Lights, Camera, Action!

Approach lighting is a complex weave of operational, political, and human factors requirements.

By Wally Roberts

THE FAMOUS PHRASE, "LIGHTS, Camera, Action!" invokes charged images of the drama of the Hollywood movie set. Where is there higher drama, though, than the appearance of the approach light system during a dark, stormy, night instrument approach with the weather hovering at minimums?

Perhaps the prevailing weather conditions are even below minimums and the runway visual range is hovering around the minimum value on the approach chart. Which one invokes the more charged image, the Hollywood movie set or the image out the windshield of the aircraft in minimum weather conditions? I'll go with the view out the aircraft windshield any day.

The order of the words in the famous Hollywood phrase for the instrument approach, however, might better be, "Action, Camera, Lights!" The "action" is the pilot successfully delivering the aircraft to a point in space where his/her "camera" (the combined efforts of the eyes and rapid mental assessments) views the available visual references for approach descent below the minimum instrument altitude to flare and touchdown.

Basic straight-in minimums

Except where the height above touchdown (HAT) of the MDA or DH/A is excessively high, or the missed approach point is located well before the runway threshold, the generic standard straight-in minimum without any approved lighting aids is 1 statute mile (sm). One statute mile visibility seems to be no big deal, since we can get to that with either special VFR or just regular VFR in uncontrolled (Class G) airspace in the daytime. Helicopters operating in Class G airspace below 1,200 feet agl have no legal VFR minimums, but that's another story.

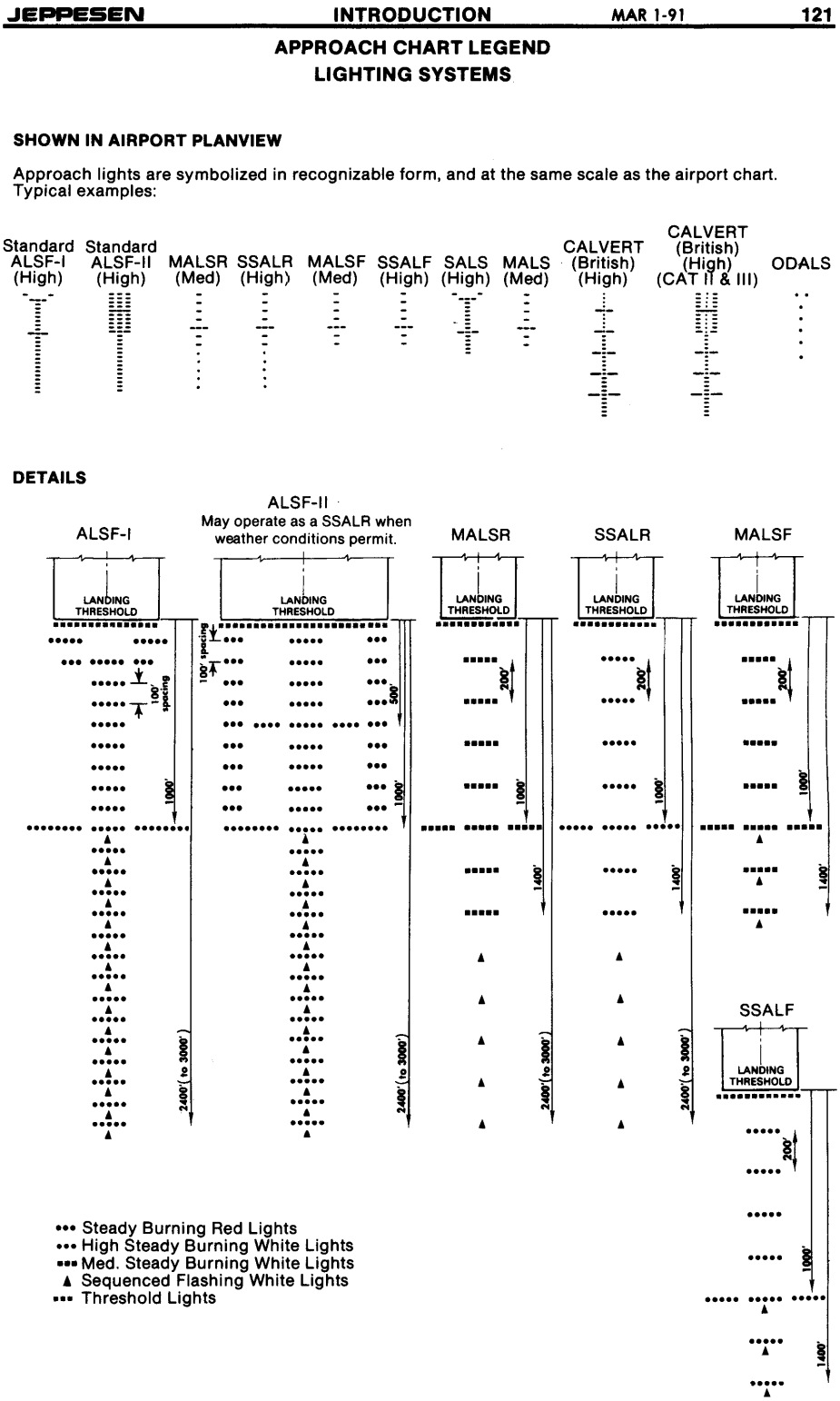

Figure 1. *Jeppesen approach light legend (continued on next page).*

The only place in the IFR world where the authorized visibility without approved lights buys an airplane less than 1 sm visibility is an unrestricted Category I ILS approach that does not have ALS. This type of ILS approach has a straight-in visibility minimum of 3/4 sm.

Approach light systems

Approach lights are required to get us a visibility minimum of less than 1 sm (or less than 3/4 sm on an unrestricted Category I ILS). Approach lights "reach out" and point the way to the runway, thus enabling the pilot to have specific limited-visibility guidance to the runway before seeing the runway itself. The historical concepts developed in the early days of IFR operations resulted in a combination of science and politics cutting in half the standard straight-in visibility minimum from 1 to 1/2 sm as the credit for approach lights. Over the ensuing years, that basic theme has remained intact, but with some complex variations for some less able approach lighting systems.

With an unrestricted Category I ILS, approach lights yield a visibility minimum of 1/2 sm for all aircraft approach categories, the idea being that the aircraft's size and maneuvering limitations don't matter when stabilized on an electronic glideslope at DH/A. Nonprecision IAPs to runways with ALS also usually get a visibility minimum of 1/2 sm with a couple of notable exceptions:

(1) The Approach Category D nonprecision straight-in minimum is 1 sm except for LOC IAPs, which is 3/4 sm.

(2) Approach Categories A, B, and C get a visibility minimum of 1/2 mile except for NDB IAPs, which are limited to 3/4 sm.

Further, in the exception (2), the Categories A, B, C, minimum for all non-precision IAPs is 3/4 sm if the approach lights are MALS, SSALS, SALS, or ODALS. Figure 1 (page 10) shows the Jeppesen legend for the different approach light systems, including the major European variation to the U.S. ALSF-I and II systems.

You might ask by this point: who can keep track of all this stuff? The short-answer is that the minima format on the approach chart has it all laid out for you. However, when the lights become either impaired or unavailable, the NOS chart user must be familiar with the inoperative components table to keep adjustments to minimums sorted out. Jeppesen, on the other hand, builds the inoperative components table into its chart minima format. It's important that instrument pilots understand these visibility reduction and adjustment concepts in principle, but trying to commit them to memory would be cumbersome and is unnecessary.

Runway lighting and RVR systems

As instrument operations matured in the U.S. and Europe, the commercial operators often found that runways rich with approach and runway lights were plainly visible at the minimum instrument altitude during authorized "look-see" operations, although reported prevailing visibility was below minimums. This led to the development of first, the runway visibility value (RVV) and later, to the runway visual range (RVR) concepts. RVV and RVR became controlling for the runway, and usually would permit approaches when prevailing visibility dropped below minimums.

RVV was derived simply by having a certified observer at the approach end of the runway, hooked by hot intercom to the tower. The observer would report a distance value, based on the ability to see runway edge lights. Then, along came today's RVR transmissometer, which sits along side the runway and electronically measures the intensity of a light representative of the runway's high intensity runway lights (HIRLs). RVR is used only in conjuction with HIRLs. In a given atmospheric condition, RVR varies with the intensity level at which the HIRLs are set, and whether it's day or night.

For most RVR-equipped runways, the lowest RVR minimum is 2,400 feet which, in FAA logic, is equivalent to a prevailing visibility of 1/2 sm. (It used to be 2,600 feet, many years ago.) On those RVR-equipped runways that not

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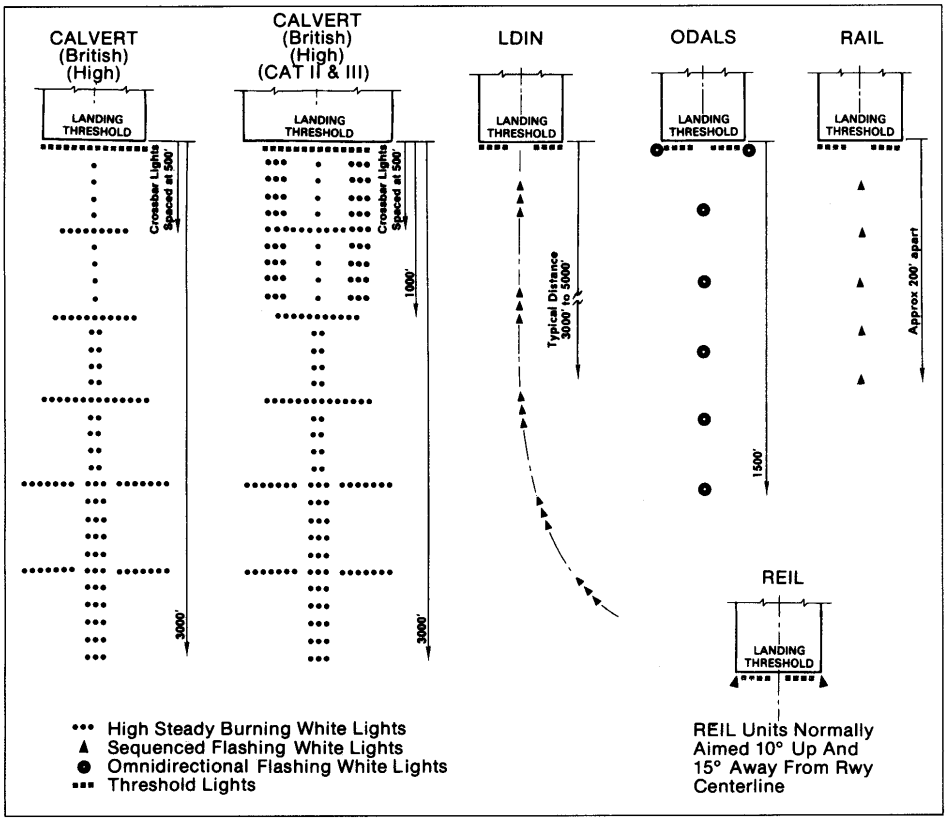

Lights, Action. . .

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only have HIRLs, but also touchdown zone (TDZ) and centerline lighting (CL) the Category I RVR-equivalent of 1/2 sm becomes 1,800 feet. This is also known informally as "Super Category I." The minimum DH/A is still 200 feet HAT, but the minimum authorized visibility is getting into the Category II regime, without the pilot or aircraft having to have special qualifications and airborne equipment.

For years, the FAA argued that approach lights provided not only alignment capability, but vertical guidance in the absence of a reliable electronic glideslope.

TDZ and CL lights go hand-in-hand with either ALSF-1 or ALSF-2. These two approach light systems are the big, "powerhouse" systems required for Category II and III approaches. Minimums can get down as low as RVR 2,400 (1,800 with most ALS and TDZ/CL lights) with any of the approach light systems, provided the runway has HIRLs and the necessary RVR transmissometer. Category II and III require multiple transmissometers, on the premise that the chances of non-homogeneous fog conditions being present increase as the visibility decreases.

I won't explore Category II and III approaches further, because most of us cannot use such approach minimums. Those who can, except for a limited Approach Category A special condition, receive specific training on the additional equipment required, and on the critical visual assessment techniques needed for low-visibility assessments.

Varying value of approach lights

For many years, the FAA argued that approach lights were a panacea; that they not only pointed to the runway and provided alignment capability, they also provided vertical guidance in the absence of a reliable electronic glideslope. A series of air carrier accidents in the 1960s and early 1970s resulted in additional testing and evaluation, which proved this premise to be incorrect. These tests did validate that seeing a substantial portion of the runway provides ***limited*** vertical guidance through perspective, but nothing nearly as positive or accurate as a VASI or PAPI.

Approach lights probably have their greatest value during intermediate visibility conditions of 1 to 2 miles, with a definite ceiling. In this case, you break out into fairly decent visibility conditions, but might be misaligned because of the limitations of a VOR or NDB IAP. When flying an ILS, however, assuming the approach is flown properly, you'll always be delivered to the precise point in space at DH/A that has you aligned and perfectly in the vertical slot for the final visual descent to flare.

What is the value of the approach lights during low-visibility Category I conditions, when they often aren't seen until just before DH/A, and through murky fog conditions? They certainly aren't needed for alignment on the properly flown ILS approach. Their primary purpose is to provide you with the ability to assess required flight visibility prior to continuing descent below DH/A, and to provide a high assurance the necessary visual conditions will remain through touchdown and landing rollout. (Some all-weather experts question the need for ALS at all for unrestricted Category III approach operations, where Alert Height replaces DH/A. In fact, the sequenced flashers can be inoperative on the ALSF for Category III approaches.)

The trap to really watch out for is overreliance on approach lights during a non-precision IAP when RVR is enabling, and the runway cannot be seen, yet the pilot believes the aircraft is in a position where descent below MDA must be commenced. Even where there is no RVR, the pitfalls are just as great when descend below MDA is made, based solely on the sighting of approach lights. FAR 91.175(c)(3)(i) permits us to descent as low as 100 feet HAT, based only on the approach light system. Does this make much sense on an NDB approach with an MDA that's 700 feet HAT? Look at FAR 91.175(c)(3)(i) closely. With ALSF-I or II, you can descend below 100 feet, without seeing any one of the nine runway visual cues, if you see either the red terminating or side row bars. Obviously, this regulation was written for the fine points of ILS flying, but the regulation does not make that distinction.

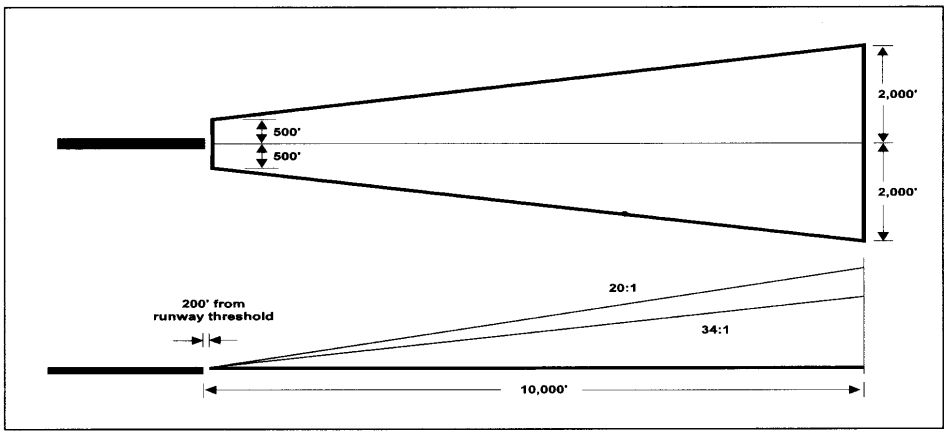

Figure 2. *Area evaluated for obstacles for visibility credit for approach lights. The profile shows the slopes that must be clear for visibility credit for approach lights. The 34:1 must be clear for 1/2-mile visibility and the 20:1 for 3/4-mile.*

Generic visual segment

In order for ALS to result in a visibility minimum of 1/2 sm, an area 10,000 feet long, which starts 200 feet outwards from the landing threshold, and which has the same lateral dimensions as the primary protected airspace

for an ILS IAP, must be clear of obstacles along a 34-to-1 slope. If the 34-to-1 slope is penetrated, but is 20-to-1 clear, then the minimum visibility must not be less than 3/4 sm. If the area isn't 20-to-1 clear, then the minimum visibility is 1 sm, with or without ALS. Where an ALS is installed, it's obvious there's incentive for airport authorities to keep this area clear of obstacles below MDA-DH/A, if at all possible.

Leaving the MDA on a sloppy VOR approach prior to entering the lateral confines of this visual segment will provide no assurance of below-MDA obstacle clearance.

Figure 2 (page 12) illustrates the generic visual segment. Keep in mind that leaving MDA on a sloppy VOR approach prior to entering the lateral confines of this visual segment will provide no assurance of below-MDA obstacle clearance, although 1/2 mile visibility on the chart indicates the illustrated zone is protected.

Lighting intensity settings

The ATC controller's handbook has detailed instructions about the intensity settings for the different approach and runway lights. The settings vary with visibility conditions and whether it's day or night. The intensity of ALS, runway lights, VASI, and REILs can all be varied. The pilot can override the recommended setting upon request. For those interested in the details of intensity settings, the ATC handbook is the best reference source.

Benefits and perils

Approach lights are almost always limited to runways that have ILS approaches. That's where the need and money dictates their placement. Ideally, all other runways should have an omnidirectional approach light system (ODALS), but the money pot ran dry before that could be realized. Nonetheless, there are often backup non-precision IAPs for such runways that are used whenever the ILS is broken. Keep in mind the perils, as well as the benefits of approach lights, when flying non-precision IAPs, and those lights will serve you well.

It's impossible for the pilot to figure out what is restricting visibility minimums to greater than 1/2 sm with approach lights. It could be: excessive HAT, obstacles penetrating the visual generic visual segment's obstacle clearance plane, less capable types of approach lights, or the type of non-precision approach. There are some positive movements within current user group efforts to get this information on the approach chart.

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