

**Statement of Jim Schoppenhorst,
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Before the

**House Armed Services Committee's Subcommittee
on Projection Forces**

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**House Armed Services Committee's Subcommittee on Projection Forces
Hearing: Jim Schoppenhorst; Director, DD(X) Program
BAE Systems / Armament Systems Division**

INTRODUCTION

Mr. Chairman and distinguished members of the Subcommittee, thank you for the opportunity to report on the development status of our weapon systems for DD(X). BAE Systems/Armament Systems Division is responsible for the development of the Advanced Gun System (AGS) and its Long Range Land Attack Projectile (LRLAP). In partnership with Raytheon, BAE Systems is co-developing the Mk 57 Advanced Vertical Launch System. We are also responsible for the Close-In Gun System (CIGS), which is the Mk 110 57-mm gun. Since AGS and LRLAP are key Engineering Development Models (EDMs) of the current phase of the DD(X) program, I will focus this discussion on their status.

The AGS weapon system includes the 155-mm vertical load gun, 300-round automated magazine, LRLAP, its associated propelling charge, and integrated system control, including fire control. Two AGSs per DD(X) comprise the main battery on the DD(X) class of ships. Features of the gun and magazine include:

- vertical load operation
- 10 rounds per minute rate of fire
- no operational manning
- electric drive throughout
- liquid cooled barrel
- low signature weather shields
- 300-round automated magazine with inventory control
- modular magazine design
- ammunition re-supply rate of 240 rounds per hour
- palletized ammunition
- system response time in seconds

The AGS is the US Navy's first large caliber electric drive gun. The development of electric drive leverages work done for the Army's Future Combat System (FCS) program and prior Crusader program. Electric drive removes hydraulic components, greatly reduces part count, reduces cost and increases reliability. Incorporation of the water cooled barrel allows AGS to fire at 10 rounds per minute continuously for the depth of the magazine while minimizing barrel wear. The innovative vertical load design significantly reduces part count and system weight while increasing reliability. Our automated magazine design employs redundant shuttles to move pallets of LRLAP rounds to the gun system. All magazine components are housed in a modular structure supplied fully tested to the shipyard for a drop-in installation. This modular, drop-in magazine design significantly reduces ship construction cost. The implementation of palletized ammunition reduces life cycle support and inventory management cost. The integrated control system lets AGS initiate fire missions in tens of seconds in support of troops under fire.

LRLAP is an advanced 155-mm munition being developed for the AGS. Features of the LRLAP include:

- Global Positioning System (GPS) guided navigation and control
- Maximum range of 83 nautical miles
- Rocket assisted, range extension glide
- Forward canard-actuated flight control
- Unitary warhead with lethality equivalent to a USMC's M795
- Six LRLAP multiple rounds simultaneous impact per gun

LRLAP uses a GPS-aided Inertial Navigation System (INS) and proven forward canard system to attain very precise accuracy. This precision and flight control will give DD(X) the capability to conduct surgical strikes, mass fires, scale response to targets, and sustain suppression.

EDM PROGRAM STATUS

The AGS EDM program covers a 37-month period, from August 2002 through September 2005. The AGS EDM is an initial prototype and is 1 of 10 EDMs being designed, built, and tested concurrently in this phase (Phase 3) of the DD(X) program. These EDMs are specifically designed to reduce risk and mature DD(X) technologies. To date, the AGS EDM design has been completed, material procured, systems fabricated, and factory testing completed.

Schedule Performance

All AGS and LRLAP EDM milestone events have been successfully completed on schedule. The major events are:

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| ➤ AGS EDM Preliminary Design Review | March 27 -28, 2003 |
| ➤ LRLAP System Requirements Review | June 26, 2003 |
| ➤ AGS System Preliminary Design Review | September 24-25, 2003 |
| ➤ AGS EDM Critical Design Review | December 8-9, 2003 |
| ➤ LRLAP Warhead Preliminary Design Review | August 4, 2004 |
| ➤ Milestone B Guided Flights | February 24, 2005 |
| ➤ AGS System Critical Design Review | April 6-7, 2005 |
| ➤ LRLAP Preliminary Design Review | May 4-5, 2005 |

The final milestone for AGS is the land-based 56-round test firing scheduled for late July. This test will demonstrate the rate of fire of 10 rounds per minute in both the gun and the magazine. We have already confirmed 10 rounds per minute using modeling and simulation and single axis and multi-axis testing.

In the EDM phase, LRLAP will complete two more guided flights, guided flight #6 in late July and guided flight #7 in late August, demonstrating range beyond 70 nautical miles.

BAE Systems has successfully met all requirements for Milestone B approval and entry into the next program phase.

Cost

On the current contracts, both AGS and LRLAP are on track to complete the EDM phase on budget. With only 3 months to go in this phase of the program, spending is 93% complete. Costs incurred to date for the EDM have been used to support Navy cost estimates for DD(X).

EDM TECHNICAL STATUS

The AGS EDM objectives are to reduce risk associated with rate of fire and progress the design towards the tactical design. BAE Systems EDM efforts focused on the major moving parts of the gun mount and magazine. The EDM contains at least one of every major moving part.

Design Maturity

Throughout its development, the AGS program has leveraged the extensive modeling and simulation capabilities of BAE Systems to analyze requirements, assess concepts, and perform comprehensive testing in a virtual environment. This has enabled engineers to assess and mitigate risks in an operational context early in the design process, prior to committing to hardware. Throughout development, BAE Systems has tracked risk mitigation through the DD(X) risk management program. At the completion of the EDM phase, all risks have been reduced to low to medium with all high risks retired.

Our engineers use Computer Aided Design (CAD) systems to complete this hardware design process. As drawings are complete and software is designed, they are tested in the virtual environments prior to hardware production. Throughout EDM development and test, we have demonstrated the fidelity of the virtual prototype to the actual hardware. As a result, all of the key AGS technologies meet the technical readiness levels required for DD(X) and are sufficiently matured at this stage of the program.

EDM Test Completion Details

The proof of success of any development program is the success of the testing phase. The test program for AGS and LRLAP was modeled after the successful Mk 45 Mod 4 program and used an interactive process to ensure all system elements worked as designed. The gun and magazine were first tested in the simulation lab (as described above). This was followed by component testing as the EDMs were fabricated.

The listing below describes the motion and operation tests in the factory:

<u>Gun Completion</u> 2/10/05	<u>Magazine Completion</u> 1/20/05	Single Axis Tests – test proper motion of each actuator and drive
3/7/05	2/4/05	Multiple Axis Tests – test proper integrated motion of simultaneously moving subsystems
<u>Gun Completion</u> 5/1/05	<u>Magazine Completion</u> 4/12/05	Sequencing tests – ensures major subsystems meet timing requirements
5/10/05	5/20/05	Factory acceptance tests – complete operation in factory of gun and magazine separately
7/05		Gun proof fire tests/Dugway – test gun system to proof pressure
<u>System Test Completion</u>		Integrated gun and magazine testing/Dugway – ensures proper operation of gun and magazine EDMs
7/13/05		- 8-round live first test
7/22/05		- 56-round line fire test

To date, all tests have been successfully completed on schedule.

The LRLAP testing program has followed a very disciplined approach. The key elements were the establishment of extensive laboratory modeling and testing capabilities and extensive testing of subsystems prior to guided flight testing. Subsystem testing proved the performance of these key subsystems:

- Airframe
- GPS and navigation systems
- Rocket motors
- Control electronics and actuators
- Warhead

Once successfully tested, their configuration was controlled and we proceeded to successful all up round Guided Flight (GF) testing. A summary of the last four guided flights (GF-2 through GF-5) and the remaining guided flights (GF-6 and GF-7) is shown below.

<u>Flight</u>	<u>Date</u>	<u>Results</u>
GF-2	1/27/05	Successfully guided flight to aimpoint - range 32 nmi
GF-3	2/24/05	Repeat of GF-2 demonstrated repeatability
GF-4	6/16/05	Successful command guided flight to 59 nmi
GF-5	6/29/05	Success guided flight to aimpoint – range 46 nmi
GF-6	7/25/05	Planned for guide to aim point – range 63 nmi
GF-7	8/25/05	Planned for guide to aimpoint – range nmi

This summary shows that LRLAP testing has been very successful and demonstrates the ability of the AGS to deliver the required capability.

DETAIL DESIGN AND PRODUCTION PHASE

As we enter the next phase of AGS development, we will complete detail design of various AGS components and move into production. Components of the gun requiring completion of detail design are the weather shield, fixed shield, off-mount cooling, train actuator, and stand bearing assembly.

In the magazine EDM, a large majority of component designs were completed and tested. The remaining components to design are the module magazine structure, pallet assembly, projectile initialization hardware, and pallet identification system.

Detail design efforts also include ship integration and interface management. Minor producibility and reliability enhancements, resulting from EDM lessons learned, will also be incorporated.

Production Program Plans

In support of planning the DD(X) Phase IV program, we have developed preliminary production schedules for AGS. We have scheduled production of four guns and four magazines on a timeline allowing deliveries to each shipyard in support of the Navy's proposed dual lead ship acquisition approach. This production cycle starts in June 2006 with material procurement and completes in November 2009 with delivery of magazine number four.

INDUSTRIAL BASE CONSIDERATIONS

BAE Systems/Armament Systems Division currently employs 295 highly skilled technical employees for development of DD(X) systems with 250 of those working on AGS, including LRLAP. The vast majority are engineers with a minimum of a Bachelors degree in Mechanical, Electrical, or Software Engineering; roughly 20% have a Masters degree or higher. Not only are the employees well educated, but they have on average approximately 10 years of experience in the design, production, test, and support of naval weapon systems (gun mounts, automated magazines, guided projectiles, propelling charges, and launching

systems). The vast majority of our technical leadership team has both advanced degrees and more than 20 years of directly applicable experience. A similar capability in naval gun system development does not exist anywhere in the country. Significant program delays will result in loss of this capability.

BAE Systems has the only medium to large caliber naval gun manufacturing facilities in the United States. In particular, our plant in Louisville, Kentucky, currently assembles and tests the Mk 45 Gun Mount. As production ends on the Mk 45 gun mount, it will be replaced by AGS production. Production work will begin in Louisville starting in 2008. In addition to the AGS workscope, BAE is also in the process of transitioning the final assembly and test of the Mk 110 57mm CIGS from Sweden to our Louisville facility. The AGS and CIGS production lines will be taking advantage of our Louisville employees' naval gun experience. Without the DD(X) program, our Louisville facility will have a significant reduction in workload.

COST SAVINGS MEASURES

From program inception, the AGS has been developed with affordability as a goal. Many cost reduction initiatives have been implemented to date:

- Vertical load gun design eliminated the gun cradle component, reducing weight approximately 90,000 pounds per gun, and reducing the number of components by over 300 parts per gun.
- Completely automated magazine and gun mount operation decreases shipboard manpower requirement.
- Modular magazine delivered to shipbuilders completely outfitted, tested, and ready for installation, reducing ship construction time. Unitary module replaces delivery of 1,300 components.
- Electric drives replace hydraulics reducing system weight, reducing maintenance spares and costs.
- Working closely with shipbuilders, the gun design is optimized for shipboard installation.

The LRLAP has also been developed with affordability as a goal. LRLAP has integrated several components and subsystems from existing and future production programs. Examples of these are:

- The Deeply Integrated Guidance Navigation Unit being developed under the U.S. Army's Common Guidance program.
- The Canard Control Unit leverages control electronics from the Guided Multiple Launch Rocket System and the U.S. Army Tactical Missile System.
- The warhead uses a similar design, several common components, and fabrication processes employed on warheads for Excalibur and 5-Inch Extended Range Guided Munition projectiles.

As we go forward, we continue our producibility and material studies pursuing reduced costs. We continue to challenge subcontractors for similar cost savings.

SUMMARY

The Advanced Gun Weapon System is a key component of DD(X) and will greatly increase the U.S. Navy's ability to provide fire support of forces ashore. With AGS, DD(X) will have rapid response, all-weather fires capability 24 hours a day, seven days a week. The precision of LRLAP allows surgical removal of threats with lethality sized to the target. DD(X) will deliver a three-fold increase in Naval Surface fires and two DD(X)s will deliver the approximate fire power of an artillery battalion, meeting the USMC fire support requirements.

Although the AGS EDM development program has had many technical challenges and a demanding schedule, our design team has successfully met program objectives. Through modeling and simulation and extensive hardware testing, we have validated system performance and shown that required war-fighting capabilities will be achieved. BAE Systems look forward to completing our work on this important program and delivering these needed capabilities to the U.S. Navy.