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NIGHT FLIGHT OPERATIONS

INTRODUCTION

Flying at night can be a very pleasant experience. The air is generally cooler and smoother, resulting in better helicopter performance and a more comfortable flight. You generally also experience less traffic and less radio congestion.

Nevertheless the human eye in the darkness easily can be slammed. They may be the very serious consequences of this in the night flight operation. We call attention to these typical danger situations in this article.

NIGHT FLIGHT PHYSIOLOGY

Before discussing night operations, it is important you understand how your vision is affected at night and how to counteract the visual illusions, which you might encounter.

Vision in flight

Vision is by far the most important sense that you have, and flying is obviously impossible without it. Most of the things you perceive while flying are visual or heavily supplemented by vision. The visual sense is especially important in collision avoidance and depth perception. Your vision sensors are your eyes, even though they are not perfect in the way they function or see objects. Since your eyes are not always able to see all things at all times, illusions and blindspots occur. The more you understand the eye and how it functions, the easier it is to compensate for these illusions and blindspots.

The eye

The eye works in much the same way as a camera. Both have an aperture, lens, method of focusing, and a surface for registering images [Figure 1].

Vision is primarily the result of light striking a photosensitive layer, called the retina, at the back of the eye. The retina is composed of light-sensitive cones and rods. The cones in your eye perceive an image best when the light is bright, while the rods work best in low light.

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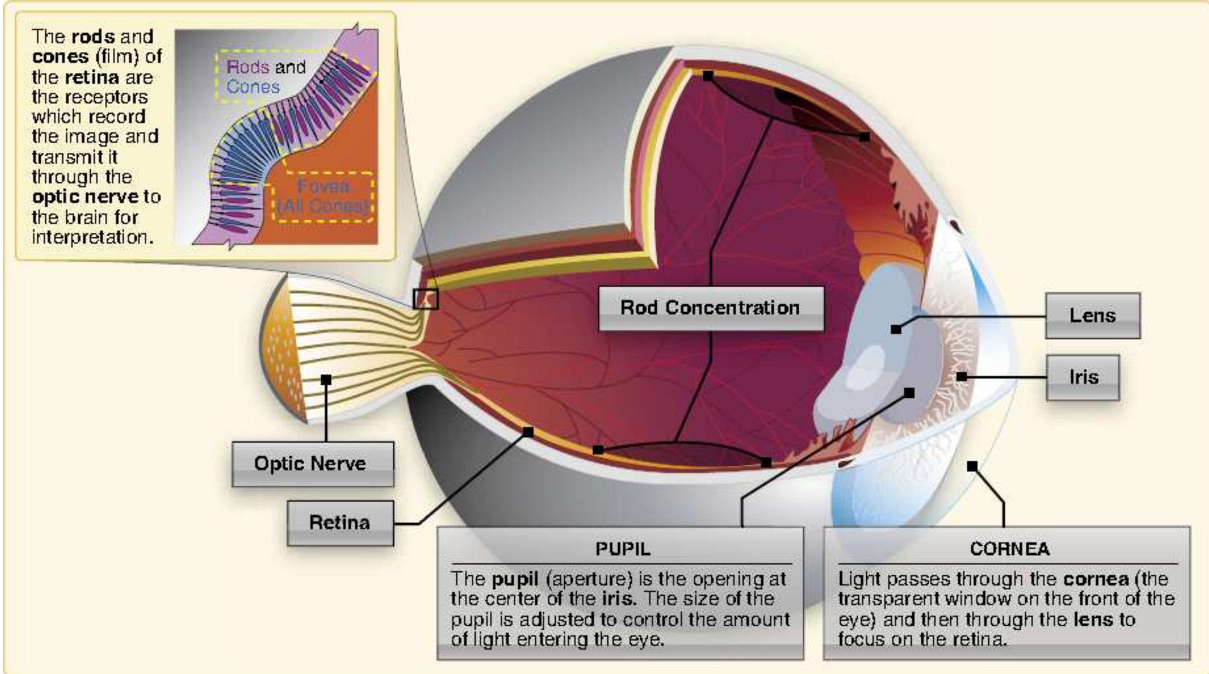

Figure 1. A camera is able to focus on near and far objects by changing the distance between the lens and the film. You can see objects clearly at various distances because the shape of your eye's lens is changed automatically by small muscles. [2]

The pattern of light that strikes the cones and rods is transmitted as electrical impulses by the optic nerve to the brain where these signals are interpreted as an image. The area where the optic nerve meets the retina contains no cones or rods, creating a blind spot in vision [1, 2, 3]. Normally, each eye compensates for the other's blind spot. [Figure 2]

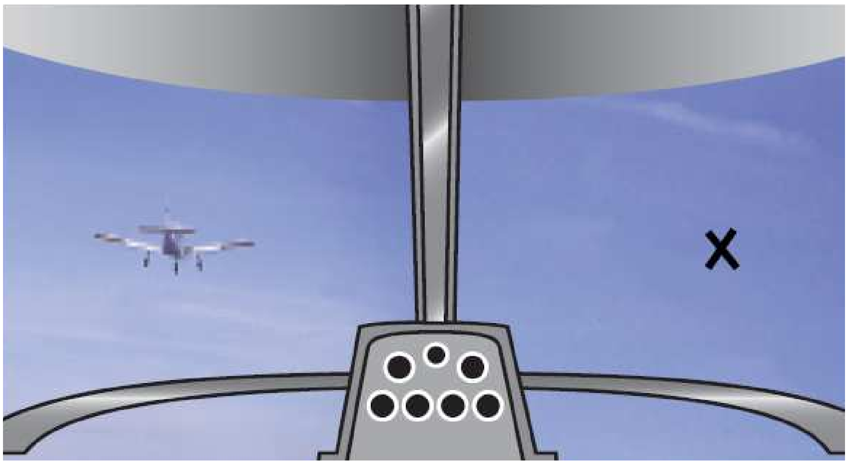

Figure 2. This illustration provides a dramatic example of the eye's blind spot. Cover your right eye and hold this page at arm's length. Focus your left eye on the X in the right side of the visual, and notice what happens to the aircraft as you slowly bring the page closer to your eye [3].

Cones

Cones are concentrated around the center of the retina. They gradually diminish in number as the distance from the center increases. Cones allow you to perceive color by sensing red, blue, and green light.

Directly behind the lens, on the retina, is a small, notched area called the fovea. This area contains only a high concentration of cone receptors. When you look directly at an object, the image is focused mainly on the fovea. The cones, however, do not function well in darkness, which explains why you cannot see color as vividly at night as you can during the day. [Figure 3]

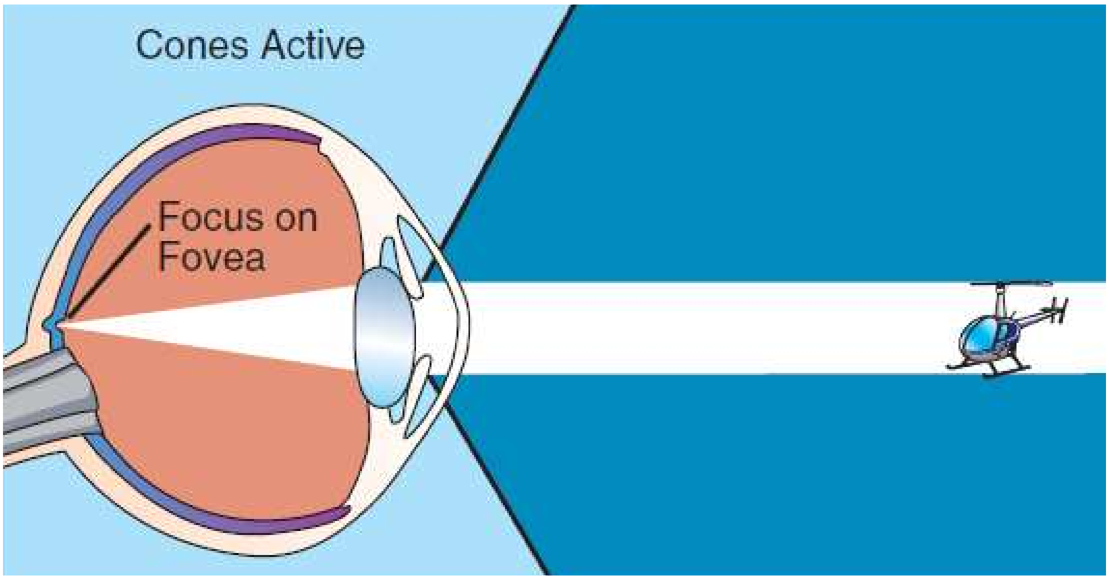

Figure 3. The best vision in daylight is obtained by looking directly at the object. This focuses the image on the fovea, where detail is best seen [3].

Rods

The rods are our dim light and night receptors and are concentrated outside the fovea area. The number of rods increases as the distance from the fovea increases.

Rods sense images only in black and white. Because the rods are not located directly behind the pupil, they are responsible for much of our peripheral vision.

Images that move are perceived more easily by the rod areas than by the cones in the fovea. If you have ever seen something move out of the corner of your eye, it was most likely detected by your rod receptors. Since the cones do not function well in the dark, you may not be able to see an object if you look directly at it. The concentration of cones in the fovea can make a night blindspot at the center of your vision. To see an object clearly, you must expose the rods to the image.

This is accomplished by looking 5° to 10° off center of the object you want to see. You can try out this effect on a dim light in a darkened room. When you look directly at the light, it dims or disappears altogether. If you look slightly off center, it becomes clearer and brighter. [Figure 4]

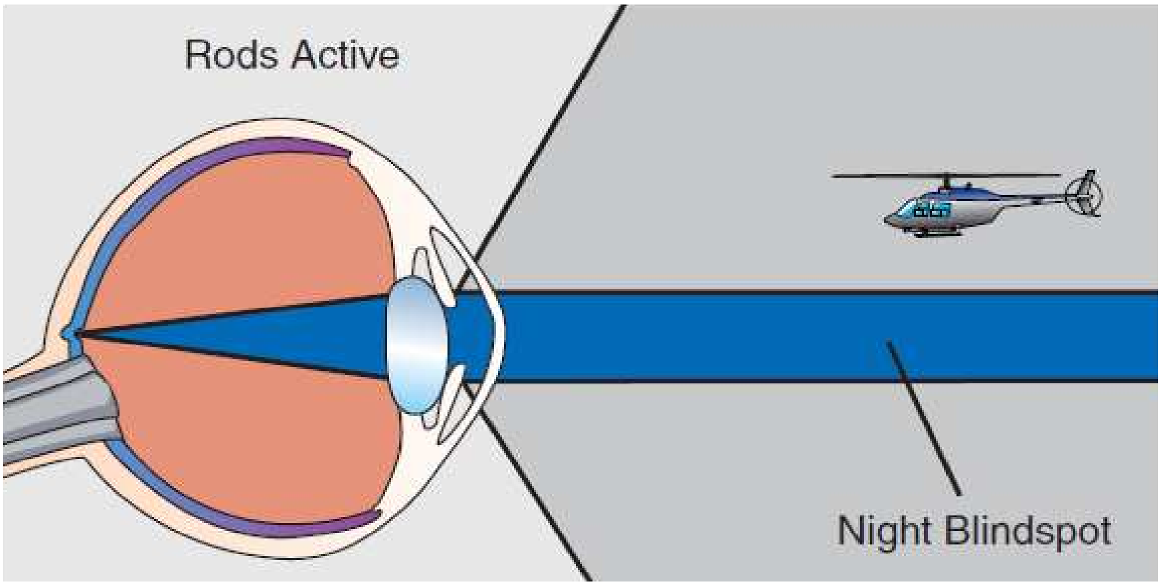

Figure 4. In low light, the cones lose much of their visual acuity, while rods become more receptive. The eye sacrifices sharpness for sensitivity. Your ability to see an object directly in front of you is reduced, and you lose much of your depth perception, as well as your judgment of size [3].

How well you see at night is determined by the rods in your eyes, as well as the amount of light allowed into your eyes. The wider the pupil is open at night, the better your night vision becomes.

Night vision

The cones in your eyes adapt quite rapidly to changes in light intensities, but the rods do not. If you have ever walked from bright sunlight into a dark movie theater, you have experienced this dark adaptation period. The rods can take approximately 30 minutes to fully adapt to the dark. Abright light, however, can completely destroy your night adaptation and severely restrict your visual acuity.

There are several things you can do to keep your eyes adapted to the dark. The first is obvious; avoid bright lights before and during the flight. For 30 minutes before a night flight, avoid any bright light sources, such as headlights, landing lights, strobe lights, or flashlights. If you encounter a bright light, close one eye to keep it light sensitive. This allows you to see again once the light is gone. Light sensitivity also can be gained by using sunglasses if you will be flying from daylight into an area of increasing darkness.

Red cockpit lighting also helps preserve your night vision, but red light severely distorts some colors, and completely washes out the color red. This makes reading an aeronautical chart difficult. A dim white light or carefully directed flashlight can enhance your night reading ability. While flying at night, keep the instrument panel and interior lights turned up no higher than necessary. This helps you see outside visual references more easily. If your eyes become blurry, blinking more frequently often helps.

Your diet and general physical health have an impact on how well you can see in the dark. Deficiencies in vitamins Aand C have been shown to reduce night acuity. Other factors, such as carbon monoxide poisoning, smoking, alcohol, certain drugs, and a lack of oxygen also can greatly decrease your night vision.

Night scanning

Good night visual acuity is needed for collision avoidance. Night scanning, like day scanning, uses a series of short, regularly spaced eye movements in 10° sectors. Unlike day scanning, however, off-center viewing is used to focus objects on the rods rather than the fovea blindspot. When you look at an object, avoid staring at it too long. If you stare at an object without moving your eyes, the retina becomes accustomed to the light intensity and the image begins to fade. To keep it clearly visible, new areas in the retina must be exposed to the image. Small, circular eye movements help eliminate the fading. You also need to move your eyes more slowly from sector to sector than during the day to prevent blurring.

Aircraft lighting

In order to see other aircraft more clearly, regulations require that all aircraft operating during the night hours have special lights and equipment. In addition to aircraft lighting, the regulations also provide a definition of nighttime, currency requirements, fuel reserves, and necessary electrical systems.

Position lights enable you to locate another aircraft, as well as help you determine its direction of flight. The approved aircraft lights for night operations are a green light on the right cabin side or wingtip, a red light on the left cabin side or wingtip, and a white position light on the tail. In addition, flashing aviation red or white anticollision lights are required for night flights. These flashing lights can be in a number of locations, but are most commonly found on the top and bottom of the cabin. [Figure 5]

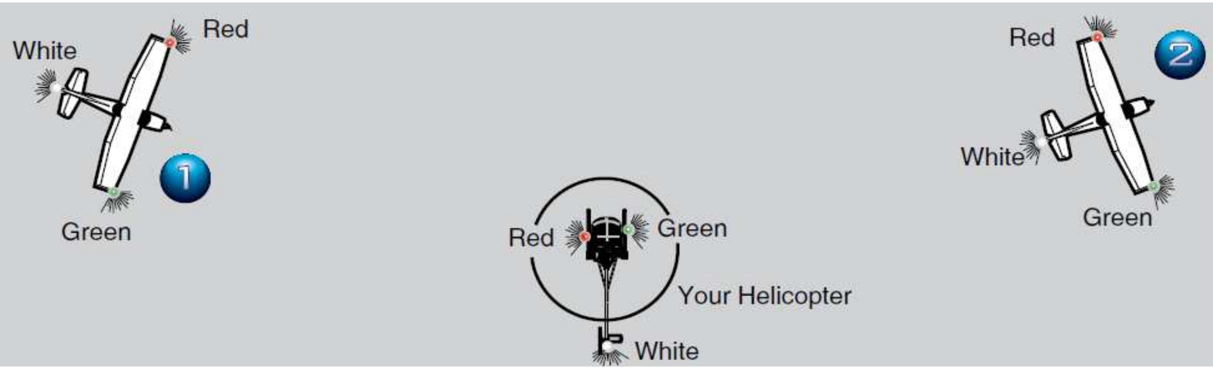

Figure 5. By interpreting the position lights on other aircraft, you can determine whether the aircraft is flying away from you or is on a collision course. If you see a red position light to the right of a green light, such as shown by aircraft number 1, it is flying toward you. You should watch this aircraft closely and be ready to change course. Aircraft number 2, on the other hand, is flying away from you, as indicated by the white position light.

NIGHT VISUAL ILLUSIONS

There are many different types of visual illusions that you can experience at any time, day or night. The next few paragraphs cover some of the illusions that commonly occur at night.

Autokinesis

Autokinesis is caused by staring at a single point of light against a dark background, such as a ground light or bright star, for more than a few seconds. After a few moments, the light appears to move on its own. To prevent this illusion, you should focus your eyes on objects at varying distances and not fixate on one target, as well as maintain a normal scan pattern.

Night myopia

Another problem associated with night flying is night myopia, or night-induced nearsightedness. With nothing to focus on, your eyes automatically focus on a point just slightly ahead of your aircraft. Searching out and focusing on distant light sources, no matter howdim, helps prevent the onset of night myopia.

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. [Figure 6] It can also occur while you are 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 the stars in the sky. [Figure 7]

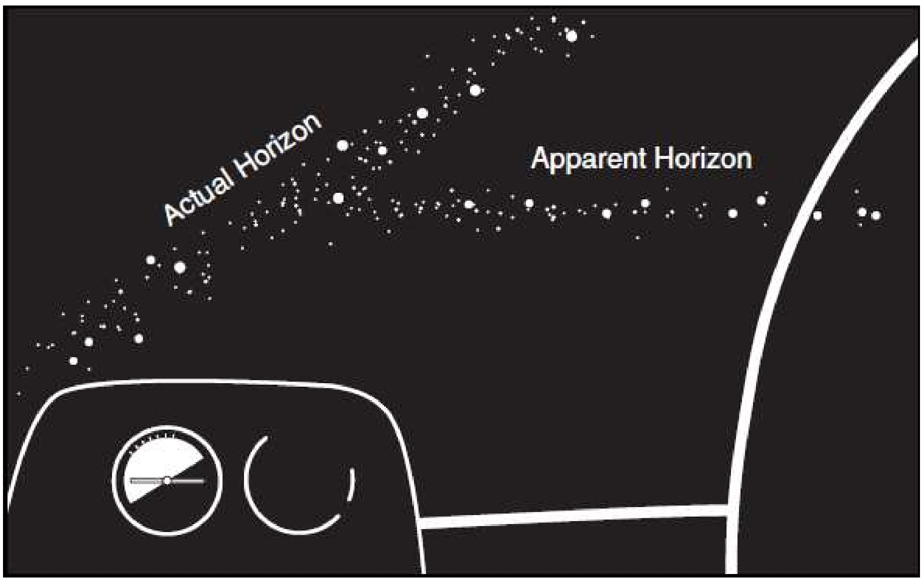

Figure 6. You can place your helicopter in an extremely dangerous flight attitude if you align the helicopter with the wrong lights. Here, the helicopter is aligned with a road and not the horizon.

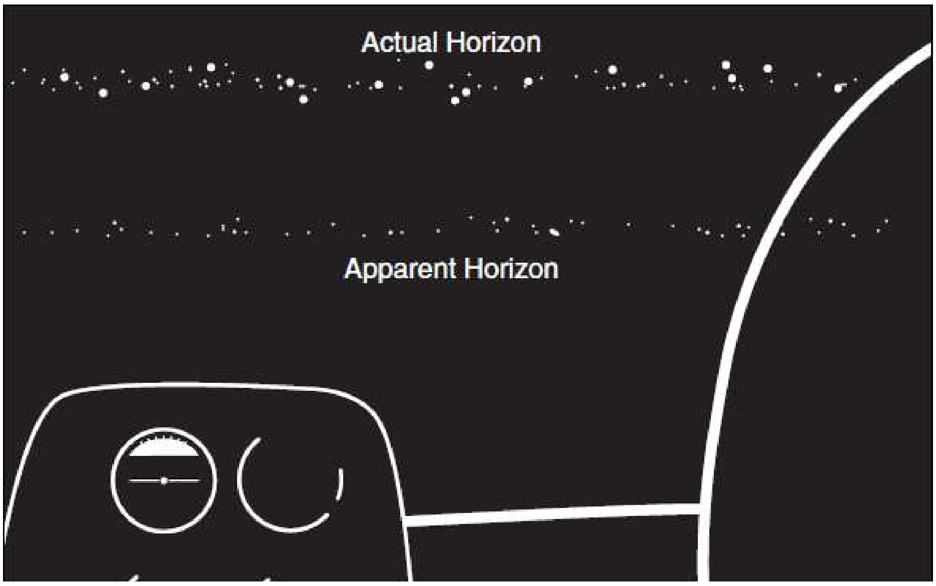

Figure 7. In this illusion, the shoreline is mistaken for the horizon. In an attempt to correct for the apparent nose-high attitude, a pilot may lower the collective and attempt to fly "beneath the shore."

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 obscuration, such as rain, haze, or a dark runway environment also can 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.

NIGHT FLIGHT

The night flying environment and the techniques you use when flying at night, depend on outside conditions. Flying on a bright, clear, moonlit evening when the visibility is good and the wind is calm, is not much different from flying during the day. However, if you are flying on an overcast night over a sparsely populated area, with little or no outside lights from the ground, the situation is quite different. Visibility is restricted so you have to be more alert in steering clear of obstructions and low clouds. Your options are also limited in the event of an emergency, as it is more difficult to find a place to land and determine wind direction and speed. At night, you have to rely more heavily on the aircraft systems, such as lights, flight instruments, and navigation equipment. As a precaution, if the visibility is limited or outside references are inadequate, you should strongly consider delaying the flight until conditions improve, unless you have received training in instrument flight and your helicopter has the appropriate instrumentation and equipment.

Preflight

The preflight inspection is performed in the usual manner, except it should be done in a well lit area or with a flashlight. Careful attention must be paid to the aircraft electrical system. In helicopters equipped with fuses, a spare set is required by regulation, and common sense, so make sure they are onboard. If the helicopter is equipped with circuit breakers, check to see that they are not tripped. A tripped circuit breaker may be an indication of an equipment malfunction. Reset it and check the associated equipment for proper operation.

Check all the interior lights, especially the instrument and panel lights. The panel lighting can usually be controlled with a rheostat or dimmer switch, allowing you to adjust the intensity. If the lights are too bright, a glare may reflect off the windshield creating a distraction. Always carry a flashlight with fresh batteries to provide an alternate source of light if the interior lights malfunction.

All aircraft operating between sunset and sunrise are required to have operable navigation lights. Turn these lights on during the preflight to inspect them visually for proper operation. Between sunset and sunrise, theses lights must be on any time the engine is running.

All recently manufactured aircraft certified for night flight, must have an anticollision light that makes the aircraft more visible to other pilots. This light is either a red or white flashing light and may be in the form of a rotating beacon or a strobe. While anticollision lights are required for night VFR flights, they may be turned off any time they create a distraction for the pilot.

One of the first steps in preparation for night flight is becoming thoroughly familiar with the helicopter's cockpit, instrumentation and control layout. It is recommended that you practice locating each instrument, control, and switch, both with and without cabin lights.

Since the markings on some switches and circuit breaker panels may be hard to read at night, you should assure yourself that you are able to locate and use these devices, and read the markings in poor light conditions. Before you start the engine, make sure all necessary equipment and supplies needed for the flight, such as charts, notepads, and flashlights, are accessible and ready for use.

Engine starting and rotor engagement

Use extra caution when starting the engine and engaging the rotors, especially in dark areas with little or no outside lights. In addition to the usual call of "clear," turn on the position and anticollision lights. If conditions permit, you might also want to turn the landing light on momentarily to help warn others that you are about to start the engine and engage the rotors.

Taxi technique

Landing lights usually cast a beam that is narrow and concentrated ahead of the helicopter, so illumination to the side is minimal. Therefore, you should slow your taxi at night, especially in congested ramp and parking areas. Some helicopters have a hover light in addition to a landing light, which illuminates a larger area under the helicopter.

When operating at an unfamiliar airport at night, you should ask for instructions or advice concerning local conditions, so as to avoid taxiing into areas of construction, or unlighted, unmarked obstructions. Ground controllers or UNICOM operators are usually cooperative in furnishing you with this type of information.

Takeoff

Before takeoff, make sure that you have a clear, unobstructed takeoff path. At airports, you may accomplish this by taking off over a runway or taxiway, however, if you are operating off-airport, you must pay more attention to the surroundings. Obstructions may also be difficult to see if you are taking off from an unlighted area. Once you have chosen a suitable takeoff path, select a point down the takeoff path to use for directional reference. During a night takeoff, you may notice a lack of reliable outside visual references after you are airborne.

This is particularly true at small airports and off-airport landing sites located in sparsely populated areas. To compensate for the lack of outside references, use the available flight instruments as an aid. Check the altimeter and the airspeed indicator to verify the proper climb attitude. An attitude indicator, if installed, can enhance your attitude reference.

The first 500 feet of altitude after takeoff is considered to be the most critical period in transitioning from the comparatively well-lighted airport or heliport into what sometimes appears to be total darkness. A takeoff at night is usually an “altitude over airspeed” maneuver, meaning you will most likely perform a nearly maximum performance takeoff. This improves the chances for obstacle clearance and enhances safety.

When performing this maneuver, be sure to avoid the cross-hatched or shaded areas of the height-velocity diagram.

En route procedures

In order to provide a higher margin of safety, it is recommended that you select a cruising altitude somewhat higher than normal. There are several reasons for this.

First, a higher altitude gives you more clearance between obstacles, especially those that are difficult to see at night, such as high tension wires and unlighted towers. Secondly, in the event of an engine failure, you have more time to set up for a landing and the gliding distance is greater giving you more options in making a safe landing. Thirdly, radio reception is improved, particularly if you are using radio aids for navigation.

During your preflight planning, it is recommended that you select a route of flight that keeps you within reach of an airport, or any safe landing site, as much of the time as possible. It is also recommended that you fly as close as possible to a populated or lighted area such as a highway or town. Not only does this offer more options in the event of an emergency, but also makes navigation a lot easier. A course comprised of a series of slight zig-zags to stay close to suitable landing sites and well lighted areas, only adds a little more time and distance to an otherwise straight course.

In the event that you have to make a forced landing at night, use the same procedure recommended for daytime emergency landings. If available, turn on the landing light during the final descent to help in avoiding obstacles along your approach path.

Collision avoidance at night

At night, the outside visual references are greatly reduced especially when flying over a sparsely populated area with little or no lights. The result is that you tend to focus on a single point or instrument, making you less aware of the other traffic around. You must make a special effort to devote enough time to scan for traffic. You can determine another aircraft's direction of flight by interpreting the position and anticollision lights.

Approach and landing

Night approaches and landings do have some advantages over daytime approaches, as the air is generally smoother and the disruptive effects of turbulence and excessive crosswinds are often absent. However, there are a few special considerations and techniques that apply to approaches at night. For example, when landing at night, especially at an unfamiliar airport, make the approach to a lighted runway and then use the taxiways to avoid unlighted obstructions or equipment.

Carefully controlled studies have revealed that pilots have a tendency to make lower approaches at night than during the day. This is potentially dangerous as you have a greater chance of hitting an obstacle, such as an overhead wire or fence, which are difficult to see. It is good practice to make steeper approaches at night, thus increasing any obstacle clearance. Monitor your altitude and rate of descent using the altimeter.

Another tendency is to focus too much on the landing area and not pay enough attention to airspeed. If too much airspeed is lost, a settling-with-power condition may result. Maintain the proper attitude during the approach, and make sure you keep some forward airspeed and movement until close to the ground. Outside visual reference for airspeed and rate of closure may not be available, especially when landing in an unlighted area, so pay special attention to the airspeed indicator

Although the landing light is a helpful aid when making night approaches, there is an inherent disadvantage. The portion of the landing area illuminated by the landing light seems higher than the dark area surrounding it. This effect can cause you to terminate the approach at too high an altitude, resulting in a settling-withpower condition and a hard landing.

SUMMARY

The article listed some typical cases, which come forward in the course of the night flight operation. The pilots have to study these, and they have to prepare themselves for the correct behaviour.

References

[1] Pilot’s Handbook of Aeronautical Knowledge. U.S. Department of Transportation Federal Aviation Administration Flight Standards Service, (FAA-H-8083-25), 2003.
[2] Pilot's Handbook of Aeronautical Knowledge. U.S. Department of Transportation Federal Aviation Administration Flight Standards Service, (FAA-H-8083-25A), 2008. http://www.faa.gov/library/manuals/aviation/pilot_handbook/
[3] Rotorcraft Flying Handbook U.S. Department of Transportation Federalaviation Administration Flight Standards Service 2000.
[4] Airplane Flying Handbook. U.S. Department of Transportation Federal Aviation Administration Flight Standards Service (FAA-H-8083-3A), 2004.