

A Study on Problems and Countermeasures of Night Flight Training for Trainee Pilot

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Abstract: Night flight training is an important part of flight training for commercial pilots. In this paper, we introduce the features and training requirements of night flight training for trainee pilots, and analyze the common problems in night flight training, including visual problems, flight illusions and night flight fatigue. Then, we propose the corresponding measures from the pre-flight preparation, dark adaptation in advance, the visual scanning, to prevent flight illusion and flight fatigue and so on. This paper is of great significance to improve the performance of night flight training for trainee pilots and ensure flight safety.

Keywords: Trainee pilot, Flight training, Night environment, Flight illusion, Fatigue.

INTRODUCTION

According to the CAAC regulations, night flight refers to 30 minutes before the sun sets today to 30 minutes after the sun rose the next day. Trainee pilots are required to undergo night flight training and periodic assessment during flight training, so each pilot must be fully cognizant and prepared for a night flight. Different from day flight, the environmental factors are complex in night flight, and easily lead to flight illusion [1]. Most of the night flight are instrument flight, so the pilot need to have better energy and need to focus more attention on the instrument and the external environment, which may induce fatigue and excessive flight stress. Therefore, trainee pilots should understand the problems in night flight training and clear its countermeasures. This is very important to improve the situational awareness and flight safety performance in flight training.

CHARACTERISTICS AND TRAINING REQUIREMENTS FOR NIGHT FLIGHT TRAINING

Night flight is an important flying operation that every commercial pilot will perform. Although there is no control difference between night flight and day flight, the environment of night flight is completely different from day flight [2]. In night, the pilots need to use the instrument, airplane lights and light information of airport and surface, visual information is limited, therefore, the difficulty of flight will be greatly increased. In addition, due to human physiological and psychological factors, it is easy to induce human error at night. Although the night flight is relatively stable and less turbulence, but there are many flight safety

hazards, so night flight training for trainee pilots is irreplaceable.

Night flight has the following characteristics: the outside light is dim, it is more difficult to observe the flight environment and determine the aircraft attitude [3]; human concentration is slow at night, the consciousness and correction of error is slow; instrument reading difficulties, it is easy to induce illusion; tire out more quickly and so on.

Teaching of night flight has the following points.

First, identify the aircraft attitude mainly based on instrument, combined with the external environment supplemented. Night natural light is dim, the object can be observed outside the plane is less [4]. So when to determine the aircraft attitude, we should according to the cockpit instrument. If it is good visibility at night, when the trainee pilot in view of the runway position and determine the attitude of the aircraft, he can refer to the relative relationship between the aircraft and the horizon line, but he still want the instrument as the main reference object. When poor visibility at night, the trainee pilot must only rely on the instrument information to avoid flight illusion, which will led to flight accidents. The trainee pilot should understand night flight training conditions, to distinguish landmarks, runway lighting information, clear aircraft position and the surrounding air traffic conditions, must observe outside flight environment carefully, and learn the correct way to view the instrument.

Second, pay attention to the shifting of attention in and out cockpit. When night training, trainee pilot should not only pay attention to observe the instrument,

but also cannot ignore the impact of external lighting environment, or very likely lead to losing direction [5]. The shifting of attention inside and outside the cockpit is not simply to pay half attention in the cockpit and half out of the cockpit, but according to the needs of flight missions and flight operations, allocate his attention reasonable, which requires long-term flight experience.

Third, enhance the attitude of the instrument as the center of observation. Attitude indicator can indicate the attitude of the aircraft, so maintain a good position of the attitude indicator is the key of smooth flight attitude. The state of the aircraft flight can mainly be analyzed from the longitudinal and lateral sides. When cruise flight at night, first maintain the pitch attitude of the instrument, observe the rate of climb indicator, altimeter and airspeed indicator auxiliary, you can maintain the aircraft's longitudinal attitude. Maintain the meridian of the attitude indicator, check the heading and radio relative bearing, you can maintain a good lateral attitude. Therefore, when observe the instrument night flight, it is necessary to strengthen the habit that the attitude indicator as the focus of observation. Especially when the aircraft is in emergency, encounter bad weather, trek and other special circumstances, pay attention to observe the attitude indicator is more important [6].

Fourth, deal with the relationship between observation instruments and flight action. First, when enter, change, attitude conversion and correct the error of a special flight movements, you must rely the information provided by the instrument display. When flight is not smooth, you cannot view the external flight environment changes. In handling the cockpit equipment, such as landing gear, flaps, etc., the attention should be mainly on the cockpit, to try to accurately manipulate the cockpit equipment and maintain good aircraft flight attitude. Second, when observe the external flight environment, maintain the original position of the control stick and rudder, control the attitude of the aircraft remained stable. When observing the flight environment outside the cockpit, the time of observation should not be too long, and the focus of the reference should not be too much. When rolling that turning to the side, you cannot observe the opposite direction. When facing the moon, avoid appearance, in order to avoid the illusion, which will affect the flight attitude and lead to flight deviation or error.

COMMON PROBLEMS IN NIGHT FLIGHT TRAINING

Adverse Effects of Night Environment on Human Vision

More than 85% of the information that the pilot needs for fly is obtained from vision. Human beings

have two kinds of photoreceptor cells, cones and rods, respectively [7]. In a better light environment, human vision depends mainly on the role of cones, and in the case of low light, human vision is mainly dependent on rods. Compared with cones, the rods in eyes located around the fovea, their sensitivity is poor, and the adaptation on low light takes a long time, about 30 minutes. Long dark adaptation time and poor visual acuity will affect the pilots to determine the flight status, which may affect flight safety.

A night blind spot refers to the fovea of the retina, as shown in figure 1. This is another problem at night [8]. The rods are located in the area around the fovea of the retina. They are the main photoreceptor of night vision. In night flight, if the low-brightness objects projected on the fovea of the retina, for the rods reduced sensitivity for low light, it will be difficult to identify the objects and affecting the pilot's judgments on outside information.

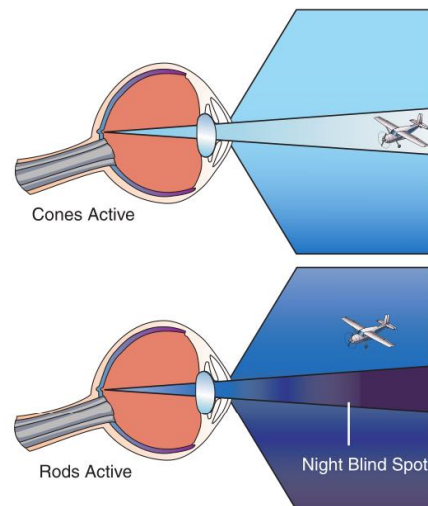


Fig-1: Night blind spot

In addition, in a night flight, hypoxia can also lead to decreasing visual function [9]. As the height increases, the oxygen content of the air decreases exponentially. According to experiments, at 1200 meters, the pilot's night vision will be reduced by 5%, 1800 meters reduced by 10%, 3000 meters reduced by 20%, 4800 meters reduced by 40%. The height of flight training for pilots at night is generally higher than 1200 meters, and training planes generally do not have oxygen supply equipment, so the pilot's night vision is generally worse than on the ground, especially in the dark environment of the evening.

Night myopia is another common problem during night flight. In night flight, because there is no obvious reference, the human eye will focus on a certain point at the space 1 to 2 meters, resulting in

visual function of myopia, which affecting the pilot's observation of external objects.

Illusion Problems in Night Flight

Due to the particularity of the night environment, the probability of flight illusions at night is higher than in the daytime, especially the incidence of visual illusions.

1.False horizon illusion

Due to dim light at Night, the pilot may confuse the long road lights, city lights with the real horizon, as shown in figure 2. So as to operate based on perceived horizon, known as the false horizon illusion. Compared with a large area of slope-like cloud, false horizon illusion caused by nighttime light problems is more common [10].

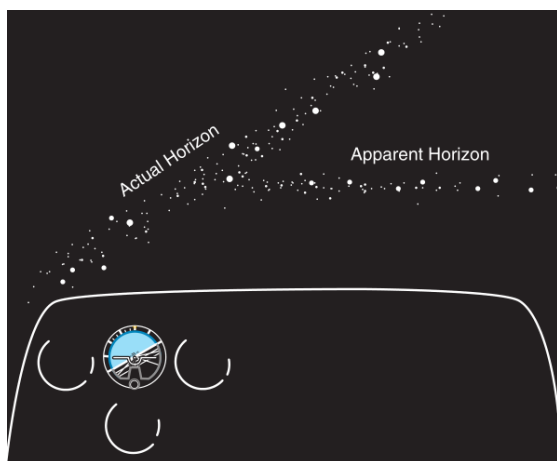


Fig-2: False horizon

2.Illusions caused by light

"Up bright and down dark" is a human cognitive that formed long-term life on the ground. This perception may induce the illusion of the pilot. In a complex weather conditions at night, if the pilot see that there are no clouds at the top left out of the plane, and can observe the stars and the moon, and there are clouds of oblique shapes blocking the bright sky, the pilot may produce a right slope gradient illusion. This is because the pilot in accordance with the fixed habit that "up bright and down dark", the bright side is associated with the sky above the plane and the dark side covered by the clouds is associated with the surface.

3.Illusions caused by runway and approach lights

During a night flight, runway lights and approach lights are an important reference in the flight process, due to limited reference. If the darkness around the airport and runway lighting is not enough, the runway for the pilot will become difficult to distinguish, the pilot will have a black hole effect, the approach is high in subjective feeling, likely to cause low approach problem [11]. On the contrary, if the runway lights and

approach lights are too bright, the pilot will have a strong visual stimulus, so that the pilot thinks the flight height is low and resulting in high approach problems. Whether the subjective approach is too high or too low, if the pilot has a wrong judgment, it will pose a huge threat to flight safety.

Fatigue Problem in Night Flight Training

Night flight training will cause the disturbance of human biological rhythm, increased stress and lack of sleep. The three problems are interactive. According to the biological rhythm of the human body, the body's function will be reduced at night, to a certain time the body needs to enter the sleep state to ensure normal bodily functions. Night flight training will disrupt the body's biological rhythm, resulting in lack of energy during flight preparation, while leading to lack of body sleep. In night flight, due to the changes in flight environment and limited visual function, the human body will be in a larger stress state, and excessive stress will affect the body's sleep quality, resulting in lack of sleep, lack of sleep will affect the body's normal biological rhythm, while increasing the body's stress. The combined effect of the three factors will make the pilot in a very tired state.

The fatigue problem of trainee pilots in night flight training is more serious. The trainee pilot's flight missions are usually very tense, they should also spend a lot of time on the study of aviation theory. Especially in the instrument flight training stage, the flight is difficult, the pilots often have to stay up late to prepare lessons, so in the implementation of night missions, most of them are in a state of fatigue. Flight fatigue causes physical and psychological indicators are not optimal, may result in the missing of flight checklist inspection items; poor flight operation ability, become bold, negligent, not careful in the manipulation of the aircraft; difficult to concentrate, and often drowsiness, etc. These symptoms will seriously threaten the night flight stability and safety, and reduce the quality of flight training [12].

COUNTERMEASURES AND SUGGESTIONS

Good Preparation for Night Flight

1. Before night flight training, trainees should develop a detailed flight plan with particular emphasis on night preparation before flight and details of the flight plan.
2. During the implementation of night missions, trainee pilots should carefully examine and read the weather reports that can be used, especially the temperature and dew point difference, because it can reflect the weather situation to a certain extent. At the same time should also focus on cruising altitude and the airport's wind direction and wind speed.
3. Make sure the check points with clear lighting

equipment on the planned route are clearly marked with a clear mark on the map. Such as tall buildings and towers, city lights and highway lights.

4. In the night transition flight, mark the flight route on the pre-selected map with a black pen to facilitate the use at night, and to select the latest appropriate chart.
5. Before takeoff, check that all night flight equipment is operational. Prepare two flashlights, one must be soft white light, for the aircraft security check before take-off, the other is red, for reading notes and charts on the aircraft, and to bring a back-up battery.
6. Before flight, do a good job in aircraft external inspection work, especially aircraft landing lights, taxi lights and crash lights. Verify that there is no loosening of the lamp by tapping the lamp holder by hand. If the lights in the light have flashed phenomenon, it should do further testing according to the corresponding procedures.
7. To focus on checking working conditions of the lighting equipment inside and outside of the cockpit and navigation flashlight can work properly. In the winter flight, flashlight has a very important role, it can help to check the ice condition of the aircraft fuselage. Make sure the aircraft lights are working properly and the aircraft generator and battery are in good condition.

Measures to Protect Night Vision

In the evening, because the eyes need to dark adaptation, so the pilot should prevent the eyes receiving strong light. The specific standard is, half an hour before the pilot into the cockpit, to avoid any direct light on the eyes, including inspection of aircraft lights before the night flight. Pilots should come into the cockpit half an hour in advance, they can use this time to familiarize themselves with the cockpit instruments and flight checklists, make a good preparation before flight. In night flight, the pilots should control the brightness of the instrument panel reasonable according to the situation outside the cockpit, which will help to mitigate the need for dark adaptation that the pilots shifting sight. Frequent blink can help dark adaptation.

When flying at night, you should know the way to observe objects. As the rod cells sensitive to dim light, to see an object clearly at night, the pilot must expose the rods to the image. This can be done by looking 5° to 10° off center of the object to be seen.

In the night, when the height is higher than 1200 meters or 4000 feet, hypoxia will affect the pilot's vision. The pilot night vision is directly related to the safety of night flight. Hypoxia will greatly reduce the night vision, so if the aircraft oxygen can be supplied, it

should be used at altitudes above 1200 meters. When flying, be sure to ensure that the cabin ventilation. When conditions permit, carrying out flight training below 4000 feet as far as possible.

Finding and observing distant light sources is an effective way to overcome night myopia, which may not be useful if the altitude is more than 3000 meters at night, but it is important at other stages of flight.

Against Flight Illusions

If the flight illusion occurred when flight training at night, the coping method is to believe the instructions of the instrument, not to determine the state of the aircraft according to their own feelings. In addition, when flying over the city or the sea, we should pay attention to distinction between true and false horizon. We can easily follow the instructions of the attitude indicator to determine the true horizon.

For the illusions caused by light, when the pilot training in peacetime, he should try to change the orientation habit of "up bright and down dark". In the observation of the external environment, not only focus on a certain area. If necessary, change the course of the aircraft, and then you can find the illusions caused by light.

For visual distance and height illusions, when the aircraft approach, according to the instructions of the instrument and the approach procedure. On the edge of the final landing preparations, pay attention to reference the plane position, often interspersed with the altimeter and vertical speed indicator. When the aircraft on the glide path, using visual approach slope indicator (VASI) to keep a steady approach.

In addition, for the adverse effects of runway lights and approach lights, you should check and analyze the airport and its surroundings and terrain, such as the airport approach map, recording the airport altitude and lighting information, understanding the terrain around the airport, and noting whether there are cities and higher buildings, this will help the pilot build stable approach and safe landing.

Prevent Flight Fatigue

There is no difference between daytime flight and nighttime flight and there are also a number of emergencies, but the pilot's energy reserve is insufficient when flying at night. Therefore, in order to achieve safe flight, pilots should take various measures to avoid flight fatigue. Pilots should improve their ability to cope with stress, before the night training, they should early adjust their biological rhythm. During night training, pilots should maintain their emotional state steady before sleep in order to promote sleep. Can not use alcohol to promote sleep, because alcohol has

an inhibitory effect on fast wave sleep, and is not conducive to the recovery of pilots mental fatigue. If the fatigue is strong, the pilot can use psychological relaxation methods, such as progressive relaxation method for fatigue recovery. In addition, the trainees should try to avoid pre-flight tensions, try to ensure a smooth state of mind, in order to prevent the destruction of sleep quality, resulting in lack of sleep, so as to avoid the strong subjective feeling of fatigue in flight. Moderate drinking coffee before a night flight has some help to improve the energy of the night flight, but be careful not to abuse, in order to avoid affecting sleep, thereby inducing flight fatigue.

CONCLUSION

Many problems of night flight training will affect flight safety, including visual problems, flight illusions and fatigue problems etc. In this paper, we have studied the above problems, and proposed the corresponding measures and the suggestions. Night flight training is essential to trainee pilots, and only after a serious night flight training, the trainee pilots can establish a good instrument flight skills and good situational awareness, and really feel the pilot's real career situation. Due to the many problems of night flight, the trainee pilots in night flight training must be taken seriously to ensure flight safety and flight training quality.

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