PATRIOT ADVANCED CAPABILITY-3 (PAC-3)

The PATRIOT air defense system that uses guided missiles to engage and destroy air-breathing targets (ABTs) and tactical ballistic missiles (TBMs). PATRIOT Advanced Capability 3 (PAC-3), Configuration-3, is the latest version. A PAC-3 battery will include a multi-function phased-array radar, an engagement control station, and communications relay groups for communicating with remote launchers and the battalion headquarters. Each PAC-3 battery will have eight launchers. Some of the launchers will have four PAC-2 blast-fragmentation warhead missiles, the primary interceptor against ABTs, while other launchers will have 16 new hit-to-kill PAC-3 missiles, the primary interceptor against TBMs. The Army has not yet determined the final distribution.

BACKGROUND INFORMATION

The PAC-3 Operational Requirement Document (ORD) was developed after the Persian Gulf War to improve the PATRIOT system, including a new PAC-3 hit-to-kill missile. Flight testing of the PAC-3 missile began in 1997 and had successful intercepts against three TBMs and two cruise missiles between March 1999 and July 2000.

The PAC-3 Limited User Test (LUT) was conducted during March-June 2000. The LUT revealed serious deficiencies in ground system suitability, as well as major effectiveness issues. These included instances when the system misidentified objects, engaged debris, or failed to engage threatening TBMs. There was a new software drop in September 2000 to correct some of these problems.

TEST & EVALUATION ACTIVITY

LUT regression testing was conducted in 1QFY01 to address the deficiencies in the FY00 LUT.

The PAC-3 DT-6 flight test was performed in October 2000. In DT-6, a PAC-3 missile intercepted a TBM target at the same time that a PAC-2 missile engaged a fixed-wing drone. The PAC-3 TBM intercept was successful, but a missile hardware failure caused the PAC-2 missile to detonate too late to destroy the drone.

The PAC-3 DT-8 flight test was performed in March 2001 (DT-7 flight test occurred in FY00). In DT-8, two PAC-3 missiles were ripple fired to engage one TBM target while one PAC-2 missile

engaged a PATRIOT missile emulating a short-range threat TBM. Both intercepts were successful. The second PAC-3 missile that was ripple fired did not detect and track any debris from the intercept and therefore self-destructed.

The PAC-3 DT/OT-9 flight test was performed in July 2001. In DT/OT-9, one PAC-3 missile destroyed a jamming full-scale fixed-wing target while another PAC-3 missile failed to intercept a TBM target. An electrical anomaly in the missile's communications bus disrupted communications between missile subsystems and prevented homing in on the target for an intercept. This was the first miss for the PAC-3 missile. The root cause of the failure has not been specifically identified, but the symptoms of the failure are known and have been replicated in the software lab. Software modifications have been implemented to reduce the likelihood of this error. The PAC-3 missile that engaged the TBM had a new conductive topcoat, which was developed to increase the radio frequency signal strength received by the missile during flight. The uplink signal power was significantly improved compared to previous flight tests. Another first for the PAC-3 flight test program was that tactical unit soldier crews operated two of the three fire units during DT/OT-9.

The last PAC-3 developmental flight-test, DT/OT-10, was performed in October 2001. In DT/OT-10, a PAC-3 missile intercepted a cruise missile target at the same time that a PAC-2 missile engaged a fixed-wing drone. Both intercepts were successful.

The PAC-3 LFT&E Program concluded the full-scale sled test series with the replication of flight test DT-6 intercept conditions to compare the lethality observed in sled testing to a TBM intercept. Lethality assessments were performed on the flight test targets discussed above and will be performed on all remaining flight test targets. The live fire light gas gun and high-speed sled TBM lethality tests are complete.

PAC-3 Configuration-3+ Developmental Test and Evaluation (CDTE-3+) was conducted in 4QFY01 and 1QFY02 and consisted of large-scale search and track exercises, hardware-in-the-loop tests, and reliability testing. Analysis of the CDTE-3+ data is incomplete, but preliminary results indicate there are several software problems that must be fixed prior to IOT&E.

TEST & EVALUATION ASSESSMENT

The PAC-3 system will not meet all of its Key Performance Parameters (KPP) prior to Milestone III. The Army plans to address these shortfalls in an evolutionary development program. The Joint Requirements Oversight Council has approved this approach but considers the KPPs essential to meet the mission need. Since the PAC-3 system will not meet all of its KPP requirements prior to Milestone III, a Follow-On Test Program (FOTP) is required. The FOTP will consist of flight tests, hardware-in-the-loop ground tests, and field exercises. It is particularly important to plan the FOTP flight-testing to evaluate the missile’s capability against deferred PAC-3 requirements, cost-reduction initiative hardware changes to the PAC-3 missile, and potential reactive threats and threat countermeasures.

Since 1999, the PAC-3 missile has hit five of six TBM targets, three of three cruise missile targets, and one of one drone fixed-wing aircraft target. PAC-3 tests to date have been in the heart of the PAC-3 missile performance envelope, which is where the PAC-3 system is designed to take all engagements possible. DOT&E is asking that the FOTP include engagements closer to the boundaries of the performance envelope. These tests will permit more comprehensive validation of the simulations used to predict the PAC-3 system performance, and thus provides higher confidence in the PAC-3 system performance assessments in areas untested.

There must be funding for additional White Sands Missile Range PAC-3 range safety telemetry frequencies to ensure that at least four PAC-3 missiles can be in flight at one time during a flight test. There are currently only two PAC-3 telemetry frequencies, which prevented a second PAC-3 missile from being fired at the TBM target in DT/OT-9. Tactically, there should have been two missiles fired at the TBM. The program office believes that a second PAC-3 missile would probably have intercepted the TBM despite the failure of the first missile.

The PAC-3 Configuration-3 ground system has had significant reliability problems, but reliability has improved over time. In CDTE-3 (FY99), the fire unit critical mission failure rate was 3.4 times larger than the threshold ORD requirement. During the LUT (FY00), the fire unit critical mission failure rate was 1.7 times larger than the threshold requirement. Preliminary results from CDTE-3+ (FY01) indicate that the reliability has significantly improved again.

Survivability is a critical missile defense system issue. The PAC-3 Configuration-3 ground system must be tested against a live anti-radiation missile (ARM) prior to Milestone III. This test will be used to validate the simulation used to assess whether the PAC-3 system meets its survivability requirement against ARMs.

The LFT&E program against TBMs was robust and characterized the damage inflicted by the PAC-3 interceptor on its threat target set. Lethality testing against air breathing threat surrogate targets was also conducted since they are secondary targets for PAC-3 missile. The LFT&E program has demonstrated that the PAC-3 missile intercept may not kill all warhead submunitions, and that there will probably be some ground effects following an intercept by the PAC-3 missile. DOT&E is working with BMDO to define and develop a ground effects predictive tool, the Post Engagement Ground Effects Model (PEGEM), to help quantify any ground effects.

LESSONS LEARNED

A large part of the success of the PAC-3 missile in flight tests derives from the program office's commitment to mitigating flight test risks through extensive ground testing.

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