HUMAN FACTORS

FULFILLS PA.I.H, CA.I.H, AI.II.A

Objective	
The student shall understand the relationship between human factors and flight safety. The student shall become familiar with appropriate methods to determine sufficient aeromedical health for flight.	
Instructor Actions	**Student Actions**
- Discuss the aeromedical phenomena and relate it to common experiences - Discuss mitigation methods for these phenomena - Relate the phenomena to flight safety - Demonstrate the risk management tools - Present AOPA medication list	- Take notes and participate in instructor's discussion - Perform a self assessment using the IMSAFE checklist and FRAT sheet and incorporate these into their preflight actions - Practice identifying hazardous attitudes in SBT
Case Studies	**Equipment**
- Hypoxic Pilots in Learjet 25 - Mooney Pilot with CO Poisoning - Laser Strike Incidents	- Computer - FAR/AIM - PHAK - White Board
Completion Standards	
The student shall explain identification and mitigation methods for aeromedical phenomena. The student shall demonstrate proficiency in identifying hazardous attitudes and using the risk management tools for given scenarios.	

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RESOURCES

14 CFR 91.17 Alcohol or drug

FAA-S-ACS-6C Private Pilot ACS - Area I Task H
FAA-S-ACS-7B Commercial Pilot ACS - Area I Task H
FAA-S-ACS-25 CFI ACS - Area II Task A

FAA-H-8083-2 Risk Management Handbook
FAA-H-8083-3C Airplane Flying Handbook
FAA-H-8083-9 Aviation Instructors Handbook
FAA-H-8083-25C PHAK Chapter 2: Aeronautical Decision Making
FAA-H-8083-25C PHAK Chapter 17: Aeromedical Factors

AC 60-22 – Aeronautical Decision Making
AC 120-51E – Crew Resource Management Training

Aeronautical Decision Making for Instructor Pilots
FRAT Information
PAVE Information
AOPA Medication Website

ERAU Aeromedical Factors Video

1. HYPOXIA

What is hypoxia? Not enough oxygen

Why is it important to understand its effects? Proactive knowledge, rather than reactive

Hypoxic Hypoxia Hypoxia as a result of insufficient oxygen, typically due to high altitude operations at high cabin altitudes. Recall 91.211 for oxygen requirements at different cabin pressure altitudes.

Hypemic Hypoxia Hypoxia as a result of inadequate oxygen carriage from hemoglobin, typically due to recent blood donation or CO poisoning. CO's bond affinity to hemoglobin is 300 times that of oxygen!

Stagnant Hypoxia Hypoxia as a result blood not flowing, typically due to sustained g forces or poor circulation.

Histotoxic Hypoxia Hypoxia as a result of cells being unable to utilize oxygen, typically due to drug to alcohol poisoning.

Symptoms of hypoxia include
- Blue fingernails and lips
- Headache
- Decreased response to stimuli and increased reaction time
- Impaired judgment
- Euphoria
- Visual impairment
- Drowsiness
- Lightheaded or dizzy sensation
- Tingling in fingers and toes
- Numbness

These two pilots experiences hypoxia on their flight in a Learjet 25.

If a pilot or passenger is experiencing hypoxia, the pilot should descend to a more oxygen rich altitude or supplement with oxygen.

1.1. Time of Useful Consciousness

> Describes the maximum time the pilot has to make rational, life-saving decisions and carry them out at a given altitude without supplemental oxygen. (PHAK Chapter 17)

Altitude [ft]	Time
45,000	9 to 15 seconds
40,000	15 to 20 seconds
35,000	30 to 60 seconds
30,000	1 to 2 minutes
28,000	2½ to 3 minutes
25,000	3 to 5 minutes
22,000	5 to 10 minutes
20,000	30 minutes or more

2. HYPERVENTILATION

Hyperventilation is an excessive rate of breathing followed by a decrease in CO_2 levels in the blood.

Symptoms of hyperventilation include
- Visual impairment
- Unconsciousness
- Lightheaded or dizzy sensation
- Tingling sensations
- Hot and cold sensations
- Muscle spasms

If a pilot or passenger is hyperventilating, the should decrease their rate of breathing or breathe into a paper bag.

3. MIDDLE EAR AND SINUS PROBLEMS

Most people are familiar with the feeling of their ears “popping", especially during altitude changes. This sensation is the ear equalizing pressure, which, if blocked due to ailments like a simple cold to a sinus infection, can prove quite painful.

If a pilot or passengers has trouble in “popping” their ears, make sure to descent slowly. In general, avoid flying while sick or with sick passengers.

4. SPATIAL DISORIENTATION AND ILLUSIONS

The body uses three systems to orient itself in space:

Visual System Our eyes tell us our orientation via visual cues such as the horizon.

Vestibular System Organs in the ear that detect orientation. Can artificially excite this system by spinning in circles.

Somatosensory System **“**Nerves in the skin, muscles, and joints that, along with hearing, sense position based on gravity, feeling, and sound.”

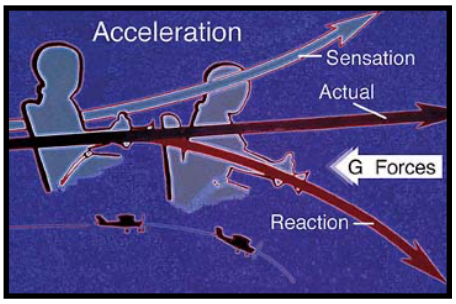
These systems sometime supply incorrect information to our brain, although it usually corrected for by the other systems. In areas where the visual system is ineffective, such as IMC or at night with no visual reference, many pilots will turn to remaining, but often incorrect, sensations from the vestibular and somatensory systems. **The best mitigation** is to trust your instruments when the visual system is impaired.

The Leans Following leveling out after a slow prolonged turn, the pilot feels they are banking in the opposite direction since the vestibular system fails to sense slow turns.

Coriolis Illusion In a prolonged turn, the fluid in the ear canal may match the speed of the turn. If the pilot moves their head, they may sense an imaginary attitude change about another axis and correct for that unexpected maneuver, actually putting themselves in a dangerous attitude.

Graveyard Spiral In a prolonged turn, the fluid in the ear canal may match the speed of the turn. Upon returning to wings level, the pilot may feel they have banked in the opposite direction. They will then inadvertently resume the original turn without noticing and will lose altitude, creating the downward spiral.

Somatogravic Illusion A longitudinal acceleration is perceived in the same was as tilting your head forward or back. A pilot who applies power may inadvertently push the nose forward to correct for an imaginary pitch up, and conversely for decelerations.



Inversion Illusion Leveling off from a climb may induce the same sensation as tumbling backward. Pilots may push the nose into a nose-low attitude.

Elevator Illusion Updrafts can stimulate the feeling of climbing, causing the pilot to pitch down. Conversely, downdrafts can stimulate the feeling of descending, causing the pilot to pitch up.

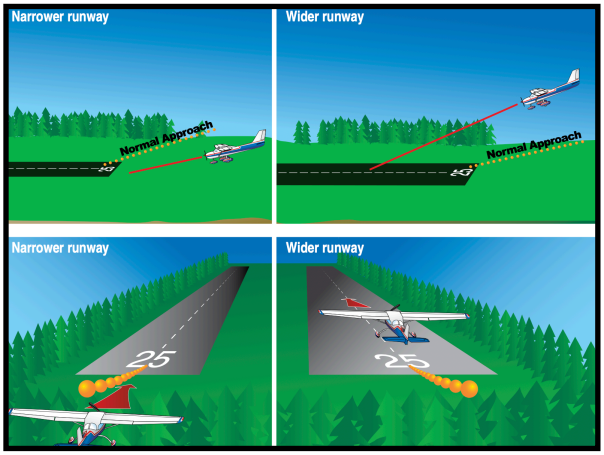
Visual illusions are equally dangerous, and by nature of being visual, a pilot may be more inclined to believe these illusions.

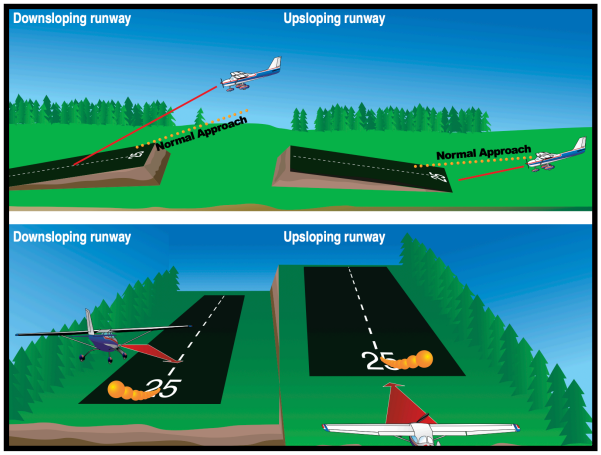
False Horizon Approaching a highway or coastline at night at an angle creates the impression of a horizon different than the actual horizon.

Autokinesis At night, a stationary light may appear to move if it is stared at for a prolonged period of time. As a result, a pilot may attempt to align the aircraft with the perceived moving light potentially causing him/her to lose control of the aircraft.

Runway Width "A narrower-than-usual runway can create an illusion that the aircraft is higher than it actually is, leading to a lower approach. A wider-than-usual runway can create an illusion that the aircraft is lower than it actually is, leading to a higher approach." – PHAK

Runway Slope "A downsloping runway can create the illusion that the aircraft is lower than it actually is, leading to a higher approach. An upsloping runway can create the illusion that the aircraft is higher than it actually is, leading to a lower approach." – PHAK





Featureless Terrain / Black Hole "An absence of surrounding ground features, as in an overwater approach over darkened areas or terrain made featureless by snow, can create an illusion that the aircraft is at a higher altitude than it actually is. This illusion, sometimes referred to as the "black hole approach," causes pilots to fly a lower approach than is desired." – PHAK

Water Refraction "Rain on the windscreen can create an illusion of being at a higher altitude due to the horizon appearing lower than it is. This can result in the pilot flying a lower approach." – PHAK

Haze "Atmospheric haze can create an illusion of being at a greater distance and height from the runway. As a result, the pilot has a tendency to be low on the approach. Conversely, extremely clear air (clear bright conditions of a high attitude airport) can give the pilot the illusion of being closer than he or she actually is, resulting in a high approach that may result in an overshoot or go around. The diffusion of light due to water particles on the windshield can adversely affect depth perception. The lights and terrain features normally used to gauge height during landing become less effective for the pilot." – PHAK

Fog "Flying into fog can create an illusion of pitching up. Pilots who do not recognize this illusion often steepen the approach abruptly." – PHAK

Ground Lights "Lights along a straight path, such as a road or lights on moving trains, can be mistaken for runway and approach lights. Bright runway and approach lighting systems, especially where few lights illuminate the surrounding terrain, may create the illusion of less distance to the runway. The pilot who does not recognize this illusion will often fly a higher approach." – PHAK

To avoid these landing illusions, make sure to conduct proper research about the airport in the Chart Supplement! Available PAPI or VASI lights can help significantly.

5. MOTION SICKNESS

Occurs when the brain receives conflicting information from various senses. To minimize, fly in smooth air and open air vents.

6. CARBON MONOXIDE

Carbon monoxide (CO) is a colorless and odorless gas that is often present around aircraft engines, which can overpower oxygen in the blood by 300x and induce hypemic hypoxia. Since it can leak into the cockpit through gaps in the firewall and windows or through exhaust leaks, CO positioning is always possible throughout flight.

Low cost detectors, such as the one in Figure x, have a small orange circle than changes to dark brown when CO is detected. However, their efficacy is debated. A more accurate option is a digital CO ppm meter, which can display the ambient concentrate of CO.

7. STRESS AND FATIGUE

Strobe light maintenance story and four strikes

Acute Stress Stress associated with an immediate danger, triggering the fight or flight response.

Chronic Stress Unrelenting stress associated with prolonged issues, such as financial and relationship problems. Chronic stress can cause significant performance degradation in the cockpit.

Acute Fatigue Fatigue typically associated with tiredness or even hypoxia. Typically resolved with eating and sleeping.

Chronic Fatigue Fatigue not resolved by eating or sleeping, usually as a result of chronic stress. Chronic fatigue can cause significant performance degradation in the cockpit.

8. DEHYDRATION AND HEATSTROKE

Dehydration is a deficit of water, often caused by high temperatures and stagnant cockpits. Symptoms include headache, fatigue, cramps, sleepiness, and dizziness. Heatstroke is a more severe manifestation that could lead to collapse.

9. ALCOHOL AND DRUGS

Following 91.17, no person may act as crew member:

(1) Within 8 hours after the consumption of any alcoholic beverage;
(2) While under the influence of alcohol;
(3) While using any drug that affects the person's faculties in any way contrary to safety; or
(4) While having an alcohol concentration of 0.04 or greater

Additionally, no pilot may carry a passenger who appears to be intoxicated or under the influence of drugs

10. DECOMPRESSION SICKNESS

High pressures associated with diving cause the body to absorb significant amounts of nitrogen. At lower pressures, such as flying, this excess nitrogen can form bubbles in the bloodstream to escape.

While the FAA's recommended waiting time varies between 12 and 24 hours depending on the dive, pilots and passengers should wait 24 hours at the minimum due to the possible severe side effects.

11. HAZARDOUS ATTITUDES

There is no such thing as a pilot who doesn't have hazardous attitudes

Attitude	Antidote
Macho: "I can do it."	**Taking chances is foolish.**
Impulsivity: "Do it quickly."	**Not so fast. Think first.**
Invulnerability: "It won't happen to me."	**It could happen to me.**
Resignation: "What's the use?"	**I'm not helpless. I can make a difference.**
Anti-Authority: "Don't tell me."	**Follow the rules. They are usually right.**

12. SAFETY OF FLIGHT

12.1. Crew Resource Management

CRM refers to the effective use of all available resources before and during a flight to ensure a successful flight.

12.2. Aeronautical Decision Making

> ADM is a systematic approach to the mental process used by aircraft pilots to consistently determine the best course of action in response to a given set of circumstances.

It's impractical to expect a pilot to run through a six-step acronym during a critical moment. However, if we take the time now to learn some ADM frameworks, decision making will become quicker, less impulsive structured, and more holistic.

The DECIDE model decomposes the elements of a thoughtful decision.

The OODA loop breaks down, in greater concision, the same steps as DECIDE.

DECIDE		OODA Loop	
D Detect	Detect a change	**O** Observe	Observe change in environment
E Estimate	Estimate the need to react (urgency)	**O** Orient	Combine new and existing information to gain unbiased, holistic understanding of situation
C Choose	Choose a course of action	**D** Decide	Choose a course of action
I Identify	Identify solutions	**A** Act	Enact decision
D Do	Do those actions		
E Evaluate	Evaluate the effect of those actions		

Both these tools emphasize the feature of "feedback", or evaluating the result of the chosen action.

12.3. Operational Pitfalls

An operational pitfall is a bad habit as a result of misplaced priorities, such as get-there-itis, scud running, or flying outside the envelope (among others).

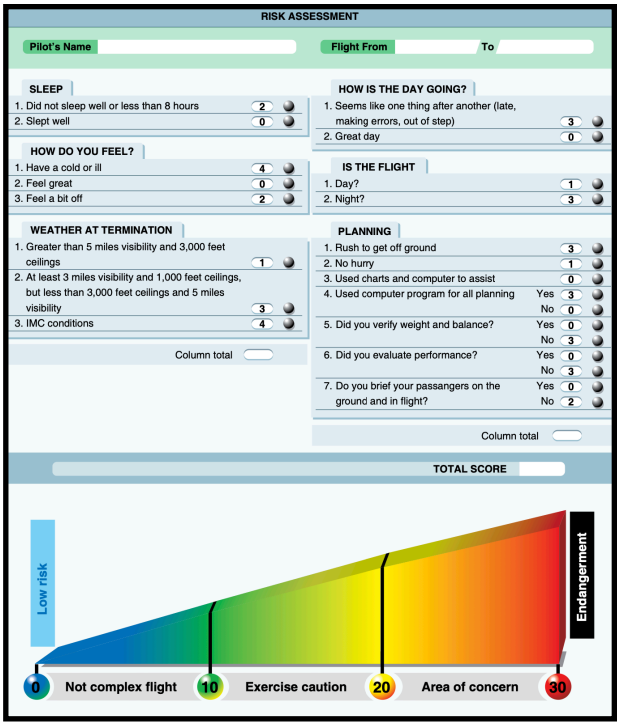
12.4. Risk Management Tools

Risk management tools ensure pilots thoroughly consider each aspect of their flight. Two excellent tools are the FRAT sheet and the PAVE checklist.

The FRAT (flight risk assessment tool) is a high level checklist that objectively quantifies certain aspects of the pilot, aircraft, and environment, and external pressures, but not necessarily to the same detail as the dedicated PAVE checklist. The FRAT helps pilots objectively analyze the risks involved with a particular flight. The pilot then sums the score received and compares it to the scale. If above a certain threshold, the sheet may recommend to consult a CFI or cancel the flight all together.

The PAVE checklist affords the pilot more judgment in evaluating the risks associated with a flight. It forces a discussion on the risks rather than a simple binary score for a particular concern.

Both tools should be used in conjunction.



PAVE		
P	Pilot	IMSAFE, Currency, Proficiency, Personal minimums
A	Aircraft	AVIATES
V	enVironment	NWKRAFT, Terrain, DA, Weather
E	External Pressures	Get-ther-itis…

IMSAFE	
I	Illness
M	Medications
S	Stress
A	Alcohol
F	Fatigue
E	Eating

The IMSAFE checklist is an excellent tool to evaluate your own physical condition before a flight and should be included under the Pilot in PAVE. Personal minimums help pilots avoid impulsively deciding to fly when external or internal conditions are not met. These apply to both weather conditions and pilot recency and health.

13. LASER STRIKE AWARENESS

14. STUDENT PRACTICE SBT