

enlarge to receive as much of the available light as possible. After approximately 5 to 10 minutes, the cones become adjusted to the dim light and the eyes become approximately 100 times more sensitive to the light than they were before the dark room was entered. Much more time, about 30 minutes, is needed for the rods to become adjusted to darkness, but when they do adjust, they are about 100,000 times more sensitive to light than they were in the lighted area. After the adaptation process is complete, much more can be seen, especially if scanning techniques are used correctly.

After the eyes have adapted to the dark, the entire process is reversed when entering a lighted room. The eyes are first dazzled by the brightness, but become completely adjusted in a very few seconds, thereby losing their adaptation to the dark. Now, if the dark room is re-entered, the eyes again go through the long process of adapting to the darkness.

Before and during night flight, the adaptation process of the eyes must be considered. First, adapt to the low level of light and then stay adapted. After the eyes are adapted to the darkness, avoid exposing them for more than one second to any bright white light as that causes temporary blindness. If exposed to a bright light source, such as search lights and landing lights, remember that each eye adapts to the dark independently. By closing or covering one eye when exposed to light, some night vision acuity is retained in the closed eye.

Temporary blindness, caused by an unusually bright light, may result in illusions or after images until the eyes recover from the brightness. The brain creates these illusions reported by the eyes. This results in misjudging or incorrectly identifying objects, such as mistaking slanted clouds for the horizon or populated areas for a landing field. Vertigo is experienced as a feeling of dizziness and imbalance that can create or increase illusions. The illusions seem very real and pilots at every level of experience and skill can be affected. Recognizing that the brain and eyes can play tricks in this manner is the best protection for flying at night.

Good eyesight depends upon physical condition. Fatigue, colds, vitamin deficiency, alcohol, stimulants, smoking, or medication can seriously impair vision. Keep these facts in mind and take adequate precautions to safeguard night vision. In addition to the principles previously discussed, the following items aid in increasing night vision effectiveness.

- Adapt the eyes to darkness prior to flight and keep them adapted. About 30 minutes is needed to adjust the eyes to maximum efficiency after exposure to a bright light.
- If oxygen is available, use it during night flying. Keep in mind that a significant deterioration in night vision can occur at cabin altitudes as low as 5,000 feet.

- Close one eye when exposed to bright light to help avoid the blinding effect.
- Do not wear sunglasses after sunset as this impairs night vision.
- Move the eyes more slowly than in daylight.
- Blink the eyes if they become blurred.
- Concentrate on seeing objects.
- Force the eyes to view off center using scanning techniques.
- Maintain good physical condition.
- Avoid smoking, drinking, and using drugs that may be harmful.

Night Illusions

In addition to night vision limitations, night illusions can cause confusion and distractions during night flying. The following discussion covers some of the common situations that cause illusions associated with night flying.

On a clear night, distant stationary lights can be mistaken for stars or other aircraft. Cloud layers or even the northern lights can confuse a pilot and indicate a false visual horizon. Certain geometrical patterns of ground lights, such as a freeway, runway, approach, or even lights on a moving train, can cause confusion. Dark nights tend to eliminate reference to a visual horizon. As a result, pilots need to rely less on outside references at night and more on flight and navigation instruments.

Visual autokinesis can occur when staring at a single light source for several seconds on a dark night. The result is that the light appears to be moving. The autokinesis effect will not occur if the visual field is expanded through scanning techniques. A good scanning procedure reduces the probability of vision becoming fixed on one source of light.

Distractions and problems can result from a flickering light in the flightdeck, anti-collision light, or other aircraft lights and can cause flicker vertigo. If continuous, the possible physical reactions can be nausea, dizziness, grogginess, unconsciousness, headaches, or confusion. Try to eliminate any light source causing blinking or flickering problems in the flightdeck.

A black-hole approach occurs when the landing is made from over water or non-lighted terrain where the runway lights are the only source of light. Without peripheral visual cues to help, orientation is difficult. The runway can seem out of position (down-sloping or up-sloping) and in the worst case, results in landing short of the runway. If an

electronic glide slope or visual approach slope indicator (VASI) is available, it should be used. If navigation aids (NAVAIDs) are unavailable, use the flight instruments to assist in maintaining orientation and a normal approach. Anytime position in relation to the runway or altitude is in doubt, execute a go-around.

Bright runway and approach lighting systems, especially where few lights illuminate the surrounding terrain, may create the illusion of being lower or having less distance to the runway. In this situation, the tendency is to fly a higher approach. Also, flying over terrain with only a few lights makes the runway recede or appear farther away. With this situation, the tendency is to fly a lower-than-normal approach. If the runway has a city in the distance on higher terrain, the tendency is to fly a lower-than-normal approach. A good review of the airfield layout and boundaries before initiating any approach helps maintain a safe approach angle.

Illusions created by runway lights result in a variety of problems. Bright lights or bold colors advance the runway, making it appear closer. Night landings are further complicated by the difficulty of judging distance and the possibility of confusing approach and runway lights. For example, when a double row of approach lights joins the boundary lights of the runway, there can be confusion where the approach lights terminate and runway lights begin. Under certain conditions, approach lights can make the aircraft seem higher in a turn to final, than when its wings are level.

Pilot Equipment

Before beginning a night flight, carefully consider personal equipment that should be readily available during the flight to include a flashlight, aeronautical charts and pertinent data for the flight, and a flightdeck checklist containing procedures for the following tasks, which can be found in 14 CFR part 91:

- Before starting engines
- Before takeoff
- Cruise
- Before landing
- After landing
- Stopping engines
- Emergencies

At least one reliable flashlight is recommended as standard equipment on all night flights. A reliable incandescent or light-emitting diode (LED) flashlight able to produce white/red light and blue for chart reading is preferable. The flash light should be large enough to be easily located in the event it is needed. The white light is used while performing

the preflight visual inspection of the airplane, and the red light is used when performing cockpit operations. It is also recommended to have a spare set of batteries for the flashlight readily available.

Since the red light is non-glaring, it will not impair night vision. Some pilots prefer two flashlights, one with a white light for preflight and the other a penlight type with a red light. The latter can be suspended by a string from around the neck to ensure the light is always readily available. One word of caution: if a red light is used for reading an aeronautical chart, the red features of the chart will not show up.

Aeronautical charts are essential for night cross-country flight and, if the intended course is near the edge of the chart, the adjacent chart should also be available. The lights of cities and towns can be seen at surprising distances at night, and if this adjacent chart is not available to identify those landmarks, confusion could result. These checklist items are not just for night flying, they are required for day light flying also. Regardless of the equipment used, organization of the flightdeck eases the burden and enhances safety. Organize equipment and charts and place them within easy reach prior to taxiing.

Airplane Equipment and Lighting

Title 14 of the Code of Federal Regulations (14 CFR) part 91 specifies the basic minimum airplane equipment that is required for night flight. This equipment includes only basic instruments, lights, electrical energy source, and spare fuses.

The standard instruments required by 14 CFR part 91 for instrument flight are a valuable asset for aircraft control at night. Title 14 CFR part 91 specifies that during the period from sunset to sunrise operating aircraft are required to have a functioning anti-collision light system, including a flashing or rotating beacon and position lights. The anti-collision lights however need not be lighted when the pilot in command (PIC) determines that, because of operating conditions, it would be in the interest of safety to turn the lights off. Airplane position lights are arranged similar to those of boats and ships. A red light is positioned on the left wingtip, a green light on the right wingtip, and a white light on the tail. *[Figure 10-2]*

This arrangement provides a means to determine the general direction of movement of other airplanes in flight. If both a red and green light of another aircraft are observed, and the red light is on the left and the green to the right, the airplane is flying the same direction. Care must be taken not to overtake the other aircraft and maintain clearance. If red were on the right and green to the left, the airplane could be on a collision course.



Figure 10-2. *Position lights.*

Landing lights are not only useful for taxi, takeoffs, and landings, but also provide a means by which airplanes can be seen at night by other pilots. Pilots are encouraged to turn on their landing lights when operating within 10 miles of an airport and below 10,000 feet. Operation lights on applies to both day and night or in conditions of reduced visibility. This should also be done in areas where flocks of birds may be expected.

Although turning on aircraft lights supports the “see and be seen” concept, do not become complacent about keeping a sharp lookout for other aircraft. Most aircraft lights blend in with the stars or the lights of the cities at night and go unnoticed unless a conscious effort is made to distinguish them from other lights.

Airport and Navigation Lighting Aids

The lighting systems used for airports, runways, obstructions, and other visual aids at night are other important aspects of night flying. Lighted airports located away from congested areas are identified readily at night by the lights outlining the runways. Airports located near or within large cities are often difficult to identify as the airport lights tend to blend with the city lights. It is important not to only know the exact location of an airport relative to the city, but also to be able to identify these airports by the characteristics of their lighting pattern.

Aeronautical lights are designed and installed in a variety of colors and configurations, each having its own purpose. Although some lights are used only during low ceiling and visibility conditions, this discussion includes only the lights that are fundamental to visual flight rules (VFR) night operation.

It is recommended that prior to a night flight, and particularly a cross-country night flight, that a check of the availability and status of lighting systems at the destination airport is made. This information can be found on aeronautical charts and in the Chart Supplements. The status of each facility can be determined by reviewing pertinent Notices to Airmen (NOTAMs).

Most airports have rotating beacons. The beacon rotates at a constant speed, thus producing a series of light flashes at regular intervals. These flashes may consist of a white flash and one or two different colors that are used to identify various types of landing areas. For example:

- Lighted civilian land airports—alternating white and green lights
- Lighted civilian water airports—alternating white and yellow lights
- Lighted military airports—alternating white and green lights, but are differentiated from civil airports by dual peaked (two quick) white flashes, then green

Beacons producing red flashes indicate obstructions or areas considered hazardous to aerial navigation. Steady-burning red lights are used to mark obstructions on or near airports and sometimes to supplement flashing lights on en route obstructions. High-intensity, flashing white lights are used to mark some supporting structures of overhead transmission lines that stretch across rivers, chasms, and gorges. These high-intensity lights are also used to identify tall structures, such as chimneys and towers.

As a result of technological advancements, runway lighting systems have become quite sophisticated to accommodate takeoffs and landings in various weather conditions. However, if flying is limited to VFR only, it is important to be familiar with the basic lighting of runways and taxiways.

The basic runway lighting system consists of two straight parallel lines of runway edge lights defining the lateral limits of the runway. These lights are aviation white, although aviation yellow may be substituted for a distance of 2,000 feet from the far end of the runway to indicate a caution zone. At some airports, the intensity of the runway edge lights can be activated and adjusted by radio control. The control system consists of a 3-step control responsive to 7, 5, and/or 3 microphone clicks. This 3-step control turns on lighting facilities capable of either 3-step, 2-step, or 1-step operation. The 3-step and 2-step lighting facilities can be altered in intensity, while the 1-step cannot. All lighting is illuminated for a period of 15 minutes from the most recent time of activation and may not be extinguished prior to end of the 15-minute period. Suggested