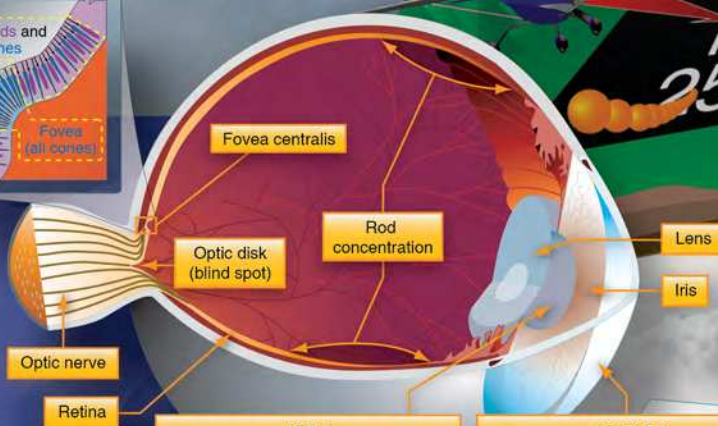
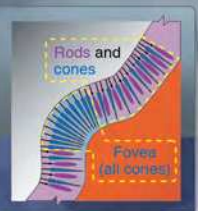


Chapter 17

Aeromedical Factors

Introduction

It is important for a pilot to be aware of the mental and physical standards required for the type of flying performed. This chapter provides information on medical certification and on a variety of aeromedical factors related to flight activities.

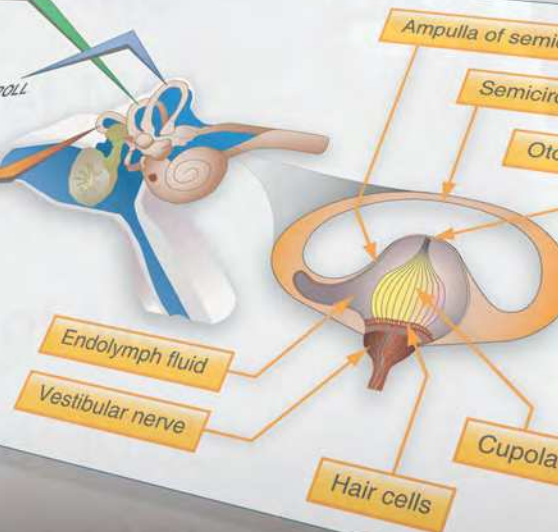


PUPIL
The **pupil** (aperture) is the opening at the center of the iris. The size of the pupil is adjusted to control the amount of light entering the eye.

CORNEA
Light passes through the **cornea** (the transparent window on the front of the eye) and then through the **lens** to focus on the retina.



The semicircular tubes are arranged at approximately right angles to each other in the roll, pitch, and yaw axes.



Obtaining a Medical Certificate

Most pilots must have a valid medical certificate to exercise the privileges of their airman certificates. Glider and free balloon pilots are not required to hold a medical certificate. Sport pilots may hold either a medical certificate or a valid state driver's license. Regardless of whether a medical certificate or driver's license is required, 14 CFR 61.53 requires every pilot not to act as a crewmember if they know, or have reason to know, of any medical condition that would make them unable to operate the aircraft in a safe manner.

Acquisition of a medical certificate requires an examination by an aviation medical examiner (AME), a physician with training in aviation medicine designated by the Civil Aerospace Medical Institute (CAMI). There are three classes of medical certificates. The class of certificate needed depends on the type of flying the pilot plans to perform.

A third-class medical certificate is required for a private or recreational pilot certificate. It is valid for 5 years for those individuals who have not reached the age of 40; otherwise it is valid for 2 years. A commercial pilot certificate requires at least a second-class medical certificate, which is valid for 1 year. First-class medical certificates are required for airline transport pilots and are valid for one year if the airman is 40 or younger; 40 and older it is valid for 6 months.

The standards are more rigorous for the higher classes of certificates. A pilot with a higher class medical certificate has met the requirements for the lower classes as well. Since the required medical class applies only when exercising the privileges of the pilot certificate for which it is required, a first-class medical certificate would be valid for 1 year if exercising the privileges of a commercial certificate and 2 or 5 years, as appropriate, for exercising the privileges of a private or recreational certificate. The same applies for a second-class medical certificate. The standards for medical certification are contained in Title 14 of the Code of Federal Regulations (14 CFR) part 67 and the requirements for obtaining medical certificates can be found in 14 CFR part 61.

Students who have physical limitations, such as impaired vision, loss of a limb, or hearing impairment may be issued a medical certificate valid for "student pilot privileges only" while learning to fly. Pilots with disabilities may require special equipment to be installed in the aircraft, such as hand controls for pilots with paraplegia. Some disabilities necessitate a limitation on the individual's certificate; for example, impaired hearing would require the limitation "not valid for flight requiring the use of radio." When all the knowledge, experience, and proficiency requirements have been met and a student can demonstrate the ability to operate the aircraft with the normal level of safety, a "statement of

demonstrated ability" (SODA) can be issued. This waiver, or SODA, is valid as long as the physical impairment does not worsen. Contact the local Flight Standards District Office (FSDO) for more information on this subject.

The FAA medical standards, 14 CFR part 67, specify fifteen medical conditions that are considered disqualifying by "history or clinical diagnosis." Regardless of when one of these conditions was diagnosed and treated, an airman may not be issued a medical certificate except through a process called a "Special Issuance Authorization," as explained in 14 CFR part 67, section 67.401. A special issuance is a discretionary issuance by the FAA Federal Air Surgeon and requires satisfactory completion of special testing determined by the FAA to demonstrate that an airman is safe to fly for the duration of the medical certificate issued. The specific disqualifying conditions include:

- Diabetes mellitus requiring oral hypoglycemic medication or insulin
- Angina pectoris
- Coronary heart disease that has been treated or, if untreated, that has been symptomatic or clinically significant
- Myocardial infarction
- Cardiac valve replacement
- Permanent cardiac pacemaker
- Heart replacement
- Psychosis
- Bipolar disorder
- Personality disorder that is severe enough to have repeatedly manifested itself by overt acts
- Substance dependence (including alcohol)
- Substance abuse
- Epilepsy
- Disturbance of consciousness and without satisfactory explanation of cause
- Transient loss of control of nervous system function(s) without satisfactory explanation of cause

However, this list includes only the mandatory disqualifying conditions. There are many other medical conditions that fall into the General Medical Condition section of the regulations that are considered by the FAA to be disqualifying even though they are not stated in the regulations. Conditions such as cancer, kidney stones, neurologic and neuromuscular conditions including Parkinson's disease and multiple sclerosis, certain blood disorders, and other conditions that

may progress over time require review by the FAA before a medical certificate may be issued.

The important thing to remember is that with very few exceptions, all disqualifying medical conditions may be considered for special issuance. If you can present satisfactory medical documentation to the FAA that your condition is stable, the chances are good that you will be able to qualify for an Authorization.

Health and Physiological Factors Affecting Pilot Performance

A number of health factors and physiological effects can be linked to flying. Some are minor, while others are important enough to require special attention to ensure safety of flight. In some cases, physiological factors can lead to inflight emergencies. Some important medical factors that a pilot should be aware of include hypoxia, hyperventilation, middle ear and sinus problems, spatial disorientation, motion sickness, carbon monoxide (CO) poisoning, stress and fatigue, dehydration, and heatstroke. Other subjects include the effects of alcohol and drugs, anxiety, and excess nitrogen in the blood after scuba diving.

Hypoxia

Hypoxia means “reduced oxygen” or “not enough oxygen.” Although any tissue will die if deprived of oxygen long enough, the greatest concern regarding hypoxia during flight is lack of oxygen to the brain, since it is particularly vulnerable to oxygen deprivation. Any reduction in mental function while flying can result in life-threatening errors. Hypoxia can be caused by several factors, including an insufficient supply of oxygen, inadequate transportation of oxygen, or the inability of the body tissues to use oxygen. The forms of hypoxia are based on their causes:

- Hypoxic hypoxia
- Hypemic hypoxia
- Stagnant hypoxia
- Histotoxic hypoxia

Hypoxic Hypoxia

Hypoxic hypoxia is a result of insufficient oxygen available to the body as a whole. A blocked airway and drowning are obvious examples of how the lungs can be deprived of oxygen, but the reduction in partial pressure of oxygen at high altitude is an appropriate example for pilots. Although the percentage of oxygen in the atmosphere is constant, its partial pressure decreases proportionately as atmospheric pressure decreases. As an aircraft ascends during flight, the percentage of each gas in the atmosphere remains the same, but there are fewer molecules available at the pressure required for them

to pass between the membranes in the respiratory system. This decrease in number of oxygen molecules at sufficient pressure can lead to hypoxic hypoxia.

Dangers of Transporting Dry Ice

Sublimation is a process in which a substance transitions from a solid to a gaseous state without passing through an intermediate liquid state. Dry ice sublimates into large quantities of CO₂ gas, which can rapidly displace oxygen-containing air and potentially cause hypoxia via carbon dioxide intoxication. Case studies have shown that both illness and death can be caused by occupational and/or unintentional exposure when transporting dry ice in small, confined spaces such as a flightdeck or airplane. Exposure to high concentration of CO₂ gas may lead to increased respiration, tachycardia, cardiac arrhythmia, and unconsciousness. Exposure to concentration of CO₂ gas in excess of 10 percent may cause convulsions, coma, and/or death.

The tendency of dry ice to rapidly sublime also means that without proper ventilation, it can rapidly pressurize. For this reason, dry ice should never be placed inside a sealed transport container (i.e., leak-proof secondary container) and must be placed within an outer shipping container or storage container that allows adequate ventilation to release the CO₂ gas and avoid pressurization. Sealing dry ice within a leak-proof container may result in explosion of the container potentially leading to serious physical injury or death.

Hypemic Hypoxia

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. Hypemic means “not enough blood.” This type of hypoxia is a result of oxygen deficiency in the blood, rather than a lack of inhaled oxygen, and can be caused by a variety of factors. It may be due to reduced blood volume (from severe bleeding), or it may result from certain blood diseases, such as anemia. More often, hypemic hypoxia occurs because hemoglobin, the actual blood molecule that transports oxygen, is chemically unable to bind oxygen molecules. The most common form of hypemic hypoxia is CO poisoning. This is explained in greater detail later in this chapter. Hypemic hypoxia can also be caused by the loss of blood due to blood donation. Blood volume can require several weeks to return to normal following a donation. Although the effects of the blood loss are slight at ground level, there are risks when flying during this time.

Stagnant Hypoxia

Stagnant means “not flowing,” and stagnant hypoxia or ischemia results when the oxygen-rich blood in the lungs is not moving, for one reason or another, to the tissues that

need it. An arm or leg “going to sleep” because the blood flow has accidentally been shut off is one form of stagnant hypoxia. This kind of hypoxia can also result from shock, the heart failing to pump blood effectively, or a constricted artery. During flight, stagnant hypoxia can occur with excessive acceleration of gravity (Gs). Cold temperatures can also reduce circulation and decrease the blood supplied to extremities.

Histotoxic Hypoxia

The inability of the cells to effectively use oxygen is defined as histotoxic hypoxia. “Histo” refers to tissues or cells, and “toxic” means poisonous. In this case, enough oxygen is being transported to the cells that need it, but they are unable to make use of it. This impairment of cellular respiration can be caused by alcohol and other drugs, such as narcotics and poisons. Research has shown that drinking one ounce of alcohol can equate to an additional 2,000 feet of physiological altitude.

Symptoms of Hypoxia

High-altitude flying can place a pilot in danger of becoming hypoxic. Oxygen starvation causes the brain and other vital organs to become impaired. The first symptoms of hypoxia can include euphoria and a carefree feeling. With increased oxygen starvation, the extremities become less responsive and flying becomes less coordinated. The symptoms of hypoxia vary with the individual, but common symptoms include:

- Cyanosis (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

As hypoxia worsens, the field of vision begins to narrow and instrument interpretation can become difficult. Even with all these symptoms, the effects of hypoxia can cause a pilot to have a false sense of security and be deceived into believing everything is normal.

Treatment of Hypoxia

Treatment for hypoxia includes flying at lower altitudes and/or using supplemental oxygen. All pilots are susceptible to the effects of oxygen starvation, regardless of physical

endurance or acclimatization. When flying at high altitudes, it is paramount that oxygen be used to avoid the effects of hypoxia. The term “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. As altitude increases above 10,000 feet, the symptoms of hypoxia increase in severity, and the time of useful consciousness rapidly decreases. [Figure 17-1] Since symptoms of hypoxia can be different for each individual, the ability to recognize hypoxia can be greatly improved by experiencing and witnessing the effects of it during an altitude chamber “flight.” The Federal Aviation Administration (FAA) provides this opportunity through aviation physiology training, which is conducted at the FAA CAMI in Oklahoma City, Oklahoma, and at many military facilities across the United States. For information about the FAA’s one-day physiological training course with altitude chamber and vertigo demonstrations, visit the FAA website at www.faa.gov.

Hyperventilation

Hyperventilation is the excessive rate and depth of respiration leading to abnormal loss of carbon dioxide from the blood. This condition occurs more often among pilots than is generally recognized. It seldom incapacitates completely, but it causes disturbing symptoms that can alarm the uninformed pilot. In such cases, increased breathing rate and anxiety further aggravate the problem. Hyperventilation can lead to unconsciousness due to the respiratory system’s overriding mechanism to regain control of breathing.

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.

Since many of the symptoms of hyperventilation are similar to those of hypoxia, it is important to correctly diagnose and treat the proper condition. If using supplemental oxygen, check the equipment and flow rate to ensure the symptoms are

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

Figure 17-1. *Time of useful consciousness.*

not hypoxia related. Common symptoms of hyperventilation include:

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

The treatment for hyperventilation involves restoring the proper carbon dioxide level in the body. Breathing normally is both the best prevention and the best cure for hyperventilation. In addition to slowing the breathing rate, breathing into a paper bag or talking aloud helps to overcome hyperventilation. Recovery is usually rapid once the breathing rate is returned to normal.

Middle Ear and Sinus Problems

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.

The middle ear is a small cavity located in the bone of the skull. It is closed off from the external ear canal by the eardrum. Normally, 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. These tubes are usually closed but open during chewing, yawning, or swallowing to equalize pressure. Even a slight difference between external pressure and middle ear pressure can cause discomfort. [Figure 17-2]

During a climb, middle ear air pressure may exceed the pressure of the air in the external ear canal causing the eardrum to bulge outward. Pilots become aware of this pressure change when they experience alternate sensations of “fullness” and “clearing.” During 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. This results in the higher outside pressure causing the eardrum to bulge inward.

This condition can be more difficult to relieve due to the fact that the partial vacuum tends to constrict the walls of the Eustachian tube. To remedy this often painful condition, which also causes a temporary reduction in hearing

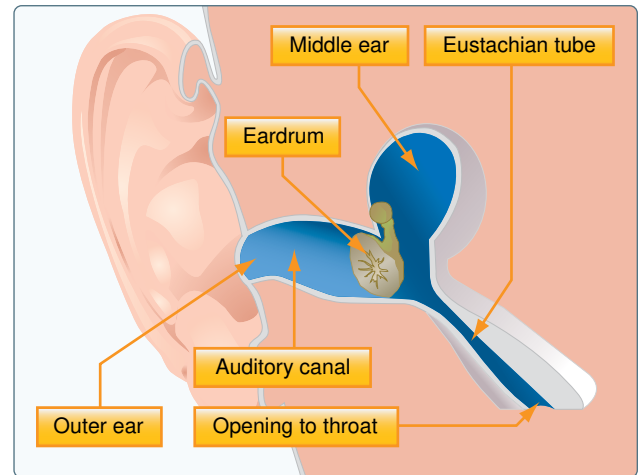


Figure 17-2. The Eustachian tube allows air pressure to equalize in the middle ear.

sensitivity, pinch the nostrils shut, close the mouth and lips, and blow slowly and gently into the mouth and nose.

This procedure 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. A flight in this condition can be extremely painful, as well as damaging to the eardrums. If experiencing minor congestion, nose drops or nasal sprays may reduce the risk of a painful ear blockage. Before using any medication, check with an AME to ensure that it will not affect the ability to fly.

In a similar way, air pressure in the sinuses equalizes with the pressure in the flight deck through small openings that connect the sinuses to the nasal passages. An upper respiratory infection, such as a cold or sinusitis, or a nasal allergic condition can produce enough congestion around an opening to slow equalization. As the difference in pressure between the sinuses and the flight deck increases, congestion may plug the opening. This “sinus block” occurs most frequently during descent. Slow descent rates can reduce the associated pain. A sinus block can occur in the frontal sinuses, located above each eyebrow, or in the maxillary sinuses, located in each upper cheek. It usually produces excruciating pain over the sinus area. A maxillary sinus block can also make the upper teeth ache. Bloody mucus may discharge from the nasal passages.

Sinus block can be avoided by not flying with an upper respiratory infection or nasal allergic condition. Adequate protection is usually not provided by decongestant sprays or drops to reduce congestion around the sinus openings. Oral decongestants have side effects that can impair pilot performance. If a sinus block does not clear shortly after landing, a physician should be consulted.

Spatial Disorientation 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 that work 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 that, along with hearing, sense position based on gravity, feeling, and sound
- Visual system—eyes, which sense position based on what is seen

All this information 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. Flying can sometimes cause these systems to supply conflicting information to the brain, which can lead to disorientation. During flight in visual meteorological conditions (VMC), the eyes are the major orientation source and usually prevail over false sensations from other sensory systems. When these visual cues are removed, as they are in instrument meteorological conditions (IMC), false sensations can cause a pilot to quickly become disoriented.

The vestibular system in the inner ear allows the pilot to sense movement and determine orientation in the surrounding environment. In both the left and right inner ear, three semicircular canals are positioned at approximate right angles to each other. [Figure 17-3] Each canal is filled with fluid and has a section full of fine hairs. Acceleration of the inner

ear in any direction causes the tiny hairs to deflect, which in turn stimulates nerve impulses, sending messages to the brain. The vestibular nerve transmits the impulses from the utricle, saccule, and semicircular canals to the brain to interpret motion.

The somatosensory system sends signals from the skin, joints, and muscles to the brain that are interpreted in relation to the Earth's gravitational pull. These signals determine posture. Inputs from each movement update the body's position to the brain on a constant basis. "Seat of the pants" flying is largely dependent upon these signals. Used in conjunction with visual and vestibular clues, these sensations can be fairly reliable. However, the body cannot distinguish between acceleration forces due to gravity and those resulting from maneuvering the aircraft, which can lead to sensory illusions and false impressions of an aircraft's orientation and movement.

Under normal flight conditions, when there is a visual reference to the horizon and ground, the sensory system in the inner ear helps to identify the pitch, roll, and yaw movements of the aircraft. When visual contact with the horizon is lost, the vestibular system becomes unreliable. Without visual references outside the aircraft, there are many situations in which combinations of normal motions and forces create convincing illusions that are difficult to overcome.

Prevention is usually the best remedy for spatial disorientation. Unless a pilot has many hours of training in instrument flight, flight should be avoided in reduced visibility or at night when the horizon is not visible. A pilot can reduce susceptibility to disorienting illusions through training and awareness and learning to rely totally on flight instruments.

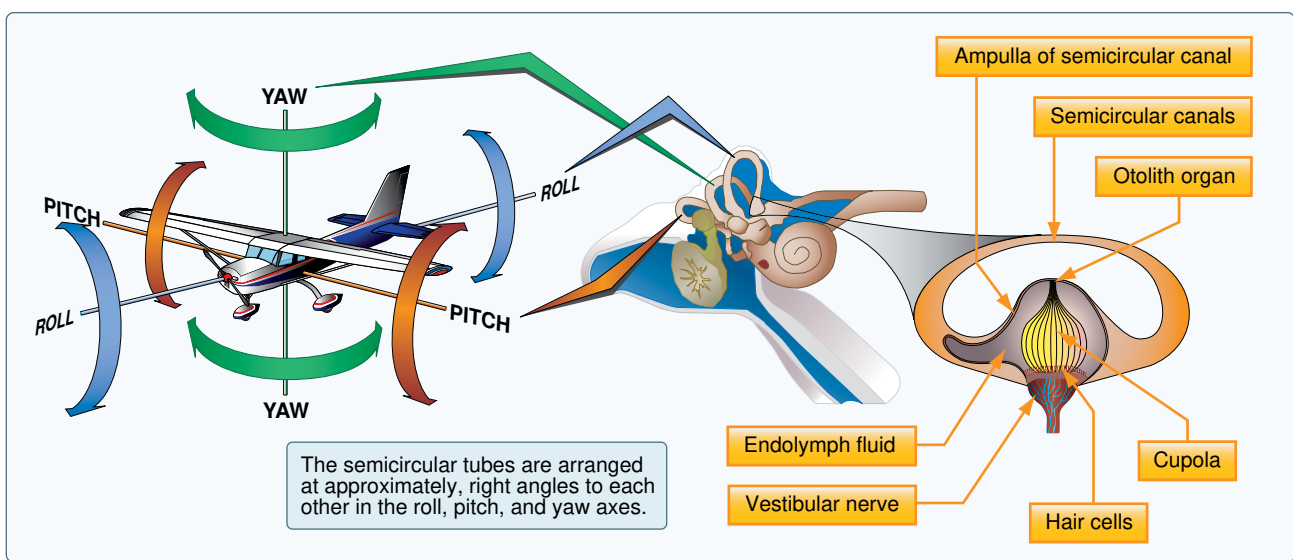


Figure 17-3. The semicircular canals lie in three planes and sense motions of roll, pitch, and yaw.

Vestibular Illusions

The Leans

A condition called the leans, is the most common illusion during flight and is caused by a sudden return to level flight following a gradual and prolonged turn that went unnoticed by the pilot. The reason a pilot can be unaware of such a gradual turn is that human exposure to a rotational acceleration of 2 degrees per second or lower is below the detection threshold of the semicircular canals. [Figure 17-4] Leveling the wings after such a turn may cause an illusion that the aircraft is banking in the opposite direction. In response to such an illusion, a pilot may lean in the direction of the original turn in a corrective attempt to regain the perception of a correct vertical posture.

Coriolis Illusion

The “coriolis illusion” occurs when a pilot has been in a turn long enough for the fluid in the ear canal to move at the same speed as the canal. A movement of the head in a different plane, such as looking at something in a different part of the flight deck, may set the fluid moving, creating the illusion of turning or accelerating on an entirely different axis. This action causes the pilot to think the aircraft is performing a maneuver it is not. The disoriented pilot may maneuver the aircraft into a dangerous attitude in an attempt to correct the aircraft’s perceived attitude.

For this reason, it is important that pilots develop an instrument cross-check or scan that involves minimal head movement. Take care when retrieving charts and other objects in the flight deck—if something is dropped, retrieve it with minimal head movement and be alert for the coriolis illusion.

Graveyard Spiral

As in other illusions, a pilot in a prolonged coordinated, constant-rate turn may experience the illusion of not turning. During the recovery to level flight, the pilot will then experience the sensation of turning in the opposite

direction causing the disoriented pilot to 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.” [Figure 17-5] This may lead to a loss of aircraft control.

Somatogravic Illusion

A rapid acceleration, such as experienced during takeoff, stimulates the otolith organs in the same way as tilting the head backwards. This action may create what is known as the “somatogravic illusion” of being in a nose-up attitude, especially in conditions with poor visual references. The disoriented pilot may push the aircraft into a nose-low or dive attitude. A rapid deceleration by quick reduction of the throttle(s) can have the opposite effect, with the disoriented pilot pulling the aircraft into a nose-up or stall attitude.

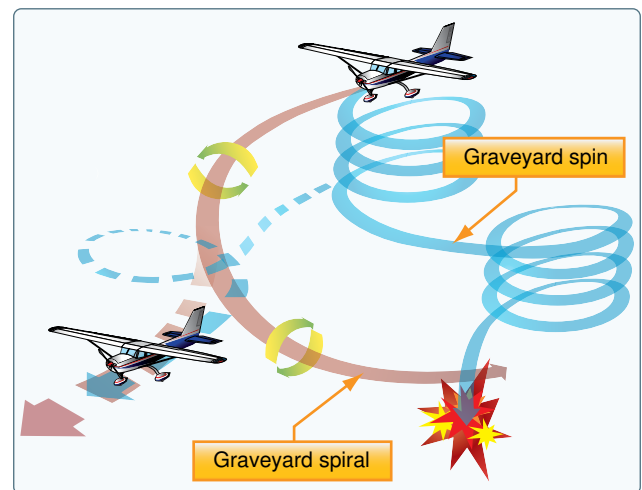


Figure 17-5. Graveyard spiral.

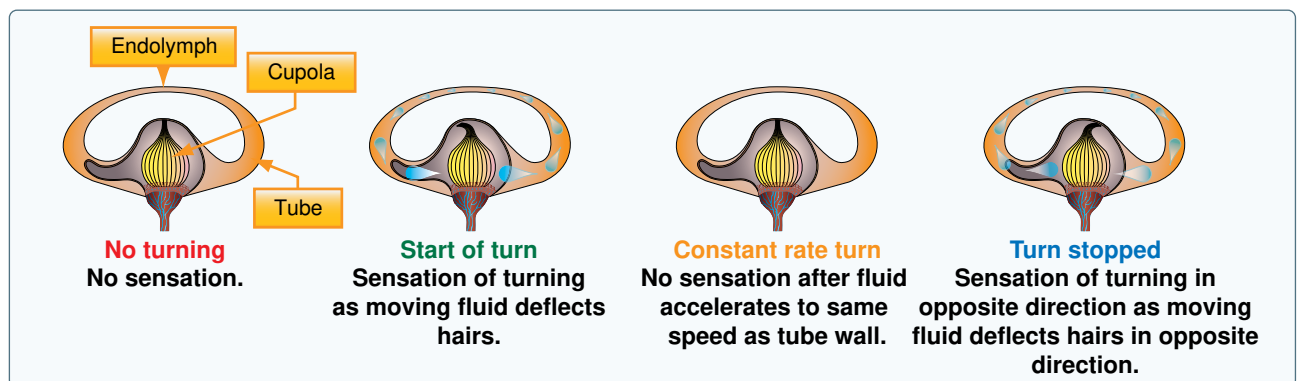


Figure 17-4. Human sensation of angular acceleration.

Inversion Illusion

An abrupt change from climb to straight-and-level flight can stimulate the otolith organs enough to create the illusion of tumbling backwards, known as “inversion illusion.” The disoriented pilot may push the aircraft abruptly into a nose-low attitude, which may intensify this illusion.

Elevator Illusion

An abrupt upward vertical acceleration, as can occur in an updraft, can stimulate the otolith organs to create the illusion of being in a climb. This is known as “elevator illusion.” The disoriented pilot may push the aircraft into a nose-low attitude. An abrupt downward vertical acceleration, usually in a downdraft, has the opposite effect with the disoriented pilot pulling the aircraft into a nose-up attitude.

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, affect the visual system only.

False Horizon

A sloping cloud formation, an obscured horizon, an aurora borealis, a dark scene spread with ground lights and stars, and certain geometric patterns of ground lights can provide inaccurate visual information, or “false horizon,” when attempting to align the aircraft with the actual horizon. The disoriented pilots as a result may place the aircraft in a dangerous attitude.

Autokinesis

When flying in the dark, 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. This illusion is known as “autokinesis.”

Postural Considerations

The postural system sends signals from the skin, joints, and muscles to the brain that are interpreted in relation to the Earth’s gravitational pull. These signals determine posture. Inputs from each movement update the body’s position to the brain on a constant basis. “Seat of the pants” flying is largely dependent upon these signals. Used in conjunction with visual and vestibular clues, these sensations can be fairly reliable. However, because of the forces acting upon the body in certain flight situations, many false sensations can occur due to acceleration forces overpowering gravity. [Figure 17-6] These situations include uncoordinated turns, climbing turns, and turbulence.

Demonstration of Spatial Disorientation

There are a number of controlled aircraft maneuvers a pilot can perform to experiment with spatial disorientation. While each maneuver normally creates a specific illusion, any false sensation is an effective demonstration of disorientation. Thus, even if there is no sensation during any of these maneuvers, the absence of sensation is still an effective demonstration because it illustrates the inability to detect bank or roll.

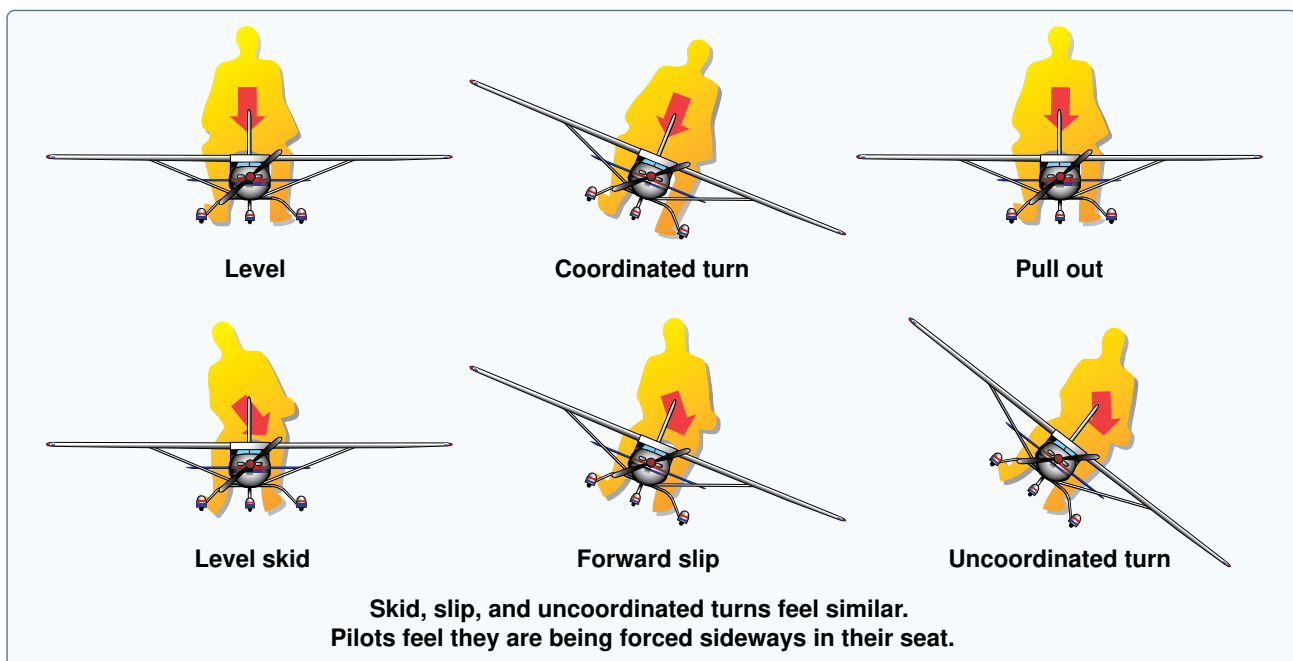


Figure 17-6. *Sensations from centrifugal force.*

There are several objectives in demonstrating these various maneuvers.

1. They teach pilots to understand the susceptibility of the human system to spatial disorientation.
2. They demonstrate that judgments of aircraft attitude based on bodily sensations are frequently false.
3. They help decrease the occurrence and degree of disorientation through a better understanding of the relationship between aircraft motion, head movements, and resulting disorientation.
4. They help instill a greater confidence in relying on flight instruments for assessing true aircraft attitude.

A pilot should not attempt any of these maneuvers at low altitudes or in the absence of an instructor pilot or an appropriate safety pilot.

Climbing While Accelerating

With the pilot's eyes closed, the instructor pilot maintains approach airspeed in a straight-and-level attitude for several seconds, then accelerates while maintaining straight-and-level attitude. The usual illusion during this maneuver, without visual references, is that the aircraft is climbing.

Climbing While Turning

With the pilot's eyes still closed and the aircraft in a straight-and-level attitude, the instructor pilot now executes, with a relatively slow entry, a well coordinated turn of about 1.5 positive G (approximately 50° bank) for 90°. While in the turn, without outside visual references and under the effect of the slight positive G, the usual illusion produced is that of a climb. Upon sensing the climb, the pilot should immediately open the eyes to see that a slowly established, coordinated turn produces the same sensation as a climb.

Diving While Turning

Repeating the previous procedure, but with the pilot's eyes should be kept closed until recovery from the turn is approximately one-half completed, can create the illusion of diving while turning.

Tilting to Right or Left

While in a straight-and-level attitude, with the pilot's eyes closed, the instructor pilot executes a moderate or slight skid to the left with wings level. This creates the illusion of the body being tilted to the right.

Reversal of Motion

This illusion can be demonstrated in any of the three planes of motion. While straight and level, with the pilot's eyes closed, the instructor pilot smoothly and positively rolls the

aircraft to approximately 45° bank attitude while maintaining heading and pitch attitude. This creates the illusion of a strong sense of rotation in the opposite direction. After this illusion is noted, the pilot should open his or her eyes and observe that the aircraft is in a banked attitude.

Diving or Rolling Beyond the Vertical Plane

This maneuver may produce extreme disorientation. While in straight-and-level flight, the pilot should sit normally, either with eyes closed or gaze lowered to the floor. The instructor pilot starts a positive, coordinated roll toward a 30° or 40° angle of bank. As this is in progress, the pilot tilts his or her head forward, looks to the right or left, then immediately returns his or her head to an upright position. The instructor pilot should time the maneuver so the roll is stopped as the pilot returns his or her head upright. An intense disorientation is usually produced by this maneuver, and the pilot experiences the sensation of falling downward into the direction of the roll.

In the descriptions of these maneuvers, the instructor pilot is doing the flying, but having the pilot do the flying can also be a very effective demonstration. The pilot should close his or her eyes and tilt the head to one side. The instructor pilot tells the pilot what control inputs to perform. The pilot then attempts to establish the correct attitude or control input with eyes closed and head tilted. While it is clear the pilot has no idea of the actual attitude, he or she will react to what the senses are saying. After a short time, the pilot will become disoriented and the instructor pilot will tell the pilot to look up and recover. This exercise allows the pilot to experience the disorientation while flying the aircraft.

Coping with Spatial Disorientation

To prevent illusions and their potentially disastrous consequences, pilots can:

1. Understand the causes of these illusions and remain constantly alert for them. Take the opportunity to experience spatial disorientation illusions in a device, such as a Barany chair, a Vertigon, or a Virtual Reality Spatial Disorientation Demonstrator.
2. Always obtain and understand preflight weather briefings.
3. Before flying in marginal visibility (less than 3 miles) or where a visible horizon is not evident, such as flight over open water during the night, obtain training and maintain proficiency in aircraft control by reference to instruments.
4. Do not fly into adverse weather conditions or into dusk or darkness unless proficient in the use of flight instruments. If intending to fly at night, maintain

night-flight currency and proficiency. Include cross-country and local operations at various airfields.

5. Ensure that when outside visual references are used, they are reliable, fixed points on the Earth's surface.
6. Avoid sudden head movement, particularly during takeoffs, turns, and approaches to landing.
7. Be physically tuned for flight into reduced visibility. Ensure proper rest, adequate diet, and, if flying at night, allow for night adaptation. Remember that illness, medication, alcohol, fatigue, sleep loss, and mild hypoxia are likely to increase susceptibility to spatial disorientation.
8. Most importantly, become proficient in the use of flight instruments and rely upon them. Trust the instruments and disregard your sensory perceptions.

The sensations that lead to illusions during instrument flight conditions are normal perceptions experienced by pilots. These undesirable sensations cannot be completely prevented, but through training and awareness, pilots can ignore or suppress them by developing absolute reliance on the flight instruments. As pilots gain proficiency in instrument flying, they become less susceptible to these illusions and their effects.

Optical Illusions

Of the senses, vision is the most important for safe flight. However, various terrain features and atmospheric conditions can create optical illusions. These illusions are primarily associated with landing. Since pilots must transition from reliance on instruments to visual cues outside the flight deck for landing at the end of an instrument approach, it is imperative that they be aware of the potential problems associated with these illusions and take appropriate corrective action. The major illusions leading to landing errors are described below.

Runway Width Illusion

A narrower-than-usual runway can create an illusion that the aircraft is at a higher altitude than it actually is, especially when runway length-to-width relationships are comparable. [Figure 17-7] The pilot who does not recognize this illusion will fly a lower approach, with the risk of striking objects along the approach path or landing short. A wider-than-usual runway can have the opposite effect with the risk of the pilot leveling out the aircraft high and landing hard or overshooting the runway.

Runway and Terrain Slopes Illusion

An upsloping runway, upsloping terrain, or both can create an illusion that the aircraft is at a higher altitude than it actually

is. [Figure 17-7] The pilot who does not recognize this illusion will fly a lower approach. Downsloping runways and downsloping approach terrain can have the opposite effect.

Featureless Terrain Illusion

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.

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.

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 altitude 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.

Fog

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

Ground Lighting Illusions

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.

How To Prevent Landing Errors Due to Optical Illusions

To prevent these illusions and their potentially hazardous consequences, pilots can:

1. Anticipate the possibility of visual illusions during approaches to unfamiliar airports, particularly at night or in adverse weather conditions. Consult airport

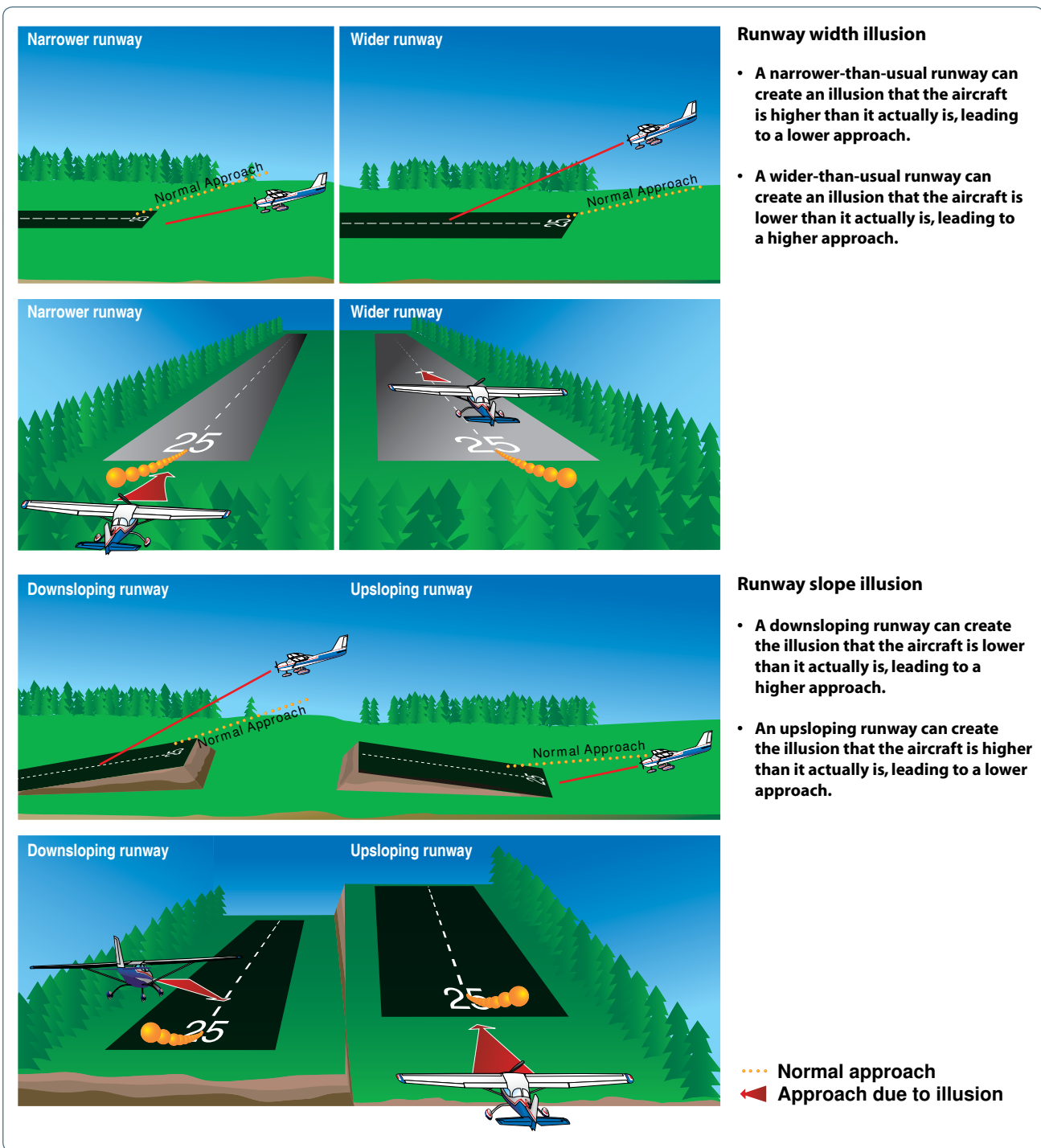


Figure 17-7. Runway illusions.

- diagrams and the Chart Supplement U.S. (formerly Airport/Facility Directory) for information on runway slope, terrain, and lighting.
2. Make frequent reference to the altimeter, especially during all approaches, day and night.
3. If possible, conduct an aerial visual inspection of unfamiliar airports before landing.
4. Use Visual Approach Slope Indicator (VASI) or Precision Approach Path Indicator (PAPI) systems for a visual reference, or an electronic glideslope, whenever they are available.
5. Utilize the visual descent point (VDP) found on many nonprecision instrument approach procedure charts.

6. Recognize that the chances of being involved in an approach accident increase when an emergency or other activity distracts from usual procedures.
7. Maintain optimum proficiency in landing procedures.

In addition to the sensory illusions due to misleading inputs to the vestibular system, a pilot may also encounter various visual illusions during flight. Illusions rank among the most common factors cited as contributing to fatal aviation accidents.

Sloping cloud formations, an obscured horizon, a dark scene spread with ground lights and stars, and certain geometric patterns of ground light can create illusions of not being aligned correctly with the actual horizon. Various surface features and atmospheric conditions encountered in landing can create illusions of being on the wrong approach path. Landing errors due to these illusions can be prevented by anticipating them during approaches, inspecting unfamiliar airports before landing, using electronic glideslope or VASI systems when available, and maintaining proficiency in landing procedures.

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. Symptoms of motion sickness include general discomfort, nausea, dizziness, paleness, sweating, and vomiting.

It is important to remember that experiencing airsickness is no reflection on one's ability as a pilot. If prone to motion sickness, let the flight instructor know, there are techniques that can be used to overcome this problem. For example, avoid lessons in turbulent conditions until becoming more comfortable in the aircraft or start with shorter flights and graduate to longer instruction periods. If symptoms of motion sickness are experienced during a lesson, opening fresh air vents, focusing on objects outside the airplane, and avoiding unnecessary head movements may help alleviate some of the discomfort. Although medications like Dramamine can prevent airsickness in passengers, they are not recommended while flying since they can cause drowsiness and other problems.

Carbon Monoxide (CO) 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 these symptoms are experienced, immediate corrective action should be taken including 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 can be medically disqualifying for pilots.

Stress

Stress is the body's response to physical and psychological demands placed upon it. The body's reaction to stress includes releasing chemical hormones (such as adrenaline) into the blood and increasing metabolism to provide more energy to the muscles. Blood sugar, heart rate, respiration, blood pressure, and perspiration all increase. The term "stressor" is used to describe an element that causes an individual to experience stress. Examples of stressors include physical stress (noise or vibration), physiological stress (fatigue), and psychological stress (difficult work or personal situations).

Stress falls into two broad categories: acute (short term) and chronic (long term). Acute stress involves an immediate threat that is perceived as danger. This is the type of stress that triggers a "fight or flight" response in an individual, whether the threat is real or imagined. Normally, a healthy person can cope with acute stress and prevent stress overload. However, ongoing acute stress can develop into chronic stress.

Chronic stress can be defined as a level of stress that presents an intolerable burden, exceeds the ability of an individual to cope, and causes individual performance to fall sharply. Unrelenting psychological pressures, such as loneliness, financial worries, and relationship or work problems can produce a cumulative level of stress that exceeds a person's ability to cope with the situation. When stress reaches these levels, performance falls off rapidly. Pilots experiencing this level of stress are not safe and should not exercise their airman privileges. Pilots who suspect they are suffering from chronic stress should consult a physician.

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. These factors seriously influence the ability to make effective decisions. Physical fatigue results from sleep loss, exercise, or physical work. Factors such as stress and prolonged performance of cognitive work result in mental fatigue.

Like stress, fatigue falls into two broad categories: acute and chronic. Acute fatigue is short term and is a normal occurrence in everyday living. It is the kind of tiredness people feel after a period of strenuous effort, excitement, or lack of sleep. Rest after exertion and 8 hours of sound sleep ordinarily cures this condition.

A special type of acute fatigue is skill fatigue. This type of fatigue has two main effects on performance:

- Timing disruption—appearing to perform a task as usual, but the timing of each component is slightly off. This makes the pattern of the operation less smooth because the pilot performs each component as though it were separate, instead of part of an integrated activity.
- Disruption of the perceptual field—concentrating attention upon movements or objects in the center of vision and neglecting those in the periphery. This is accompanied by loss of accuracy and smoothness in control movements.

Acute fatigue has many causes, but the following are among the most important for the pilot:

- Mild hypoxia (oxygen deficiency)
- Physical stress
- Psychological stress
- Depletion of physical energy resulting from psychological stress
- Sustained psychological stress

Sustained psychological stress accelerates the glandular secretions that prepare the body for quick reactions during an emergency. These secretions make the circulatory and respiratory systems work harder, and the liver releases energy to provide the extra fuel needed for brain and muscle work. When this reserve energy supply is depleted, the body lapses into generalized and severe fatigue.

Acute fatigue can be prevented by proper diet and adequate rest and sleep. A well-balanced diet prevents the body from needing to consume its own tissues as an energy source. Adequate rest maintains the body's store of vital energy.

Chronic fatigue, extending over a long period of time, usually has psychological roots, although an underlying disease is sometimes responsible. Continuous high-stress levels produce chronic fatigue. Chronic fatigue is not relieved by proper diet and adequate rest and sleep and usually requires treatment by a physician. An individual may experience this condition in the form of weakness, tiredness, palpitations of the heart, breathlessness, headaches, or irritability. Sometimes chronic fatigue even creates stomach or intestinal problems and generalized aches and pains throughout the body. When the condition becomes serious enough, it leads to emotional illness.

If suffering from acute fatigue, stay on the ground. If fatigue occurs in the flight deck, no amount of training or experience can overcome the detrimental effects. Getting adequate rest is the only way to prevent fatigue from occurring. Avoid flying without a full night's rest, after working excessive hours, or after an especially exhausting or stressful day. Pilots who suspect they are suffering from chronic fatigue should consult a physician.

Exposure to Chemicals

When conducting preflight and post-flight inspections, pilots must verify that the fluid levels in their aircraft meet the levels specified for safe operations as stated in the Pilot's Operating Handbook. These fluids include, but are not limited to hydraulic fluid, engine oil, and fuel.

It is important that every pilot recognize the potential hazards of working with these fluids as well as the recommended first aid measures to follow should any of these fluids come in contact with their eyes, skin, and/or respiratory system. As the specific first aid measures for dealing with exposure to these chemicals can vary by chemical type, it is important that every pilot be familiar with the location and use of the Material Safety Data Sheet (MSDS) for each chemical they encounter.

The procedures described in the following sections are minimum guideline for first aid for each of the indicated scenarios. Ultimately, the pilot should consult the MSDS for first aid procedures specific to the type of chemical and exposure scenario.

Hydraulic Fluid

- Eye Contact—immediately flush the eyes with clean water and seek medical attention if irritation occurs.
- Skin Contact—remove all contaminated clothing and thoroughly cleanse the affected areas with mild soap and water or a waterless hand cleaner. If irritation or redness develops and persists, seek medical attention. Should the hydraulic fluid get into or under the skin, or into any other part of the body, regardless of the

appearance of the wound or its size, seek medical attention immediately.

- Inhalation—if respiratory symptoms develop, move away from the source of exposure and into fresh air in a position comfortable for breathing. If symptoms persist, seek medical attention.
- Ingestion—first aid is not normally required; however, if swallowed and symptoms develop, seek medical attention.

Engine Oil

- Eye Contact—immediately flush the eyes with clean water and seek medical attention if irritation occurs.
- Skin Contact—remove all contaminated clothing and thoroughly cleanse the affected areas with soap and water. Launder contaminated clothing before reuse.
- Inhalation—move away from the source of exposure and into fresh air. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical attention. If breathing stops, assisted ventilation is required via a bag-valve-mask or cardiopulmonary resuscitation (CPR).
- Ingestion—seek immediate medical attention. If immediate medical attention is not available, contact a regional poison control center or emergency medical professional regarding the induction of vomiting or use of activated charcoal. Vomiting should never be induced to a person who is groggy or unconscious.

Fuel

- Eye Contact—immediately flush the eyes with clean water for at least 15 minutes and seek medical attention immediately.
- Skin Contact—remove all contaminated clothing and thoroughly cleanse the affected areas with mild soap and water or a waterless hand cleaner. If skin surface is damaged, apply a clean dressing and seek medical attention. If irritation or redness develops, seek medical attention. Launder contaminated clothing before reuse.
- Inhalation—move away from the source of exposure and into fresh air. If breathing stops, assisted ventilation is required via a bag-valve-mask or cardiopulmonary resuscitation (CPR). Once breathing is restored, the use of additional oxygen may be necessary. Seek medical attention immediately.
- Ingestion—seek immediate medical attention. Do not induce vomiting or take anything by mouth as this may cause the material to enter the lungs and cause severe

lung damage. Should vomiting occur, keep head below the hips to reduce the risks of aspiration. Monitor for breathing difficulties. Rinse out any material which enters the mouth until the taste is dissipated.

Dehydration and Heatstroke

Dehydration is the term given to a critical loss of water from the body. Causes of dehydration are hot flight decks and flight lines, wind, humidity, and diuretic drinks—coffee, tea, alcohol, and caffeinated soft drinks. Some common signs of dehydration are headache, fatigue, cramps, sleepiness, and dizziness.

The first noticeable effect of dehydration is fatigue, which in turn makes top physical and mental performance difficult, if not impossible. Flying for long periods in hot summer temperatures or at high altitudes increases the susceptibility to dehydration because these conditions tend to increase the rate of water loss from the body.

To help prevent dehydration, drink two to four quarts of water every 24 hours. Since each person is physiologically different, this is only a guide. Most people are aware of the eight-glasses-a-day guide: If each glass of water is eight ounces, this equates to 64 ounces, which is two quarts. If this fluid is not replaced, fatigue progresses to dizziness, weakness, nausea, tingling of hands and feet, abdominal cramps, and extreme thirst.

The key for pilots is to be continually aware of their condition. Most people become thirsty with a 1.5 quart deficit or a loss of 2 percent of total body weight. This level of dehydration triggers the “thirst mechanism.” The problem is that the thirst mechanism arrives too late and is turned off too easily. A small amount of fluid in the mouth turns this mechanism off and the replacement of needed body fluid is delayed.

Other steps to prevent dehydration include:

- Carrying a container in order to measure daily water intake.
- Staying ahead—not relying on the thirst sensation as an alarm. If plain water is not preferred, add some sport drink flavoring to make it more acceptable.
- Limiting daily intake of caffeine and alcohol (both are diuretics and stimulate increased production of urine).

Heatstroke is a condition caused by any inability of the body to control its temperature. Onset of this condition may be recognized by the symptoms of dehydration, but also has been known to be recognized only upon complete collapse.

To prevent these symptoms, it is recommended that an ample supply of water be carried and used at frequent intervals on any long flight, whether thirsty or not. The body normally absorbs water at a rate of 1.2 to 1.5 quarts per hour. Individuals should drink one quart per hour for severe heat stress conditions or one pint per hour for moderate stress conditions. If the aircraft has a canopy or roof window, wearing light-colored, porous clothing and a hat will help provide protection from the sun. Keeping the flight deck well ventilated aids in dissipating excess heat.

Alcohol

Alcohol impairs the efficiency of the human body. [Figure 17-8] Studies have shown that consuming alcohol is closely linked to performance deterioration. Pilots must make hundreds of decisions, some of them time-critical, during the course of a flight. The safe outcome of any flight depends on the ability to make the correct decisions and take

the appropriate actions during routine occurrences, as well as abnormal situations. The influence of alcohol drastically reduces the chances of completing a flight without incident. Even in small amounts, alcohol can impair judgment, decrease sense of responsibility, affect coordination, constrict visual field, diminish memory, reduce reasoning ability, and lower attention span. As little as one ounce of alcohol can decrease the speed and strength of muscular reflexes, lessen the efficiency of eye movements while reading, and increase the frequency at which errors are committed. Impairments in vision and hearing can occur from consuming as little as one drink.

The alcohol consumed in beer and mixed drinks is ethyl alcohol, a central nervous system depressant. From a medical point of view, it acts on the body much like a general anesthetic. The “dose” is generally much lower and more slowly consumed in the case of alcohol, but the basic effects on the human body are similar. Alcohol is easily and quickly absorbed by the digestive tract. The bloodstream absorbs about 80 to 90 percent of the alcohol in a drink within 30 minutes when ingested on an empty stomach. The body requires about 3 hours to rid itself of all the alcohol contained in one mixed drink or one beer.

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.

Altitude multiplies the effects of alcohol on the brain. When combined with altitude, the alcohol from two drinks may have the same effect as three or four drinks. Alcohol interferes with the brain’s ability to utilize oxygen, producing a form of histotoxic hypoxia. The effects are rapid because alcohol passes quickly into the bloodstream. In addition, the brain is a highly vascular organ that is immediately sensitive to changes in the blood’s composition. For a pilot, the lower oxygen availability at altitude and the lower capability of the brain to use the oxygen that is available can add up to a deadly combination.

Intoxication is determined by the amount of alcohol in the bloodstream. This is usually measured as a percentage by weight in the blood. 14 CFR part 91 requires that blood alcohol level be less than .04 percent and that 8 hours pass between drinking alcohol and piloting an aircraft. A pilot with a blood alcohol level of .04 percent or greater after 8 hours cannot fly until the blood alcohol falls below that amount. Even though blood alcohol may be well below .04 percent, a pilot cannot fly sooner than 8 hours after drinking alcohol.

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% (10–50 mg)	average individual appears normal	
0.03–0.12%* (30–120 mg)	mild euphoria, talkativeness, decreased inhibitions, decreased attention, impaired judgment, increased reaction time	
0.09–0.25% (90–250 mg)	emotional instability, loss of critical judgment, impairment of memory and comprehension, decreased sensory response, mild muscular incoordination	
0.18–0.30% (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% (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% (350–500 mg)	unconsciousness, depressed or abolished reflexes, abnormal body temperature, coma, possible death from respiratory paralysis (450 mg or above)	
* Legal limit for motor vehicle operation in most states is 0.08 or 0.10% (80–100 mg of alcohol per dL of blood).		

Figure 17-8. Impairment scale with alcohol use.

Although the regulations are quite specific, it is a good idea to be more conservative than the regulations.

Drugs

The Federal Aviation Regulations include no specific references to medication usage. Two regulations, though, are important to keep in mind. Title 14 of the CFR part 61, section 61.53 prohibits acting as pilot-in-command or in any other capacity as a required pilot flight crewmember, while that person:

1. Knows or has reason to know of any medical condition that would make the person unable to meet the requirement for the medical certificate necessary for the pilot operation, or
2. Is taking medication or receiving other treatment for a medical condition that results in the person being unable to meet the requirements for the medical certificate necessary for the pilot operation.

Further, 14 CFR part 91, section 91.17 prohibits the use of any drug that affects the person's faculties in any way contrary to safety.

There are several thousand medications currently approved by the U.S. Food and Drug Administration (FDA), not including OTC (over the counter) drugs. Virtually all medications have the potential for adverse side effects in some people. Additionally, herbal and dietary supplements, sport and energy boosters, and some other "natural" products are derived from substances often found in medications that could also have adverse side effects. While some individuals experience no side effects with a particular drug or product, others may be noticeably affected. The FAA regularly reviews FDA and other data to assure that medications found acceptable for aviation duties do not pose an adverse safety risk. Drugs that cause no apparent side effects on the ground can create serious problems at even relatively low altitudes. Even at typical general aviation altitudes, the changes in concentrations of atmospheric gases in the blood can enhance the effects of seemingly innocuous drugs that can result in impaired judgment, decision-making, and performance. In addition, fatigue, stress, dehydration, and inadequate nutrition can increase an airman's susceptibility to adverse effects from various drugs, even if they appeared to tolerate them in the past. If multiple medications are being taken at the same time, the adverse effects can be even more pronounced.

Another important consideration is that the medical condition for which a medication is prescribed may itself be disqualifying. The FAA will consider the condition in the context of risk for medical incapacitation, and the medication as well for cognitive impairment, and either or both could be found unacceptable for medical certification.

Some of the most commonly used OTC drugs, antihistamines and decongestants, have the potential to cause noticeable adverse side effects, including drowsiness and cognitive deficits. The symptoms associated with common upper respiratory infections, including the common cold, often suppress a pilot's desire to fly, and treating symptoms with a drug that causes adverse side effects only compounds the problem. Particularly, medications containing diphenhydramine (e.g., Benadryl) are known to cause drowsiness and have a prolonged half-life, meaning the drugs stay in one's system for an extended time, which lengthens the time that side effects are present.

Many medications, such as tranquilizers, sedatives, strong pain relievers, and cough suppressants, have primary effects that may impair judgment, memory, alertness, coordination, vision, and the ability to make calculations. [Figure 17-9] Others, such as antihistamines, blood pressure drugs, muscle relaxants, and agents to control diarrhea and motion sickness, have side effects that may impair the same critical functions. Any medication that depresses the nervous system, such as a sedative, tranquilizer, or antihistamine, can make a pilot more susceptible to hypoxia.

Painkillers are grouped into two broad categories: analgesics and anesthetics. Analgesics are drugs that reduce pain, while anesthetics are drugs that deaden pain or cause loss of consciousness.

Over-the-counter analgesics, such as acetylsalicylic acid (aspirin), acetaminophen (Tylenol), and ibuprofen (Advil), have few side effects when taken in the correct dosage. Although some people are allergic to certain analgesics or may suffer from stomach irritation, flying usually is not restricted when taking these drugs. However, flying is almost always precluded while using prescription analgesics, such as drugs containing propoxyphene (e.g., Darvon), oxycodone (e.g., Percodan), meperidine (e.g., Demerol), and codeine, since these drugs are known to cause side effects, such as mental confusion, dizziness, headaches, nausea, and vision problems.

Anesthetic drugs are commonly used for dental and surgical procedures. Most local anesthetics used for minor dental and outpatient procedures wear off within a relatively short period of time. The anesthetic itself may not limit flying as much as the actual procedure and subsequent pain.

There is evidence taking illicit drugs significantly elevates the risk of having an aviation accident. Even though the Drug Enforcement Administration (DEA) defines marijuana as a Schedule I drug on its controlled substances list, states have taken steps to allow the possession, sale,

and use of marijuana withing their border. The FAA has stated, "Marijuana is an illicit drug per federal law and its use by airmen is prohibited."

Stimulants are drugs that excite the central nervous system and produce an increase in alertness and activity. Amphetamines, caffeine, and nicotine are all forms of stimulants. Common uses of these drugs include appetite suppression, fatigue reduction, and mood elevation. Some of these drugs may cause a stimulant reaction, even though

this reaction is not their primary function. In some cases, stimulants can produce anxiety and mood swings, both of which are dangerous when flying.

Depressants are drugs that reduce the body's functioning in many areas. These drugs lower blood pressure, reduce mental processing, and slow motor and reaction responses. There are several types of drugs that can cause a depressing effect on the body, including tranquilizers, motion sickness medication, some types of stomach medication, decongestants, and antihistamines. The most common depressant is alcohol.

Substance	Generic Or Brand Name	Treatment for	Possible Side Effects
Alcohol	Beer Liquor Wine	N/A	Impaired judgment and perception Impaired coordination and motor control Reduced reaction time Impaired sensory perception Reduced intellectual functions Reduced tolerance to G-forces Inner-ear disturbance and spatial disorientation (up to 48 hours) Central nervous system depression
Nicotine	Cigars Cigarettes Pipe tobacco Chewing tobacco Snuff	N/A	Sinus and respiratory system infection and irritation Impaired night vision Hypertension Carbon monoxide poisoning (from smoking)
Amphetamines	Ritalin Obetrol Eskatrol	Obesity (diet pills) Tiredness	Prolonged wakefulness Nervousness Impaired vision Suppressed appetite Shakiness Excessive sweating Rapid heart rate Sleep disturbance Seriously impaired judgment
Caffeine	Coffee Tea Chocolate No-Doz	N/A	Impaired judgment Reduced reaction time Sleep disturbance Increased motor activity and tremors Hypertension Irregular heart rate Rapid heart rate Body dehydration (through increased urine output) Headaches
Antacid	Alka-2 Di-Gel Maalox	Stomach acids	Liberations of carbon dioxide at altitude (distension may cause acute abdominal pain and may mask other medical problems)
Antihistamines	Coricidin Contac Dristan Dimetapp Omade Chlor-Trimeton Diphenhydramine	Allergies Colds	Drowsiness and dizziness (sometimes recurring) Visual disturbances (when medications also contain antispasmodic drugs)
Aspirin	Bayer Bufferin Alka-Seltzer	Headaches Fevers Aches Pains	Irregular body temperature Variation in rate and depth of respiration Hypoxia and hyperventilation (two aspirin can contribute to) Nausea, ringing in ears, deafness, diarrhea, and hallucinations when taken in excessive dosages Corrosive action on the stomach lining Gastrointestinal problems Decreased clotting ability of the blood (clotting ability could be the difference between life and death in a survival situation)

Figure 17-9. Adverse affects of various drugs.

Some drugs that are classified as neither stimulants nor depressants have adverse effects on flying. For example, some antibiotics can produce dangerous side effects, such as balance disorders, hearing loss, nausea, and vomiting. While many antibiotics are safe for use while flying, the infection requiring the antibiotic may prohibit flying. In addition, unless specifically prescribed by a physician, do not take more than one drug at a time, and never mix drugs with alcohol because the effects are often unpredictable.

The dangers of illegal drugs also are well documented. Certain illegal drugs can have hallucinatory effects that occur days or weeks after the drug is taken. Obviously, these drugs have no place in the aviation community.

14 CFR prohibits pilots from performing crewmember duties while using any medication that affects the body in any way contrary to safety. The safest rule is not to fly as a crewmember while taking any medication, unless approved to do so by the FAA. If there is any doubt regarding the effects of any medication, consult an AME before flying.

Prior to each and every flight, all pilots must do a proper physical self-assessment to ensure safety. A great mnemonic, covered in Chapter 2 on Aeronautical Decision-Making, is IMSAFE, which stands for Illness, Medication, Stress, Alcohol, Fatigue, and Emotion.

For the medication component of IMSAFE, pilots need to ask themselves, “Am I taking any medicines that might affect my judgment or make me drowsy? For any new medication, OTC or prescribed, you should wait at least 48 hours after the first dose before flying to determine you do not have any adverse side effects that would make it unsafe to operate an aircraft. In addition to medication questions, pilots should also consider the following –

- Do not take any unnecessary or elective medications;
- Make sure you eat regular balanced meals;
- Bring a snack for both you and your passengers for the flight;
- Maintain good hydration - bring plenty of water;
- Ensure adequate sleep the night prior to the flight; and
- Stay physically fit.

Additionally, you should wait at least five maximal dosing intervals, the time between recommended or prescribed dosing, (e.g., a dosing interval of 5 to 6 hours would require you to wait 30 hours) before flying after taking any medication that has potentially adverse side effects (e.g., sedating or dizziness). Observing the recommended dosing interval doesn’t eliminate the risk for adverse side effects because

everyone metabolizes medications differently. However, five times the dosing interval is a reasonable rule of thumb.

Altitude-Induced Decompression Sickness (DCS)

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. Nitrogen is an inert gas normally stored throughout the human body (tissues and fluids) in physical solution. When the body is exposed to decreased barometric pressures (as in flying an unpressurized aircraft to altitude or during a rapid decompression), the nitrogen dissolved in the body comes out of solution. If the nitrogen is forced to leave the solution too rapidly, bubbles form in different areas of the body causing a variety of signs and symptoms. The most common symptom is joint pain, which is known as “the bends.” [Figure 17-10]

What to do when altitude-induced DCS occurs:

- Put on oxygen mask immediately and switch the regulator to 100 percent oxygen.
- Begin an emergency descent and land as soon as possible. Even if the symptoms disappear during descent, land and seek medical evaluation while continuing to breathe oxygen.
- If one of the symptoms is joint pain, keep the affected area still; do not try to work pain out by moving the joint around.
- Upon landing, seek medical assistance from an FAA medical officer, AME, military flight surgeon, or a hyperbaric medicine specialist. Be aware that a physician not specialized in aviation or hypobaric medicine may not be familiar with this type of medical problem.
- Definitive medical treatment may involve the use of a hyperbaric chamber operated by specially-trained personnel.
- Delayed signs and symptoms of altitude-induced DCS can occur after return to ground level regardless of presence during flight.

DCS After Scuba Diving

Scuba diving subjects the body to increased pressure, which allows more nitrogen to dissolve in body tissues and fluids. [Figure 17-11] 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

DCS Type	Bubble Location	Signs and Symptoms (Clinical Manifestations)
BENDS	Mostly large joints of the body (elbows, shoulders, hip, wrists, knees, ankles)	- Localized deep pain, ranging from mild (a “niggle”) to excruciating—sometimes a dull ache, but rarely a sharp pain - Active and passive motion of the joint aggravating the pain - Pain occurring at altitude, during the descent, or many hours later
NEUROLOGIC Manifestations	Brain	- Confusion or memory loss - Headache - Spots in visual field (scotoma), tunnel vision, double vision (diplopia), or blurry vision - Unexplained extreme fatigue or behavior changes - Seizures, dizziness, vertigo, nausea, vomiting, and unconsciousness
	Spinal cord	- Abnormal sensations, such as burning, stinging, and tingling, around the lower chest and back - Symptoms spreading from the feet up and possibly accompanied by ascending weakness or paralysis - Girdling abdominal or chest pain
	Peripheral nerves	- Urinary and rectal incontinence - Abnormal sensations, such as numbness, burning, stinging and tingling (paresthesia) - Muscle weakness or twitching
CHOKES	Lungs	- Burning deep chest pain (under the sternum) - Pain aggravated by breathing - Shortness of breath (dyspnea) - Dry constant cough
SKIN BENDS	Skin	- Itching usually around the ears, face, neck, arms, and upper torso - Sensation of tiny insects crawling over the skin - Mottled or marbled skin usually around the shoulders, upper chest, and abdomen accompanied by itching - Swelling of the skin, accompanied by tiny scar-like skin depressions (pitting edema)

Figure 17-10. *Signs and symptoms of altitude decompression sickness.*

evolved gas can occur during exposure to low altitude and create a serious inflight 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 (nondecompression stop diving), and at least 24 hours after diving that does require controlled ascent (decompression stop diving). The waiting time before going to flight altitudes above 8,000 feet should be at least 24 hours after any scuba dive. These recommended altitudes are actual flight altitudes above mean sea level (MSL) and not pressurized cabin altitudes. This takes into consideration the risk of decompression of the aircraft during flight.

Vision in Flight

Of all the senses, vision is the most important for safe flight. Most of the things perceived while flying are visual or heavily supplemented by vision. As remarkable and vital as it is, vision is subject to limitations, such as illusions and blind spots. The more a pilot understands about the eyes and how they function, the easier it is to use vision effectively and compensate for potential problems.

The eye functions much like a camera. Its structure includes an aperture, a lens, a mechanism for focusing, and a surface for registering images. Light enters through the cornea at the front of the eyeball, travels through the lens, and falls on the retina. The retina contains light sensitive cells that convert



Figure 17-11. *To avoid the bends, scuba divers must not fly for specific time periods following dives.*

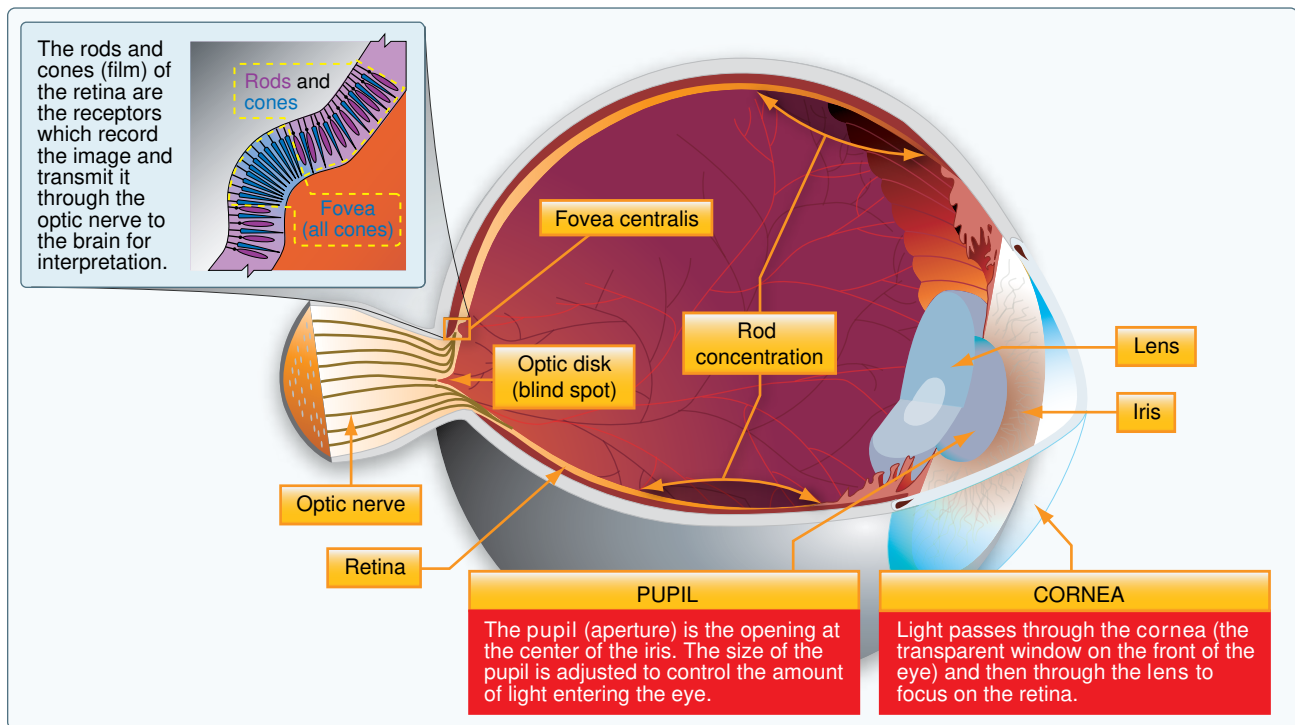


Figure 17-12. *The human eye.*

light energy into electrical impulses that travel through nerves to the brain. The brain interprets the electrical signals to form images. There are two kinds of light-sensitive cells in the eyes: rods and cones. [Figure 17-12]

The cones are responsible for all color vision, from appreciating a glorious sunset to discerning the subtle shades in a fine painting. Cones are present throughout the retina, but are concentrated toward the center of the field of vision at the back of the retina. There is a small pit called the fovea where almost all the light sensing cells are cones. This is the area where most “looking” occurs (the center of the visual field where detail, color sensitivity, and resolution are highest).

While the cones and their associated nerves are well suited to detecting fine detail and color in high light levels, the rods are better able to detect movement and provide vision in dim light. The rods are unable to discern color but are very sensitive at low-light levels. The trouble with rods is

that a large amount of light overwhelms them, and they take longer to “reset” and adapt to the dark again. There are so many cones in the fovea that are at the very center of the visual field but virtually has no rods at all. So in low light, the middle of the visual field is not very sensitive, but farther from the fovea, the rods are more numerous and provide the major portion of night vision.

Vision Types

There are three types of vision: photopic, mesopic, and scotopic. Each type functions under different sensory stimuli or ambient light conditions. [Figure 17-13]

Photopic Vision

Photopic vision provides the capability for seeing color and resolving fine detail (20/20 or better), but it functions only in good illumination. Photopic vision is experienced during daylight or when a high level of artificial illumination exists.

Types of Vision						
Types of vision used	Light level	Technique of viewing	Color perception	Receptors used	Acuity best	Blind spot
Photopic	High	Central	Good	Cones	20/20	Day
Mesopic	Medium/Low	Both	Some	Cones/Rods	Varies	Day/Night
Scotopic	Low	Scanning	None	Rods	20/200	Day/Night

Figure 17-13. *Types of vision.*

The cones concentrated in the fovea centralis of the eye are primarily responsible for vision in bright light. [Figure 17-12] Because of the high light level, rhodopsin, which is a biological pigment of the retina that is responsible for both the formation of the photoreceptor cells and the first events in the perception of light, is bleached out causing the rod cells to become less effective.

Mesopic Vision

Mesopic vision is achieved by a combination of rods and cones and is experienced at dawn, dusk, and during full moonlight. Visual acuity steadily decreases as available light decreases and color perception changes because the cones become less effective. Mesopic viewing period is considered the most dangerous period for viewing. As cone sensitivity decreases, pilots should use off-center vision and proper scanning techniques to detect objects during low-light levels.

Scotopic Vision

Scotopic vision is experienced under low-light levels and the cones become ineffective, resulting in poor resolution of detail. Visual acuity decreases to 20/200 or less and enables a person to see only objects the size of or larger than the big "E" on visual acuity testing charts from 20 feet away. In other words, a person must stand at 20 feet to see what can normally be seen at 200 feet under daylight conditions. When using scotopic vision, color perception is lost and a night blind spot in the central field of view appears at low light levels when the cone-cell sensitivity is lost.

Central Blind Spot

The area where the optic nerve connects to the retina in the back of each eye is known as the optic disk. There is a total absence of cones and rods in this area, and consequently, each eye is completely blind in this spot. [Figure 17-14] As a result, it is referred to as the blind spot that everyone

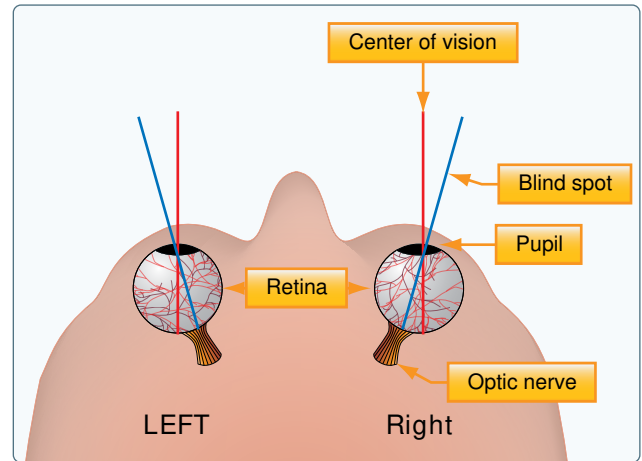


Figure 17-14. Central blind spot.

has in each eye. Under normal binocular vision conditions (both eyes are used together), this is not a problem because an object cannot be in the blind spot of both eyes at the same time. On the other hand, where the field of vision of one eye is obstructed by an object (windshield divider or another aircraft), a visual target could fall in the blind spot of the other eye and remain undetected.

Figure 17-15 provides a dramatic example of the eye's blind spot.

1. Hold this page at an arm's length.
2. Completely cover your left eye (without closing or pressing on it) using your hand or other flat object.
3. With your right eye, stare directly at the airplane on the left side of the picture page. In your periphery, you will notice the black X on the right side of the picture.
4. Slowly move the page closer to you while continuing to stare at the airplane.



Figure 17-15. The eye's blind spot.

5. When the page is about 16–18 inches from you, the black X should disappear completely because it has been imaged onto the blind spot of your right eye. (Resist the temptation to move your right eye while the black X is gone or else it reappears. Keep staring at the airplane.)
6. As you continue to look at the airplane, keep moving the page closer to you a few more inches, and the black X will come back into view.
7. There is an interval where you are able to move the page a few inches backward and forward, and the black X will be gone. This demonstrates to you the extent of your blind spot.
8. You can try the same thing again, except this time with your right eye covered stare at the black X with your left eye. Move the page in closer and the airplane will disappear.

Another way to check your blind spot is to do a similar test outside at night when there is a full moon. Cover your left eye, looking at the full moon with your right eye. Gradually move your right eye to the left (and maybe slightly up or down). Before long, all you will be able to see is the large halo around the full moon; the entire moon itself will seem to have disappeared.

Empty-Field Myopia

Empty-field myopia is a condition that usually occurs when flying above the clouds or in a haze layer that provides nothing specific to focus on outside the aircraft. This causes the eyes to relax and seek a comfortable focal distance that may range from 10 to 30 feet. For the pilot, this means looking without seeing, which is dangerous. Searching out and focusing on distant light sources, no matter how dim, helps prevent the onset of empty-field myopia.

Night Vision

There are many good reasons to fly at night, but pilots must keep in mind that the risks of night flying are different than during the day and often times higher. [Figure 17-16] Pilots who are cautious and educated on night-flying techniques can mitigate those risks and become very comfortable and proficient in the task.

Night Blind Spot

It is estimated that once fully adapted to darkness, the rods are 10,000 times more sensitive to light than the cones, making them the primary receptors for night vision. Since the cones are concentrated near the fovea, the rods are also responsible for much of the peripheral vision. The concentration of cones in the fovea can make a night blind spot in the center of the field of vision. To see an object clearly at night, the pilot must



Figure 17-16. *Night vision.*

expose the rods to the image. This can be done by looking 5° to 10° off center of the object to be seen. This can be tried in a dim light in a darkened room. When looking directly at the light, it dims or disappears altogether. When looking slightly off center, it becomes clearer and brighter.

When looking directly at an object, the image is focused mainly on the fovea, where detail is best seen. At night, the ability to see an object in the center of the visual field is reduced as the cones lose much of their sensitivity and the rods become more sensitive. Looking off center can help compensate for this night blind spot. Along with the loss of

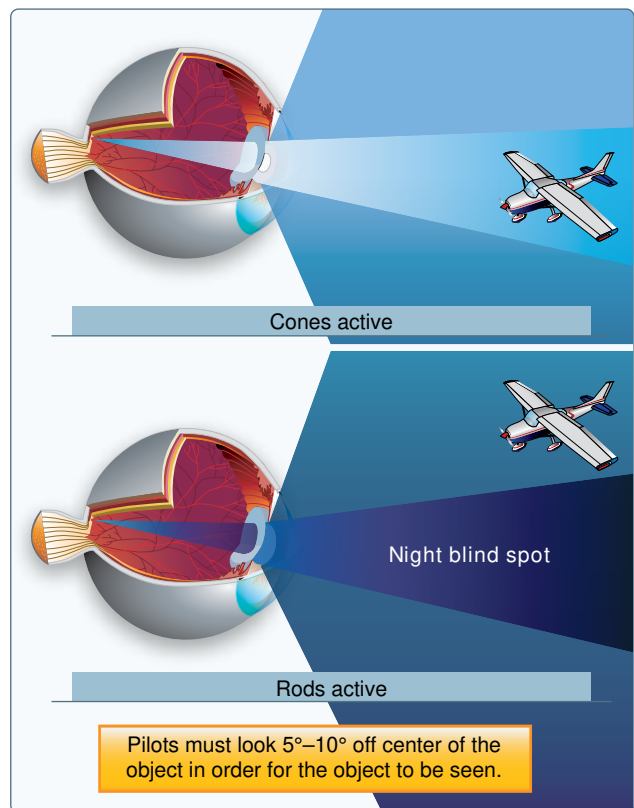


Figure 17-17. *Night blind spot.*

sharpness (acuity) and color at night, depth perception and judgment of size may be lost. [Figure 17-17]

Dark Adaptation

Dark adaptation is the adjustment of the human eye to a dark environment. That adjustment takes longer depending on the amount of light in the environment that a person has just left. Moving from a bright room into a dark one takes longer than moving from a dim room and going into a dark one.

While the cones adapt rapidly to changes in light intensities, the rods take much longer. Walking from bright sunlight into a dark movie theater is an example of this dark adaptation period experience. The rods can take approximately 30 minutes to fully adapt to darkness. A bright light, however, can completely destroy night adaptation, leaving night vision severely compromised while the adaptation process is repeated.

Scanning Techniques

Scanning techniques are very important in identifying objects at night. To scan effectively, pilots must look from right to left or left to right. They should begin scanning at the greatest distance an object can be perceived (top) and move inward toward the position of the aircraft (bottom). For each stop, an area approximately 30° wide should be scanned. The duration of each stop is based on the degree of detail that is required, but no stop should last longer than 2 to 3 seconds. When

moving from one viewing point to the next, pilots should overlap the previous field of view by 10°. [Figure 17-18]

Off-center viewing is another type of scan that pilots can use during night flying. It is a technique that requires an object be viewed by looking 10° above, below, or to either side of the object. [Figure 17-19] In this manner, the peripheral vision can maintain contact with an object.

With off-center vision, the images of an object viewed longer than 2 to 3 seconds will disappear. This occurs because the rods reach a photochemical equilibrium that prevents any further response until the scene changes. This produces a potentially unsafe operating condition. To overcome this night vision limitation, pilots must be aware of the phenomenon and avoid viewing an object for longer than 2 or 3 seconds. The peripheral field of vision will continue to pick up the object when the eyes are shifted from one off-center point to another.

Night Vision Protection

Several things can be done to help with the dark adaptation process and to keep the eyes adapted to darkness. Some of the steps pilots and flight crews can take to protect their night vision are described in the following paragraphs.

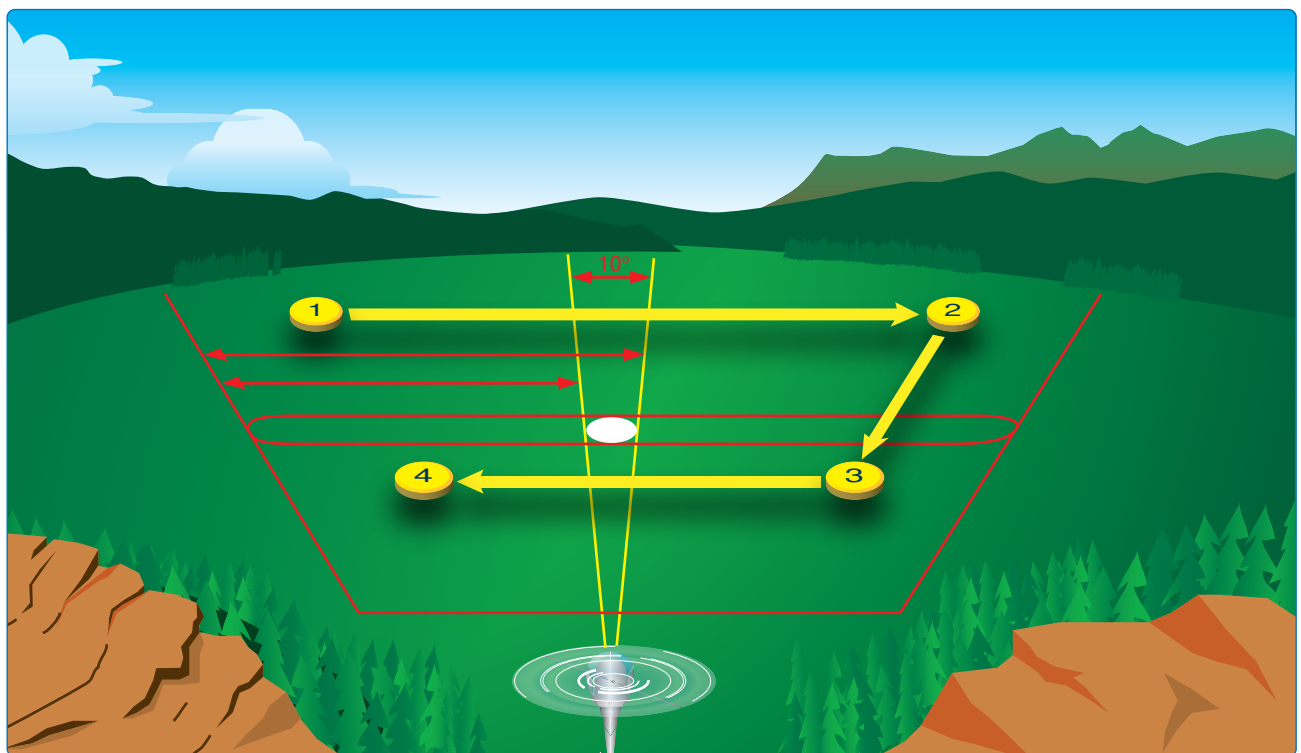


Figure 17-18. Scanning techniques.

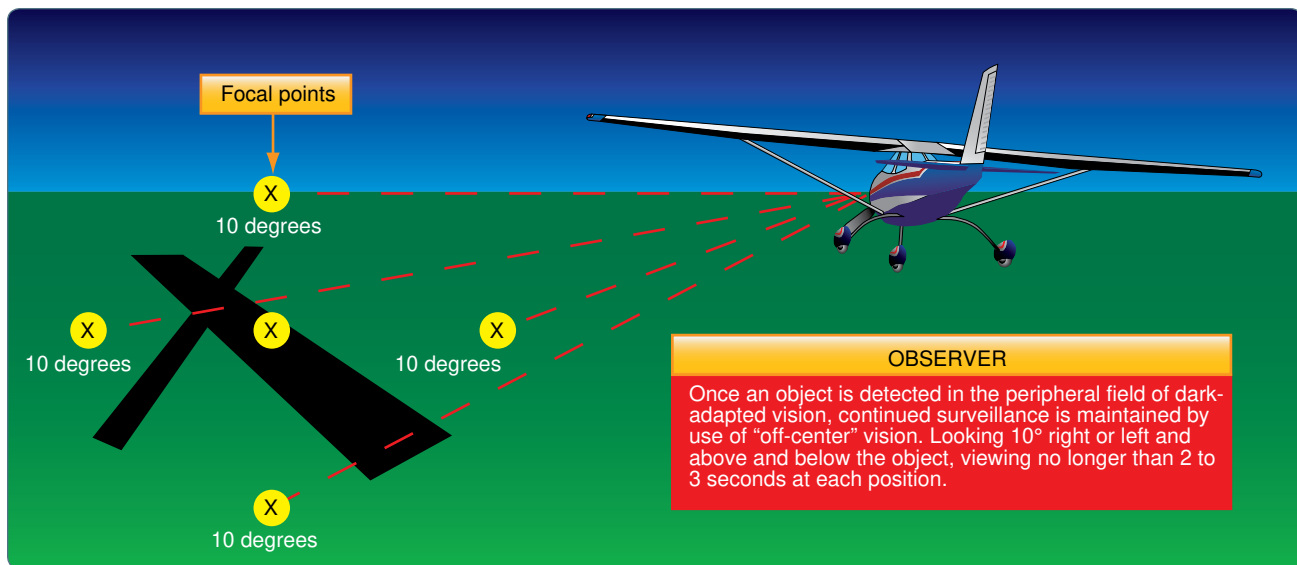


Figure 17-19. Off-center viewing.

Sunglasses

If a night flight is scheduled, pilots and crew members should wear neutral density (N-15) sunglasses or equivalent filter lenses when exposed to bright sunlight. This precaution increases the rate of dark adaptation at night and improves night visual sensitivity.

Oxygen Supply

Unaided night vision depends on optimum function and sensitivity of the rods of the retina. Lack of oxygen to the rods (hypoxia) significantly reduces their sensitivity. Sharp clear vision (with the best being equal to 20–20 vision) requires significant oxygen especially at night. Without supplemental oxygen, an individual's night vision declines measurably at pressure altitudes above 4,000 feet. As altitude increases, the available oxygen decreases, degrading night vision. Compounding the problem is fatigue, which minimizes physiological well being. Adding fatigue to high altitude exposure is a recipe for disaster. In fact, if flying at night at an altitude of 12,000 feet, the pilot may actually see elements of his or her normal vision missing or not in focus. Missing visual elements resemble the missing pixels in a digital image while unfocused vision is dim and washed out.

For the pilot suffering the effects of hypoxic hypoxia, a simple descent to a lower altitude may not be sufficient to reestablish vision. For example, a climb from 8,000 feet to 12,000 feet for 30 minutes does not mean a descent to 8,000 feet will rectify the problem. Visual acuity may not be regained for over an hour. Thus, it is important to remember, altitude and fatigue have a profound effect on a pilot's ability to see.

High Intensity Lighting

If, during the flight, any high intensity lighting areas are encountered, attempt to turn the aircraft away and fly in the periphery of the lighted area. This will not expose the eyes to such a large amount of light all at once. If possible, plan your route to avoid direct over flight of built-up, brightly lit areas.

Flightdeck Lighting

Flightdeck lighting should be kept as low as possible so that the light does not monopolize night vision. After reaching the desired flight altitude, pilots should allow time to adjust to the flight conditions. This includes readjustment of instrument lights and orientation to outside references. During the adjustment period, night vision should continue to improve until optimum night adaptation is achieved. When it is necessary to read maps, charts, and checklists, use a dim white light flashlight and avoid shining it in your or any other crewmember's eyes.

Airfield Precautions

Often time, pilots have no say in how airfield operations are handled, but listed below are some precautions that can be taken to make night flying safer and help protect night vision.

- Airfield lighting should be reduced to the lowest usable intensity.
- Maintenance personnel should practice light discipline with headlights and flashlights.
- Position the aircraft at a part of the airfield where the least amount of lighting exists.

- Select approach and departure routes that avoid highways and residential areas where illumination can impair night vision.

Self-Imposed Stress

Night flight can be more fatiguing and stressful than day flight, and many self-imposed stressors can limit night vision. Pilots can control this type of stress by knowing the factors that can cause self-imposed stressors. Some of these factors are listed in the following paragraphs. [Figure 17-20]

Drugs

Drugs can seriously degrade visual acuity during the day and especially at night. Pilots who become ill should consult an aviation medical examiner (AME) or flight surgeon as to which drugs are appropriate to take while flying.

Exhaustion

Pilots who become fatigued during a night flight will not be mentally alert and will respond more slowly to situations requiring immediate action. Exhausted pilots tend to concentrate on one aspect of a situation without considering the total requirement. Their performance may become a safety hazard depending on the degree of fatigue and instead of using proper scanning techniques may get fixated on the instruments or stare off rather than multitask.

Poor Physical Conditioning

To overcome poor physical conditioning, pilots should participate in regular exercise programs. People who are physically fit become less fatigued during flight and have better night scanning efficiency. However, too much exercise in a given day may leave crew members too fatigued for night flying.

Alcohol

Alcohol is a sedative and its use impairs both coordination and judgment. As a result, pilots who are impaired by alcohol fail to apply the proper techniques of night vision. They are likely to stare at objects and to neglect scanning techniques. The amount of alcohol consumed determines the degree to which night vision is affected. The effects of alcohol are long lasting and the residual effects of alcohol can also impair visual scanning efficiency.

Tobacco

Of all the self-imposed stressors, cigarette smoking most decreases visual sensitivity at night. Smoking significantly increases the amount of carbon monoxide carried by the hemoglobin in red blood cells. This reduces the blood's capacity to combine with oxygen, so less oxygen is carried in the blood. Hypoxia caused by carbon monoxide poisoning

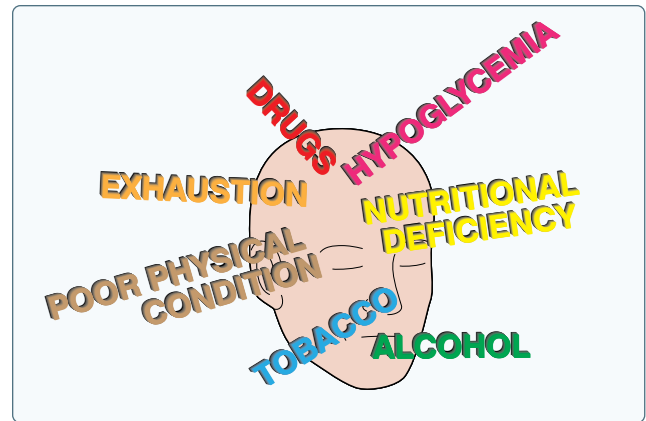


Figure 17-20. *Self-imposed stress.*

affects peripheral vision and dark adaptation. The results are the same as those for hypoxia caused by high altitude. Smoking 3 cigarettes in rapid succession or 20 to 30 cigarettes within a 24-hour period may saturate from 8 to 10 percent of the capacity of hemoglobin. Smokers lose 20 percent of their night vision capability at sea level, which is equal to a physiological altitude of 5,000 feet.

Hypoglycemia and Nutritional Deficiency

Missing or postponing meals can cause low blood sugar, which impairs night flight performance. Low blood sugar levels may result in stomach contractions, distraction, breakdown in habit pattern, and a shortened attention span. Likewise, an insufficient consumption of vitamin A may also impair night vision. Foods high in vitamin A include eggs, butter, cheese, liver, apricots, peaches, carrots, squash, spinach, peas, and most types of greens. High quantities of vitamin A do not increase night vision but a lack of vitamin A certainly impairs it.

Distance Estimation and Depth Perception

Knowledge of the mechanisms and cues affecting distance estimation and depth perception assist pilots in judging distances at night. These cues may be monocular or binocular. The monocular cues that aid in distance estimation and depth perception include motion parallax, geometric perspective, retinal image size, and aerial perspective.

Motion Parallax

Motion parallax refers to the apparent motion of stationary objects as viewed by an observer moving across the landscape. When the pilot or crewmember looks outside the aircraft perpendicular to the direction of travel, near objects appear to move backward, past, or opposite the path of motion; far objects seem to move in the direction of motion or remain fixed. The rate of apparent movement depends on the distance the observer is from the object.

Geometric Perspective

An object may appear to have a different shape when viewed at varying distances and from different angles. Geometric perspective cues include linear perspective, apparent foreshortening, and vertical position in the field.

- Linear perspective—parallel lines, such as runway lights, power lines and railroad tracks, tend to converge as distance from the observer increases. [Figure 17-21A]
- Apparent foreshortening—the true shape of an object or a terrain feature appears elliptical when viewed from a distance. [Figure 17-21B]
- Vertical position in the field—objects or terrain features farther away from the observer appear higher on the horizon than those closer to the observer. [Figure 17-21C]

Aerial Perspective

The clarity of an object and the shadow cast by it are perceived by the brain and are cues for estimating distance. Subtle variations in color or shade are clearer the closer the observer is to an object. However, as distance increases, these distinctions may become blurry. The same applies to an object detail or texture. As a person gets farther from an object, its discrete details become less apparent. Another important fact to remember while flying at night is that every object casts a shadow from a light source. The direction in which the shadow is cast depends on the position of the light source. If the shadow of an object is cast toward the observer, the object is closer than the light source is to the observer.

Binocular Cues

Binocular cues of an object are dependent upon the slightly different viewing angle of each eye of an object. Binocular perception is useful only when the object is close enough to

make an obvious difference in the viewing angle of both eyes. In the flight environment, most distances outside the cockpit are so great that binocular cues are of little, if any, value. In addition, binocular cues operate on a more subconscious level than monocular cues and are performed automatically.

Night Vision Illusions

There are many different types of visual illusions that commonly occur at night. Anticipating and maintaining awareness of them is usually the best way to avoid them.

Autokinesis

Autokinesis is caused by staring at a single point of light against a dark background for more than a few seconds. After a few moments, the light appears to move on its own. Apparent movement of the light source will begin in about 8 to 10 seconds. To prevent this illusion, focus the eyes on objects at varying distances and avoid fixating on one source of light. This illusion can be eliminated or reduced by visual scanning, by increasing the number of lights, or by varying the light intensity. The most important of the three solutions is visual scanning. A light or lights should not be stared at for more than 10 seconds.

False Horizon

A false horizon can occur when the natural horizon is obscured or not readily apparent. It can be generated by confusing bright stars and city lights. It can also occur while flying toward the shore of an ocean or a large lake. Because of the relative darkness of the water, the lights along the shoreline can be mistaken for stars in the sky. [Figure 17-22]

Reversible Perspective Illusion

At night, an aircraft may appear to be moving away from a second aircraft when it is, in fact, approaching a second aircraft. This illusion often occurs when an aircraft is flying

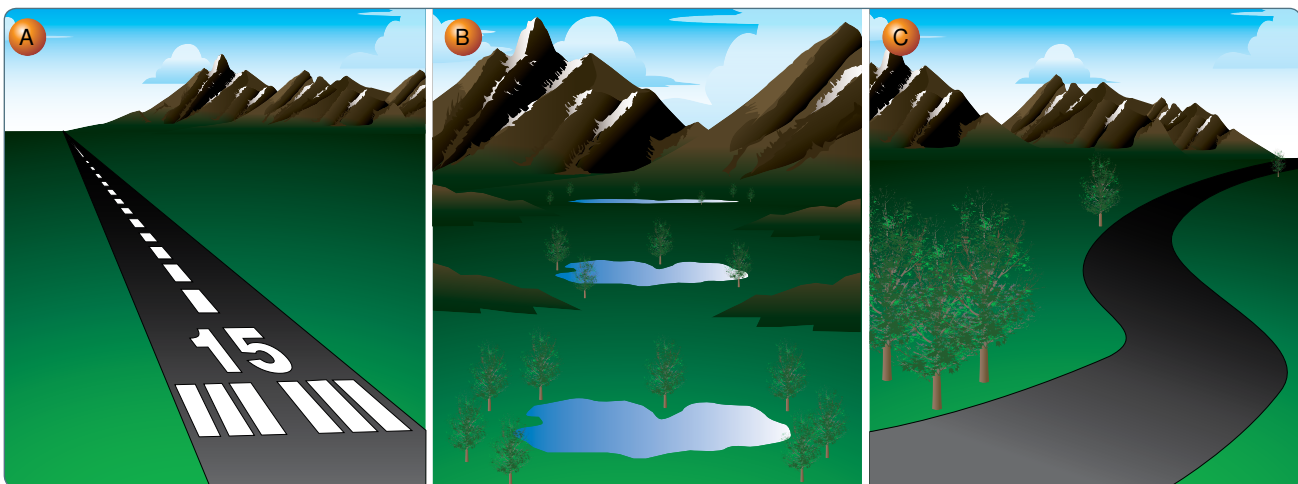


Figure 17-21. *Geometric perspective.*



Figure 17-22. At night, the horizon may be hard to discern due to dark terrain and misleading light patterns on the ground.

parallel to another's course. To determine the direction of flight, pilots should observe aircraft lights and their relative position to the horizon. If the intensity of the lights increases, the aircraft is approaching; if the lights dim, the aircraft is moving away.

Size-Distance Illusion

This illusion results from viewing a source of light that is increasing or decreasing in luminance (brightness). Pilots may interpret the light as approaching or retreating.

Fascination (Fixation)

This illusion occurs when pilots ignore orientation cues and fix their attention on a goal or an object. Student pilots tend to have this happen when they are concentrating on the aircraft instruments or attempting to land. They become fixated on one task and forget to look at what is going on around them. At night, this can be especially dangerous because aircraft ground-closure rates are difficult to determine, and there may be minimal time to correct the situation.

Flicker Vertigo

A light flickering at a rate between 4 and 20 cycles per second can produce unpleasant and dangerous reactions. Such conditions as nausea, vomiting, and vertigo may occur. On rare occasions, convulsions and unconsciousness may also occur. Proper scanning techniques at night can prevent pilots from getting flicker vertigo.

Night Landing Illusions

Landing illusions occur in many forms. Above featureless terrain at night, there is a natural tendency to fly a lower-than-normal approach. Elements that cause any type of visual obscurities, such as rain, haze, or a dark runway environment, can also cause low approaches. Bright lights,

steep surrounding terrain, and a wide runway can produce the illusion of being too low with a tendency to fly a higher-than-normal approach. A set of regularly spaced lights along a road or highway can appear to be runway lights. Pilots have even mistaken the lights on moving trains as runway or approach lights. Bright runway or approach lighting systems can create the illusion that the aircraft is closer to the runway, especially where few lights illuminate the surrounding terrain.

Prior to flying at night, it is best to learn and know the challenges of the area in which you are flying in. Study the area and know how to navigate your way through areas that may pose a problem at night. For example, many areas near water may be obscured by low lying clouds or fog. To help deal with this type of situation, it is important to have a plan before you leave the ground. In the daytime, fly the routes and passes that you will be flying at night and determine the minimum altitude you are willing to use at night. If weather prevents you from maintaining the altitude that you planned, make a decision early to turn 180° and land at an alternate airport with better weather conditions. Always consider safer alternatives rather than hope things will work out by taking a chance.

Pilots who fly at night should strongly consider oxygen supplementation at altitudes and times not required by the FAA, especially at night when critical judgment and hand-eye coordination is necessary (e.g., IFR) or if he/she is a smoker or not perfectly healthy.

Enhanced Night Vision Systems

Synthetic Vision Systems (SVS) and Enhanced Flight Vision Systems (EFVS) are two systems that can improve the safety of flight at night. The technology of both is evolving rapidly and being used more and more. [Figure 17-23]



Figure 17-23. Synthetic and enhanced vision systems.

Synthetic Vision System

A Synthetic Vision System (SVS) is an electronic means to display a synthetic vision image of the external scene topography to the flight crew. [Figure 17-24] It is not a real-time image like that produced by an EFVS. Unlike EFVS, SVS requires a terrain and obstacle database, a precise navigation solution, and a display. The terrain image is based on the use of data from a Digital Elevation Model (DEM) that is stored within the SVS. With SVS, the synthetic terrain/vision image is intended to enhance pilot awareness of spatial position relative to important features in all visibility conditions. This is particularly useful during critical phases of flight, such as takeoff, approach, and landing, where important features, such as terrain, obstacles, runways, and landmarks, may be depicted on the SVS display. [Figure 17-25] During approach operations, the

obvious advantages of SVS are that the digital terrain image remains on the pilot's display regardless of how poor the visibility is outside.

An SVS image can be displayed on either a head-down display or head-up display (HUD); however, to date, SVS has only been certified on head-down displays. Development efforts to display a synthetic image on a HUD are currently underway as are efforts that would combine SVS with a real-time sensor image produced by an EFVS. These systems are known as Combined Vision Systems. While SVS is currently certified as an aid to situation awareness only, the FAA and aviation industry are working on defining operational concepts and airworthiness criteria that would enable SVS to be used for operational credit in certain low visibility conditions. Other future enhancements to SVS displays could include integrating ADS-B to display traffic information.

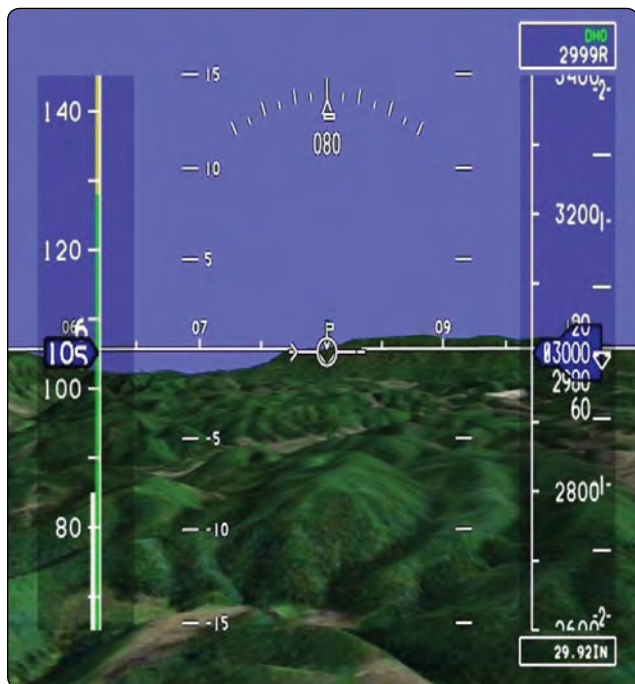


Figure 17-24. SVS system.

Enhanced Flight Vision System

Enhanced Vision (EV) or Enhanced Flight Vision System (EFVS) is an electronic means to provide a display of

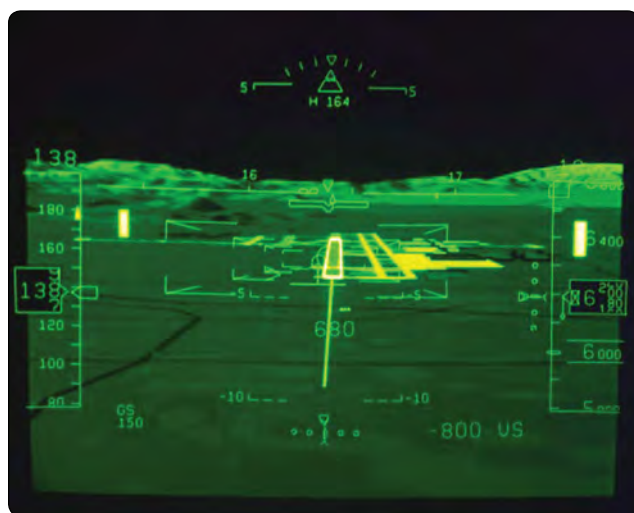


Figure 17-25. Night time SVS system.

the external scene by use of an imaging sensor, such as a Forward-Looking InfraRed (FLIR) or millimeter wave radar (MMWR). In 2004, 14 CFR part 91, section 91.175 was amended to reflect that operators conducting straight-in instrument approach procedures (in other than Category II or Category III operations) may now operate below the published decision height (DH) or minimum descent altitude (MDA) when using an approved EFVS shown on the pilot's HUD. This rule change provides "operational credit" for EV equipage. No such credit exists for SV.

Chapter Summary

This chapter provides an introduction to aeromedical factors relating to flight activities. More detailed information on the subjects discussed in this chapter is available in the Aeronautical Information Manual (AIM) and online at www.faa.gov.

Appendix A

Performance Data for Cessna Model 172R and Challenger 605

Short Field Takeoff Distance at 2,450 Pounds for a Cessna Model 172R

CONDITIONS:

Flaps 10°
Full Throttle Prior to Brake Release
Paved, level, dry runway
Zero Wind
Lift Off: 51 KIAS
Speed at 50 Ft: 57 KIAS

Press Alt In Feet	0°C		10°C		20°C		30°C		40°C	
	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst
S. L.	845	1510	910	1625	980	1745	1055	1875	1135	2015
1000	925	1660	1000	1790	1075	1925	1160	2070	1245	2220
2000	1015	1830	1095	1970	1185	2125	1275	2290	1365	2455
3000	1115	2020	1205	2185	1305	2360	1400	2540	1505	2730
4000	1230	2245	1330	2430	1435	2630	1545	2830	1655	3045
5000	1355	2500	1470	2715	1585	2945	1705	3175	1830	3430
6000	1500	2805	1625	3060	1750	3315	1880	3590	2020	3895
7000	1660	3170	1795	3470	1935	3770	2085	4105	2240	4485
8000	1840	3620	1995	3975	2150	4345	2315	4775	---	---

NOTES:

1. Short field technique as specified in Section 4.
2. Prior to takeoff from fields above 3000 feet elevation, the mixture should be leaned to give maximum RPM in a full throttle, static runup.
3. Decrease distances 10% for each 9 knots headwind. For operation with tail winds up to 10 knots, increase distances by 10% for each 2 knots.
4. For operation on dry, grass runway, increase distances by 15% of the "ground roll" figure.
5. Where distance value has been deleted, climb performance is minimal.

Time, Fuel, and Distance to Climb at 2,450 Pounds for a Cessna Model 172R

CONDITIONS:

Flaps Up
Full Throttle
Standard Temperature

PRESS ALT FT	TEMP °C	CLIMB SPEED KIAS	RATE OF CLIMB FPM	FROM SEA LEVEL		
				TIME IN MIN	FUEL USED GAL	DIST NM
S.L.	15	79	720	0	0.0	0
1000	13	78	670	1	0.4	2
2000	11	77	625	3	0.7	4
3000	9	76	575	5	1.2	6
4000	7	76	560	6	1.5	8
5000	5	75	515	8	1.8	11
6000	3	74	465	10	2.1	14
7000	1	73	415	13	2.5	17
8000	-1	72	365	15	3.0	21
9000	-3	72	315	18	3.4	25
10,000	-5	71	270	22	4.0	29
11,000	-7	70	220	26	4.6	35
12,000	-9	69	170	31	5.4	43

NOTES:

1. Add 1.1 gallons of fuel for engine start, taxi and takeoff allowance.
2. Mixture leaned above 3000 feet for maximum RPM.
3. Increase time, fuel and distance by 10% for each 10°C above standard temperature.
4. Distances shown are based on zero wind.

Cruise Performance for a Cessna Model 172R

CONDITIONS:

2450 Pounds

Recommended Lean Mixture At All Altitudes (Refer to Section 4, Cruise)

PRESS ALT FT	RPM	20°C BELOW STANDARD TEMP			STANDARD TEMPERATURE			20°C ABOVE STANDARD TEMP		
		% BHP	KTAS	GPH	% BHP	KTAS	GPH	% BHP	KTAS	GPH
2000	2250	---	---	---	79	115	9.0	74	114	8.5
	2200	79	112	9.1	74	112	8.5	70	111	8.0
	2100	69	107	7.9	65	106	7.5	62	105	7.1
	2000	61	101	7.0	58	99	6.6	55	97	6.4
	1900	54	94	6.2	51	91	5.9	50	89	5.8
4000	2300	--	---	---	79	117	9.1	75	117	8.6
	2250	80	115	9.2	75	114	8.6	70	114	8.1
	2200	75	112	8.6	70	111	8.1	66	110	7.6
	2100	66	106	7.6	62	105	7.1	59	103	6.8
	2000	58	100	6.7	55	98	6.4	53	95	6.2
	1900	52	92	6.0	50	90	5.8	49	87	5.6
6000	2350	--	---	---	80	120	9.2	75	119	8.6
	2300	80	117	9.2	75	117	8.6	71	116	8.1
	2250	76	115	8.7	71	114	8.1	67	113	7.7
	2200	71	112	8.1	67	111	7.7	64	109	7.3
	2100	63	105	7.2	60	104	6.9	57	101	6.6
	2000	56	98	6.4	53	96	6.2	52	93	6.0

NOTE:

1. Cruise speeds are shown for an airplane equipped with speed fairings. Without speed fairings, decrease speeds shown by 2 knots.

Short Field Landing Distance at 2,450 Pounds for a Cessna Model 172R

CONDITIONS:

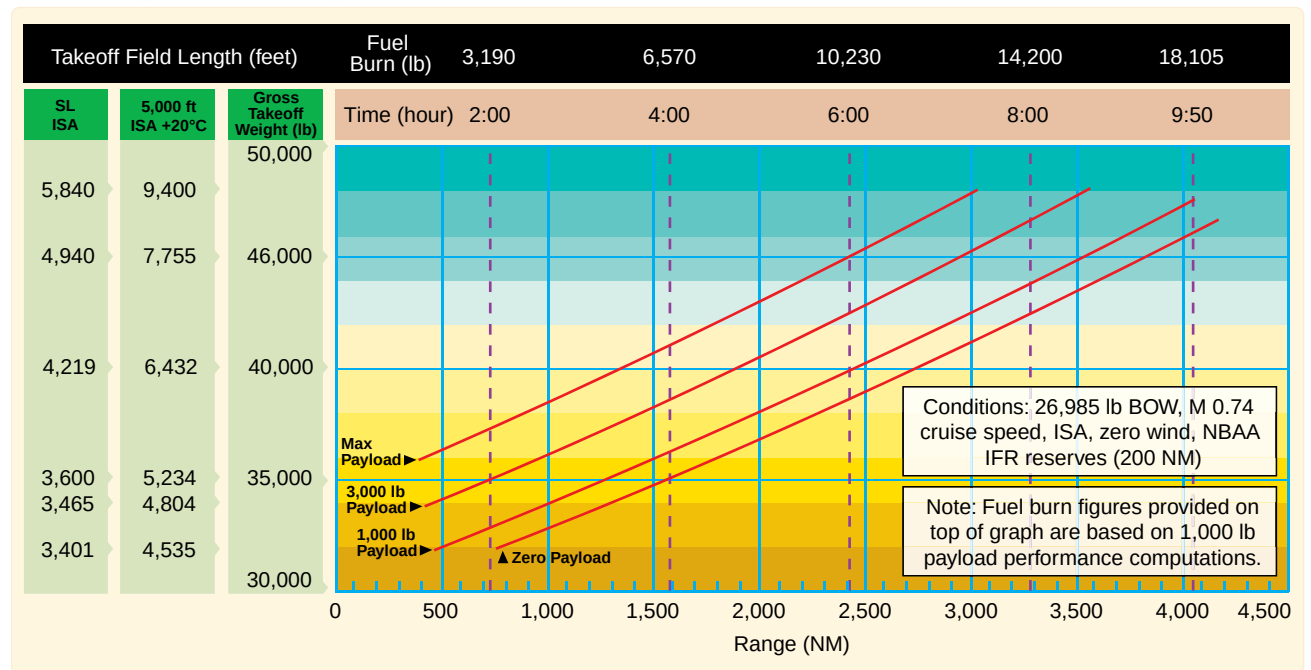
Flaps 30°
 Power Off
 Maximum Braking
 Paved, level, dry runway
 Zero Wind
 Speed at 50 Ft: 62 KIAS

Press Alt In Feet	0°C		10°C		20°C		30°C		40°C	
	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst	Grnd Roll Ft	Total Ft To Clear 50 Ft Obst
S. L.	525	1250	540	1280	560	1310	580	1340	600	1370
1000	545	1280	560	1310	580	1345	600	1375	620	1405
2000	565	1310	585	1345	605	1375	625	1410	645	1440
3000	585	1345	605	1380	625	1415	650	1445	670	1480
4000	605	1380	630	1415	650	1450	670	1485	695	1520
5000	630	1415	650	1455	675	1490	700	1525	720	1560
6000	655	1455	675	1490	700	1530	725	1565	750	1605
7000	680	1495	705	1535	730	1570	755	1610	775	1650
8000	705	1535	730	1575	755	1615	780	1655	810	1695

NOTES:

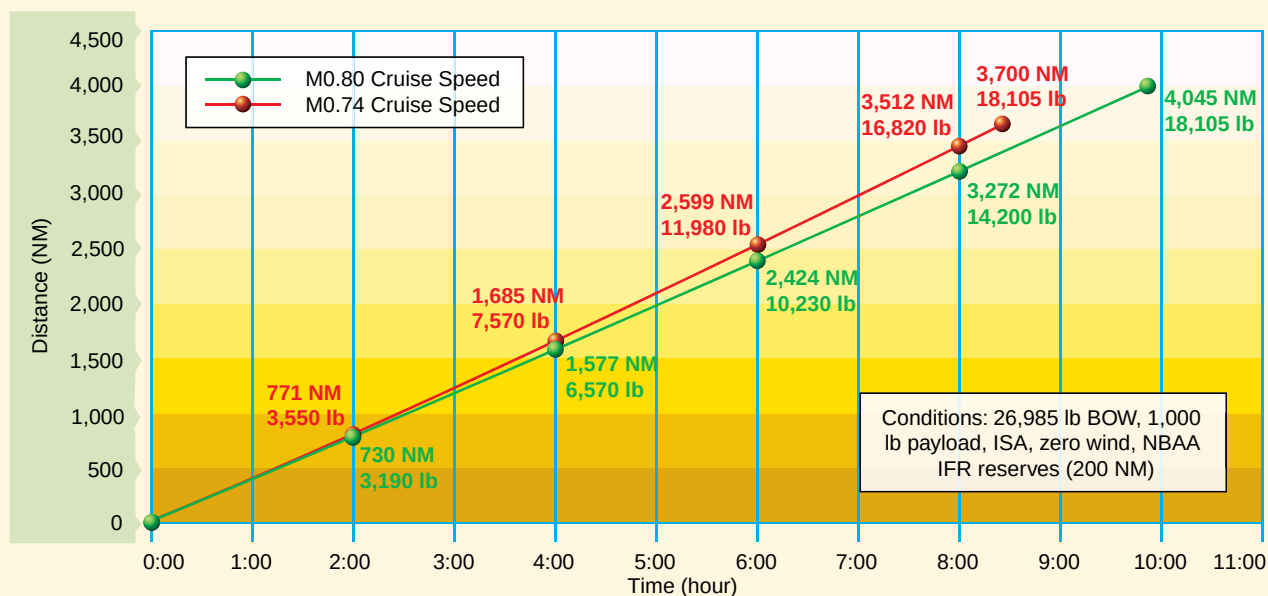
1. Short field technique as specified in Section 4.
2. Decrease distances 10% for each 9 knots headwind. For operation with tail winds up to 10 knots, increase distances by 10% for each 2 knots.
3. For operation on dry, grass runway, increase distances by 45% of the "ground roll" figure.
4. If landing with flaps up, increase the approach speed by 7 KIAS and allow for 35% longer distances.

Challenger 605 Range/Payload Profile



Challenger 605 Time and Fuel Versus Distance

CHALLENGER 605 TIME AND FUEL VERSUS DISTANCE

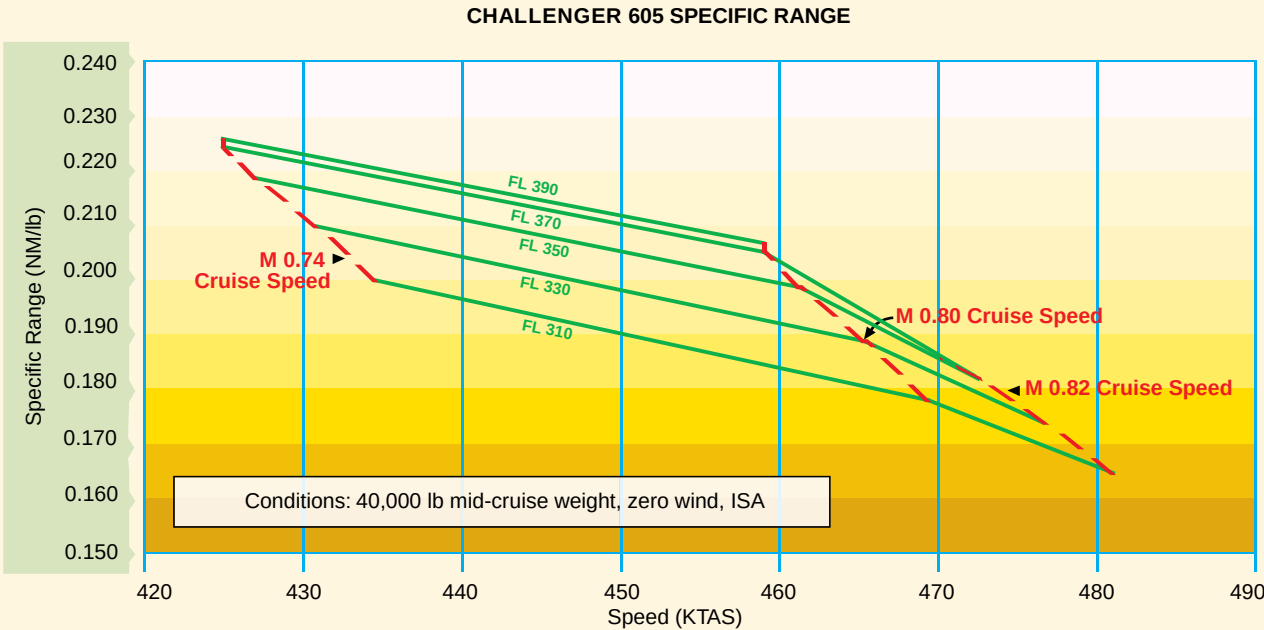


M0.80 Cruise Speed	Time	0:00	2:00	4:00	6:00	8:00	8:25
Distance (NM)		0	771	1,685	2,599	3,512	3,701
Fuel (lb)		0	3,550	7,570	11,980	16,820	18,105
M0.74 Cruise Speed	Time	0:00	2:00	4:00	6:00	8:00	9:50
Distance (NM)		0	730	1,577	2,424	3,272	4,045
Fuel (lb)		0	3,190	6,570	10,230	14,200	18,105

Conditions: 1,000 lb payload, ISA, zero wind, NBAA IFR reserves (200 NM alternate), 26,985 lb BOW

Note: All Challenger 605 performance data are for discussion purposes only. By this document, Bombardier Inc., does not intend to make, and is not making, any offer, commitment, representation or warranty of any kind whatsoever. All data are subject to change without prior notice.

Challenger 605 Time and Fuel Versus Distance



Plotting of constant FL lines		M0.82	M0.80	M0.74
Flight Level				
290	Speed			
	Spc Range			
310	Speed	481	469	434
	Spc Range	0.165	0.178	0.199
330	Speed	477	465	430
	Spc Range	0.174	0.188	0.208
350	Speed	473	461	427
	Spc Range	0.181	0.197	0.216
370	Speed	470	459	424
	Spc Range	0.185	0.204	0.222
390	Speed		459	424
	Spc Range		0.205	0.223

Plotting of Long Range Cruise and High Speed Cruise lines						
	FL290	FL310	FL330	FL350	FL370	FL390
M0.74 "X"	434	430	427	424	424	424
M0.74 "Y"	0.199	0.208	0.216	0.222	0.222	0.223
M0.80 "X"	469	465	461	459	459	459
M0.80 "Y"	0.178	0.188	0.197	0.204	0.204	0.205
M0.82 "X"	481	477	473	470	470	470
M0.82 "Y"	0.165	0.174	0.181	0.185	0.185	0.185

Note: Based on 40,000 lb mid-cruise weight, ISA Conditions, zero wind

Note: All Challenger 605 performance data are for discussion purposes only. By this document, Bombardier Inc., does not intend to make, and is not making, any offer, commitment, representation or warranty of any kind whatsoever. All data are subject to change without prior notice.

Appendix B

Acronyms, Abbreviations, and NOTAM Contractions

This is a list of common acronyms and abbreviations used in the aviation industry as well as NOTAM contractions. For a more complete list of contractions used in aviation, see FAA Order JO 7340.2 (as amended). Additional information regarding NOTAMs can be found at pilotweb.nas.faa.gov/PilotWeb/.

A

A/C—aircraft	ADIN—AUTODIN service
A/FD—airport/facility directory	ADIZ—air defense identification zone
A/G—air to ground	ADJ—adjacent
A/HA—altitude/height	ADL—aeronautical data-link
AAF—Army Air Field	ADLY—arrival delay
AAI—arrival aircraft interval	ADO—airline dispatch office
AAP—advanced automation program	ADP—automated data processing
AAR—airport acceptance rate	ADS—automatic dependent surveillance
ABDIS—Automated Data Interchange System Service B	ADSIM—airfield delay simulation model
ABN—aerodrome beacon	ADSY—administrative equipment systems
ABV—above	ADTN—Administrative Data Transmission Network
ACAIS—air carrier activity information system	ADTN2000—Administrative Data Transmission Network 2000
ACAS—aircraft collision avoidance system	ADVO—administrative voice
ACC—area control center; Airports Consultants Council	ADZD—advised
ACCT—accounting records	AEG—Aircraft Evaluation Group
ACCUM—accumulate	AERA—automated en route air traffic control
ACD—Automatic Call Distributor	AEX—automated execution
ACDO—Air Carrier District Office	AF—airway facilities
ACF—Area Control Facility	AFB—Air Force Base
ACFO—Aircraft Certification Field Office	AFIS—automated flight inspection system
ACFT—aircraft	AFP—area flight plan
ACID—aircraft identification	AFRES—Air Force Reserve Station
ACI-NA—Airports Council International-North America	AFS—airways facilities sector
ACIP—airport capital improvement plan	AFSFO—AFS field office
ACLS—automatic carrier landing system	AFSFU—AFS field unit
ACLT—actual landing time calculated	AFSOU—AFS field office unit (standard is AFSFOU)
ACO—Office of Airports Compliance and Field Operations;	AFSS—automated flight service station
Aircraft Certification Office	AFTN—Automated Fixed Telecommunications Network
ACR—air carrier	AGIS—airports geographic information system
ACRP—Airport Cooperative Research Program	AGL—above ground level
ACS—Airman Certification Standard	AID—airport information desk
ACT—active, activated, or activity	AIG—Airbus Industries Group
ADA—air defense area	AIM—Airman's Information Manual
ADAP—Airport Development Aid Program	AIP—airport improvement plan
ADAS—AWOS data acquisition system	AIRMET—Airmen's Meteorological Information
ADCCP—advanced data communications control procedure	AIRNET—Airport Network Simulation Model
ADDA—administrative data	AIS—aeronautical Information service
ADF—automatic direction finding	AIT—automated information transfer
ADI—automatic de-ice and inhibitor	ALP—airport layout plan

ALS—approach light system
 ALSF1—ALS with sequenced flashers I
 ALSF2—ALS with sequenced flashers II
 ALSIP—Approach Lighting System Improvement Plan
 ALSTG—altimeter setting
 ALT—altitude
 ALTM—altimeter
 ALTN—alternate
 ALTNLY—alternately
 ALTRV—altitude reservation
 AMASS—airport movement area safety system
 AMCC—ADF/ARTCC Maintenance Control Center
 AMDT—amendment
 AMGR—Airport Manager
 AMOS—Automatic meteorological observing system
 AMP—ARINC Message Processor; Airport Master Plan
 AMVER—automated mutual assistance vessel rescue system
 ANC—alternate network connectivity
 ANCA—Airport Noise and Capacity Act
 ANG—Air National Guard
 ANGB—Air National Guard Base
 ANMS—automated network monitoring system
 ANSI—American National Standards Group
 AOA—air operations area
 AP—airport; acquisition plan
 APCH—approach
 APL—airport lights
 APP—approach; approach control; Approach Control Office
 APS—airport planning standard
 AQAFO—Aeronautical Quality Assurance Field Office
 ARAC—Army Radar Approach Control (AAF); Aviation Rulemaking Advisory Committee
 ARCTR—FAA Aeronautical Center or Academy
 ARF—airport reservation function
 ARFF—aircraft rescue and fire fighting
 ARINC—Aeronautical Radio, Inc.
 ARLNO—Airline Office
 ARO—Airport Reservation Office
 ARP—airport reference point
 ARR—arrive; arrival
 ARRA—American Recovery and Reinvestment Act of 2009
 ARSA—airport service radar area
 ARSR—air route surveillance radar
 ARTCC—air route traffic control center
 ARTS—automated radar terminal system
 ASAS—aviation safety analysis system
 ASC—AUTODIN switching center
 ASCP—Aviation System Capacity Plan
 ASD—aircraft situation display
 ASDA—accelerate-stop distance available
 ASLAR—aircraft surge launch and recovery
 ASM—available seat mile
 ASOS—automated surface observing system

ASP—arrival sequencing program
 ASPH—asphalt
 ASQP—airline service quality performance
 ASR—airport surveillance radar
 ASTA—airport surface traffic automation
 ASV—airline schedule vendor
 AT—air traffic
 ATA—Air Transport Association of America
 ATAS—airspace and traffic advisory service
 ATC—air traffic control
 ATCAA—air traffic control assigned airspace
 ATCBI—air traffic control beacon indicator
 ATCCC—Air Traffic Control Command Center
 ATCO—Air Taxi Commercial Operator
 ATCRB—air traffic control radar beacon
 ATCRBS—air traffic control radar beacon system
 ATCSCC—Air Traffic Control System Command Center
 ATCT—airport traffic control tower
 ATIS—automatic terminal information service
 ATISR—ATIS recorder
 ATM—air traffic management; asynchronous transfer mode
 ATMS—advanced traffic management system
 ATN—Aeronautical Telecommunications Network
 ATODN—AUTODIN terminal (FUS)
 ATOMS—air traffic operations management system
 ATOVN—AUOTVON (facility)
 ATS—air traffic service
 ATSCCP—ATS contingency command post
 AUTH—authority
 AUTOB—automatic weather reporting system
 AUTODIN—DoD Automatic Digital Network
 AUTOVON—DoD Automatic Voice Network
 AVBL—available
 AVN—Aviation Standards National Field Office, Oklahoma City
 AVON—AUTOVON service
 AWIS—airport weather information
 AWOS—automatic weather; observing/reporting system
 AWP—Aviation Weather Processor
 AWP—aviation weather products generator
 AWS—air weather station
 AWY—airway
 AZM—azimuth

B

BA FAIR—braking action fair
 BA NIL—braking action nil
 BA POOR—braking action poor
 BANS—BRITE alphanumeric system
 BART—billing analysis reporting tool (GSA software tool)
 BASIC—basic contract observing station
 BASOP—military base operations

BC—back course
 BCA—benefit/cost analysis
 BCN—beacon
 BCR—benefit/cost ratio
 BDAT—digitized beacon data
 BERM—snowbank(s) containing earth/gravel
 BLW—below
 BMP—best management practices
 BND—bound
 BOC—Bell Operating Company
 bps—bits per second
 BRG—bearing
 BRI—basic rate interface
 BRITE—bright radar indicator terminal equipment
 BRL—building restriction line
 BUEC—back-up emergency communications
 BUECE—back-up emergency communications equipment
 BYD—beyond

C

C/S/S/N—capacity/safety/security/noise
 CAA—civil aviation authority; Clean Air Act
 CAAS—Class A Airspace
 CAB—civil aeronautics board
 CARF—Central Altitude Reservation Facility
 CASFO—Civil Aviation Security Office
 CAT—category; clear-air turbulence
 CAU—Crypto Ancillary Unit
 CBAS—Class B airspace
 CBI—computer based instruction
 CBSA—Class B surface area
 CC&O—customer cost and obligation
 CCAS—Class C Airspace
 CCC—Communications Command Center
 CCCC—staff communications
 CCCH—central computer complex host
 CCLKWS—counterclockwise
 CCS7-NI—Communication Channel Signal-7-Network Interconnect
 CCSA—Class C surface area
 CCSD—Command Communications Service Designator
 CCU—Central Control Unit
 CD—clearance delivery; common digitizer
 CDAS—Class D Airspace
 CDR—cost detail report
 CDSA—Class D surface area
 CDT—controlled departure time
 CDTI—cockpit display of traffic information
 CEAS—Class E Airspace
 CENTX—central telephone exchange
 CEP—capacity enhancement program
 CEQ—council on environmental quality

CERAP—center radar approach control; combined center radar approach control
 CESA—Class E surface area
 CFC—central flow control
 CFCF—Central Flow Control Facility
 CFCS—central flow control service
 CFR—Code of Federal Regulations
 CFWP—central flow weather processor
 CFWU—central flow weather unit
 CGAS—Class G Airspace; Coast Guard Air Station
 CHG—change
 CIG—ceiling
 CK—check
 CL—centerline
 CLC—course line computer
 CLIN—contract line item
 CLKWS—clockwise
 CLR—clearance, clear(s), cleared to
 CLSD—closed
 CLT—calculated landing time
 CM—commercial service airport
 CMB—climb
 CMSND—commissioned
 CNL—cancel
 CNMPS—Canadian Minimum Navigation Performance Specification Airspace
 CNS—consolidated NOTAM system
 CNSP—consolidated NOTAM system processor
 CO—central office
 COE—U.S. Army Corps of Engineers
 COM—communications
 COMCO—command communications outlet
 CONC—concrete
 CONUS—Continental United States
 CORP—private corporation other than ARINC or MITRE
 CPD—coupled
 CPE—customer premise equipment
 CPMIS—consolidated personnel management information system
 CRA—conflict resolution advisory
 CRDA—converging runway display aid
 CRS—course
 CRT—cathode ray tube
 CSA—communications service authorization
 CSIS—centralized storm information system
 CSO—customer service office
 CSR—communications service request
 CSS—central site system
 CTA—controlled time of arrival; control area
 CTA/FIR—control area/flight information region
 CTAF—common traffic advisory frequency
 CTAS—center-TRACON automation system

CTC—contact
CTL—control
CTMA—Center Traffic Management Advisor
CUPS—consolidated uniform payroll system
CVFR—controlled visual flight rules
CVTS—compressed video transmission service
CW—continuous wave
CWSU—Central Weather Service Unit
CWY—clearway

D

DA—direct access; decision altitude/decision height;
Descent Advisor
DABBS—DITCO automated bulletin board system
DAIR—direct altitude and identity readout
DALGT—daylight
DAR—Designated Agency Representative
DARC—direct access radar channel
dBA—decibels A-weighted
DBCRC—Defense Base Closure and Realignment
Commission
DBE—disadvantaged business enterprise
DBMS—database management system
DBRITE—digital bright radar indicator tower equipment
DCA—Defense Communications Agency
DCAA—dual call, automatic answer device
DCCU—Data Communications Control Unit
DCE—data communications equipment
DCMSND—decommissioned
DCT—direct
DDA—dedicated digital access
DDD—direct distance dialing
DDM—difference in depth of modulation
DDS—Digital Data Service
DEA—Drug Enforcement Agency
DEDS—data entry and display system
DEGS—degrees
DEIS—Draft Environmental Impact Statement
DEP—depart/departure
DEPPROC—departure procedures
DEWIZ—distance early warning identification zone
DF—direction finder
DFAX—digital facsimile
DFI—direction finding indicator
DGPS—Differential Global Positioning Satellite (System)
DH—decision height
DID—direct inward dial
DIP—drop and insert point
DIRF—direction finding
DISABLD—disabled
DIST—distance
DITCO—Defense Information Technology Contracting
Office Agency

DLA—delay or delayed
DLT—delete
DL Y—daily
DME—distance measuring equipment
DME/P—precision distance measuring equipment
DMN—Data Multiplexing Network
DMSTN—demonstration
DNL—day-night equivalent sound level (also called Ldn)
DOD—direct outward dial
DoD—Department of Defense
DOI—Department of Interior
DOS—Department of State
DOT—Department of Transportation
DOTCC—Department of Transportation Computer Center
DOTS—dynamic ocean tracking system
DP—dew point temperature
DRFT—snowbank(s) caused by wind action
DSCS—digital satellite compression service
DSPLCD—displaced
DSUA—dynamic special use airspace
DTS—dedicated transmission service
DUAT—direct user access terminal
DVFR—defense visual flight rules; day visual flight rules
DVOR—doppler very high frequency omni-directional range
DYSIM—dynamic simulator

E

E—east
EA—environmental assessment
EARTS—en route automated radar tracking system
EB—eastbound
ECOM—en route communications
ECVFP—expanded charted visual flight procedures
EDCT—expedite departure path
EFC—expect further clearance
EFIS—electronic flight information systems
EIAF—expanded inward access features
EIS—environmental impact statement
ELEV—elevation
ELT—emergency locator transmitter
ELWRT—electrowriter
EMAS—engineered materials arresting system
EMPS—en route maintenance processor system
EMS—environmental management system
E-MSAW—en route automated minimum safe altitude
warning
ENAV—en route navigational aids
ENG—engine
ENRT—en route
ENTR—entire
EOF—emergency Operating Facility
EPA—Environmental Protection Agency
EPS—Engineered Performance Standards

EPSS—enhanced packet switched service
 ERAD—en route broadband radar
 ESEC—en route broadband secondary radar
 ESF—extended superframe format
 ESP—en route spacing program
 ESYS—en route equipment systems
 ETA—estimated time of arrival
 ETE—estimated time en route
 ETG—enhanced target generator
 ETMS—enhanced traffic management system
 ETN—Electronic Telecommunications Network
 EVAS—enhanced vortex advisory system
 EVCS—emergency voice communications system
 EXC—except

F

F&E—facility and equipment
 FAA—Federal Aviation Administration
 FAAAC—FAA aeronautical center
 FAACIS—FAA communications information system
 FAATC—FAA technical center
 FAATSAT—FAA telecommunications satellite
 FAC—facility/facilities
 FAF—final approach fix
 FAN—MKR fan marker
 FAP—final approach point
 FAPM—FTS2000 associate program manager
 FAR—Federal Aviation Regulation
 FAST—final approach spacing tool
 FAX—facsimile equipment
 FBO—fixed base operator
 FBS—fall back switch
 FCC—Federal Communications Commission
 FCLT—freeze calculated landing time
 FCOM—FSS radio voice communications
 FCPU—Facility Central Processing Unit
 FDAT—flight data entry and printout (FDEP) and flight data service
 FDC—flight data center
 FDE—flight data entry
 FDEP—flight data entry and printout
 FDIO—flight data input/output
 FDIOC—flight data input/output center
 FDIOR—flight data input/output remote
 FDM—frequency division multiplexing
 FDP—flight data processing
 FED—federal
 FEIS—Final Environmental Impact Statement
 FEP—front end processor
 FFAC—from facility
 FI/P—flight inspection permanent
 FI/T—flight inspection temporary
 FIFO—Flight Inspection Field Office

FIG—flight inspection group
 FINO—Flight Inspection National Field Office
 FIPS—federal information publication standard
 FIR—flight information region
 FIRE—fire station
 FIRMR—Federal Information Resource Management Regulation
 FL—flight level
 FLOWSIM—traffic flow planning simulation
 FM—from
 FMA—final monitor aid
 FMF—facility master file
 FMIS—FTS2000 management information system
 FMS—flight management system
 FNA—final approach
 FNMS—FTS2000 network management system
 FOIA—Freedom Of Information Act
 FONSI—finding of no significant impact
 FP—flight plan
 FPM—feet per minute
 FRC—request full route clearance
 FREQ—frequency
 FRH—fly runway heading
 FRI—Friday
 FRZN—frozen
 FSAS—flight service automation system
 FSDO—Flight Standards District Office
 FSDPS—flight service data processing system
 FSEP—facility/service/equipment profile
 FSP—flight strip printer
 FSPD—freeze speed parameter
 FSS—flight service station
 FSSA—flight service station automated service
 FSTS—federal secure telephone service
 FSYS—flight service station equipment systems
 FTS—federal telecommunications system
 FT—feet/foot
 FTS2000—Federal Telecommunications System 2000
 FUS—functional units or systems
 FWCS—flight watch control station

G

GA—general aviation
 GAA—general aviation activity
 GAAA—general aviation activity and avionics
 GADO—General Aviation District Office
 GC—ground control
 GCA—ground control approach
 GIS—geographic information system
 GNAS—general national airspace system
 GNSS—global navigation satellite system
 GOES—Geostationary Operational Environmental Satellite
 GOESF—GOES feed point

GOEST—GOES terminal equipment
GOVT—government
GP—glide path
GPRA—Government Performance Results Act
GPS—global positioning system
GPWS—ground proximity warning system
GRADE—graphical airspace design environment
GRVL—gravel
GS—glide slope indicator
GSA—General Services Administration
GSE—ground support equipment

H

H—non-directional radio homing beacon (NDB)
HAA—height above airport
HAL—height above landing
HARS—high altitude route system
HAT—height above touchdown
HAZMAT—hazardous materials
HCAP—high capacity carriers
HDG—heading
HDME—NDB with distance measuring equipment
HDQ—FAA headquarters
HEL—helicopter
HELI—heliport
HF—high frequency
HH—NDB, 2kw or more
HI-EFAS—high altitude EFAS
HIRL—high intensity runway lights
HIWAS—Hazardous Inflight Weather Advisory Service
HLDC—high level data link control
HLDG—holding
HOL—holiday
HOV—high occupancy vehicle
HP—holding pattern
HR—hour
HSI—horizontal situation indicators
HUD—housing and urban development
HWAS—hazardous in-flight weather advisory
Hz—Hertz

I

I/AFSS—international AFSS
IA—indirect access
IAF—initial approach fix
IAP—instrument approach procedures
IAPA—instrument approach procedures automation
IBM—International Business Machines
IBP—international boundary point
IBR—intermediate bit rate
ICAO—International Civil Aviation Organization
ICSS—international communications switching systems

ID—identification
IDAT—interfacility data
IDENT—identify/identifier/identification
IF—intermediate fix
IFCP—interfacility communications processor
IFDS—interfacility data system
IFEA—in-flight emergency assistance
IFO—International Field Office
IFR—instrument flight rules
IFSS—international flight service station
ILS—instrument landing system
IM—inner marker
IMC—instrument meteorological conditions
IN—inch/inches
INBD—inbound
INDEFLY—indefinitely
INFO—information
INM—integrated noise model
INOP—inoperative
INS—inertial navigation system
INSTR—instrument
INT—intersection
INTL—international
INTST—intensity
IR—ice on runway(s)
IRMP—information resources management plan
ISDN—integrated services digital network
ISMLS—interim standard microwave landing system
ITI—interactive terminal interface
IVRS—interim voice response system
IW—inside wiring

K

Kbps—Kilobits per second
Khz—Kilohertz
KT—knots
KVDT—keyboard video display terminal

L

L—left
LAA—local airport advisory
LAAS—low altitude alert system
LABS—leased A B service
LABSC—LABS GS-200 computer
LABSR—LABS remote equipment
LABSW—LABS switch system
LAHSO—land and hold short operation
LAN—local area network
LAT—latitude
LATA—local access and transport area
LAWRS—limited aviation weather reporting station
LB—pound/pounds

LC—local control
 LCF—local control facility
 LCN—local communications network
 LCTD—located
 LDA—localizer-type directional aid; landing directional aid
 LDG—landing
 LDIN—lead-in lights
 LEC—local exchange carrier
 LF—low frequency
 LGT—light or lighting
 LGTD—lighted
 LINCS—leased interfacility NAS C
 LIRL—low intensity runway lights
 LIS—logistics and inventory system
 LLWAS—low level wind shear alert system
 LLZ—localizer
 LM—compass locator at ILS middle marker
 LM/MS—low/medium frequency
 LMM—locator middle marker
 LO—compass locator at ILS outer marker
 LOC—local; locally; location; localizer
 LOCID—location identifier
 LOI—letter of intent
 LOM—compass locator at outer marker
 LONG—longitude
 LPV—lateral precision performance with vertical guidance
 LRCO—limited remote communications outlet
 LRNAV—long range navigation
 LRR—long range radar
 LSR—loose snow on runway(s)
 LT—left turn

M

MAA—maximum authorized altitude
 MAG—magnetic
 MAINT—maintain, maintenance
 MALS—medium intensity approach light system
 MALSF—medium intensity approach light system with sequenced flashers
 MALSR—medium intensity approach light system with runway alignment indicator lights
 MAP—maintenance automation program; military airport program; missed approach point; modified access pricing
 MAPT—missed approach point
 Mbps—megabits per second
 MCA—minimum crossing altitude
 MCAS—Marine Corps air station
 MCC—maintenance control center
 MCL—middle compass locator
 MCS—maintenance and control system
 MDA—minimum descent altitude
 MDT—maintenance data terminal
 MEA—minimum en route altitude

MED—medium
 METI—meteorological information
 MF—middle frequency
 MFJ—modified final judgment
 MFT—meter fix crossing time/slot time
 MHA—minimum holding altitude
 Mhg—Meghertz
 MIA—minimum IFR altitudes
 MIDO—Manufacturing Inspection District Office
 MIN—minute
 MIRL—medium intensity runway lights
 MIS—Meteorological Impact Statement
 MISC—miscellaneous
 MISO—Manufacturing Inspection Satellite Office
 MIT—miles in trail
 MITRE—Mitre Corporation
 MLS—microwave landing system
 MM—middle marker
 MMAC—Mike Monroney Aeronautical Center
 MMC—maintenance monitoring console
 MMS—maintenance monitoring system
 MNM—minimum
 MNPS—minimum navigation performance specification
 MNPSA—minimum navigation performance specifications airspace
 MNT—monitor; monitoring; monitored
 MOA—memorandum of agreement; military operations area
 MOC—minimum obstruction clearance
 MOCA—minimum obstruction clearance altitude
 MODE C—altitude-encoded beacon reply; altitude reporting mode of secondary radar
 MODE S—mode select beacon system
 MON—Monday
 MOU—memorandum of understanding
 MPO—Metropolitan Planning Organization
 MPS—maintenance processor subsystem or master plan supplement
 MRA—minimum reception altitude
 MRC—monthly recurring charge
 MSA—minimum safe altitude; minimum sector altitude
 MSAW—minimum safe altitude warning
 MSG—message
 MSL—mean sea level
 MSN—message switching network
 MTCS—modular terminal communications system
 MTI—moving target indicator
 MU—mu meters
 MUD—mud
 MUNI—municipal
 MUX—multiplexor
 MVA—minimum vectoring altitude
 MVFR—marginal visual flight rules

N

N—north
NA—not authorized
NAAQS—national ambient air quality standards
NADA—ADIN concentrator
NADIN—National Airspace Data Interchange Network
NADSW—NADIN switches
NAILS—National Airspace Integrated Logistics Support
NAMS—NADIN IA
NAPRS—National Airspace Performance Reporting System
NAS—National Airspace System or Naval Air Station
NASDC—National Aviation Safety Data
NASP—National Airspace System Plan
NASPAC—National Airspace System Performance Analysis Capability
NATCO—National Communications Switching Center
NAV—navigation
NAVAID—navigation aid
NAVMN—navigation monitor and control
NAWAU—National Aviation Weather Advisory Unit
NAWPF—National Aviation Weather Processing Facility
NB—northbound
NCAR—National Center for Atmospheric Research, Boulder, CO
NCF—National Control Facility
NCIU—NEXRAD Communications Interface Unit
NCP—noise compatibility program
NCS—national communications system
NDB—non-directional radio beacon
NDNB—NADIN II
NE—northeast
NEM—noise exposure map
NEPA—National Environmental Policy Act
NEXRAD—next generation weather radar
NFAX—National Facsimile Service
NFDC—National Flight Data Center
NFIS—NAS Facilities Information System
NGT—night
NI—network interface
NICS—national interfacility communications system
NM—nautical mile(s)
NMAC—near mid-air collision
NMC—National Meteorological Center
NMCE—network monitoring and control equipment
NMCS—network monitoring and control system
NMR—nautical mile radius
NOAA—National Oceanic and Atmospheric Administration
NOC—notice of completion
NONSTD—nonstandard
NOPT—no procedure turn required
NOTAM—notice to airmen
NPDES—National pollutant discharge elimination system
NPE—non-primary airport entitlement

NPIAS—national plan of integrated airport systems
NR—number
NRC—non-recurring charge
NRCS—national radio communications systems
NSAP—National Service Assurance Plan
NSRCATN—National Strategy to Reduce Congestion on America's Transportation Network
NSSFC—National Severe Storms Forecast Center
NSSL—National Severe Storms Laboratory, Norman, OK
NSWRH—NWS Regional Headquarters
NTAP—Notices To Airmen Publication
NTP—National Transportation Policy
NTSB—National Transportation Safety Board
NTZ—no transgression zone
NW—northwest
NWS—National Weather Service
NWSR—NWS weather excluding NXRD
NXRD—advanced weather radar system

O

OAG—official airline guide
OALT—operational acceptable level of traffic
OAW—off-airway weather station
OBSC—obscured
OBST—obstruction
ODAL—omnidirectional approach lighting system
ODAPS—oceanic display and processing station
OEP—operational evolution plan/partnership
OFA—object free area
OFDPS—offshore flight data processing system
OFT—outer fix time
OFZ—obstacle free zone
OM—outer marker
OMB—Office Of Management and Budget
ONER—Oceanic Navigational Error Report
OPLT—operational acceptable level of traffic
OPR—operate
OPS—operation
OPSW—operational switch
OPX—off premises exchange
ORD—operational readiness demonstration
ORIG—original
OTR—oceanic transition route
OTS—out of service; organized track system
OVR—over

P

PABX—private automated branch exchange
PAD—packet assembler/disassembler
PAEW—personnel and equipment working
PAM—peripheral adapter module
PAPI—precision approach path indicator
PAR—precision approach radar; preferential arrival route

PARL—parallel
 PAT—pattern
 PATWAS—Pilots Automatic Telephone Weather Answering Service
 PAX—passenger
 PBCT—proposed boundary crossing time
 PBRF—pilot briefing
 PBX—private branch exchange
 PCA—positive control airspace
 PCL—pilot controlled lighting
 PCM—pulse code modulation
 PD—Pilot Deviation
 PDAR—preferential arrival and departure route
 PDC—pre-departure clearance; program designator code
 PDN—Public Data Network
 PDR—preferential departure route
 PERM—permanent/permanently
 PFC—passenger facility charge
 PGP—planning grant program
 PIC—principal interexchange carrier
 PIDP—programmable indicator data processor
 PIREP—pilot weather report
 PJE—parachute jumping exercise
 PLA—practice low approach
 PLW—plow/plowed
 PMS—program management system
 PNR—prior notice required
 POLIC—police station
 POP—point of presence
 POT—point of termination
 PPIMS—personal property information management system
 PPR—prior permission required
 PR—primary commercial service airport
 PREV—previous
 PRI—primary rate interface
 PRM—precision runway monitor
 PRN—pseudo random noise
 PROC—procedure
 PROP—propeller
 PSDN—public switched data network
 PSN—packet switched network
 PSR—packed snow on runway(s)
 PSS—packet switched service
 PSTN—public switched telephone network
 PTC—presumed-to-conform
 PTCHY—patchy
 PTN—procedure turn
 PUB—publication
 PUP—principal user processor
 PVC—permanent virtual circuit
 PVD—plan view display
 PVT—private

R

RAIL—runway alignment indicator lights
 RAMOS—remote automatic meteorological observing system
 RAPCO—radar approach control (USAF)
 RAPCON—radar approach control (FAA)
 RATCC—Radar Air Traffic Control Center
 RATCF—Radar Air Traffic Control Facility (USN)
 RBC—rotating beam ceilometer
 RBDPE—radar beacon data processing equipment
 RBSS—Radar Bomb Scoring Squadron
 RCAG—remote communications air/ground facility
 RCC—Rescue Coordination Center
 RCCC—Regional Communications Control Centers
 RCF—Remote Communication Facility
 RCIU—Remote Control Interface Unit
 RCL—runway centerline; radio communications link
 RCLL—runway centerline light system
 RCLR—RCL repeater
 RCLT—RCL terminal
 RCO—remote communications outlet
 RCU—remote control unit
 RDAT—digitized radar data
 RDP—radar data processing
 RDSIM—runway delay simulation model
 REC—receive/receiver
 REIL—runway end identifier lights
 RELCTD—relocated
 REP—report
 RF—radio frequency
 RL—General Aviation Reliever Airport
 RLLS—runway lead-in lights system
 RMCC—Remote Monitor Control Center
 RMCF—Remote Monitor Control Facility
 RML—radio microwave link
 RMLR—RML repeater
 RMLT—RML terminal
 RMM—remote maintenance monitoring
 RMMS—remote maintenance monitoring system
 RMNDR—remainder
 RMS—remote monitoring subsystem
 RMSC—remote monitoring subsystem concentrator
 RNAV—area navigation
 RNP—required navigation performance
 ROD—record of decision
 ROSA—report of service activity
 ROT—runway occupancy time
 RP—restoration priority
 RPC—restoration priority code
 RPG—radar processing group
 RPLC—replace

RPZ—runway protection zone
 RQRD—required
 RRH—remote reading hygrometer
 RRHS—remote reading hydrometer
 RRL—runway remaining lights
 RRWDS—remote radar weather display
 RRWSS—RWDS sensor site
 RSA—runway safety area
 RSAT—runway safety action team
 RSR—en route surveillance radar
 RSS—remote speaking system
 RSVN—reservation
 RT—right turn; remote transmitter
 RT & BTL—radar tracking and beacon tracking level
 RTAD—remote tower alphanumeric display
 RTCA—Radio Technical Commission for Aeronautics
 RTE—route
 RTP—regional transportation plan
 RTR—remote transmitter/receiver
 RTRD—remote tower radar display
 RTS—return to service
 RUF—rough
 RVR—runway visual range
 RVRM—runway visual range midpoint
 RVRR—runway visual range rollout
 RVRT—runway visual range touchdown
 RW—runway
 RWDS—same as RRWDS
 RWP—real-time weather processor
 RWY—runway

S

S—south
 S/S—sector suite
 SA—sand, sanded
 SAC—Strategic Air Command
 SAFI—semi-automatic flight inspection
 SALS—short approach lighting system
 SAT—Saturday
 SATCOM—satellite communications
 SAWR—Supplementary Aviation Weather Reporting Station
 SAWRS—Supplementary Aviation Weather Reporting System
 SB—southbound
 SBGP—state block grant program
 SCC—System Command Center
 SCVTS—Switched Compressed Video Telecommunications Service
 SDF—simplified directional facility; simplified direction finding; software defined network
 SDIS—switched digital integrated service
 SDP—service delivery point

SD-ROB—radar weather report
 SDS—switched data service
 SE—southeast
 SEL—single event level
 SELF—simplified short approach lighting system with sequenced flashing lights
 SFAR-38—Special Federal Aviation Regulation 38
 SFL—sequence flashing lights
 SHPO—State Historic Preservation Officer
 SIC—service initiation charge
 SID—standard instrument departure; station identifier
 SIGMET—significant meteorological information
 SIMMOD—airport and airspace simulation model
 SIMUL—simultaneous
 SIP—state implementation plan
 SIR—packed or compacted snow and ice on runway(s)
 SKED—scheduled
 SLR—slush on runway(s)
 SM—statute miles
 SMGC—surface movement guidance and control
 SMPS—sector maintenance processor subsystem
 SMS—safety management system; simulation modeling system
 SN—snow
 SNBNK—snowbank(s) caused by plowing
 SNGL—single
 SNR—signal-to-noise ratio, also: S/N
 SOAR—system of airports reporting
 SOC—service oversight center
 SOIR—simultaneous operations on intersecting runways
 SOIWR—simultaneous operations on intersecting wet runways
 SPD—speed
 SRAP—sensor receiver and processor
 SSALF—simplified short approach lighting system with sequenced flashers
 SSALR—simplified short approach lighting system with runway alignment indicator lights
 SSALS—simplified short approach lighting system
 SSB—single side band
 SSR—secondary surveillance radar
 STA—straight-in approach
 STAR—standard terminal arrival route
 STD—standard
 STMUX—statistical data multiplexer
 STOL—short takeoff and landing
 SUN—Sunday
 SURPIC—surface picture
 SVC—service
 SVCA—service A
 SVCB—service B
 SVCC—service C

SVCO—service O
 SVFB—interphone service F (B)
 SVFC—interphone service F (C)
 SVFD—interphone service F (D)
 SVFO—interphone service F (A)
 SVFR—special visual flight rules
 SW—southwest
 SWEPT—swept or broom/broomed

T

T—temperature
 T1MUX—T1 multiplexer
 TAA—terminal arrival area
 TAAS—terminal advance automation system
 TACAN—tactical air navigation
 TACR—TACAN at VOR, TACAN only
 TAF—terminal area forecast
 TAR—terminal area surveillance radar
 TARS—terminal automated radar service
 TAS—true air speed
 TATCA—terminal air traffic control automation
 TAVT—terminal airspace visualization tool
 TCA—traffic control airport or tower control airport;
 terminal control area
 TCACCIS—Transportation Coordinator Automated
 Command And Control Information System
 TCAS—Traffic Alert and Collision Avoidance System
 TCC—DOT Transportation Computer Center
 TCCC—Tower Control Computer Complex
 TCE—tone control equipment
 TCLT—tentative calculated landing time
 TCO—Telecommunications Certification Officer
 TCOM—Terminal Communications
 TCS—tower communications system
 TDLS—Tower Data-Link Services
 TDMUX—time division data multiplexer
 TDWR—terminal doppler weather radar
 TDZ—touchdown zone
 TDZ LG—touchdown zone lights
 TELCO—telephone company
 TELMS—telecommunications management system
 TEMPO—temporary
 TERPS—terminal instrument procedures
 TFAC—to facility
 TFC—traffic
 TFR—temporary flight restriction
 TGL—touch-and-go landings
 TH—threshold
 THN—thin
 THR—threshold
 THRU—through
 THU—Thursday
 TIL—until

TIMS—telecommunications information management system
 TIPS—terminal information processing system
 TKOF—takeoff
 TL—taxilane
 TM—traffic management
 TM&O—telecommunications management and operations
 TMA—Traffic Management Advisor
 TMC—Traffic Management Coordinator
 TMC/MC—Traffic Management Coordinator/Military
 Coordinator
 TMCC—terminal information processing system; Traffic
 Management Computer Complex
 TMF—Traffic Management Facility
 TML—television microwave link
 TMLI—television microwave link indicator
 TMLR—television microwave link repeater
 TMLT—television microwave link terminal
 TMP—Traffic Management Processor
 TMPA—traffic management program alert
 TMS—traffic management system
 TMSPS—traffic management specialists
 TMU—traffic management unit
 TNAV—terminal navigational aids
 TODA—takeoff distance available
 TOF—time of flight
 TOFMS—time of flight mass spectrometer
 TOPS—Telecommunications Ordering And Pricing System
 (GSA software tool)
 TORA—take-off run available
 TR—telecommunications request
 TRACAB—terminal radar approach control in tower cab
 TRACON—Terminal Radar Approach Control Facility
 TRAD—terminal radar service
 TRB—Transportation Research Board
 TRML—terminal
 TRNG—training
 TRSN—transition
 TSA—taxiway safety area; Transportation Security
 Administration
 TSEC—terminal secondary radar service
 TSNT—transient
 TSP—telecommunications service priority
 TSR—telecommunications service request
 TSYS—terminal equipment systems
 TTMA—TRACON Traffic Management Advisor
 TTY—teletype
 TUE—Tuesday
 TVOR—terminal VHF omnidirectional range
 TW—taxiway
 TWEB—transcribed weather broadcast
 TWR—tower
 TWY—taxiway
 TY—type (FAACIS)

U

UAS—unmanned aircraft systems
UFN—until further notice
UHF—ultra high frequency
UNAVBL—unavailable
UNLGTD—unlighted
UNMKD—unmarked
UNMNT—unmonitored
UNREL—unreliable
UNUSBL—unusable
URA—Uniform Relocation Assistance and Real Property
Acquisition Policies Act of 1970
USAF—United States Air Force
USC—United States Code
USOC—Uniform Service Order Code

V

V/PD—Vehicle/pedestrian deviation
VALE—voluntary airport low emission
VASI—visual approach slope indicator
VDME—VOR with distance measuring equipment
VDP—visual descent point
VF—voice frequency
VFR—visual flight rules
VGSI—visual glide slope indicator
VHF—very high frequency
VIA—by way of
VICE—instead/versus
VIS—visibility
VLF—very low frequency
VMC—visual meteorological conditions
VNAV—visual navigational aids
VNTSC—Volpe National Transportation System Center
VOL—volume
VON—virtual on-net
VOR—VHF omnidirectional range
VOR/DME—VHF omnidirectional range/distance
measuring equipment
VORTAC—VOR and TACAN (collocated)
VOT—VOR Test Facility
VP/D—vehicle/pedestrian deviation
VRS—voice recording system
VSCS—voice switching and control system
VTA—vertex time of arrival
VTAC—VOR and TACAN (collocated)
VTOL—vertical takeoff and landing
VTS—voice telecommunications system

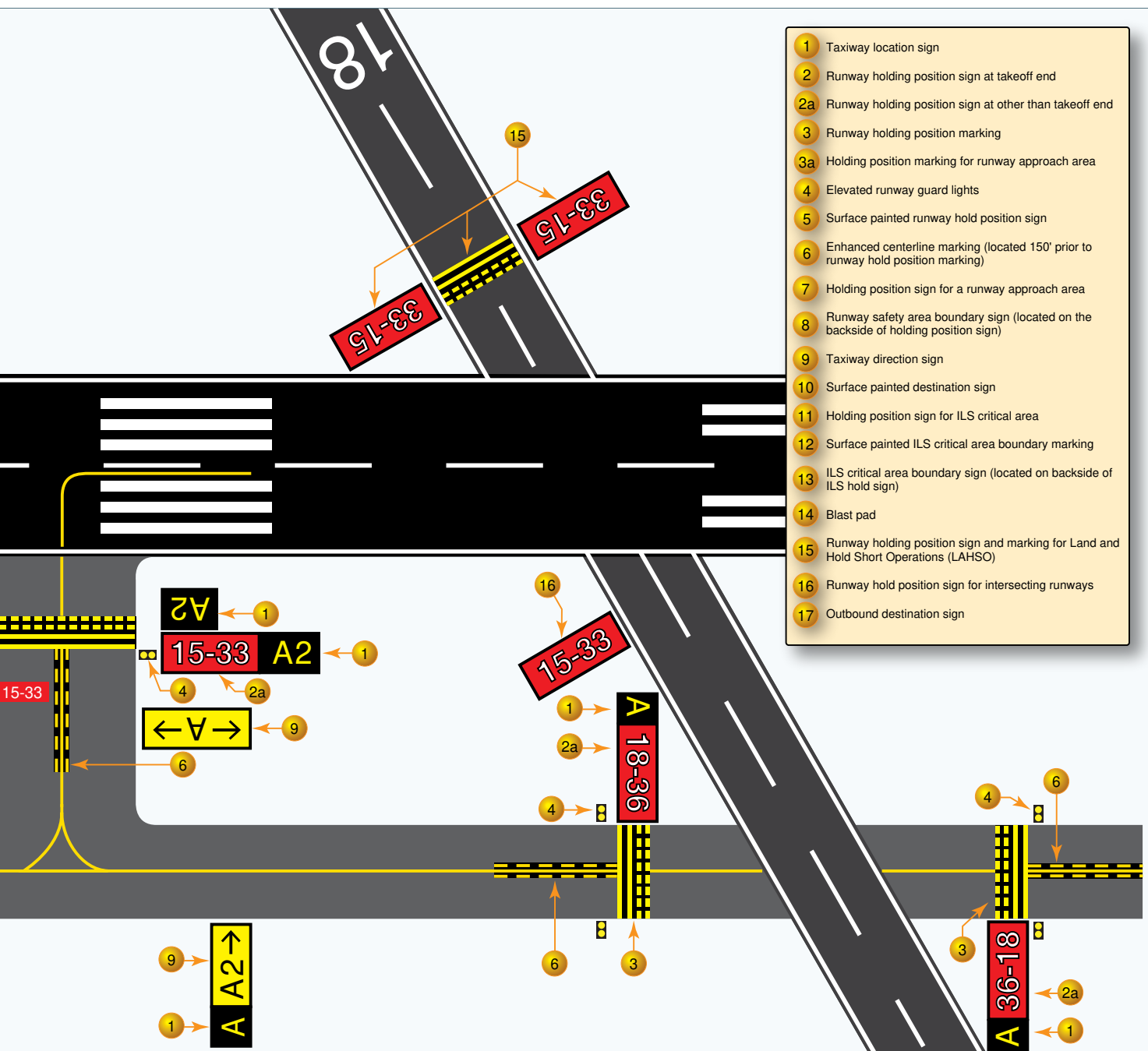
W

W—west
WAAS—Wide Area Augmentation System
WAN—wide area network
WB—westbound
WC—work center
WCP—Weather Communications Processor
WECO—Western Electric Company
WED—Wednesday
WEF—with effect from; effective from
WESCOM—Western Electric Satellite Communications
WI—within
WIE—with immediate effect, or effective immediately
WKDAYS—Monday through Friday
WKEND—Saturday and Sunday
WMSC—Weather Message Switching Center
WMSCR—Weather Message Switching Center Replacement
WND—wind
WPT—waypoint
WSCMO—Weather Service Contract Meteorological
Observatory
WSFO—Weather Service Forecast Office
WSMO—Weather Service Meteorological Observatory
WSO—Weather Service Office
WSR—wet snow on runway(s)
WTHR—weather
WTR—water on runway(s)
WX—weather

Airport Signs and Markings

Airport Signs			
Type of Sign	Action or Purpose	Type of Sign	Action or Purpose
	Taxiway/Runway Hold Position: Holding position for RWY 4-22 on TWY A.		Runway Safety Area Boundary: Identifies exit boundary of runway safety area.
	Runway/Runway Intersection: Identifies intersecting runways or holding position for LAHSO operations.		ILS Critical Area Boundary: Identifies exit boundary of ILS critical area.
	Runway Approach Hold Position: Runway approach holding position for RWY 8 on TWY B.		Taxiway Direction: Defines direction and designation of intersecting taxiway(s).
	ILS Critical Area Hold Position: Holding position for the ILS critical area on TWY C.		Runway Exit: Defines direction and designation of exit taxiway from runway.
	No Entry: Identifies paved areas where aircraft entry is prohibited.		Outbound Destination: Defines directions to takeoff runway(s).
	Taxiway Location: Identifies taxiway on which aircraft is located.		Inbound Destination: Defines directions to destination for arriving aircraft.
	Runway Location: Identifies runway on which aircraft is located.		Taxiway Ending Marker: Indicates taxiway does not continue.
	Runway Distance Remaining: Provides remaining runway length in 1,000-foot increments.		Direction Sign Array: Identifies location in conjunction with multiple intersecting taxiways.

Figure C-1. Samples and explanations of standard airport signs.



Airport Markings		
Type of Marking	Action or Purpose	
	Holding Position: Denotes entrance to a runway from a taxiway, approach hold position on a taxiway, or LAHSO holding position on a runway.	
	ILS Critical Area Boundary: Denotes entrance to an area to be protected for an ILS signal.	
	Taxiway/Taxiway Holding Position: Denotes location on taxiway or apron where aircraft hold short of another taxiway.	
	Non-Movement Area Boundary: Delineates movement area under control of ATC, from non-movement area.	
	Surface Painted Holding Position: Denotes entrance to a runway from a taxiway.	
	Enhanced Taxiway Centerline: Provides visual cue to help identify location of a runway holding position on a taxiway. These markings are installed 150 feet prior to the holding position markings.	
	Surface Painted Taxiway Direction: Defines designation/direction of intersecting taxiway(s).	
	Surface Painted Taxiway Location: Identifies taxiway on which the aircraft is located.	
Type of Marking	Action or Purpose	
	Taxiway Edge: Solid Double Yellow Lines Defines edge of usable, full strength taxiway. Adjoining pavement IS NOT intended for use by aircraft.	
Type of Marking	Action or Purpose	
	Taxiway Edge: Dashed Double Yellow Lines Defines taxiway edge where adjoining pavement IS USABLE , such as along an apron or ramp.	

Figure C-3. Samples and explanations of standard airport markings.

Glossary

A

14 CFR. See Title 14 of the Code of Federal Regulations.

100-hour inspection. An inspection identical in scope to an annual inspection. Conducted every 100 hours of flight on aircraft of under 12,500 pounds that are used to carry passengers for hire.

Absolute accuracy. The ability to determine present position in space independently, and is most often used by pilots.

Absolute altitude. The actual distance between an aircraft and the terrain over which it is flying.

Absolute pressure. Pressure measured from the reference of zero pressure, or a vacuum.

A.C. Alternating current.

Acceleration. Force involved in overcoming inertia, and which may be defined as a change in velocity per unit of time.

Acceleration error. A magnetic compass error apparent when the aircraft accelerates while flying on an easterly or westerly heading, causing the compass card to rotate toward North.

Accelerate-go distance. The distance required to accelerate to V_1 with all engines at takeoff power, experience an engine failure at V_1 , and continue the takeoff on the remaining engine(s). The runway required includes the distance required to climb to 35 feet by which time V_2 speed must be attained.

Accelerate-stop distance. The distance required to accelerate to V_1 with all engines at takeoff power, experience an engine failure at V_1 , and abort the takeoff and bring the airplane to a stop using braking action only (use of thrust reversing is not considered).

Accelerometer. A part of an inertial navigation system (INS) that accurately measures the force of acceleration in one direction.

ADC. See air data computer.

ADF. See automatic direction finder.

ADI. See attitude director indicator.

Adiabatic cooling. A process of cooling the air through expansion. For example, as air moves up slope it expands with the reduction of atmospheric pressure and cools as it expands.

Adiabatic heating. A process of heating dry air through compression. For example, as air moves down a slope it is compressed, which results in an increase in temperature.

Adjustable-pitch propeller. A propeller with blades whose pitch can be adjusted on the ground with the engine not running, but which cannot be adjusted in flight. Also referred to as a ground adjustable propeller. Sometimes also used to refer to constant-speed propellers that are adjustable in flight.

Adjustable stabilizer. A stabilizer that can be adjusted in flight to trim the airplane, thereby allowing the airplane to fly hands-off at any given airspeed.

ADM. See aeronautical decision-making.

ADS-B. See automatic dependent surveillance-broadcast.

Advection fog. Fog resulting from the movement of warm, humid air over a cold surface.

Adverse yaw. A condition of flight in which the nose of an airplane tends to yaw toward the outside of the turn. This is caused by the higher induced drag on the outside wing, which is also producing more lift. Induced drag is a by-product of the lift associated with the outside wing.

Aerodynamics. The science of the action of air on an object, and with the motion of air on other gases. Aerodynamics deals with the production of lift by the aircraft, the relative wind, and the atmosphere.

Aeronautical chart. A map used in air navigation containing all or part of the following: topographic features, hazards and obstructions, navigation aids, navigation routes, designated airspace, and airports.

Aeronautical decision-making (ADM). A systematic approach to the mental process used by pilots to consistently determine the best course of action in response to a given set of circumstances.

Agonic line. An irregular imaginary line across the surface of the Earth along which the magnetic and geographic poles are in alignment, and along which there is no magnetic variation.

Ailerons. Primary flight control surfaces mounted on the trailing edge of an airplane wing, near the tip. Ailerons control roll about the longitudinal axis.

Aircraft. A device that is used, or intended to be used, for flight.

Aircraft altitude. The actual height above sea level at which the aircraft is flying.

Aircraft approach category. A performance grouping of aircraft based on a speed of 1.3 times the stall speed in the landing configuration at maximum gross landing weight.

Air data computer (ADC). An aircraft computer that receives and processes pitot pressure, static pressure, and temperature to calculate very precise altitude, indicated airspeed, true airspeed, and air temperature.

Airfoil. Any surface, such as a wing, propeller, rudder, or even a trim tab, which provides aerodynamic force when it interacts with a moving stream of air.

Air mass. An extensive body of air having fairly uniform properties of temperature and moisture.

AIRMET. Inflight weather advisory issued as an amendment to the area forecast, concerning weather phenomena of operational interest to all aircraft and that is potentially hazardous to aircraft with limited capability due to lack of equipment, instrumentation, or pilot qualifications.

Airplane. An engine-driven, fixed-wing aircraft heavier than air that is supported in flight by the dynamic reaction of air against its wings.

Airplane Flight Manual (AFM). A document developed by the airplane manufacturer and approved by the Federal Aviation Administration (FAA). It is specific to a particular make and model airplane by serial number and it contains operating procedures and limitations.

Airplane Owner/Information Manual. A document developed by the airplane manufacturer containing general information about the make and model of an airplane. The airplane owner's manual is not FAA approved and is not specific to a particular serial numbered airplane. This manual is not kept current, and therefore cannot be substituted for the AFM/POH.

Airport diagram. The section of an instrument approach procedure chart that shows a detailed diagram of the airport. This diagram includes surface features and airport configuration information.

Airport/Facility Directory (A/FD). See Chart Supplement U.S.

Airport surface detection equipment (ASDE). Radar equipment specifically designed to detect all principal features and traffic on the surface of an airport, presenting the entire image on the control tower console; used to augment visual observation by tower personnel of aircraft and/or vehicular movements on runways and taxiways.

Airport surveillance radar (ASR). Approach control radar used to detect and display an aircraft's position in the terminal area.

Airport surveillance radar approach. An instrument approach in which ATC issues instructions for pilot compliance based on aircraft position in relation to the final approach course and the distance from the end of the runway as displayed on the controller's radar scope.

Air route surveillance radar (ARSR). Air route traffic control center (ARTCC) radar used primarily to detect and display an aircraft's position while en route between terminal areas.

Air route traffic control center (ARTCC). Provides ATC service to aircraft operating on IFR flight plans within controlled airspace and principally during the en route phase of flight.

Airspeed. Rate of the aircraft's progress through the air.

Airspeed indicator. A differential pressure gauge that measures the dynamic pressure of the air through which the aircraft is flying. Displays the craft's airspeed, typically in knots, to the pilot.

Air traffic control radar beacon system (ATCRBS). Sometimes called secondary surveillance radar (SSR), which utilizes a transponder in the aircraft. The ground equipment is an interrogating unit, in which the beacon antenna is mounted so it rotates with the surveillance antenna. The interrogating unit transmits a coded pulse sequence that actuates the aircraft transponder. The transponder answers the coded sequence by transmitting a preselected coded sequence back to the ground equipment, providing a strong return signal and positive aircraft identification, as well as other special data.

Airway. An airway is based on a centerline that extends from one navigation aid or intersection to another navigation aid (or through several navigation aids or intersections); used to establish a known route for en route procedures between terminal areas.

Airworthiness Certificate. A certificate issued by the FAA to all aircraft that have been proven to meet the minimum standards set down by the Code of Federal Regulations.

Airworthiness Directive. A regulatory notice sent out by the FAA to the registered owner of an aircraft informing the owner of a condition that prevents the aircraft from continuing to meet its conditions for airworthiness. Airworthiness Directives (AD notes) are to be complied with within the required time limit, and the fact of compliance, the date of compliance, and the method of compliance are recorded in the aircraft's maintenance records.

Alert area. An area in which there is a high volume of pilot training or an unusual type of aeronautical activity.

Almanac data. Information the global positioning system (GPS) receiver can obtain from one satellite which describes the approximate orbital positioning of all satellites in the constellation. This information is necessary for the GPS receiver to know what satellites to look for in the sky at a given time.

ALS. See approach lighting system.

Alternate airport. An airport designated in an IFR flight plan, providing a suitable destination if a landing at the intended airport becomes inadvisable.

Alternate static source valve. A valve in the instrument static air system that supplies reference air pressure to the altimeter, airspeed indicator, and vertical speed indicator if the normal static pickup should become clogged or iced over.

Altimeter. A flight instrument that indicates altitude by sensing pressure changes.

Altimeter setting. Station pressure (the barometric pressure at the location the reading is taken) which has been corrected for the height of the station above sea level.

Altitude engine. A reciprocating aircraft engine having a rated takeoff power that is producible from sea level to an established higher altitude.

Ambient pressure. The pressure in the area immediately surrounding the aircraft.

Ambient temperature. The temperature in the area immediately surrounding the aircraft.

AME. See aviation medical examiner.

Amendment status. The circulation date and revision number of an instrument approach procedure, printed above the procedure identification.

Ammeter. An instrument installed in series with an electrical load used to measure the amount of current flowing through the load.

Aneroid. The sensitive component in an altimeter or barometer that measures the absolute pressure of the air. It is a sealed, flat capsule made of thin disks of corrugated metal soldered together and evacuated by pumping all of the air out of it.

Aneroid barometer. An instrument that measures the absolute pressure of the atmosphere by balancing the weight of the air above it against the spring action of the aneroid.

Angle of attack. The angle of attack is the angle at which relative wind meets an airfoil. It is the angle that is formed by the chord of the airfoil and the direction of the relative wind or between the chord line and the flight path. The angle of attack changes during a flight as the pilot changes the direction of the aircraft and is related to the amount of lift being produced.

Angle of incidence. The acute angle formed between the chord line of an airfoil and the longitudinal axis of the aircraft on which it is mounted.

Anhedral. A downward slant from root to tip of an aircraft's wing or horizontal tail surface.

Annual inspection. A complete inspection of an aircraft and engine, required by the Code of Federal Regulations, to be accomplished every 12 calendar months on all certificated aircraft. Only an A&P technician holding an Inspection Authorization can conduct an annual inspection.

Anti-ice. Preventing the accumulation of ice on an aircraft structure via a system designed for that purpose.

Antiservo tab. An adjustable tab attached to the trailing edge of a stabilator that moves in the same direction as the primary control. It is used to make the stabilator less sensitive.

Approach lighting system (ALS). Provides lights that will penetrate the atmosphere far enough from touchdown to give directional, distance, and glidepath information for safe transition from instrument to visual flight.

Area chart. Part of the low-altitude en route chart series, this chart furnishes terminal data at a larger scale for congested areas.

Area forecast (FA). A report that gives a picture of clouds, general weather conditions, and visual meteorological conditions (VMC) expected over a large area encompassing several states.

Area navigation (RNAV). Allows a pilot to fly a selected course to a predetermined point without the need to overfly ground-based navigation facilities, by using waypoints.

Arm. See moment arm.

ARSR. See air route surveillance radar.

ARTCC. See air route traffic control center.

ASDE. See airport surface detection equipment.

ASOS. See Automated Surface Observing System.

Aspect ratio. Span of a wing divided by its average chord.

ASR. See airport surveillance radar.

Asymmetric thrust. Also known as P-factor. A tendency for an aircraft to yaw to the left due to the descending propeller blade on the right producing more thrust than the ascending blade on the left. This occurs when the aircraft's longitudinal axis is in a climbing attitude in relation to the relative wind. The P-factor would be to the right if the aircraft had a counterclockwise rotating propeller.

ATC. Air Traffic Control.

ATCRBS. See air traffic control radar beacon system.

ATIS. See automatic terminal information service.

Atmospheric propagation delay. A bending of the electromagnetic (EM) wave from the satellite that creates an error in the GPS system.

Attitude. A personal motivational predisposition to respond to persons, situations, or events in a given manner that can, nevertheless, be changed or modified through training as sort of a mental shortcut to decision-making.

Attitude and heading reference system (AHRS). A system composed of three-axis sensors that provide heading, attitude, and yaw information for aircraft. AHRS are designed to replace traditional mechanical gyroscopic flight instruments and provide superior reliability and accuracy.

Attitude director indicator (ADI). An aircraft attitude indicator that incorporates flight command bars to provide pitch and roll commands.

Attitude indicator. The foundation for all instrument flight, this instrument reflects the airplane's attitude in relation to the horizon.

Attitude instrument flying. Controlling the aircraft by reference to the instruments rather than by outside visual cues.

Attitude management. The ability to recognize hazardous attitudes in oneself and the willingness to modify them as necessary through the application of an appropriate antidote thought.

Autokinesis. Nighttime visual illusion that a stationary light is moving, which becomes apparent after several seconds of staring at the light.

Automated Surface Observing System (ASOS). Weather reporting system which provides surface observations every minute via digitized voice broadcasts and printed reports.

Automated Weather Observing System (AWOS). Automated weather reporting system consisting of various sensors, a processor, a computer-generated voice subsystem, and a transmitter to broadcast weather data.

Automatic dependent surveillance—broadcast (ADS-B). A function on an aircraft or vehicle that periodically broadcasts its state vector (i.e., horizontal and vertical position, horizontal and vertical velocity) and other information.

Automatic direction finder (ADF). Electronic navigation equipment that operates in the low- and medium-frequency bands. Used in conjunction with the ground-based nondirectional beacon (NDB), the instrument displays the number of degrees clockwise from the nose of the aircraft to the station being received.

Automatic terminal information service (ATIS). The continuous broadcast of recorded non-control information in selected terminal areas. Its purpose is to improve controller effectiveness and relieve frequency congestion by automating repetitive transmission of essential but routine information.

Autopilot. An automatic flight control system which keeps an aircraft in level flight or on a set course. Automatic pilots can be directed by the pilot, or they may be coupled to a radio navigation signal.

Aviation medical examiner (AME). A physician with training in aviation medicine designated by the Civil Aerospace Medical Institute (CAMI).

Aviation Routine Weather Report (METAR). Observation of current surface weather reported in a standard international format.

AWOS. See Automated Weather Observing System.

Axes of an aircraft. Three imaginary lines that pass through an aircraft's center of gravity. The axes can be considered as imaginary axes around which the aircraft rotates. The three axes pass through the center of gravity at 90° angles to each other. The axis from nose to tail is the longitudinal axis (pitch), the axis that passes from wingtip to wingtip is the lateral axis (roll), and the axis that passes vertically through the center of gravity is the vertical axis (yaw).

Axial flow compressor. A type of compressor used in a turbine engine in which the airflow through the compressor is essentially linear. An axial-flow compressor is made up of several stages of alternate rotors and stators. The compressor ratio is determined by the decrease in area of the succeeding stages.

Azimuth card. A card that may be set, gyroscopically controlled, or driven by a remote compass.

B

Back course (BC). The reciprocal of the localizer course for an ILS. When flying a back-course approach, an aircraft approaches the instrument runway from the end at which the localizer antennas are installed.

Balance tab. An auxiliary control mounted on a primary control surface, which automatically moves in the direction opposite the primary control to provide an aerodynamic assist in the movement of the control.

Baro-aiding. A method of augmenting the GPS integrity solution by using a nonsatellite input source. To ensure that baro-aiding is available, the current altimeter setting must be entered as described in the operating manual.

Barometric scale. A scale on the dial of an altimeter to which the pilot sets the barometric pressure level from which the altitude shown by the pointers is measured.

Basic empty weight (GAMA). Basic empty weight includes the standard empty weight plus optional and special equipment that has been installed.

BC. See back course.

Bernoulli's Principle. A principle that explains how the pressure of a moving fluid varies with its speed of motion. An increase in the speed of movement causes a decrease in the fluid's pressure.

Biplanes. Airplanes with two sets of wings.

Block altitude. A block of altitudes assigned by ATC to allow altitude deviations; for example, "Maintain block altitude 9 to 11 thousand."

Bypass ratio. The ratio of the mass airflow in pounds per second through the fan section of a turbofan engine to the mass airflow that passes through the gas generator portion of the engine.

C

Cabin altitude. Cabin pressure in terms of equivalent altitude above sea level.

Cage. The black markings on the ball instrument indicating its neutral position.

Calibrated. The instrument indication compared with a standard value to determine the accuracy of the instrument.

Calibrated orifice. A hole of specific diameter used to delay the pressure change in the case of a vertical speed indicator.

Calibrated airspeed. The speed at which the aircraft is moving through the air, found by correcting IAS for instrument and position errors.

Camber. The camber of an airfoil is the characteristic curve of its upper and lower surfaces. The upper camber is more pronounced, while the lower camber is comparatively flat. This causes the velocity of the airflow immediately above the wing to be much higher than that below the wing.

Canard. A horizontal surface mounted ahead of the main wing to provide longitudinal stability and control. It may be a fixed, movable, or variable geometry surface, with or without control surfaces.

Canard configuration. A configuration in which the span of the forward wings is substantially less than that of the main wing.

Cantilever. A wing designed to carry loads without external struts.

CAS. Calibrated airspeed.

CDI. Course deviation indicator.

Ceiling. The height above the earth's surface of the lowest layer of clouds, which is reported as broken or overcast, or the vertical visibility into an obscuration.

Center of gravity (CG). The point at which an airplane would balance if it were possible to suspend it at that point. It is the mass center of the airplane, or the theoretical point at which the entire weight of the airplane is assumed to be concentrated. It may be expressed in inches from the reference datum, or in percentage of mean aerodynamic chord (MAC). The location depends on the distribution of weight in the airplane.

Center of gravity limits. The specified forward and aft points within which the CG must be located during flight. These limits are indicated on pertinent airplane specifications.

Center of gravity range. The distance between the forward and aft CG limits indicated on pertinent airplane specifications.

Center of pressure. A point along the wing chord line where lift is considered to be concentrated. For this reason, the center of pressure is commonly referred to as the center of lift.

Centrifugal flow compressor. An impeller-shaped device that receives air at its center and slings the air outward at high velocity into a diffuser for increased pressure. Also referred to as a radial outflow compressor.

Centrifugal force. An outward force that opposes centripetal force, resulting from the effect of inertia during a turn.

Centripetal force. A center-seeking force directed inward toward the center of rotation created by the horizontal component of lift in turning flight.

CG. See center of gravity.

Changeover point (COP). A point along the route or airway segment between two adjacent navigation facilities or waypoints where changeover in navigation guidance should occur.

Chart Supplement U.S. (formerly Airport/Facility Directory). An FAA publication containing information on all airports, communications, and NAVAIDs.

Checklist. A tool that is used as a human factors aid in aviation safety. It is a systematic and sequential list of all operations that must be performed to properly accomplish a task.

Chord line. An imaginary straight line drawn through an airfoil from the leading edge to the trailing edge.

Circling approach. A maneuver initiated by the pilot to align the aircraft with a runway for landing when a straight-in landing from an instrument approach is not possible or is not desirable.

Class A airspace. Airspace from 18,000 feet MSL up to and including FL 600, including the airspace overlying the waters within 12 NM of the coast of the 48 contiguous states and Alaska; and designated international airspace beyond 12 NM of the coast of the 48 contiguous states and Alaska within areas of domestic radio navigational signal or ATC radar coverage, and within which domestic procedures are applied.

Class B airspace. Airspace from the surface to 10,000 feet MSL surrounding the nation's busiest airports in terms of IFR operations or passenger numbers. The configuration of each Class B airspace is individually tailored and consists of a surface area and two or more layers, and is designed to contain all published instrument procedures once an aircraft enters the airspace. For all aircraft, an ATC clearance is required to operate in the area, and aircraft so cleared receive separation services within the airspace.

Class C airspace. Airspace from the surface to 4,000 feet above the airport elevation (charted in MSL) surrounding those airports having an operational control tower, serviced by radar approach control, and having a certain number of IFR operations or passenger numbers. Although the configuration of each Class C airspace area is individually tailored, the airspace usually consists of a 5 NM radius core surface area that extends from the surface up to 4,000 feet above the airport elevation, and a 10 NM radius shelf area that extends from 1,200 feet to 4,000 feet above the airport elevation.

Class D airspace. Airspace from the surface to 2,500 feet above the airport elevation (charted in MSL) surrounding those airports that have an operational control tower. The configuration of each Class D airspace area is individually tailored, and when instrument procedures are published, the airspace is normally designed to contain the procedures.

Class E airspace. Airspace that is not Class A, Class B, Class C, or Class D, and is controlled airspace.

Class G airspace. Airspace that is uncontrolled, except when associated with a temporary control tower, and has not been designated as Class A, Class B, Class C, Class D, or Class E airspace.

Clean configuration. A configuration in which all flight control surfaces have been placed to create minimum drag. In most aircraft this means flaps and gear retracted.

Clearance. ATC permission for an aircraft to proceed under specified traffic conditions within controlled airspace, for the purpose of providing separation between known aircraft.

Clearance delivery. Control tower position responsible for transmitting departure clearances to IFR flights.

Clearance limit. The fix, point, or location to which an aircraft is cleared when issued an air traffic clearance.

Clearance on request. An IFR clearance not yet received after filing a flight plan.

Clearance void time. Used by ATC, the time at which the departure clearance is automatically canceled if takeoff has not been made. The pilot must obtain a new clearance or cancel the IFR flight plan if not off by the specified time.

Clear ice. Glossy, clear, or translucent ice formed by the relatively slow freezing of large, supercooled water droplets.

Coefficient of lift (C_L). The ratio between lift pressure and dynamic pressure.

Cold front. The boundary between two air masses where cold air is replacing warm air.

Compass course. A true course corrected for variation and deviation errors.

Compass locator. A low-power, low- or medium-frequency (L/MF) radio beacon installed at the site of the outer or middle marker of an ILS.

Compass rose. A small circle graduated in 360° increments, to show direction expressed in degrees.

Complex aircraft. An aircraft with retractable landing gear, flaps, and a controllable-pitch propeller.

Compressor pressure ratio. The ratio of compressor discharge pressure to compressor inlet pressure.

Compressor stall. In gas turbine engines, a condition in an axial-flow compressor in which one or more stages of rotor blades fail to pass air smoothly to the succeeding stages. A stall condition is caused by a pressure ratio that is incompatible with the engine rpm. Compressor stall will be indicated by a rise in exhaust temperature or rpm fluctuation, and if allowed to continue, may result in flameout and physical damage to the engine.

Computer navigation fix. A point used to define a navigation track for an airborne computer system such as GPS or FMS.

Concentric rings. Dashed-line circles depicted in the plan view of IAP charts, outside of the reference circle, that show en route and feeder facilities.

Condensation. A change of state of water from a gas (water vapor) to a liquid.

Condensation nuclei. Small particles of solid matter in the air on which water vapor condenses.

Cone of confusion. A cone-shaped volume of airspace directly above a VOR station where no signal is received, causing the CDI to fluctuate.

Configuration. This is a general term, which normally refers to the position of the landing gear and flaps.

Constant-speed propeller. A controllable-pitch propeller whose pitch is automatically varied in flight by a governor to maintain a constant rpm in spite of varying air loads.

Continuous flow oxygen system. System that supplies a constant supply of pure oxygen to a rebreather bag that dilutes the pure oxygen with exhaled gases and thus supplies a healthy mix of oxygen and ambient air to the mask. Primarily used in passenger cabins of commercial airliners.

Control and performance. A method of attitude instrument flying in which one instrument is used for making attitude changes, and the other instruments are used to monitor the progress of the change.

Control display unit. A display interfaced with the master computer, providing the pilot with a single control point for all navigation systems, thereby reducing the number of required flight deck panels.

Controllability. A measure of the response of an aircraft relative to the pilot's flight control inputs.

Controllable-pitch propeller (CPP). A type of propeller with blades that can be rotated around their long axis to change their pitch. If the pitch can be set to negative values, the reversible propeller can also create reverse thrust for braking or reversing without the need of changing the direction of shaft revolutions.

Controlled airspace. An airspace of defined dimensions within which ATC service is provided to IFR and VFR flights in accordance with the airspace classification. It includes Class A, Class B, Class C, Class D, and Class E airspace.

Control pressures. The amount of physical exertion on the control column necessary to achieve the desired attitude.

Convective weather. Unstable, rising air found in cumuliform clouds.

Convective SIGMET. Weather advisory concerning convective weather significant to the safety of all aircraft, including thunderstorms, hail, and tornadoes.

Conventional landing gear. Landing gear employing a third rear-mounted wheel. These airplanes are also sometimes referred to as tailwheel airplanes.

Coordinated flight. Flight with a minimum disturbance of the forces maintaining equilibrium, established via effective control use.

COP. See changeover point.

Coriolis illusion. The illusion of rotation or movement in an entirely different axis, caused by an abrupt head movement, while in a prolonged constant-rate turn that has ceased to stimulate the brain's motion sensing system.

Coupled ailerons and rudder. Rudder and ailerons are connected with interconnected springs in order to counteract adverse yaw. Can be overridden if it becomes necessary to slip the aircraft.

Course. The intended direction of flight in the horizontal plane measured in degrees from north.

Cowl flaps. Shutter-like devices arranged around certain air-cooled engine cowlings, which may be opened or closed to regulate the flow of air around the engine.

Crew resource management (CRM). The application of team management concepts in the flight deck environment. It was initially known as cockpit resource management, but as CRM programs evolved to include cabin crews, maintenance personnel, and others, the phrase "crew resource management" was adopted. This includes single pilots, as in most general aviation aircraft. Pilots of small aircraft, as well as crews of larger aircraft, must make effective use of all available resources; human resources, hardware, and information. A current definition includes all groups routinely working with the flight crew who are involved in decisions required to operate a flight safely. These groups include, but are not limited to pilots, dispatchers, cabin crewmembers, maintenance personnel, and air traffic controllers. CRM is one way of addressing the challenge of optimizing the human/machine interface and accompanying interpersonal activities.

Critical altitude. The maximum altitude under standard atmospheric conditions at which a turbocharged engine can produce its rated horsepower.

Critical angle of attack. The angle of attack at which a wing stalls regardless of airspeed, flight attitude, or weight.

Critical areas. Areas where disturbances to the ILS localizer and glideslope courses may occur when surface vehicles or aircraft operate near the localizer or glideslope antennas.

CRM. See crew resource management.

Cross-check. The first fundamental skill of instrument flight, also known as “scan,” the continuous and logical observation of instruments for attitude and performance information.

Cruise clearance. An ATC clearance issued to allow a pilot to conduct flight at any altitude from the minimum IFR altitude up to and including the altitude specified in the clearance. Also authorizes a pilot to proceed to and make an approach at the destination airport.

Current induction. An electrical current being induced into, or generated in, any conductor that is crossed by lines of flux from any magnet.

D

DA. See decision altitude.

Datum (Reference Datum). An imaginary vertical plane or line from which all measurements of arm are taken. The datum is established by the manufacturer. Once the datum has been selected, all moment arms and the location of CG range are measured from this point.

D.C. Direct current.

Dark adaptation. Physical and chemical adjustments of the eye that make vision possible in relative darkness.

Dead reckoning. Navigation of an airplane solely by means of computations based on airspeed, course, heading, wind direction and speed, groundspeed, and elapsed time.

Deceleration error. A magnetic compass error that occurs when the aircraft decelerates while flying on an easterly or westerly heading, causing the compass card to rotate toward South.

Decision altitude (DA). A specified altitude in the precision approach, charted in feet MSL, at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.

Decision height (DH). A specified altitude in the precision approach, charted in height above threshold elevation, at which a decision must be made either to continue the approach or to execute a missed approach.

Deice. The act of removing ice accumulation from an aircraft structure.

Delta. A Greek letter expressed by the symbol Δ to indicate a change of values. As an example, Δ CG indicates a change (or movement) of the CG.

Density altitude. Pressure altitude corrected for nonstandard temperature. Density altitude is used in computing the performance of an aircraft and its engines.

Departure procedure (DP). Preplanned IFR ATC departure, published for pilot use, in textual and graphic format.

Deposition. The direct transformation of a gas to a solid state, in which the liquid state is bypassed. Some sources use sublimation to describe this process instead of deposition.

Detonation. The sudden release of heat energy from fuel in an aircraft engine caused by the fuel-air mixture reaching its critical pressure and temperature. Detonation occurs as a violent explosion rather than a smooth burning process.

Deviation. A magnetic compass error caused by local magnetic fields within the aircraft. Deviation error is different on each heading.

Dew. Moisture that has condensed from water vapor. Usually found on cooler objects near the ground, such as grass, as the near-surface layer of air cools faster than the layers of air above it.

Dewpoint. The temperature at which air reaches a state where it can hold no more water.

DGPS. Differential global positioning system.

DH. See decision height.

Differential ailerons. Control surface rigged such that the aileron moving up moves a greater distance than the aileron moving down. The up aileron produces extra parasite drag to compensate for the additional induced drag caused by the down aileron. This balancing of the drag forces helps minimize adverse yaw.

Differential Global Positioning System (DGPS). A system that improves the accuracy of Global Navigation Satellite Systems (GNSS) by measuring changes in variables to provide satellite positioning corrections.

Differential pressure. A difference between two pressures. The measurement of airspeed is an example of the use of differential pressure.

Dihedral. The positive acute angle between the lateral axis of an airplane and a line through the center of a wing or horizontal stabilizer. Dihedral contributes to the lateral stability of an airplane.

Diluter-demand oxygen system. An oxygen system that delivers oxygen mixed or diluted with air in order to maintain a constant oxygen partial pressure as the altitude changes.

Direct indication. The true and instantaneous reflection of aircraft pitch-and-bank attitude by the miniature aircraft, relative to the horizon bar of the attitude indicator.

Direct User Access Terminal System (DUATS). A system that provides current FAA weather and flight plan filing services to certified civil pilots, via personal computer, modem, or telephone access to the system. Pilots can request specific types of weather briefings and other pertinent data for planned flights.

Directional stability. Stability about the vertical axis of an aircraft, whereby an aircraft tends to return, on its own, to flight aligned with the relative wind when disturbed from that equilibrium state. The vertical tail is the primary contributor to directional stability, causing an airplane in flight to align with the relative wind.

Distance circle. See reference circle.

Distance measuring equipment (DME). A pulse-type electronic navigation system that shows the pilot, by an instrument-panel indication, the number of nautical miles between the aircraft and a ground station or waypoint.

DME. See distance measuring equipment.

DME arc. A flight track that is a constant distance from the station or waypoint.

DOD. Department of Defense.

Doghouse. A turn-and-slip indicator dial mark in the shape of a doghouse.

Domestic Reduced Vertical Separation Minimum (DRVSM). Additional flight levels between FL 290 and FL 410 to provide operational, traffic, and airspace efficiency.

Double gimbal. A type of mount used for the gyro in an attitude instrument. The axes of the two gimbals are at right angles to the spin axis of the gyro, allowing free motion in two planes around the gyro.

DP. See departure procedure.

Drag. The net aerodynamic force parallel to the relative wind, usually the sum of two components: induced drag and parasite drag.

Drag curve. The curve created when plotting induced drag and parasite drag.

Drift angle. Angle between heading and track.

DRVSM. See Domestic Reduced Vertical Separation Minimum.

DUATS. See direct user access terminal system.

Duplex. Transmitting on one frequency and receiving on a separate frequency.

Dutch roll. A combination of rolling and yawing oscillations that normally occurs when the dihedral effects of an aircraft are more powerful than the directional stability. Usually dynamically stable but objectionable in an airplane because of the oscillatory nature.

Dynamic hydroplaning. A condition that exists when landing on a surface with standing water deeper than the tread depth of the tires. When the brakes are applied, there is a possibility that the brake will lock up and the tire will ride on the surface of the water, much like a water ski. When the tires are hydroplaning, directional control and braking action are virtually impossible. An effective anti-skid system can minimize the effects of hydroplaning.

Dynamic stability. The property of an aircraft that causes it, when disturbed from straight-and-level flight, to develop forces or moments that restore the original condition of straight and level.

E

Eddy currents. Current induced in a metal cup or disc when it is crossed by lines of flux from a moving magnet.

Eddy current damping. The decreased amplitude of oscillations by the interaction of magnetic fields. In the case of a vertical card magnetic compass, flux from the oscillating permanent magnet produces eddy currents in a damping disk or cup. The magnetic flux produced by the eddy currents opposes the flux from the permanent magnet and decreases the oscillations.

EFC. See expect-further-clearance.

EFD. See electronic flight display.

EGT. See exhaust gas temperature.

Electronic flight display (EFD). For the purpose of standardization, any flight instrument display that uses LCD or other image-producing system (cathode ray tube (CRT), etc.)

Elevator. The horizontal, movable primary control surface in the tail section, or empennage, of an airplane. The elevator is hinged to the trailing edge of the fixed horizontal stabilizer.

Elevator illusion. The sensation of being in a climb or descent, caused by the kind of abrupt vertical accelerations that result from up- or downdrafts.

Emergency. A distress or urgent condition.

Empennage. The section of the airplane that consists of the vertical stabilizer, the horizontal stabilizer, and the associated control surfaces.

Emphasis error. The result of giving too much attention to a particular instrument during the cross-check, instead of relying on a combination of instruments necessary for attitude and performance information.

Empty-field myopia. Induced nearsightedness that is associated with flying at night, in instrument meteorological conditions and/or reduced visibility. With nothing to focus on, the eyes automatically focus on a point just slightly ahead of the airplane.

EM wave. Electromagnetic wave.

Encoding altimeter. A special type of pressure altimeter used to send a signal to the air traffic controller on the ground, showing the pressure altitude the aircraft is flying.

Engine pressure ratio (EPR). The ratio of turbine discharge pressure divided by compressor inlet pressure, which is used as an indication of the amount of thrust being developed by a turbine engine.

En route facilities ring. Depicted in the plan view of IAP charts, a circle which designates NAVAIDs, fixes, and intersections that are part of the en route low altitude airway structure.

En route high-altitude charts. Aeronautical charts for en route instrument navigation at or above 18,000 feet MSL.

En route low-altitude charts. Aeronautical charts for en route IFR navigation below 18,000 feet MSL.

EPR. See engine pressure ratio.

Equilibrium. A condition that exists within a body when the sum of the moments of all of the forces acting on the body is equal to zero. In aerodynamics, equilibrium is when all opposing forces acting on an aircraft are balanced (steady, unaccelerated flight conditions).

Equivalent airspeed. Airspeed equivalent to CAS in standard atmosphere at sea level. As the airspeed and pressure altitude increase, the CAS becomes higher than it should be, and a correction for compression must be subtracted from the CAS.

Evaporation. The transformation of a liquid to a gaseous state, such as the change of water to water vapor.

Exhaust gas temperature (EGT). The temperature of the exhaust gases as they leave the cylinders of a reciprocating engine or the turbine section of a turbine engine.

Expect-further-clearance (EFC). The time a pilot can expect to receive clearance beyond a clearance limit.

Explosive decompression. A change in cabin pressure faster than the lungs can decompress. Lung damage is possible.

F

FA. See area forecast.

FAA. Federal Aviation Administration.

FAF. See final approach fix.

False horizon. Inaccurate visual information for aligning the aircraft, caused by various natural and geometric formations that disorient the pilot from the actual horizon.

FDI. See flight director indicator.

Federal airways. Class E airspace areas that extend upward from 1,200 feet to, but not including, 18,000 feet MSL, unless otherwise specified.

Feeder facilities. Used by ATC to direct aircraft to intervening fixes between the en route structure and the initial approach fix.

Final approach. Part of an instrument approach procedure in which alignment and descent for landing are accomplished.

Final approach fix (FAF). The fix from which the IFR final approach to an airport is executed, and which identifies the beginning of the final approach segment. An FAF is designated on government charts by a Maltese cross symbol for nonprecision approaches, and a lightning bolt symbol for precision approaches.

Fixating. Staring at a single instrument, thereby interrupting the cross-check process.

Fixed-pitch propellers. Propellers with fixed blade angles. Fixed-pitch propellers are designed as climb propellers, cruise propellers, or standard propellers.

Fixed slot. A fixed, nozzle shaped opening near the leading edge of a wing that ducts air onto the top surface of the wing. Its purpose is to increase lift at higher angles of attack.

FL. See flight level.

Flameout. A condition in the operation of a gas turbine engine in which the fire in the engine goes out due to either too much or too little fuel sprayed into the combustors.

Flaps. Hinged portion of the trailing edge between the ailerons and fuselage. In some aircraft ailerons and flaps are interconnected to produce full-span “flaperons.” In either case, flaps change the lift and drag on the wing.

Floor load limit. The maximum weight the floor can sustain per square inch/foot as provided by the manufacturer.

Flight configurations. Adjusting the aircraft control surfaces (including flaps and landing gear) in a manner that will achieve a specified attitude.

Flight director indicator (FDI). One of the major components of a flight director system, it provides steering commands that the pilot (or the autopilot, if coupled) follows.

Flight level (FL). A measure of altitude (in hundreds of feet) used by aircraft flying above 18,000 feet with the altimeter set at 29.92 "Hg.

Flight management system (FMS). Provides pilot and crew with highly accurate and automatic long-range navigation capability, blending available inputs from long- and short-range sensors.

Flight path. The line, course, or track along which an aircraft is flying or is intended to be flown.

Flight patterns. Basic maneuvers, flown by reference to the instruments rather than outside visual cues, for the purpose of practicing basic attitude flying. The patterns simulate maneuvers encountered on instrument flights such as holding patterns, procedure turns, and approaches.

Flight strips. Paper strips containing instrument flight information, used by ATC when processing flight plans.

FMS. See flight management system.

FOD. See foreign object damage.

Fog. Cloud consisting of numerous minute water droplets and based at the surface; droplets are small enough to be suspended in the earth's atmosphere indefinitely. (Unlike drizzle, it does not fall to the surface. Fog differs from a cloud only in that a cloud is not based at the surface, and is distinguished from haze by its wetness and gray color.)

Force (F). The energy applied to an object that attempts to cause the object to change its direction, speed, or motion. In aerodynamics, it is expressed as F, T (thrust), L (lift), W (weight), or D (drag), usually in pounds.

Foreign object damage (FOD). Damage to a gas turbine engine caused by some object being sucked into the engine while it is running. Debris from runways or taxiways can cause foreign object damage during ground operations, and the ingestion of ice and birds can cause FOD in flight.

Form drag. The drag created because of the shape of a component or the aircraft.

Frise-type aileron. Aileron having the nose portion projecting ahead of the hinge line. When the trailing edge of the aileron moves up, the nose projects below the wing's lower surface and produces some parasite drag, decreasing the amount of adverse yaw.

Front. The boundary between two different air masses.

Frost. Ice crystal deposits formed by sublimation when temperature and dewpoint are below freezing.

Fuel load. The expendable part of the load of the airplane. It includes only usable fuel, not fuel required to fill the lines or that which remains trapped in the tank sumps.

Fundamental skills. Pilot skills of instrument cross-check, instrument interpretation, and aircraft control.

Fuselage. The section of the airplane that consists of the cabin and/or cockpit, containing seats for the occupants and the controls for the airplane.

G

GAMA. General Aviation Manufacturers Association.

Gimbal ring. A type of support that allows an object, such as a gyroscope, to remain in an upright condition when its base is tilted.

Glideslope (GS). Part of the ILS that projects a radio beam upward at an angle of approximately 3° from the approach end of an instrument runway. The glideslope provides vertical guidance to aircraft on the final approach course for the aircraft to follow when making an ILS approach along the localizer path.

Glideslope intercept altitude. The minimum altitude of an intermediate approach segment prescribed for a precision approach that ensures obstacle clearance.

Global landing system (GLS). An instrument approach with lateral and vertical guidance with integrity limits (similar to barometric vertical navigation (BARO VNAV)).

Global navigation satellite system (GNSS). Satellite navigation system that provides autonomous geospatial positioning with global coverage. It allows small electronic receivers to determine their location (longitude, latitude, and altitude) to within a few meters using time signals transmitted along a line of sight by radio from satellites.

Global positioning system (GPS). Navigation system that uses satellite rather than ground-based transmitters for location information.

GLS. See global landing system.

GNSS. See global navigation satellite system.

Goniometer. As used in radio frequency (RF) antenna systems, a direction-sensing device consisting of two fixed loops of wire oriented 90° from each other, which separately sense received signal strength and send those signals to two rotors (also oriented 90°) in the sealed direction-indicating instrument. The rotors are attached to the direction-indicating needle of the instrument and rotated by a small motor until minimum magnetic field is sensed near the rotors.

GPS. See global positioning system.

GPS Approach Overlay Program. An authorization for pilots to use GPS avionics under IFR for flying designated existing nonprecision instrument approach procedures, with the exception of LOC, LDA, and SDF procedures.

GPWS. See ground proximity warning system.

Graveyard spiral. The illusion of the cessation of a turn while still in a prolonged, coordinated, constant rate turn, which can lead a disoriented pilot to a loss of control of the aircraft.

Great circle route. The shortest distance across the surface of a sphere (the Earth) between two points on the surface.

Ground adjustable trim tab. Non-movable metal trim tab on a control surface. Bent in one direction or another while on the ground to apply trim forces to the control surface.

Ground effect. The condition of slightly increased air pressure below an airplane wing or helicopter rotor system that increases the amount of lift produced. It exists within approximately one wing span or one rotor diameter from the ground. It results from a reduction in upwash, downwash, and wingtip vortices, and provides a corresponding decrease in induced drag.

Ground proximity warning system (GPWS). A system designed to determine an aircraft's clearance above the Earth and provides limited predictability about aircraft position relative to rising terrain.

Groundspeed. Speed over the ground, either closing speed to the station or waypoint, or speed over the ground in whatever direction the aircraft is going at the moment, depending upon the navigation system used.

GS. See glideslope.

GWPS. See ground proximity warning system.

Gyroscopic precession. An inherent quality of rotating bodies, which causes an applied force to be manifested 90° in the direction of rotation from the point where the force is applied.

H

HAA. See height above airport.

HAL. See height above landing.

HAT. See height above touchdown elevation.

Hazardous attitudes. Five aeronautical decision-making attitudes that may contribute to poor pilot judgment: anti-authority, impulsivity, invulnerability, machismo, and resignation.

Hazardous Inflight Weather Advisory Service (HIWAS). An en route FSS service providing continuously updated automated of hazardous weather within 150 nautical miles of selected VORs, available only in the conterminous 48 states.

Head-up display (HUD). A special type of flight viewing screen that allows the pilot to watch the flight instruments and other data while looking through the windshield of the aircraft for other traffic, the approach lights, or the runway.

Heading. The direction in which the nose of the aircraft is pointing during flight.

Heading indicator. An instrument which senses airplane movement and displays heading based on a 360° azimuth, with the final zero omitted. The heading indicator, also called a directional gyro (DG), is fundamentally a mechanical instrument designed to facilitate the use of the magnetic compass. The heading indicator is not affected by the forces that make the magnetic compass difficult to interpret.

Headwork. Required to accomplish a conscious, rational thought process when making decisions. Good decision-making involves risk identification and assessment, information processing, and problem solving.

Height above airport (HAA). The height of the MDA above the published airport elevation.

Height above landing (HAL). The height above a designated helicopter landing area used for helicopter instrument approach procedures.

Height above touchdown elevation (HAT). The DA/DH or MDA above the highest runway elevation in the touchdown zone (first 3,000 feet of the runway).

HF. High frequency.

Hg. Abbreviation for mercury, from the Latin hydrargyrum.

High performance aircraft. An aircraft with an engine of more than 200 horsepower.

Histotoxic hypoxia. The inability of cells to effectively use oxygen. Plenty of oxygen is being transported to the cells that need it, but they are unable to use it.

HIWAS. See Hazardous Inflight Weather Advisory Service.

Holding. A predetermined maneuver that keeps aircraft within a specified airspace while awaiting further clearance from ATC.

Holding pattern. A racetrack pattern, involving two turns and two legs, used to keep an aircraft within a prescribed airspace with respect to a geographic fix. A standard pattern uses right turns; nonstandard patterns use left turns.

Homing. Flying the aircraft on any heading required to keep the needle pointing to the 0° relative bearing position.

Horizontal situation indicator (HSI). A flight navigation instrument that combines the heading indicator with a CDI, in order to provide the pilot with better situational awareness of location with respect to the courseline.

Horsepower. The term, originated by inventor James Watt, means the amount of work a horse could do in one second. One horsepower equals 550 foot-pounds per second, or 33,000 foot-pounds per minute.

Hot start. In gas turbine engines, a start which occurs with normal engine rotation, but exhaust temperature exceeds prescribed limits. This is usually caused by an excessively rich mixture in the combustor. The fuel to the engine must be terminated immediately to prevent engine damage.

HSI. See horizontal situation indicator.

HUD. See head-up display.

Human factors. A multidisciplinary field encompassing the behavioral and social sciences, engineering, and physiology, to consider the variables that influence individual and crew performance for the purpose of optimizing human performance and reducing errors.

Hung start. In gas turbine engines, a condition of normal light off but with rpm remaining at some low value rather than increasing to the normal idle rpm. This is often the result of insufficient power to the engine from the starter. In the event of a hung start, the engine should be shut down.

Hydroplaning. A condition that exists when landing on a surface with standing water deeper than the tread depth of the tires. When the brakes are applied, there is a possibility that the brake will lock up and the tire will ride on the surface of the water, much like a water ski. When the tires are hydroplaning, directional control and braking action are virtually impossible. An effective anti-skid system can minimize the effects of hydroplaning.

Hypemic hypoxia. A type of hypoxia that is a result of oxygen deficiency in the blood, rather than a lack of inhaled oxygen. It can be caused by a variety of factors. Hypemic means “not enough blood.”

Hyperventilation. Occurs when an individual is experiencing emotional stress, fright, or pain, and the breathing rate and depth increase, although the carbon dioxide level in the blood is already at a reduced level. 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.

Hypoxia. A state of oxygen deficiency in the body sufficient to impair functions of the brain and other organs.

Hypoxic hypoxia. This type of hypoxia is a result of insufficient oxygen available to the lungs. A decrease of oxygen molecules at sufficient pressure can lead to hypoxic hypoxia.

I

IAF. See initial approach fix.

IAP. See instrument approach procedures.

IAS. See indicated airspeed.

ICAO. See International Civil Aviation Organization.

Ident. Air Traffic Control request for a pilot to push the button on the transponder to identify return on the controller’s scope.

IFR. See instrument flight rules.

ILS. See instrument landing system.

ILS categories. Categories of instrument approach procedures allowed at airports equipped with the following types of instrument landing systems:

ILS Category I: Provides for approach to a height above touchdown of not less than 200 feet, and with runway visual range of not less than 1,800 feet.

ILS Category II: Provides for approach to a height above touchdown of not less than 100 feet and with runway visual range of not less than 1,200 feet.

ILS Category IIIA: Provides for approach without a decision height minimum and with runway visual range of not less than 700 feet.

ILS Category IIIB: Provides for approach without a decision height minimum and with runway visual range of not less than 150 feet.

ILS Category IIIC: Provides for approach without a decision height minimum and without runway visual range minimum.

IMC. See instrument meteorological conditions.

Inclinometer. An instrument consisting of a curved glass tube, housing a glass ball, and damped with a fluid similar to kerosene. It may be used to indicate inclination, as a level, or, as used in the turn indicators, to show the relationship between gravity and centrifugal force in a turn.

Indicated airspeed (IAS). Shown on the dial of the instrument airspeed indicator on an aircraft. Indicated airspeed (IAS) is the airspeed indicator reading uncorrected for instrument, position, and other errors. Indicated airspeed means the speed of an aircraft as shown on its pitot static airspeed indicator calibrated to reflect standard atmosphere adiabatic compressible flow at sea level uncorrected for airspeed system errors. Calibrated airspeed (CAS) is IAS corrected for instrument errors, position error (due to incorrect pressure at the static port) and installation errors.

Indicated altitude. The altitude read directly from the altimeter (uncorrected) when it is set to the current altimeter setting.

Indirect indication. A reflection of aircraft pitch-and-bank attitude by instruments other than the attitude indicator.

Induced drag. Drag caused by the same factors that produce lift; its amount varies inversely with airspeed. As airspeed decreases, the angle of attack must increase, in turn increasing induced drag.

Induction icing. A type of ice in the induction system that reduces the amount of air available for combustion. The most commonly found induction icing is carburetor icing.

Inertial navigation system (INS). A computer-based navigation system that tracks the movement of an aircraft via signals produced by onboard accelerometers. The initial location of the aircraft is entered into the computer, and all subsequent movement of the aircraft is sensed and used to keep the position updated. An INS does not require any inputs from outside signals.

Initial approach fix (IAF). The fix depicted on IAP charts where the instrument approach procedure (IAP) begins unless otherwise authorized by ATC.

Inoperative components. Higher minimums are prescribed when the specified visual aids are not functioning; this information is listed in the Inoperative Components Table found in the United States Terminal Procedures Publications.

INS. See inertial navigation system.

Instantaneous vertical speed indicator (IVSI). Assists in interpretation by instantaneously indicating the rate of climb or descent at a given moment with little or no lag as displayed in a vertical speed indicator (VSI).

Instrument approach procedures (IAP). A series of predetermined maneuvers for the orderly transfer of an aircraft under IFR from the beginning of the initial approach to a landing or to a point from which a landing may be made visually.

Instrument flight rules (IFR). Rules and regulations established by the Federal Aviation Administration to govern flight under conditions in which flight by outside visual reference is not safe. IFR flight depends upon flying by reference to instruments in the flight deck, and navigation is accomplished by reference to electronic signals.

Instrument landing system (ILS). An electronic system that provides both horizontal and vertical guidance to a specific runway, used to execute a precision instrument approach procedure.

Instrument meteorological conditions (IMC). Meteorological conditions expressed in terms of visibility, distance from clouds, and ceiling less than the minimums specified for visual meteorological conditions, requiring operations to be conducted under IFR.

Instrument takeoff. Using the instruments rather than outside visual cues to maintain runway heading and execute a safe takeoff.

Intercooler. A device used to reduce the temperatures of the compressed air before it enters the fuel metering device. The resulting cooler air has a higher density, which permits the engine to be operated with a higher power setting.

Interference drag. Drag generated by the collision of airstreams creating eddy currents, turbulence, or restrictions to smooth flow.

International Civil Aviation Organization (ICAO). The United Nations agency for developing the principles and techniques of international air navigation, and fostering planning and development of international civil air transport.

International standard atmosphere (IAS). A model of standard variation of pressure and temperature.

Interpolation. The estimation of an intermediate value of a quantity that falls between marked values in a series. Example: In a measurement of length, with a rule that is marked in eighths of an inch, the value falls between 3/8 inch and 1/2 inch. The estimated (interpolated) value might then be said to be 7/16 inch.

Inversion. An increase in temperature with altitude.

Inversion illusion. The feeling that the aircraft is tumbling backwards, caused by an abrupt change from climb to straight-and-level flight while in situations lacking visual reference.

Inverter. A solid-state electronic device that converts D.C. into A.C. current of the proper voltage and frequency to operate A.C. gyro instruments.

Isobars. Lines which connect points of equal barometric pressure.

Isogonic lines. Lines drawn across aeronautical charts to connect points having the same magnetic variation.

IVSI. See instantaneous vertical speed indicator.

J

Jet route. A route designated to serve flight operations from 18,000 feet MSL up to and including FL 450.

Jet stream. A high-velocity narrow stream of winds, usually found near the upper limit of the troposphere, which flows generally from west to east.

Judgment. The mental process of recognizing and analyzing all pertinent information in a particular situation, a rational evaluation of alternative actions in response to it, and a timely decision on which action to take.

K

KIAS. Knots indicated airspeed.

Knot. The knot is a unit of speed equal to one nautical mile (1.852 km) per hour, approximately 1.151 mph.

Kollsman window. A barometric scale window of a sensitive altimeter used to adjust the altitude for the altimeter setting.

L

LAAS. See local area augmentation system.

Lag. The delay that occurs before an instrument needle attains a stable indication.

Land breeze. A coastal breeze flowing from land to sea caused by temperature differences when the sea surface is warmer than the adjacent land. The land breeze usually occurs at night and alternates with the sea breeze that blows in the opposite direction by day.

Land as soon as possible. Land without delay at the nearest suitable area, such as an open field, at which a safe approach and landing is assured.

Land as soon as practical. The landing site and duration of flight are at the discretion of the pilot. Extended flight beyond the nearest approved landing area is not recommended.

Land immediately. The urgency of the landing is paramount. The primary consideration is to ensure the survival of the occupants. Landing in trees, water, or other unsafe areas should be considered only as a last resort.

Lateral axis. An imaginary line passing through the center of gravity of an airplane and extending across the airplane from wingtip to wingtip.

Lateral stability (rolling). The stability about the longitudinal axis of an aircraft. Rolling stability or the ability of an airplane to return to level flight due to a disturbance that causes one of the wings to drop.

Latitude. Measurement north or south of the equator in degrees, minutes, and seconds. Lines of latitude are also referred to as parallels.

LDA. See localizer-type directional aid.

Lead radial. The radial at which the turn from the DME arc to the inbound course is started.

Leading edge. The part of an airfoil that meets the airflow first.

Leading edge devices. High lift devices which are found on the leading edge of the airfoil. The most common types are fixed slots, movable slats, and leading edge flaps.

Leading-edge flap. A portion of the leading edge of an airplane wing that folds downward to increase the camber, lift, and drag of the wing. The leading-edge flaps are extended for takeoffs and landings to increase the amount of aerodynamic lift that is produced at any given airspeed.

Leans, the. A physical sensation caused by an abrupt correction of a banked attitude entered too slowly to stimulate the motion sensing system in the inner ear. The abrupt correction can create the illusion of banking in the opposite direction.

Licensed empty weight. The empty weight that consists of the airframe, engine(s), unusable fuel, and undrainable oil plus standard and optional equipment as specified in the equipment list. Some manufacturers used this term prior to GAMA standardization.

Lift. A component of the total aerodynamic force on an airfoil and acts perpendicular to the relative wind.

Limit load factor. Amount of stress, or load factor, that an aircraft can withstand before structural damage or failure occurs.

Lines of flux. Invisible lines of magnetic force passing between the poles of a magnet.

L/MF. See low or medium frequency.

LMM. See locator middle marker.

Load factor. The ratio of a specified load to the total weight of the aircraft. The specified load is expressed in terms of any of the following: aerodynamic forces, inertial forces, or ground or water reactions.

Loadmeter. A type of ammeter installed between the generator output and the main bus in an aircraft electrical system.

LOC. See localizer.

Local area augmentation system (LAAS). A differential global positioning system (DGPS) that improves the accuracy of the system by determining position error from the GPS satellites, then transmitting the error, or corrective factors, to the airborne GPS receiver.

Localizer (LOC). The portion of an ILS that gives left/right guidance information down the centerline of the instrument runway for final approach.

Localizer-type directional aid (LDA). A NAVAID used for nonprecision instrument approaches with utility and accuracy comparable to a localizer but which is not a part of a complete ILS and is not aligned with the runway. Some LDAs are equipped with a glideslope.

Locator middle marker (LMM). Nondirectional radio beacon (NDB) compass locator, collocated with a middle marker (MM).

Locator outer marker (LOM). NDB compass locator, collocated with an outer marker (OM).

LOM. See locator outer marker.

Longitude. Measurement east or west of the Prime Meridian in degrees, minutes, and seconds. The Prime Meridian is 0° longitude and runs through Greenwich, England. Lines of longitude are also referred to as meridians.

Longitudinal axis. An imaginary line through an aircraft from nose to tail, passing through its center of gravity. The longitudinal axis is also called the roll axis of the aircraft. Movement of the ailerons rotates an airplane about its longitudinal axis.

Longitudinal stability (pitching). Stability about the lateral axis. A desirable characteristic of an airplane whereby it tends to return to its trimmed angle of attack after displacement.

Low or medium frequency. A frequency range between 190 and 535 kHz with the medium frequency above 300 kHz. Generally associated with nondirectional beacons transmitting a continuous carrier with either a 400 or 1,020 Hz modulation.

Lubber line. The reference line used in a magnetic compass or heading indicator.

M

MAA. See maximum authorized altitude.

MAC. See mean aerodynamic chord.

Mach number. The ratio of the true airspeed of the aircraft to the speed of sound in the same atmospheric conditions, named in honor of Ernst Mach, late 19th century physicist.

Mach meter. The instrument that displays the ratio of the speed of sound to the true airspeed an aircraft is flying.

Magnetic bearing (MB). The direction to or from a radio transmitting station measured relative to magnetic north.

Magnetic compass. A device for determining direction measured from magnetic north.

Magnetic dip. A vertical attraction between a compass needle and the magnetic poles. The closer the aircraft is to a pole, the more severe the effect.

Magnetic heading (MH). The direction an aircraft is pointed with respect to magnetic north.

Magneto. A self-contained, engine-driven unit that supplies electrical current to the spark plugs; completely independent of the airplane's electrical system. Normally there are two magnetos per engine.

Magnus effect. Lifting force produced when a rotating cylinder produces a pressure differential. This is the same effect that makes a baseball curve or a golf ball slice.

Mandatory altitude. An altitude depicted on an instrument approach chart with the altitude value both underscored and overscored. Aircraft are required to maintain altitude at the depicted value.

Mandatory block altitude. An altitude depicted on an instrument approach chart with two underscored and overscored altitude values between which aircraft are required to maintain altitude.

Maneuverability. Ability of an aircraft to change directions along a flight path and withstand the stresses imposed upon it.

Maneuvering speed (V_A). The design maneuvering speed. Operating at or below design maneuvering speed does not provide structural protection against multiple full control inputs in one axis or full control inputs in more than one axis at the same time.

Manifold absolute pressure. The absolute pressure of the fuel/air mixture within the intake manifold, usually indicated in inches of mercury.

MAP. See missed approach point.

Margin identification. The top and bottom areas on an instrument approach chart that depict information about the procedure, including airport location and procedure identification.

Marker beacon. A low-powered transmitter that directs its signal upward in a small, fan-shaped pattern. Used along the flight path when approaching an airport for landing, marker beacons indicate both aurally and visually when the aircraft is directly over the facility.

Mass. The amount of matter in a body.

Maximum altitude. An altitude depicted on an instrument approach chart with overscored altitude value at which or below aircraft are required to maintain altitude.

Maximum authorized altitude (MAA). A published altitude representing the maximum usable altitude or flight level for an airspace structure or route segment.

Maximum landing weight. The greatest weight that an airplane normally is allowed to have at landing.

Maximum ramp weight. The total weight of a loaded aircraft, including all fuel. It is greater than the takeoff weight due to the fuel that will be burned during the taxi and runup operations. Ramp weight may also be referred to as taxi weight.

Maximum takeoff weight. The maximum allowable weight for takeoff.

Maximum weight. The maximum authorized weight of the aircraft and all of its equipment as specified in the Type Certificate Data Sheets (TCDS) for the aircraft.

Maximum zero fuel weight (GAMA). The maximum weight, exclusive of usable fuel.

MB. See magnetic bearing.

MCA. See minimum crossing altitude.

MDA. See minimum descent altitude.

MEA. See minimum en route altitude.

Mean aerodynamic chord (MAC). The average distance from the leading edge to the trailing edge of the wing.

Mean sea level. The average height of the surface of the sea at a particular location for all stages of the tide over a 19-year period.

MEL. See minimum equipment list.

Meridians. Lines of longitude.

Mesosphere. A layer of the atmosphere directly above the stratosphere.

METAR. See Aviation Routine Weather Report.

MFD. See multi-function display.

MH. See magnetic heading.

MHz. Megahertz.

Microbursts. A strong downdraft which normally occurs over horizontal distances of 1 NM or less and vertical distances of less than 1,000 feet. In spite of its small horizontal scale, an intense microburst could induce windspeeds greater than 100 knots and downdrafts as strong as 6,000 feet per minute.

Microwave landing system (MLS). A precision instrument approach system operating in the microwave spectrum which normally consists of an azimuth station, elevation station, and precision distance measuring equipment.

Mileage breakdown. A fix indicating a course change that appears on the chart as an “x” at a break between two segments of a federal airway.

Military operations area (MOA). Airspace established for the purpose of separating certain military training activities from IFR traffic.

Military training route (MTR). Airspace of defined vertical and lateral dimensions established for the conduct of military training at airspeeds in excess of 250 knots indicated airspeed (KIAS).

Minimum altitude. An altitude depicted on an instrument approach chart with the altitude value underscored. Aircraft are required to maintain altitude at or above the depicted value.

Minimum crossing altitude (MCA). The lowest allowed altitude at certain fixes an aircraft must cross when proceeding in the direction of a higher minimum en route altitude (MEA).

Minimum descent altitude (MDA). The lowest altitude (in feet MSL) to which descent is authorized on final approach, or during circle-to-land maneuvering in execution of a nonprecision approach.

Minimum drag. The point on the total drag curve where the lift-to-drag ratio is the greatest. At this speed, total drag is minimized.

Minimum en route altitude (MEA). The lowest published altitude between radio fixes that ensures acceptable navigational signal coverage and meets obstacle clearance requirements between those fixes.

Minimum equipment list (MEL). A list developed for larger aircraft that outlines equipment that can be inoperative for various types of flight including IFR and icing conditions. This list is based on the master minimum equipment list (MMEL) developed by the FAA and must be approved by the FAA for use. It is specific to an individual aircraft make and model.

Minimum obstruction clearance altitude (MOCA). The lowest published altitude in effect between radio fixes on VOR airways, off-airway routes, or route segments, which meets obstacle clearance requirements for the entire route segment and which ensures acceptable navigational signal coverage only within 25 statute (22 nautical) miles of a VOR.

Minimum reception altitude (MRA). The lowest altitude at which an airway intersection can be determined.

Minimum safe altitude (MSA). The minimum altitude depicted on approach charts which provides at least 1,000 feet of obstacle clearance for emergency use within a specified distance from the listed navigation facility.

Minimum vectoring altitude (MVA). An IFR altitude lower than the minimum en route altitude (MEA) that provides terrain and obstacle clearance.

Minimums section. The area on an IAP chart that displays the lowest altitude and visibility requirements for the approach.

Missed approach. A maneuver conducted by a pilot when an instrument approach cannot be completed to a landing.

Missed approach point (MAP). A point prescribed in each instrument approach at which a missed approach procedure shall be executed if the required visual reference has not been established.

Mixed ice. A mixture of clear ice and rime ice.

MLS. See microwave landing system.

MM. Middle marker.

MOA. See military operations area.

MOCA. See minimum obstruction clearance altitude.

Mode C. Altitude reporting transponder mode.

Moment. The product of the weight of an item multiplied by its arm. Moments are expressed in pound-inches (lb-in). Total moment is the weight of the airplane multiplied by the distance between the datum and the CG.

Moment arm. The distance from a datum to the applied force.

Moment index (or index). A moment divided by a constant such as 100, 1,000, or 10,000. The purpose of using a moment index is to simplify weight and balance computations of airplanes where heavy items and long arms result in large, unmanageable numbers.

Monocoque. A shell-like fuselage design in which the stressed outer skin is used to support the majority of imposed stresses. Monocoque fuselage design may include bulkheads but not stringers.

Monoplanes. Airplanes with a single set of wings.

Movable slat. A movable auxiliary airfoil on the leading edge of a wing. It is closed in normal flight but extends at high angles of attack. This allows air to continue flowing over the top of the wing and delays airflow separation.

MRA. See minimum reception altitude.

MSA. See minimum safe altitude.

MSL. See mean sea level.

MTR. See military training route.

Multi-function display (MFD). Small screen (CRT or LCD) in an aircraft that can be used to display information to the pilot in numerous configurable ways. Often an MFD will be used in concert with a primary flight display.

MVA. See minimum vectoring altitude.

N

N_1 . Rotational speed of the low pressure compressor in a turbine engine.

N_2 . Rotational speed of the high pressure compressor in a turbine engine.

Nacelle. A streamlined enclosure on an aircraft in which an engine is mounted. On multiengine propeller-driven airplanes, the nacelle is normally mounted on the leading edge of the wing.

NACG. See National Aeronautical Charting Group.

NAS. See National Airspace System.

National Airspace System (NAS). The common network of United States airspace—air navigation facilities, equipment and services, airports or landing areas; aeronautical charts, information and services; rules, regulations and procedures, technical information; and manpower and material.

National Aeronautical Charting Group (NACG). A Federal agency operating under the FAA, responsible for publishing charts such as the terminal procedures and en route charts.

National Route Program (NRP). A set of rules and procedures designed to increase the flexibility of user flight planning within published guidelines.

National Security Area (NSA). Areas consisting of airspace of defined vertical and lateral dimensions established at locations where there is a requirement for increased security and safety of ground facilities. Pilots are requested to voluntarily avoid flying through the depicted NSA. When it is necessary to provide a greater level of security and safety, flight in NSAs may be temporarily prohibited. Regulatory prohibitions are disseminated via NOTAMs.

National Transportation Safety Board (NTSB). A United States Government independent organization responsible for investigations of accidents involving aviation, highways, waterways, pipelines, and railroads in the United States. NTSB is charged by congress to investigate every civil aviation accident in the United States.

NAVAID. Navigational aid.

NAV/COM. Navigation and communication radio.

NDB. See nondirectional radio beacon.

Negative static stability. The initial tendency of an aircraft to continue away from the original state of equilibrium after being disturbed.

Neutral static stability. The initial tendency of an aircraft to remain in a new condition after its equilibrium has been disturbed.

NM. Nautical mile.

NOAA. National Oceanic and Atmospheric Administration.

No-gyro approach. A radar approach that may be used in case of a malfunctioning gyro-compass or directional gyro. Instead of providing the pilot with headings to be flown, the controller observes the radar track and issues control instructions “turn right/left” or “stop turn,” as appropriate.

Nondirectional radio beacon (NDB). A ground-based radio transmitter that transmits radio energy in all directions.

Nonprecision approach. A standard instrument approach procedure in which only horizontal guidance is provided.

No procedure turn (NoPT). Term used with the appropriate course and altitude to denote that the procedure turn is not required.

NoPT. See no procedure turn.

NOTAM. See Notice to Airmen.

Notice to Air men (NOTAM). A notice filed with an aviation authority to alert aircraft pilots of any hazards en route or at a specific location. The authority in turn provides means of disseminating relevant NOTAMs to pilots.

NRP. See National Route Program.

NSA. See National Security Area.

NTSB. See National Transportation Safety Board.

NWS. National Weather Service.

O

Obstacle departure procedures (ODP). A preplanned instrument flight rule (IFR) departure procedure printed for pilot use in textual or graphic form to provide obstruction clearance via the least onerous route from the terminal area to the appropriate en route structure. ODPs are recommended for obstruction clearance and may be flown without ATC clearance unless an alternate departure procedure (SID or radar vector) has been specifically assigned by ATC.

Obstruction lights. Lights that can be found both on and off an airport to identify obstructions.

Occluded front. A frontal occlusion occurs when a fast-moving cold front catches up with a slow moving warm front. The difference in temperature within each frontal system is a major factor in determining whether a cold or warm front occlusion occurs.

ODP. See obstacle departure procedures.

OM. Outer marker.

Omission error. The failure to anticipate significant instrument indications following attitude changes; for example, concentrating on pitch control while forgetting about heading or roll information, resulting in erratic control of heading and bank.

Optical illusion. A misleading visual image. For the purpose of this handbook, the term refers to the brain's misinterpretation of features on the ground associated with landing, which causes a pilot to misread the spatial relationships between the aircraft and the runway.

Orientation. Awareness of the position of the aircraft and of oneself in relation to a specific reference point.

Otolith organ. An inner ear organ that detects linear acceleration and gravity orientation.

Outer marker. A marker beacon at or near the glideslope intercept altitude of an ILS approach. It is normally located four to seven miles from the runway threshold on the extended centerline of the runway.

Outside air temperature (OAT). The measured or indicated air temperature (IAT) corrected for compression and friction heating. Also referred to as true air temperature.

Overcontrolling. Using more movement in the control column than is necessary to achieve the desired pitch-and-bank condition.

Overboost. A condition in which a reciprocating engine has exceeded the maximum manifold pressure allowed by the manufacturer. Can cause damage to engine components.

Overpower. To use more power than required for the purpose of achieving a faster rate of airspeed change.

P

P-static. See precipitation static.

PAPI. See precision approach path indicator.

PAR. See precision approach radar.

Parallels. Lines of latitude.

Parasite drag. Drag caused by the friction of air moving over the aircraft structure; its amount varies directly with the airspeed.

Payload (GAMA). The weight of occupants, cargo, and baggage.

Personality. The embodiment of personal traits and characteristics of an individual that are set at a very early age and extremely resistant to change.

P-factor. A tendency for an aircraft to yaw to the left due to the descending propeller blade on the right producing more thrust than the ascending blade on the left. This occurs when the aircraft's longitudinal axis is in a climbing attitude in relation to the relative wind. The P-factor would be to the right if the aircraft had a counterclockwise rotating propeller.

PFD. See primary flight display.

Phugoid oscillations. Long-period oscillations of an aircraft around its lateral axis. It is a slow change in pitch accompanied by equally slow changes in airspeed. Angle of attack remains constant, and the pilot often corrects for phugoid oscillations without even being aware of them.

PIC. See pilot in command.

Pilotage. Navigation by visual reference to landmarks.

Pilot in command (PIC). The pilot responsible for the operation and safety of an aircraft.

Pilot report (PIREP). Report of meteorological phenomena encountered by aircraft.

Pilot's Operating Handbook/Airplane Flight Manual (POH/AFM). FAA-approved documents published by the airframe manufacturer that list the operating conditions for a particular model of aircraft.

PIREP. See pilot report.

Pitot pressure. Ram air pressure used to measure airspeed.

Pitot-static head. A combination pickup used to sample pitot pressure and static air pressure.

Plan view. The overhead view of an approach procedure on an instrument approach chart. The plan view depicts the routes that guide the pilot from the en route segments to the IAF.

Planform. The shape or form of a wing as viewed from above. It may be long and tapered, short and rectangular, or various other shapes.

Pneumatic. Operation by the use of compressed air.

POH/AFM. See Pilot's Operating Handbook/Airplane Flight Manual.

Point-in-space approach. A type of helicopter instrument approach procedure to a missed approach point more than 2,600 feet from an associated helicopter landing area.

Poor judgment chain. A series of mistakes that may lead to an accident or incident. Two basic principles generally associated with the creation of a poor judgment chain are: (1) one bad decision often leads to another; and (2) as a string of bad decisions grows, it reduces the number of subsequent alternatives for continued safe flight. ADM is intended to break the poor judgment chain before it can cause an accident or incident.

Position error. Error in the indication of the altimeter, ASI, and VSI caused by the air at the static system entrance not being absolutely still.

Position report. A report over a known location as transmitted by an aircraft to ATC.

Positive static stability. The initial tendency to return to a state of equilibrium when disturbed from that state.

Power. Implies work rate or units of work per unit of time, and as such, it is a function of the speed at which the force is developed. The term "power required" is generally associated with reciprocating engines.

Powerplant. A complete engine and propeller combination with accessories.

Precession. The characteristic of a gyroscope that causes an applied force to be felt, not at the point of application, but 90° from that point in the direction of rotation.

Precipitation. Any or all forms of water particles (rain, sleet, hail, or snow) that fall from the atmosphere and reach the surface.

Precipitation static (P-static). A form of radio interference caused by rain, snow, or dust particles hitting the antenna and inducing a small radio-frequency voltage into it.

Precision approach. A standard instrument approach procedure in which both vertical and horizontal guidance is provided.

Precision approach path indicator (PAPI). A system of lights similar to the VASI, but consisting of one row of lights in two- or four-light systems. A pilot on the correct glideslope will see two white lights and two red lights. See VASI.

Precision approach radar (PAR). A type of radar used at an airport to guide an aircraft through the final stages of landing, providing horizontal and vertical guidance. The radar operator directs the pilot to change heading or adjust the descent rate to keep the aircraft on a path that allows it to touch down at the correct spot on the runway.

Precision runway monitor (PRM). System allows simultaneous, independent instrument flight rules (IFR) approaches at airports with closely spaced parallel runways.

Preferred IFR routes. Routes established in the major terminal and en route environments to increase system efficiency and capacity. IFR clearances are issued based on these routes, listed in the Chart Supplement U.S. except when severe weather avoidance procedures or other factors dictate otherwise.

Preignition. Ignition occurring in the cylinder before the time of normal ignition. Preignition is often caused by a local hot spot in the combustion chamber igniting the fuel-air mixture.

Pressure altitude. Altitude above the standard 29.92 "Hg plane.

Pressure demand oxygen system. A demand oxygen system that supplies 100 percent oxygen at sufficient pressure above the altitude where normal breathing is adequate. Also referred to as a pressure breathing system.

Prevailing visibility. The greatest horizontal visibility equaled or exceeded throughout at least half the horizon circle (which is not necessarily continuous).

Preventive maintenance. Simple or minor preservative operations and the replacement of small standard parts not involving complex assembly operation as listed in 14 CFR part 43, appendix A. Certificated pilots may perform preventive maintenance on any aircraft that is owned or operated by them provided that the aircraft is not used in air carrier service.

Primary and supporting. A method of attitude instrument flying using the instrument that provides the most direct indication of attitude and performance.

Primary flight display (PFD). A display that provides increased situational awareness to the pilot by replacing the traditional six instruments used for instrument flight with an easy-to-scan display that provides the horizon, airspeed, altitude, vertical speed, trend, trim, and rate of turn among other key relevant indications.

PRM. See precision runway monitor.

Procedure turn. A maneuver prescribed when it is necessary to reverse direction to establish an aircraft on the intermediate approach segment or final approach course.

Profile view. Side view of an IAP chart illustrating the vertical approach path altitudes, headings, distances, and fixes.

Prohibited area. Designated airspace within which flight of aircraft is prohibited.

Propeller. A device for propelling an aircraft that, when rotated, produces by its action on the air, a thrust approximately perpendicular to its plane of rotation. It includes the control components normally supplied by its manufacturer.

Propeller/rotor modulation error. Certain propeller rpm settings or helicopter rotor speeds can cause the VOR course deviation indicator (CDI) to fluctuate as much as $\pm 6^\circ$. Slight changes to the rpm setting will normally smooth out this roughness.

R

Rabbit, the. High-intensity flasher system installed at many large airports. The flashers consist of a series of brilliant blue-white bursts of light flashing in sequence along the approach lights, giving the effect of a ball of light traveling toward the runway.

Radar. A system that uses electromagnetic waves to identify the range, altitude, direction, or speed of both moving and fixed objects such as aircraft, weather formations, and terrain. The term RADAR was coined in 1941 as an acronym for Radio Detection and Ranging. The term has since entered the English language as a standard word, radar, losing the capitalization in the process.

Radar approach. The controller provides vectors while monitoring the progress of the flight with radar, guiding the pilot through the descent to the airport/heliport or to a specific runway.

Radar services. Radar is a method whereby radio waves are transmitted into the air and are then received when they have been reflected by an object in the path of the beam. Range is determined by measuring the time it takes (at the speed of light) for the radio wave to go out to the object and then return to the receiving antenna. The direction of a detected object from a radar site is determined by the position of the rotating antenna when the reflected portion of the radio wave is received.

Radar summary chart. A weather product derived from the national radar network that graphically displays a summary of radar weather reports.

Radar weather report (SD). A report issued by radar stations at 35 minutes after the hour, and special reports as needed. Provides information on the type, intensity, and location of the echo tops of the precipitation.

Radials. The courses oriented from a station.

Radio or radar altimeter. An electronic altimeter that determines the height of an aircraft above the terrain by measuring the time needed for a pulse of radio-frequency energy to travel from the aircraft to the ground and return.

Radio frequency (RF). A term that refers to alternating current (AC) having characteristics such that, if the current is input to antenna, an electromagnetic (EM) field is generated suitable for wireless broadcasting and/or communications.

Radio magnetic indicator (RMI). An electronic navigation instrument that combines a magnetic compass with an ADF or VOR. The card of the RMI acts as a gyro-stabilized magnetic compass, and shows the magnetic heading the aircraft is flying.

Radiosonde. A weather instrument that observes and reports meteorological conditions from the upper atmosphere. This instrument is typically carried into the atmosphere by some form of weather balloon.

Radio wave. An electromagnetic (EM) wave with frequency characteristics useful for radio transmission.

RAIM. See receiver autonomous integrity monitoring.

RAM recovery. The increase in thrust as a result of ram air pressures and density on the front of the engine caused by air velocity.

Random RNAV routes. Direct routes, based on area navigation capability, between waypoints defined in terms of latitude/longitude coordinates, degree-distance fixes, or offsets from established routes/airways at a specified distance and direction.

Ranging signals. Transmitted from the GPS satellite, signals allowing the aircraft's receiver to determine range (distance) from each satellite.

Rapid decompression. The almost instantaneous loss of cabin pressure in aircraft with a pressurized cockpit or cabin.

RB. See relative bearing.

RBI. See relative bearing indicator.

RCO. See remote communications outlet.

Receiver autonomous integrity monitoring (RAIM). A system used to verify the usability of the received GPS signals and warns the pilot of any malfunction in the navigation system. This system is required for IFR-certified GPS units.

Recommended altitude. An altitude depicted on an instrument approach chart with the altitude value neither underscored nor overscored. The depicted value is an advisory value.

Receiver-transmitter (RT). A system that receives and transmits a signal and an indicator.

Reduced vertical separation minimum (RVSM). Reduces the vertical separation between flight levels (FL) 290 and 410 from 2,000 feet to 1,000 feet, and makes six additional FLs available for operation. Also see DRVSM.

Reference circle (also, distance circle). The circle depicted in the plan view of an IAP chart that typically has a 10 NM radius, within which chart the elements are drawn to scale.

Regions of command. The “regions of normal and reversed command” refers to the relationship between speed and the power required to maintain or change that speed in flight.

Region of reverse command. Flight regime in which flight at a higher airspeed requires a lower power setting and a lower airspeed requires a higher power setting in order to maintain altitude.

REIL. See runway end identifier lights.

Relative bearing (RB). The angular difference between the aircraft heading and the direction to the station, measured clockwise from the nose of the aircraft.

Relative bearing indicator (RBI). Also known as the fixed-card ADF, zero is always indicated at the top of the instrument and the needle indicates the relative bearing to the station.

Relative humidity. The ratio of the existing amount of water vapor in the air at a given temperature to the maximum amount that could exist at that temperature; usually expressed in percent.

Relative wind. Direction of the airflow produced by an object moving through the air. The relative wind for an airplane in flight flows in a direction parallel with and opposite to the direction of flight; therefore, the actual flight path of the airplane determines the direction of the relative wind.

Remote communications outlet (RCO). An unmanned communications facility that is remotely controlled by air traffic personnel.

Required navigation performance (RNP). A specified level of accuracy defined by a lateral area of confined airspace in which an RNP-certified aircraft operates.

Restricted area. Airspace designated under 14 CFR part 73 within which the flight of aircraft, while not wholly prohibited, is subject to restriction.

Reverse sensing. The VOR needle appearing to indicate the reverse of normal operation.

RF. Radio frequency.

Rhodopsin. The photosensitive pigments that initiate the visual response in the rods of the eye.

Rigging. The final adjustment and alignment of an aircraft and its flight control system that provides the proper aerodynamic characteristics.

Rigidity. The characteristic of a gyroscope that prevents its axis of rotation tilting as the Earth rotates.

Rigidity in space. The principle that a wheel with a heavily weighted rim spinning rapidly will remain in a fixed position in the plane in which it is spinning.

Rime ice. Rough, milky, opaque ice formed by the instantaneous freezing of small supercooled water droplets.

Risk. The future impact of a hazard that is not eliminated or controlled.

Risk elements. There are four fundamental risk elements in aviation: the pilot, the aircraft, the environment, and the type of operation that comprise any given aviation situation.

Risk management. The part of the decision-making process which relies on situational awareness, problem recognition, and good judgment to reduce risks associated with each flight.

RMI. See radio magnetic indicator.

RNAV. See area navigation.

RNP. See required navigation performance.

RT. See receiver-transmitter.

Rudder. The movable primary control surface mounted on the trailing edge of the vertical fin of an airplane. Movement of the rudder rotates the airplane about its vertical axis.

Ruddervator. A pair of control surfaces on the tail of an aircraft arranged in the form of a V. These surfaces, when moved together by the control wheel, serve as elevators, and when moved differentially by the rudder pedals, serve as a rudder.

Runway centerline lights. Runway lighting which consists of flush centerline lights spaced at 50-foot intervals beginning 75 feet from the landing threshold.

Runway edge lights. A component of the runway lighting system that is used to outline the edges of runways at night or during low visibility conditions. These lights are classified according to the intensity they are capable of producing.

Runway end identifier lights (REIL). A pair of synchronized flashing lights, located laterally on each side of the runway threshold, providing rapid and positive identification of the approach end of a runway.

Runway visibility value (RVV). The visibility determined for a particular runway by a transmissometer.

Runway visual range (RVR). The instrumentally derived horizontal distance a pilot should be able to see down the runway from the approach end, based on either the sighting of high-intensity runway lights, or the visual contrast of other objects.

RVR. See runway visual range.

RVV. See runway visibility value.

S

SA. See selective availability.

St. Elmo's Fire. A corona discharge which lights up the aircraft surface areas where maximum static discharge occurs.

Satellite ephemeris data. Data broadcast by the GPS satellite containing very accurate orbital data for that satellite, atmospheric propagation data, and satellite clock error data.

Sea breeze. A coastal breeze blowing from sea to land caused by the temperature difference when the land surface is warmer than the sea surface. The sea breeze usually occurs during the day and alternates with the land breeze that blows in the opposite direction at night.

Sea level engine. A reciprocating aircraft engine having a rated takeoff power that is producible only at sea level.

Scan. The first fundamental skill of instrument flight, also known as "cross-check;" the continuous and logical observation of instruments for attitude and performance information.

Sectional aeronautical charts. Designed for visual navigation of slow- or medium-speed aircraft. Topographic information on these charts features the portrayal of relief, and a judicious selection of visual check points for VFR flight. Aeronautical information includes visual and radio aids to navigation, airports, controlled airspace, restricted areas, obstructions and related data.

SDF. See simplified directional facility.

Selective availability (SA). A satellite technology permitting the Department of Defense (DOD) to create, in the interest of national security, a significant clock and ephemeris error in the satellites, resulting in a navigation error.

Semicircular canal. An inner ear organ that detects angular acceleration of the body.

Semimonocoque. A fuselage design that includes a substructure of bulkheads and/or formers, along with stringers, to support flight loads and stresses imposed on the fuselage.

Sensitive altimeter. A form of multipointer pneumatic altimeter with an adjustable barometric scale that allows the reference pressure to be set to any desired level.

Service ceiling. The maximum density altitude where the best rate-of-climb airspeed will produce a 100-feet-per-minute climb at maximum weight while in a clean configuration with maximum continuous power.

Servo. A motor or other form of actuator which receives a small signal from the control device and exerts a large force to accomplish the desired work.

Servo tab. An auxiliary control mounted on a primary control surface, which automatically moves in the direction opposite the primary control to provide an aerodynamic assist in the movement of the control.

SIDS. See standard instrument departure procedures.

SIGMET. The acronym for Significant Meteorological information. A weather advisory in abbreviated plain language concerning the occurrence or expected occurrence of potentially hazardous en route weather phenomena that may affect the safety of aircraft operations. SIGMET is warning information, hence it is of highest priority among other types of meteorological information provided to the aviation users.

Signal-to-noise ratio. An indication of signal strength received compared to background noise, which is a measure of the adequacy of the received signal.

Significant weather prognostic. Presents four panels showing forecast significant weather.

Simplex. Transmission and reception on the same frequency.

Simplified directional facility (SDF). A NAVAID used for nonprecision instrument approaches. The final approach course is similar to that of an ILS localizer; however, the SDF course may be offset from the runway, generally not more than 3°, and the course may be wider than the localizer, resulting in a lower degree of accuracy.

Single-pilot resource management (SRM). The ability for a pilot to manage all resources effectively to ensure the outcome of the flight is successful.

Situational awareness. Pilot knowledge of where the aircraft is in regard to location, air traffic control, weather, regulations, aircraft status, and other factors that may affect flight.

Skidding turn. An uncoordinated turn in which the rate of turn is too great for the angle of bank, pulling the aircraft to the outside of the turn.

Skills and procedures. The procedural, psychomotor, and perceptual skills used to control a specific aircraft or its systems. They are the airmanship abilities that are gained through conventional training, are perfected, and become almost automatic through experience.

Skin friction drag. Drag generated between air molecules and the solid surface of the aircraft.

Slant range. The horizontal distance from the aircraft antenna to the ground station, due to line-of-sight transmission of the DME signal.

Slaved compass. A system whereby the heading gyro is “slaved to,” or continuously corrected to bring its direction readings into agreement with a remotely located magnetic direction sensing device (usually a flux valve or flux gate compass).

Slipping turn. An uncoordinated turn in which the aircraft is banked too much for the rate of turn, so the horizontal lift component is greater than the centrifugal force, pulling the aircraft toward the inside of the turn.

Small airplane. An airplane of 12,500 pounds or less maximum certificated takeoff weight.

Somatogravic illusion. The misperception of being in a nose-up or nose-down attitude, caused by a rapid acceleration or deceleration while in flight situations that lack visual reference.

Spatial disorientation. The state of confusion due to misleading information being sent to the brain from various sensory organs, resulting in a lack of awareness of the aircraft position in relation to a specific reference point.

Special flight permit. A flight permit issued to an aircraft that does not meet airworthiness requirements but is capable of safe flight. A special flight permit can be issued to move an aircraft for the purposes of maintenance or repair, buyer delivery, manufacturer flight tests, evacuation from danger, or customer demonstration. Also referred to as a ferry permit.

Special use airspace. Airspace in which flight activities are subject to restrictions that can create limitations on the mixed use of airspace. Consists of prohibited, restricted, warning, military operations, and alert areas.

Special fuel consumption. The amount of fuel in pounds per hour consumed or required by an engine per brake horsepower or per pound of thrust.

Speed. The distance traveled in a given time.

Spin. An aggravated stall that results in an airplane descending in a helical, or corkscrew path.

Spiral instability. A condition that exists when the static directional stability of the airplane is very strong as compared to the effect of its dihedral in maintaining lateral equilibrium.

Spiraling slipstream. The slipstream of a propeller-driven airplane rotates around the airplane. This slipstream strikes the left side of the vertical fin, causing the aircraft to yaw slightly. Rudder offset is sometimes used by aircraft designers to counteract this tendency.

Spoilers. High-drag devices that can be raised into the air flowing over an airfoil, reducing lift and increasing drag. Spoilers are used for roll control on some aircraft. Deploying spoilers on both wings at the same time allows the aircraft to descend without gaining speed. Spoilers are also used to shorten the ground roll after landing.

SRM. See single-pilot resource management.

SSR. See secondary surveillance radar.

SSV. See standard service volume.

Stabilator. A single-piece horizontal tail surface on an airplane that pivots around a central hinge point. A stabilator serves the purposes of both the horizontal stabilizer and the elevators.

Stability. The inherent quality of an airplane to correct for conditions that may disturb its equilibrium, and to return or to continue on the original flight path. It is primarily an airplane design characteristic.

Stagnant hypoxia. A type of hypoxia that results when the oxygen-rich blood in the lungs is not moving to the tissues that need it.

Stall. A rapid decrease in lift caused by the separation of airflow from the wing's surface, brought on by exceeding the critical angle of attack. A stall can occur at any pitch attitude or airspeed.

Standard atmosphere. At sea level, the standard atmosphere consists of a barometric pressure of 29.92 inches of mercury ("Hg) or 1013.2 millibars, and a temperature of 15 °C (59 °F). Pressure and temperature normally decrease as altitude increases. The standard lapse rate in the lower atmosphere for each 1,000 feet of altitude is approximately 1 "Hg and 2 °C (3.5 °F). For example, the standard pressure and temperature at 3,000 feet mean sea level (MSL) are 26.92 "Hg (29.92 "Hg – 3 "Hg) and 9 °C (15 °C – 6 °C).

Standard empty weight (GAMA). This weight consists of the airframe, engines, and all items of operating equipment that have fixed locations and are permanently installed in the airplane including fixed ballast, hydraulic fluid, unusable fuel, and full engine oil.

Standard holding pattern. A holding pattern in which all turns are made to the right.

Standard instrument departure procedures (SIDS). Published procedures to expedite clearance delivery and to facilitate transition between takeoff and en route operations.

Standard rate turn. A turn in which an aircraft changes its direction at a rate of 3° per second (360° in 2 minutes) for low- or medium-speed aircraft. For high-speed aircraft, the standard rate turn is 1½° per second (360° in 4 minutes).

Standard service volume (SSV). Defines the limits of the volume of airspace which the VOR serves.

Standard terminal arrival route (STAR). A preplanned IFR ATC arrival procedure published for pilot use in graphic and/or textual form.

Standard weights. Weights established for numerous items involved in weight and balance computations. These weights should not be used if actual weights are available.

STAR. See standard terminal arrival route.

Static longitudinal stability. The aerodynamic pitching moments required to return the aircraft to the equilibrium angle of attack.

Static pressure. Pressure of air that is still or not moving, measured perpendicular to the surface of the aircraft.

Static stability. The initial tendency an aircraft displays when disturbed from a state of equilibrium.

Station. A location in the airplane that is identified by a number designating its distance in inches from the datum. The datum is, therefore, identified as station zero. An item located at station +50 would have an arm of 50 inches.

Stationary front. A front that is moving at a speed of less than 5 knots.

Steep turns. In instrument flight, any turn greater than standard rate; in visual flight, anything greater than a 45° bank.

Stepdown fix. The point after which additional descent is permitted within a segment of an IAP.

Strapdown system. An INS in which the accelerometers and gyros are permanently “strapped down” or aligned with the three axes of the aircraft.

Stratosphere. A layer of the atmosphere above the tropopause extending to a height of approximately 160,000 feet.

Stress. The body’s response to demands placed upon it.

Stress management. The personal analysis of the kinds of stress experienced while flying, the application of appropriate stress assessment tools, and other coping mechanisms.

Structural icing. The accumulation of ice on the exterior of the aircraft.

Sublimation. Process by which a solid is changed to a gas without going through the liquid state.

Suction relief valve. A relief valve in an instrument vacuum system required to maintain the correct low pressure inside the instrument case for the proper operation of the gyros.

Supercharger. An engine- or exhaust-driven air compressor used to provide additional pressure to the induction air so the engine can produce additional power.

Supercooled water droplets. Water droplets that have been cooled below the freezing point, but are still in a liquid state.

Surface analysis chart. A report that depicts an analysis of the current surface weather. Shows the areas of high and low pressure, fronts, temperatures, dewpoints, wind directions and speeds, local weather, and visual obstructions.

Synchro. A device used to transmit indications of angular movement or position from one location to another.

Synthetic vision. A realistic display depiction of the aircraft in relation to terrain and flight path.

T

TAA. See terminal arrival area.

TACAN. See tactical air navigation.

Tactical air navigation (TACAN). An electronic navigation system used by military aircraft, providing both distance and direction information.

Takeoff decision speed (V_1). Per 14 CFR section 23.51: “the calibrated airspeed on the ground at which, as a result of engine failure or other reasons, the pilot assumed to have made a decision to continue or discontinue the takeoff.”

Takeoff distance. The distance required to complete an all-engines operative takeoff to the 35-foot height. It must be at least 15 percent less than the distance required for a one-engine inoperative engine takeoff. This distance is not normally a limiting factor as it is usually less than the one-engine inoperative takeoff distance.

Takeoff safety speed (V_2). Per 14 CFR part 1: “A referenced airspeed obtained after lift-off at which the required one-engine-inoperative climb performance can be achieved.”

TAWS. See terrain awareness and warning system.

Taxiway lights. Omnidirectional lights that outline the edges of the taxiway and are blue in color.

Taxiway turnoff lights. Lights that are flush with the runway which emit a steady green color.

TCAS. See traffic alert collision avoidance system.

TCH. See threshold crossing height.

TDZE. See touchdown zone elevation.

TEC. See Tower En Route Control.

Technique. The manner in which procedures are executed.

Telephone information briefing service (TIBS). An FSS service providing continuously updated automated telephone recordings of area and/or route weather, airspace procedures, and special aviation-oriented announcements.

Temporary flight restriction (TFR). Restriction to flight imposed in order to:

1. Protect persons and property in the air or on the surface from an existing or imminent flight associated hazard;
2. Provide a safe environment for the operation of disaster relief aircraft;
3. Prevent an unsafe congestion of sightseeing aircraft above an incident;
4. Protect the President, Vice President, or other public figures; and,
5. Provide a safe environment for space agency operations.

Pilots are expected to check appropriate NOTAMs during flight planning when conducting flight in an area where a temporary flight restriction is in effect.

Tension. Maintaining an excessively strong grip on the control column, usually resulting in an overcontrolled situation.

Terminal aerodrome forecast (TAF). A report established for the 5 statute mile radius around an airport. Utilizes the same descriptors and abbreviations as the METAR report.

Terminal arrival area (TAA). A procedure to provide a new transition method for arriving aircraft equipped with FMS and/or GPS navigational equipment. The TAA contains a “T” structure that normally provides a NoPT for aircraft using the approach.

Terminal instrument approach procedure (TERP). Prescribes standardized methods for use in designing instrument flight procedures.

TERP. See terminal instrument approach procedure.

Terminal radar service areas (TRSA). Areas where participating pilots can receive additional radar services. The purpose of the service is to provide separation between all IFR operations and participating VFR aircraft.

Terrain awareness and warning system (TAWS). A timed-based system that provides information concerning potential hazards with fixed objects by using GPS positioning and a database of terrain and obstructions to provide true predictability of the upcoming terrain and obstacles.

TFR. See temporary flight restriction.

Thermosphere. The last layer of the atmosphere that begins above the mesosphere and gradually fades away into space.

Threshold crossing height (TCH). The theoretical height above the runway threshold at which the aircraft’s glideslope antenna would be if the aircraft maintained the trajectory established by the mean ILS glideslope or MLS glidepath.

Thrust. The force which imparts a change in the velocity of a mass. This force is measured in pounds but has no element of time or rate. The term “thrust required” is generally associated with jet engines. A forward force which propels the airplane through the air.

Thrust (aerodynamic force). The forward aerodynamic force produced by a propeller, fan, or turbojet engine as it forces a mass of air to the rear, behind the aircraft.

Thrust line. An imaginary line passing through the center of the propeller hub, perpendicular to the plane of the propeller rotation.

Time and speed table. A table depicted on an instrument approach procedure chart that identifies the distance from the FAF to the MAP, and provides the time required to transit that distance based on various groundspeeds.

Timed turn. A turn in which the clock and the turn coordinator are used to change heading a definite number of degrees in a given time.

TIS. See traffic information service.

Title 14 of the Code of Federal Regulations (14 CFR). Includes the federal aviation regulations governing the operation of aircraft, airways, and airmen.

Torque. (1) A resistance to turning or twisting. (2) Forces that produce a twisting or rotating motion. (3) In an airplane, the tendency of the aircraft to turn (roll) in the opposite direction of rotation of the engine and propeller. (4) In helicopters with a single, main rotor system, the tendency of the helicopter to turn in the opposite direction of the main rotor rotation.

Torquemeter. An instrument used with some of the larger reciprocating engines and turboprop or turboshaft engines to measure the reaction between the propeller reduction gears and the engine case.

Total drag. The sum of the parasite drag and induced drag.

Touchdown zone elevation (TDZE). The highest elevation in the first 3,000 feet of the landing surface, TDZE is indicated on the instrument approach procedure chart when straight-in landing minimums are authorized.

Touchdown zone lights. Two rows of transverse light bars disposed symmetrically about the runway centerline in the runway touchdown zone.

Tower En Route Control (TEC). The control of IFR en route traffic within delegated airspace between two or more adjacent approach control facilities, designed to expedite traffic and reduce control and pilot communication requirements.

TPP. See United States Terminal Procedures Publication.

Track. The actual path made over the ground in flight.

Tracking. Flying a heading that will maintain the desired track to or from the station regardless of crosswind conditions.

Traffic Alert Collision Avoidance System (TCAS). An airborne system developed by the FAA that operates independently from the ground-based Air Traffic Control system. Designed to increase flight deck awareness of proximate aircraft and to serve as a “last line of defense” for the prevention of midair collisions.

Traffic information service (TIS). A ground-based service providing information to the flight deck via data link using the S-mode transponder and altitude encoder to improve the safety and efficiency of “see and avoid” flight through an automatic display that informs the pilot of nearby traffic.

Trailing edge. The portion of the airfoil where the airflow over the upper surface rejoins the lower surface airflow.

Transcribed Weather Broadcast (TWEB). An FSS service, available in Alaska only, providing continuously updated automated broadcast of meteorological and aeronautical data over selected L/MF and VOR NAVAIDs.

Transponder. The airborne portion of the ATC radar beacon system.

Transponder code. One of 4,096 four-digit discrete codes ATC assigns to distinguish between aircraft.

Trend. Immediate indication of the direction of aircraft movement, as shown on instruments.

Tricycle gear. Landing gear employing a third wheel located on the nose of the aircraft.

Trim. To adjust the aerodynamic forces on the control surfaces so that the aircraft maintains the set attitude without any control input.

Trim tab. A small auxiliary hinged portion of a movable control surface that can be adjusted during flight to a position resulting in a balance of control forces.

Tropopause. The boundary layer between the troposphere and the stratosphere which acts as a lid to confine most of the water vapor, and the associated weather, to the troposphere.

Troposphere. The layer of the atmosphere extending from the surface to a height of 20,000 to 60,000 feet, depending on latitude.

True airspeed. Actual airspeed, determined by applying a correction for pressure altitude and temperature to the CAS.

True altitude. The vertical distance of the airplane above sea level—the actual altitude. It is often expressed as feet above mean sea level (MSL). Airport, terrain, and obstacle elevations on aeronautical charts are true altitudes.

Truss. A fuselage design made up of supporting structural members that resist deformation by applied loads. The truss-type fuselage is constructed of steel or aluminum tubing. Strength and rigidity is achieved by welding the tubing together into a series of triangular shapes, called trusses.

T-tail. An aircraft with the horizontal stabilizer mounted on the top of the vertical stabilizer, forming a T.

Turbine discharge pressure. The total pressure at the discharge of the low-pressure turbine in a dual-turbine axial-flow engine.

Turbine engine. An aircraft engine which consists of an air compressor, a combustion section, and a turbine. Thrust is produced by increasing the velocity of the air flowing through the engine.

Turbocharger. An air compressor driven by exhaust gases, which increases the pressure of the air going into the engine through the carburetor or fuel injection system.

Turbofan engine. A fanlike turbojet engine designed to create additional thrust by diverting a secondary airflow around the combustion chamber.

Turbojet engine. A turbine engine which produces its thrust entirely by accelerating the air through the engine.

Turboprop engine. A turbine engine which drives a propeller through a reduction gearing arrangement. Most of the energy in the exhaust gases is converted into torque, rather than using its acceleration to drive the aircraft.

Turboshaft engine. A gas turbine engine that delivers power through a shaft to operate something other than a propeller.

Turn-and-slip indicator. A flight instrument consisting of a rate gyro to indicate the rate of yaw and a curved glass inclinometer to indicate the relationship between gravity and centrifugal force. The turn-and-slip indicator indicates the relationship between angle of bank and rate of yaw. Also called a turn-and-bank indicator.

Turn coordinator. A rate gyro that senses both roll and yaw due to the gimbal being canted. Has largely replaced the turn-and-slip indicator in modern aircraft.

TWEB. See Transcribed Weather Broadcast.

U

UHF. See ultra-high frequency.

Ultra-high frequency (UHF). The range of electromagnetic frequencies between 300 MHz and 3,000 MHz.

Ultimate load factor. In stress analysis, the load that causes physical breakdown in an aircraft or aircraft component during a strength test, or the load that according to computations, should cause such a breakdown.

Uncaging. Unlocking the gimbals of a gyroscopic instrument, making it susceptible to damage by abrupt flight maneuvers or rough handling.

Uncontrolled airspace. Class G airspace that has not been designated as Class A, B, C, D, or E. It is airspace in which air traffic control has no authority or responsibility to control air traffic; however, pilots should remember there are VFR minimums which apply to this airspace.

Underpower. Using less power than required for the purpose of achieving a faster rate of airspeed change.

United States Terminal Procedures Publication (TPP). Booklets published in regional format by FAA Aeronautical Navigation Products (AeroNav Products) that include DPs, STARs, IAPs, and other information pertinent to IFR flight.

Unusual attitude. An unintentional, unanticipated, or extreme aircraft attitude.

Useful load. The weight of the pilot, copilot, passengers, baggage, usable fuel, and drainable oil. It is the basic empty weight subtracted from the maximum allowable gross weight. This term applies to general aviation aircraft only.

User-defined waypoints. Waypoint location and other data which may be input by the user, this is the only GPS database information that may be altered (edited) by the user.

V

V₁. See takeoff decision speed.

V₂. See takeoff safety speed.

V_A. See maneuvering speed.

Vapor lock. A problem that mostly affects gasoline-fuelled internal combustion engines. It occurs when the liquid fuel changes state from liquid to gas while still in the fuel delivery system. This disrupts the operation of the fuel pump, causing loss of feed pressure to the carburetor or fuel injection system, resulting in transient loss of power or complete stalling. Restarting the engine from this state may be difficult. The fuel can vaporize due to being heated by the engine, by the local climate or due to a lower boiling point at high altitude.

Variation. Compass error caused by the difference in the physical locations of the magnetic north pole and the geographic north pole.

VASI. See visual approach slope indicator.

VDP. See visual descent point.

Vector. A force vector is a graphic representation of a force and shows both the magnitude and direction of the force.

Vectoring. Navigational guidance by assigning headings.

VEF. Calibrated airspeed at which the critical engine of a multi-engine aircraft is assumed to fail.

Velocity. The speed or rate of movement in a certain direction.

Venturi tube. A specially shaped tube attached to the outside of an aircraft to produce suction to allow proper operation of gyro instruments.

Vertical axis. An imaginary line passing vertically through the center of gravity of an aircraft. The vertical axis is called the z-axis or the yaw axis.

Vertical card compass. A magnetic compass that consists of an azimuth on a vertical card, resembling a heading indicator with a fixed miniature airplane to accurately present the heading of the aircraft. The design uses eddy current damping to minimize lead and lag during turns.

Vertical speed indicator (VSI). A rate-of-pressure change instrument that gives an indication of any deviation from a constant pressure level.

Vertical stability. Stability about an aircraft's vertical axis. Also called yawing or directional stability.

Very-high frequency (VHF). A band of radio frequencies falling between 30 and 300 MHz.

Very-high frequency omnidirectional range (VOR). Electronic navigation equipment in which the flight deck instrument identifies the radial or line from the VOR station, measured in degrees clockwise from magnetic north, along which the aircraft is located.

Vestibule. The central cavity of the bony labyrinth of the ear, or the parts of the membranous labyrinth that it contains.

V_{FE} . The maximum speed with the flaps extended. The upper limit of the white arc.

VFR. See visual flight rules.

VFR on top. ATC authorization for an IFR aircraft to operate in VFR conditions at any appropriate VFR altitude.

VFR over the top. A VFR operation in which an aircraft operates in VFR conditions on top of an undercast.

VFR terminal area chart. At a scale of 1:250,000, a chart that depicts Class B airspace, which provides for the control or segregation of all the aircraft within the Class B airspace. The chart depicts topographic information and aeronautical information including visual and radio aids to navigation, airports, controlled airspace, restricted areas, obstructions, and related data.

V-G diagram. A chart that relates velocity to load factor. It is valid only for a specific weight, configuration and altitude and shows the maximum amount of positive or negative lift the airplane is capable of generating at a given speed. Also shows the safe load factor limits and the load factor that the aircraft can sustain at various speeds.

Victor airways. Airways based on a centerline that extends from one VOR or VORTAC navigation aid or intersection, to another navigation aid (or through several navigation aids or intersections); used to establish a known route for en route procedures between terminal areas.

Visual approach slope indicator (VASI). A visual aid of lights arranged to provide descent guidance information during the approach to the runway. A pilot on the correct glideslope will see red lights over white lights.

Visual descent point (VDP). A defined point on the final approach course of a nonprecision straight-in approach procedure from which normal descent from the MDA to the runway touchdown point may be commenced, provided the runway environment is clearly visible to the pilot.

Visual flight rules (VFR). Flight rules adopted by the FAA governing aircraft flight using visual references. VFR operations specify the amount of ceiling and the visibility the pilot must have in order to operate according to these rules. When the weather conditions are such that the pilot cannot operate according to VFR, he or she must use instrument flight rules (IFR).

Visual meteorological conditions (VMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling meeting or exceeding the minimums specified for VFR.

V_{LE} . Landing gear extended speed. The maximum speed at which an airplane can be safely flown with the landing gear extended.

V_{LO} . Landing gear operating speed. The maximum speed for extending or retracting the landing gear if using an airplane equipped with retractable landing gear.

V_{MC} . Minimum control airspeed. This is the minimum flight speed at which a light, twin-engine airplane can be satisfactorily controlled when an engine suddenly becomes inoperative and the remaining engine is at takeoff power.

VMC. See visual meteorological conditions.

V_{NE} . The never-exceed speed. Operating above this speed is prohibited since it may result in damage or structural failure. The red line on the airspeed indicator.

V_{NO} . The maximum structural cruising speed. Do not exceed this speed except in smooth air. The upper limit of the green arc.

VOR. See very-high frequency omnidirectional range.

VORTAC. A facility consisting of two components, VOR and TACAN, which provides three individual services: VOR azimuth, TACAN azimuth, and TACAN distance (DME) at one site.

VOR test facility (VOT). A ground facility which emits a test signal to check VOR receiver accuracy. Some VOTs are available to the user while airborne, while others are limited to ground use only.

VOT. See VOR test facility.

VSI. See vertical speed indicator.

V_{S0} . The stalling speed or the minimum steady flight speed in the landing configuration. In small airplanes, this is the power-off stall speed at the maximum landing weight in the landing configuration (gear and flaps down). The lower limit of the white arc.

V_{S1} . The stalling speed or the minimum steady flight speed obtained in a specified configuration. For most airplanes, this is the power-off stall speed at the maximum takeoff weight in the clean configuration (gear up, if retractable, and flaps up). The lower limit of the green arc.

V-tail. A design which utilizes two slanted tail surfaces to perform the same functions as the surfaces of a conventional elevator and rudder configuration. The fixed surfaces act as both horizontal and vertical stabilizers.

V_X . Best angle-of-climb speed. The airspeed at which an airplane gains the greatest amount of altitude in a given distance. It is used during a short-field takeoff to clear an obstacle.

V_Y . Best rate-of-climb speed. This airspeed provides the most altitude gain in a given period of time.

V_{YSE} . Best rate-of-climb speed with one engine inoperative. This airspeed provides the most altitude gain in a given period of time in a light, twin-engine airplane following an engine failure.

W

WAAS. See wide area augmentation system.

Wake turbulence. Wingtip vortices that are created when an airplane generates lift. When an airplane generates lift, air spills over the wingtips from the high pressure areas below the wings to the low pressure areas above them. This flow causes rapidly rotating whirlpools of air called wingtip vortices or wake turbulence.

Warm front. The boundary area formed when a warm air mass contacts and flows over a colder air mass. Warm fronts cause low ceilings and rain.

Warning area. An area containing hazards to any aircraft not participating in the activities being conducted in the area. Warning areas may contain intensive military training, gunnery exercises, or special weapons testing.

WARP. See weather and radar processing.

Waste gate. A controllable valve in the tailpipe of an aircraft reciprocating engine equipped with a turbocharger. The valve is controlled to vary the amount of exhaust gases forced through the turbocharger turbine.

Waypoint. A designated geographical location used for route definition or progress-reporting purposes and is defined in terms of latitude/longitude coordinates.

WCA. See wind correction angle.

Weather and radar processor (WARP). A device that provides real-time, accurate, predictive, and strategic weather information presented in an integrated manner in the National Airspace System (NAS).

Weather depiction chart. Details surface conditions as derived from METAR and other surface observations.

Weight. The force exerted by an aircraft from the pull of gravity.

Wide area augmentation system (WAAS). A differential global positioning system (DGPS) that improves the accuracy of the system by determining position error from the GPS satellites, then transmitting the error, or corrective factors, to the airborne GPS receiver.

Wind correction angle (WCA). The angle between the desired track and the heading of the aircraft necessary to keep the aircraft tracking over the desired track.

Wind direction indicators. Indicators that include a wind sock, wind tee, or tetrahedron. Visual reference will determine wind direction and runway in use.

Wind shear. A sudden, drastic shift in windspeed, direction, or both that may occur in the horizontal or vertical plane.

Winds and temperature aloft forecast (FB). A twice daily forecast that provides wind and temperature forecasts for specific locations in the contiguous United States.

Wing area. The total surface of the wing (in square feet), which includes control surfaces and may include wing area covered by the fuselage (main body of the airplane), and engine nacelles.

Wings. Airfoils attached to each side of the fuselage and are the main lifting surfaces that support the airplane in flight.

Wing root. The wing root is the part of the wing on a fixed-wing aircraft that is closest to the fuselage. Wing roots usually bear the highest bending forces in flight and during landing, and they often have fairings to reduce interference drag between the wing and the fuselage. The opposite end of a wing from the wing root is the wing tip.

Wing span. The maximum distance from wingtip to wingtip.

Wingtip vortices. The rapidly rotating air that spills over an airplane's wings during flight. The intensity of the turbulence depends on the airplane's weight, speed, and configuration. Also referred to as wake turbulence. Vortices from heavy aircraft may be extremely hazardous to small aircraft.

Wing twist. A design feature incorporated into some wings to improve aileron control effectiveness at high angles of attack during an approach to a stall.

Work. A measurement of force used to produce movement.

World Aeronautical Charts (WAC). A standard series of aeronautical charts covering land areas of the world at a size and scale convenient for navigation (1:1,000,000) by moderate speed aircraft. Topographic information includes cities and towns, principal roads, railroads, distinctive landmarks, drainage, and relief. Aeronautical information includes visual and radio aids to navigation, airports, airways, restricted areas, obstructions and other pertinent data.

Z

Zone of confusion. Volume of space above the station where a lack of adequate navigation signal directly above the VOR station causes the needle to deviate.

Zulu time. A term used in aviation for coordinated universal time (UTC) which places the entire world on one time standard.

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