Navy Tests Lasers To Help Carrier Pilots

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The U. S. Navy has developed visual aids using lasers that promise to make night carrier landings easier and safer.

Red, green and amber eye-safe lasers will help the pilot intercept the landing centerline and glideslope from as far away as 10 mi. from the carrier.

The systems will be useful in daylight, but their greatest contribution will be at night, when there are few lineup and glideslope cues, according to Cdr. Frank Pfeiffer, program manager at the Naval Air Engineering Center (NAEC).

Lining up the aircraft on the centerline is the most critical problem on a carrier. Pilots of the smaller aircraft need to land within 20 ft. of the centerline to avoid hitting aircraft parked on the right side of the landing area or going off the left side of the deck into the water. Aircraft with longer wingspans, such as the E-2, only have +/ - 10 ft. centerline margin.

Carrier movement complicates the problem. Because the pilot lands on a deck angled at a nominal 10 deg. from the ship's centerline, the carrier's speed causes the centerline to move to the right at about 10 kt. By day, the three-dimensional carrier and its wake in the water help the pilot's perspective, but those cues are missing in the dark.

At night, all the pilot currently sees is the outline of the carrier deck, the centerline, and glideslope information from the Fresnel lens optical landing system.

Loss of depth perception makes night landings more difficult anywhere, but exponentially so at sea, Pfeiffer said.

With a 10,000 ft. stationary runway, lineup is not hard, but it is difficult to get the perspective to line up on the short landing area. Only the angled deck, which is used for landings, is lighted. On the Navy's largest carriers, the Nimitz class, the angled deck measures 786 X 100 ft. With current visual landing aids, the pilot cannot line up accurately early in the approach. This increases his workload while approaching the carrier and can lead to potentially hazardous aircraft oscillations. The Navy is testing the Laser Centerline Localizer (LCL) to help the pilot line up at longer distances. The LCL was built by Humbug Mountain Research Laboratories in Duarte, Calif., under a Navy contract. With the brightness of low-power and eye-safe lasers, pilots can get useful information out to 10 mi., Pfeiffer said. The device uses color to show the pilot the direction back to the centerline and flashing lights to indicate how much correction is needed.

The laser colors follow the convention of sidelights on ships — green for starboard (right) and red for port (left). If the pilot is to the right of the centerline, he will see a green light, on centerline an amber and if to the left a red light. When lined up just a little to the right he will see a steady green light, which will flash as he deviates farther right-slowly at first and more rapidly the more he is off center.

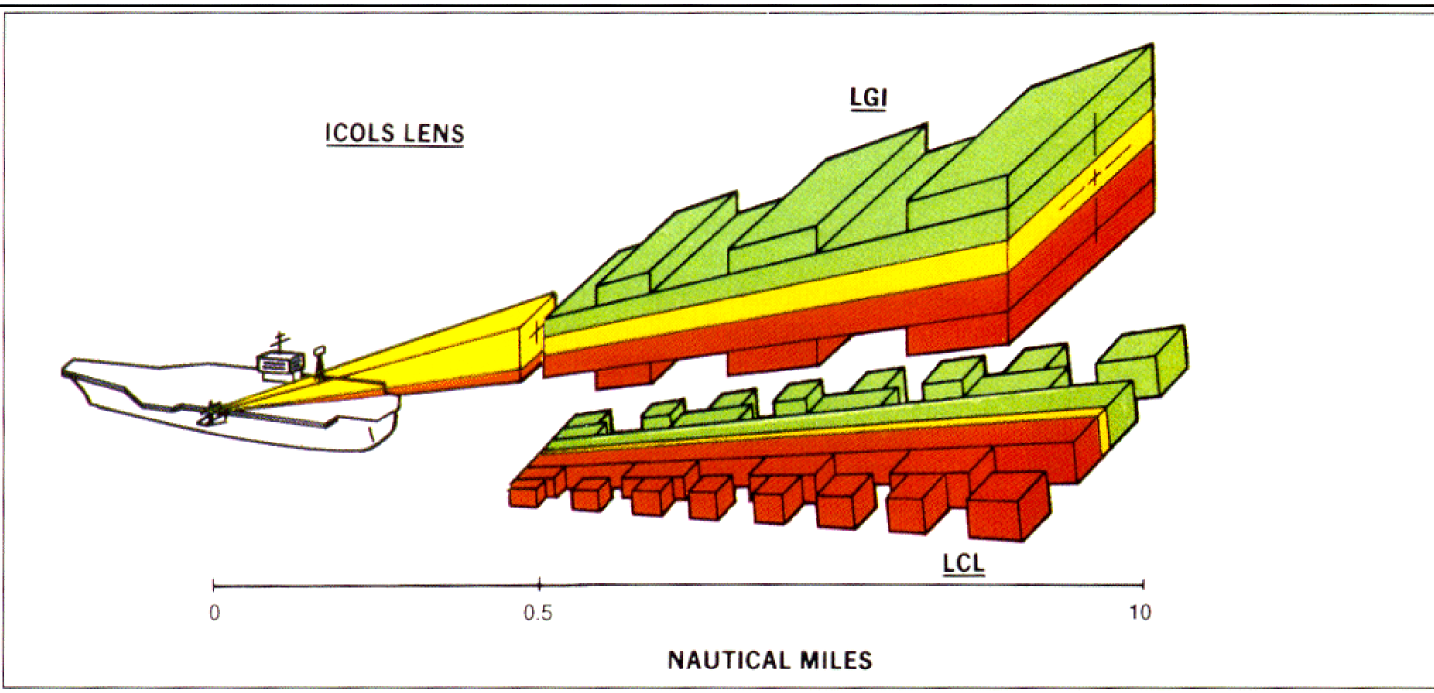
The total beam covers 10.95 deg. either side of the landing centerline. To avoid overloading the pilot with information, the laser centerline localizer is designed so that the pilot will fly out of the beam and lose the LCL information at one-half mile. At that point he can shift to the traditional deck lighting cues.

LCL would be installed on the stem, below the flight-deck level, so that aircraft or workers on deck would not block the pilot's view. Fiber-optic cables connect the lasers to the optics for each corridor. This allows the lasers and the solenoid shutters that cause the flashing to be placed in a more protected location where they can be isolated from vibration and thermal gradients. The optics connected by fiber-optic cables are designed to withstand the elements.

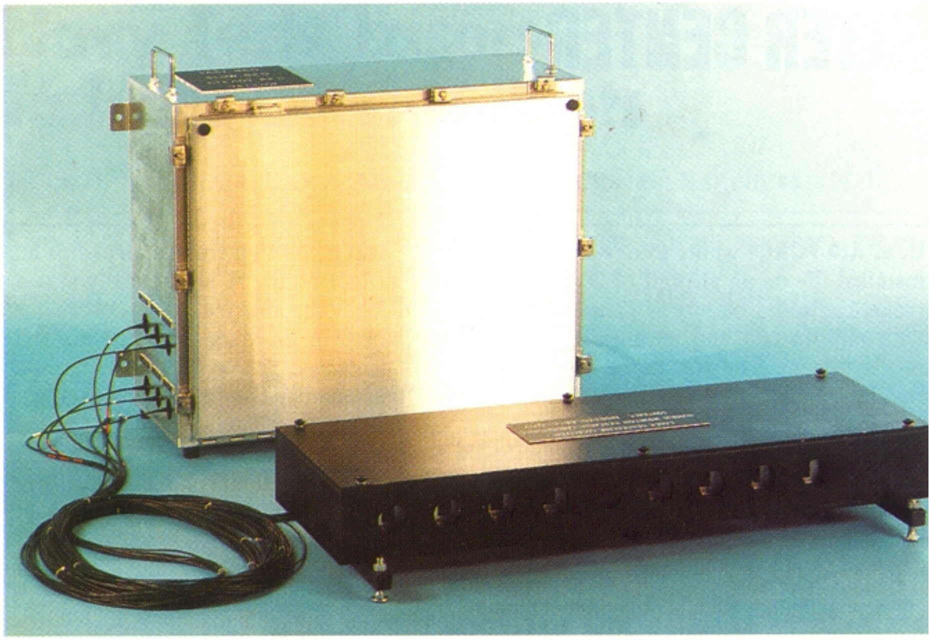
The helium neon lasers transmit red beams at a wavelength of 633 manometer and amber at 594 manometer. The green 514-nanometer light comes from an argon laser. The laser's life expectancy currently ranges from 4,000 to 10,000 hr., and the system has an average luminous intensity of 500 candela.

The Navy also is evaluating improvements similar to the LCL to help the pilot fly the correct glideslope. There is not much margin for glideslope error either, as a pilot approaches the carrier at speeds between 105 and 135 kt. (121-155 mph.), depending on the aircraft type.

Since the carrier uses four arresting wires



Navy is testing the Laser Glideslope Indicator (LGI), Laser Centerline Localizer (LCL) and the Improved Carrier Optical Landing System (ICOLS) lens to help carrier pilots land at night. The laser systems use color and flashing eye-safe lasers to give the pilot corrections.



Eye-safe lasers in the Laser Centerline Localizer would help pilots intercept the landing centerline during visual approaches to aircraft carriers. The light beams are transmitted from the lenses (foreground box), which are linked with fiber-optic cables to the lasers, which are in four boxes that can be protected from the elements (background).

spaced 40 ft. apart, the actual area in which the pilot must land is 120 x 40 ft. If the pilot, is 20 ft. above the optimum glideslope, he will miss the arresting wires and bolter, which is an unplanned touch-and-go. If he is 20 ft. low, he will crash into the blunt end of the ship, Pfeiffer said.

Navy pilots currently use the Fresnel lens optical landing system for glideslope information. It is an improvement over the British-invented mirror landing system. With either of these systems, a pilot on the optimum glideslope sees an amber "meatball" aligned with a row of horizontal, green datum lights. If the amber ball appears below the datum lights, the pilot is low. If the pilot goes lower, the ban turns red as a danger warning before disappearing off the bottom of the display.

The Laser Glideslope Indicator (LGD) allows a pilot to see the glideslope as far away as 10 mi., from 4,000 ft. In contrast, the glideslope on the current Fresnel lens can be discerned at approximately 3/4 mi. from the carrier. Although the Navy would probably not use LGI to commence approaches from 10 mi., the ability to stabilize the aircraft at 4 mi. and 1,600 ft. would be a great improvement, Pfeiffer said.

Humbug Mountain Research Laboratories also makes the LGI, which defines the glideslope with five planes or corridors of laser light. Like the Fresnel lens, LGI indicates "on glideslope" with an amber ball.

Steady red signifies below glideslope and flashing red means dangerously below. Correspondingly, a steady green means high, and flashing green signifies well above glideslope. At about 1/2 mi. from the carrier, the pilot will lose the LGI and shift to the Fresnel lens or its replacement.

The Naval Air Engineering Center is testing an improvement to the Fresnel lens, called the Improved Carrier Optical Landing System (ICOLS). It has a higher resolution glideslope display, Pfeiffer said, and improved stabilization. Pilots would be able to start using it at 1-1/4 mi., nearly double that for the Fresnel lens. Perhaps more importantly, the improved lens would give more precise close-in glideslope control.

The ICOLS lens achieves the increased sensitivity by using 10 lenses to display vertical ball displacement, instead of the five used in the Fresnel lens. This difference means that pilots will be able to detect smaller deviations from the glideslope. For example, if a pilot could compare the two side by side, when the Fresnel lens showed him one ball high, the ICOLS lens would more accurately display nearly two balls above glide path. If the pilot can see and correct smaller deviations, he should be able to fly a more stable and safer carrier approach.

The new system uses anachromatic ground glass lenses instead of plastic optics, to gain increased clarity and range. Light from each quartz projector lamp will be conducted and spread to a rectangular shape by fiber-optic cable and focused with the ground class lens.

The Fresnel lens was stabilized, but the ICOLS lens design should have improved stability. Without stabilization, the glideslope would gyrate with each pitch, yaw and heave of the ship's stern. The whole mass of the Fresnel lens moves to counter the ship's motion. In contrast, the ICOLS lens should have more precise response because only the individual lights will pivot.

Fog or low clouds would degrade the long ranges possible with the laser systems, as they do existing systems. However, even the ability to visually intercept the glideslope at 3 mi. would be a major improvement and would more than double the time a pilot has to visually stabilize the aircraft on the optimum path.

NAEC Lakehurst had 20 carrier aviators evaluate the systems in November, 1989. The aviators saw the landing aids from a civilian PA-32 Piper Cherokee 6 aircraft that Pfeiffer flew.

Because of their favorable responses, fleet and Naval Air Test Center pilots tested the prototype systems in May. Two aircraft of the following types were used: F-14, F/A-18, A-6, EA-6, S-3, E-2, A-7, TA-4 and T-34C.

The test pilots found that the laser centerline system gave useful lineup information at 12 mi. (the maximum range tested), and that the magnitude and direction of lineup deviation were easy to determine from the color and flash of light. Inside 1 naut. mi., they shifted their lineup scan to the deck centerline.

Similarly, the laser glideslope indicator was visible at the maximum range tested — 12 naut. mi. The pilots found that LGI made it easy to intercept the glideslope precisely at 5 naut. mi. at 2,500 ft., and to stay on the glide path until shifting their scan to the Fresnel lens, or ICOLS lens, with a centered ball. The pilots recommended that a stabilization system be developed for LGI and that LGI be tested on a carrier. LGI would be installed on the right side of the landing area.

A pilot seeing two amber lights would know that the one on the right was the glideslope, with the centerline localizer to the left. Transition from the LGI to the ICOLS lens, located to the left of the landing area, was no problem.

The pilots also liked the increased sensitivity of the ICOLS lens and praised it for helping the pilot recognize small deviations. The pilots recommended testing the effect of a pitching deck on the more sensitive ICOLS lens. The test pilots recommended the LCL, LGI and ICOLS lens for further development.

This AVIATION WEEK & SPACE TECHNOLOGY editor also had a chance to observe the lighting as Pfeiffer flew a half dozen night approaches. The visibility and clarity of the two laser systems was startling. One of my concerns had been whether the colors would be easy to differentiate. The colors from the lasers were clear and easily distinguishable even at the maximum range. The convention of flashing to steady to amber gave an almost intuitive pull to the centerline and glideslope.

NAEC also is considering this technology to assist helicopters and the Marine Corps' AV-8 Harriers. The first helicopter demonstration was conducted in an SH-2 helicopter from the Navy's HSL-32 squadron in mid-October.