Aircraft Systems

Second Edition

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Fig. 1-2. *The Renegade amphibian.* (Compliments of Lake Aircraft, Inc.)

and fertilizers are particularly troublesome to crop duster aircraft. Moisture, and especially salt water, trapped on a metal surface by dirt, mud, damp floor carpeting, or insulation, or the result of a plugged drain hole will also result in corrosion. Even hangared airplanes are susceptible, as bird droppings will cause the same problem.

Fundamentally, an electrical circuit is synthesized and the metal that offers the least resistance to corrosion becomes the anode resulting in its corroding. In general, corrosion is likely in areas where the surface is unprotected. Always touch up a surface scratch that has removed the paint down to bare metal. Another area conducive to the formation of corrosion is anywhere you can expect metal fatigue for such reasons as flexing, rubbing, and compression.

Areas particularly requiring frequent inspection include engine exhaust areas, landing gear, wheel well areas, the external cooling vanes on engine cylinders, surface skin seams, piano hinges on control surfaces and access doors, and battery compartments and vents. To neutralize a battery box in which there has been an acid spill, dust the box with baking soda, flush well with water, then thoroughly clean the box. When the box is completely dry, you can refinish it with zinc chromate primer. Make sure to coat the battery terminals with grease to retard future corrosion.

There are several things that the owner can do to minimize the potential for corrosion. Storing the aircraft in a hangar will go a long way toward protecting it. The airframe should also be washed and waxed regularly and thoroughly dried. An aircraft needs to be flown periodically to heat up the engine and air out the airframe. All electrical equipment

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should be periodically used to evaporate moisture. Fix any exhaust leak immediately, both for your own safety as well as to reduce the potential for corrosion. Periodically check the battery and fuel vent lines to be sure they're open and have a free flow of fresh air. Use a fluid, thin film coating spray penetrant on screws, rivets, and joints where practical to get rid of moisture, stop electrolysis, and inhibit corrosion.

AIRCRAFT LIGHTING

In the earliest days of flying, there was no need for any type of aircraft lighting. As aircraft became more practical to use, intrepid aviators began penetrating the night sky to go further and get more work done. But it wasn't until the 1920s that there was enough nighttime air traffic to begin to cause concern about seeing other aircraft. It was then that aircraft engineers turned once again to the sea to carry over some traditions to the sky.

Aeronautical position lighting took on the characteristics of its nautical cousin. The port wingtip was marked with a red lamp, the starboard with a green lamp, and the tail with white. They were clear, six-candlepower bulbs dipped in red or green lacquer as appropriate and, because in those days aircraft had no electrical systems, a 6-volt auto battery was carried onboard to power the lights.

Position Lights

Today, the descendants of those red, green, and white position lights are required by current regulations whenever operating during the period of sunset to sunrise. The requirement is somewhat different when operating in Alaska. There, position lights must be illuminated during the period when a prominent unlighted object cannot be seen from three statute miles or the sun is more than 6 degrees below the horizon. This same regulation also covers taxiing or parking aircraft and requires that the area be illuminated well, the area be marked by obstruction lights, or the aircraft have lighted position lights.

According to FAR Part 23.1385, which deals with position light system installation, the forward red and green lights should be spaced as far apart as practicable, typically on each wingtip. The lights face forward, with the red light on the left side and the green light on the right from the pilot's point of reference. The rear-position white light should be mounted as far aft as practicable, usually on the tail, though some aircraft have aft-facing white wingtip lights instead. The purpose of position lights is not simply to be seen at night. They also help the pilots of other aircraft determine your direction of travel, so position light field-of-coverage is carefully specified in the regulations.

The visible vertical pattern must be 180 degrees centered on the horizontal centerline, as illustrated in Figure 1-3. The horizontal pattern for the red and green lights is 110 degrees of coverage each, from the centerline, and 140 degrees for the white light. The phrase used by many pilots to help remember the proper orientation is "red, right, return," which means if you see an airplane with a red light showing to your right side, then it is traveling toward (returning to) you.

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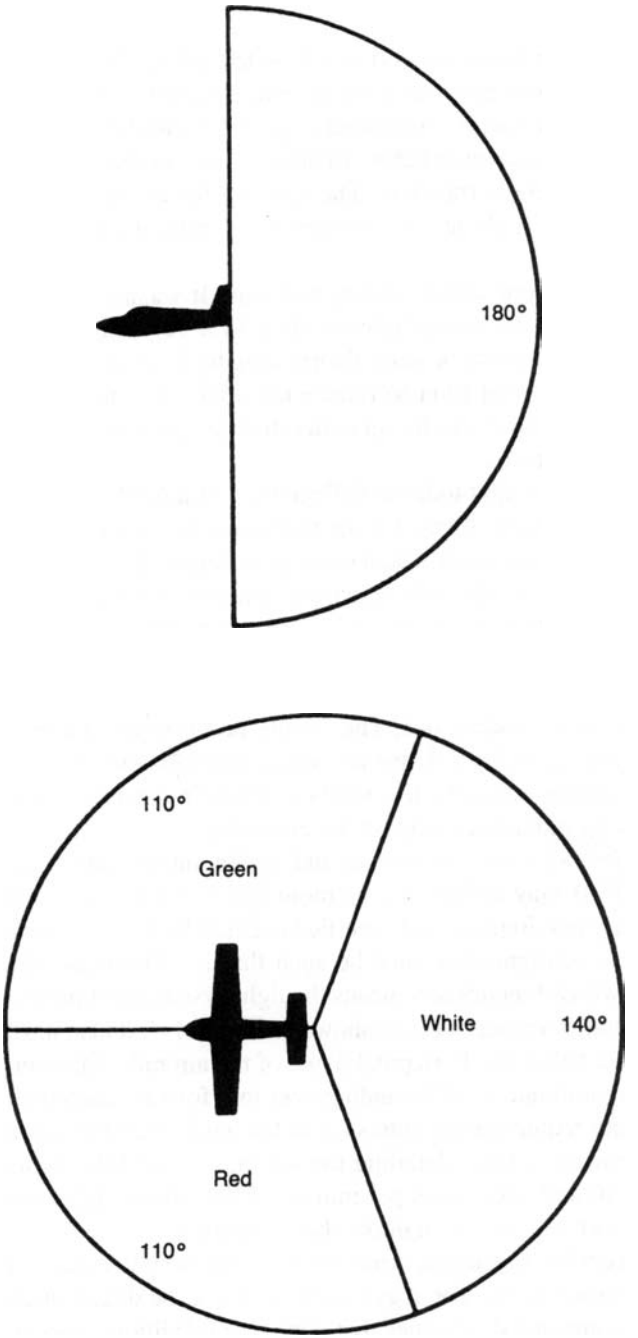

Fig. 1-3. *Position light pattern requirements.*

Anticollision Lights

The post-WWII era saw an economic boom in the United States, a large number of military-trained pilots, and many ex-military transport aircraft available for conversion to civilian use. By the 1950s these factors combined to produce a proliferation of airlines; the skies were more crowded than ever before in history, and for the first time airplanes were routinely carrying business travelers. The demand for greater aircraft conspicuity paralleled the demand for night airline operations, so anticollision lights were developed.

The earliest anticollision lights were white rotating beacons. It wasn't too long before it became obvious that a flashing white light resulted in a very significant, bright backscatter in the cockpit which could be very disorienting to the crew. As a result the white light was covered with a red filter to reduce the effect. Eventually the strobe light was developed and the requirement for an anticollision light broadened to include either a rotating beacon or a strobe.

The requirement for an anticollision light today is defined by four aircraft certification date categories. If the aircraft was certificated prior to August 11, 1971, it must have at least a red rotating beacon. If it was certificated on or after August 11, 1971, the regulations call for a white incandescent light, which is more luminous than the traditional red light. For aircraft certificated after July 18, 1977, the requirements regarding power and coverage for anticollision lights are more stringent yet.

While aircraft are grandfathered in, it is always acceptable to upgrade the older anticollision light systems for a more modern one. The simple fact is older collision light requirements are inadequate for today's dense air traffic environment. All aircraft can now be outfitted with simple, cost-effective strobes, which in most cases can utilize existing wiring and lighting mounts already on the airframe.

The current specifications for both rotating beacon and strobe anticollision light systems as defined by FAR 23.1401 may include one or more lights of either aviation red or aviation white. The intensity requirements are specified in detail by the regulation to assure adequate visibility. The configuration must be such that it "illuminates the vital areas around the airplane," which functionally means the light system must project light 360 degrees around the aircraft's vertical axis, as shown in Figure 1-4. It also must project light 75 degrees above and below the horizontal plane of the aircraft. Additionally, the system must produce a minimum of 400 candlepower in a forward direction, though the effective light-intensity requirement diminishes as the angle increases from the centerline (the regulation provides a table detailing the tolerances), and the lights must have a flash rate between 40 and 100 cycles per minute. While strobe lights are very effective, there are some drawbacks of which pilots should be aware.

Some people are highly susceptible to nausea, disorientation, and even the onset of epileptic episodes as a result of strobe lights. The regulations allow for the deactivation of strobe systems if the pilot in command determines that operating conditions warrant it. It is highly recommended that a strobe system be turned off when flying in clouds or fog, which causes the light to scatter around the aircraft and into the cockpit. **It** is also acceptable to turn them off during ground operations because the intensity of a strobe is

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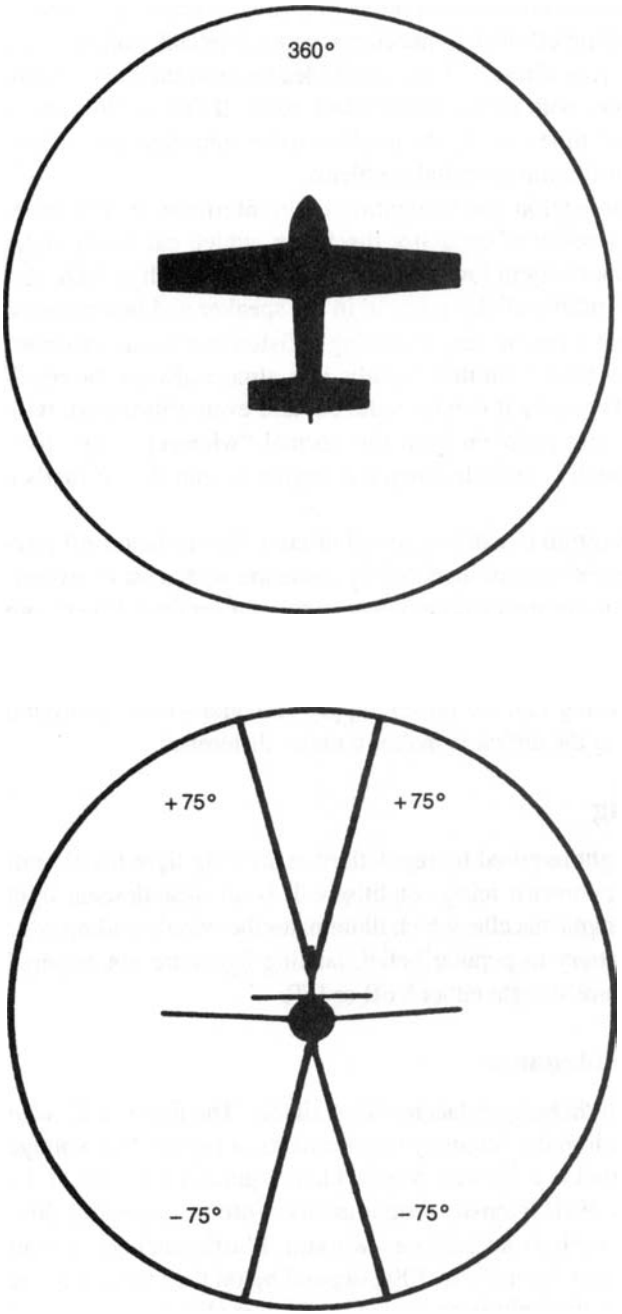

Fig. 1-4. *FAR 23.1401 strobe light projection requirements.*

so great it can easily cause short-term blindness of pilots in nearby aircraft. And there is still a problem with strobes reflecting off of airframe components, especially off the back of props. If you have strobes on your aircraft, it is a good idea to paint the back of propellers, nacelles, and wing surfaces with nonreflective black paint. If you do this, check it on the ground, at night, the first time you fly the airplane to be sure there are no surprises in flight. Strobes present still more potential problems.

Some systems cause communication and navigation radio interference. The problem is strobe lights function as a result of capacitor discharge, which can cause radio frequency interference (RFI), especially in low-frequency equipment such as ADF and LORAN C. It can also cause an audible clicking sound in the speaker and headphones. None of this affects the signal, but it can be very annoying to listen to it for an extended period of time. If your aircraft suffers from this malady, it is almost always the result of poor installation technique. Typically it can be reduced, and even eliminated, with cable shielding. Don't confuse that problem with the normal "wheeeep...pop" tone of the strobes' power supply, which is audible when the engine is shut down; that's a normal condition.

As always, an ounce of prevention is worth a pound of cure. You're better off paying a little more and having a strobe system installed by someone with a lot of experience. They will make sure never to locate a strobe power supply closer than 3 feet from any antenna, especially a low-frequency one. Also, the lamp-unit wiring should never cross or lay next to nav/comm wiring; bundling wires is a major cause of interference. And something as simple as ensuring that the power supply case and shielding around the wires are properly grounded to the airframe makes a major difference.

Other Required Lighting

The only other exterior aircraft light required by regulations is an icing light for aircraft certified for flight into known or forecast icing conditions. It is an incandescent light installed in the fuselage or on an engine nacelle, which illuminates the wing's leading edge to monitor icing in the dark. Contrary to popular belief, landing lights are not required unless the aircraft is operated for hire at night either VFR or IFR.

Lighting Preventive Maintenance

There are three types of position light bulb replacements available. The first is a 21-watt bulb, which simply won't meet minimum intensity requirements at typical line voltage and should not be used. The second is a 26-watt bulb, which requires 13.2 volts at the light assembly to comply with the FAR intensity requirements. Unfortunately, this does not allow for plastic enclosures, such as an enclosed wingtip. Plastic enclosures over position lights alter the light's output from 5% to 30%, depending on the clarity and the radius of the curve through which the light is projected, making it all too easy to drop below minimum intensity requirements. The third is a 37-watt bulb that will comply with the 12.5-volt system capability and provide a much brighter light than required at normal line voltage.

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Keeping a strobe light system healthy is a bit more complex than simply changing bulbs occasionally. The power supply's longevity depends on regular use of the system. Extended periods of nonuse result in the electrolytic condenser losing polarity formation. If a system is not used for over a year, there is significant potential for the system to fail. Should you find yourself in this situation, the solution is to remove the power supply, operate it at 75% of the normal voltage for 10-15 minutes, then reinstall it and use the system normally. If you remove a power supply, remember that these are condenser-based systems. Use caution, as the condenser can build up and store approximately 450 volts DC.

To periodically check the health of the xenon flashtube, you can use a paper cup like a stethoscope to listen to it flash. A healthy power supply and trigger transformer will make a "snapping" sound much like a spark plug. You can also feel the snap, which is a very low energy pulse, by placing a finger in close proximity to the strobe light. Xenon tubes are highly photosensitive, so a tube going bad may fire in the daylight because the ambient light conditions aid it, but the same tube may not fire at night. The tube may also fire when the engine is running but not when it is shut down because of the lower battery output.

Flash tubes are also subject to the effect of aging and will prematurely age when kept routinely in areas of high temperatures. The tube itself is airtight, and occasionally a leak will develop as a result of eggshelling of the glass or partial failure of the seals where the wire enters the glass. This condition is inevitable, as it is caused by the hot and cold cycling of the system; everything gets old and wears out.

One common reason for replacement is self-ionization. When one or more strobes begin to glow a continuous light blue, the entire system will become inoperative. This typically will occur when the system voltage is highest. To verify that the problem is ionization, turn off the system, wait a few minutes, then turn it back on. If everything operates normally for a minute or so, then fails and you see the glow, you've got self-ionization; replace the affected xenon tubes.

When replacing an old xenon tube, you may discover that other tubes begin to misfire or skip. In most cases, this signifies that they too are getting near the end of their service life. To check them out, remove the tube and operate it at 20% of its normal input power supply. If it operates at the reduced level, it still has good service life left. Another problem, found only in double-flash systems, is an intermittent second flash. Such systems are designed to operate at normal line voltage. What probably is happening is the system voltage is dropping below the battery-charging voltage and the second flash isn't getting off. Other electrical system problems probably are to blame rather than the strobe system.

CONDUCTING AN INTERIOR PREFLIGHT

The most important aspect of an interior preflight is carefully adhering to the published checklist. Beyond that, check the cabin for cleanliness. Dust floating in the air during flight can cause eye and respiratory problems. As a student pilot, I found that the airplanes were so dirty at my local FBO that for a long time I logged two sneezes for every touch and go. Loose objects are also a major concern in an aircraft cabin. In turbulence or during a fast stop, they can become lethal projectiles hurtling through the air.