LIVE FIRE TEST & EVALUATION

Overview

In FY87 Congress passed Title 10, Section 2366, requiring the Department to conduct realistic survivability and lethality testing of major conventional air, land, and sea platforms, as well as munition and missile programs. The Federal Acquisition Streamlining Act of 1994 moved responsibility for LFT&E from the Under Secretary for Acquisition, Technology, and Logistics to DOT&E. LFT&E is an integral part of DOT&E's evaluation of operational effectiveness, suitability, and survivability of major defense acquisition programs. The LFT&E program goal is to provide a timely and reasonable assessment of the survivability and/or lethality of a system with particular attention to preventing or minimizing crew casualties.

INVESTMENT INITIATIVES

The LFT&E office provides technical and fiscal oversight to several programs related to its statutory responsibilities for survivability and lethality test and evaluation. Through these programs, DOT&E funds testing and evaluation of fielded air, land, and sea platforms, the production of joint munitions effectiveness manuals, and advanced technologies and methodologies to increase aircraft survivability.

From its involvement in the acquisition process and through the investment programs, DOT&E focuses on efforts that are of immediate concern to our deployed forces. For example, in FY04 DOT&E learned that helicopter pilots and crews in Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) were unfamiliar with the launch signature of a rocket-propelled grenade. Enemy combatants were using rocket-propelled grenades, traditionally a ground-to-ground weapon, to attack helicopters. Through the Joint Live Fire (JLF) program, DOT&E funded an extensive three-phase test and evaluation program consisting of firing rocket-propelled grenades against helicopters. The Joint Aircraft Survivability Program assembled video footage of rocket-propelled grenades launches to aid training of deployed forces. Feedback from units that received the training aid indicates it is very helpful in preparing pilots and crews to identify this new threat to helicopters.

During FY04, the U.S. inventory of 5.56mm and 7.62mm ball ammunition became low. To allow time for U.S. production to replenish depleted stocks, the Army decided to purchase ammunition from Great Britain using standard NATO agreements. As part of the Army Materiel Release process, DOT&E reviewed technical specifications and ballistic data from Great Britain to ensure that the munitions purchased provided lethality comparable to U.S.-produced ammunition. In both cases, DOT&E concluded that the British and U.S. munitions were comparable.

There has been much controversy about the lethality of the U.S.'s primary 5.56mm bullet, the M855 ball round, against OEF/OIF enemy combatants. The M855 cartridge, designed in the 1960s, demonstrates significant effectiveness against a medium build, lightly armored combatant. Developmental testing demonstrated the M855 cartridge is the best all-purpose bullet for the M16 family of infantry rifles. However, the OEF/OIF combatants are not of medium build and are not armor protected. Moreover, the M16 family of rifles includes the M4 rifles that have a shorter barrel. These factors combine to decrease the lethality of the M855 in current OEF/OIF theater operations. For the near term, U.S. forces try to overcome the decrease in lethality through good marksmanship and shot discipline. For the long term, DoD should consider a new round to increase lethality.

DOT&E is participating with the Army and with the Special Operations Command in investigating the lethality of the M855 compared to other available ammunitions, and also evaluating new technologies in ammunition manufacturing. The Army funded an effort to standardize ballistic wound test and evaluation. The Army effort will generate data on the performance of over 40 cartridges of various calibers and design. These data may lead to the identification of a projectile that is better suited for engaging a thin, lightly clothed combatant.

JOINT LIVE FIRE PROGRAM (JLF)

OSD initiated the JLF program in March of 1984 to establish a formal process to test and evaluate fielded U.S. systems against realistic ballistic threats. The program continues with emphasis on addressing urgent needs of deployed forces and assisting program managers in the acquisition community. JLF can rapidly fund urgent needs of deployed forces and can quickly execute test programs to address data shortfalls (such as rocket propelled grenade effects against helicopters). JLF also addresses the vulnerability of legacy platforms.

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The JLF program consists of three groups: Aircraft Systems (JLF/AS), Armor/Anti-Armor (JLF/A/AA), and Sea Systems (JLF/SS). Following are examples of projects funded by JLF.

Aircraft Systems Program

- **AH-1 Testing.** JLF investigated the vulnerability of the AH-1 Cobra front-line attack helicopter to the rocket propelled grenade threat. The goal was to identify potential survivability enhancements for this and other helicopter platforms. This effort was the first empirical vulnerability investigation of helicopters to this threat. It also provided information to aid combat mission planning, aid battle damage assessment repair training, provided vulnerability reduction recommendations, and increased aircraft/aircrew survival and effectiveness in combat. Testing examined rocket propelled grenade fuze sensitivity and effects of a near-miss detonation against light-skinned helicopters. The project will culminate in 1QFY05 with tests against an operational helicopter.

- **CH-47 Testing.** JLF is conducting a joint effort with the Cargo Helicopter Program Manager and commercial armor developers to design, manufacture, and qualify a shield that will reduce fuel fires resulting from small caliber projectile impacts on the CH-47D Chinook engine fuel feed shutoff valve. This effort will provide recommendations for more survivable helicopter fuel feed shutoff valves and will increase the survivability of two fielded Army H-47 models and the future production F model.

- **CH-53 Testing.** In FY04 and continuing into FY05, JLF will conduct vulnerability testing against the CH-53 using several threat munitions: 12.7mm armor piercing incendiary (API), 14.5mm API, 23mm API, and high explosive incendiary munitions. Test personnel will perform post-damage endurance testing on dynamic components to evaluate the reduction or loss of dynamic flight load capability.

- **H-60 Testing.** In FY05, JLF will test dry-bay foam vulnerability reduction alternatives, improved gearbox durability, and engine nacelle fire extinguishing effectiveness against ballistic threats. Results of this project will be applicable to all tri-Service H-60 aircraft and to the future production of the Army's UH-60M model.

- **Predator Unmanned Aerial Vehicle (UAV) Testing.** In FY04, JLF conducted system vulnerability testing of a Predator wing. Shot line selection used a Computation of Vulnerable Areas and Repair Times simulation analysis completed in FY03. That analysis identified vulnerable areas in the current Predator design. Other unmanned aircraft programs can also benefit from the lessons learned from this effort.

- **Large Turbofan Engine Testing.** In FY04, JLF initiated a multi-year effort to investigate the vulnerability of the CF6 large turbofan engine to Man-Portable Air Defense Systems. This effort will assess Man-Portable Air Defense Systems damage affects on engine thrust and on safety-of-flight. Test results from this effort will support large aircraft (i.e., C-5, KC-10, and E-10A) operational risk assessments and vulnerability analyses leading to improved warfighter protection.

Armor/Anti-Armor Program

- **Munitions Lethality.** Lethality testing finished against a classified foreign main battle tank to:
  - Assess the lethality of current and developmental U.S. munitions.
  - Acquire empirical data to calibrate current vulnerability methodologies.
  - Provide data to assist field commanders in training on how to engage and defeat the tested threat target.
  - Update Joint Effectiveness Manuals for munitions effectiveness.

- **Fast Air Target Encounter Penetration (FATEPEN) Model Methodology Improvements.** JLF funded testing to compare the results of firing steel fragments into steel and aluminum plates with FATEPEN penetration model predictions. These tests provided data for larger mass (1500-grain fragments) and higher obliquity (70 degrees) impacts identified as data deficiencies during the recent accreditation of the FATEPEN model.

- **Low-Speed Rod Penetration Testing Weapon.** JLF fired munitions containing penetration rods similar in size and mass to rods deployed by the passive attack weapon against various targets. Data from this test supports refinement of the penetration equations used to model low speed rod impacts.

- **Lithium-Ion Battery Vulnerability Testing.** The Future Combat System (FCS) program, among others, is considering Lithium-Ion batteries as a technology for storing energy in hybrid-electric propulsion systems. JLF funded experiments to identify potential vulnerabilities associated with ballistic impacts into these types of batteries and is investigating applicable vulnerability reduction measures.

- **Blast Overpressure Testing on Graphite Epoxy Panels.** JLF conducted blast testing against graphite epoxy panels to generate data to validate engineering lethality predictions and to generate composite response algorithms for a wide spectrum of vehicle types. Program managers can now use these composite materials in the FCS, helicopter system upgrades, and UAVs.

Sea Systems Program

The FY04 Sea Systems Program investigated fire and explosive phenomena resulting from ignition of hydraulic oil mist in submarines. The tests showed the results would usually be catastrophic, once ignited. Mitigation methods using current submarine fire fighting equipment were unsuccessful. Although this type of casualty has not occurred on U.S. submarines in peacetime since World War II, there is some likelihood of occurrence in a combat situation.

The JLF Sea Systems Program also initiated an effort to improve the validation of modeling and simulation technologies for the prediction of a Full Ship Shock Trial. JLF Sea Systems will assess the validation for potential application to the DD(X) and Littoral Combat Ship acquisition programs.

JOINT TECHNICAL COORDINATING GROUP FOR MUNITIONS EFFECTIVENESS (JTCG/ME)

About 40 years ago, the Joint Logistics Commanders chartered the JTCG/ME to serve as the DoD focal point for authenticating munitions effectiveness information on all major U.S. conventional (non-nuclear) weapons. The JTCG/ME disseminates this information via Joint Munitions Effectiveness Manuals (JMEMs). U.S. Armed Forces, NATO, and other allies use JMEMs to plan operational missions, for training and tactics development, and to support force-level analyses. Mission planners extensively used JMEMs in planning and executing combat missions in OEF/OIF. The ability to select the "best" weapon to engage a specific target enhances both weapon effectiveness and the ability to minimize collateral damage. In FY04, the JTCG/ME:

- Enhanced the operational tools and data for the Air-to-Surface Weaponeering System, Joint Anti-Air Combat Effectiveness - Air Superiority, and Surface-to-Surface Weaponeering Effectiveness System JMEMs.
- Generated and distributed weapons effectiveness and target vulnerability data for 60 new or updated targets prioritized by the Combatant Commanders.
- Continued expanding existing databases to incorporate newly fielded weapons.

- Continued the development of standardized operational tools and methodology for Air-to-Surface, Surface-to-Surface, and Anti-air effectiveness calculations.
- Conducted Configuration Management/Verification, Validation, and Accreditation efforts on specific JTCG/ME models.
- Coordinated with Joint Chiefs of Staff to develop instructions to codify the Combatant Command requirements data call process and prioritization to support the FY05 JTCG/ME program.

JOINT AIRCRAFT SURVIVABILITY PROGRAM (JASP)

The Joint Aeronautical Commanders Group established JASP by Charter in January 2003 through the integration of the JTCG on Aircraft Survivability, the Joint Live Fire Aircraft Systems program, the Joint Combat Assessment Team, and the Joint Accreditation Support Activity. The program focuses on establishing aircraft survivability as a design discipline and furthering aircraft survivability research, development, test, and evaluation. The JASP:

- Develops vulnerability and susceptibility reduction technologies.
- Provides standard accredited models to assess aircraft survivability.
- Supports combat survivability education.
- Collects combat damage data for analysis.
- Conducts Joint Live Fire tests on combat aircraft.

In FY04, JASP worked with the defense acquisition community, the Department of Homeland Security, the Federal Aviation Administration, the Transportation Security Administration, and the National Aeronautics and Space Administration, to identify critical issues regarding aircraft survivability. Accordingly, JASP funded approximately $8.3M for 60 survivability projects.

- **Vulnerability Reduction:**
  - The Rocket Propelled Grenade Launch and Detonation Video project provided standard, Night Vision Goggles and Forward Looking Infrared video footage showing the signatures of rocket propelled grenades to forces deployed in Iraq, continental U.S. training centers, and the Joint Combat Assessment Team for threat identification training and assessment. The JASP completed this effort in June 2004 in response to a request from the Commander of Marine Aircraft Group 16 to support Marine Aviation units.
  - The Intumescent Instant Firewall project will optimize and demonstrate technologies that form low-cost and lightweight instant firewalls for the control, containment, and management of fire in aircraft compartments.
  - The Air Vehicle Armor Enhancement project will provide enhanced armor package options for the CH-53 and AH-1 helicopter programs.

- **Survivability Assessment:**
  - Developed new vulnerability assessment tools that are modular, physics-based packages the Services can incorporate into their latest vulnerability architectures.
  - Coordination continued with the JTCG/ME and the Services on a set of standard penetration equations for fragments that will be credible over a wide range of impact conditions.
  - The Integrated Survivability Assessment project improved the capability to use operational test data, Live Fire Test data, and modeling and simulation, to develop a more comprehensive survivability assessment of a system.

- **Susceptibility Reduction:**
  - The Common Service Exciter project continued development of a jammer exciter that has 800 MHz of instantaneous bandwidth to jam threat radars effectively. The Common Service Exciter has agilities to support Navy and Air Force needs relating to stand-in jamming and self-protection of UAVs.
  - The Reactive Infrared Suppressor project developed a capability that provides significantly greater signature reductions than current systems.
  - The Affordable Visible Missile Warning System project researched technologies to detect the launch of portable shoulder-fired missiles and to reduce the cost by an order of magnitude over current infrared and ultraviolet sensor systems.

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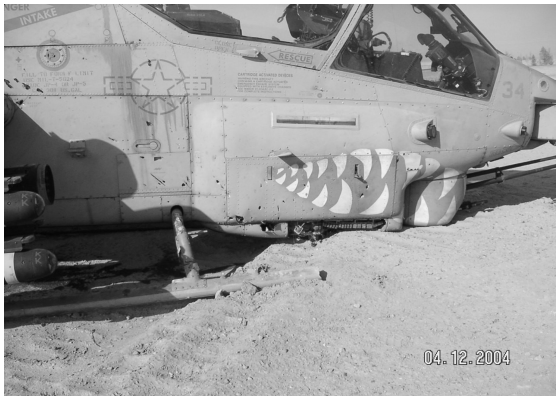
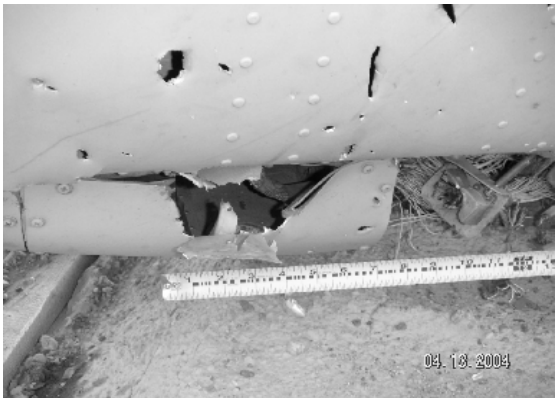
The Joint Combat Assessment Team (JCAT) deployed to OIF in FY04 in direct support of the 3rd Marine Aircraft Wing. Their primary task was to capture perishable data on U.S. fixed- and rotary-wing aircraft, and to ascertain what threats caused the damage. The JCAT accomplished this by inspecting aircraft, acquiring available documentation, and interviewing aircrew and intelligence, weapons and tactics, and logistics personnel. This effort provided valuable information to commanders in OIF, allowing them to make changes to their tactics, techniques, and procedures based on the actual threats encountered. The photographs below show ballistic damage to a Cobra helicopter.





LFT&E investment initiatives, along with Service LFT&E programs, have helped to increase the survivability of our warfighters.