-280B/ED-110B) for data link services air traffic control clearance and information/air traffic control communications management/air traffic control microphone check.*

4. *If the letter R is used, the performance–based navigation levels that are authorized must be specified in Item 18 following the indicator PBN/. For further details, see Paragraph 5–1–9 b 8, Item 18 (c) and (d).*

5. *If the letter Z is used, specify in Item 18 the other equipment carried, preceded by COM/, DAT/, and/or NAV/, as appropriate.*

6. *Information on navigation capability is provided to ATC for clearance and routing purposes.*

b Transponder Capability

TBL 5-1-5

Aircraft Surveillance Equipment, Including Designators for Transponder, ADS-B, ADS-C, and Capabilities

INSERT N if no surveillance equipment for the route to be flown is carried, or the equipment is unserviceable, OR *INSERT* one or more of the following descriptors, to a maximum of 20 characters, to describe the serviceable surveillance equipment and/or capabilities on board:	
SSR Modes A and C	
A	Transponder - Mode A (4 digits – 4096 codes)
C	Transponder - Mode A (4 digits – 4096 codes) and Mode C
SSR Mode S	
E	Transponder - Mode S, including aircraft identification, pressure-altitude and extended squitter (ADS-B) capability
H	Transponder - Mode S, including aircraft identification, pressure-altitude and enhanced surveillance capability
I	Transponder - Mode S, including aircraft identification, but no pressure-altitude capability
L	Transponder - Mode S, including aircraft identification, pressure-altitude, extended squitter (ADS B) and enhanced surveillance capability
P	Transponder - Mode S, including pressure-altitude, but no aircraft identification capability
S	Transponder - Mode S, including both pressure-altitude and aircraft identification capability
X	Transponder - Mode S with neither aircraft identification nor pressure-altitude capability
NOTE– *Enhanced surveillance capability is the ability of the aircraft to down-link aircraft derived data via a Mode S transponder.*	
Followed by one or more of the following codes if the aircraft has ADS-B capability:	
B1	ADS-B with dedicated 1090 MHz ADS-B "out" capability
B2	ADS-B with dedicated 1090 MHz ADS-B "out" and "in" capability
U1	ADS-B "out" capability using UAT
U2	ADS-B "out" and "in" capability using UAT
V1	ADS-B "out" capability using VDL Mode 4
V2	ADS-B "out" and "in" capability using VDL Mode 4
NOTE– *File no more than one code for each type of capability; for example, file B1 or B2,but not both.*	
Followed by one or more of the following codes if the aircraft has ADS-C capability:	
D1	ADS-C with FANS 1/A capabilities
G1	ADS-C with ATN capabilities

EXAMPLE–

1. *SDGW/SB1U1 {VOR, ILS, VHF, DME, GNSS, RVSM, Mode S transponder, ADS-B 1090 Extended Squitter out, ADS-B UAT out}*

2. *S/C {VOR, ILS, VHF, Mode C transponder}*

- Example
  a If your aircraft had:
    1. A VHF Radio, VOR and ILS S
    2. An IFR approved GPS G
    3. PBN Capable R
        a. If you are able to accept PBN routes and procedures. PBN is a new concept encompassing both RNAV and RNP. If you're using RNAV or RNP for any phase of the flight, this applies to you.
    4. Mode C Transponder C

  b The final entry into Box 10 would be SGR/C

c. We mentioned earlier that Remarks may be required for PBN aircraft. By listing PBN (R) in your equipment, you only notified ATC that your equipment is PBN approved. Since PBN describes many different types of equipment, you must specify what you're equipped with in the Remarks, box 18.
   1. The majority of general aviation piston aircraft will enter: PBN/B2C2D2
      a. B2= RNAV 5 capability, C2 = RNAV 2 capability, D2 = RNAV 1 capability
      b. By listing this code, you are telling ATC you are capable of handling RNAV based procedures for the en route structure and terminal procedures.

iii. For more information:
   a. A great, short ICAO flight plan instructional video from AOPA
   b. ICAO Flight Plan instructions expected to be included in the 2017 AIM
   c. FAA Aircraft Type Designators
   d. ICAO Flight Plan Form
   e. AIM 5-1-9 – International Flight Plan - IFR Flights

6. Control Sequence on an IFR Cross Country (With Towers)

A. AFSS - Obtain a weather briefing for departure/destination/alternate and file flight plan
B. ATIS - Preflight complete, obtain present conditions and approach/runways in use
C. Clearance Del - Obtain departure clearance
D. Ground Control - Noting that you are IFR, receive clearance/taxi instructions
E. Tower - Pretakeoff checks complete, receive T/O clearance
F. Departure Control - Contact departure to establish radar contract
G. ARTCC - Once out of the departure controller's area, center will coordinate flight en route
H. EFAS/HIWAS - Coordinate with ATC to obtain in flight weather information
I. ATIS - Coordinate with ATC to obtain weather information at your destination airport
J. Approach Control - Center will hand off to approach who will provide additional info/clearances
K. Tower - Approach passes to Tower who will clear you to land and cancel your flight plan

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant exhibits instructional knowledge of cross country flight planning by describing the:
1. Regulatory requirements for instrument flight within various types of airspace.
2. Computation of estimated time en route and total fuel requirement for an IFR cross-country flight.
3. Selection and correct interpretation of the current and applicable en route charts, RNAV, DPs, STARs, and standard instrument approach procedure charts (IAP).
4. Procurement and interpretation of the applicable NOTAM information.
5. Completes and files an IFR flight plan that accurately reflects the conditions of the proposed flight. (Does not have to be filed with ATC.)
6. Demonstrates adequate knowledge of GPS and RAIM capability, when aircraft is so equipped.
7. Demonstrates the ability to recognize wing contamination due to airframe icing.
8. Demonstrates adequate knowledge of the adverse effects of airframe icing during landing phases of flight and corrective actions: pretakeoff, takeoff, and cruise.
9. Demonstrates familiarity with any icing procedures and/or information published by the manufacturer that is specific to the aircraft used on the practical test.

III.C. Instrument Cockpit Check

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15)

Objectives	The student should develop knowledge of the elements related to checking the instruments prior to flight.
Key Elements	1. Develop a pattern 2. Stick to the pattern
Elements	1. Communications Equipment 2. Navigation Equipment 3. Magnetic Compass 4. HI/HIS/RMI 5. Attitude Indicator 6. Altimeter 7. Turn-and-Slip Indicator/Turn Coordinator (TC) 8. VSI 9. Airspeed Indicator 10. Outside Air Temperature 11. Clock 12. Pitot Heat 13. Electronic Flight Instrument Display 14. Traffic/Terrain Awareness 15. FMS/Auto Pilot
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has developed an effective preflight check for the instruments.

Instructors Notes:

Introduction:

Attention
Interesting fact or attention-grabbing story

Overview
Review Objectives and Elements/Key ideas

What
This will explain how to check the communications, navigation, and other equipment to ensure proper operation prior to flight.

Why
This is important because, you don't want to discover a problem with your instruments in the clouds where you are entirely reliant on your instruments.

How:

1. **Communications Equipment**
    - A. Loss of communications under IFR may be considered an emergency requiring compliance with 91.185
        - i. Confirm position, stability of radio antennas
        - ii. Use all radios prior to flight. Request "radio check" if necessary
        - iii. Transponder on standby
            - a. Reply light ON during warm-up
2. **Navigation Equipment**
    - A. VORs
        - i. Confirm position, stability of nav antennas
        - ii. 91.171 requires VOR accuracy check within 30 days prior to IFR flight
            - a. Record date, place, bearing error(s) and sign - every 30 days
    - B. DME
        - i. Note distance from VOR/DME if available
    - C. ILS
        - i. If LOC on field, then tune, identify, note correct indication
    - D. GPS
        - i. Confirm IFR approved, certified
        - ii. Follow appropriate start-up and self-test procedures
        - iii. Check RAIM availability
3. **Magnetic Compass**
    - A. Fluid-filled
    - B. Moves freely
    - C. Correctly indicates known headings (taxiways, runways)
4. **Heading Indicator (HI)/Horizontal Situation Indicator (HSI)/Remote Magnetic Indicator (RMI)**
    - A. Note correct indications on known headings during taxi
5. **Attitude Indicator (AI)**
    - A. Allow 5 minutes for gyro speed up
    - B. Note horizon bar aligned correctly
    - C. Unreliable if
        - i. More than 5°pitch or bank during taxi

6. **Altimeter (ALT)**
    A. Check maintenance logbook for static system and altimeter check within 24 months (91.411)
        i. Check static ports open, clear
        ii. Set to current reported altimeter setting
        iii. Record ALT error = difference between ALT indication and known field elevation
        iv. Conservative, safe practice: add any ALT error to approach MDA or DH during flight
        v. ALT error **> 75 feet** indicates ALT needs evaluation and repair
7. **Turn-and-Slip Indicator/Turn Coordinator (TC)**
    A. During taxi turns, ball moves freely to outside of turn
    B. During straight taxi, miniature airplane level
8. **Vertical-Speed Indicator (VSI)**
    A. Check maintenance logbook for static system (and altimeter) check within 24 months (91.411)
    B. Note/set level indication
9. **Airspeed Indicator**
    A. Check maintenance logbook for static system (and altimeter) check within 24 months (91.411)
    B. Confirm pitot heat available
    C. Note appropriately increasing rate during initial takeoff roll
10. **Outside Air Temperature**
    A. Note correct indication
11. **Clock**
    A. Set correct time
    B. Confirm operating
12. **Pitot Heat**
    A. During the preflight turn on the pitot heat and check to ensure it is operating per the manufacturer's instructions
13. **Electronic Flight Instrument Display**
    A. On power up ensure the instruments are displayed properly and any cautions/warnings shown are normal
    B. Most displays are very clear when an instrument has failed
        i. Ex. Red X across the instrument
    C. Of course, follow the specific manufacturer's instructions to verify proper operation
14. **Traffic/Terrain Awareness**
    A. Ensure proper operation on power up of these systems based on the manufacturer's required procedures
15. **FMS/Auto Pilot**
    A. FMS
        i. Check for proper operation of the FMS as required by the manufacturer
        ii. Ensure proper satellite coverage (check RAIM if necessary)
            a. Be alert for warnings of insufficient satellite signal
    B. Auto Pilot
        i. Based on the manufacturer's requirements, ensure the auto pilot is working
            a. Usually at least includes ensuring that the auto pilot can be disconnected/turned off in order to avoid a runway auto pilot

Conclusion:
Brief review of the main points

PTS Requirements:

To determine that the applicant exhibits instructional knowledge of an instrument cockpit check by describing the reasons for the check and the detection of defects that could affect safe instrument flight. The check shall include:

1. Communications equipment.
2. Navigation equipment.
3. Magnetic compass.
4. Heading indicator/horizontal situation indicator/remote magnetic indicator.
5. Attitude indicator.
6. Altimeter.
7. Turn-and-slip indicator/turn coordinator.
8. Vertical-speed indicator.
9. Airspeed indicator.
10. Outside air temperature.
11. Clock.
12. Pitot Heat.
13. Electronic flight instrument display.
14. Traffic awareness/warning/avoidance system.
15. Terrain awareness/warning/alert system.
16. Flight management system (FMS).
17. Automatic pilot.

PREFLIGHT LESSON ON A MANEUVER TO BE PERFORMED IN FLIGHT

IV.A. Maneuver Lesson

The examiner shall select at least one maneuver from AREAS OF OPERATION VI through IX and ask the applicant to present a preflight lesson on the selected maneuver as the lesson would be taught to a student. Previously developed lesson plans from the applicant's library may be used.

All lessons necessary for this lesson are found in sections VI through IX

PTS Requirements:

To determine that the applicant exhibits instructional knowledge of the selected maneuver by:

1. Using a lesson plan that includes all essential items to make an effective and organized presentation.
2. Stating the objective.
3. Giving an accurate, comprehensive description of the maneuver, including the elements and associated common errors.
4. Using instructional aids, as appropriate.
5. Describing the recognition, analysis, and correction of common errors.

AIR TRAFFIC CONTROL CLEARANCES & PROCEDURES

V.A. Air Traffic Control Clearances

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15)

Objectives	The student should develop knowledge of the elements related to communications with ATC as well as copying and read back of an IFR clearance.
Key Elements	1. Pilot/Controller Responsibilities 2. C-R-A-F-T 3. Always clarify instructions if confused
Elements	1. Air Traffic Clearance 2. Pilot Controller Responsibilities 3. ATC IFR Clearance 4. Interpretation, Clarification, Change of an ATC Clearance 5. Setting Com and Nav Frequencies
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 ATC communication system, the format behind an IFR clearance, as well as how to obtain a clearance when necessary.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

This lesson will examine the responsibilities of the controller and pilot during communication in the IFR world. You will also learn to the format of an IFR clearance, which is required for every IFR flight, and finally how to most efficiently set up your communications for flight.

Why

Communication is a huge part of IFR flight. Due to potentially restricted visibility, communication with ATC becomes essential for safety. The understanding of that communication is therefore imperative.

How:

1. **Air Traffic Clearance**
    - A. An authorization by ATC, for the purpose of preventing collision between know aircraft, for an aircraft to proceed under specified traffic conditions within controlled airspace
2. **Pilot/Controller Responsibilities (Tower, En Route Control, Clearance Void Times)**
    - A. Pilot Responsibilities
        - i. Acknowledge and receipt and understanding of an ATC clearance
        - ii. Read back any hold short instructions issued by ATC
        - iii. Request clarification or amendment, as appropriate, any time clearance is not fully understood
            - a. Or considered unacceptable from a safety standpoint
        - iv. Promptly complies with ATC clearance upon receipt except as necessary to cope with an emergency
            - a. Advises ATC as soon as possible and obtains an amended clearance, if deviation is necessary
        - v. PIC is directly responsible for and the final authority as to the operation of the aircraft (91.3)
            - a. In emergencies, PIC may deviate from 14 CFR to the extent necessary to maintain safety and then, if requested, send a written report to the Administrator
        - vi. Pilot is always responsible to **see and avoid traffic** when operating in VMC
        - vii. To operate under IFR in controlled airspace (91.173)
            - a. File an IFR flight plan
            - b. Obtain an ATC clearance
    - B. Controller responsibilities
        - i. Issuing appropriate clearances for the operation to be conducted
        - ii. In IFR clearances, assigning altitudes above the minimum IFR altitudes in controlled airspace
        - iii. Ensuring pilot acknowledgement/read back of clearances
            - a. If incorrect, distorted, or incomplete, makes corrections as appropriate
    - C. Tower En Route Control
        - i. The control of IFR en route traffic within delegated airspace between two or more adjacent approach control facilities
            - a. An ATC program that uses overlapping approach control radar services to provide IFR clearances

b. You are routed by airport control towers
c. Usually for aircraft operating below 10,000’

ii. Advantages
a. Designed to expedite traffic and reduce control and pilot communication requirements
b. Abbreviated filing procedures, fewer delays and reduced traffic separation requirements

iii. There are many locations where instrument flight can be conducted entirely in terminal airspace
a. TEC routes can be found in the A/FD
b. Pilots desiring to use TEC should include it in the remarks section of the flight plan

D. Clearance Void Time
i. May receive a clearance, when operating from an airport w/o a tower, which contains a provision for the clearance to be void if not airborne by a specific time
a. Used by ATC to advise an aircraft that the departure clearance is automatically canceled if T/O is not made prior to a specified time

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

3. ATC IFR Clearance

A. Clearance is received from Clearance Del when available, otherwise Ground will perform this function

B. When “Ready to copy” inform the controller and copy as follows:

i. **C**learance Limit
a. Occasionally a short-range clearance to a fix w/in or just outside the terminal area and provides frequency on which the long-range clearance will be received

ii. **R**oute, including any departure procedure
a. Normally "as filed," but may be changed for established flow patterns or preferred routes
b. Pilot responsibility to notify ATC if unable to comply with clearance
- e.g., radio equipment unable to receive necessary signals

iii. **A**ltitude, the initial altitude (to maintain)
a. **Cruise,** instead of maintain, assigns a block of airspace from min IFR altitude to the cruise altitude
- Within this block climb, descent and level-off are at pilot's discretion
- Once pilot begins descent and verbally reports leaving an altitude, he may not climb back to that altitude w/o further clearance

iv. **F**requency, for departure control

v. **T**ransponder Code

vi. Often you will know most of these before copying
a. Clearance limit is usually the destination; Route is often what you provided; DPs/Initial Altitude/Frequency can be heard as other aircraft are given clearances

C. Read Back
i. Promptly read back the clearance you just copied
ii. Inform ATC of any items you missed; correct any errors and read back those items again for confirmation

iii. Note "read back correct" from controller confirming correctness
iv. Reading back of initial clearance does not imply acceptance
v. Ensure appropriate phraseology is used
    a. AIM Pilot Controller Glossary

4. Interpretation, Clarification, Change of an ATC clearance

A. Interpretation
  i. Know what to expect from the controller
    a. Pilot Controller Glossary
    b. En route locations of nav facilities, waypoints, etc.
    c. CRAFT
    d. DPs

B. Clarification and Change
  i. Once the clearance is accepted, you are required to comply with ATC instructions
    a. You may request a clearance different from what was received
    b. Request clarification/amendment as appropriate anytime a clearance is not fully understood or unsafe
      - The pilot is responsible for requesting an amended clearance if the aircraft will be put in jeopardy

5. Setting Com and Nav Frequencies

A. Setup of all com/nav info according to the clearance received creates a much smoother flight
  i. Com Setup:
    a. Com 1: Departure Frequencies
      - Tower in the active frequency and Departure in standby
    b. Com 2: Arrival Frequencies

B. Set HI bug on initial assigned departure heading
C. Bug the initial altitude
D. Enter and check assigned route, all waypoints, including DP, in GPS and activate flight plan
E. Using primary navigation system (GPS): enter, check frequency/ID of first 1st station,
  i. Set OBS to initial assigned course
F. Set secondary NAV radio to the frequency of the approach facility (e.g., ILS) that would be used in case of emergency return to departure airport in IMC
G. Check transponder set to assigned code and on standby until ready for T/O, then switch to ALT mode

Conclusion:
Brief review of the main points

PTS Requirements:

To determine that the applicant exhibits instructional knowledge of air traffic control clearances by describing:

1. Pilot and controller responsibilities to include tower, en route control, and clearance void times.
2. Correct and timely copying of an ATC clearance.
3. Ability to comply with the clearance.
4. Correct and timely read-back of an ATC clearance, using standard phraseology.
5. Correct interpretation of an ATC clearance and, when necessary, request for clarification, verification, or change.
6. Setting of communication and navigation frequencies in compliance with an ATC clearance.

V.B. Compliance with Departure, En Route, and Arrival Procedures and Clearances

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), AIM

Objectives	The student should develop knowledge of the elements related to operating en route, on DPs, STARs, etc.
Key Elements	1. Write down ATC instructions 2. Pre-Approach Brief! 3. Current Charts
Elements	1. Navigation Publications 2. SIDs 3. STARs 4. En Route Charts 5. Communication Frequencies 6. Navaids 7. Checklist Items 8. Compliance
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP’s Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP’s Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands how to operate in departure, en route, and arrival areas.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

This lesson provides an overview of the departure, en route and arrival procedures, as well as their uses and instructions.

Why

Departures, STARs, and en route IFR procedures differ considerably from VFR procedures. It is vital you understand how to operate in these environments.

How:

1. **Navigation Publications**
   A. Selecting
      i. En Route Low Altitude Charts
         a. To effectively depart and navigate en route under instrument conditions this is necessary
         b. Select the chart(s) that will cover the entire planned route of flight, including the alternate
         c. Ensure the chart is current and check the AFD and NOTAMs for any changes
      ii. Terminal Procedure Publications
         a. Necessary for instrument approaches, departures, arrivals (for all terminal procedures)
         b. Ensure you have the plates necessary for your route of flight, including alternates
         c. Ensure the plates are current
            - Check the FDC NOTAMS for any updates to the TPP
      iii. A/FD
         a. Provides a large amount of information regarding airports as well as en route information
         b. Ensure your copy is current and useful for your specific route of flight
   B. Use
      i. En Route Low Altitude Charts
         a. Outline your route of flight and fold the map in a way that it can be easily used
         b. Keep all charts organized in a place where they can be easily accessed
      ii. TPP
         a. Mark the specific procedures that may be necessary to the flight
         b. Keep the charts organized and in a place where they can be easily reached
      iii. AFD
         a. The AFD is used primarily prior to the flight but can also be very useful in flight
         b. Runway lengths, airport frequencies, operations, lighting, etc. can be found in the AFD
2. **SIDs**
   A. ATC procedures printed for pilot/controller use in graphic form to provide obstruction clearance and a transition from the terminal area to the appropriate en route structure
      i. Primarily designed for system enhancement and to reduce pilot/controller workload

ii. ATC clearance must be received before flying a SID

B. Pilots and SIDs
   i. All pilots are encouraged to file and fly a DP at night, in VMC/IMC when one is available
   ii. The pilot must ensure the DP requirements can be met
      a. Unless specified otherwise, required obstacle clearance is based on:
         - Crossing the departure end of the runway at, at least 35', climbing to 400' before making the initial turn and maintaining a climb of at least 200 fpnm until the minimum IFR altitude
   iii. Obstacle clearance responsibility lies with the pilot climbing in visual conditions in lieu of flying a DP
   iv. When used by the controller during departure, the term "radar contact" should not be interpreted as relieving pilots of their responsibilities to maintain appropriate terrain and obstruction clearance
   v. Pilots of civil aircraft operating where SIDs are established may expect a SID
      a. Use of DPs requires pilot possession of the text/graphic depiction of the approved, current DP
      b. RNAV SIDs must be retrievable from the database and conform to the charted procedure
      c. ATC must be immediately advised of the pilot does not possess the SID or not capable of flying it
         - Notification may be accomplished by putting "No SIDs" in the remarks section
         - Or, the less desirable way of verbally informing ATC
   vi. Adherence to all restrictions on the DP is required unless clearance to deviate is received

C. SID Responsibilities
   i. ATC
      a. Responsible for specifying the direction of T/O or initial heading when necessary
      b. Obtaining pilot concurrence that the procedure complies with local traffic patterns, terrain, and obstruction clearance
      c. Including the DP as part of the ATC clearance when pilot compliance for separation is necessary
   ii. Pilot
      a. Acknowledgement and understanding of an ATC clearance
      b. Read back any part of a clearance that contains "hold short" instructions
      c. Request clarification of clearances
      d. Request an amendment to a clearance if it is unacceptable from a safety perspective
      e. Promptly comply with ATC requests (advise immediately if unable)
      f. When planning for a departure:
         - Consider the type of terrain and other obstructions
         - Determine if obstacle clearance can be maintained visually or if a DP is needed
         - Determine if an ODP or SID is available for the departure airport
         - Determine what actions allow for a safe departure from an airport w/o affiliated DPs
         - Consider the effect of degraded climb performance and actions to take if the engine is lost

3. STARs

A. An ATC coded IFR arrival route established for application to arriving IFR aircraft at certain airports

B. The purpose is to simplify clearance delivery procedures and facilitate transition between en route and instrument approach procedures

C. Pilots and STARS
   i. STARS may have planning info depicted to inform pilots what clearances to **expect**
      a. Theses speeds/altitudes are published so that pilots may have the info for planning purposes
         - They should not be used in the event of lost communications unless specifically told to expect them as part of a further clearance
   ii. Maintain the last assigned altitude until receiving authorization to descend so as to comply with all published/issued restrictions
      a. This authorization will include the phraseology "descend via"

- Clearance to "Descend Via" authorizes pilots to:
  a Vertically and laterally navigate on a STAR/FMSP, STAR/RNAV

b. Air traffic is responsible for obstacle clearance when issuing a "descend via" instruction

iii. IFR aircraft destined to locations where STARs have been published may be issued a STAR

a. Use of STARs requires pilot possession of at least the approved chart

b. RNAV STARs must be retrievable by the procedure name from the aircraft database

c. It is the responsibility of the pilot to accept or refuse an issued STAR

- Notify ATC by placing "NO STAR" in the remarks section of the flight plan
- Or by the less desirable way of informing ATC verbally

4. En Route Charts

A. Ensure the chart in use is current

B. When navigating on the depicted airways, maintain the MEAs, MCAs, MAAs, reporting points, etc.

C. ATC may vector you below the MEAs as they have Minimum Vectoring Altitudes

i. We do not have access to these

ii. If vectored below MEA and it appears to be dangerous contact ATC asap for an amended clearance

5. Communication Frequencies

A. Selection and Use

Communications Facility	Description	Frequency
ATIS	Continuous broadcast prepared by ATC controller containing wind direction and velocity, temperature, altimeter setting, runway and approach un use, and other information of interest to pilots	Listed in the A/FD under the city name; also on sectional charts in airport data block and in the communications panel, and on terminal area charts
UNICOM “[Airport Name] UNICOM”	Airport advisories from an airport without an operating control tower or AFSS	Listed in the A/FD under the city name; also on section charts in the airport data box
Clearance Delivery “[Airport Name] CLEARANCE”	Control tower position responsible for transmitting departure clearances to IFR flights	Listed on instrument approach procedure charts
Ground Control “[Airport Name] GROUND”	At tower controlled airports, a position in the tower responsible for controlling aircraft taxiing to and from the runways	Listed in the A/FD under city name
Tower “[Airport Name] TOWER”	“Local” controller responsible for operations on the runways and in Class B, C, or D airspace surrounding the airport	Listed in the A/FD under city name; also on sectional/terminal control charts in the airport data block and comm panel
ARTCC “[Name] CENTER”	En route radar facilities that maintain separation between IFR flights, and IFR and known VFR flights. Centers provide VFR advisories workload permitting.	Listed in the A/FD, and on instrument en route charts
Approach/Departure Control “[Airport Name] APPROACH”	Positions at a terminal radar facility responsible for handling of IFR flights to and from the primary airport	Listed in the A/FD; also on sectional charts in the comm panel, and on terminal charts
HIWAS	Continuous broadcast of forecast hazardous weather conditions on selected NAVAIDs. No communication capability	Block circle with white “H” in VOR frequency box; notation in A/FD airport listing under “Radio Aids to Navigation”
EFAS “FLIGHT WATCH”	For in-flight weather information	122.0 MHz (0600-2200 local time)
CTAF	Provides a single frequency for pilots in the area to use for contacting the facility and/or broadcasting their position and intentions to other pilots	Listed in A/FD; also on sectional charts in the airport data block (followed by a white C on a blue or magenta background). At airports with no tower, CTAF is 122.9, the “MULTICOM” frequency
Airport Advisory Area “[AFSS Name] RADIO”	AFSS personnel provide traffic advisories to pilots operating w/in 10 miles of the airport	123.6 MHz
AFSS “[Facility Name] RADIO”	Provides info and services to pilots, using RCOs and GCOs	Listed in the A/FD and sectional charts, under city name and in a separate listing of AFSS frequencies. On sectional charts, listed above the VOR boxes, or in separate boxes when remotes
MULTICOM “[Airport Name] TRAFFIC”	Intended for use by pilots at airports with no radio facilities. Pilots should use self-announce procedures given in AIM	122.9 MHz A/FD shows 122.9 as CTAF; also on sectionals 122.9 is followed by a white C on a dark background, indicating CTAF

B. When transitioning through airspace ATC will provide new frequencies to maintain contact

i. Copy the new frequency down, acknowledge it and contact the next Center

a. Contact with your call sign and current altitude

6. **NAVAIDs**
   A. Record/check frequencies of NAVAIDS on flight plan form
   B. Record/check correct way points
   C. Tune and identify first NAVAID before takeoff if within range
      i. Verify on G1000 comm box by noting the NAVAID identifier
      ii. Or, use the NAV button to listen to and identify the Morse code
   D. En route, tune and identify each NAVAID used
      i. Confirm NAVAID identification on G1000
      ii. Confirm correct Morse code
         a. Change navigation guidance at the appropriate changeover points (COPs)
            - Change frequency from station behind to station ahead at COP
            - Use COP depicted, if none depicted, use midpoint or point where heading changes
7. **Checklist Items**
   A. Pre-Approach Brief (FFIIMMMMS)
      i. **F**ixes
      ii. **F**requencies
      iii. **I**nbound Course
      iv. **I**dentify
      v. **M**arker Beacons
      vi. **M**inutes
      vii. **M**inimums
      viii. **M**issed
      ix. **S**ecurity
   B. Pre Landing Checklist (LBGUMPS)
      i. **L**anding Light
      ii. **B**oost Pump/Brake
      iii. **G**as
      iv. **U**ndercarriage
      v. **M**ixture
      vi. **P**rop
      vii. **S**ecurity
   C. Fix/Glide Slope Intercept (5 T's – Ask and answer at approach fix/heading change)
      i. **T**urn (Which way?)
      ii. **T**ime (Start Timer)
      iii. **T**wist (Rotate OBS)
      iv. **T**hrottle (11-13" Hg, 2300 rpm)
      v. **T**alk (Report to ATC)
   D. Inside Outer Marker/FAF
      i. **Reds** – Mixture, Rich
      ii. **Blues** – Propeller, Forward
      iii. **Greens** – Gear Down (3 Green)
      iv. **Whites** – Landing Light
      v. **Power** – 11-13" Hg
8. **Compliance**
   A. Vectors
      i. When a heading is assigned or a turn is requested by ATC, promptly initiate the turn, complete the turn, and maintain the new heading unless issued additional instructions
      ii. Question any assigned heading/altitude believed to be incorrect

- iii. If operating VFR and any radar vector/altitude would cause CFR violation, advise ATC and obtain a revised clearance
- iv. Controller:
  - a. Vectors aircraft in controlled airspace
    - For separation
    - For noise abatement
    - To obtain an operational advantage for the pilot/controller
  - b. Vectors aircraft in controlled airspace when requested by the pilot
  - c. Vectors IFR aircraft at or above minimum vectoring altitudes
  - d. May vector VFR aircraft, not at an ATC assigned altitude, at any altitude
    - In these cases, terrain separation is the pilot's responsibility

B. Altitude
- i. Unless otherwise authorized by ATC, the following rules apply:
  - a. IN controlled airspace: Maintain the altitude or flight level assigned by ATC
  - b. VFR On Top: Follow the rules prescribed in 91.159
  - c. In uncontrolled airspace:
    - When operating below 18,000 MSL, and
      - a On a magnetic course of 0^o through 179^o, any ODD THOUSAND FOOT MSL altitude
      - b On a magnetic course of 180^o to 359^o, any EVEN THOUSAND FOOR MSL altitude

C. Airspeed
- i. When given an airspeed to maintain, you are expected to maintain that airspeed ± 10 knots
  - a. If your aircraft cannot maintain the speed assigned, you must advise ATC
- ii. Comply with speed adjustments given by ATC
  - a. Unless it interferes with the min/max speed of the aircraft
- iii. The maximum speeds in part 91 still apply
  - a. PICs responsibility to advise ATC if an assigned speed would cause you to exceed these limits
  - b. It is normal for faster aircraft to level off at 10,000' MSL while slowing to the 250 KIAS limit
    - Controllers anticipate this and plan accordingly

D. Climbs
- i. Pilots are expected to execute a clearance or instruction upon receipt
- ii. "*Immediately*" is used to impress urgency to avoid an imminent situation, and expeditious compliance is expected and necessary for safety
- iii. *"Climb at pilot's discretion"* means you have the option to:
  - a. Start a climb when you wish
  - b. Climb at any rate
  - c. Temporarily level off at any intermediate altitude as desired
    - Although, once you vacate an altitude, you may not return to that altitude
- iv. When the term *"at pilot's discretion"* is not used, and no climb restrictions are imposed, you should:
  - a. Climb at an optimum rate consistent with the operating characteristics of your aircraft to 1,000' below the assigned altitude, and then attempt to climb at a rate of between 500 and 1500 fpm
  - b. If at any time you are unable to climb at a rate of at least 500 fpm, advise ATC
  - c. If it is necessary to level off at an intermediate altitude, advise ATC
- v. *"Expedite climb"* normally indicates you should use the approximately best rate of climb without an exceptional change in aircraft handling characteristics
  - a. Normally the controller will inform you of the reason to expedite
- vi. The term *"cruise"* may be used instead of "maintain" to assign a block of airspace to an aircraft
  - a. Block extends from the minimum IFR altitude up to and including the altitude in the clearance

b. You may level off at any intermediate altitude within this clock of airspace
   - You are allowed to climb/descend within the block at you own discretion, however:
     - *a* Once you start descent and verbally report leaving an altitude to ATC, you may not return to that altitude without additional ATC clearance

E. Descents
   i. ATC may ask you to descend and maintain a specific altitude
      a. Generally, this is for en route traffic separation purposes and you need to respond to it promptly
         - Descend at the optimum rate for your aircraft until 1,000' above the assigned altitude, then descend at a rate between 500 and 1,500 fpm
         - If at any time you cannot descend at a rate of 500 fpm, advise ATC
   ii. *"At pilot's discretion"*
      a. Begin the descent whenever you choose and at any rate you choose
      b. You may also level off, temporarily, at any intermediate altitude during the descent
         - However, once you leave an altitude, you may not return to it

F. Airspace Restrictions
   i. Stay within protected airspace – this depends on:
      a. Accurate flying (Stay as close as possible to the centerline of the intended course)
      b. Accurate navigation equipment
      c. Accurate navigations signals from ground/space transmitters
      d. Accurate direction by ATC
      e. Accurate charts and publications

9. Two Way Radio Communication Failure
   A. See CFII Lesson 09.A.

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant exhibits instructional knowledge of the elements related to compliance with departure, en route, and arrival procedures and clearances by describing:

1. Selection and use of current and appropriate navigation publications.
2. Pilot and controller responsibilities with regard to DPs, En Route Low and High-Altitude Charts, and STARs.
3. Selection and use of appropriate communications frequencies.
4. Selection and identification of the navigation aids.
5. Accomplishment of the appropriate checklist items.
6. Pilot's responsibility for compliance with vectors and also altitude, airspeed, climb, descent, and airspace restrictions.
7. Pilot's responsibility for the interception of courses, radials, and bearings appropriate to the procedure, route, or clearance.
8. Procedures to be used in the event of two-way communications failure.
9. The uses of the multifunction display and other graphical navigational displays, if installed, to monitor position track, wind drift, and other parameters to maintain situational awareness and desired flightpath.

FLIGHT BY REFERENCE TO INSTRUMENTS

VI.A-E. Basic Attitude Instrument Flight

References: Instrument Flying Handbook (FAA-H-8083-15)

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

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

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

Why

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

Note

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

How:

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

    b. The amount of deviation from that desired will determine the magnitude of correction

C. Bank Control
  i. Changes are made by changing the bank attitude by precise amounts in relation to the bank scale
    a. Normally use a bank angle that does not exceed 30°

D. Power Control
  i. Made by throttle adjustments and reference to the power indicators
    a. Little attention is necessary to ensure the power setting remains constant
  ii. From experience, you know how far to move the throttles to change the power a given amount
    a. Make power changes primarily by throttle movement and then crosscheck the indicators
      - DON'T FIXATE on the indicators while setting the power

E. CE – Applying control inputs without reference to the AI

4. Trim

A. Trim the plane out for hands off flights
B. CE – Not trimming or over/under controlling but not so much flying with the trim in the DA20
C. CE – Frequently and in small amounts

5. Instrument Crosscheck

A. The continuous and logical observation of instruments for attitude and performance information
  i. The pilot maintains an attitude by reference to instruments that will give the desired performance
B. It is impossible to establish an attitude and have performance remain constant for a long period of time
  i. It is therefore necessary to constantly check the instruments and make appropriate changes
C. Different Crosschecks
  i. Select Radial Crosscheck
    a. Based off the AI
      - Eyes never travel directly between the flight instruments, but move by way of the AI
    b. Begin with the AI, scan an instrument and return to the AI before moving to another
  ii. Inverted V Crosscheck
    a. Moving your eyes from the AI to the TC, up to the AI, to the VSI, and back to the AI
  iii. Rectangular Crosscheck
    a. Move your eyes across the top three instruments and drop down to scan the bottom three
    b. This gives equal weight to each instrument, regardless of its importance to the maneuver
    c. But, this method lengthens the time for your eyes to return to a maneuver's critical instrument
D. Crosscheck and Bank
  i. After establishing, check the HI and TC to ensure the airplane is performing as desired
E. Crosscheck and Pitch
  i. After establishing, check the Altimeter, VSI and ASI to ensure the airplane is performing as desired
F. Crosscheck Errors
  i. CE - Fixation
    a. Staring at a single instrument (AI is the most common)
    b. This occurs for a variety of reasons and eliminates the crosscheck of other pertinent instruments
  ii. CE - Omission
    a. Omitting an instrument from the crosscheck
    b. May be caused by failure to anticipate major instrument indications following attitude changes
  iii. CE – Emphasis (VSI -chasing- is common or emphasizing pitch or bank instruments)
    a. Putting emphasis on a single instrument, instead of the necessary combination of instruments
    b. You may naturally tend to rely on the instrument most understood
G. Instrument Interpretation
    a. Understanding each instrument's construction and operating principles and applying this
    b. CE - Tendency to chase the VSI thinking it's an instantaneous reading (but it's a lag instrument**)**

ii. As the performance capabilities of the aircraft are learned, the instrument indications will be interpreted appropriately in terms of the attitude of the aircraft
    a. If the pitch is to be determined, the ASI, Alt, VSI and AI provide the necessary information
    b. If the bank attitude is to be determined, the HI, TC, and AI must be interpreted
iii. For each maneuver, you will learn what performance to expect and the combination of instruments to interpret to control the aircraft

6. Adjust

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

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

7. Straight-and-Level Flight

Pitch + Power = Desired Performance
Nose on Horizon + Cruise Power = Straight and Level

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

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

8. Constant Airspeed Climbs

Pitch + Power = Desired Performance
10° Nose Up + Full Power = Constant Airspeed Climb

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

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

9. Constant Airspeed Descents

Pitch + Power = Desired Performance
3° Nose Down + Descent Power = Constant Airspeed Descent

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

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

10. Turns to Headings

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

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

A. Prior to entering, determine which direction the turn should be made and the angle of bank required
   i. Use an angle of bank equal to the number of degrees to turn, not to exceed 30°
B. Establish – coordinated aileron and rudder pressure to establish the desired bank angle on the AI
   i. If standard rate, use the TC to check
   ii. Adjust pitch as necessary (probably increase) to maintain level flight
C. Trim – Trim the airplane
D. Crosscheck
E. Adjust – Correct any performance errors as necessary and go through the process again
F. Rolling Out
   i. Apply coordinated rudder and aileron pressure to level the wings on the AI
      a. Depending on the amount of turn, rollout about 10° before the desired heading
         - Or use ½ the bank angle or less for small turns
   ii. Adjust the pitch to maintain level flight

Common Errors:

- "Fixation," "Omission," and "Emphasis" errors during instrument crosscheck
- Improper instrument interpretation
- Improper control applications

- Failure to establish proper pitch, bank, or power adjustments during altitude, heading, or airspeed corrections
- Faulty trim procedure

Conclusion:
Brief review of the main points

VI.A. Straight-and-Level Flight

References: Instrument Flying Handbook (FAA-H-8083-15)

Objectives	The student should develop knowledge of the elements related to flying straight and level by reference to only the instruments.
Key Elements	1. Pitch + Power = Performance 2. Establish, Trim, Crosscheck, Repeat 3. Trim!
Elements	1. Pitch, Bank, and Power 2. Full Panel and Partial Panel 3. Trim Technique
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands how to maintain straight and level flight based on the instruments.

Instructors Notes:

Introduction:

Attention
Interesting fact or attention-grabbing story

Overview
Review Objectives and Elements/Key ideas

What
This lesson covers the most fundamental piece of instrument flying, straight and level flight based solely on the instruments

Why
Straight and level flight based on the instruments is the basis of all instrument flight. It's very important in developing your IFR abilities and instrument scan.

How:

1. **Pitch, Bank, and Power**
   A. Pitch
      i. Pitch Attitude: The angle between the longitudinal axis of the airplane and the actual horizon
      ii. The pitch instruments are the Attitude Indicator, the Altimeter, the VSI, and the Airspeed Indicator
      iii. Attitude Indicator
         a. Provides a Direct Indication of pitch attitude
         b. Adjustments are made using the elevators to raise/lower the aircraft in relation to the horizon
            - This corresponds to the way pitch attitude is adjusted in visual flight (in relation to horizon)
         c. Level flight as shown on the AI may not be level flight as shown on the altimeter, VSI, ASI
            - airspeed must be constant (at a constant airspeed, there is only one pitch attitude for level flight)
            - If adjusted properly on the ground, the mini aircraft should show level flight at normal cruise
         d. Pitch adjustments by reference to instruments are much smaller than those for visual flight
            - Smooth pitch changes with positive pressure
      iv. Altimeter (Considered primary instrument for pitch during level flight)
         a. At constant power, any deviation from level flight is the result of a pitch change: Therefore, the altimeter gives an Indirect Indication of the pitch attitude in level flight
         b. Since the altitude should remain constant in level flight, any deviation from the desired altitude signals the need for a pitch change
            - Gaining altitude, lower the nose and vice versa
         c. Rate of movement is as important as the direction of movement for maintaining level flight w/o an attitude indicator
            - An excessive pitch deviation results in a rapid change of altitude and vice versa
         d. Corrections
            - Light control pressures should be used for a
               a Change of attitude to stop the needle movement, then a
               b Change of attitude to return to the desired altitude
            - When you observe that the needle movement indicates an altitude deviation, apply just enough pressure to slow the rate of movement

- a If it slows abruptly, ease off some of the pressure, keeping it slow
- b When the needle stops moving, you are in level flight
- Adjust the pitch attitude to return to the desired altitude
  - a Use elevator pressure for a 'normal' pitch correction
- Rule of Thumb:
  - a For errors less than 100', use a half-bar-width correction
  - b For errors in excess of 100', use an initial full-bar-width correction

v. VSI
  a. Indirect Indication of pitch attitude and is both a trend, and rate instrument
    - Trend Instrument: It shows immediately the initial vertical movement of the airplane which can be considered a reflection of pitch change
  b. To maintain level flight, use the VSI in coordination with the AI and Altimeter
    - Note any trend of the needle and apply a very light corrective pressure
    - As the needle returns to zero, relax the corrective pressure
  c. Lag Characteristics
    - Lag: The delay that occurs before the needle attains a stable indication after a pitch change
      - a If a slow, smooth pitch change is initiated lag will be minimal
      - b If a large, abrupt change is initiated erratic needle movement, reversal can/will occur
      - c Do not chase the needle in turbulent conditions
  d. To maintain level flight in coordination with the altimeter and AI keep this in mind:
    - The amount the altimeter has moved from the desired altitude governs the rate at which you should return to that altitude
      - a Make an attitude change that will result in a vertical-speed rate approximately double the error
        1. If altitude is off by 100', the correction should be approximately 200 fpm
           a. Over-controlling is indicated if more than 200 fpm over that desired

vi. Airspeed Indicator
  a. Indirect Indication of pitch attitude
  b. At a constant power setting/pitch attitude, airspeed remains constant
  c. As the pitch attitude lowers, airspeed increases and the nose should be raised and vice versa
  d. A rapid change in airspeed indicates a large change in pitch attitude and vice versa

B. Bank
  i. The angle between the lateral axis of the airplane and the natural horizon
    a. To maintain straight you must keep the wings of the airplane level with the horizon
    b. Adjustments are made using coordinated aileron and rudder pressure
  ii. The instruments used for bank control are the AI, the heading indicator, and the turn coordinator
  iii. Attitude Indicator
    a. Direct Indication of bank attitude
    b. Keep the wings level
  iv. Heading Indicator (This is the primary bank instrument)
    a. The bank attitude is shown indirectly, since banking results in a turn and change in heading
    b. The rate of movement of the HI can indicate the amount the airplane is banked
    c. When deviations from straight flight are found on the Heading Indicator,
      - Correct to desired heading with a bank angle no greater than the degrees to be turned
        - a Do not exceed a standard rate turn
  v. Turn Coordinator
    a. Indirect Indication of the bank attitude of the airplane

- When the mini aircraft is level, the airplane is in straight flight

b. Include in your cross check and correct for even the smallest deviations from desired position

c. Ball – Indicates the quality of the turn

- If the ball is off center, the airplane is slipping or skidding and the mini aircraft shows an error in bank attitude
- Corrections
  - a If the ball is out of center, apply the necessary rudder pressure to return it to center
  - b And at the same time, level the wings, crosschecking the HI and AI

C. Power

i. Any change in power results in a change in airspeed or altitude of an airplane

a. At any given airspeed, the power level determines whether the airplane is in, a climb, descent, or level

- Increasing the power and keeping airspeed constant will result in a climb and vice versa
- On the other hand, if you hold altitude constant, the power applied will determine the airspeed

ii. The relationship between altitude and airspeed determines the need for a change in pitch or power

a. If the airspeed is off the desired value, check the altimeter before deciding a power change is needed

- Altitude and Airspeed are interchangeable:
  - a You can change altitude for airspeed by lowering the nose and airspeed for altitude by raising it
- If altitude is high and airspeed low, a change in pitch alone may return the plan to the altitude/airspeed

b. If both airspeed and power are high or low, then a change in both pitch and power are needed

iii. When making power changes, pitch, bank, power must be coordinated to maintain altitude/heading

a. When you increase power, pitch instrument will show a climb – forward elevator is needed

- The airplane will tend to yaw and roll left unless you apply corrective pressures
- Keeping ahead of these changes requires an increase in your crosscheck speed

2. Full Panel and Partial Panel

A. Full Panel

i. Use the AI to establish level flight and crosscheck it with the necessary instruments

a. For Pitch: Use the Altimeter (P), VSI, ASI, AI

b. For Bank: Use the Heading Indicator (P), TC, AI

c. For Power: Use the Airspeed Indicator (P), Manifold Pressure, Tachometer

ii. Establish a crosscheck and make corrections as they are recognized on the instruments

B. Partial Panel

i. Since the altimeter normally is the primary pitch instrument, you still have the info needed to maintain level flight when partial panel

a. However, straight and level is more difficult w/o the AI because there is no instantaneous pitch indication

- The VSI and ASI are helpful in maintain level flight
- It is even more important to apply gentle pressures and patiently wait for the results on the primary instruments

ii. W/o the HI, you must use the MC and TC to maintain heading

a. When doing so, keep the mini airplane as level as possible

b. Before making adjustments, give the MC time to stabilize

- If swinging, average the readings and correct back to the desired heading w/timed SR Turns

a. EX. 10° off desired heading = 3 second SRT

3. Trim Technique

A. Apply control pressures to establish a desired attitude
B. Then adjust trim so the aircraft will maintain that attitude when the flight controls are released
C. Changes in attitude, power, configuration will require a trim adjustment in most cases

Common Errors

- Slow or improper crosscheck during straight and level flight
- Improper power control
- Failure to make smooth, precise corrections, as required
- Uncoordinated use of controls
- Improper trim control

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant:

1. Exhibits instructional knowledge of teaching straight-and-level flight by describing-
   A. the relationship of pitch, bank, and power in straight-and-level flight.
   B. procedure using full panel and partial panel.
   C. coordination of controls and trim.
2. Exhibits instructional knowledge of common errors related to straight-and-level flight by describing-
   A. slow or improper cross-check during straight-and-level flight.
   B. improper power control.
   C. failure to make smooth, precise corrections, as required.
   D. uncoordinated use of controls.
   E. improper trim control.
3. Demonstrates and simultaneously explains straight-and-level flight from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to straight-and-level flight.

ACS Skills Standards

1. Maintain altitude ±100 feet during level flight, selected headings ±10°, airspeed ±10 knots, and bank angles ±5° during turns.
2. Use proper instrument cross-check and interpretation, and apply the appropriate pitch, bank, power, and trim corrections when applicable.

VI.B. Turns

References: Instrument Flying Handbook (FAA-H-8083-15)

Objectives	The student should develop knowledge of the elements related to completing standard rate turns in instrument conditions.
Key Elements	1. Standard Rate = 3° per second 2. Standard Rate Bank Angle = TAS/10 + 5
Elements	1. True Airspeed and Angle of Bank 2. Entry and Recovery of a Constant Rate Turn 3. Coordination of Controls and Trim
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands what a standard rate turn is, how to approximate the bank angle required for a standard rate turn, and how to enter and recover from the turn.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

A standard rate turn is a turn at a rate of 3° per second.

Why

A standard rate turn is the basis for all IFR turns, it provides for a safe, standard rate of turn for all aircraft to use.

How:

1. **True Airspeed and Angle of Bank**
   A. Rate of turn varies with TAS and angle of bank
      i. The rate of turn at any given airspeed depends on the amount of sideward force causing the turn
         a. That is, the horizontal component of lift
      ii. This varies directly in proportion to the bank in a coordinated turn
         a. So, the rate of turn at a given airspeed increases as the angle of bank increases, and the turn radius decreases
      iii. As you increase airspeed, the turn rate gets slower and the turn radius gets larger
      iv. And, a reduction in airspeed or an increase in bank angle, will result in a faster rate and smaller radius
   B. Estimate angle of bank for a standard rate turn by, dividing TAS by 10 and adding 5 to the result
      i. Ex. Standard Rate Turn at 110 knots = 11 + 5, or 16°
      ii. Standard Rate turn is approximately 3° per second
      iii. There are various formulas for estimating the angle of bank for a standard rate turn. Use whichever one works best for you and your aircraft:
         a. TAS/10 +5
         b. TAS/10 + 7
         c. 15% of TAS
2. **Entry and Recovery of a Constant Rate Turn**
   A. Entry
      i. Use the AI to establish the approximate angle of bank you expect will result in a standard rate turn
         a. The AI is primary for bank while rolling into the turn
      ii. The TC will indicate a standard rate turn; maintain this bank angle throughout the turn
         a. The TC is primary for bank reference while in the turn
         b. Note the exact degree of bank when the TC shows a standard rate turn (maintain it)
         c. The Altimeter is primary for pitch because there is not an intended change in altitude
      iii. Bank Control
         a. Discussed above in TAS and Angle of Bank
      iv. Pitch Control
         a. Due to the loss of vertical lift, the nose will tend to pitch down and back elevator is needed
         b. Scan your pitch instruments during the roll in, roll out, and through the turn

- Attitude Indicator: Watch to ensure you are holding the intended pitch
- VSO: Watch for pitch deviations which the VSI will amplify
- Altimeter: Watch to make sure the pitch attitude maintains the desired altitude

v. Power Control
  a. Airspeed tends to be lost in level turns because the increased AOA results in increased induced drag
  b. To maintain speed, additional power is needed
  c. Cross check the instruments to ensure you maintain your airspeed as well as pitch and bank

B. Recovery
  i. To stop the turn on the desired heading, lead the roll-out by approximately ½ the angle of bank
  ii. Used coordinate rudder and aileron pressure to roll out
  iii. As you initiate the recovery, the AI becomes the primary bank instrument
  iv. When approximately level, the HI is the primary bank instrument

C. Half Standard Rate Turn
  i. Perform the same as a standard rate turn except divide the bank angle in half and use the TC to maintain approximately ½ standard rate turn

3. Coordination of Controls and Trim
  A. Throughout the turn ensure the ball remains centered and make any necessary corrections as needed
  B. Once the controls pressures have been established, trim as necessary to relieve them

Common Errors
- Improper cross check procedures
- Improper bank control during roll-in and roll-out
- Failure to make smooth, precise corrections, as required
- Uncoordinated use of controls
- Improper trim technique

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant:
1. Exhibits instructional knowledge of teaching turns by describing-
   A. the relationship of true airspeed and angle of bank to a standard rate turn.
   B. technique and procedure using full panel and partial panel for entry and recovery of a constant rate turn, including the performance of a half-standard rate turn.
   C. coordination of controls and trim.
2. Exhibits instructional knowledge of common errors related to turns by describing-
   A. improper cross-check procedures.
   B. improper bank control during roll-in and roll-out.
   C. failure to make smooth, precise corrections, as required.
   D. uncoordinated use of controls.
   E. improper trim technique.
3. Demonstrates and simultaneously explains turns from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to turns.

ACS Skills Standards

1. Maintain altitude ±100 feet during level flight, selected headings ±10°, airspeed ±10 knots, and bank angles ±5° during turns.
2. Use proper instrument cross-check and interpretation, and apply the appropriate pitch, bank, power, and trim corrections when applicable.

VI.C. Change of Airspeed in Straight-and-Level and Turning Flight

References: Instrument Flying Handbook (FAA-H-8083-15)

Objectives	The student should develop knowledge of the elements related to adjusting airspeed in different flight conditions and configurations.
Key Elements	1. Establish, Trim, Crosscheck, Adjust 2. Trim! 3. Scan, Scan, Scan
Elements	1. Maintaining Altitude and Changing Airspeed in Straight-and-Level Flight 2. Maintaining Altitude and Changing Airspeed in Turning Flight 3. Coordination of Controls and Trim
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands how to change airspeed with no other effect on level flight or turning flight.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

As airspeed is increased or decreased lift is increased or decreased in tandem. If adjustments are not made for changes in speed altitude will suffer. This lesson will explain how to adjust for changes in airspeed in straight and level and turning flight.

Why

This is necessary in order to obtain a better understanding of how an airplane performs at different speeds and the required control inputs necessary to maintain altitude. The student also will obtain a better feel for the aircraft and its abilities.

How:

1. **Maintaining Altitude and Changing Airspeed in Straight-and-Level Flight**
   - A. Full Panel
     - i. Decrease the power to the desired level (Usually lower than the power that will be required)
     - ii. As discussed before, a reduction in power will require an increase in pitch/lift to maintain altitude
       - a. As the airspeed begins to slow, increase back pressure to maintain altitude
         - Trim the airplane as necessary to relieve control pressures
       - b. If gear or flaps are being extended, adjust the pitch as necessary to maintain the altitude
         - Nose may pitch forward or upward
     - iii. Cross check will have to be increased to maintain altitude/bank as well as reduce airspeed
     - iv. Increase power to the level necessary to maintain the desired airspeed
   - B. Partial Panel
     - i. Failure of the vacuum gyro instruments; controlling with the altimeter, ASI, TC, VSI and MC
       - a. When flying partial panel, it is even more important to apply gentle pressure and patiently wait for results on the primary instruments
     - ii. The same process is used to change airspeed in straight-and-level flight
       - a. The scan although is not the same as the HI and AI cannot be used
       - b. Ensure altitude is maintained with the Altimeter
         - If a climb or descent is entered, 1st re-establish level flight and then gently correct back
           - a Extra control pressures may be needed to climb back to your altitude when losing airspeed
             - 1. Caution using large pitch changes to return to altitude, increase power if necessary
       - c. Use the MC and TC to maintain heading
         - While doing so, it is extremely important to keep the mini airplane as level as possible
         - Before making adjustments, give the MC time to stabilize
           - a If the compass card is bouncing, take the average and correct back w/standard turns
             - 1. 3° per second as a reference (EX. 10° off would take a 3 second turn to return)

2. Maintaining Altitude and Changing Airspeed in Turning Flight

A. Full Panel
   i. Proper execution requires rapid cross check and interpretation as well as smooth control
   ii. The angle of bank necessary for a given rate of turn is proportional to the true airspeed
      a. Since the turns are executed at standard rate, the angle of bank must be varied in direct proportion to the airspeed change to maintain a constant rate of turn
      b. When reducing airspeed, you must decrease the angle of bank and increase pitch to maintain altitude
   iii. The altimeter and turn coordinator indications should remain constant throughout the turn
      a. The altimeter is primary for pitch
      b. The miniature aircraft of the TC is primary for bank
      c. The manifold pressure gauge is primary for power while the airspeed is changing
         - As the airspeed is approaching the new indication, the ASI becomes primary for power control
   iv. Two Methods for Changing Airspeed in Turns
      a. Airspeed is changed after the turn is established
      b. Airspeed is changed simultaneously with the turn entry
      c. In both methods, the rate of crosscheck is increased as you reduce power
         - As the airplane decelerates, check the altimeter, VSI for needed pitch changes
         - If the mini aircraft of the TC shows a deviation adjust the bank
      d. Adjust pitch attitude to maintain altitude
      e. When approaching the desired airspeed, increase power to maintain it

B. Partial Panel
   i. Failure of the vacuum gyro instruments; controlling with the altimeter, ASI, TC, VSI and MC
   ii. Use the TC to establish and maintain partial panel turns
   iii. Without the AI you must use the ASI, VSI, and altimeter to maintain altitude
   iv. As in all partial panel situations, the scan rate must be increased
   v. Performed the same as above, just in a turn, maintain altitude and make corrections as necessary
   vi. Use the MC to roll out of the turn (careful for MC errors – ANDS, UNOS)

3. Coordination of Controls and Trim

A. Trim is important throughout the maneuver to relive control pressures
B. Maintain coordination between aileron and rudder pressures
C. Ensure coordination in regards to changing airspeed and bank angle

Common Errors

- Slow or improper crosscheck during straight and level flight and turns
- Improper power control
- Failure to make smooth, precise corrections, as required
- Uncoordinated use of controls
- Improper trim technique

Conclusion:

Brief review of the main points

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of teaching change of airspeed in straight-and-level flight and turns by describing-
    A. procedure using full panel and partial panel for maintaining altitude and changing airspeed in straight-and-level and turning flight.
    B. coordination of controls and trim technique.
2. Exhibits instructional knowledge of common errors related to changes of airspeed in straight-and-level and turning flight by describing-
    A. slow or improper cross-check during straight-and-level flight and turns.
    B. improper power control.
    C. failure to make smooth, precise corrections, as required.
    D. uncoordinated use of controls.
    E. improper trim technique.
3. Demonstrates and simultaneously explains changes of airspeed in straight-and-level and turning flight from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to changes of airspeed in straight-and-level and turning flight.

ACS Skills Standards

1. Maintain altitude ±100 feet during level flight, selected headings ±10°, airspeed ±10 knots, and bank angles ±5° during turns.
2. Use proper instrument cross-check and interpretation, and apply the appropriate pitch, bank, power, and trim corrections when applicable.

VI.D. Constant Airspeed Climbs and Descents

References: Instrument Flying Handbook (FAA-H-8083-15)

Objectives	The student should develop knowledge of the elements related to constant airspeed climbs and descents in both straight flight and turning flight.
Key Elements	1. Establish, Trim, Crosscheck, Adjust 2. Trim! 3. Scan, Scan, Scan
Elements	1. Constant Airspeed Straight Climbs 2. Constant Airspeed Climbing Turns 3. Constant Airspeed Straight Descents 4. Constant Airspeed Turning Descents
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the concepts behind constant airspeed climbs and is competent in performing them.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

This lesson will discuss the ability to climb and descend at a constant airspeed and maintain that airspeed throughout the climb and in a turn.

Why

Aircraft specific speeds are published for performance as well as safety reasons. In order to obtain this performance and remain safe, a consistent speed must be able to be maintained.

How:

1. **Constant Airspeed Straight Climbs**
   - A. When established, your objective is to maintain a desired airspeed for a specific power setting
   - B. Add power, adjust the pitch attitude for the desired airspeed and accept the resulting rate of climb
     - i. During the pitch transition, the attitude indicator is the primary pitch instrument
     - ii. The airspeed indicator is the primary pitch instrument once established whether climbing straight or turning
       - a. This is because the airspeed indications tell you whether pitch adjustments are necessary
   - C. Corrections
     - i. Pitch controls the airspeed during a constant power climb
       - a. If the airspeed gets too slow, adjust the pitch down and vice versa to maintain the desired airspeed
   - D. Entry
     - i. Raise the mini aircraft to the approximate nose high indication for the desired climb speed
       - a. Apply gentle back elevator pressure to initiate and maintain the climb attitude
     - ii. Power may be advanced to the climb power setting simultaneously with the pitch change, or after the pitch is established and the airspeed approaches the climb speed
   - E. Partial Panel Entry
     - i. Partial panel climb entries are easier/more accurate if entered from the climbing airspeed
       - a. Slow the airplane to the climbing airspeed and apply the necessary climb power setting
       - b. Without an AI, use the Altimeter, VSI, and ASI in place of it to make pitch changes
         - Because none are direct indications of pitch, it is very important to make smooth, gradual control inputs and allow time for the changes to take affect
         - The rate of movement of the altimeter also gives indirect pitch info
   - F. Stabilized Climb
     - i. Once stabilized at a constant airspeed and attitude, the ASI is primary for pitch and HI for bank
       - a. Monitor the tach/MP to ensure power is maintained
     - ii. If the climb attitude is correct for the power setting, the airspeed will stabilize at the appropriate speed
       - a. If the airspeed is high or low, make the appropriate small pitch correction

G. Leveling Off
    i. It will be necessary to start the level off before reaching the desired altitude
        a. Lead the altitude by 10% of the vertical speed shown
    ii. To level off at cruising airspeed,
        a. Apply smooth/steady forward elevator toward level flight attitude for the speed desired
        b. As the AI shows the pitch change, the VSI will move toward 0, and the altimeter will slow
            - Also, the airspeed will begin to show an acceleration
        c. Once the Alt, AI, VSI show level, constant change in pitch/torque are needed as airspeed increases
        d. As the airspeed approaches cruising speed, reduce power to the cruise setting
            - Or adjust power to the setting necessary for the airspeed desired

2. Constant Airspeed Climbing Turns

A. For climbing turns, combine the straight climbs with the turn techniques
    i. Roll out of the turn as necessary to attain the desired heading on the MC (take into account errors)

B. The rate of crosscheck and interpretation must be increased to enable bank control and pitch changes

3. Constant Airspeed Straight Descent

A. Entry
    i. Reduce airspeed to the selected descent airspeed while maintaining straight-and-level flight
    ii. Reduce power further, and simultaneously lower the nose to maintain a constant airspeed and trim
        a. Lower the nose to the approximate attitude to provide the desired descent speed

B. Partial Panel Entry
    i. Slow the airplane to the descent airspeed and apply the necessary power setting
    ii. Without an AI, use the Altimeter, VSI, and ASI in place of it to make pitch changes
        a. Because none are direct indications of pitch, it is very important to make smooth, gradual control inputs and allow time for the changes to take affect
        b. The rate of movement of the altimeter also gives indirect pitch info

C. Stabilized Descent
    i. Any deviation from the desired airspeed requires a pitch adjustment, power should remain constant

D. Leveling Off
    i. The level off must be started before reaching the desired altitude
    ii. To level off at an airspeed above the descent airspeed, lead the altitude by 100-150’
        a. At the lead point, add power to the appropriate level flight cruise setting
    iii. To level off at descent airspeed, lead the desired altitude by approximately 50’
        a. Simultaneously adjust pitch and add power to a setting that will hold the airspeed constant
    iv. Then trim off the control pressures

4. Constant Airspeed Turning Descents

A. For climbing turns, combine the straight climbs with the turn techniques
    i. Roll out of the turn as necessary to attain the desired heading on the MC (take into account errors)

B. The rate of crosscheck and interpretation must be increased to enable bank control and pitch changes

Common Errors

- Failure to use a proper power setting and pitch attitude
- Improper correction of vertical rate, airspeed, heading, or rate-of-turn errors
- Uncoordinated use of controls
- Improper trim control

Conclusion:

Brief review of the main points

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of constant airspeed climbs and descents by describing-
   A. procedure using full panel and partial panel for an entry into a straight climb or climbing turn, from either cruising or climbing airspeed.
   B. a stabilized straight climb or climbing turn.
   C. a level-off from a straight climb or climbing turn, at either cruising or climbing airspeed.
   D. procedure using full panel and partial panel for an entry into a straight descent or descending turn from either cruising or descending airspeed.
   E. a stabilized straight descent or descending turn.
   F. a level-off from a straight descent or descending turn, at either cruising or descending airspeed.
2. Exhibits instructional knowledge of common errors related to constant airspeed climbs and descents by describing-
   A. failure to use a proper power setting and pitch attitude.
   B. improper correction of vertical rate, airspeed, heading, or rate-of-turn errors.
   C. uncoordinated use of controls.
   D. improper trim control.
3. Demonstrates and simultaneously explains a constant airspeed climb and a constant airspeed descent from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to constant airspeed climbs and descents.

ACS Skills Standards

1. Maintain altitude ±100 feet during level flight, selected headings ±10°, airspeed ±10 knots, and bank angles ±5° during turns.
2. Use proper instrument cross-check and interpretation, and apply the appropriate pitch, bank, power, and trim corrections when applicable.

VI.E. Constant Rate Climbs and Descents

References: Instrument Flying Handbook (FAA-H-8083-15)

Objectives	The student should develop knowledge of the elements related to maintaining a constant rate of climb whether flying straight or in a turn.
Key Elements	1. Establish, Trim, Crosscheck, Adjust 2. Trim! 3. Scan, Scan, Scan
Elements	1. Constant Rate Straight Climbs 2. Constant Rate Climbing Turns 3. Constant Rate Straight Descents 4. Constant Rate Descending Turns
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands the concepts behind constant rate climbs and is competent in performing them.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

This lesson will discuss the ability to climb and descend at a constant rate and maintaining that rate whether straight or in a turn.

Why

Maintaining a constant rate is most often used in descents. A stable rate will allow better descent and climb planning as well as increase the pilot's scan and flying abilities.

How:

1. **Constant Rate Straight Climbs**
   - A. When established, your objective is to maintain a desired specific vertical velocity in addition to controlling airspeed
     - i. You may use a constant rate climb within 1,000' of assigned altitude
   - B. Since the VSI may lag 6 or more seconds, use the ASI to fine tune the pitch until the VSI stabilizes
     - i. During the pitch transition, the AI is the primary pitch instrument
     - ii. The VSI is the primary pitch instrument once established whether climbing straight or turning
   - C. Corrections
     - i. Pitch controls the airspeed during a constant power climb
       - a. If the airspeed gets too high, adjust the pitch down and vice versa to maintain the desired airspeed
   - D. Entry
     - i. Raise the mini aircraft to the approximate nose high indication for the desired climb
       - a. Apply gentle back elevator pressure to initiate and maintain the climb attitude
     - ii. Power may be advanced to the climb power setting simultaneously with the pitch change, or after the pitch is established and the airspeed approaches the climb speed
     - iii. Once the VSI stabilizes, fine tune the climb rate
   - E. Partial Panel Entry
     - i. Partial panel climb entries are easier/more accurate if entered from the climbing airspeed
       - a. Slow the airplane to the climbing airspeed and apply the necessary climb power setting
       - b. Without an AI, use the Altimeter, VSI, and ASI in place of it to make pitch changes
         - Because none are direct indications of pitch, it is very important to make smooth, gradual control inputs and allow time for the changes to take affect
         - The rate of movement of the altimeter also gives indirect pitch info
   - F. Stabilized Climb
     - i. Once stabilized at a constant rate and attitude, the VSI is primary for pitch and HI for bank
       - a. The ASI is primary for power, if it indicates low, try a higher power setting, if available
         - If airspeed is high and climb rate is low, pitching up, w/o adjusting power may correct

- ii. If the climb attitude is correct for the power setting, the VS will stabilize at the appropriate rate
  - a. If the VS is high or low, make the appropriate small pitch correction
    - Opposite of a constant speed climb: If too low, increase back pressure and vice versa

G. Leveling Off
- i. It will be necessary to start the level off before reaching the desired altitude
  - a. Lead the altitude by 10% of the vertical speed shown
- ii. To level off at cruising airspeed,
  - a. Apply smooth/steady forward elevator toward level flight attitude for the speed desired
  - b. As the AI shows the pitch change, the VSI will move toward 0, and the altimeter will slow
    - Also, the airspeed will begin to show an acceleration
  - c. Once the Alt, AI, VSI show level, constant change in pitch/torque are needed as airspeed increases
  - d. As the airspeed approaches cruising speed, reduce power to the cruise setting
    - Or adjust power to the setting necessary for the airspeed desired

2. Constant Rate Climbing Turns

A. For climbing turns, combine the straight climbs with the turn techniques
- i. Roll out of the turn as necessary to attain the desired heading on the MC (take into account errors)

B. The rate of crosscheck and interpretation must be increased to enable bank control and pitch changes

3. Constant Rate Straight Descent

A. Differs from constant airspeed in that you use pitch to control the rate of descent and power to control airspeed

B. Entry
- i. Reduce power and simultaneously lower the nose and trim
  - a. Lower the nose to the approximate attitude to provide the desired descent speed

C. Partial Panel Entry
- i. Slow the airplane to the descent airspeed and apply the necessary power setting
- ii. Without an AI, use the Altimeter, VSI, and ASI in place of it to make pitch changes
  - a. Because none are direct indications of pitch, it is very important to make smooth, gradual control inputs and allow time for the changes to take affect
  - b. The rate of movement of the altimeter also gives indirect pitch info

D. Stabilized Descent
- i. The VSI is the primary instrument for pitch once established, and it has stabilized
- ii. The ASI is primary for power
  - a. If speed is too slow, add power

E. Leveling Off
- i. The level off must be started before reaching the desired altitude
- ii. To level off at an airspeed above the descent airspeed, lead the altitude by 100-150’
  - a. At the lead point, add power to the appropriate level flight cruise setting
- iii. To level off at descent airspeed, lead the desired altitude by approximately 50’
  - a. Simultaneously adjust pitch and add power to a setting that will hold the airspeed constant
- iv. Then trim off the control pressures

4. Constant Rate Descending Turns

A. For descending turns, combine the straight climbs with the turn techniques
- i. Roll out of the turn as necessary to attain the desired heading on the MC (take into account errors)

B. The rate of crosscheck and interpretation must be increased to enable bank control and pitch changes

Common Errors

- Failure to use a proper power setting and pitch attitude

- Improper correction of vertical rate, airspeed, heading, or rate-of-turn errors
- Uncoordinated use of controls
- Improper trim control

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant:
1. Exhibits instructional knowledge of constant rate climbs and descents by describing-
   A. procedure using full panel and partial panel for an entry into a constant rate climb or descent.
   B. a stabilized constant rate straight climb or climbing turn, using the vertical speed indicator.
   C. a level-off from a constant rate straight climb or climbing turn.
   D. an entry into a constant rate straight descent or descending turn.
   E. a stabilized constant rate straight descent or descending turn using the vertical speed indicator.
   F. level-off from a constant rate straight descent or descending turn.
2. Exhibits instructional knowledge of common errors related to constant rate climbs and descents by describing-
   A. failure to use a proper power setting and pitch attitude.
   B. improper correction of vertical rate, airspeed, heading, or rate-of-turn errors.
   C. uncoordinated use of controls.
   D. improper trim control.
3. Demonstrates and simultaneously explains a constant rate climb and a constant rate descent from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to constant rate climbs and descents.

ACS Skills Standards
1. Maintain altitude ±100 feet during level flight, selected headings ±10°, airspeed ±10 knots, and bank angles ±5° during turns.
2. Use proper instrument cross-check and interpretation, and apply the appropriate pitch, bank, power, and trim corrections when applicable.

VI.F. Timed Turns to Magnetic Compass Headings

References: Instrument Flying Handbook (FAA-H-8083-15)

Objectives	The student should develop knowledge of the elements related to magnetic compass errors and using a compass for heading information.
Key Elements	1. North Lags 2. South Leads 3. UNOS – Undershoot N, Overshoot S 4. ANDS – Accelerate N, Decelerate S
Elements	1. Magnetic Compass 2. Calibration of the miniature aircraft of the TC 3. Full Panel and Partial Panel Compass Turns
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands how to compensate for errors in the compass and can competently make turns to various headings using the magnetic compass.

Instructors Notes:

Introduction:

Attention
Interesting fact or attention-grabbing story

Overview
Review Objectives and Elements/Key ideas

What
The magnetic compass is not as simple as a heading indicator when making turns. This lesson will describe the operation of the magnetic compass and its innate errors as well as how to overcome them in the airplane.

Why
In the case you lost your gyro instruments (heading indicator) you would need to turn to the magnetic compass for heading information. It is very important you understand its operation so that in this situation you can comfortably navigate through the clouds to an airport for landing.

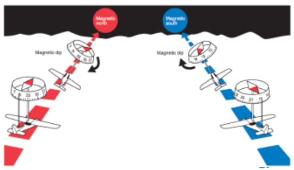
How:

1. **Magnetic Compass (MC)**
   A. Operation
      i. Two small magnets attached to a metal float sealed inside a bowl of clear compass fluid
      ii. A card is wrapped around the float and visible from the outside with a lubber line
         - Lubber Line: The reference line used in a magnetic compass or heading indicator
      iii. The float/card has a steel pivot in the center riding inside a spring loaded, hard glass jewel cup
         - The buoyancy of the float takes most of the weight off the pivot
         - The jewel and pivot type mounting allows the float to rotate and tilt up to approximately 18°
      iv. The magnets align with the Earth's magnetic field and direction is read opposite the lubber line
         - The pilot sees the card from its backside
            a The reason for this is the card remains stationary and the housing/pilot turn around it
   B. Errors
      i. Variation
         - Caused by the difference in the locations of the magnetic and geographic north pole
         - The north magnetic pole is not collocated with the geographic north pole
            a The difference between true and magnetic directions
         - Isogonic Lines: Lines drawn across aeronautical charts connecting points have the same magnetic variation
         - Agonic Line: An irregular imaginary line across the surface of the Earth along which the magnetic and geographic poles are aligned and along which there is no magnetic variation
      ii. Deviation
         - Caused by local magnetic fields within the aircraft; different on each heading
         - The magnets in a compass align with any magnetic field
            a Local magnets caused by electrical currents will conflict with the Earth's field
         - Deviation varies by heading and is shown on a compass correction card
      iii. Finding the Compass Course
         - True Course ± Variation = Magnetic Course ± Deviation = Compass Course

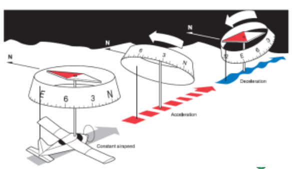
- Remember: East is Least, West is Best
    - a Subtract variation from true course, Add variation to true course

iv. Dip Errors

- What's Going On
    - a The lines of magnetic flux are considered to leave the Earth at the magnetic N pole and enter at the magnetic S pole
        1. At both poles, the lines are perpendicular to the surface
        2. Over the equator, the lines are parallel to the surface
    - b The magnets align with these fields and near the poles they dip, tilt, the float/card
    - c The float is balanced with a small dip compensating weight, so it stays relatively level
- Northerly Turning Error
    - a Caused by the pull of the vertical component of the Earth's magnetic field
    - b When flying on a heading of N, a turn to the E results in:



        1. The aircraft banking to the right and the compass card tilting to the right
        2. Then, the vertical component pulls the N seeking end of the compass to the right
            a. The float rotates, causing the card to rotate toward the W (opposite the turn)
    - The same happens when turning to the W; the float rotates to the E (opposite)
    - Remember: When starting a turn from a N heading, the compass lags behind the turn
    - e When flying on a heading of S, a turn to the E results in:
        1. The Earth's field pulling on the end of the magnet that rotates the card toward the E (same as the turn)
    - f When turning to the W, the same happens; the float rotates to the W (same direction)
    - g Remember: When starting a turn from a S heading, the compass leads the turn
    - h Remember: UNOS - Undershoot North, Overshoot South
- Acceleration Error



    - The dip-correction weight causes the end of the float and card marked N (S seeking end) to be heavier than the opposite end
    - If the aircraft accelerates on a heading of E, the inertia of the weight holds its end of the float back, and the card rotates toward the N
    - If the aircraft decelerates on a heading of E, inertia causes the weight to move ahead and the card rotates to the S
    - d When flying on a heading of W, the same things happen
    - e Remember: ANDS – Accelerate → North, Decelerate → South

b. Oscillation Error

- Oscillation is a combination of all the other errors
    - a It results in the compass card swinging back and forth around the heading being flown
- When setting the HI to the MC, use the average indication

2. Calibration of the miniature aircraft of the Turn Coordinator

A. Establish a standard rate turn as the second hand of the turn of the clock passes a cardinal direction and check the heading on the heading indicator or MC

B. Note the changes at 10 second interval. If the airplane turns more than 30° in ten seconds adjust the amount of bank applied to produce a standard rate turn

C. Once the turn coordinator is calibrated in both directions, note the desired corrections and apply them to all timed turns

D. Cross check and control the aircraft in the same manner as usual except substitute the clock for the heading indicator

i. The Turn & Bank will be primary for bank

ii. The altimeter is primary for pitch
iii. The Airspeed Indicator is primary for power

3. **Full Panel and Partial Panel Compass Turns**
   A. Enter the turn and start the time
   B. Maintain a standard rate turn until the time elapses and roll wings level
   C. When executing turns partial panel check the MC at the completion of the turn. Take compass deviation errors into account when using the MC

Common Errors

- Incorrect calibration procedures
- Improper timing
- Uncoordinated use of the controls
- Improper trim control

Conclusion:

Brief review of the main points

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of timed turns to magnetic compass headings by describing-
   A. operating characteristics and errors of the magnetic compass.
   B. calibration of the miniature aircraft of the turn coordinator, both right and left, using full panel and the clock.
   C. procedures using full panel and partial panel performing compass turns to a specified heading.
2. Exhibits instructional knowledge of common errors related to timed turns to magnetic compass headings by describing-
   A. incorrect calibration procedures.
   B. improper timing.
   C. uncoordinated use of controls.
   D. improper trim control.
3. Demonstrates and simultaneously explains timed turns to magnetic compass headings from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to timed turns to magnetic compass headings.

ACS Skills Standards

1. Maintain altitude ±100 feet during level flight, selected headings ±10°, airspeed ±10 knots, and bank angles ±5° during turns.
2. Use proper instrument cross-check and interpretation, and apply the appropriate pitch, bank, power, and trim corrections when applicable.

VI.G. Steep Turns

References: Instrument Flying Handbook (FAA-H-8083-15)

Objectives	The student should develop knowledge of the elements related to performing steep turns in IMC conditions.
Key Elements	1. Establish, Trim, Crosscheck, Adjust 2. Trim! 3. Scan, Scan, Scan
Elements	1. General 2. Full Panel and Partial Panel Entry and Recovery 3. Crosscheck 4. Coordination
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can complete a steep turn making the proper adjustments in order to maintain altitude and airspeed throughout the turn and recovering on the entry heading.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

Standard rate turns are the desired turns in IMC conditions, but there are situations in which steeper bank angles will be necessary. The student will learn the control inputs necessary to maintain altitude and airspeed at higher angles of bank by reference to the instruments.

Why

It is important to understand and have the ability to make turns steeper than 3° per second. This will teach the student the necessary inputs to control the airplane at steeper bank angles as well as provide the student a better understanding of how the airplane performs and is controlled

How:

1. **General**
   - A. In instrument flight, any turn greater than standard rate may be considered steep
   - B. Pronounced changes occur in the effects of aerodynamic forces on aircraft control at progressively steepening attitudes
     - i. Skill in crosscheck, interpretation, and control is increasingly necessary in proportion to the amount of these changes
   - C. The techniques for entering, maintaining, recovering are the same in principle as for shallow turns
2. **Full Panel and Partial Panel Entry and Recovery**
   - A. Entry
     - i. Enter exactly as you do a shallower turn, but prepare to crosscheck rapidly as the turn steepens
     - ii. Bank Control (Primary Instrument is the AI – maintaining a specific bank angle)
       - a. Maintain the bank angle on the AI (45°)
     - iii. Pitch control (Primary instrument is the Altimeter)
       - a. Unless immediately noted and corrected, the loss of vertical lift results in rapid movement of the altimeter, VSI, and ASI
         - The faster the change in bank, the more suddenly the change in lift occurs
       - b. If you overbank w/o adjusting pitch, the corrections require increasingly stronger back pressure
         - The loss of vertical lift/increased wing loading reach a point where more pressure tightens the turn w/o raising the nose
         - Overbanking is recognized by a rapid downward movement of the altimeter/VSI and an increase in airspeed despite application of back pressure
           - a You are in a diving spiral
           - b To recover, immediately shallow the bank with coordinated aileron and rudder
           - c Hold or slightly relax elevator pressure and increase your crosscheck
           - d Reduce power if airspeed increase is rapid
     - iv. Power (Primary Instrument is the ASI)

a. The power necessary to maintain constant airspeed increases as the bank and drag increases
b. Increase power to maintain airspeed

B. Partial Panel
   i. The airspeed indicator is primary for power
   ii. The altimeter is primary for pitch
   iii. The MC should be used to time the roll out
   iv. The VSI will show indications of climbs and descents but the instrument has some lag

C. Recovery
   i. Power control must be coordinated with bank control
      a. Back elevator pressure and power must be decreased
   ii. Begin the rollout approximately ½ your bank angle prior to the desired heading

3. Crosscheck
   A. Confirm the bank angle with the AI. Scan the altimeter for pitch changes and the HI to time the roll out
   B. The scan rate should be much faster and deviations should be corrected instantly

4. Coordination
   A. Maintain coordination between the ailerons and rudder throughout the turn

Common Errors
- Failure to recognize and make proper corrections for pitch, bank, or power errors
- Failure to compensate for precession of the horizon bar of the attitude indicator
- Uncoordinated use of controls
- Improper trim technique

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant:
1. Exhibits instructional knowledge of timed turns to steep turns by describing-
   A. procedure using full panel and partial panel for entry and recovery of a steep turn.
   B. the need for a proper instrument cross-check.
   C. roll-in/roll-out procedure.
   D. coordination of control and trim.
2. Exhibits instructional knowledge of common errors related to steep turns by describing-
   A. failure to recognize and make proper corrections for pitch, bank, or power errors.
   B. failure to compensate for precession of the horizon bar of the attitude indicator.
   C. uncoordinated use of controls.
   D. improper trim technique.
3. Demonstrates and simultaneously explains steep turns from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to steep turns.

ACS Skills Standards
1. Maintain altitude ±100 feet during level flight, selected headings ±10°, airspeed ±10 knots, and bank angles ±5° during turns.
2. Use proper instrument cross-check and interpretation, and apply the appropriate pitch, bank, power, and trim corrections when applicable.

VI.H. Recovery from Unusual Flight Attitudes

References: Instrument Flying Handbook (FAA-H-8083-15), POH/AFM

Objectives	The student should develop knowledge of the elements related to recovering from entry into unusual flight attitudes.
Key Elements	1. Nose High – Power, Nose, Bank 2. Nose Low – Power, Bank, Nose 3. Establish, Trim, Crosscheck, Adjust
Elements	1. General 2. Unusual Attitude Situations and Conditions 3. Recognizing Unusual Attitudes 4. Recovery Basics 5. Nose High Recovery 6. Nose Low Recovery 7. Partial Panel Recovery 8. Coordination During Recovery
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to safely recover from nose high and nose low unusual attitudes.

Instructors Notes:

Introduction:

Attention
Interesting fact or attention-grabbing story

Overview
Review Objectives and Elements/Key ideas

What
This lesson will explain common causes of unusual attitudes as well as the proper techniques to recover from a climbing turn or spiraling descent using a full or partial panel (gyro failure).

Why
Safety. In the off chance that you end up in an unusual attitude in the clouds it is essential that you have the ability to recognize and recover from an unusual attitude solely by reference to the instruments.

How:

1. **General**
   A. Since unusual attitudes are not intentional maneuvers, they are often unexpected
      i. The reaction is therefore, instinctive rather than intelligent and deliberate
         a. Individuals usually react with abrupt muscular effort, which is purposeless and even hazardous in turbulent conditions, at excessive speeds, or at low altitudes
   B. When an unusual attitude is noticed on your crosscheck, the immediate problem is not how it got there, but what it is doing and how to get it back to straight and level flight as quickly as possible*
2. **Unusual Attitude Situations and Conditions**
   A. Without adequate visual references, a pilot may unintentionally allow the aircraft enter a UA
   B. Unusual attitudes may result from a number of conditions, such as:
      - Turbulence
      - Disorientation
      - Instrument Failure
      - Confusion
      - Preoccupation with cockpit duties
      - Carelessness in crosschecking
      - Errors in instrument interpretation
      - Lack of proficiency in aircraft control
3. **Recognizing Unusual Attitudes**
   A. General Rule: If you note an instrument rate of movement or indication other than those you associate with the basic instrument flight maneuvers already learned, assume an unusual attitude and increase the speed of crosscheck to confirm the attitude, or instrument error, or instrument malfunction
   B. *When an unusual attitude is noticed on your crosscheck, the immediate problem is not how it got there, but what it is doing and how to get it back to straight and level flight as quickly as possible
   C. To avoid aggravating the UA with incorrect controls, the initial instrument reading must be accurate
   D. Nose High Attitudes (Climbing Turn)
      i. Shown by the rate/direction of movement of the altimeter, VSI, and ASI as well as the AI indications
         a. Rapidly decreasing airspeed
         b. Rapidly increasing Altitude (or increasing faster than desired)
         c. The TC indicates a bank
   E. Nose Low Attitudes (Diving Spiral)
      i. Shown by the same instruments but in the opposite directions
         a. Rapidly increasing airspeed

b. Rapidly decreasing Airspeed (or decreasing faster than desired)
c. The turn coordinator indicates a bank

F. CE - Failure to recognize an unusual flight attitude
   i. This error is due to poor instrument crosscheck and interpretation
   ii. Once in an unusual attitude, determine how to get out, not how the airplane got there
   iii. Unusually loud or soft engine and wind noise may provide an indication

4. Recovery Basics

A. In moderate unusual attitudes, the pilot can normally reorient with the attitude indicator, but this should not be done:
   i. If the attitude indicator is spillable, its upset limits may have been exceeded
   ii. It may have become inoperative due to mechanical malfunction
   iii. Even if it isn't spillable/is operating properly, errors of up to 5^{o} pitch and bank may result
   iv. Indications are difficult to interpret in extreme attitudes

B. Recovery, instead, is initiated by reference to the ASI, Altimeter, VSI, and TC

C. CE - Attempting to recover from an unusual attitude by "feel" rather than by instrument indications
   i. The most hazardous illusions leading to spatial disorientation are created by the info received in the inner ear
      a. The motion system in the inner ear can be tricked, and produce false sensations
   ii. You must believe and interpret the flight instruments since spatial disorientation is normal in UA

5. Nose High (Climbing Turn) Recovery

A. Nose High Attitudes - If the airspeed is decreasing, or below that desired:
   i. Increase power
   ii. Apply forward elevator pressure to lower the nose (preventing a stall)
   iii. Correct bank by apply coordinated aileron and rudder pressure by reference to the TC
      a. Aileron pressure before reducing the AOA could result in a spin
   iv. The pressures listed are made in the order described but almost simultaneously
   v. CE - Inappropriate control applications during recovery
      a. Accurately interpret the instrument indications before starting a recovery
      b. Follow the recovery steps in sequence
      c. Control movements may be large but they must be smooth, positive, prompt, and coordinated

B. After initial control has been applied, continue with a fast crosscheck to ensure proper corrections
   i. Level Flight is indicated by:
      a. Reversal and stabilization of the Altimeter and ASI
   ii. Straight and Coordinated Flight is indicated by:
      a. Level miniature aircraft and centered ball on the TC
   iii. CE - Failure to recognize from instrument indications when the passing through level flight
      a. With an operative AI, level flight exists when the miniature airplane is level with the horizon
      b. Without the AI, level flight is indicated by the reversal and stabilization of the ASI and altimeter

6. Nose Low (Diving Spiral) Recovery

A. Nose Low Attitudes – If the airspeed is increasing, or above that desired:
   i. Decrease power to idle
   ii. Level the Wings
      a. Correct the bank attitude with coordinated aileron and rudder pressure by reference to the turn coordinator
   iii. Raise the nose to level flight attitude by applying smooth back-elevator pressure
      a. Increasing pitch attitude without decreasing bank will result in excessive G's on the airplane
         - The instinctive reaction is to pull back on the controls
      b. Raise the nose smoothly to avoid overstressing the airplane

iv. The pressures listed should be made in the sequence given
v. CE - Inappropriate control applications during recovery
  a. Accurately interpret the instrument indications before starting a recovery
  b. Follow the recovery steps in sequence
  c. Control movements may be large but they must be smooth, positive, prompt, and coordinated

B. After initial control has been applied, continue with a fast crosscheck to ensure proper corrections
  i. Level Flight is indicated by the altimeter and airspeed indicator needles stopping and reversing direction
  ii. When airspeed returns to normal, set cruise power
  iii. CE - Failure to recognize from instrument indications when passing through level flight
    a. With an operative attitude indicator, level flight exists when the miniature airplane is level with the horizon
    b. Without the attitude indicator, level flight is indicated by the reversal and stabilization of the airspeed indicator and altimeter

7. Partial Panel Recovery

A. Use the turn coordinator to stop the turn and the pitot static instruments to arrest an unintended climb/descent

B. You are passing through level flight when you stop and reverse the direction of the airspeed indicator/altimeter
  i. Use the elevator to maintain the pitch, give the instruments a moment to stabilize and correct again

8. Coordination During Recovery

A. The attitude indicator and turn coordinator should be checked to determine straight/coordinated flight (wings level, ball centered)
  i. Skidding and slipping sensations can easily aggravate disorientation and retard recovery
  ii. A nose low recovery could result in excessive G's *and* uncoordinated flight, causing big problems

Common Errors:

- Failure to recognize an unusual flight attitude
- Consequences of attempting to recover from an unusual flight attitude by "feel" rather than by instrument indications
- Inappropriate control applications during recovery
- Failure to recognize from instrument indications when the airplane is passing through a level flight attitude

Conclusion:
Brief review of the main points
When recovering from an unusual attitude, it is essential to use the Airspeed indicator, Altimeter, Turn Coordinator, Heading Indicator and VSI to determine the situation, ignoring the AI. Recovery should be made promptly in the proper order to avoid damaging the airplane or aggravating the condition. Once level flight has been attained, the airplane should be reconfigured for straight-and-level flight.

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of recovery from unusual flight attitudes by describing-
   A. conditions or situations which contribute to the development of unusual flight attitudes.
   B. procedure using full panel and partial panel for recovery from nose-high and nose-low unusual
2. Exhibits instructional knowledge of common errors related to recovery from unusual flight attitudes by describing-

    A. incorrect interpretation of the flight instruments.
    B. inappropriate application of controls.
3. Demonstrates and simultaneously explains recovery from unusual flight attitudes, solely by reference to instruments, from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to recovery from unusual flight attitudes.

ACS Skills Standards

1. Use proper instrument cross-check and interpretation to identify an unusual attitude (including both nose-high and nose-low), and apply the appropriate pitch, bank, and power corrections, in the correct sequence, to return to a stabilized level flight attitude.

NAVIGATION SYSTEMS

VII.A. Intercepting and Tracking Navigational Systems and DME Arcs

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), AIM

Objectives	The student should develop knowledge of the elements related to operation and use of VORs.
Key Elements	1. Always check the VOR ID 2. Never fly the tail of the CDI (avoid reverse sensing) 3. VORs are Line-of-sight
Elements	1. Using the VOR 2. Tracking with the VOR 3. VOR Tips 4. Intercepting and Maintaining a Selected Course 5. Intercepting and Maintaining a DME Arc
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 VOR, and has the ability to VORs for navigation as well as approach procedures

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

The VOR (or very high frequency omni-directional range) is an instrument used for navigation and approach procedures in the IFR system. Since the student is already familiar on a basic level with VORs from the PPL, this lesson will provide a more in-depth overview of using the VOR, and tracking and intercepting radials.

Why

VORs are the backbone of the federal airway system and are used on almost every flight. Beyond airways, many airports use approaches based off of nearby or on-field VORs. The VOR is an extremely important piece of the IFR system.

How:

1. **Using the VOR**
   A. Identifying It
      i. Station can be identified by its Morse code identification or a voice stating the name and VOR
      ii. If the VOR is out of service, the coded identification is removed and not transmitted
         a. It should not be used for navigation
      iii. VOR receivers have an alarm flag to indicate when signal strength is inadequate
         a. The plane is either too far or too low and is out of the line-of-sight of the transmitting signal
   B. There are 2 required components for VOR radio navigation
      i. The ground transmitter and the receiver
         a. Ground transmitter is at a specific position on the ground and transmits on an assigned frequency
         b. The airplane equipment includes the receiver with a tuning device and a VOR instrument
            - The navigation instrument consists of:
               a An OBS (Omnibearing Selector), referred to as the course selector
               b A CDI (Course Deviation Indicator) Needle
               c A To/From Indicator
      ii. The course selector is an azimuth dial that is rotated to select a radial/determine the radial on
         a. In addition, the magnetic course TO or FROM the station can be determine
      iii. When the OBS is rotated, the CDI moves to show the position of the radial relative to the plane
      iv. If OBS is rotated to center the CDI, the radial (MC FROM)/its reciprocal (MC TO) can be found
      v. The CDI will also move to the right or left if the airplane is away from the radial selected
   C. TO and FROM
      i. By centering the needle, either the course "FROM" or "TO" the station will be indicated
         a. If the flag displays "TO," the course on the course selector must be flown to the station
         b. If "FROM" is displayed and the course shown followed, the plane flies away from the station
2. **Tracking with VOR**
   A. Tune the VOR frequency and check the identifiers to verify the desired VOR is being received

B. Rotate the OBS to center the CDI with a "TO" indication
   i. If centered with a "FROM" indication, rotate 180^o
      a. From indicates the radial we are on, TO indicates TO the station
C. Turn to the heading indicated on the VOR azimuth dial or course selector
   i. This will track directly to the station in a no wind situation
D. If there is a X-wind, and heading is maintained, you will drift off course
   i. If the X-wind is from the R, the airplane will drift to the L of course
      a. The CDI will gradually be moving R
   ii. To return to the desired radial, the heading must be altered to the R
      a. As the plane returns, the needle will move back to the center
   iii. When centered, the airplane is on the radial, now it must be crabbed to the right, into the wind
      a. This will establish wind correction (the amount necessary will depend on the wind strength)
         - Trial and error will establish the necessary heading to maintain the desired track
E. Upon arriving, and passing the VOR station, the "TO" indication will change to a "FROM" indication
   i. Generally, the same procedures apply for tracking outbound as inbound
      a. If the intent is to continue on the same heading the course selector shouldn't be changed
      b. If tracking outbound on a different course, the new course must be set into the selector
         - Turn to intercept this course and track the same as previously discussed
F. Reverse Sensing
   i. If flying toward a VOR with a FROM indication, CDI will indicate opposite the direction it should
      a. If the plane drifts to the R of course, the needle will move R, or point away from the radial
   ii. And vice versa (from a station with a TO indication and opposite drift indications)

3. **VOR Tips**
   A. Positively identify the station by its code or voice identification
   B. Remember, VOR signals are line-of-sight
   C. When navigating TO, determine the inbound radial and use it (Don't reset the radial, correct drift)
   D. When flying TO a station always fly the selected course with a TO indication
   E. When flying FROM a station always fly the selected course with a FROM indication
4. **Intercepting and Maintaining a Selected Course**
   A. Where are we? What radial is the aircraft on?
   B. Where do we want to go? Which direction is the course and do we want to fly inbound or outbound?
   C. How do we get there? We determine the difference between the heading we are flying and the radial we want to intercept. We double the difference and apply it in the direction we want to fly.
   D. Does it make sense? Will the bearing we have chosen get us to the course we want to fly?
5. **Intercepting and Maintaining a DME arc**
   A. Intercept the radial designated in the approach
      i. Fly outbound on that radial until reaching the DME distance required
   B. Make a 90^o right turn approximately ½ mile before reaching the DME distance
      i. Also, turn the OBS needle 10^o in the direction you will be flying
   C. When the needle re-centers, turn it 10^o further and make a 3 second standard rate turn
      i. When the needle re-centers, do the same until reaching approximately 10^o prior to the inbound course
   D. If the DME distance is getting too far or too close, adjust the turns as necessary to regain the distance
   E. OR, load the DME arc approach in the GPS and follow the needle!

Common Errors:

- Incorrect tuning and identification procedures
- Failure to properly set the navigation selector on the course to be intercepted

- Failure to use the proper procedures for course DME arc interception and tracking
- Improper procedures for intercepting a course or localizer from a DME arc

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant:
1. Exhibits instructional knowledge of the elements of intercepting and tracking navigational systems and DME arcs by describing-
   A. tuning and identification of a navigational facility.
   B. setting of a selected course on the navigation selector or the correct identification of a selected bearing on the RMI.
   C. method for determining aircraft position relative to a facility.
   D. procedure for intercepting and maintaining a selected course.
   E. procedure for intercepting and maintaining a DME arc.
   F. procedure for intercepting a course or localizer from a DME arc.
   G. recognition of navigation facility or waypoint passage.
   H. recognition of navigation receiver or facility failure.
2. Exhibits instructional knowledge of common errors related to intercepting and tracking navigational systems and DME arcs by describing-
   A. incorrect tuning and identification procedures.
   B. failure to properly set the navigation selector on the course to be intercepted.
   C. failure to use proper procedures for course or DME arc interception and tracking.
   D. improper procedures for intercepting a course or localizer from a DME arc.
3. Demonstrates and simultaneously explains intercepting and tracking navigational systems and DME arcs from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to intercepting and tracking navigational systems and DME arcs.
5. Exhibits instructional knowledge on the uses of the MFD and other graphical navigational displays, if installed, to monitor position in relation to the desired flightpath during holding.

ACS Skills Standards
1. Tune and correctly identify the navigation facility/program the navigation system and verify system accuracy as appropriate for the equipment installed in the aircraft.
2. Determine aircraft position relative to the navigational facility or waypoint.
3. Set and correctly orient to the course to be intercepted.
4. Intercept the specified course at appropriate angle, inbound to or outbound from a navigational facility or waypoint.
5. Maintain airspeed ±10 knots, altitude ±100 feet, and selected headings ±5°.
6. Apply proper correction to maintain a course, allowing no more than ¾-scale deflection of the CDI. If a DME arc is selected, maintain that arc ±1 nautical mile.
7. Recognize navigational system or facility failure, and when required, report the failure to ATC.
8. Use an MFD and other graphical navigation displays, if installed, to monitor position, track wind drift, and to maintain situational awareness.
9. Properly use the autopilot, if installed, to intercept courses.

VII.B. Holding Procedures

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), AIM

Objectives	The student should develop knowledge of the elements related to holding procedures.
Key Elements	1. Use the entry that makes the most sense 2. Standard turns are to the Right 3. Triple the wind correction on the outbound leg
Elements	1. General 2. Holding Instructions 3. Navigation Equipment 4. Holding Airspeeds 5. Standard Entry Procedures 6. Recognition of Arrival at the Holding Fix 7. Timing Procedure 8. Wind Drift Correction 9. DME in a Holding Pattern 10. Lost Comms – 91.185
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to draw a hold based on given holding instructions, can choose and perform the necessary entry into the hold, and maintain the hold making the corrections required for wind and time.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

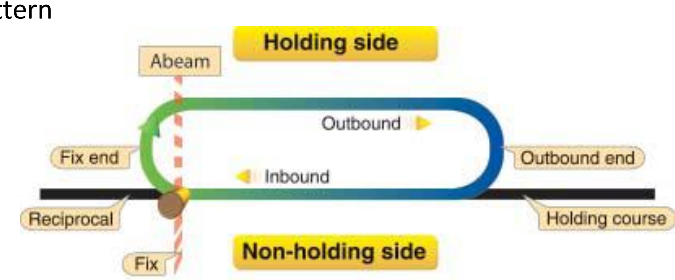
A hold is an IFR maneuver used to keep an airplane in a specific, protected area for a certain amount of time. There are various reasons an aircraft may be requested to hold, including over congestion at the destination airport, weather, runway closures, another aircraft on the IFR approach into an uncontrolled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

Why

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

How:

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



Standard pattern: Right turns (illustrated)
Non-standard pattern: Left turns

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

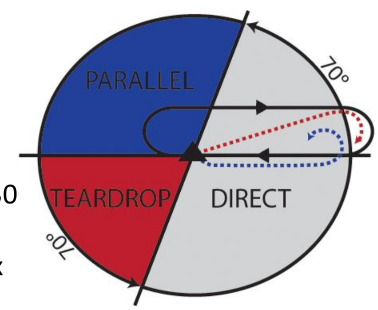
2. **Holding Instructions**
   - A. If you arrive at your clearance limit before receiving clearance beyond the fix, ATC expects you to
     - i. Maintain the last altitude
     - ii. Begin holding in accordance with the depicted pattern
       - a. If the pattern is not depicted, hold in a standard pattern on the course you approached on
         - Immediately request further clearance
   - B. When a holding pattern is not depicted, ATC clearance will specify the following:

- i. Direction of holding from the fix in terms of the 8 cardinal compass points (N, NE, E, SE, etc.)
- ii. Holding fix
- iii. Radial, course, bearing, airway, or route on which the aircraft is to hold
- iv. Leg length in miles if DME or RNAV is to be used
- v. Direction of turns if L turns are to be made
- vi. Time to EFC and any pertinent additional delay info

3. Navigation Equipment

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

4. Holding Airspeeds



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

5. Standard Entry Procedure

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

6. Recognition of Arrival at the Holding Fix

- A. If the holding fix is a VOR, when the To/From flag switches you have reached the holding fix
- B. At a DME distance, once the readout indicates the distance desired you have reached the holding fix
- C. Once you have reached the fix, promptly enter the turn to begin the entry to the hold
  - i. Directly over the fix (don’t wait)

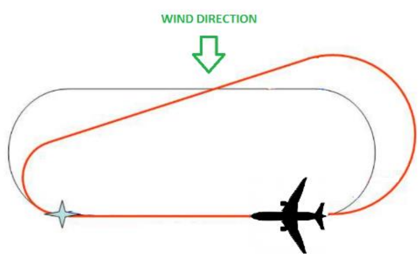
7. Timing Procedure

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

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

8. Wind Drift Correction

A. Continue to adjust the outbound timing to achieve a 1 min inbound leg
B. The effect of wind is counteracted by applying drift correction to the inbound leg to maintain course
   i. Triple the wind correction angle for the outbound leg
      a. EX. If 4° of wind correction is necessary to maintain the course inbound, apply 12° correction outbound
   ii. Why Triple the Drift?
      a. The wind has an opposite effect on your groundspeed in each of the turns in the hold
      b. For example, as pictured below, there is a crosswind from the North
         - As you make the turn from the inbound to the outbound leg, groundspeed will decrease, and as you make the turn from the outbound leg to the inbound leg groundspeed will increase
            a A slower groundspeed has a smaller turn radius
            b A faster groundspeed has a larger turn radius
         - Because of the change in groundspeed, and therefore the different sized turns, it is necessary to overcorrect on the outbound leg
         - Not correcting in this case, would result in the aircraft consistently being blown past the inbound leg



9. DME in a Holding Pattern

A. The same entry and holding procedures apply to DME except distances are substituted for time
B. The length of the outbound leg will be specified by the controller
   i. The end of the leg is determined by the DME readout

10. Lost COMMs - 91.185

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

Common Errors

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

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant:

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

ACS Skills Standards

1. Explain and use an entry procedure that ensures the aircraft remains within the holding pattern airspace for a standard, nonstandard, published, or non-published holding pattern.
2. Change to the holding airspeed appropriate for the altitude or aircraft when 3 minutes or less from, but prior to arriving at, the holding fix and set appropriate power as needed for fuel conservation.
3. Recognize arrival at the holding fix and promptly initiate entry into the holding pattern.
4. Maintain airspeed within ±10 knots; altitude ±100 feet; selected headings within ±10°; and track a selected course, radial or bearing within ¾-scale deflection of the CDI.
5. Use proper wind correction procedures to maintain the desired pattern and to arrive over the fix as close as possible to a specified time and maintain pattern leg lengths when specified.
6. Use an MFD and other graphical navigation displays, if installed, to monitor position in relation to the desired flightpath during holding.
7. Comply with ATC reporting requirements and restrictions associated with the holding pattern.
8. Demonstrate SRM.

INSTRUMENT APPROACH PROCEDURES

VIII.A. Non-Precision Instrument Approach

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), AIM, IAP

Objectives	The student should develop knowledge of the elements related to non-precision instrument approaches.
Key Elements	1. Ensure you have the correct chart 2. 5 T's at every waypoint: Turn, Time, Twist, Throttle, Talk 3. Brief the Approach
Elements	1. Appropriate Instrument Approach Procedure Chart 2. Pertinent Info on the Approach Chart 3. Radio Com with ATC and Compliance with Clearances, Instructions, and Procedures 4. Aircraft Configuration, Airspeed, and Checklist Items 5. Tuning, Identifying, and Determination of Status of Ground/Aircraft Nav Equipment 6. Aircraft Approach Category 7. Maintenance of Altitude, Airspeed, and Track 8. Appropriate Rate of Descent 9. Determination of a Straight-in-Approach, Circling Approach, Missed Approach
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to set up for, brief, and execute non-precision approaches without the assistance of the instructor.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

A non-precision approach provides lateral, but not vertical guidance to a runway. There are various types of non-precision approaches, such as VOR, GPS, and Localizer approaches. Non-precision approaches do not take you as close to the ground as precision approaches (like an ILS) but does provide an avenue for landing in marginal weather. Non-precision approaches are more common in smaller airports, larger airports tend to use the ILS.

Why

Non-precision approaches are commonly flown at all levels of flying. Even commercial airlines and charter services will fly non-precision approaches from time to time. It is important to understand how they operate.

How:

1. **Appropriate Instrument Approach Procedure Chart**
   - A. Often ATIS will provide pilots with the approaches that are in use
     - i. If more than one is in use, an educated guess may be necessary until ATC assigns an approach
       - a. This is based on weather, direction of arrival, any NOTAMS, and previous experience
     - ii. ATC can inform you of the approach that can be expected
       - a. Pilots may request specific approaches to meet the individual needs of their equipment or regulatory restrictions at any time and ATC will most likely accommodate the request
     - iii. If operating into an airport without a control tower, the crew occasionally will be allowed to choose
2. **Pertinent Info on the Approach Chart**
   - A. FFIIMMMMS
     - i. **F**ixes
     - ii. **F**requencies
     - iii. **I**nbound Course
     - iv. **I**dentify
     - v. **M**arker Beacons
     - vi. **M**inimums
     - vii. **M**inutes
     - viii. **M**issed Approach
     - ix. **S**ecurity
3. **Radio Com with ATC and Compliance with Clearances, Instructions, and Procedures**
   - A. Comply with ATC clearances and instructions given
     - i. Repeat back important information regarding clearances to ensure positive transfer
   - B. If unable to comply with an instruction advise ATC “unable”
     - i. ATC can make mistakes
   - C. If you do not understand an instruction from ATC request “say again” or clarification
4. **Aircraft Configuration, Airspeed, and Checklist Items**
   - A. Configuration

    i. Procedure Turn (inbound/Outbound), Localizer Intercept
        a. Airspeed: 100 KIAS
        b. Power: 18-20" Hg, 2300 RPM
    ii. One Mile Outside the FAF
        a. Airspeed: Decelerating to 90 KIAS
        b. Power: 18-20" Hg 2300 RPM
        c. Flaps: Takeoff Flaps
    iii. FAF
        a. Airspeed: 90 KIAS
        b. Power: 11-13" Hg 2300 RPM
        c. Pitch: 6^{o} Nose Down
  B. Checklist Items
    i. Pre-Landing Checklist
        a. LBBGUMPS
    ii. Arriving at a Fix (5 T's)
        a. Turn
        b. Time
        c. Twist
        d. Throttle
        e. Talk
    iii. Inside Outer Marker/FAF
        a. Reds, Blues, Greens, Whites, Power: 11-13" Hg

5. Tuning, Identifying, and Determination of Status of Ground/Aircraft Nav Equipment
  A. Tune the desired navaid frequency
  B. To identify/verify there are two options in the G1000
    i. The G1000 will put the navaids ID next to the frequency, this indicates it is tuned and identified
    ii. Listen to the Nav for the Morse code identifier
        a. In the case that the Morse code identifier is not heard, the navaid is out of service
  C. Aircraft navigation equipment that is inoperable will show a flag indicating that it is not working

6. Aircraft Approach Category
  A. Aircraft Approach Category - A grouping of aircraft based on reference landing speed, if specified, if it is not, 1.3 V_{SO} (stall speed/min steady flight in the landing configuration) at the max certificated landing weight
    i. Reference Landing Speed - The speed of the airplane, in a specified landing configuration. At the point where it descends through the 50' height in determination of the landing distance
  B. Categories
    i. A: Speed less than 91 knots
    ii. B: Speed 91 knots or more but less than 121 knots
    iii. C: Speed 121 knots or more but less than 141 knots
    iv. D: Speed 141 knots or more but less than 166 knots
    v. E: Speed 166 knots or more
  C. An airplane is only certified in one approach category
    i. Pilots are responsible for determining if a higher approach category applies
        a. If a faster approach speed is used that places the aircraft in a higher approach category, the minimums for the higher category must be used
        b. Emergency returns at weights exceeding max, approaches w/inoperative flaps, and icing conditions are examples of situations that may require a higher approach category
    ii. An airplane cannot be flown to the minimums of a slower approach category

D. Circling Approaches
  i. Circling approaches at faster than normal approach speeds require consideration of the larger circling approach area
    a. The published circling minimums provide obstacle clearance only within an appropriate area of protection, and is based on the approach category speed
  ii. The size of the circling area varies with the approach category of the airplane
    a. A min of 300' obstacle clearance is provided in the circling segment
  iii. Remain at or above the circling altitude until the airplane is continuously in a position from which a descent to landing can be made at a normal rate of descent with normal maneuvers

7. Maintenance of Altitude, Airspeed, and Track

A. Establish, Trim, Crosscheck, Adjust
B. Keep the scan moving, include everything in your scan
  i. Occasionally include the approach chart in the scan
C. Always ask, "What am I doing next?"
  i. Stay ahead of altitudes, airspeed, track
  ii. Use the 5 T's at every waypoint
    a. Turn, Time, Twist, Throttle, Talk
      - Will I need any of these?

8. Appropriate Rate of Descent

A. A descent rate of greater than 1,000 FPM is unacceptable during the final stages of an approach
  i. This is due to human perceptual limitation independent of the type of airplane
B. A descent rate should be used that will ensure reaching the MDA at a distance from the threshold that will allow landing in the touchdown zone
  i. On many IAPs this will be annotated by a VDP
  ii. To determine the required rate of descent:
    a. Subtract the TDZE from the FAF altitude and divide this by the time inbound
    b. EX. If the FAF altitude is 2,000' MSL, the TDZE is 400' MSL and the time inbound is 2 min, an 800 FPM rate of descent should be used
  iii. To verify the airplane is on an approximate 3^{o} glidepath, use a calculation of "300' to 1 NM"
    a. The glidepath height above TDZE is calculated by multiplying the NM distance from the threshold by 300
      - EX. At 10 NM the aircraft should be 3,000' above the TDZE, at 5 NM 1,500', etc.
        a In the above EX, the aircraft (800' MSL, or 400 above TDZE) should be 1.3 NM out

9. Determination of a Straight-in-Approach, Circling Approach, Missed Approach

A. Straight-in-Approach
  i. Should be used when available based on aircraft equipment, ground equipment, etc.
B. Circling Approach
  i. When necessary due to closed runways, weather (wind), or equipment dictating a circling approach be flown
C. Missed Approach
  i. The primary reason for a missed approach is that the required flight visibility does not exist or the required visual references for the runway cannot be seen at the DA, DH, MAP
    a. Once a descent below DA, DH, or MDA is begun, a missed approach must be executed if the required visibility is lost or the runway environment is no longer visible
  ii. In addition, the aircraft must be in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal maneuvers
  iii. Also required upon the execution of a rejected landing for any reason
    a. Mean and equipment, or animals on the runway, not stabilized approach, etc.

- iv. The missed approach course begins at the MAP and continues until the aircraft has reached the designated fix and a holding pattern has been entered
    - a. Unless a holding pattern is not published
- v. Non-precision Approaches and MAP
    - a. On some, the MAP is given as a distance associated with a time from the FAF to the MAP based on GS
        - Pilots must determine the approximate ground speed and time based on the approach speed and TAS and current winds
        - A clock/stopwatch should be started at the FAF
    - b. Many use a specific fix as the MAP
        - These can be identified by a course (LOC or VOR) and DME, a cross radial from a VOR, or a RNAV (GPS) waypoint
    - c. Obstacles in the missed approach segment may require steeper climb gradients
        - If so, a note will be published on the approach chart in the plan view

Common Errors

- Failure to have essential knowledge of the information on the instrument approach chart
- Incorrect communications procedures or noncompliance with ATC clearances or instructions
- Failure to accomplish checklist items
- Faulty basic instrument flying technique
- Inappropriate descent below MDA

Conclusion:

Brief review of the main points

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of the elements of a non-precision instrument approach by describing-
    - A. selection of the appropriate instrument approach procedure chart.
    - B. pertinent information on the selected instrument approach chart.
    - C. radio communications with ATC and compliance with ATC clearances, instructions, and procedures.
    - D. appropriate aircraft configuration, airspeed, and checklist items.
    - E. selection, tuning, identification, and determination of operational status of ground and aircraft navigation equipment.
    - F. adjustments applied to the published MDA and visibility criteria for the aircraft approach category.
    - G. maintenance of altitude, airspeed, and track, where applicable.
    - H. establishment and maintenance of an appropriate rate of descent during the final approach segment.
    - I. factors that should be considered in determining whether:
        - i. the approach should be continued straight-in to a landing;
        - ii. a circling approach to a landing should be made; or
        - iii. a missed approach should be performed.
2. Exhibits instructional knowledge of common errors related to a non-precision instrument approach by describing-
    - A. failure to have essential knowledge of the information on the instrument approach chart.
    - B. incorrect communications procedures or noncompliance with ATC clearances or instructions.

   C. failure to accomplish checklist items.
   D. faulty basic instrument flying technique.
   E. inappropriate descent below the MDA.
3. Demonstrates and simultaneously explains a non-precision instrument approach from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to a non-precision instrument approach.
5. Exhibits instructional knowledge on the uses of the MFD and other graphical navigational displays, if installed, to monitor position, track, wind drift, and other parameters to maintain desired flightpath.

ACS Skills Standards

1. Accomplish the appropriate nonprecision instrument approaches as selected by the evaluator.
2. Establish two-way communications with ATC, as appropriate, to the phase of flight or approach segment, and uses proper communication phraseology.
3. Select, tune, identify, and confirm the operational status of navigation equipment to be used for the approach.
4. Comply with all clearances issued by ATC or the evaluator.
5. Recognize if any flight instrumentation is inaccurate or inoperative, and take appropriate action.
6. Advise ATC or the evaluator if unable to comply with a clearance.
7. Establish the appropriate aircraft configuration and airspeed considering turbulence and wind shear, and complete the aircraft checklist items appropriate to the phase of the flight.
8. Maintain altitude ±100 feet, heading ±10°, airspeed ±10 knots prior to beginning the final approach segment.
9. Apply adjustments to the published MDA and visibility criteria for the aircraft approach category, as appropriate, for factors that include NOTAMs, inoperative aircraft or navigation equipment, or inoperative visual aids associated with the landing environment, etc.
10. Establish a stabilized descent to the appropriate altitude.
11. For the final approach segment, maintain no more than a ¾-scale deflection of the CDI, and maintain airspeed ±10 knots, and altitude, if applicable, above MDA, +100/-0 feet, to the Visual Descent Point (VDP) or Missed Approach Point (MAP).
12. Execute the missed approach procedure if the required visual references for the intended runway are not distinctly visible and identifiable at the appropriate point or altitude for the approach profile.
13. Execute a normal landing from a straight-in or circling approach when instructed by the evaluator.
14. Use an MFD and other graphical navigation displays, if installed, to monitor position, track wind drift and other parameters to maintain desired flightpath.

VIII.B. Precision Instrument Approach

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), AIM, IAP

Objectives	The student should develop knowledge of the elements related to precision approaches.
Key Elements	1. Ensure you have the correct chart 2. 5 T's at every waypoint: Turn, Time, Twist, Throttle, Talk 3. Brief the Approach
Elements	1. Appropriate Instrument Approach Procedure Chart 2. Pertinent Info on the Approach Chart 3. Radio Com with ATC and Compliance with Clearances, Instructions, and Procedures 4. Aircraft Configuration, Airspeed, and Checklist Items 5. Tuning, Identifying, and Determination of Status of Ground/Aircraft Nav Equipment 6. Aircraft Approach Category 7. Maintenance of Altitude, Airspeed, and Track 8. Appropriate Rate of Descent 9. Determination of a Straight-in-Approach, Circling Approach, Missed Approach
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student has the ability to set up for, brief, and execute precision approaches without the assistance of the instructor.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

A precision approach provides lateral and vertical guidance to a runway (ILS). Because of the addition of vertical guidance (the glide slope), the precision approach has the ability to get an aircraft closer to the ground than a non-precision would allow. The ILS is an expensive system, so although it makes it easier to get into an airport in poor weather or visibility, they are most often located at the larger, busier airports.

Why

The ILS system is important to understand since it is used throughout the US, and has the ability to get you within 200' AGL before starting your missed approach. The ILS, if available, is the default approach assigned by ATC.

How:

1. **Appropriate Instrument Approach Procedure Chart**
   - A. Often ATIS will provide pilots with the approaches that are in use
     - i. If more than one is in use, an educated guess may be necessary until ATC assigns an approach
       - a. This is based on weather, direction of arrival, any NOTAMS, and previous experience
   - B. ATC can inform you of the approach that can be expected
     - i. Pilots may request specific approaches to meet the individual needs of their equipment or regulatory restrictions at any time and ATC will most likely accommodate the request
   - C. If operating into an airport without a control tower, the crew occasionally will be allowed to choose
   - D. Double check the approach plate you are using/briefing coincides with the assigned approach
2. **Pertinent Info on the Approach Chart**
   - A. FFIIMMMMS
     - i. **F**ixes
     - ii. **F**requencies
     - iii. **I**nbound Course
     - iv. **I**dentify
     - v. **M**arker Beacons
     - vi. **M**inimums
     - vii. **M**inutes
     - viii. **M**issed Approach
     - ix. **S**ecurity
3. **Radio Com with ATC and Compliance with Clearances, Instructions, and Procedures**
   - A. Comply with ATC clearances and instructions given
     - i. Repeat back important information regarding clearances to ensure positive transfer
   - B. If unable to comply with an instruction advise ATC "unable"
     - i. ATC can make mistakes
   - C. If you do not understand an instruction from ATC request "say again" or clarification
4. **Aircraft Configuration, Airspeed, and Checklist Items**

A. Configuration
   i. Procedure Turn (inbound/Outbound), Localizer Intercept
      a. Airspeed: 100 KIAS
      b. Power: 18-20" Hg, 2300 RPM
   ii. ½ Dot Above Glide Slope
      a. Airspeed: Decelerating to 90 KIAS
      b. Power: 18-20" Hg 2300 RPM
      c. Flaps: Takeoff Flaps
   iii. Glide Slope Intercept (FAF)
      a. Airspeed: 90 KIAS
      b. Power: 13-14" MP 2300 RPM
      c. Pitch: 5° Nose Down
B. Checklist Items
   i. Pre-Landing Checklist
      a. LBBGUMPS
   ii. Arriving at any Fix (5 T's)
      a. Turn
      b. Time
      c. Twist
      d. Throttle
      e. Talk
   iii. Inside Outer Marker/FAF
      a. Reds, Blues, Greens, Whites, Power: 11-13" Hg

5. Tuning, Identifying, and Determination of Status of Ground/Aircraft Nav Equipment

A. Tune the desired navaid frequency
B. To identify/verify there are two options in the G1000
   i. The G1000 will put the navaids ID next to the frequency, this indicates it is tuned and identified
   ii. Listen to the Nav for the Morse code identifier
      a. In the case that the Morse code identifier is not heard, the navaid is out of service
C. Aircraft navigation equipment that is inoperable will show a flag indicating that it is not working

6. Aircraft Approach Category

A. Aircraft Approach Category - A grouping of aircraft based on reference landing speed, if specified, if it is not, 1.3 V_{SO} (stall speed/min steady flight in the landing configuration) at the max certificated landing weight
   i. Reference Landing Speed - The speed of the airplane, in a specified landing configuration. At the point where it descends through the 50' height in determination of the landing distance
B. Categories
   i. A: Speed less than 91 knots
   ii. B: Speed 91 knots or more but less than 121 knots
   iii. C: Speed 121 knots or more but less than 141 knots
   iv. D: Speed 141 knots or more but less than 166 knots
   v. E: Speed 166 knots or more
C. An airplane is only certified in one approach category
   i. Pilots are responsible for determining if a higher approach category applies
      a. If a faster approach speed is used that places the aircraft in a higher approach category, the minimums for the higher category must be used
      b. Emergency returns at weights exceeding max, approaches with inoperative flaps, and icing conditions are examples of situations that may require a higher approach category

        ii. An airplane cannot be flown to the minimums of a slower approach category
    D. Circling Approaches
        i. Circling approaches at faster than normal approach speeds require consideration of the larger circling approach area
            a. The published circling minimums provide obstacle clearance only within an appropriate area of protection, and is based on the approach category speed
        ii. The size of the circling area varies with the approach category of the airplane
            a. A min of 300' obstacle clearance is provided in the circling segment
        iii. Remain at or above the circling altitude until the airplane is continuously in a position from which a descent to landing can be made at a normal rate of descent with normal maneuvers

7. Maintenance of Altitude, Airspeed, and Track
    A. Establish, Trim, Crosscheck, Adjust
    B. Keep the scan moving, include everything in your scan
        i. Occasionally include the approach chart in the scan
    C. Always ask, "What am I doing next?"
        i. Stay ahead of altitudes, airspeed, track
        ii. Use the 5 T's at every waypoint
            a. Turn, Time, Twist, Throttle, Talk
                - Will I need any of these?
    D. Keep the localizer needle centered
        i. Be proactive in maintaining the localizer course
            a. Make adjustments for wind
                - Use the heading bug to bug the heading that will maintain the desired course
                - Make adjustments to the R/L of the heading bug to correct for course deviations
    E. When the glide slope centers, pitch down approximately 5^{o} and maintain a centered glide slope indication
        i. Be proactive in maintain glide slope
            a. If the ball starts to move up/down make small adjustments immediately to arrest the movement
            b. As GS increases, rate of descent must increase as well
            c. As GS decreases, rate of descent must decrease as well

8. Appropriate Rate of Descent
    A. A descent rate of greater than 1,000 FPM is unacceptable during the final stages of an approach
        i. This is due to human perceptual limitation independent of the type of airplane
    B. A descent rate should be used that will ensure reaching the DA at a distance from the threshold that will allow landing in the touchdown zone
        i. The glide slope will ensure you maintain the appropriate rate of descent, Follow it

9. Determination of a Straight-in-Approach, Circling Approach, Missed Approach
    A. Straight-in-Approach
        i. Should be used when available based on aircraft equipment, ground equipment, etc.
    B. Circling Approach
        i. When necessary due to closed runways, weather (wind), or equipment dictating a circling approach be flown
    C. Missed Approach
        i. The primary reason for a missed approach is that the required flight visibility does not exist or the required visual references for the runway cannot be seen at the DA, DH, MAP
            a. Once a descent below DA, DH, or MDA is begun, a missed approach must be executed if the required visibility is lost or the runway environment is no longer visible

ii. In addition, the aircraft must be in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal maneuvers
iii. Also required upon the execution of a rejected landing for any reason
   a. Men and equipment, or animals on the runway, not stabilized approach, etc.
iv. The missed approach course begins at the MAP and continues until the aircraft has reached the designated fix and a holding pattern has been entered
   a. Unless a holding pattern is not published
v. Non-precision Approaches and MAP
   a. On some, the MAP is given as a distance associated with a time from the FAF to the MAP based on GS
      - Pilots must determine the approximately GS and time based on the approach speed and TAS and current winds
      - A clock/stopwatch should be started at the FAF
   b. Many use a specific fix as the MAP
      - These can be identified by a course (LOC or VOR) and DME, a cross radial from a VOR, or a RNAV (GPS) waypoint
   c. Obstacles in the missed approach segment may require steeper climb gradients
      - If so, a note will be published on the approach chart in the plan view

Common Errors

- Failure to have essential knowledge of the information on the instrument approach chart
- Incorrect communications procedures or noncompliance with ATC clearances or instructions
- Failure to accomplish checklist items
- Faulty basic instrument flying technique
- Inappropriate descent below MDA

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant:

1. Exhibits instructional knowledge of the elements of a precision instrument approach by describing-
   A. selection of the appropriate instrument approach chart.
   B. pertinent information on the selected instrument approach chart.
   C. selection, tuning, identification, and determination of operational status of ground and aircraft navigation equipment.
   D. radio communications with ATC and compliance with ATC clearances, instructions, and procedures.
   E. appropriate aircraft configuration, airspeed, and checklist items.
   F. adjustments applied to the published DH/DA and visibility criteria for the aircraft approach category.
   G. maintenance of altitude, airspeed, and track, where applicable.
   H. establishment and maintenance of an appropriate rate of descent during the final approach segment.
   I. factors that should be considered in determining whether:
      i. the approach should be continued straight-in to a landing;
      ii. a circling approach to a landing should be made; or

      iii. a missed approach should be performed.
2. Exhibits instructional knowledge of common errors related to a precision instrument approach by describing-
   A. failure to have essential knowledge of the information on the instrument approach procedure chart.
   B. incorrect communications procedures or noncompliance with ATC clearances.
   C. failure to accomplish checklist items.
   D. faulty basic instrument flying technique.
   E. inappropriate application of DH/DA.
3. Demonstrates and simultaneously explains a precision instrument approach from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to a precision instrument approach.
5. Exhibits instructional knowledge on the uses of the MFD and other parameters to maintain desired flightpath.

ACS Skills Standards

1. Accomplish the precision instrument approach(es) selected by the examiner.
2. Establish two-way communications with ATC appropriate for the phase of flight or approach segment, and use proper communication phraseology.
3. Select, tune, identify, and confirm the operational status of navigation equipment to be used for the approach procedure.
4. Comply with all clearances issued by ATC or the evaluator.
5. Recognize if any flight instrumentation is inaccurate or inoperative, and take appropriate action.
6. Advise ATC or the evaluator of any inability to comply with a clearance.
7. Establish the appropriate aircraft configuration and airspeed considering turbulence and wind shear, and complete the aircraft checklist items appropriate to the phase of the flight.
8. Maintain altitude ±100 feet, selected heading ±10°, airspeed ±10 knots, prior to beginning the final approach segment.
9. Apply adjustments to the published DA/DH and visibility criteria for the aircraft approach category, as appropriate for factors that include NOTAMs, inoperative aircraft or navigation equipment, or inoperative visual aids associated with the landing environment, etc.
10. Establish a predetermined rate of descent at the point at the point where vertical guidance begins, which approximates that required for the aircraft to follow the vertical guidance.
11. Maintain a stabilized final approach from the Final Approach Fix (FAF) to DA/DH allowing no more than ¾-scale deflection of either the vertical or lateral guidance indications and maintain the desired airspeed within ±10 knots.
12. Immediately initiate the missed approach when at the DA/DH, and the required visual references for the runway are not unmistakably visible and identifiable.
13. Transition to a normal landing approach only when the aircraft is in a position from which a descent to a landing on the runway can be made at a normal rate of descent using normal maneuvering.
14. Maintain a stabilized visual flight path from the DA/DH to the runway aiming point where a normal landing may be accomplished within the touchdown zone.
15. Use an MFD and other graphical navigation displays, if installed, to monitor position, track wind drift, and to maintain situational awareness.

VIII.C. Missed Approach

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), AIM, IAP

Objectives	The student should develop knowledge of the elements related to reading and flying a missed approach procedure.
Key Elements	1. Brief the Missed Approach 2. Know the first step of the Missed Approach (Don't hesitate when it's time to go missed) 3. 5 T's at every waypoint: Turn, Time, Twist, Throttle, Talk
Elements	1. General 2. Pertinent Information on the IAP 3. Conditions Requiring a Missed Approach 4. Initiation of the Missed Approach 5. Required Reports to ATC 6. Compliance with the Published Missed Approach Procedure 7. Notification if Unable to Comply with Clearance, Instruction, Gradient, Restriction 8. Recommended Checklist Items
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can understand a fly missed approach procedures without the assistance of the instructor.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

The missed approach is a published route and altitude that will keep the aircraft safe from obstacles and other aircraft in the case you are unable to land. The missed approach can be required for various reasons, such as weather below minimums, another aircraft on the runway, or an unstable approach.

Why

The missed approach is necessary to provide a safe published option to leave the approach and reassess the situation (try the approach again, depart to the alternate airport, etc.)

How:

1. **General**
   A. A missed approach procedure is formulated for each published instrument approach and allow the pilot to return to the airway structure while remaining clear of obstacles
   B. The procedure should be somewhat memorized before beginning the approach as the workload is high
2. **Pertinent Information on the IAP**
   A. Each chart defines its respective missed approach
      i. The approach is given in text form as well as in graphic form
         a. The text is show in the **MISSED APCH** box
         b. The diagram is show with a dashed line and usually is followed by a hold over some fix
   B. Before beginning the approach be sure to look over and understand the missed approach procedures
3. **Conditions Requiring a Missed Approach**
   A. 91.175: May not operate below MDA or continue below the DA unless:
      i. The aircraft is continually in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal maneuvers
      ii. The flight visibility is not less than the visibility prescribed in the standard instrument approach being used
      iii. At least one of the following visual references for the intended runway is distinctly visible and identifiable to the pilot:
         a. The Approach Light System
            - Cannot descend below 100’ above TDZE unless the red terminating bars or side row bars are also visible and identifiable
         b. The Threshold
         c. The Threshold Marking
         d. The Threshold Lights
         e. The REIL
         f. The VASI
         g. The Touchdown Zone or Touchdown Zone Markings
         h. The Touchdown Zone Lights

        i. The Runway or Runway Markings
        j. The Runway Lights
    iv. In the case of an unstable approach go missed and request another attempt to ensure safety
    v. Once descent below DA, DH, or MDA is begun, a missed approach must be executed if the required visibility is lost, or if of the runway environment is no longer visible
        a. Unless the loss of sight is a result of normal banking of the aircraft
    vi. A missed approach is also required in the case of a rejected landing for any reason

4. Initiation of the Missed Approach

A. Recognizing the MAP
    i. The MAP can be given in many different ways
        a. On non-precision approaches, it is given as a fixed distance with an associated time from the FAF
            - This is based on GS
            - A table will show the distance in NM from the FAF to the MAP and the time at certain GS
        b. Many non-precision designate a specific fix as the MAP
            - These can be identified by a course and DME, cross radial from a VOR, or RNAV waypoint
        c. Precisions approach MAPs are upon arrival at the DA
B. Initiate the missed approach upon reaching the MAP for any of the above reasons
C. Promptly apply full power and verify a positive rate of climb
D. Pitch the nose Up 7°
E. Remove flaps as the airplane begins to climb
F. Maintain an airspeed of 66 – 70 KIAS
G. Get away from the Ground!

5. Required Reports to ATC

A. Advise ATC that a missed approach will be made
    i. Include the reason for the missed approach, unless it is initiated by ATC
B. Entering the hold
    i. Time and Altitude

6. Compliance with the Published Missed Approach Procedure

A. Comply with the missed approach course/missed approach instructions
    i. Unless other instructions have been issued by ATC
B. If executing a missed approach prior to reaching the MAP, fly the lateral nav path of the IAP to the MAP
    i. Do not start the turn early as obstacle clearance will not be guaranteed
C. Following the missed approach, request clearance for specific action
    i. i.e. another approach, hold for improved conditions, proceed to an alternate

7. Notification if Unable to Comply with Clearance, Instruction, Gradient, Restriction

A. Request clarification or amendment, as appropriate, any time a clearance is not fully understood or considered unacceptable from a safety standpoint
B. Question any assigned heading or altitude if believed to be incorrect
C. If unable to comply with any clearance, etc. from ATC inform them of the situation and request an alternate clearance
    i. A climb gradient of at least 200 FPNM is required during the missed approach

8. Recommended Checklist Items

A. Power
    i. Apply full power
B. Attitude
    i. Establish a climbing attitude
    ii. 7° Nose Up
C. Configuration

        i. Configure the airplane for the climb
        ii. Flaps Up or to T/O setting
   D. Importance of Positive Aircraft Control
        i. Just like in a go around, the missed approach can be a dangerous maneuver, especially in IFR
        ii. Maintain positive control of the aircraft to ensure safety
            a. Avoid a departure stall
        iii. Maintain the prescribed missed approach course for safety
            a. Avoid obstacles/obstructions that may be around the course

Common Errors

- Failure to have essential knowledge of the information on the instrument approach chart
- Failure to recognize conditions requiring a missed approach
- Failure to promptly initiate a missed approach
- Failure to make the required report to ATC
- Failure to comply with the missed approach procedure
- Faulty basic instrument flying technique
- Descent below the MDA prior to initiating a missed approach

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant:

1. Exhibits instructional knowledge of the elements of a missed approach procedure by describing-
    A. pertinent information on the selected instrument approach chart.
    B. conditions requiring a missed approach.
    C. initiation of the missed approach, including the prompt application of power, establishment of a climb attitude, and reduction of drag.
    D. required report to ATC.
    E. compliance with the published or alternate missed approach procedure.
    F. notification of ATC if the aircraft is unable to comply with a clearance, instruction, restriction, or climb gradient.
    G. performance of recommended checklist items appropriate to the go-around procedure.
    H. importance of positive aircraft control.
2. Exhibits instructional knowledge of common errors related to a missed approach by describing-
    A. failure to have essential knowledge of the information on the instrument approach chart.
    B. failure to recognize conditions requiring a missed approach.
    C. failure to promptly initiate a missed approach.
    D. failure to make the required report to ATC.
    E. failure to comply with the missed approach procedure.
    F. faulty basic instrument flying technique.
    G. descent below the MDA prior to initiating a missed approach.
3. Demonstrates and simultaneously explains a missed approach from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to a missed approach.
5. Exhibits instructional knowledge on the uses of the MFD and other graphical navigational displays, if installed, to monitor position and track to help navigate the missed approach.

ACS Skills Standards

1. Initiate the missed approach promptly by applying power, establishing a climb attitude, and reducing drag in accordance with the aircraft manufacturer's recommendations.
2. Report to ATC upon beginning the missed approach procedure.
3. Comply with the published or alternate missed approach procedure.
4. Advise ATC or the evaluator of any inability to comply with a clearance, restriction, or climb gradient.
5. Follow the recommended checklist items appropriate to the missed approach/go-around procedure.
6. Request, if appropriate, ATC clearance to the alternate airport, clearance limit, or as directed by the evaluator.
7. Maintain the recommended airspeed ±10 knots; heading, course, or bearing ±10°; and altitude(s) ±100 feet during the missed approach procedure.
8. Use an MFD and other graphical navigation displays, if installed, to monitor position and track to help navigate the missed approach.
9. Demonstrate SRM.

VIII.D. Circling Approach

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), AIM, IAP

Objectives	The student should develop knowledge of the elements related to executing a circling approach.
Key Elements	1. Use the Circling Minimums (not straight-in) 2. Lose Visual, Go Missed 3. Normal descent using normal maneuvers or Go Missed
Elements	1. General 2. Selection of the Appropriate Circling Maneuver 3. Compliance with Advisories, Clearances, Restrictions 4. Circling Approach Minimums and the IAP Chart 5. Circling Rules 6. Stay within the Published Visibility Criteria and Maintain Altitude Above the Circling MDA 7. Circling Area of Protection
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands and can perform a circling approach to landing or a missed approach.

Instructors Notes:

Introduction:

Attention
Interesting fact or attention-grabbing story

Overview
Review Objectives and Elements/Key ideas

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

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

How:

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

3. **Compliance with Advisories, Clearances, Restrictions**
   A. Comply with the clearances, restrictions, etc. given by ATC
   B. In the case that the clearance seems unsafe question ATC or reply Unable
4. **Circling Approach Minimums and the IAP Chart**
   A. Use the appropriate circling minimums, rather than the straight-in minimums
5. **Circling Rules**
   A. Maneuver the shortest path to the base or downwind leg, weather permitting
      i. There is no restriction to passing over the airport or other runways
   B. Circling maneuvers may be made while VFR or other flying is in progress at the airport
      i. Standard left turns or specific instruction from the controller must be considered when landing
   C. At airports without a control tower, it may be desirable to fly over the airport to observe wind and turn indicators and other traffic which may be in the vicinity
6. **Stay within the Published Visibility Criteria and Maintain Altitude Above the Circling MDA**
   A. During a circling approach, maintain visual contact with the runway of intended landing
      i. If visual contact is lost, go missed
         a. The first turn on the missed from a circling maneuver should be toward the landing runway
         b. When the airplane is reestablished on course, the published missed approach should be flown
   B. Fly no lower than the circling minimums until you are in a position to make a final descent for a landing
      i. Remain at or above until a normal rate of descent and normal maneuvers will allow for landing
      ii. Minimums are the lowest you can fly, if allowable, fly at an altitude close to a VFR pattern
7. **Circling Area of Protection**
   A. Aircraft must remain in their respective Category protected areas
      i. Protected areas are designed based on approach speed (category) to provide maneuvering airspace at or above the MDA
   B. Standard Circling Minimums
      i. Circling approach protected areas use the radius distance shown in the table on page B2 of the U.S. TPP
      ii. Standard minimums are based on fixed radius distances, dependent on aircraft category
      iii. Circling Radius:

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

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

Circling MDA in feet MSL	Approach Category and Circling Radius (NM)				
	CAT A	CAT B	CAT C	CAT D	CAT E
1000 or less	1.3	1.7	2.7	3.6	4.5
1001-3000	1.3	1.8	2.8	3.7	4.6
3001-5000	1.3	1.8	2.9	3.8	4.8
5001-7000	1.3	1.9	3.0	4.0	5.0

7001-9000	1.4	2.0	3.2	4.2	5.3
9001 and above	1.4	2.1	3.3	4.4	5.5

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

Conclusion:
Brief review of the main points

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

ACS Skills Standards
1. Select and comply with the circling approach procedure considering turbulence, wind shear, and the maneuvering capabilities of the aircraft.
2. Confirm the direction of traffic and adhere to all restrictions and instructions issued by ATC or the evaluator.
3. Maneuver the aircraft, at or above the MDA, 90° or more from the final approach course, on a flightpath permitting a normal landing on a suitable runway.
4. Avoid circling beyond visibility requirements and maintain the appropriate circling altitude until in a position from which a descent to a normal landing can be made.
5. Establish the approach and landing configuration for the situation and maintain altitude +100/-0 feet until a descent to a normal landing can be made.
6. Demonstrate SRM.

VIII.E. Landing from a Straight-In Approach

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), AIM, IAP

Objectives	The student should develop knowledge of the elements related to landing after a straight in instrument approach.
Key Elements	1. Maintain a stabilized approach 2. Do not disregard GS/LOC once visual 3. Use VASI/PAPI to help transition
Elements	1. General 2. Transition to, and Maintenance of, a Visual Flight Condition 3. Maintain a Stabilized Approach to Landing 4. Adherence to ATC Advisories 5. Completion of Appropriate Checklist Items 6. Maintenance of Positive Aircraft Control
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can competently and comfortably transition from an instrument approach to visual landing.

Instructors Notes:

Introduction:

Attention
Interesting fact or attention-grabbing story

Overview
Review Objectives and Elements/Key ideas

What
The pilot must have the ability to transition from an instrument (inside the cockpit) approach to a visual approach (outside the cockpit) for landing.

Why
If you plan on safely landing after an instrument approach you're going to have to be able to transition to the visual approach and make the landing.

How:

1. **General**
   A. According to Part 91, no pilot may land when the flight visibility is less than the visibility prescribed in the standard IAP being used
      i. ATC will provide the current visibility reports
         a. This may be in the form of prevailing visibility, runway visual value (RVV), RVR
            - Prevailing Visibility: The greatest horizontal visibility equaled or exceeded throughout at least half the horizon circle (which is not necessarily continuous)
            - RVV: The visibility determined for a particular runway by a transmissometer
            - RVR: An instrumentally derived value, based on standard calibrations, that represents the horizontal distance a pilot will see down the runway from the approach end
      ii. However, only the pilot can determine if the flight visibility meets the landing requirements
         a. If the flight visibility meets the minimum prescribed for the approach, then the approach may be continued to landing
         b. If the flight visibility does not meet the prescribed minimums, then the pilot must execute a missed approach, *regardless of the reported visibility*
         c. RVR is very difficult to argue against in the case an approach to landing is made with visibility reported to be lower than that required
2. **Transition to, and Maintenance of, a Visual Flight Condition**
   A. 100' to 200' above MDA/DA most attention should be directed outside the airplane to visually acquire at least one visual reference for the runway
      i. Approach Light System
      ii. Threshold/Threshold Markings/Threshold Lights
      iii. REIL
      iv. VASI
      v. Touchdown Zone/Touchdown Zone Markings/Touchdown Zone Lights
      vi. Runway/Runway Markings/Runway Lights
   B. Ensure the instruments are being monitored (Do not focus only outside)
   C. Use the VASI/PAPI to transition to visual flight
      i. Do not disregard the instruments; on the ILS, maintain the localizer and glide slope

3. **Maintain a Stabilized Approach to Landing**
    A. Essential for safe operations
    B. The process of maintain the approach path is simplified by maintain a constant approach speed, descent rate, vertical flight path, and configuration during the final stages of an approach
    C. This also helps to recognize wind shear situations should abnormal indications exist during the approach
4. **Adherence to ATC Advisories**
    A. Adhere to any advisories provided by ATC
        i. Consider the advisories impact on the specific flight and take action to ensure safety of the passengers and yourself
            a. Advisories could include NOTAMs, wind shear, wake turbulence, runway surface, and braking conditions
                - How will this affect this flight? Can the flight be completed as planned/intended?
5. **Completion of Appropriate Checklist Items**
    A. Once transitioned to visual flight complete the before landing checklist
        i. Reds, Blues, Greens, Whites
    B. Ensure you are maintaining the normal approach speed of 70 KIAS
        i. Add landing flaps, if needed
6. **Maintenance of Positive Aircraft Control**
    A. A stabilized approach is necessary for safety of flight
        i. Without positive control, the approach most likely is not stabilized and therefore dangerous
        ii. Perform a missed approach if the airplane cannot be positively controlled for any reason
            a. Whether weather, pilot work overload, or inability
            b. Once missed, advise ATC what you would like to do next
                - Repeat the approach, Transition to an alternate, etc.

Common Errors

- Inappropriate division of attention during the transition from instrument to visual flight conditions
- Failure to complete required checklist items
- Failure to properly plan and perform the turn to final approach
- Improper technique for wind shear, wake turbulence, and crosswind
- Failure to maintain positive aircraft control throughout the complete landing maneuver

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant:

1. Exhibits instructional knowledge of the elements related to landing from a straight in approach by describing-
    A. effect of specific environmental, operational, and meteorological factors.
    B. transition to, and maintenance of, a visual flight condition.
    C. adherence to ATC advisories, such as NOTAMs, wind shear, wake turbulence, runway surface, and braking conditions.
    D. completion of appropriate checklist items.
    E. maintenance of positive aircraft control.

2. Exhibits instructional knowledge of common errors related to landing from a straight-in approach by describing-
   A. inappropriate division of attention during the transition from instrument to visual flight conditions.
   B. failure to complete required checklist items.
   C. failure to properly plan and perform the turn to final approach.
   D. improper technique for wind shear, wake turbulence, and crosswind.
   E. failure to maintain positive aircraft control throughout the complete landing maneuver.
3. Demonstrates and simultaneously explains a landing from a straight-in approach from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to landing from a straight-in approach.

ACS Skills Standards

1. Transition at the DA/DH, MDA, or Visual Descent Point (VDP) to a visual flight condition, allowing for safe visual maneuvering and a normal landing.
2. Adhere to all ATC or evaluator advisories, such as NOTAMs, wind shear, wake turbulence, runway surface, braking conditions, and other operational considerations.
3. Complete the appropriate checklist items for the pre-landing and landing phase.
4. Maintain positive aircraft control throughout the complete landing maneuver.
5. Demonstrate SRM.

EMERGENCY OPERATIONS

IX.A. Loss of Communications

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), AIM, IAP

Objectives	The student should develop knowledge of the elements related to loss of communications on an IFR flight plan in IFR and VFR conditions.
Key Elements	1. Squawk 7600 2. Route: AVE F 3. Altitude: MEA
Elements	1. General 2. Recognition of Loss of Communications 3. When to Continue as Filed and when to Deviate 4. The CFRs – 91.185 5. Determining the Time to Begin the Approach
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can safely and properly react to a lost communications situation on an IFR flight plan.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

Lost communications is the inability to communicate with ATC on an IFR flight plan. It may be a total, 2-way, loss of communication or just the inability to receive or transmit communications.

Why

Radio communication is essential to the safety and organization of aircraft when flying on an IFR flight plan. Without radio communication there must be rules to follow so that ATC knows the route and altitude the pilot will fly in order to keep the pilot as well as surrounding traffic separated and safe.

How:

1. **General**
   - A. 91.185
   - B. Pilots can use the transponder to alert ATC to a radio communication failure by squawking 7600
2. **Recognition of Loss of Communications**
   - A. If it has been abnormally quiet on the radio check for a loss of communications
     - i. Query ATC to see if it is a communication problem or just quiet
   - B. Do not immediately assume a loss of communications
     - i. Check the volume, was it turned down
     - ii. Are you on the right frequency?
       - a. If you can hear someone else, but not ATC, transmit a message through them to ATC
         - A frequency change may be necessary as you could be out of range
     - iii. Check the other Com for operation
     - iv. Ensure proper set up of the Coms
   - C. You may be able to hear ATC but not transmit
     - i. In this case you can still receive ATC instruction
     - ii. Response may be done by using the Ident button
3. **When to Continue as Filed and When to Deviate**
   - A. The primary objective of the regulations governing communication failure is to preclude extended IFR no-radio ops in the ATC system since these ops may adversely affect other users of the airspace
   - B. If the radio fails while operating on an IFR clearance, but in VFR conditions
     - i. Continue the flight under VFR conditions, if possible, and land as soon as practicable
       - a. This does not mean land as soon as possible
   - C. If IFR conditions prevail, pilots must comply with the procedures designated in the CFRs
     - i. This will ensure aircraft separation
4. **The CFRs – 91.185**
   - A. Route (AVE F)– In order of importance:
     - i. By the route assigned in the last ATC clearance received

        ii. If being radar vectored, by the direct route from the point of radio failure to the fix, route, or airway specified in the vector clearance
        iii. By the route that ATC has advised may be expected in a further clearance
        iv. By the route filed in the flight plan
    B. Altitude (MEA) – at the highest of the following for the route segment being flown:
        i. The minimum altitude for IFR operations
        ii. The altitude ATC has advised may be expected
        iii. The altitude assigned in the last ATC clearance received

5. **Determining the Time to begin the Approach**
    A. Leaving a Clearance Limit
        i. When the clearance limit is a fix from which an approach begins
            a. Commence descent as close as possible to the EFC time if one has been received
            b. If one has not been received, as close as possible to the ETA filed
        ii. When the clearance limit is not a fix from which an approach begins
            a. Leave the clearance limit at the EFC time, if one has been received
            b. If one has not been received, leave upon arrival over the clearance limit, and proceed to a fix from which an approach begins and commence descent as close as possible to the ETA on the filed flight plan

Conclusion:
Brief review of the main points

PTS Requirements:

To determine that the applicant exhibits instructional knowledge of the elements related to loss of communications by describing:

1. Recognition of loss of communications.
2. When to continue with flight plan as filed or when to deviate.
3. How to determine the time to begin an approach at destination.

ACS Skills Standards

1. Recognize a simulated loss of communication.
2. Simulate actions to re-establish communication.
3. Determine whether to continue to flight plan destination or deviate.
4. Determine appropriate time to begin an approach.

IX.B. Approach with Loss of Primary Flight Instrument Indicators

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), AIM, IAP

Objectives	The student should develop knowledge of the elements related to partial panel flying.
Key Elements	1. Notify ATC 2. Get VFR, if possible 3. Ignore the failed instruments
Elements	1. General 2. Recognition of Inaccurate/Inoperative Gyro Instruments 3. Notification of ATC 4. Transition from Full to Partial Panel Condition
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can competently handle the airplane without gyro instruments in all phases of an IFR flight.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

A failure in the gyro system could result in a loss of the heading indicator, attitude indicator, and/or turn coordinator.

Why

A loss of the gyro driven instruments has an effect on the instruments you will use to fly the airplane. The pilot must be able to transition to the remaining instruments to continue the flight and fly an approach to landing.

How:

1. **General**
   A. One possible cause of instrument failure is a loss of the suction or pressure source
      i. Occasionally these pumps fail, leaving the pilot with inoperative attitude and heading indicators
2. **Recognition of Inaccurate/Inoperative Gyro Instruments**
   A. Usually identified by a warning indicator or an inconsistency between the AI and the supporting performance instruments
   B. Immediately compare the AI with the TC and VSI
      i. Along with providing pitch and bank information, this compares the static, suction, electric systems
      ii. Identify the failed components and use the remaining functional instrument to maintain control
   C. On a G1000, the faulty instruments will be displayed with a red 'x'
      i. Navigate with the standby instruments and use the MFD (moving map) as necessary to assist navigation
3. **Notification of ATC**
   A. Notify ATC and advise of your ability to continue the flight in instrument conditions
      i. Notify ATC of loss of gyro instruments
   B. Continue flight in VFR conditions (to reasonably close airport where repairs can be made)
   C. If IFR, request vectors to VFR conditions
   D. If VFR conditions are unable, choose/execute best available approach with ATC vectors if available
4. **Transition from Full to Partial Panel Condition**
   A. Importance of timely transition from full to partial panel condition
      i. Failed AI and HI can distract and trick pilot into making improper control inputs leading to disorientation in an unusual attitude
      ii. Ignore failed AI and HI and cover them ASAP
      iii. Go to partial panel scan at once
         a. Wings level with TC (primary for bank), centered ball
         b. Pitch level with ALT (primary for pitch), VSI, ASI
         c. Navigation with MC for heading information
            - Timed turns

- Compass turns

iv. With the G1000, the moving map is extremely helpful in maintaining course and orientation
   a. Using the track up setting (rather than North up) allows for easier tracking of the displayed course
      - Much easier to orient yourself with

Common Errors:

- Slow to recognize inaccurate or primary flight indications
- Failure to notify ATC of situation
- Failure to adequately transition from full to partial panel condition

Conclusion:

Brief review of the main points

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of the elements related to loss of primary flight instrument indicators by describing-
   A. recognition of inaccurate or inoperative primary instrument indicators and advising ATC and the examiner.
   B. notification of ATC or examiner anytime that the aircraft is unable to comply with an ATC clearance or whether able to continue the flight.
   C. importance of utilizing navigation equipment in an emergency situation and demonstrating a non-precision approach without the use of primary flight instruments.
2. Exhibits instructional knowledge of common errors related to loss of primary flight instrument indicators by describing-
   A. recognition of failed system components that relate to primary flight instrument indication(s).
   B. failure to notify ATC of situation.
   C. failure to transition to emergency mode/standby instrumentation.
3. Demonstrates and simultaneously explains loss of primary flight instrument indicators by conducting a non-precision approach without the use of these indicators.
4. Analyzes and corrects common errors related to loss of primary flight instrument indicators.

ACS Skills Standards

1. Advise ATC or evaluator if unable to comply with a clearance.
2. Complete a nonprecision instrument approach without the use of the primary flight instruments using the skill elements of the nonprecision approach Task (See Area of Operation VI, Task A).
3. Demonstrate SRM

IX.C. Engine Failure during Straight-and-Level Flight and Turns

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), POH/AFM

Objectives	The student should develop knowledge of the elements related to single engine operation by reference to instruments.
Key Elements	1. Fly First 2. Zero Sideslip 3. Rudder Control
Elements	1. Instrument Flight Procedural Steps 2. Maneuvering with One Engine Inoperative 3. Zero Sideslip by Instruments 4. Turning Flight 5. Managing the Engine Failure
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can handle an engine failure and maneuver the aircraft as necessary in instrument conditions.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

The ability to properly and safely control an engine failure in instrument conditions will be discussed in this lesson, emphasizing the importance of flying the plane first and handling the checklists second.

Why

Being able to manage an engine failure and control the aircraft is obviously necessary for safety. An incompetent pilot during an engine failure in instrument conditions is most likely not going to survive.

How:

1. **Instrument Flight Procedural Steps**
   - A. *Establish* - an attitude/power setting on the control instruments resulting in the desired performance
     - i. Known or computed attitude changes and approximate power settings will help reduce workload
   - B. *Trim* - until control pressures are neutralized.
     - i. Trimming is essential for smooth, precise control and allows attention to be diverted elsewhere
   - C. *Crosscheck* – the performance instruments to determine if the desired performance is being obtained
     - i. Involves seeing and interpreting
     - ii. If a deviation is noted, determine the magnitude and direction of correction necessary
   - D. *Adjust* – the attitude or power setting on the control instruments as necessary
2. **Maneuvering with One Engine Inoperative**
   - A. Recognize engine failure and maintain control
     - i. When an engine fails use rudder and aileron to maintain directional control
       - Establish a zero-sideslip configuration by adding approximately 2-3° of bank to counteract the roll and rudder in order to achieve a ½ ball deflection toward the operating engine
       - After a couple degrees of bank are established and rudder pressure is set to maintain heading double check the zero sideslip on the instruments and make changes needed
         - a A zero sideslip will vary based on the aircraft flown, but 1-3° bank toward the operating engine and ½ ball deflection (on the TC) toward the operating engine should be close
   - B. This is done strictly by instruments
3. **Zero Side Slip by Instruments**

Pitch + Power = Desired Performance

Nose slightly high + Zero Sideslip + 80% power = SE Straight and Level

Pitch		Bank	
A/I	4° Nose High	A/I	1-3° Bank
Alt	Constant	DG	Constant
VSI	0	Compass	Constant
A/S	V_{yse} or higher	T/C	½ ball deflection

   - A. Establish **-** Use the AI to establish a wings level, nose on the horizon attitude adjusting power as needed
   - B. Trim – Trim to relieve the control pressures

C. Crosscheck
D. Adjust – Correct any performance errors as necessary and retrim the airplane, then crosscheck again

4. Turning Flight

Pitch + Power = Desired Performance
Nose slightly high + Zero Sideslip + 80% Power = SE Level Turns

Pitch		Bank	
A/I	5-6° Nose High	A/I	10° Bank
Alt	Constant	DG	Turning
VSI	0	Compass	Turning
A/S	V_{yse} or higher	T/C	½ ball deflection

A. Continue the scan
  i. Add bank as necessary
    a. Keep "coordinated" (zero sideslip)
  ii. Increase pitch attitude to maintain altitude
B. Establish, Trim, Crosscheck, Adjust

5. Managing the Engine Failure

A. Use the same steps as an engine failure in visual conditions:
  i. Full Power
  ii. Reduce Drag
  iii. Identify
  iv. Verify
  v. Fix or Feather
  vi. Restart the Inoperative Engine
B. Pay even more attention to your instrument scan/flying the aircraft
  i. Between every step stop and check for zero sideslip, heading, altitude, engine indications

Common Errors:

- Failure to recognize an inoperative engine
- Hazards of improperly identifying and verifying the inoperative engine
- Failure to properly adjust engine controls and reduce drag
- Failure to establish and maintain the best engine inoperative airspeed
- Failure to follow the prescribed checklist
- Failure to establish and maintain the recommended flight attitude for best performance
- Failure to maintain positive aircraft control while maneuvering
- Hazards of exceeding the aircraft's operating limitations
- Faulty basic instrument flying technique

Conclusion:
Brief review of the main points
Fly first; maintain control of the aircraft (keep up the scan) during the entire process. There is no rush to complete the checklist

PTS Requirements:

To determine that the applicant:

1. Exhibits instructional knowledge of the elements related to engine failure during straight-and-level flight and turns, solely by reference to instruments, by describing-

   A. appropriate methods to be used for identifying and verifying the inoperative engine.
   B. technique for maintaining positive aircraft control by reference to instruments.
   C. importance of accurately assessing the aircraft's performance capability with regard to action that maintains altitude or minimum sink rate considering existing conditions.
2. Exhibits instructional knowledge of common errors related to engine failure during straight-and-level flight and turns, solely by reference to instruments, by describing-
   A. failure to recognize an inoperative engine.
   B. hazards of improperly identifying and verifying the inoperative engine.
   C. failure to properly adjust engine controls and reduce drag.
   D. failure to establish and maintain the best engine inoperative airspeed.
   E. failure to follow the prescribed checklist.
   F. failure to establish and maintain the recommended flight attitude for best performance.
   G. failure to maintain positive aircraft control while maneuvering.
   H. hazards of exceeding the aircraft's operating limitations.
   I. faulty basic instrument flying technique.
3. Demonstrates and simultaneously explains straight-and-level flight and turns after engine failure, solely by reference to instruments, from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to straight-and-level flight and turns after engine failure, solely by reference to instruments.

ACS Skills Standards

1. Promptly recognize an engine failure and maintain positive aircraft control.
2. Set the engine controls, reduce drag, identify and verify the inoperative engine, and simulate feathering of the propeller on the inoperative engine. (Evaluator should then establish a zero-thrust on the inoperative engine).
3. Establish the best engine-inoperative airspeed and trim the aircraft.
4. Use flight controls in the proper combination as recommended by the manufacturer, or as required to maintain best performance, and trim as required.
5. Verify the prescribed checklist procedures normally used for securing the inoperative engine.
6. Attempt to determine and resolve the reason for the engine failure.
7. Monitor all engine control functions and make necessary adjustments.
8. Maintain the specified altitude ±100 feet, or minimum sink rate if applicable, airspeed ±10 knots, and the specified heading ±10°.
9. Assess the aircraft's performance capability and decide an appropriate action to ensure a safe landing.
10. Avoid loss of aircraft control, or attempted flight contrary to the engine-inoperative operating limitations of the aircraft.
11. Demonstrate SRM.

IX.D. Instrument Approach and Landing with an Inoperative Engine (by Ref to Instruments)

References: 14 CFR part 91, Instrument Flying Handbook (FAA-H-8083-15), IAP, POH/AFM

Objectives	The student should develop knowledge of the elements related to a single engine instrument approach.
Key Elements	1. Zero Sideslip 2. Never go below V_{MC} 3. Maintain directional control (Fly the Airplane!)
Elements	1. Manage the Engine Failure 2. Brief the Approach 3. Precision Approach 4. Non-Precision Approach 5. Maintenance of Altitude, Airspeed, and Track 6. Appropriate Rate of Descent 7. Landing
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student can competently fly a precision and non-precision approach solely by reference to the instruments.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

This lesson will discuss how to perform an instrument approach with an inoperative engine.

Why

An instrument approach in a single vs multi engine aircraft is basically the same thing (other than different speeds/power settings). The primary difference though is that in a multi-engine aircraft it is possible to continue flight with an engine failed. For this reason, if you want instrument privileges on your multi engine rating you must prove to the examiner that you can handle an instrument approach with a failed engine.

How:

1. **Manage the Engine Failure**
   - A. Recognize engine failure and maintain control
     - i. When an engine fails use rudder and aileron to maintain directional control
       - Establish a zero-sideslip configuration by adding approximately 2-3° of bank to counteract the roll and rudder in order to achieve a ½ ball deflection toward the operating engine
     - ii. This is done strictly by instruments
   - B. Use the same steps as an engine failure in visual conditions:
     - i. Full Power
     - ii. Reduce Drag
     - iii. Identify
     - iv. Verify
     - v. Feather
   - C. Pay even more attention to your instrument scan/flying the aircraft
     - i. Between every step stop and check for zero sideslip, heading, altitude, engine indications
2. **Brief the Approach**
   - A. Normal approach brief
   - B. Speeds and aircraft configuration will change but the approach itself stays the same
3. **Precision Approach**
   - A. Configuration
     - i. Maintain a zero sideslip
       - a. As power is reduced on the approach, rudder should be reduced as well
       - b. Scan will have to be increased to maintain scan as well as glideslope/localizer
     - ii. Procedure Turn (inbound/Outbound), Localizer Intercept
       - a. Airspeed: 100 KIAS
       - b. Power: 80%
     - iii. ½ Dot Below Glide Slope
       - a. Airspeed: Decelerating to 90 KIAS
       - b. Power: 65%

        c. Flaps: As necessary
    iv. Glide Slope Intercept (FAF)
        a. Airspeed: SE Approach (no slower than V_{yse})
        b. Power: Approximately 65%
        c. Pitch: Approximately 5° Nose Down
  B. Checklist Items
    i. Pre-Landing Checklist
    ii. Arriving at any Fix (5 T's)
        a. Turn
        b. Time
        c. Twist
        d. Throttle
        e. Talk

4. Non-precision Approach
  A. Configuration
    i. Maintain a zero sideslip
        a. As power is reduced on the approach, rudder should be reduced as well
        b. Scan will have to be increased to maintain scan as well as course and monitor step downs
    ii. Procedure Turn (inbound/Outbound), Localizer Intercept
        a. Airspeed: 100 KIAS
        b. Power: 80%
    iii. 1 nm from FAF
        a. Airspeed: Decelerating to 90 KIAS
        b. Power: 65%
        c. Flaps: As necessary
    iv. FAF
        a. Airspeed: SE Approach (no slower than V_{yse})
        b. Power: Approximately 55%
        c. Pitch: Approximately 6° Nose Down
            - Descend slightly faster than Precision Approach in order to reach MDA prior to missed
                a Provides time to find and then descend to the runway
    v. MDA/Step Down
        a. Level off without going below MDA/Step down altitude
            - Approximately 80% power, do not slow below V_{yse}
            - With increased power comes increased rudder, maintain a zero sideslip
  B. Checklist Items
    i. Pre-Landing Checklist
    ii. Arriving at any Fix (5 T's)
        a. Turn
        b. Time
        c. Twist
        d. Throttle
        e. Talk

5. Maintenance of Altitude, Airspeed, and Track
  A. Establish, Trim, Crosscheck, Adjust
    i. Keep the zero sideslip while focusing on the approach
  B. Keep the scan moving, include everything in your scan
    i. Occasionally include the approach chart in the scan

C. Always ask, “What am I doing next?”
    i. Stay ahead of altitudes, airspeed, track
    ii. Use the 5 T’s at every waypoint
        a. Turn, Time, Twist, Throttle, Talk
            - Will I need any of these?

D. Keep the localizer needle centered
    i. Be proactive in maintaining the localizer course
        a. Make adjustments for wind
            - Use the heading bug to bug the heading that will maintain the desired course
            - Make adjustments to the R/L of the heading bug to correct for course deviations

E. When the glide slope centers, pitch down approximately 5° and maintain a centered glide slope indication
    i. Be proactive in maintaining glide slope
        a. If the ball starts to move up/down make small adjustments immediately to arrest the movement
        b. As GS increases, rate of descent must increase as well
        c. As GS decreases, rate of descent must decrease as well

6. Appropriate Rate of Descent

A. A descent rate of greater than 1,000 FPM is unacceptable during the final stages of an approach
    i. This is due to human perceptual limitation independent of the type of airplane
    ii. Especially applicable in a single engine situation, maintain a controlled, stabilized approach

B. A descent rate should be used that will ensure reaching the DA at a distance from the threshold that will allow landing in the touchdown zone
    i. The glide slope will ensure you maintain the appropriate rate of descent, Follow it

7. Landing

A. Perform a visual landing as previously discussed/taught

Common Errors:

- Failure to have essential knowledge of the information that appears on the selected instrument approach chart
- Failure to use proper communications procedures
- Noncompliance with ATC clearances
- Incorrect use of navigation equipment
- Failure to identify and verify the inoperative engine and to follow the emergency checklist
- Inappropriate procedure in the adjustment of engine controls and the reduction of drag
- Inappropriate procedure in the establishment and maintenance of the best engine inoperative airspeed
- Failure to establish and maintain the proper flight attitude for best performance
- Failure to maintain positive aircraft control
- Faulty basic instrument flying technique
- Inappropriate descent below the MDA or DH
- Faulty technique during roundout and touchdown

Conclusion:
Brief review of the main points
Fly first; maintain control of the aircraft (keep up the scan) during the entire process.

PTS Requirements:
To determine that the applicant:

1. Exhibits instructional knowledge of the elements related to an instrument approach with one engine inoperative by describing-
   A. maintenance of altitude, airspeed and track appropriate to the phase of flight or approach segment.
   B. procedure if unable to comply with an ATC clearance or instruction.
   C. application of necessary adjustments to the published MDA and visibility criteria for the aircraft approach category.
   D. establishment and maintenance of an appropriate rate of descent during the final approach segment.
   E. factors that should be considered in determining whether:
      i. the approach should be continued straight-in to a landing; or
      ii. a circling approach to a landing should be performed.
2. Exhibits instructional knowledge of common errors related to an instrument approach with one engine inoperative by describing-
   A. failure to have essential knowledge of the information that appears on the selected instrument approach chart.
   B. failure to use proper communications procedures.
   C. noncompliance with ATC clearances.
   D. incorrect use of navigation equipment.
   E. failure to identify and verify the inoperative engine and to follow the emergency checklist.
   F. inappropriate procedure in the adjustment of engine controls and the reduction of drag.
   G. inappropriate procedure in the establishment and maintenance of the best engine inoperative airspeed.
   H. failure to establish and maintain the proper flight attitude for best performance.
   I. failure to maintain positive aircraft control.
   J. faulty basic instrument flying technique.
   K. inappropriate descent below the MDA or DH.
   L. faulty technique during roundout and touchdown.
3. Demonstrates and simultaneously explains an instrument approach with one engine inoperative from an instructional standpoint.
4. Analyzes and corrects simulated common errors related to an instrument approach with one engine inoperative.

ACS Skills Standards

1. Promptly recognize an engine failure and maintain positive aircraft control. Set the engine controls, reduce drag, identify and verify the inoperative engine, and simulate feathering of the propeller on the inoperative engine. (Evaluator should then establish a zero-thrust on the inoperative engine).
2. Use the flight controls in the proper combination as recommended by the manufacturer, or as required to maintain best performance, and trim as required.
3. Follow the manufacturer's recommended emergency procedures.
4. Monitor the operating engine and make necessary adjustments.
5. Request and follow an actual or a simulated ATC clearance for an instrument approach.
6. Maintain altitude ±100 feet or minimum sink rate if applicable, airspeed ±10 knots, and selected heading ±10°.
7. Establish a rate of descent that will ensure arrival at the MDA or DH/DA with the aircraft in a position from which a descent to a landing on the intended runway can be made, either straight in or circling as appropriate.
8. On final approach segment, maintain vertical (as applicable) and lateral guidance within ¾-scale deflection.

9. Avoid loss of aircraft control, or attempted flight contrary to the operating limitations of the aircraft.
10. Comply with the published criteria for the aircraft approach category if circling.
11. Execute a normal landing.
12. Complete the appropriate checklist.

POST FLIGHT PROCEDURES

X.A. Checking Instruments and Equipment

References: POH/AFM

Objectives	The student should develop knowledge of the elements related to ensuring proper operation of instruments and equipment and reasons for making a written record of improper operation.
Key Elements	1. Always Record Maintenance Issues 2. Don't leave problems for the next pilot 3. Safety is the #1 Priority
Elements	1. General 2. Documenting Equipment Malfunctions 3. Written Records of Improper Operation/calibration
Schedule	1. Discuss Objectives 2. Review material 3. Development 4. Conclusion
Equipment	1. White board and markers 2. References
IP's Actions	1. Discuss lesson objectives 2. Present Lecture 3. Ask and Answer Questions 4. Assign homework
SP's Actions	1. Participate in discussion 2. Take notes 3. Ask and respond to questions
Completion Standards	The student understands how to check the instruments and equipment for proper functionality and when to make a written record of improper operation.

Instructors Notes:

Introduction:

Attention

Interesting fact or attention-grabbing story

Overview

Review Objectives and Elements/Key ideas

What

The instrument

Why

Safety. Checking instruments and equipment prior to shutdown allows the pilot to make a record of any issues found. Maintenance can be performed prior to the next flight, and the next pilot can be made aware of the problem rather than discovering it during flight.

How:

1. **General**
   - A. Extremely important to check the instruments for any flight involving control by instruments only
     - i. Check all instruments and their sources of power for proper operation
       - a. During or after the flight, make a note of any instrumentation, or equipment that is not functioning properly and report the malfunctions
2. **Documenting Equipment Malfunctions**
   - A. Document malfunctions in a binder or maintenance log
     - i. Different flight schools, aircraft owners, etc. may have different ways of documenting equipment malfunctions
     - ii. Ensure there is some sort of written record to refer to
       - a. This will assist maintenance as well as others who fly the aircraft
   - B. Documenting the issues helps to get the issues fixed
     - i. Don't leave problems for the next person
       - a. Safety is #1, if you don't report an issue, the next person to fly has to deal with it
         - Treat it as though it's your aircraft
   - C. Documenting Issues allows others to see a history of problems the aircraft has experienced
     - i. Pilots can note trends before taking the aircraft
       - a. For example, If the aircraft tends to have a problem with a specific piece of equipment needed for a trip, the pilot can take a different aircraft or get the issue fixed
   - D. The maintenance logbook should include documentation of all work done on the aircraft by a certified A&P mechanic
3. **Written Records of Improper Operation/Calibration**
   - A. Alerts other pilots/personnel to make changes before flying again
     - i. Ensure any operational problems are taken care of before flying the airplane again
     - ii. Keeps all issues recorded in one place that anyone can access
   - B. Much safer
   - C. Someone else doesn't get caught in the air with faulty instrument readings or equipment

Conclusion:
Brief review of the main points

PTS Requirements:
To determine that the applicant exhibits instructional knowledge of the elements related to checking instruments and equipment by describing:

1. Importance of noting instruments and navigation equipment for improper operation.
2. Reasons for making a written record of improper operation or failure and/or calibration of instruments prior to next IFR flight.