

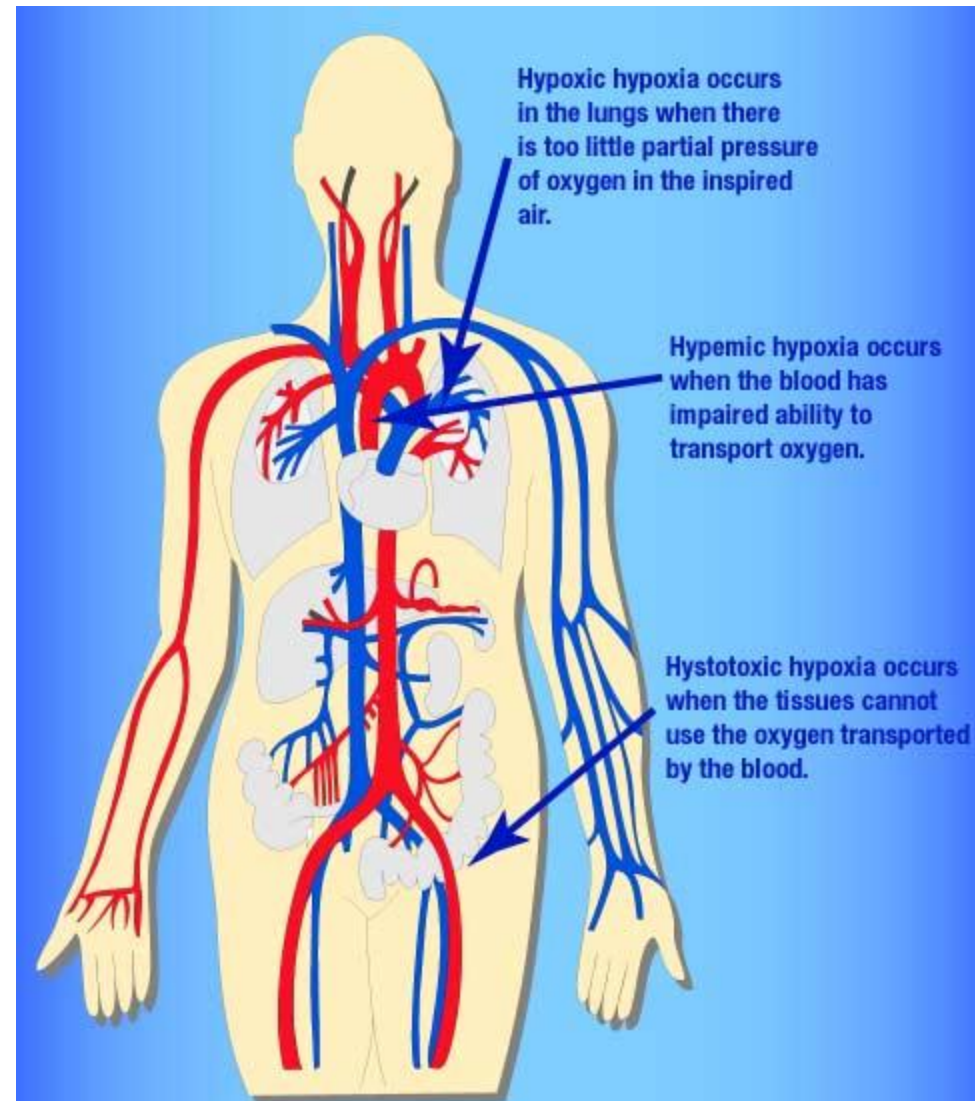
# Aviation Physiological Factors

G. White

# Hypoxia

- **Hypoxia**

- Hypoxia means “reduced oxygen” or “not enough oxygen.”
- May be Health or Environment Related
- Three Main Types



# Hypoxia Symptoms

- Cyanosis (blue fingernails and lips)
- Headache
- Decreased reaction time
- Impaired judgment
- Euphoria
- Visual impairment
- Drowsiness
- Lightheaded or dizzy sensation
- Tingling in fingers and toes
- Numbness

# Altitude

- Effects can begin as low as 3,000' or less depending on your medical condition.

| Altitude        | Time of Useful Consciousness |
|-----------------|------------------------------|
| 45,000 feet MSL | 9 to 15 seconds              |
| 40,000 feet MSL | 15 to 20 seconds             |
| 35,000 feet MSL | 30 to 60 seconds             |
| 30,000 feet MSL | 1 to 2 minutes               |
| 28,000 feet MSL | 2½ to 3 minutes              |
| 25,000 feet MSL | 3 to 5 minutes               |
| 22,000 feet MSL | 5 to 10 minutes              |
| 20,000 feet MSL | 30 minutes or more           |

# Causes and Types of Hypoxia

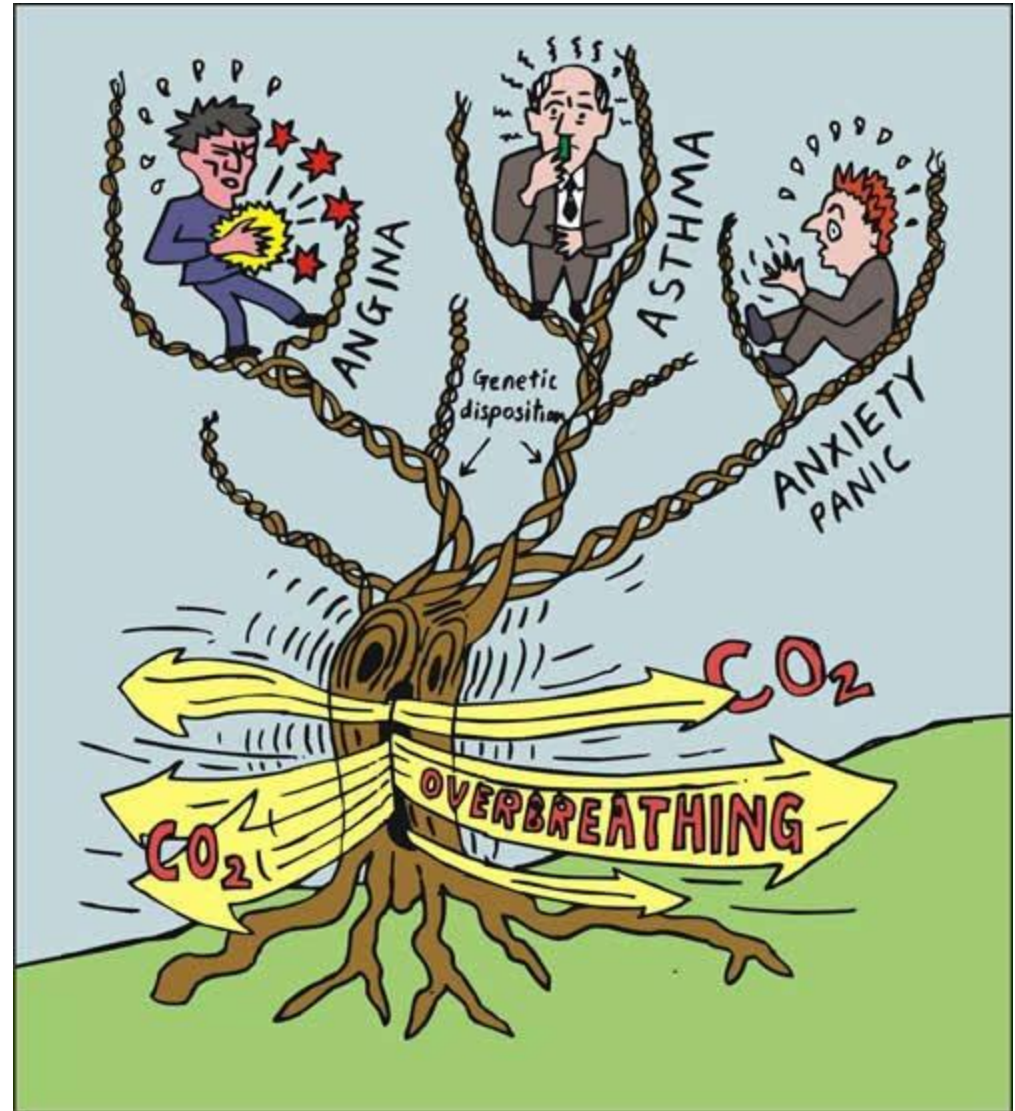
- **Hypoxic** hypoxia is a result of insufficient oxygen available to the body as a whole. **Body is deprived from sufficient oxygen – e.g., flying at altitude**
- **Hypemic** hypoxia occurs when the blood is not able to take up and transport a sufficient amount of oxygen to the cells in the body. **Usually caused by flying shortly after blood donation**

# Causes and Types (cont.)

- **Histotoxic Hypoxia** is the inability of the cells to effectively use oxygen. **Usually caused by drugs, alcohol. 1 Oz of alcohol Equates to Flying at 2,000' higher.**

# Hyperventilation

- Hyperventilation is the excessive rate and depth of respiration leading to abnormal loss of carbon dioxide from the blood.



# Common Aviation Causes

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



# Hyperventilation Symptoms

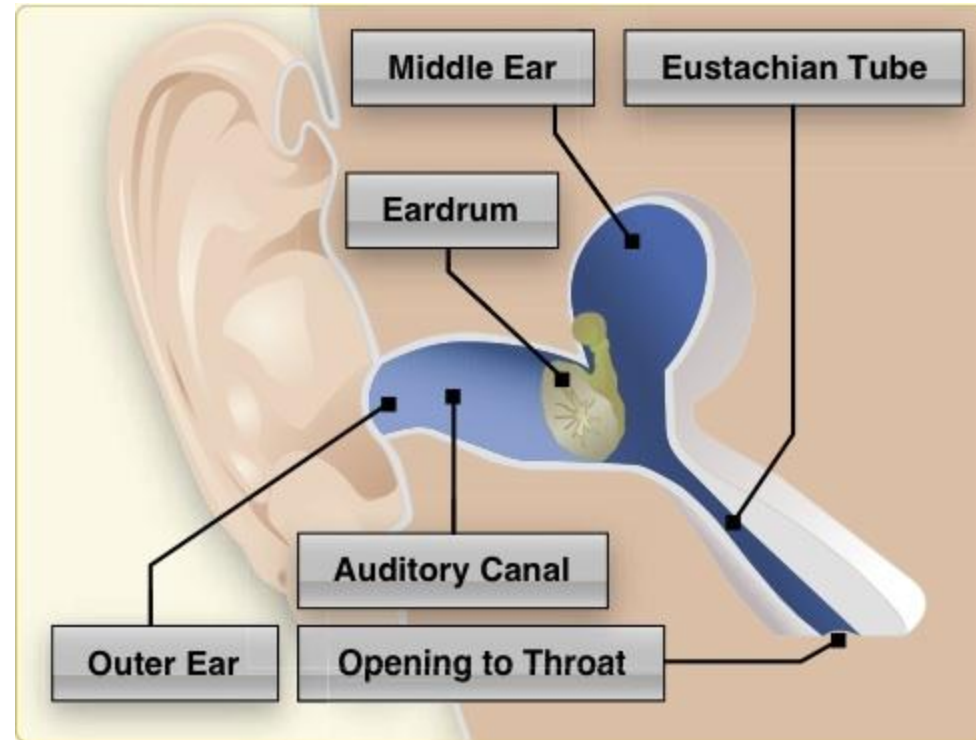
- Visual impairment
- Unconsciousness
- Lightheaded or dizzy sensation
- Tingling sensations
- Hot and cold sensations
- Muscle spasms

Symptoms Similar to Hypoxia – Can Reduce Breathing Rate By Breathing into Paper Bag – Also Talking Aloud Helps Reduce Breathing Rate



# Middle Ear, Sinus, Etc.

- During climbs and descents, the free gas formerly present in various body cavities expands due to a difference between the pressure of the air outside the body and that of the air inside the body. If the escape of the expanded gas is impeded, pressure builds up within the cavity and pain is experienced. Trapped gas expansion accounts for ear pain and sinus pain, as well as a temporary reduction in the ability to hear.

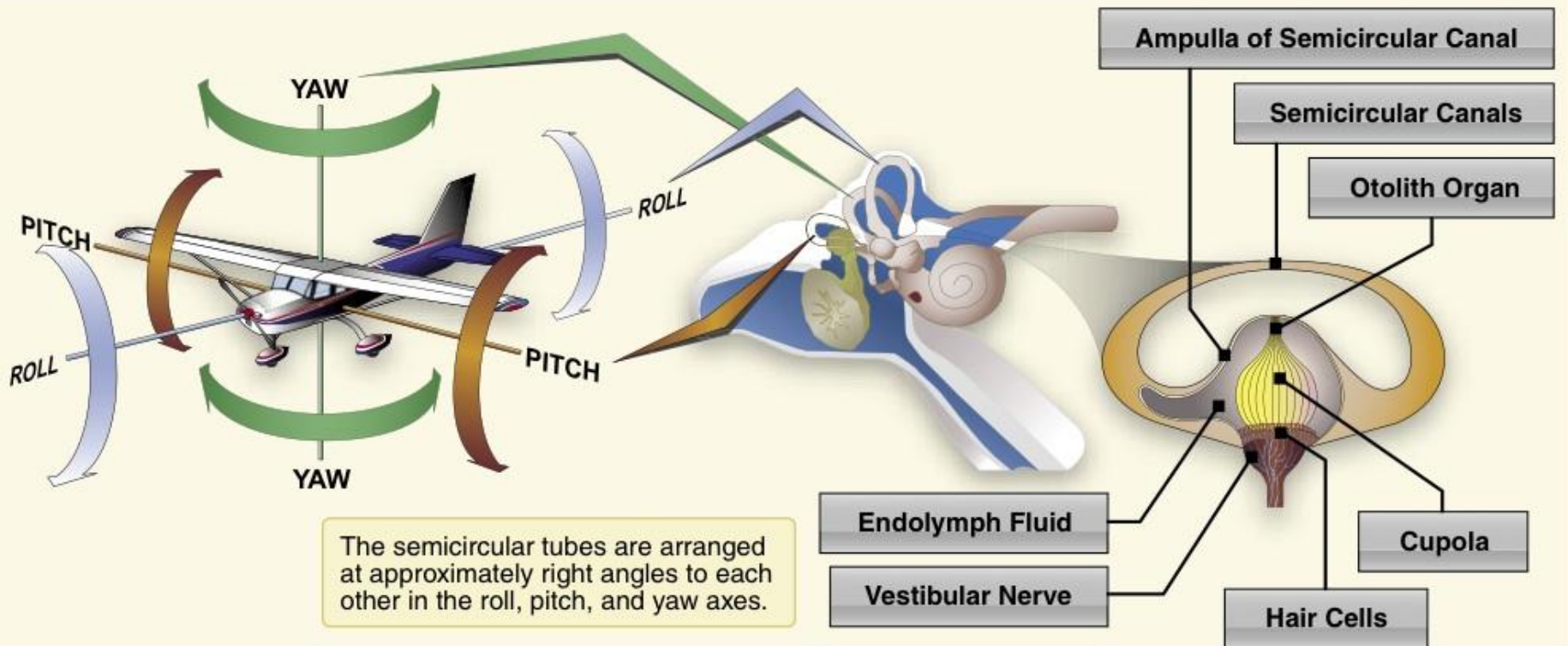


# Spatial Disorders and Illusions

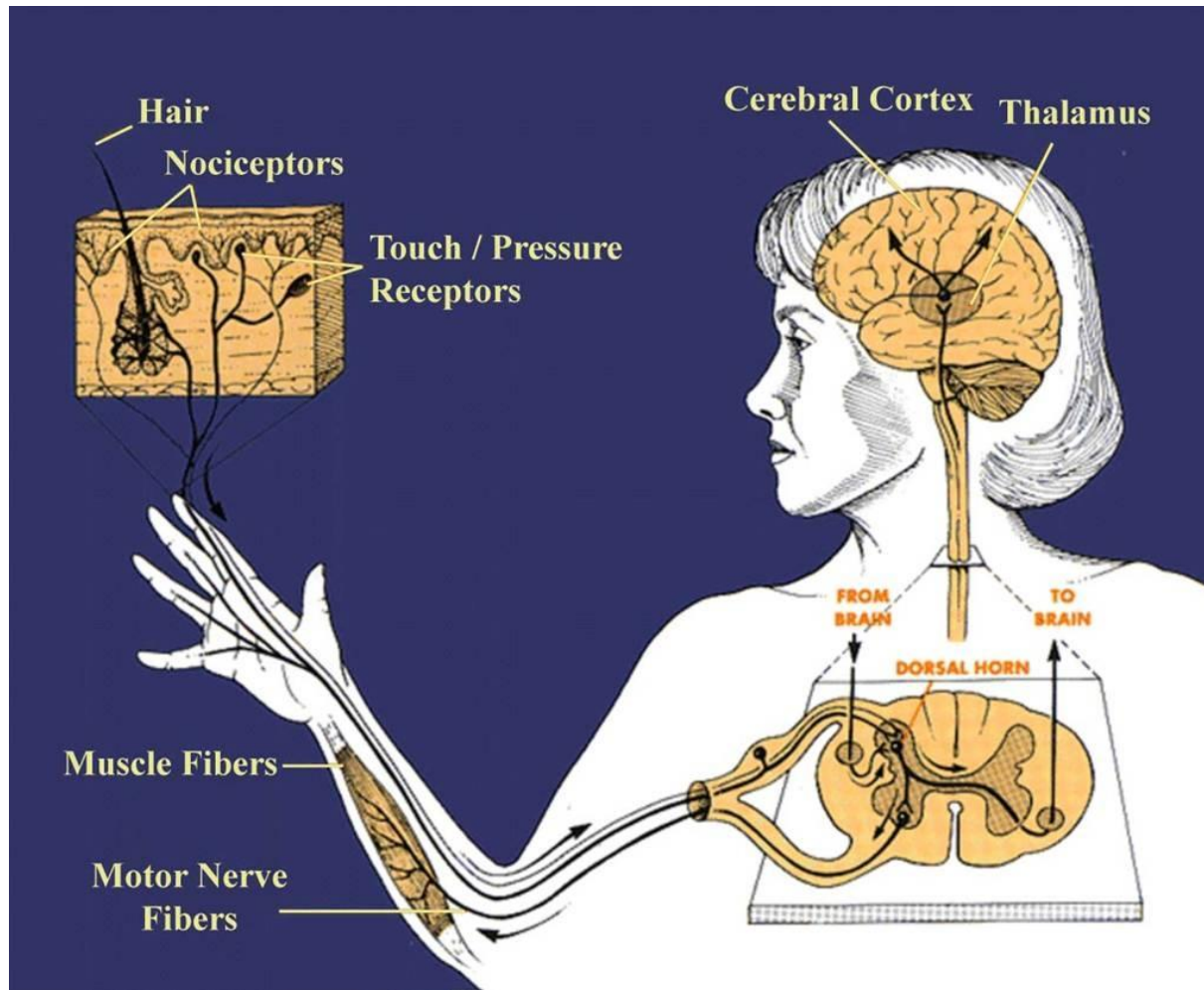
- Spatial disorientation specifically refers to the lack of orientation with regard to the position, attitude, or movement of the airplane in space. The body uses three integrated systems working together to ascertain orientation and movement in space.
  - Vestibular system—organs found in the inner ear that sense position by the way we are balanced.
  - Somatosensory system—nerves in the skin, muscles, and joints, which, along with hearing, sense position based on gravity, feeling, and sound.
  - Visual system—eyes, which sense position based on what is seen.

# Spatial Disorders and Illusions (cont.)

## Vestibular System

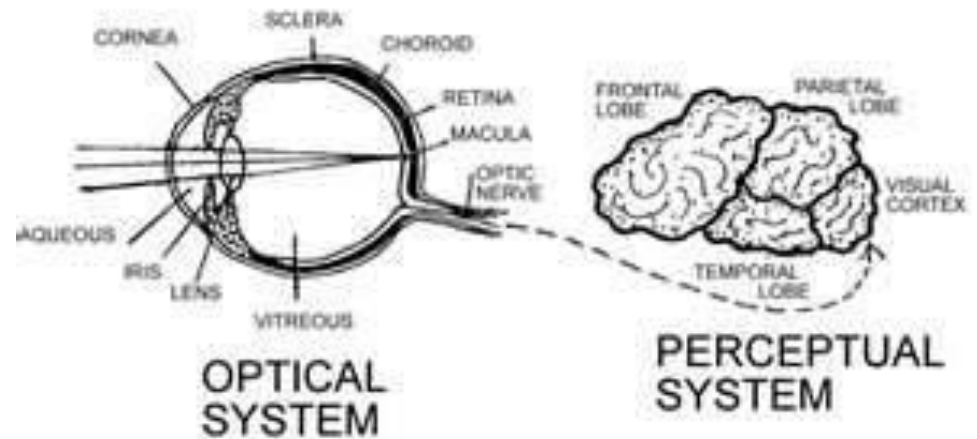


# Somatosensory System



# Visual System

- One Might Think the Visual System is Foolproof – Guess Again
- Visual Illusions Have Caused Many Accidents

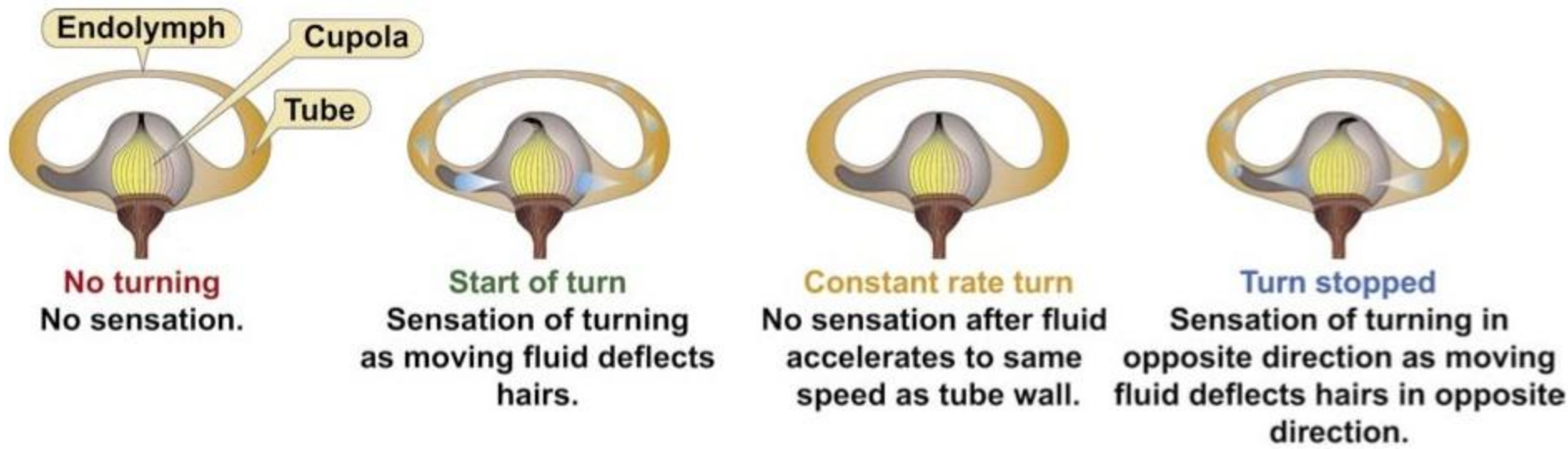


# Illusions

- Vestibular Illusions

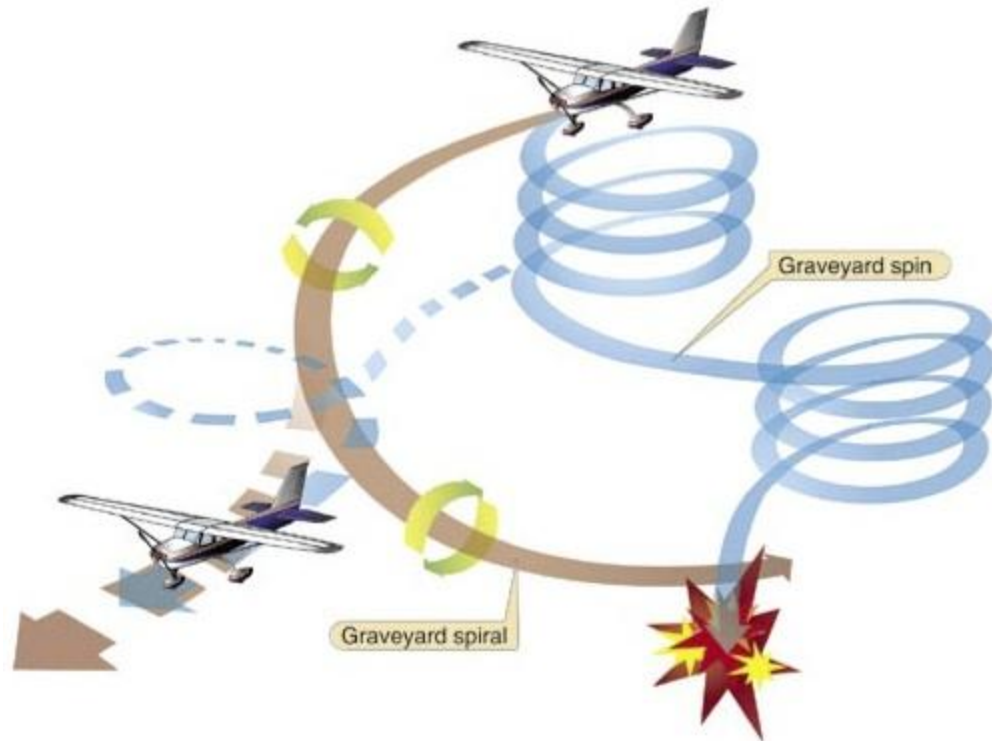
- Leans

- Caused By Holding Coordinated Turn and Allowing Vestibular Fluid to Believe You Are Straight and Level



# Graveyard Spiral

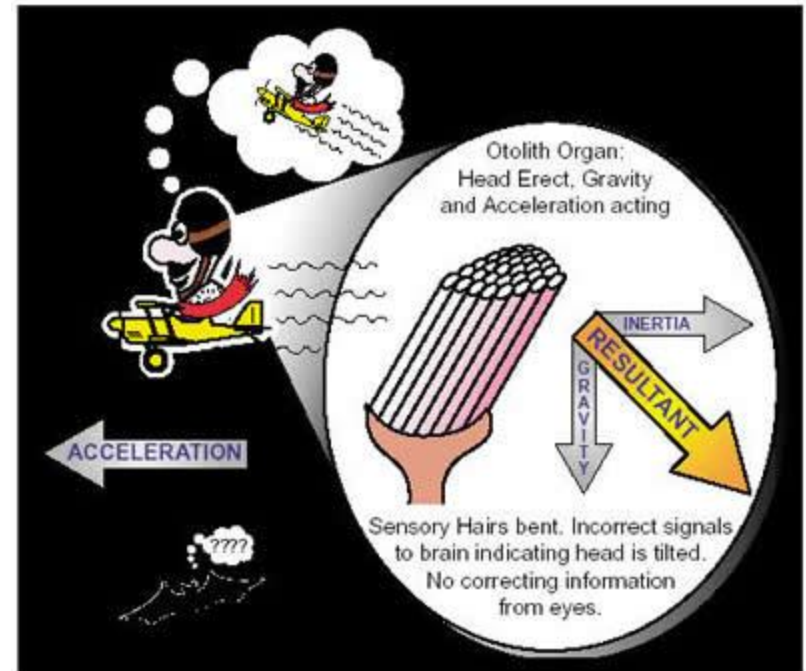
- Extension of Leans
- As in other illusions, a pilot in a prolonged coordinated, constant-rate turn, will have the illusion of not turning. During the recovery to level flight, the pilot will experience the sensation of turning in the opposite direction. The disoriented pilot may return the aircraft to its original turn. Because an aircraft tends to lose altitude in turns unless the pilot compensates for the loss in lift, the pilot may notice a loss of altitude. The absence of any sensation of turning creates the illusion of being in a level descent. The pilot may pull back on the controls in an attempt to climb or stop the descent. This action tightens the spiral and increases the loss of altitude; this illusion is referred to as a graveyard spiral





# Somatogravic Illusion

- Acceleration Illusion
- Remember, Vestibular System is Part of Somatogravic System
- Any External Force, Without Visual Frame of Reference Can Cause an Illusion
- Updraft Can Create an 'Elevator Illusion'



# False Sense if Not Correlated With Visual Cues



Level



Coordinated turn



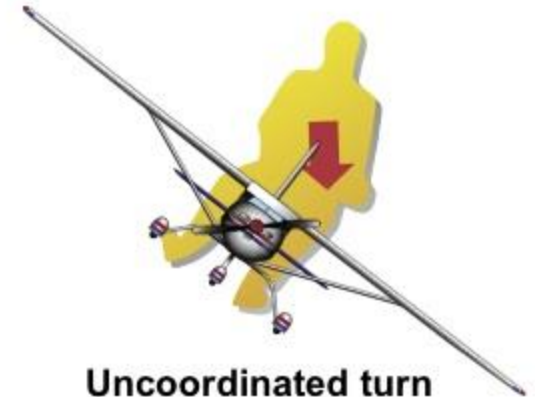
Pull out



Level skid



Forward slip



Uncoordinated turn

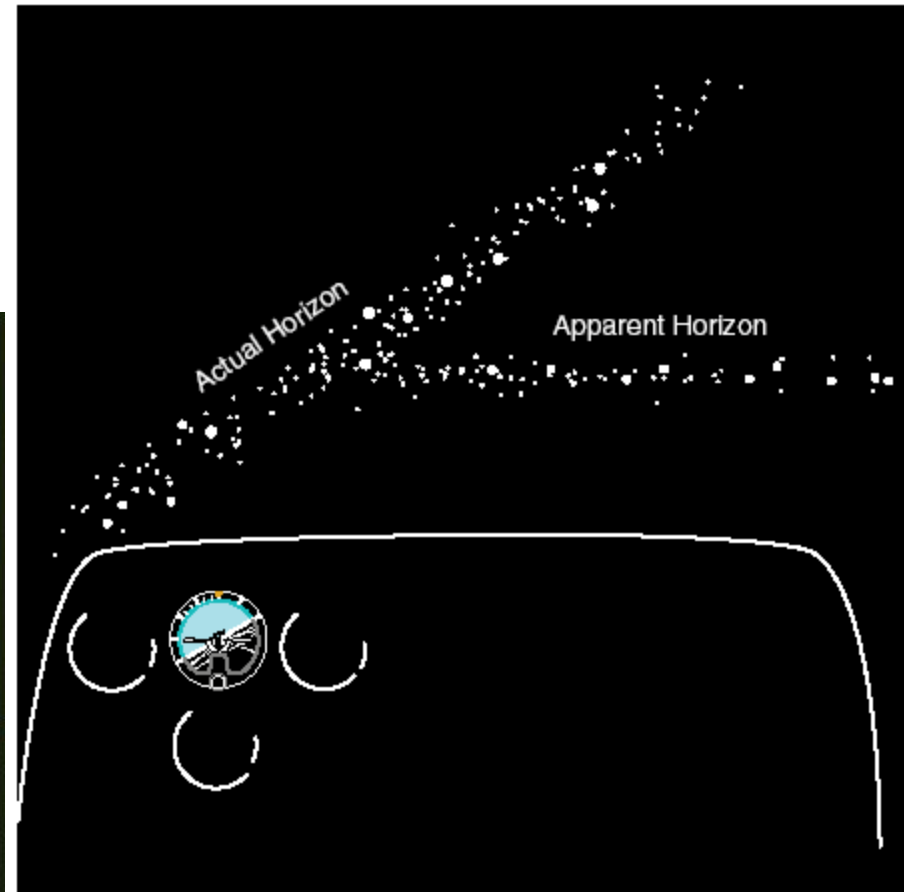
**Skid, slip, and uncoordinated turns feel similar.  
Pilots feel they are being forced sideways in their seat.**

# Visual Illusions

- Visual illusions are especially hazardous because pilots rely on their eyes for correct information.
- Two illusions that lead to spatial disorientation, false horizon and autokinesis, are concerned with only the visual system.

# False Horizon

- Sloping Cloud Formation
- Ground Lights and Patterns
- Stars
- Haze and Clouds



# Autokinesis

- In the Dark, Staring at a Steady Light May Appear to Move

# Optical Illusions

- Of the senses, vision is the most important for safe flight.
- However, various terrain features and atmospheric conditions can create optical illusions.

# Runway Width Illusion

- More Insidious at Night

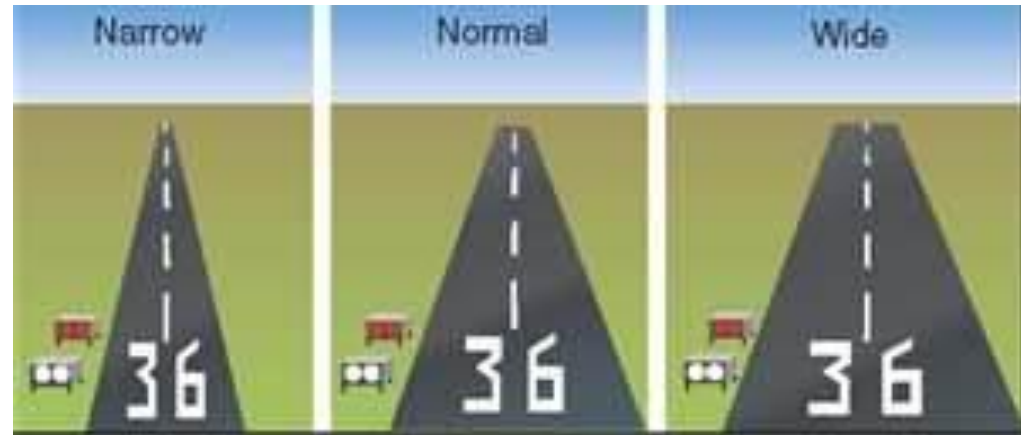


Figure 15-4. Runway Illusions.

# Runway Slope Illusion



Figure 1-9B  
Runway slope illusion

- 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.



- Normal approach
- Approach due to illusion



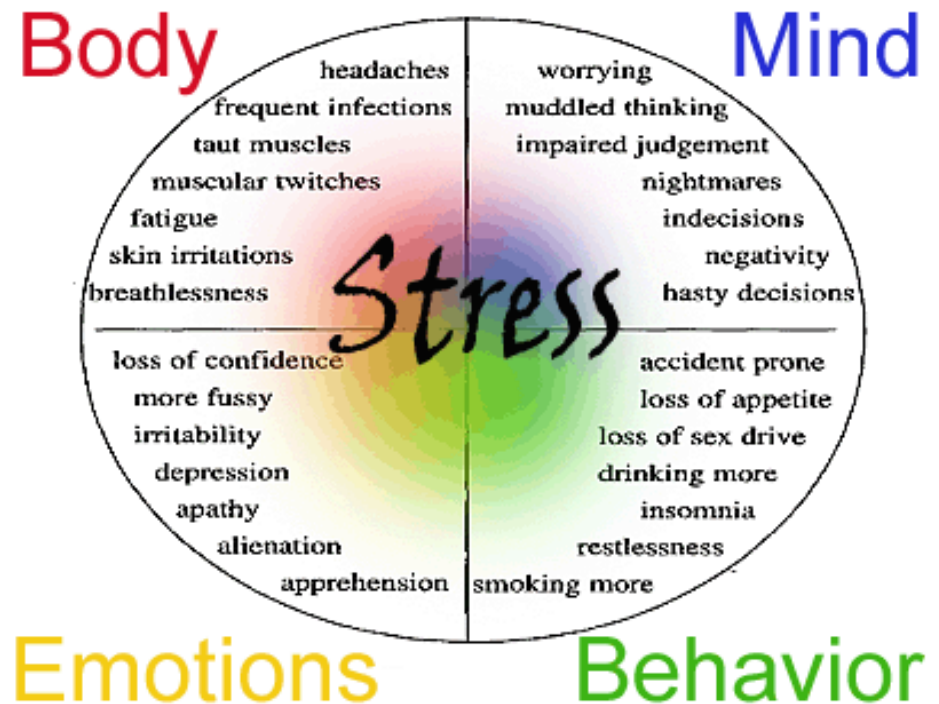
# Carbon Monoxide Poisoning

CO is a colorless and odorless gas produced by all internal combustion engines. Attaching itself to the hemoglobin in the blood about 200 times more easily than oxygen, CO prevents the hemoglobin from carrying oxygen to the cells, resulting in hypemic hypoxia. The body requires up to 48 hours to dispose of CO. If severe enough, the CO poisoning can result in death. Aircraft heater vents and defrost vents may provide CO a passageway into the cabin, particularly if the engine exhaust system has a leak or is damaged. If a strong odor of exhaust gases is detected, assume that CO is present. However, CO may be present in dangerous amounts even if no exhaust odor is detected. Disposable, inexpensive CO detectors are widely available. In the presence of CO, these detectors change color to alert the pilot of the presence of CO. Some effects of CO poisoning are headache, blurred vision, dizziness, drowsiness, and/or loss of muscle power. Any time a pilot smells exhaust odor, or any time that these symptoms are experienced, immediate corrective actions should be taken. These include turning off the heater, opening fresh air vents and windows, and using supplemental oxygen, if available.

Tobacco smoke also causes CO poisoning. Smoking at sea level can raise the CO concentration in the blood and result in physiological effects similar to flying at 8,000 feet. Besides hypoxia, tobacco causes diseases and physiological debilitation that are medically disqualifying for pilots.

# Stress

- Both Short Term and Long Term (Chronic)
- Stress, Especially Chronic, Can Impair Judgment, Ability to Perform



# Fatigue

- Fatigue is frequently associated with pilot error.
- Some of the effects of fatigue include degradation of attention and concentration, impaired coordination, and decreased ability to communicate.

# Fatigue (cont.)

- FAA and NTSB Giving More Attention to This Issue



# Dehydration and Heatstroke

- Dehydration Leads to Fatigue, Physical, and Diminished Mental Abilities
- Stay Hydrated
  - Two to Four Qts / 24 hours
- Heatstroke
  - Inability to Control Body Temp
  - May Lead to Collapse and/or Death



# Motion Sickness

- Motion sickness, or airsickness, is caused by the brain receiving conflicting messages about the state of the body. A pilot may experience motion sickness during initial flights, but it generally goes away within the first few lessons. Anxiety and stress, which may be experienced at the beginning of flight training, can contribute to motion sickness.



# Alcohol

## Blood Alcohol Content %

**8 Hours – Bottle to Throttle  
No More than .04% Blood  
Alcohol Content**

| Type Beverage   | Typical Serving (oz) | Pure Alcohol Content (oz) |
|-----------------|----------------------|---------------------------|
| Table Wine      | 4.0                  | .48                       |
| Light Beer      | 12.0                 | .48                       |
| Aperitif Liquor | 1.5                  | .38                       |
| Champagne       | 4.0                  | .48                       |
| Vodka           | 1.0                  | .50                       |
| Whiskey         | 1.25                 | .50                       |

|                            |  |
|----------------------------|--|
| 0.01–0.05<br>(10–50 mg%)   | average individual appears normal  |
| 0.03–0.12*<br>(30–120 mg%) | mild euphoria, talkativeness, decreased inhibitions, decreased attention, impaired judgment, increased reaction time                               |
| 0.09–0.25<br>(90–250 mg%)  | emotional instability, loss of critical judgment, impairment of memory and comprehension, decreased sensory response, mild muscular incoordination |

|                            |   |
|----------------------------|---|
| 0.18–0.30<br>(180–300 mg%) | confusion, dizziness, exaggerated emotions (anger, fear, grief) impaired visual perception, decreased pain sensation, impaired balance, staggering gait, slurred speech, moderate muscular incoordination |
| 0.27–0.40<br>(270–400 mg%) | apathy, impaired consciousness, stupor, significantly decreased response to stimulation, severe muscular incoordination, inability to stand or walk, vomiting, incontinence of urine and feces            |
| 0.35–0.50<br>(350–500 mg%) | unconsciousness, depressed or abolished reflexes, abnormal body temperature, coma; possible death from respiratory paralysis (450 mg% or above)   |

# Alcohol (cont.)

- While experiencing a hangover, a pilot is still under the influence of alcohol. Although a pilot may think he or she is functioning normally, motor and mental response impairment is still present. Considerable amounts of alcohol can remain in the body for over 16 hours, so pilots should be cautious about flying too soon after drinking





# Drugs

| Psychoactive Drugs   | Range of Effects  |  | Development of Tolerance | Prolonged Use of Large Amounts   | Withdrawal Symptoms After Prolonged Use  |
|--|---|--|--------------------------|--|--|
|  | From  | To   |                          |  |  |
| <b>Alcohol</b><br>Beer<br>Wine<br>Hard Liquor  | Relaxation, lowered inhibitions, reduced intensity of physical sensations, digestive upsets, body heat loss, reduced muscular coordination. | Loss of body control, passing out (also causing physical injuries), susceptibility to pneumonia, cessation of breathing  | Moderate                 | Liver damage, ulcers, chronic diarrhea, amnesia, vomiting, brain damage, internal bleeding, debilitation | Convulsions, shakes, hallucinations, loss of memory, uncontrolled muscular spasms, psychosis |
| <b>Sedative Hypnotics</b><br><b>Barbiturates:</b><br>- Nembutal<br>- Phenobarbital<br>- Seconal<br><b>Tranquilizers:</b><br>- Valium<br>- Librium<br>- Quaaludes | Relaxation, lowered inhibitions, reduced intensity of physical sensations, digestive upsets, body heat loss, reduced muscular coordination  | Passing out, loss of body control, stupor, severe depression of respiration, possible death (Effects are exaggerated when used in combination with alcohol— synergistic effect.) | Moderate                 | Amnesia, confusion, drowsiness, personality changes  |  |

- Check With AME for any Prescription or Over-the-Counter Meds You are Using Before Flying

# Drugs (cont.)

|              |   |  |   |          |  |  |
|--------------|---|--|---|----------|--|--|
| Opiates      | Opium<br>Morphine<br>Heroin<br>Codeine<br>Dilaudid<br>Percodan<br>Darvon<br>Methadone | Suppression of pain, lowered blood pressure and respiratory rate, constipation, disruption of menstrual cycle, hallucinations, sleep | Clammy skin, convulsions, coma, respiratory depression, possible death  | High     | Depressed sexual drive, lethargy, general physical debilitation, infections, hepatitis | Watery eyes, runny nose, severe back pains, stomach cramps, sleeplessness, nausea, diarrhea, sweating, muscle spasms |
| Stimulants   | Dexedrine<br>Methamphetamine<br>Diet Pills<br>Ritalin<br>Cocaine<br>Caffeine          | Increased blood pressure and pulse rate, appetite loss, increased alertness, dilated and dried out bronchi, restlessness, insomnia   | Paranoid reaction, temporary psychosis, irritability, convulsions, palpitations (not generally true for caffeine)                             | High     | Psychosis, insomnia, paranoia, nervous system damage (not generally true for caffeine) | Severe depression, both physical and mental (not true for caffeine)  |
| Psychedelics | LSD<br>Mescaline<br>Psilocybin<br>PCP   | Distorted perceptions, hallucinations, confusion, vomiting   | Psychosis, hallucinations, vomiting, anxiety, panic, stupor. With PCP: Aggressive behavior, catatonia, convulsions, coma, high blood pressure | High     | Psychosis, continued hallucinations, mental disruption                                 | Occasional flashback phenomena, depression   |
| THC          | Marijuana<br>Hashish  | Sedation, euphoria, increased appetite, altered mental processes   | Distorted perception, anxiety, panic  | Moderate | Amotivation (loss of drive)  | No true withdrawal symptoms except possible depression   |

# Decompression Sickness

- Decompression sickness (DCS) describes a condition characterized by a variety of symptoms resulting from exposure to low barometric pressures that cause inert gases (mainly nitrogen), normally dissolved in body fluids and tissues, to come out of physical solution and form bubbles.

# Decompression (cont.)

Whoops, Need to  
Surface, my Flight  
Leaves in 3 Hours



# Decompression (cont.)

- ***DCS After Scuba Diving***

Scuba diving subjects the body to increased pressure, which allows more nitrogen to dissolve in body tissues and fluids. The reduction of atmospheric pressure that accompanies flying can produce physical problems for scuba divers. A pilot or passenger who intends to fly after scuba diving should allow the body sufficient time to rid itself of excess nitrogen absorbed during diving. If not, DCS due to evolved gas can occur during exposure to altitude and create a serious in-flight emergency.

- The recommended waiting time before going to flight altitudes of up to 8,000 feet is at least 12 hours after diving that does not require controlled ascent (no decompression stop diving), and at least 24 hours after diving that does require controlled ascent (decompression stop diving).