Flight Testing AESA Radars: Lessons from the F-15C and F-15E

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Over the last 15 years, the USAF has undertaken an extensive radar modernization program for its fleet of F-15s, developing and testing AESA (Airborne Electronically Scanned Array) radar retrofits for both the F-15C and the F-15E. As these programs move into full production and fielding, we examine the development and test history of each, drawing lessons about how future AESA tests can be conducted more efficiently, safely, and effectively.

The F-15C's APG-63(v)3 radar (hereafter called "V3") began as a classified program that sought to rapidly field a squadron of AESA-capable jets. Testing was rapid and tightly focused, and quickly yielded a basic AESA capability with improvements planned for future upgrades. Follow-on development expanded upon and improved this initial system, and has followed more traditional lines. The F-15E's APG-82(v)1 (hereafter called Radar Modernization Program, or "RMP") has been a traditional hardware improvement program from its inception, and has sought to rapidly develop a system by mating proven antenna hardware from the V3 program with processing hardware and software from the F/A-18's AESA radar.

Both programs' experiences highlighted the fact that traditional radar flight test techniques must be adjusted to account for greatly expanded radar detection ranges, complex onboard radar processing, system waveform selection, and multi-mode capabilities. These factors meant that test efficiency was a major consideration when designing and conducting performance evaluations, especially when multiple target runs were required to generate statistically significant results. Both the V3 and RMP radar programs developed unique procedures and test assets to maximize flight effectiveness.

Although performance evaluation made up a large portion of the flight test efforts, overcoming system integration challenges was another significant part of testing, and was often much harder to plan and execute. This is likely to be true for any aircraft where AESA is added as a retrofit. In the case of the F-15C, radar electrical loads were such that single-generator operations need to be evaluated through specific flight test procedures. In both the F-15E and F-15C, environmental control system modifications required both development and evaluation testing. These test points in particular often required flight at the extremes of the aircraft's design envelope (both in terms of low-speed/high altitude and high-speed). Planning and execution of these test points yielded several lessons that can be applied to increase safety and efficiency in future AESA testing efforts.

Finally, radio frequency interference became a major system integration problem for both systems in the wake of an engineering change to the original V3 antenna hardware. This radio interference problem, the investigation into its source, and the follow-on flight testing required to resolve it highlighted the importance of communication among flight test programs, the sensitivity of high-powered radio frequency systems to hardware modification, and the critical importance of procuring and maintaining dedicated developmental test aircraft.

AESA radar retrofits are likely to become increasingly common as the technology continues to develop and mature. We seek to take the lessons from the F-15C and F-15E AESA programs to ensure future AESA tests are conducted more efficiently, safely, and effectively.