ASSESSING EFFECTS OF LIVE FIRE ON THE ENHANCED M1A2 TANK

Mike Cast

Introduction

As the Army transforms itself for the 21st century by developing a "system-of-systems" that interoperates seamlessly on the battlefield, it is also adding digital-age enhancements to fielded weapon systems such as the Abrams M1A2 tank.

In 1994, the Army contracted General Dynamics Land Systems (GDLS) to design system enhancements to the M1A2. In 1995, GDLS was awarded another contract to supply 240 of the enhanced M1A2s, with delivery scheduled to begin in 1999. The resulting M1A2 Systems Enhancement Package includes an embedded version of the tank commander's display unit for color digital terrain maps, an improved thermal-imaging sighting system that gives the tank gunner increased range, and an improved system for managing the tank's temperature. The enhancement package also includes improved data processing, an enhanced position-location reporting system, a radio-frequency digital communications system, and an improved crew intercom.

Component Vulnerability

Adding the new components to the M1A2 made it necessary for the Army to evaluate its vulnerability to threats the tank might encounter. The Army Developmental Test Command's Aberdeen Test Center (ATC), the Army Research Laboratory (ARL), the Army Evaluation Center (AEC), the Army Ordnance Center and School (OC&S), and other Army organizations are working as a team to conduct live-fire vulnerability tests on the enhanced M1A2.

ATC prepared a detailed test plan and will prepare a final report on the live-fire tests, which began in October 2000 at ATC ranges at Aberdeen Proving Ground (APG), MD. As the tester, ATC controls the ranges used for 16 shots that will provide data on ballistic threats; the data-collection instrumentation; operation, maintenance, and repair of test systems; data collection and documentation; and transmittal of data to supporting agencies and the test "customer"—the Army Training and Doctrine Command (TRADOC) Systems Manager/Abrams Tank System. ATC also conducts post-shot inspections and reviews data and damage assessments as a member of the Damage Assessment Team.

ARL's Survivability/Lethality Analysis Directorate (SLAD) prepares a pre-shot predictions report and M1A2 damage assessment list, a tool used to determine how shot damage can affect systems operations. SLAD also collects various test data and assesses probable crew casualties, vehicle vulnerability, and loss of vehicle mobility and firepower. SLAD helped prepare the test plan and will assist in preparing the final report. Additionally, SLAD chairs the Damage Assessment Team, which includes TRADOC representatives and a team from the OC&S. SLAD is also preparing a detailed damage assessment report.

AEC is the lead for independently evaluating test results and for preparing the live-fire test and evaluation strategy, the event design plan, and the system evaluation report. AEC also reviews ATC's test plan, observes testing, and evaluates damage assessments and the final test report.

The OC&S team prepared a battlefield damage assessment and repair (BDAR) support plan, a key part of ATC's test plan. The team also conducts, documents, and prepares an evaluation report of BDAR, which is included in the final test report.

Complex Assessment Process

According to Paul Kuss, SLAD System Leader for the Abrams Tank System, the damage assessment process can be complex because the analysis of shot damage must cover a broad spectrum of interactions between threat and target at component, subsystem, and system levels. He also said that the process involves thorough planning, accurate data review, detailed analysis, and comprehensive reports covering test results and damage assessment.

In developing the live-fire strategy, AEC chose munitions that posed a credible threat, based on historical anecdotes. These included munitions that penetrate or perforate armor to produce ballistic shock, blast, and fragmenting or spalling effects. Some of the munitions detonate above the vehicle rather than on impact, and some test shots involve static detonations rather than firing projectiles from a gun.

"The intent is to ensure that, with the new digitized components, there is no degradation in the M1A2's survivability," said AEC's Lawrence Kravitz, who chairs the Army integrated process team (IPT) for planning, conducting, and evaluating live-fire tests. He also said the tests are part of four phases proposed in the overall evaluation strategy. With 16 shots, AEC is trying to sample the universe of threats against the tank and relate them to components that may be vulnerable.

Testing Various Configurations

ATC is not only testing fully operational M1A2s, but also lesser configurations that are sufficient for determining the effects of live fire on various components. Most of the tests are conducted at ATC's Vehicle Vulnerability/Survivability Test Range. ATC's high-tech Depleted Uranium Containment Facility, also known as the "superbox," was used for some shots.

Kravitz said that knowing the vulnerability of components to live fire is important because the failure of even a single item can impair the tank's ability to operate. Testing at ATC is designed to enable evaluators to assess how

An M1A2 with Systems Enhancement Package takes a hit at an ATC range.

damage to one component or system in the tank could adversely impact the operation of other components. Kravitz explained, "That means looking at a criticality analysis or some kind of functional diagram of the vehicle and trying to imagine how a component's failure could affect other components electrically, mechanically, or hydraulically." ARL does the associated modeling and, after the test is completed, refines the model based on the demonstrated results.

Predictions Refine Testing

According to Kuss, before any munitions are fired or detonated, ARL's SLAD makes pre-shot predictions based on carefully calculated constructed component-level vulnerability models and/or engineering test experience. These predictions help testers structure live fire to obtain data with an optimal use of test resources. Additionally, the predictions help determine the spare parts needed to repair damage so that further testing can be conducted without delay.

The prediction process started a year or two before the live-fire execution. Although the IPT began to form in mid-1997, prior to that time, the program manager tasked SLAD to determine whether a live-fire program was needed. An engineering analysis was performed, but some questions couldn't be answered because the effect of design changes on the vulnerability of the system was not known.

The Damage Assessment List developed with TRADOC's input relates damage from testing to various "kill" categories. A kill indicates a loss in function shortly after sustaining damage that cannot be repaired by a crew on the battlefield. A *mobility kill* means the tank would become incapable of executing controlled movements; a *firepower kill* indicates loss of ability to provide controlled direct fire; a *command-and-control kill* indicates loss of command-and-control functions; a *tactical kill* indicates loss of tactical functions; and a *catastrophic kill* means the tank sustained severe damage that couldn't be economically repaired.

Although M1A2 enhancements raised questions, previous test programs helped the Abrams tank incorporate improvements that reduced its vulnerability as it developed into the present weapon system. Transitioning from the M1A1 to the M1A2, the Army significantly reduced ballistic vulnerability by adding dual, redundant components and data buses and distributing electrical power systems so all power controls were not in one place, Kuss concluded.

Testing BDAR

Kravitz noted that an important element of the test program was assessing the crew's ability to repair damage on the battlefield and to keep their tank in the fight. In fact, a goal of TRADOC—which is a participant in the live-fire tests—is to provide battlefield damage repair and recovery. TRADOC's role is to help the Army assess a crew's ability to repair a tank damaged by enemy fire, as well as test and refine standard procedures for battlefield damage assessment and repair.

After each shot, a report is prepared and incorporated with the information from ATC and ARL. The main objective is to get the tank back into the battle. At a minimum, it should have a "limp-home" capability. Now, with the Brigade Combat Team and "fast-fix forward," BDAR is going to play a much larger role than it has previously.

Conclusion

Lessons learned from live-fire testing on the M1A2 should be applicable to similar weapon systems. Said Kravitz, "With the particular model of tank that we're testing, we try to generalize and incorporate modifications or survivability enhancements into the whole universe of tanks. We also try to communicate the nature of the test program here, the nature of the threats to this vehicle, and aspects that should be considered in other test programs."

MIKE CAST is a Public Affairs Specialist with the Army Developmental Test Command at APG. He has a B.S. degree in journalism from Arizona State University. For nearly 20 years, Cast has held various Army positions in writing, editing, and photography.
