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The Honorable James M. Talent
Chairman
The Honorable Edward M. Kennedy
Ranking Minority Member
Subcommittee on Seapower
Committee on Armed Services
United States Senate

The Honorable Roscoe G. Bartlett
Chairman
The Honorable Gene Taylor
Ranking Minority Member
Subcommittee on Projection Forces
Committee on Armed Services
House of Representatives

Subject: *Progress of the DD(X) Destroyer Program*

The Navy is developing a new destroyer, the DD(X), to serve as a next-generation multimission surface combatant ship. It will provide advanced land attack capability to support forces ashore and contribute to military dominance in shallow coastal water environments. To reduce program risk and demonstrate the ship's 12 technologies, the Navy is building 10 engineering development models that represent the ship's most critical subsystems. This approach is intended to improve the assessment of these key subsystems by designing, developing, and testing working models early in the process.

In September 2004, we reported that while the engineering development model process could be beneficial, the program's schedule does not allow enough time to acquire appropriate levels of knowledge before key decisions are made. We also reported that some of the engineering development models were progressing according to plan, but others faced significant technical challenges.

This letter provides an update on the progress of DD(X) subsystems, as demonstrated by recent tests and design reviews of the engineering development models. Our review concentrated on five of the ten engineering development models. These five development models were chosen because of their importance to the overall ship design, congressional interest in specific models, or the occurrence of recent test events. We provide more limited information on the remaining five development models. We conducted our work under the Comptroller General's authority and are addressing the report to you because of your subcommittee's jurisdiction on the issues discussed in this report.

Background

The program currently is approaching two key decision points. One is Milestone B, when the Navy will decide on whether to authorize the award of a detail design and construction contract for production of the lead ship(s). In an August 2004 memorandum to the Secretary of the Navy, the acting Under Secretary of Defense for Acquisition, Technology and Logistics detailed specific exit criteria to be met before Milestone B. Milestone B was planned for March 2005 but has been delayed several times and is now expected to take place before the end of the fiscal year.

In addition to the Milestone B decision, the program will complete a critical design review by August 2005. This review is intended to demonstrate the design maturity of the ship and its readiness to proceed to production.

To develop and test the ship's twelve critical technologies, the Navy is building ten engineering development models that represent the ship's most critical subsystems. The development models are described in Table 1.

Table 1: Description of Engineering Development Models

Engineering development models	Description
Advanced gun system	Will provide long-range fire support for forces ashore through the use of unmanned operations and the long-range land attack projectile.
Autonomic fire suppression system	Intended to reduce crew size by providing a fully automated response to fires.
Dual band radar	Horizon and volume search improved for performance in adverse environments.
Hull form	Designed to significantly reduce radar cross section.
Infrared mockup	Seeks to reduce ship's heat signature in multiple areas.
Integrated deckhouse and apertures	A composite structure that integrates apertures of radar and communications systems.
Integrated power system	Power system that integrates power generation, propulsion, and power distribution and management.
Integrated undersea warfare system	System for mine avoidance and submarine warfare with automated software to reduce workload.
Peripheral vertical launch system	Multipurpose missile launch system located on the periphery of the ship to reduce damage to ship systems.[a]
Total ship computing environment	Provides single computing environment for all ship systems to speed command while reducing manning.

Source: DD(X) program office and contractors.

[a]The Navy refers to both the enclosure for the launcher and the full subsystem as the Peripheral vertical launch system.

As a baseline for assessing developmental progress and for informing decision making, the program has established two sets of quantitative metrics, one for the ship as a whole, referred to as performance parameters, and one for the engineering development models, referred to as critical technical parameters. According to the DD(X) program's test and evaluation plan, "failure to achieve a critical technical parameter should be considered a reliable indicator that the system is behind in the planned development schedule or will likely not achieve an operational requirement."

Summary

The DD(X) program's demonstrations and component tests met the exit criteria for its engineering development models established by the Undersecretary's August 2004 memorandum. While progress has been made, the level of technology maturity demonstrated remains below what is recommended by best practices, as outlined in our September 2004 report. Tests of several engineering development models resulted in successful demonstration of exit criteria. In other cases, tests identified technical problems that will need to be overcome before ship installation or that have led to changes in the ship design. The permanent magnet motor, a key element of the integrated power system, failed tests, and was replaced by the advanced induction motor. Because the Navy maintained the induction motor as a fallback technology, the integrated power system was able to meet the exit criteria. The substitution of the advanced induction motor does change the noise, weight, and space usage of the power system, which could have implications for the ship design. The multifunction radar, a segment of the dual band radar, successfully completed the land-based testing described in the exit criteria, but the volume search radar has encountered technical problems with a key component. The integrated deckhouse and apertures development model will soon begin testing for antenna placement and radar cross section. Questions about the properties of the proposed component materials are delaying production of an article for fire and shock testing. The advanced gun system demonstrated exit criteria through modeling, and additional component tests have verified this performance. An early failure in required munitions flight testing was overcome, and two further flight tests have been completed successfully. Tests of the peripheral vertical launch system led to a redesign effort; tests to determine the suitability of the new design will complete in June 2005. Additional information on these five engineering development models is presented in enclosures I to V. The status of the other five engineering development models is discussed in enclosure VI.

Weight is a challenge for individual subsystems and the ship as a whole. The integrated power system, advanced gun system, and integrated deckhouse all have encountered problems staying within weight limits. These problems have contributed to overall weight growth in DD(X). As a result, the current design is slightly over the margin reserved for weight in the system development phase, which ends with critical design review in August.[1] A number of key events to demonstrate technology will occur near the end of this phase, and it remains to be seen whether they will have any impact on weight. Other elements of the design for certain subsystems, including space issues for the power system and materials issues on the deckhouse, remain unclear. These challenges could result in changes late in design or during construction, leading to higher costs.

[1] There is additional margin for weight in later phases of design that allow for growth.

Agency Comments and Our Evaluation

The Department of Defense reviewed a draft of this letter and provided technical comments which we incorporated as appropriate. Their response is included as Enclosure VII.

Scope and Methodology

To complete our review, we examined the DD(X) program's operational requirements document, test and evaluation master plan, developmental test reports, early operational assessment, and risk management plan. We supplemented this information with discussions with Navy program and test officials as well as key contractors. In addition, we visited selected facilities to further enrich the quality of our analysis. We conducted our work between January and June 2005 in accordance with generally accepted government auditing standards.

We are sending copies of this letter to the Honorable Donald H. Rumsfeld, Secretary of Defense; the Honorable Gordon R. England, Secretary of the Navy; and interested congressional committees. We will make copies available to other interested parties upon request. In addition, the letter will be available at no charge on the GAO Web site at http://www.gao.gov.

Please contact me at (202) 512-4841 if you or your staff have any questions concerning this letter. Other major contributors to this letter were Karen Zuckerstein, J. Kristopher Keener and Marc Castellano.

Paul L. Francis, Director
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Enclosures

Enclosure I: Integrated Power System

Summary

Design of the propulsion and power distribution systems has changed significantly. Due to problems discovered in component testing, the advanced induction motor will be used in the design instead of the permanent magnet motor, which will alter the ship's layout and increase weight.

Description

The integrated power system centrally generates and distributes power to the ship for all functions, including propulsion. This design allows greater flexibility in power use and will allow the integration of high energy weapons in the future. The integrated power system consists of three primary components: turbine generator sets, a power distribution system, and propulsion motors. A significant technical challenge is development of propulsion motors which are used to turn the shaft and propeller. To reduce risk the program is carrying two designs of propulsion motor, the permanent magnet motor and the advanced induction motor.

Table 2: Performance Parameters Relating to Integrated Power System

Performance parameters	Threshold	Objective
Speed — rate at which the ship travels	30 knots	30+ knots
Endurance — nautical miles the ship can travel	4500 nm	6000 nm
Acoustic signature — low noise to avoid detection	Classified	Classified
Survivability — ability to produce power when damaged	Identify and isolate faults, supply power as user requires	Steady state power at set rate with one or more faults

Sources: U.S. Navy (data); GAO (analysis and presentation).

Table 3: Critical Technical Parameters Relating to Integrated Power System

Critical technical parameters	Description	Demonstrated?
Generator no load open circuit voltage	Ability of turbine generator sets to produce amount of power needed	Yes
Generator full rated current at rated speed	Ability of turbine generator sets to produce rate of power needed	Yes
Motor and drive rated speed at rated voltage	Ability of propulsion motor to produce power needed to turn shaft	Yes
Main turbine generator set fuel consumption at endurance load	Amount of fuel needed by turbine generator set to reach endurance	Future
Propulsion motor torque at maximum rated speed	Ability of propulsion motor to turn shaft and produce speed	Future

Sources: U.S. Navy (data); GAO (analysis and presentation).

Progress of Engineering Development Model

In order to complete Milestone B for DD(X) the integrated power system was required by the August 2004 memorandum to complete factory acceptance testing[1] on a number of critical components. All the required tests have been performed and met expectations, with the exception of the permanent magnet motor.

Table 4: Schedule of Key Events Relating to Integrated Power System

2004	2005	2006 and beyond
October: Main turbine generator set factory acceptance test	**January**: Auxiliary turbine generator factory acceptance test	**To be determined**: Full power load test
October: Advanced induction motor factory acceptance test	**January**: Permanent magnet motor test failure	**To be determined**: Integration and testing with ship control system
November: Auxiliary turbine generator factory acceptance test	**July-September**: Land-based testing of integrated power system	

Source: U.S. Navy.

The program has completed initial testing on propulsion motors for DD(X). The program is carrying two designs of propulsion motor, the permanent magnet motor and the advanced induction motor. The program prefers to use the permanent magnet motor due to its ability to meet requirements with less weight and noise, but was carrying the advanced induction motor as a backup. Recently, the permanent magnet motor failed to demonstrate the speed needed to produce the required power. The advanced induction motor tested successfully in October 2004 and has now been selected as the propulsion motor for DD(X). This change has implications for design as the advanced induction motor is heavier and less efficient than the permanent magnet motor and will require more space. The change to advanced induction motor also has implications for testing scheduled for this summer. As these tests were designed to use both propulsion motors, it is unclear whether the same knowledge can be gained with just the advanced induction motor. The program manager has stated that there is the possibility of reintroducing the permanent magnet motor should it resolve its problems.

Factory acceptance tests on turbine generators were performed to demonstrate their ability to produce the power needed for DD(X). The design for DD(X) requires two main turbine generators and two auxiliary turbine generators which are tested to similar requirements. The main turbine generator set, a Rolls-Royce MT-30 turbine and a generator produced by Curtiss-Wright, was tested in October 2004. Due to limitations of contractor facilities the turbine engine and the generator were tested separately. Some problems with heat were experienced in testing of the turbine engine, but program officials have stated these issues have been resolved. The program tested two different turbine engines for the auxiliary generator sets, a Rolls-Royce MT-5 and a General Electric LM-500. Both turbine generator sets

[1] Factory acceptance testing generally demonstrates the basic performance of a component as specified by the contractor.

demonstrated they were able to produce the power necessary and actually produced more power than predicted.

Design of the power distribution system was also changed to reduce weight and improve performance. According to officials, the Navy will use a system it has been developing called “integrated fight through power,” which includes the use of solid state components and rapid switching technologies.

Enclosure II: Dual Band Radar

Summary

Of the two major parts of the dual band radar subsystem, the multifunction radar is proceeding well while the volume search radar faces several technical challenges. Specifically, a core component of the volume search radar encountered problems in testing, creating additional pressure on an already challenging schedule.

Background

The dual band radar monitors airborne and surface activities, guides weaponry to targets, and conducts environmental mapping. The dual band radar is made up of two major radar systems, the multifunction radar and the volume search radar, unique technologies that are brought to bear jointly on a range of critical tasks to improve overall depth and quality of battlespace "vision." The volume search radar specializes in providing information on aircraft, missiles, and other activities in the vast, open sky environment. In contrast, the multifunction radar is designed to monitor airspace at "horizon" or near-the-surface levels for threats such as low-flying antiship cruise missiles.

Table 5: Performance Parameters Relating to Dual Band Radar

Performance parameters	Threshold	Objective
Ability to identify and engage antiship missiles, aircraft, and other aerial threats	Classified	Classified
Ability to identify and engage swarm boat groups, surface ships, and periscopes (submarines)	Classified	Classified

Sources: U.S. Navy (data); GAO (analysis and presentation).

Table 6: Critical Technical Parameters Relating to Dual Band Radar

Critical technical parameters	Description	Demonstrated?
Search and track multitask capability	Ability to search and track simultaneously	VSR — Future MFR — Future
Firm track range (sensitivity)	Distance from which an object's exact location, speed, and trajectory can be identified definitively	VSR — Future MFR — Yes
Clutter rejection	Ability to operate in a maritime environment and maintain full functionality under good or bad weather conditions	VSR — Future MFR — Yes

Sources: U.S. Navy (data); GAO (analysis and presentation).

Progress of Engineering Development Model

Testing and development of the multifunction radar is proceeding well. There have been a number of design changes, including a power/cooling system redesign that reduced weight. These changes will be validated in land based tests with the volume search radar in August 2007. Tests of the multifunction radar's clutter rejection capabilities and firm track range, two critical technical parameters required for demonstration by the August 2004 memorandum, have been proven in demonstrations with realistic targets. In a simulated scenario, the multifunction radar has demonstrated the ability to guide an Evolved Sea Sparrow Missile against an inbound cruise missile. Testing of the radar's ability to communicate with one of its own outbound missiles will take place in 2007, when the fully assembled dual band radar undergoes land-based tests. A significant risk remaining is ensuring that the shape and placement of the multifunction radar meets radar cross section requirements.

Table 7 - Schedule of Key Events Relating to Dual Band Radar

2004	2005	2006	2007 and beyond
September–October: Multifunction radar tests for clutter rejection and sensitivity	**September**: Multifunction radar cross section tests	**February**: Integration and test of volume search radar array **February-May**: Multifunction radar at sea tests **May**: Engineering development model "string" test for the volume search radar **June**: Volume search radar array delivery	**August**: Dual band radar land-based tests **To be determined**: continued development of volume search radar to meet requirements

Source: U.S. Navy.

The transmit/receive units, the individual radiating elements that are the essence of the volume search radar, encountered difficulties when a key component failed in testing. Officials believe they have identified a solution to the problem, but a further design iteration is needed to fully satisfy performance requirements for the engineering development model. Additional iterations of design will be necessary before ship installation.

The schedule for construction of the dual band radar is already challenging, with the radar for the first DD(X) scheduled for placement after the ship is already afloat. Additional delay in development of the volume search radar could further endanger the schedule for ship construction.

Enclosure III: Integrated Deckhouse and Apertures

Summary

Construction of the fire and shock test article, one of two test articles for the integrated deckhouse, was postponed until the detailed design and construction phase and will not be tested until after DD(X) critical design review. The second article, designed to test radar cross section and interference between antennas, is nearly complete and will begin testing in May and June of this year.

Background

Integrated deckhouse and apertures refers to the superstructure on the deck of the ship and the openings in which radar, sensor, and communication equipment are placed. A major focus of deckhouse design is to reduce the ship's radar cross section signature. A separate technical challenge, referred to as co-site interference, involves placing apertures in precise locations to ensure the signals from the multitude of antennas do not interfere with one another.

Table 8: Performance Parameters Relating to Integrated Deckhouse

Performance parameters	Threshold	Objective
Radar cross section — Needs to be reduced so that enemy radar cannot easily identify the DD(X)[a]	Classified	Classified
Interoperability — Ensuring all systems within the deckhouse work together without conflict[a]	Classified	Classified
Survivability — Deckhouse resilience to fire and shock	Classified	Classified

Sources: U.S. Navy (data); GAO (analysis and presentation).

[a]Key performance parameter.

Table 9: Critical Technical Parameters Relating to Integrated Deckhouse

Critical technical parameters	Description	Demonstrated?
Co-site interference	Ensuring operation of deckhouse antennas and equipment do not interfere with one another	Future
Radar cross section reduction	The deckhouse will contribute to total ship radar cross section reduction	Ongoing

Sources: U.S. Navy (data); GAO (analysis and presentation).

Progress of Engineering Development Model

The contractor, Northrop Grumman, is building two test articles to fulfill requirements for the testing of the deckhouse. One is a fire and shock test article that will be subjected to underwater explosions, and the other is an integrated deckhouse article that will be tested for radar cross section and antenna placement.

Northrop Grumman halted construction on the fire and shock test article because of issues pertaining to design of the joints that hold panels of composite material together. A contractor official has stated that specifications required that no damage be experienced in testing, as has been the case with composite structures in other programs. The Navy decided that these specifications were too conservative as the rest of the ship is not held to the same requirement. According to the contractor, the Navy relaxed this specification. Construction of the fire and shock test article has been further delayed because facilities for shock testing are not available until 2006. In addition, further time is needed to conduct analysis of composite properties regarding issues such as structural strength, corrosion, toxicity of fumes when composites catch fire, and ability to bind composites with the steel hull. The program office states that the ability of the deckhouse design to meet requirements will continue to be analyzed in support of the critical design review. Testing of the fire and shock article is now scheduled for the next contract period, after DD(X) critical design review.

Table 10: Schedule of Key Events Relating to Integrated Deckhouse

2004	2005	2006 and beyond
August: Begin antenna predelivery tests **November**: Begin fire and shock testing (postponed)	**February**: End antenna predelivery tests **March**: Shielding effectiveness tests **April**: Lightning-protection tests **June**: Co-site interference tests **July:** End fire and shock testing (postponed) **September**: Radar cross section tests	**August**: Begin antenna pre-delivery **November**: Begin fire and shock testing (postponed)

Source: U.S. Navy.

Since May 2004, a series of changes involving equipment, antenna size, and positioning have been made to the deckhouse, which has caused changes in the placement of apertures. The integrated deckhouse test article is now nearly complete as are preparations at the test range. Tests of radar cross section, including all deckhouse antennas and the multifunction radar (half of the dual band radar system), will begin in May 2005. Co-site tests for interference will follow in June 2005.

The deckhouse has experienced some problems remaining within its margins for weight. To reduce weight the program has made a number of changes to the design including modifications to fragmentation protection, and redesigned power and cooling systems for the radars and other components. The program office states that the deckhouse is now in compliance with its weight budget.

A contract official has indicated that lessons learned from production of the test articles has reduced risk and validated processes.

Enclosure IV: Advanced Gun System

Summary

Tests performed for the advanced gun system in support of Milestone B were completed with modeling of a virtual prototype and partially validated with subsequent component tests. Two of three munition flight tests were completed successfully. Final design of the advanced gun system exceeds previous weight margins due to changes made to facilitate ship construction.

Description

The advanced gun system is a large caliber, unmanned gun system designed to fire long-range projectiles in support of land attack missions, such as strikes at specific targets or suppressing fire in support of ground troops. The DD(X) design calls for two gun systems with approximately 300 rounds in each magazine, with an additional 320 rounds in an auxiliary magazine. Because the gun system provides supporting fire for land attack, a fundamental mission objective of the DD(X), it needs to be able to quickly and accurately hit a substantial number of land-based targets from a significant distance. The system consists of the mount (the gun together with its housing and movement mechanisms), a fully automated magazine, and a munition known as the long range land attack projectile.

Table 11: Performance Parameters Relating to Advanced Gun System

Performance parameters	Threshold	Objective
Number of advanced gun systems[a]	2	2
Total ship advanced gun systems magazine capacity[a]	600	1200
Ship personnel (with helicopter detachment)[a]	175	125
Gun ready — time required to execute a mission	2.5 min.	1 min.
Maximum rate of fire — number of rounds per minute	10	12
Sustained rate of fire — rounds at maximum rate	300	600
Accuracy — distance of impact from target	Classified	Classified
Range — distance in nautical miles munition can travel	63	100
Lethality — explosive power of munition	current 155mm	current 155mm

Sources: U.S. Navy (data); GAO (analysis and presentation).

[a]Key performance parameter

Table 12: Critical Technical Parameters Relating to Advanced Gun System

Critical technical parameters	Description	Demonstrated?
Pallet unloading rate (which demonstrates gun ready time and rate of fire)	Time required to unload pallet of munitions (8 munitions per pallet)	Yes
Projectile muzzle velocity	Speed at which the projectile exits the barrel	Yes

Sources: U.S. Navy (data); GAO (analysis and presentation).

Progress of Engineering Development Model

In order to complete Milestone B for DD(X), the advanced gun system was required by the Under Secretary's memorandum of August 2004 to demonstrate its required firing rate through modeling. In October 2004, it did so by using a physics-based software model that includes the software functionality for all major components of the advanced gun system and incorporates the results of physical testing. Results met or exceeded expectations for response time, rate of fire, sustained rate of fire, range, and pallet unloading rate. The contractor has begun verifying the results through testing of physical components. In April, the magazine component of the advanced gun system successfully completed factory acceptance testing by demonstrating its ability to meet requirements and has been shipped to Dugway, Utah, for integration into further land-based tests. Land-based tests will demonstrate the entire firing sequence of the advanced gun system. These tests will not demonstrate the ability of the gun system to communicate target information to the munition or the ability to move the gun side to side. The munition will not be tested with the gun until after ship installation.

Table 13: Schedule of Key Events Relating to Advanced Gun System

2004	2005	2006 and beyond
October: Virtual testing to meet DD(X) Milestone B criteria **Second quarter**: Component testing begins **December**: First munition guided flight test	**First quarter**: Component testing ends **April**: Factory acceptance testing of the magazine **January–February**: Munition guided flight tests **May**: Factory acceptance testing of the mount **May**: Long-range land attack projectile preliminary design review **July**: Land-based testing of the mount and magazine **April–September**: Further guided flight tests of munition	**To be determined**: Munition firing from gun system

Source: U.S. Navy.

The munition for advanced gun system, known as long-range land attack projectile, has completed three flight tests at Point Mugu, California; and has successfully demonstrated launch, tail fin deployment, canard deployment, rocket motor ignition, global positioning system acquisition, and some flight maneuvers. The first guided flight test failed when the canards deployed improperly and controlled flight was lost. The issue was identified, corrected, and successfully resolved in later flight tests. The current schedule calls for completion of an additional twelve flight tests by the end of September 2005. There is a proposal to reduce the number of tests in this time period to four or five but to continue to test requirements for all phases of flight including distance. Information is incomplete about what details of testing might be lost under this proposal.

Recently, the design of the advanced gun system was changed to support ease of production for DD(X). The advanced gun system will now be constructed as a single modular unit, transported to the shipyard, and installed as a block. This redesign has added some weight which has been accounted for in the current design.

Enclosure V: Peripheral Vertical Launch System

Summary

A demonstration to test the peripheral vertical launch system against expected threats resulted in a dramatic destruction of the test article that necessitated redesign and further testing. A second test replicating the same conditions with the new design and representative materials will be held in June 2005.

Description

The peripheral vertical launch system consists of the missile launcher, referred to as the advanced vertical launch system, and the enclosure for the launcher, referred to as the peripheral vertical launch system. The system is located on the sides of the ship to improve survivability, rather than the more traditional central positioning. The launcher is an evolutionary improvement on the existing design to ease introduction of new missile types. The enclosure is a revolutionary design that prevents damage by directing explosions away from the ship.

Table 14: Performance Parameters Relating to Peripheral Vertical Launch

Performance parameters	Threshold	Objective
Number of advanced vertical launch cells[a]	80	128
Survivability	Classified	Classified
Launch time	Classified	Classified

Sources: U.S. Navy (data); GAO (analysis and presentation).

[a]Key performance parameter.

Table 15: Critical Technical Parameters Relating to Peripheral Vertical Launch

Critical technical parameters	Description	Demonstrated?
Antipropagation wall impact velocity	The wall will not impact the cell canister of adjacent stored missiles with velocity of greater than a certain number of meters per second	Future
Blast overpressure	Blast pressure in the adjacent module shall be less than the ordinance sensitivity threshold	Yes
Launcher response time	Time between mission request and launch	Yes

Sources: U.S. Navy (data); GAO (analysis and presentation).

Progress of Engineering Development Model

In May 2004, the program conducted a test to verify the design of the peripheral vertical launch system enclosure by detonating a surrogate of an enemy missile among the missiles the DD(X) is expected to carry. The design operates by allowing the wall facing away from the interior spaces of the ship to fragment first and release pressure. During the test the walls intended to protect the ship and adjacent launchers from explosion were pierced by shrapnel. The result was an immense explosion that severely damaged the test article. While program officials believe that the critical technical parameters were partially demonstrated in the test, the amount of damage caused by shrapnel has led to a redesign effort. Program officials are concerned that this shrapnel could cause explosions in adjacent enclosures and have proposed adding material, Kevlar or a similar material, and some additional steel bracing, to the inside of the enclosures to prevent this. The new design has been partially validated through component testing, and will be fully demonstrated in June.

Table 16: Schedule of Key Events Relating to Peripheral Vertical Launch

2004	2005	2006 and beyond
May: Initial most credible detonation event test for enclosure	**April**: Launcher factory acceptance testing **May**: Peripheral vertical launch system four cell test **June**: Repeat of detonation event test **May**: 8-cell full system test (postponed)	**To be determined**: 8-cell full system test

Source: U.S. Navy.

Although the new design of the peripheral vertical launch system calls for Kevlar, which is in short supply, or a similar material for ballistic protection, the contractor does not believe the construction times will be affected. Officials have also stated that the weight added by the redesign does not push the peripheral vertical launch system beyond its margins.

According to a contractor official, scheduling of a new most credible detonation event test will push a planned eight-cell test, which would have demonstrated the ability of both the enclosure and the launcher to survive an explosion, into the next phase of the contract. To mitigate risk the program will perform a similar test with a four-cell test article before the ship's critical design review.

Enclosure VI: Other Engineering Development Models

Integrated Undersea Warfare

Description

The integrated undersea warfare system is used to detect mines and submarines in the littorals and consists of medium and high frequency arrays, towed arrays, and decision-making software to reduce workload. The undersea warfare system is tested for three performance parameters (manning, mine avoidance, and ability to attack submarines) by demonstrating three critical technical parameters (detection and classification of mines, angle of approach of mines, and detection and classification of submarines). Tests for the demonstration of mine warfare's critical technical parameters were scheduled for May; submarine warfare tests were scheduled for June.

Progress

- According to program officials, at-sea tests of algorithms for antisubmarine warfare have been changed to laboratory testing due to a lack of test ships.
- Significant advances in the automation of submarine detection and tracking may be required to meet manpower goals.
- The portion of the sonar array used to detect mines experienced some issues receiving sonar beams in recent testing. The program office states that these issues have been resolved.

Table 17: Schedule of Key Events Relating to Integrated Undersea Warfare

2003	2004	2005
November: Preliminary design review	**March**: Critical design review	**May**: At-sea tests for mine avoidance
	December: Array interference tests at Seneca Lake	**June:** Lab tests for antisubmarine warfare

Source: U.S. Navy.

Infrared Signature Mockups

Description

The DD(X) program seeks to reduce the heat signature of the ship using material treatments on the deckhouse, passive air cooling for engine exhaust, and a sheeting water system on the hull. The infrared signature mockups support the ship's performance parameters for survivability by demonstrating three critical technical parameters, all of which relate to heat signatures of various parts of the ship.

Progress

- The use of infrared materials to reduce heat signature has changed due to design tradeoffs for performance, weight, and cost. Program officials state that the operational requirements are still achievable using the new design.

- Program officials have determined that further testing of exhaust suppressors for the main turbine generator is no longer necessary. Previously the program had tested the suppressors with a surrogate main turbine engine.
- Sheeting water system for the hull has been deleted from the ship design and replaced with an alternate system.

Table 18: Schedule of Key Events Relating to Infrared Signature Mockups

2003	2004	2005
March: Preliminary design review	**March**: Completion of at-sea materials testing **March-April**: At-sea panel tests **October**: Critical design review **December**: Design tests	**Third Quarter**: Small exhaust suppressor testing (cancelled due to change in materials)

Source: U.S. Navy.

Hull Form

Description

DD(X) uses a radically new hull design to reduce the radar cross section of the ship. Development also includes design of a new propeller. The hull form development model supports ship performance parameters for survivability, operations in various ocean environments, and speed. Models are currently being tested for three critical technical parameters: hull form resistance, efficiency of the propeller, and capsize probability.

Progress

- Development of software model used to predict hull form behavior is continuing.

Table 19: Schedule of Key Events Relating to Hull Form

2004	2005	2006 to Future
December: Initial model tests **September**: Maneuvering tests	**February**: Resistance, powering, and cavitation tests with design propeller **March**: Sea keeping and loads tests **July:** Hull form scale model tests **July**: Critical design review	**To be determined**

Source: U.S. Navy.

Autonomic Fire Suppression System

Description

The autonomic fire suppression system utilizes new technologies such as smart valves, flexible hosing, nozzles, sensors, and autonomic operations to reduce the crew and time needed for damage control. This system is vital for meeting performance parameters for ship survivability and manning as measured by three critical technical parameters: time for automatic reconfiguration of fire suppression systems and the autonomic reduction of temperature in the primary and adjacent damage areas. Testing for these critical technical parameters was performed on two Navy test ships and has been successful.

Progress

- An initial test aboard the ex-*Peterson*, a test ship, successfully demonstrated the system's ability to detect damage and control fires.
- Tests aboard the ex-*Shadwell*, another test ship, are demonstrating the same abilities for specific ship environments.
- Because the exact components used in testing aboard the ex-*Shadwell* may not be the ones used in ship construction, Navy officials state that it is unclear how the engineering development model will translate into final ship design.

Table 20: Schedule of Events Relating to Autonomic Fire Suppression System

2003	2004	2005
September: Preliminary design review	**January**: Weapons effects testing on ex-*Peterson* **September**: Critical design review	**January-April**: Testing for specific ship environments on ex-*Shadwell*

Source: U.S. Navy.

Total Ship Computing Environment

Description

This engineering development model seeks to demonstrate a single computing environment for all ship systems to speed command while reducing manning. This development model consists primarily of software, with program officials estimating that it will require a total of 20 million lines of new and reused code. The system contributes to manning, interoperability, and survivability performance parameters and is measured by six critical technical parameters. These include speed of data delivery, defense against information security threats, the ability to both track and engage targets, contribution to ship threat response times, and time required to recover after equipment failure. The program office states that the ability of the total ship computing environment to achieve these parameters was demonstrated through testing of the second software release.

Progress

- Two of seven software blocks released.
- Software production following disciplined development plan.
- Schedule has limited margin for correction of defects found in testing.

Table 21: Schedule of Events Relating to Total Ship Computing Environment

2003	2004	2005
September: Preliminary design review	**May**: Critical design review **June**: Software release 1 certification	**March**: Software release 2 certification **May-September**: Land-based tests **September**: Software release 3 certification

Source: U.S. Navy.

Enclosure VII: Agency Comments

OFFICE OF THE UNDER SECRETARY OF DEFENSE

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ACQUISITION,
TECHNOLOGY
AND LOGISTICS

JUN 13 2005

Mr. Paul L. Francis
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Francis:

This is the Department of Defense (DoD) response to the Government Accountability Office (GAO) draft report, "Progress of the DD(X) Destroyer Program," dated May 23, 2005 (GAO Code 120403/GAO-05-752R).

The GAO report does not contain recommendations. The Department has no formal comments on this draft report. However, the Department provided technical corrections separately.

I appreciate the opportunity to comment on the draft report.

Sincerely,

Darlene Costello for

Glenn F. Lamartin
Director
Defense Systems

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