
# LT Brent “ROTC” Robinson

## Magic Carpet

Project Magic Carpet is an innovative set of flight control laws combined with enhanced Head-Up Display (HUD) symbology for the F/A-18 E/F/G designed to significantly simplify the carrier landing task. The improvement to the flight control laws is twofold. First, we introduce Integrated Direct Lift Control (IDLC), and second we let the flight control computers compute and then maintain the desired ‘ideal’ glideslope. IDLC uses combined trailing edge flap and aileron movements to affect lift directly with an improved auto-throttle function. This allows the pilot extremely precise glidepath control using a single controller (the stick) to affect lift, vice the traditional method of artfully balancing AoA, manual throttle manipulations, and stick inputs. Furthermore, because most of the glideslope deviations will now come from lift, the engines remain in a much tighter RPM band; thus, waiting for engine spool-up/down is no longer a factor. To make this whole ‘landing on a moving boat’ task even easier, the system can now maintain itself on the ideal glideslope with little to no inputs from the pilot. The glideslope reference angle and ship speed is selected by the pilot prior to the approach turn (or during, in cases of the SHB!). Then, with a subsequent depression of a single button, the aircraft will rotate, capture, and maintain the glideslope…hands off!

The enhanced HUD includes a new Ship Relative Velocity Vector (SRVV) and a Glideslope Reference line while removing the normal velocity vector and E-bracket. Together, these two tools allow the pilot to precisely view not only the magnitude of deviations, but also the magnitude of commanded corrections, completely removing the guesswork currently involved in flying the ball. Additionally, the SRVV acts as a novel lineup aid by allowing the pilot to simply place the symbol on the landing area centerline in order to maintain sufficient lineup to avoid a call from the Air Boss…essentially just ‘put the thing on the thing!”

After successful shore based testing, we took two jets to the mighty USS G.H.W. Bush to truly put MAGIC CARPET through her paces. After 181 approaches of intentional (and some un-intentional) ‘underline’ high, low, and overshooting starts, the data were eye-watering. With a significant decrease in pilot workload ratings, an increase in handling qualities ratings, and a reduction of over 50% in average touchdown dispersion the team believes they are on the cusp of revolutionizing the most stressful and dangerous part of daily operations of pointy-nose aircraft aboard carriers! Over the next two years, we will be further refining MAGIC CARPET to make the system more robust and useable in any F/A-18E/F/G configuration including asymmetric loadouts, half flaps, and single engine. MAGIC CARPET is expected to hit the fleet at the same time as the H12 SCS release.

### "Shake, Rattle and Roll"

VX-23 Ship Suitability performs Shake, Rattle, and Roll (SRR) loads testing on aircraft, systems, and ordnance to ensure those test articles are able to withstand the unique demands of shipboard flight operations. A standard "shake" is executed at our unique shore based facility here at Pax and utilizes actual shipboard TC-7 catapult and Mk-7 arresting gear systems. The primary goal of the catapult testing is to demonstrate sufficient operational capability under maximum allowable longitudinal acceleration (Nx) and off-center alignment launch scenarios. Arrestment testing requires much more difficult flying techniques and truly embodies the 'art' of ship suitability flying. Shake arrestments typically begin with buildup to a high sink rate landing using a MK-8 Fresnel Lens Optical Landing System (FLOLS) gradually increased from 3.5° up to as high as 6°! The end point rate of decent is usually greater than 20 fps or 1200 fpm, nearly twice the 'standard' fleet operational landing rate of decent. A "free flight" arrestment is performed such that the hook engages the wire prior to the main landing gear touching the deck, requiring a very shallow and precise approach usually flown at ~2.5° on the FLOLS. A "roll/yaw" test point is performed with greater than 5 degrees wing down and up to full opposite rudder pedal on touchdown. Maximum deceleration test points are achieved by targeting a specific ground speed near the limit of either the arresting gear or the aircraft itself. Depending on flight conditions, pilots may fly these approaches at angles of attack between 6°-12°. Usually conducted last, off-center points require the pilot to target an engagement 18 ft to the right and/or left of centerline, without exceeding 20 ft, which would then 'down' the arresting gear.

Over the past 12 months CVS shake testing on F/A-18E/F/G has been fairly light, but the successful events included: Advanced Capability Mission Computers (ACMC) for Super Hornets, Aerial Refueling Store (ARS) Upgrade package for Super Hornets, E-2/C-2 Wing cracking investigation, APX-123 Transponder for F/A-18 A-D, and F-35C Initial Sea Trials Demonstration. In the next 12 months we should see a return to a busy shake schedule as we attempt to break numerous items on their way out to the fleet. These include: F-35C mis-serviced landing gear, Harpoon Block 2+, Common Range Integrated Instrumentation System (CRIIS) Pod, CRU-123 On-Board Oxygen Generating System (OBOGS), F/A-18E/F/G Fiber Channel Network Switching (FCNS) System, and the long-awaited Infrared Search and Track (IRST) Pod!

*MAGIC CARPET Enhanced HUD Symbology*

### Precision Approach Landing System (PALS)

Equally important to developing new technologies such as Magic Carpet and EMALS is the responsibility to verify and if required fix current fleet systems. VX-23 verifies the precision approach and landing systems (PALS) for all CVN, LHD and LHA class ships. For CVNs, PALS certification testing examines the Improved Fresnel Lens Optical Landing System (IFLOLS), Instrument Carrier Landing System (ICLS) and the Automatic Carrier Landing System (ACLS). The goal is to make sure the systems are functioning properly, are aligned with each other, and get the pilot to a good start.

The PALS certification process typically takes about three weeks. It starts with engineers from NAVAIR 4.11.7 visiting the ship up to two weeks prior to flight test to inspect and overhaul all of the systems. Testing culminates with flight tests flown by VX-23 pilots in Hornets and Rhinos. While some flight tests can be conducted with the ship at the pier (Norfolk only), the majority of flight test is conducted with the ship at sea. VX-23 pilots frequently borrow fleet aircraft to conduct the flight test. Flight testing can be conducted concurrently with Case I CQ with flight test aircraft flying under the Case I CQ pattern. PALS verification of LHD and LHA class ships is conducted similarly to a CVN verification. For LHD and LHA, the precision approach radar (SPN-35), ICLS and optical lens are aligned. NAVAIR 4.11.7 engineering examinations precede flight test. Flight test is conducted with Hornets or Rhinos that break off approaches at 200 feet AGL.

continued...

As PALS systems continue to age on all ships, system certification tests are conducted every two years to prevent impending failures. The mechanical components of the SPN-46 radars frequently need to be overhauled to eliminate slop in gearing that can cause approach path errors. If you are having trouble with any part of PALS, please do not hesitate to contact the VX23 Carrier Suitability Department. We can help troubleshoot the system and, if required, send engineers and pilots to conduct flight test wherever your ship may currently be. In the meantime, we'll see you next time your boat is due for certification.

### What to Expect When Coupled Up

For some aviators, the Mode I approach has a reputation as the "VFA Department Head Night- Currency Maintenance Machine." For others, handing over a carrier approach and arrestment to "Hal" is disagreeable. While there might be some truth in this reputation and sentiment, a Mode I approach is a valuable tool for the aviator who may have experienced hypoxia, severe fatigue, and/or disorientation. Experiencing such a problem should not be the first time one couples up to a Mode I, as the automatic carrier landing system (ACLS) flies an approach to arrestment in a manner distinctly different than a fleet aviator. Understanding how ACLS works and how it flies differently may prevent an aviator from unnecessarily de-coupling during an approach.

The ACLS system aims to fly an exact 3.5-degree glideslope. In fact it is good enough to typically be within one foot of a perfect glideslope at ¾ nmi. Conversely, the IFLOLS can be set within its calibration specification anywhere between 3.45 and 3.55 degrees (four feet off glideslope at ¾ nmi). With an IFLOLS technician biased to set higher IFLOLS glideslopes (3.5 to 3.55 degrees), pilots frequently see a sagging ball from the start to touchdown when riding the Mode I. This can frustrate carrier aviators since we strive to not accept a low pass and fly the cresting ball to touchdown. Accustomed to flying slightly high passes, a Mode I pass may look a little low all the way. In reality, normal uncoupled passes tend to average a little higher than the nominal glideslope.

ACLS reacts to deviations in glideslope when they occur while a fleet aviator anticipates deviations. For example, many pilots add a little power approaching the burble to prevent a settle. The ACLS is unaware of the impending burble and thus typically has a little settle in close. Further, just before touchdown the SPN-46 antennas lose the ability to track the aircraft due to the rapidly increasing line of sight tracking rate approaching and crossing the ramp. One and a half seconds prior to touchdown the system enters 'command freeze' and attempts to hold the last commanded rate of descent. The flight controls and throttle continue to maintain the last commanded descent rate through the remainder of the approach. Any unpredicted disturbances in the flight path during the command freeze (e.g., shifting or turbulent winds) will not result in an updated descent rate. The ACLS has frequently already reacted to a settle in the burble with a decreased rate of descent when command freeze occurs. Thus the last commanded descent rate is shallower resulting in the typical Mode I pass: (SIC)(LOBAR).

The strength of the burble is increased by starboard winds and greater wind over the deck. A stronger burble will increase the deviations observed during a Mode I approach. Rhinos tend to overcorrect for the settle in the burble, get a little flatter at the ramp, and land a little long and right with the occasional bolter. Hornets do not have the same power response and do not overreact to the burble and tend to land a little short of the ideal touchdown point in strong burble conditions.

These ACLS behaviors are general trends and will vary with environmental conditions and aircraft configuration. Ultimately it is up to the pilot and the LSO to determine the acceptable magnitude of deviations, so hopefully the information above gives you a better idea of normal Mode I expectations. Please contact VX-23 if you have any questions about the Mode I performance you're seeing on your ship.


*F/A-18C "Endos" after a high-sink test point. NO 904!*