The AOA Indicator

SMALL DEVICE, HUGE IMPACT

BY VADM. ROBERT F. DUNN

From the post-WWII Banshees and Panthers to the Hornets of today, naval aircraft have steadily improved: engines, navigation, hydraulic, electrical, control and weapons systems have gradually modernized. Some improvements are less visible, but at the time were revolutionary. Here is a description of one of them: The angle of attack (AOA) indicator.

Today's Navy and Marine fixed-wing aircrews take this device for granted. It is a relatively small instrument (a dial) on the instrument panel or a unique indicator on a multi-function or heads-up display (HUD) that shows in analog fashion the aircraft's angle of attack at any moment.

Patrol aircraft have only the dial. Carrier aircraft have other devices, one usually on the glare shield (the "indexer"), and another group of three lights arranged vertically in the vicinity of the nosewheel strut showing a red, amber or green light when in a landing configuration. The latter two displays show the pilot and the LSO the landing attitude of the aircraft relative to the optimum for landing.

The dial can also be used to establish the optimum landing attitude, but it is much less convenient than the indexer or a HUD. Neither the indexer nor the nose-strut lights will illuminate if the wheels are up.

Wheels-up landings were much more common years ago, and some of the improvement has to be attributed to the installation of AOA systems. Unfortunately, for the analyst or the historian, data is available only on mishaps, not mishaps avoided.

The AOA system is simple; when first seen in the 1950s, it elicited such comments as, "Why haven't we had this all along?"

Landing approach speeds on a carrier, whether too slow or too fast, will prompt a waveoff from the LSO. Before AOA indicators the pilot calculated his landing approach speed according to the aircraft weight, its configuration and external load. Flaps up or down or partial. Speed brakes in or out. The optimum airspeed could vary by as much as 9 or 10 knots.

Maintaining the indicated airspeed required looking at the instrument panel, while also looking out to line up on the ship's centerline. Trying to fly the proper glide slope as indicated by the LSO or the mirror was often a serious and sometimes deadly task. Earlier jets had a small margin between stall and approach speeds. A hung bomb or unused fuel could make a significant difference. More than one jet in the 1950s went into the water astern of the carrier because of miscalculated approach weight. The AOA indicator solved this problem.

THE AOA SYSTEM WAS BUILT with a damping system that permitted its use in turbulence without giving misleading or unreadable information, a feature not available in airspeed indicators alone. In aircraft with attitude gyros that could tumble at any moment, inadequate stabilization-augmentation systems and no automatic-power compensators, the AOA system was a godsend.

The AOA indicator also helped the LSOs. When compared with prop approaches, the jets had almost imperceptible variations in approach attitude that could mean significant airspeed changes. These variations were difficult to determine at night, and flying at night in the late 1950s was becoming more and more common. The LSOs continued to rely as much as possible on the relation between the wing and the horizontal stabilizer to determine attitude. The nose-strut lights working off the AOA indicator took a lot of guesswork out of the game.

Fleet-wide back-fit installations of the AOA indicator systems took place in the late 1950s and 1960, and all production aircraft after that were so equipped.

It matters not whether flaps are up or down, speed brakes in or out, or the weight and aerodynamics of external stores. With the airspeed at the optimum AOA the aircraft will be at the optimum speed for its configuration. Of course, weight and actual airspeed may be a consideration for arresting-gear engagement, but that's a different problem. At the optimum AOA the aircraft will be at the right attitude for touchdown. A "bug" displaying the optimum AOA on the indicator normally is set at 3 o'clock so that all the pilot has to do in the landing approach is to match the AOA needle with the bug.

The AOA indicator also can be used to establish maximum-range and endurance airspeeds, and speeds for other flight operations.

Commonplace today, the AOA indicator is one of those under-appreciated pieces of equipment that has contributed to the safety of fixed-wing naval aircraft. It has been key to the avoidance of numerous close calls and mishaps over the years, and continues to contribute to operational safety and efficiency.

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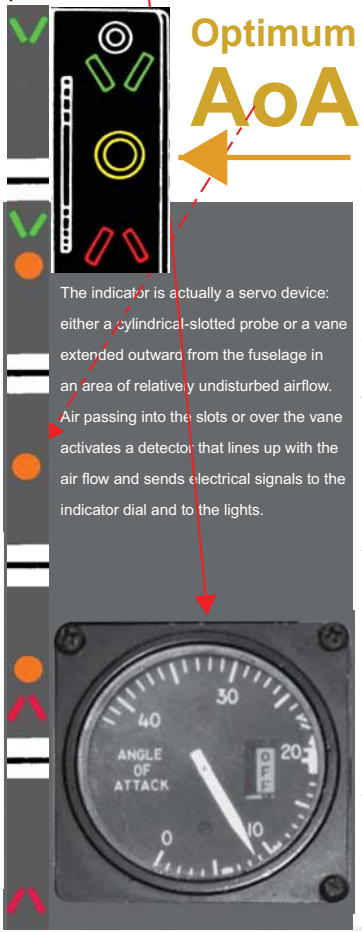

http://www.public.navy.mil/navsafecen/Documents/media/approach/AppJan-Feb11.pdf

Angle of attack: The angle between the chord of the wing and the relative wind.