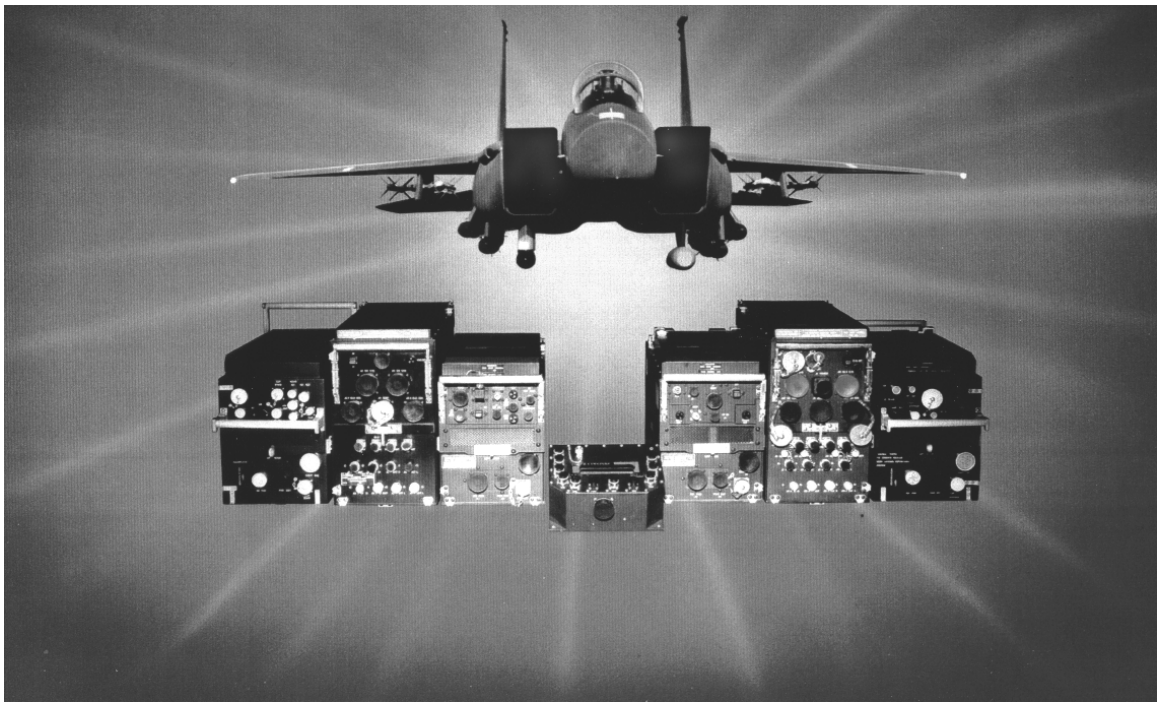
F-15 TACTICAL ELECTRONIC WARFARE SYSTEM (TEWS) (AN/ALQ-135 BAND 1.5)



Air Force ACAT III Program

Total Number of Systems:	162
Total Program Cost (TY$):	$368.7M
Average Unit Cost (TY$):	$2.057M

Prime Contractor

Northrop Grumman

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2020

The F-15 Tactical Electronic Warfare System (TEWS) AN/ALQ-135 Band 1.5 contributes to ***full-dimensional protection*** by improving individual aircraft probability of survival through improved air crew situation awareness of the radar guided threat environment, cueing both active and passive countermeasures in the Band 1.5 frequency spectrum, and adding a waveform select feature for jamming optimization against specific threats. The F-15 TEWS consists of the AN/ALR-56C radar warning receiver, the AN/ALQ-135 internal countermeasures set, the AN/ALQ-128 electronic warfare warning set, and the AN/ALE-40/45 countermeasures dispenser. TEWS provides electronic detection and identification of surface and airborne threats. In addition, it allows for activation of appropriate countermeasures, including electronic jamming and dispensing of expendables such as chaff and flares.

Integral to F-15 TEWS, ALQ-135 is an internally mounted responsive radio frequency jammer designed to counter surface-to-air and air-to-air threats with minimum aircrew activity. The system has an improved reprogramming support capability that rapidly changes pre-flight message software in response to changing threat parameters and mission requirements. ALQ-135 has been fielded in several phases to provide incremental improvements to jamming coverage. The Band 3 version of the ALQ-135

operates against threats at higher frequencies and has been fielded with the F-15E for over 10 years. It allows full interoperability and robust jamming techniques against modern Pulse-Doppler radar threat systems. Currently, there is no ALQ-135 capability against threats operating at lower frequencies. For this reason, the U.S. Air Force has placed high priority on the Band 1.5 program to fill this void. Band 1.5 is completely dependent on Band 3 for signal reception, processing, and interfacing with the rest of aircraft avionics. Future plans call for the integration of a Fiber Optic Towed Decoy (FOTD) to the existing TEWS system. FOTD is based on Integrated Defensive Electronic Countermeasures technology and is currently scheduled for TEWS integration in 2005.

Operational maintenance of TEWS is supported by the incorporation of a Built-In-Test (BIT) system to allow detection and isolation of system malfunctions by maintainers. BIT also functions to ascertain system health and status for the aircrew prior to entering a threat area; it is designed to contribute to ***focused logistics*** aspects of ***Joint Vision 2020*** by implementing a means for aircrew and maintainers to assess confidence in TEWS performance prior to and during a mission.

BACKGROUND INFORMATION

ALQ-135 is an outgrowth of an early 1980s feasibility demonstration and a follow-on quick reaction capability high band jammer developed to counter rapidly changing threats. Since then, there has been a continuing need for the F-15E aircraft to possess a radio frequency countermeasures system to survive engagements with hostile surface-to-air and air-to-air weapon systems. The jamming system must be integrated with other F-15E avionics and be interoperable within multi-ship F-15E flights. A multi-faceted development and test program was established within the constraints of funding and technology. Since most high priority threats are in the higher frequency bands, early priority was placed on the ALQ-135 Band 3 sub-system. Band 3 was initially deployed with the 4th Fighter Wing F-15Es during Operations Desert Shield/Storm.

DOT&E has exercised test oversight only on the TEWS version installed in the F-15E Strike Eagle. Testing conducted under DOT&E oversight was as follows:

- In November 1990, Air Combat Command (ACC) completed an Early Operational Assessment of the F-15E TEWS and identified system problems fundamentally due to the early stage of software development.
- Four years later, in 1994, AFOTEC conducted an Operational Assessment of the F-15E leading to the conclusion that the system would be unlikely to pass IOT&E.
- In 1998, the Band 1.5 DT phase began, but was encumbered by software immaturity and integration problems with Band 3.0.
- IOT&E began in May 1999, and was completed in July 1999. During this period, 38 open-air range test sorties were conducted, accumulating over 84 flight hours (103 operating hours) with numerous re-sets, BIT false alarms, and unexplained in-flight faults. Seven deficiency reports were written by AFOTEC.

In October 1999, as a result of those deficiency reports, the AFOTEC commander de-certified the system from IOT&E, leading to the year 2000 Combined DT/OT and IOT&E (referred to herein as 2000 IOT&E). This effort consisted of Installed System Test Facility (ISTF) operations in the PRIMES anechoic chamber at Eglin AFB, and a series of 55 open-air range sorties at the Eglin AFB Multi-Spectral Test and Training Environment and the Nellis AFB Test and Training Range.

TEST & EVALUATION ACTIVITY

In-plant testing of the new Operational Flight Program (OFP) (version NPT629) was conducted during the period November 1999-February 2000. Based on this testing (including a re-evaluation of BIT performance) at the Northrup Grumman facility in Rolling Meadows, IL, the ALQ-135 was re-certified to enter its year 2000 IOT&E.

The 2000 IOT&E consisted of ISTF operations in the PRIMES anechoic chamber and a series of 55 open-air range sorties at Eglin AFB and Nellis AFB. A total of 109 flight hours (137 operating hours) were accumulated during this IOT&E. Fifteen of the 55 sorties were dedicated to evaluation of the system's contribution to reducing the lethality of SAM systems. Additional test sorties were added as opportunities arose to evaluate effectiveness against air-to-air missile systems. Twenty-eight sorties were run to assess suitability improvements. Three operational aircraft from Nellis AFB, as well as one Eglin AFB instrumented aircraft, participated in this test sub-phase. Twelve sorties were flown at Nellis AFB under operationally realistic conditions involving air-to-ground ordnance release and the use of chaff and maneuvers to accompany active ALQ-135 jamming.

TEST & EVALUATION ASSESSMENT

DOT&E concludes that the system is operationally effective but not suitable (see the B-LRIP report to Congress dated December 2000 for more detail).

Results of the 2000 IOT&E indicate that the ALQ-135 is effective as measured by the system's capability to reduce the lethality of those SAM systems required by Air Combat Command. However, the ALQ-135 threshold criteria for effectiveness was focused only on Band 1.5 and does not address the newer SAM systems.

Effectiveness of the entire TEWS against air-to-air systems and capability to engage multiple high duty cycle type threats remains to be evaluated. The addition of Band 1.5 equipment to the existing TEWS adds value to the self-protection capability of the F-15E and completes the TEWS suite as originally designed.

Reliability, Maintainability, and Operational Availability do not meet System Operational Requirements Document specified thresholds and objectives.

Suitability of the ALQ-135 depends on the capability of the Built-In-Test (BIT) to identify faults, along with the capability to take corrective action in a timely manner. The OFP changes made to improve BIT were ineffective; BIT false alarm rate is 65 percent. The BIT system for the ALQ-135 is the only means available for the aircrew to establish readiness (health) of the system prior to entering a threat area. An excessive false alarm rate (e.g., $\geq$ 20 percent) causes not only an unwarranted number of maintenance actions, but also operates to distract aircrew attention from primary mission functions.

The TEWS system BIT/Integrated Diagnostics capability is totally inadequate and, in operational practice, is ignored because of its unreliability. Based on the data analyzed during IOT&E, it is apparent that F-15E aircrews have a tactical jammer that is: (1) unreliable; (2) unable to diagnose true systems

status/operational capability; and (3) does not provide aircrew adequate cues or confidence of its actual operating status. The lack of a quality, trusted integrated diagnostics and BIT system is unsatisfactory.

Operational Availability (Ao) is a measure of the system's readiness for use when needed (uptime) as compared to total "ownership" time (uptime plus downtime). Ao was 80 percent based on Follow-On DT/OT data compared to the 63 percent estimate achieved during 1999 IOT&E. The Air Combat Command objective for Ao is greater than 96 percent.

An additional shortfall with the TEWS system is a longstanding problem with the ALR-56C Radar Warning Receiver. In a dense signal environment, ALR-56C lacks adequate processing capability, as evidenced by incomplete and/or slow display of threat emitters to aircrews. The lack of timely threat cueing and processor throughput is recognized by the Air Force, but correction of this deficiency awaits higher priority in the F-15E funding program.

RECOMMENDATIONS

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Because the Band 1.5 equipment adds an important capability to the F-15E for operations defended by a widely deployed though older SAM system, Band 1.5 production should continue. However, neither development nor reliability testing of the F-15E TEWS has been adequate. Additional development work on BIT design, and a reliability improvement program and FOT&E on the ALQ-135 is needed. A dedicated IOT&E for the TEWS/Fiber Optic Towed Decoy (FOTD) appliqué, currently scheduled for deployment around 2005, will be required.

Corrective action and further operational testing are required in three areas in order to reduce: latent hardware reliability problems, latent software reliability problems, and BIT performance. In addition, experience with installation of Band 1.5 ship sets into operational aircraft for the 2000 IOT&E indicates that systemic problems will exist as Band 1.5 is installed.

Latent hardware deficiencies should be corrected and tested in order to reduce those that show up intermittently (such as when the system is airborne and not on the ground)—a possible reason for the large number of false alarms. Environmental chamber testing, such as that performed for standard qualification and reliability growth testing, should be conducted at the ALQ-135 system level.

Latent software deficiencies manifested by a high re-set rate (0.46 per hour; 1.2 per sortie) need to be addressed in order to avoid future problems with the FOTD appliqué. This will require that adequate regression and stress testing become institutionalized, in addition to careful monitoring of software performance during the qualification/reliability growth tests recommended above.

Additional development work on BIT design, and a software/hardware reliability improvement program are needed. The F-15E Band 3 system has been in operational use for over 10 years. ACC seems to have accepted its RAM deficiencies, and has placed first priority on completing the ALQ-135 by installing Band 1.5 equipment. However, until the known system deficiencies (jammer outages under threat exposure conditions and inability to maintain consistent BIT performance), the Band 1.5 addition should not be considered fully effective and suitable.

The most immediate area of corrective action is the need to reduce the false alarm rate of the BIT sub-system. This problem erodes confidence in the BIT but more importantly operates to reduce the reliability of the system by inability to distinguish real failures from false alarms. With a non-reliable

BIT, many real failures tend to remain undiscovered as maintainers attribute them to BIT misdiagnoses rather than to specific ALQ-135 components.

A system reliability improvement program and a BIT fundamental design review with updated documentation should be instituted. Such efforts would be advisable as the FOTD is integrated into TEWS. Also, because of the production effects exhibited during year 2000 IOT&E, additional oversight of the contractor's in-plant quality system is needed.