II.C. Visual Scanning and Collision Avoidance

References: FAA-H-8083-3; FAA-8083-3-25; AC 90-48; AIM

Objectives
The student should develop knowledge of the elements related to proper visual scanning and collision threat avoidance. The student also will have knowledge regarding in flight and landing illusions as well as how to avoid trusting them.

Key Elements
1. “See and Avoid”
2. Clearing Procedures
3. Trust Your Instruments

Elements
1. “See and Avoid” Concept
2. Proper Visual Scanning
3. Clearing Procedures
4. Recognizing Hazards
5. Collision Avoidance
6. Conditions that Degrade Vision
7. In Flight Illusions
8. Landing Illusions

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

Equipment
1. White board and markers
2. References

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

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

Completion Standards
The student understands the importance of maintaining a vigilant traffic scan and consistently scans for traffic. In the onset of an illusion the student understands it is an illusion and trusts the instruments to maintain safe flight.
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Instructors Notes:

Introduction:
   Attention
   AC90-48C Appendix 1:
   How much time do you think you would have to react if two planes were approaching each other at 360 mph from 10 miles out? 100 seconds
   How about from 4 miles? 40 seconds
   1 mile? 10 seconds
   ½ Mile? 5 seconds
   What if the planes were approaching at 600 MPH? 12 seconds from 2 miles; 3 seconds from ½ mile
   So, it’s probably important that we look out for other approaching traffic, isn’t it?

Overview
   Review Objectives and Elements/Key ideas

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

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

How:
1. “See and Avoid” (FAR part 91, AC 90-48C)
   A. Flight rules prescribed in FAR part 91 set forth the concept of “See and Avoid”
   B. The Concept
      i. Vigilance shall be maintained at all times, by each person operating an aircraft, regardless of whether the operation is conducted under IFR or VFR

2. Proper Visual Scanning (AIM 8-1-6)
   A. Remain constantly alert to all traffic movement within the field of vision, as well as periodically scanning the entire visual field to ensure detection of conflicting traffic
   B. Effective scanning
      i. At one glance, only a very small center area called the fovea, in the rear of the eye, has the ability to send a clear, sharply focused message (image) to the brain
         a. All other visual info not processed directly through the fovea will be of less detail
      ii. Short, regularly spaced eye movements bringing successive areas of the sky in the central visual field
         a. Each movement should not exceed 10° and should be observed for at least 1 second
      iii. Peripheral Vision
         a. Can be very useful in spotting collision threats
            • Apparent movement is often detected by the peripherals
         b. Visual search at night depends almost entirely on the peripherals
   C. Poor Visual Scanning
      i. Increases the risk of midair collisions
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3. Clearing Procedures
   A. Before Takeoff
      i. Prior to taxiing onto the runway
         a. Scan the approach area for traffic, with appropriate maneuvers to provide a view of the area
   B. Climbs and Descents
      i. Execute gentle banks L and R at a frequency which permits continuous scanning of the airspace
   C. Straight and Level
      i. Execute appropriate clearing procedures at periodic intervals
   D. Traffic Patterns
      i. Entries into traffic patterns while descending should be avoided
         a. Enter at pattern altitude, scanning for other traffic
   E. Traffic at VOR Sites
      i. Due to converging traffic, sustained vigilance should be maintained in the vicinity of VORs and intersections
   F. Training Operations
      i. Vigilance should be maintained and clearing turns should be made prior to a practice maneuver
         a. Verbalize clearing procedures
            • “Clear Left, Right, Above, Below”
   G. Blind Spots
      i. High wing and low wing aircraft have their respective blind spots
         a. Low Wing
            • Momentarily lower the wing in the direction of the intended turn to look for traffic before turning

4. Recognizing Hazards
   A. Aircraft Speed and Collision Risk
      i. Approaching aircraft have very high closure rates
      ii. Studies have shown that the minimum time it takes for a pilot to spot the traffic, identify it, realize it’s a collision threat, react, and have the airplane respond is at least 12.5 seconds
   B. Recognize High Hazard Areas
      i. Aircraft tend to cluster near VORs, and Class B, C, D, and E surface areas
         a. Being in a radar environment still requires vigilance
   C. Determining Relative Altitude
      i. Use the horizon as a reference point
         a. If the aircraft is above the horizon, it is probably on a higher flight path
         b. If the aircraft is below the horizon, it is probably on a lower flight path
   D. Collision Course Targets
      i. Any aircraft that appears to have no relative motion is likely to be on a collision course
         a. If the aircraft shows no lateral or vertical motion, but increases in size, take evasive action
            • Similar to an aiming point when landing
               a. Object remains stationary
   E. Taking Appropriate Action
      i. If on an obvious collision course one should be able to take immediate actions
         a. Hopefully in compliance with the FARS
            • Know the rules
               a. Be familiar with Right-of-Way rules (FAR 91.113)
         b. Anticipate that the other pilot may make a quick maneuver as well
5. **Collision Avoidance** (AIM 8-1-8)
   A. Cockpit Management
      i. Studying maps, checklists and manuals before flight, with other proper preflight planning (radio frequencies, organizing materials) can permit more time for scanning
   B. Visual obstructions in the Cockpit
      i. Move to see around blind spots caused by aircraft structures (posts, wings, etc)
         a. Maneuver the aircraft if necessary (in the case of wings)
   C. Windshield Conditions
      i. Dirty or bug smeared windshields can greatly reduce vision
         a. Keep a clean windshield
   D. Be More Visible
      i. Use of exterior lights
         a. But keep interior lights low at night
   E. ATC Support
      i. Radar Traffic Advisories as long as workload permits
         a. Use whenever possible

6. **Conditions that Degrade Vision** (AIM 8-1-6)
   A. Physical Health and Vision
      i. Diet and physical health have an impact on how well a pilot can see, especially in the dark
      ii. Anything that may affect a pilot’s physical or mental condition will reduce visual acuity
         a. Illness, medication, stress, alcohol, fatigue, emotion, hypoxia, etc
         b. Deficiencies in Vitamin A and C have been shown to reduce night acuity
      iii. Other factors such as carbon monoxide poisoning, smoking, alcohol, certain drugs, and a lack of oxygen also can greatly decrease night vision
   B. Environmental Conditions
      i. Dim illumination
         a. Small print and colors become unreadable unless adequate lighting is available
            ● Aeronautical charts, instruments become hard to read
      ii. Darkness
         a. Dark Adaptation - Vision becomes more sensitive to light
            ● Exposure to darkness for at least 30 minutes is required for complete dark adaptation
            ● Impaired By:
               a. Exposure to cabin pressure altitudes above 5,000'
               b. Carbon monoxide inhaled in smoking and from exhaust fumes
               c. Deficiency of Vitamin A in the diet
               d. Prolonged exposure to bright sunlight
            ● Since any degree of dark adaptation is lost within a few seconds of viewing a bright light, a pilot should close one eye when using light to preserve some degree of night vision
      iii. Excessive Illumination
         a. EXs: Light reflected off the canopy, surfaces inside the aircraft, clouds, water, snow, and desert terrain
            ● These can produce glare, with uncontrollable squinting, watering of the eyes, and even temporary blindness
      iv. Visual
         a. Smoke, haze, dust, rain, and flying toward the sun can reduce the ability to see other aircraft
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v. Empty Field Myopia
   a. Induced nearsightedness
   b. Another problem associated with flying at night, in IMC and/or reduced visibility
      • With nothing to focus on, the eyes automatically focus on a point slightly ahead of the plane
   c. Preventing
      • Searching out and focusing on distant light sources, no matter how dim, helps

7. In Flight Illusions
   A. Preventing Spatial Disorientation
      i. Can only be prevented by visual reference to reliable, fixed points on the ground, or to flight instruments
   B. The Leans
      i. Reason
         a. An abrupt correction of a banked attitude which has been entered too slowly
            • The motion sensing system in the inner ear was not stimulated
      ii. Illusion
         a. Can create the illusion of banking in the opposite direction
      iii. Result
         a. The disoriented pilot will roll the aircraft back into its original dangerous attitude (the turn), thinking (feeling) the airplane is straight and level
         b. Or, will feel compelled to lean to the perceived vertical plane until the illusion subsides
   C. Coriolis Illusion
      i. Reason
         a. An abrupt head movement in a prolonged constant rate turn that has stopped stimulating the motion sensing system
      ii. Illusion
         a. Can create the illusion of rotation or movement in an entirely different axis
      iii. Result
         a. The disoriented pilot will maneuver the aircraft into a dangerous attitude in order to stop the perceived rotation
      iv. Prevention
         a. Don’t make sudden head movements
            • Especially when in prolonged constant rate turns in IFR conditions
   D. Graveyard Spin
      i. Reason
         a. Recovery from a spin that has ceased stimulating the motion sensing system
      ii. Illusion
         a. Can create the illusion of being in a spin in the opposite direction
      iii. Result
         a. The disoriented pilot will return the aircraft to its original spin
   E. Graveyard Spiral
      i. Reason
         a. There is an observed loss of altitude during a prolonged constant rate turn which has ceased to stimulate the motion sensing system
      ii. Illusion
         a. Can create the illusion of a level descent
      iii. Result
a. The disoriented pilot will pull back on the controls, tightening the spiral and increasing the loss of altitude

F. Somatogravic Illusion
   i. Reason
      a. A rapid acceleration
         • Often during takeoff
      b. A rapid deceleration
   ii. Illusion
      a. In the case of a rapid accelerating, it can create the illusion of being in a nose up attitude
      b. In the case of a rapid deceleration, it can create the illusion of being in nose down attitude
   iii. Result
      a. The disoriented pilot will put the aircraft in a nose low, or dive attitude
      b. The disoriented pilot will put the aircraft in a nose up, or stall attitude

G. Inversion Illusion
   i. Reason
      a. An abrupt change from a climb to straight and level flight
   ii. Illusion
      a. Can create the illusion of tumbling backwards
   iii. Result
      a. The disoriented pilot will push the aircraft abruptly into a nose low attitude
         • This could intensify the situation

H. Elevator Illusion
   i. Reason
      a. An abrupt upward vertical acceleration, usually due to an updraft
      b. An abrupt downward vertical acceleration, usually due to a down draft
   ii. Illusion
      a. Upward vertical acceleration can create the illusion of being in a climb
      b. Downward vertical acceleration can create the illusion of being in a descent
   iii. Result
      a. The disoriented pilot will push the aircraft into a nose low attitude
      b. The disoriented pilot will pull the aircraft into a nose up attitude

I. False Horizon
   i. Reason
      a. Sloping cloud formations, an obscured horizon, a dark scene spread with ground lights and stars, and certain geometric patterns of ground light
   ii. Illusions
      a. Can create the illusion of not being aligned with the horizon properly
   iii. Result
      a. The disoriented pilot will put the aircraft in a dangerous attitude

J. Autokinesis
   i. Reason
      a. In the dark
   ii. Illusion
      a. A static light when started at for many seconds will appear to move about
   iii. Result
      a. The disoriented pilot will lose control of the aircraft in attempting to align it with the light
8. Landing Illusions

   A. Preventing landing illusions
      i. Anticipate them during approaches
      ii. Aerial visual inspection of unfamiliar airports
      iii. Using glide slope or VASI systems when available
      iv. Maintaining optimum proficiency in landing procedures

   B. Runway Width Illusion
      i. Reason
         a. A narrower than usual runway
         b. A wider than usual runway
      ii. Illusion
         a. Narrow - Can create the illusion that the aircraft is at a higher altitude than it actually is
         b. Wide - Can create the illusion that the aircraft is at a lower altitude than it actually is
      iii. Result
         a. Narrow - The pilot who doesn’t recognize this will fly a lower approach, with the risk of striking objects along the approach path or landing short
         b. Wide – the pilot who doesn’t recognize this will fly a higher approach, with the risk of leveling out high and landing hard or overshooting the runway

   C. Runway and Terrain Slope Illusion
      i. Reason
         a. An upsloping runway, upsloping terrain, or both
         b. A downsloping runway, downsloping terrain, or both
      ii. Illusion
         a. Upslope – Can create the illusion that the aircraft is at a higher altitude than it actually is
         b. Downslope – Can create the illusion that the aircraft is at a lower altitude than it actually is
      iii. Result
         a. Upslope – The pilot who does not recognize this will fly a lower approach
         b. Downslope – The pilot who does not recognize this will fly a higher approach

   D. Featureless Terrain Illusion
      i. Reason
         a. An absence of ground features, as when landing over water, darkened areas, and terrain made featureless by snow
      ii. Illusion
         a. Can create the illusion that the aircraft is at a higher altitude than it actually is
      iii. Result
         a. The pilot who doesn’t recognize this will fly a lower approach

   E. Atmospheric Illusions
      i. Reason
         a. Rain on the windscreen
         b. Atmospheric Haze
         c. Penetration of fog
      ii. Illusion
         a. Rain - Can create the illusion of greater height
         b. Atmospheric Haze – Can create the illusion of distance
         c. Penetration of Fog – Can create the illusion of pitching up
      iii. Result
         a. Rain & Haze - The pilot who does not recognize these illusions will fly a lower approach
b. Fog – The pilot who does not recognize this will steepen the approach (descent), often quite abruptly

F. Ground Lighting Illusions
   i. Reason
      a. Lights along a straight path, such as a road, and even lights on moving trains
   ii. Illusions
      a. Can create the illusion of runway and approach lighting systems
   iii. Result
      a. The pilot may attempt to land on a path, road, or train
   iv. Reason
      a. Bright runway and approach light systems
   v. Illusion
      a. Can create the illusion of less distance to the runway
      • Especially where few lights illuminate the surrounding terrain
   vi. Result
      a. The pilot who does not recognize this illusion will fly a higher approach

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

PTS Requirements:
To determine that the applicant exhibits instructional knowledge of the elements of visual scanning and collision avoidance by describing:
1. Relationship between a pilot’s physical condition and vision
2. Environmental conditions that degrade vision.
4. “See and avoid” concept.
5. Proper visual scanning procedure.
6. Relationship between poor visual scanning habits and increased collision risk.
7. Proper clearing procedures.
8. Importance of knowing aircraft blind spots.
9. Relationship between aircraft speed differential and collision risk.
10. Situations which involve the greatest collision risk.