[N] = Nightlights

Using Pilot "Nightlights" to Find Your Way in the Dark

TOM HOFFMANN

Ok, I admit it. I was a nightlight kid growing up. Besides keeping the under-the-bed variety of monsters at bay, the light also helped me safely circumnavigate the battlefield of plastic dinosaurs and army soldiers that would often collect on my bedroom floor. Even today, the groggy nocturnal schleps to the bathroom are always a bit safer with a nightlight's steady glow helping me avoid painful encounters with walls and other obstacles.

I feel a similar reassurance to another type of "nightlight" that was first revealed during my introduction to VFR night flying. I'm referring, of course, to the rhythmic green and white flashes of a civilian airport beacon that would always catch my attention among a sea of endless city lights. Once I was able to lock in on a beacon, I would quickly make out the landing area, set up my entry for downwind, and with a few empowering clicks of the mic, the once dark expanse of the runway would be ablaze with light. Descending into the darkness was also made a little less daunting with the help of visual approach slope indicator (VASI) or precision approach path indicator (PAPI) lights to keep me safely on glidepath.

Today, advances in technology are helping pilots find their way in the dark with new lighting options — namely light-emitting diodes (LEDs) — that are more durable, efficient, and reliable. But with every new technology comes new challenges. This is precisely why the FAA is taking a hard look at how LED and other new lighting technologies can be safely integrated into the National Airspace System (NAS). So, let's have a look at some of the nightlight options pilots now have along with a peek at some future developments.

The Aviation Lighthouse

Like the ships that safely navigate through harbors using a lighthouse, airport rotating beacon lights fulfill a similarly important role in guiding aircraft safely to the ground. A far cry from earlier airport navigational aids like bonfires, lighted concrete arrows, and signal flags, airport beacons can often be spotted well over a 40-mile range on a clear night and at altitudes far above their designed 1-10 degree range of vertical light distribution. In addition to identifying the type of airport (see chart), beacons can also be operated during the day to signify if ceilings drop below 1,000 feet and if visibility is less than three miles. Don't rely on that however; always verify independently if the weather meets VFR requirements.

Some other beacon lights you might encounter — either on or off an airport — include those that identify obstructions or areas hazardous to flight. These are identified with flashing or steady red lights and are painted orange and white for daytime opera-

tions. High intensity flashing white lights are used to mark some supporting structures of overhead transmission lines over rivers, chasms, and gorges, as well as tall structures like chimneys and towers.

Many manufacturers now offer FAA-certified LED kits that can easily replace existing incandescent obstruction lights. Newer high flux (or Piranha) LED technology is also available with many of these lights. In addition to providing more light than traditional LEDs, this technology is more resistant to vibration while providing more viewing angle options. These improvements, along with the reduced need for harrowing high-wire acts to perform maintenance, will likely lead to LED obstruction lights becoming more the norm in the years to come. That's good news given an LED's propensity for color accuracy and conspicuity under varying conditions and distances. And although there are some known issues with night vision goggle compatibility, efforts are underway to improve LED visibility with these. Initiatives are also ongoing to address compatibility issues with other installed vision systems. One solution being considered is to embed infrared emitters in the LED bulb itself.

Another place you'll find LEDs is with different components of airport surface lighting including runway end identifier lights, runway edge lights, and in-runway lighting applications for runways and taxiways. In fact, there are already over 700,000 LEDs in use today, many of which are located at the nation's larger part 139 commercial airports. Although few in number, there have been valid pilot concerns about LED surface lighting that the FAA has addressed or is currently working on but more on that later.

Call the Ball

Who can forget the opening scene of the film *Top Gun* when Maverick makes a cool-as-a-cucumber F-14 carrier landing shortly after a tussle with some unfriendly "bogeys"? On the approach, the carrier controller advises Maverick he's at ¾ of a mile and to call the ball (a type of glideslope indicator the Navy uses). Maverick's calm response: "Roger, Maverick has the ball." Too bad his fellow naval aviator, Cougar, "dropped the ball" on his landing attempt!

While you likely won't hear ATC ask you to "call the ball" on your next approach, there are similar types of visual aids that can help you manage your approach and keep you safely on glidepath, especially at night. Several variations of visual glidepath systems exist, so be sure to know which to expect at your destination.

Common Color Combinations for Airport Beacons

- Flashing white and green – civilian land airport
- Flashing white and yellow – water airport
- Flashing white, yellow and green – heliport
- Two quick white flashes followed by green flash – military airport

The most common type you'll find is the standard two-bar VASI system. It uses red and white lights to project a visual glidepath and provide obstruction clearance within the approach zone. If you're on glidepath (normally three degrees), you'll see red lights on top and white on bottom. Otherwise, with two reds — you're too low and with two whites — you're too high. An easier way to remember is with the popular aviation idiom "red over white, you're alright."

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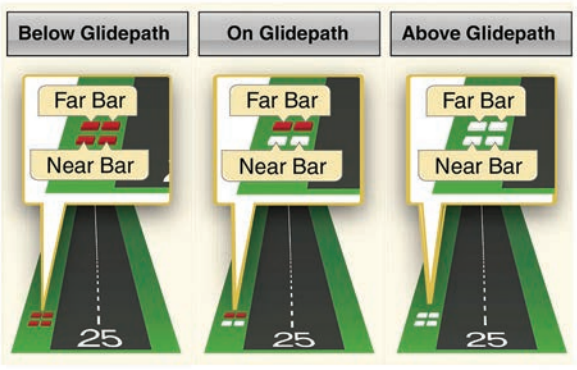
At night, VASI lights can be seen up to 20 miles away, but a descent should not start until you are visually aligned with the runway. In addition to the two light configuration, VASIs can also have 4, 6, 12, or 16 lights. You can see a diagram of each in section 2-1-2 of the Aeronautical Information Manual (AIM).

PAPI systems use lights similar to VASIs but are aligned in a single row, usually on the left side of the runway. Like VASIs, PAPIs provide safe obstruction clearance within plus or minus 10 degrees of the extended runway centerline and up to four miles from the threshold. A proper glidepath will be indi-



Two-bar VASI system.

For a side by side comparison of PAPIs using LEDs vs. incandescent lights, check out the video on

http://go.usa.gov/3JcsT

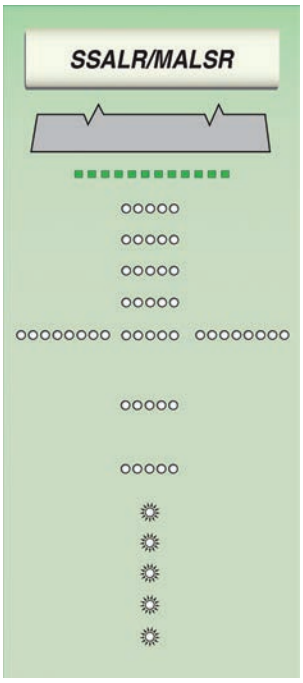
cated by having two white lights on the left and two red on the right.

There are roughly 940 PAPI systems in the NAS and they are currently being used to replace VASIs. This expanding role for PAPIs has made it a prime candidate for modernization using LED lights. Testing is still ongoing but the outlook is extremely promising for leveraging the superior efficiency of LEDs for these systems.

Other glidepath systems you may encounter include the tri-color system and the pulsating visual approach indicator, both of which use a single light unit. See section 2-1-4 of the AIM for more on these.

It's All in Your Approach

Although primarily designed for instrument approaches, a variety of approach lighting systems can be of great help during night VFR operations to keep you on target for a safe landing. The type of system you'll find depends on whether the landing surface is a precision or a non-precision runway. The most sophisticated of them is the High Intensity Approach Lighting System with Sequenced Flashing Lights (also known as ALSF-2) which is only found at roughly 150 airports. It uses a mix of more than 250 steady and flashing lights that extend out 2,400 feet from the runway threshold to provide visual information on not only runway alignment, but also height, roll, and horizontal reference for Category II/III precision approaches. The ALSF-2 system also includes a high-intensity flasher system known as a "rabbit" which looks like a giant ball of light sliding toward the runway two times per second.



MALSR—Medium intensity approach lght system with runway alignment indicator lights

The ALSF-2's smaller sibling — and quite possibly the FAA's lengthiest acronym — is the Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (or MALSR). With 900 locations, this is the system you will more likely encounter. MALSR uses threshold lamps, light bars, and flashers to provide guidance for Category I approaches.

A typical MALSR uses 18 green lamps along the runway threshold spaced 10 feet apart, nine white light bars with five lights separated every 200 feet, and five sequenced flashers also separated every 200 feet over a distance of 2,400 feet from the runway threshold. At the 1,000 foot point there are three light bars (15 lamps) for added visual reference for the pilot on final approach. Sequenced flashing lights provide added visual guidance down the runway centerline path.

To improve reliability and lower maintenance of these systems, the FAA has long considered using LEDs to replace the MALSR's less efficient incandescent lights. Early operational field tests at Phoenix Sky Harbor International Airport and Grand Forks International Airport in North Dakota, where green LED MALSR threshold lights were installed on select runways, further fueled this initiative. The test results were very encouraging and helped dispel some of the narrative about LED approach lights being too bright or distracting. Of pilots who were polled, most did not notice any difference with regard to the approach lights. Those who did stated the change was positive and not at all distracting. As a result, no adverse pilot human factors issues were revealed and the test was deemed a complete success for LEDs. The FAA later conducted a feasibility study on LED use for the MALSR which showed that the lights would pay for themselves in just two years. These findings paved the way for further FAA operational

testing. This includes the possibility of LED replacement for other MALSR components like the steady burning white lights and flashers.

Too Good to Be True?

While LED use may seem like a no-brainer, there are operational safety concerns and issues — as well as popular misconceptions — that the FAA needs to address before continuing with a more mass integration. Among those concerns include excessive glare and brightness, distraction, compatibility with existing electrical infrastructure, and as mentioned earlier, compatibility with night vision goggles.

To provide a more collaborative approach for addressing many of these issues, as well as help advance efforts for increased LED use, the FAA's Flight Operations Branch in Flight Standards last year hosted a LED Symposium together with the aviation community. Working groups were formed at the meeting to put together an achievable action plan for LEDs, including identifying areas of research and testing still needed. Since then several follow-up meetings have occurred indicating how ongoing research is helping to provide more definitive data and drive what needs to be done in a test environment. Discussions are ongoing on ways the FAA can adjust for some of the concerns like glare from wet pavement, light dispersion in fog, the fact that LEDs don't produce enough heat to melt snow build-up like their incandescent counterparts do, and reducing the intensity of LEDs to match the brightness of incandescent bulbs.

"LEDs can be a bit trickier than incandescent lights to operate," says Flight Operations branch manager Coby Johnson. "For example, to dim an LED is not a matter of simply reducing current. They operate by turning off and on at a high frequency — the flicker effect — so we must use what's called pulse wave modulation to adjust the brightness." An example of how this technology is used can be seen with the FAA's use of new, five-step current regulators in certain in-runway lighting applications to better control dimming. This step was taken in response to pilot feedback on LED runway lights being too bright. Johnson adds that further flight testing of these systems is still needed to determine baseline brightness levels as the lowest of these levels may still be too bright.

The LED symposium is just one of many steps taken by the FAA to ensure safety remains paramount with LED technology. It's a paradigm shift for pilots and the entire aviation industry that will require additional testing and training, but which carries the potential for many far-reaching safety benefits.

"LEDs are the way of the future and they are here to stay," says Johnson. "It might take us some time to smooth out all the wrinkles with this technology, but by joining forces with manufacturers and academic experts worldwide, we're on the right track for a successful and safe integration."

The future of aviation nightlights sure looks bright! And I think an LED replacement for my home nightlight is in order.

Tom Hoffmann is the managing editor of FAA Safety Briefing. *He is a commercial pilot and holds an A&P certificate.*

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